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# 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[1]. Dental caries is the main oral condition affecting schoolchildren[2,3] and is the main reason for dental restoration failure[4], tooth loss and the need for dental prostheses[5,6]. It is estimated that around 621 million children are affected by dental caries in the primary dentition[7]. Therefore, dental caries has an impact on the population's daily activities[8-14] and, consequently, has a major impact on quality of life[15].

Recent studies have shown that some oral problems can impact academic activities in terms of absenteeism or even performance[16,17]. 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[18]. 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[19].

Oral health problems, such as dental caries, will result in pain[20] which, in turn, will influence students' well-being, ultimately interfering with school activities and classroom attendance[16,17,21]. The presence of students in social environments is essential for the development of skills and competencies envisaged for the 21st 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[22]. Moreover, Vygotsky's theory of proximal development, based on cognitive enhancement, is also dependent on social interaction[23,24]. 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[25,26], there are a number of conflicting issues, such as the definition of exposures and outcomes[21]. 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[27] 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 schoolchildren, 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[28] 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.[29]. The prevalence ratio measures were converted to OR using the formula: PR = odds ratio/1 - risk0 + risk0 x odds ratio, where risk0 is the prevalence of the disease among non-exposed individuals[30-33]. 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-value<0.05 or* $I^2$*>50%*), the random-effect model was preferred[34]. 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.[55], 2015 | USA | Exposure and outcome with inverted data |
| BAÑOS GARCIA et al.[56], 2001 | Cuba | Exposure and outcome were not evaluated |
| BERNABE et al.[8], 2007 | Peru | Association between outcome and exposure was not evaluated |
| BESSELIN et al.[57], 2013 | Laos | Outcome was not evaluated |
| BROWN et al.[58], 2005 | USA | Exposure and outcome were not evaluated |
| BUTANI et al.[59], 2009 | USA | Non-representative sample |
| COLARES and FEITOSA[60], 2003 | Brazil | Non-representative sample |
| DAVID et al.[61], 2006 | India | Exposure and outcome with inverted data |
| DE PAULA and MIALHE[62], 2013 | Brazil | Review article |
| DETTY and OZA-FRANK[63], 2014 | USA | Ecological study |
| EDELSTEIN et al.[64], 2006 | USA | Outcome was not evaluated |
| FEITOSA et al.[65], 2005 | Brazil | Exposure and outcome with inverted data |
| FREIRE and SHEIHAM[66], 2008 | Brazil | Exposure and outcome with inverted data |
| GARG et al.[67], 2012 | India | Non-representative sample |
| GHERUNPONG et al.[68], 2006 | Thailand | Exposure and outcome were not evaluated |
| GIFT et al.[19], 1992 | USA | Ecological study |
| HALBOUB et al.[69], 2016 | Yemen | Exposure was not evaluated |
| HONKALA et al.[70], 2011 | Finland | Exposure was not evaluated |
| JURGENSEN and PETERSEN[71], 2011 | Laos | Exposure and outcome were not evaluated |
| KUMAR et al.[72], 2018 | India | Outcome was not evaluated |
| LOGAN et al.[73], 2008 | USA | Exposure was not evaluated |
| MAHARANI et al.[74], 2017 | Indonesia | Non-representative sample |
| MITTAL et al.[75], 2012 | India | Outcome was not evaluated |
| MUIRHEAD and MARCENES[76], 2004 | UK | Ecological study |
| MUIRHEAD and LOCKER[77], 2006 | Canada | Ecological study |
| MURRAY et al.[78], 2015 | New Zealand | Outcome was not evaluated |
| NAAVAAL and KELEKAR[79], 2018 | USA | Outcome was not evaluated |
| NG[80], 2011 | USA | Article comment on another article |
| PAU et al.[81], 2008 | Pakistan | Association between outcome and exposure was not evaluated |
| PETERSEN et al.[82], 2008 | China | Exposure was not evaluated |
| PETRIDOU et al.[83], 1996 | Greece | Exposure and outcome with inverted data |
| POURAT and NICHOLSON[84], 2009 | USA | Descriptive study |
| SHAIKH et al.[85], 2016 | Saudi Arabia | Descriptive study |

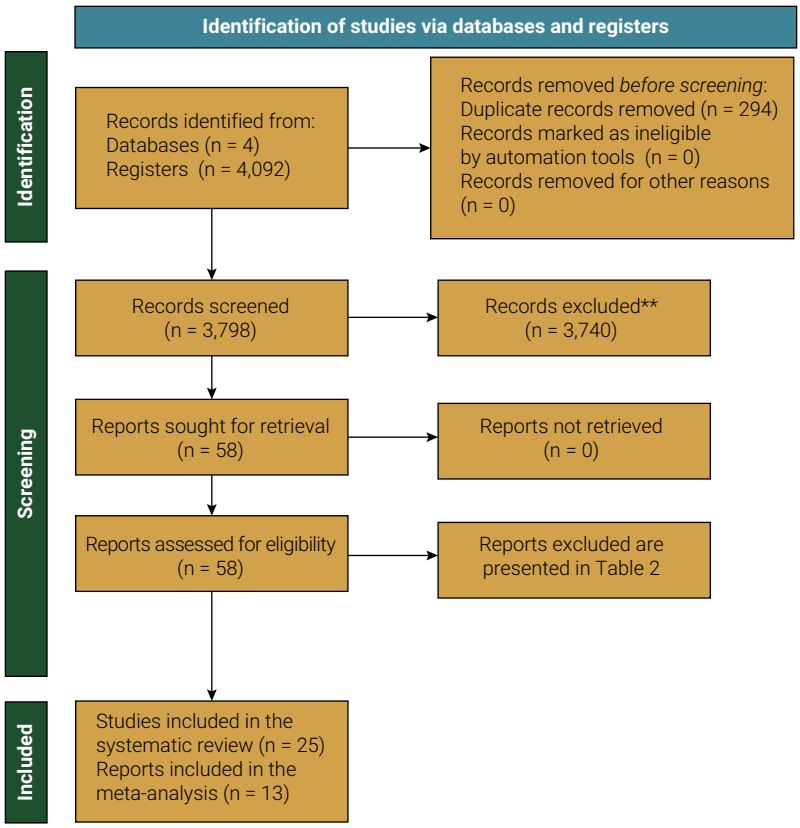


**Figure 1.** Article selection prisma flowchart.

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

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 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.[54], 2019 | 44735 (6-17) | USA | Toothache | Questionnaire | School absenteeism | School data | 1.72 OR | 75% |
| GUSKUMA et al.[49], 2017 | 12 | Brazil | Toothache | Questionnaire | School absenteeism | School data | 5.19 OR | 100% |
| JACKSON et al.[17], 2011 | 2183 (0-18) | USA | Fair/poor dental health | Questionnaire | Poor school performance | Questionnaire | 1.62 OR | 87.5% |
| JIANG et al.[50], 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.[47], 2019 | 1151 (5-15) | Nepal | Dental caries | Untreated caries | School absenteeism | School data | 1.11 OR | 75% |
| KRISDAPONG et al.[51], 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.[26], 2015 | 836 (3-5) | Brazil | Dental Caries | DMTF | School absenteeism | Questionnaire | 2.87 OR | 100% |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PIOVESAN et al.[21], 2012 | | Brazil | | | | | | 100% |
| | 312 (12) | | Dental caries | DMFT | School absenteeism | School data | 1.31 OR | |
| | 312 (12) | | Fair/poor dental health | Questionnaire | School absenteeism | School data | 0.54 OR | |
| POURHASHEMI et al.[48], 2015 | 300 (7-14) | Iran | Dental caries | Questionnaire | School absenteeism | Questionnaire | 1.34 OR | 75% |
| SEIRAWAN et al.[52], 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[16, 35-39]. Three presented results using means and regression coefficients[40-42] and three studies did not present the data required to calculate the measures of effect[43-45].

Authors[35,40] 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[16,36-38,42]. 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[39,41,43-45].

## 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.

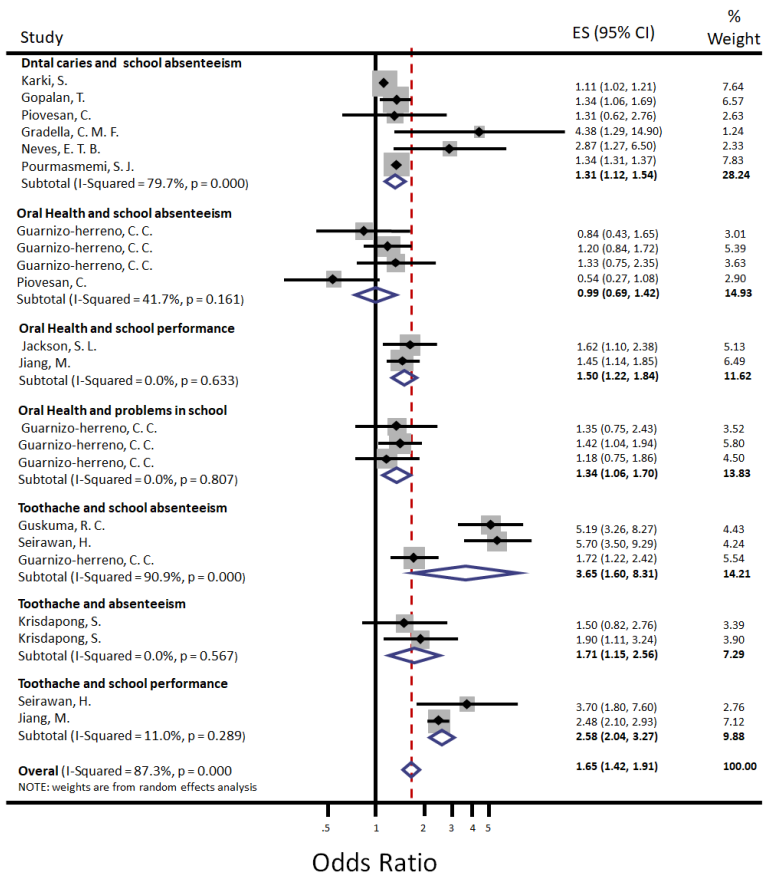



Figure 2. Meta-analysis results with description of odds ratios and respective 95% confidence intervals.

### Dental caries and school absenteeism

The pooled effect[21,25,26,46-48] 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[26] (Supplementary Figure 1A).

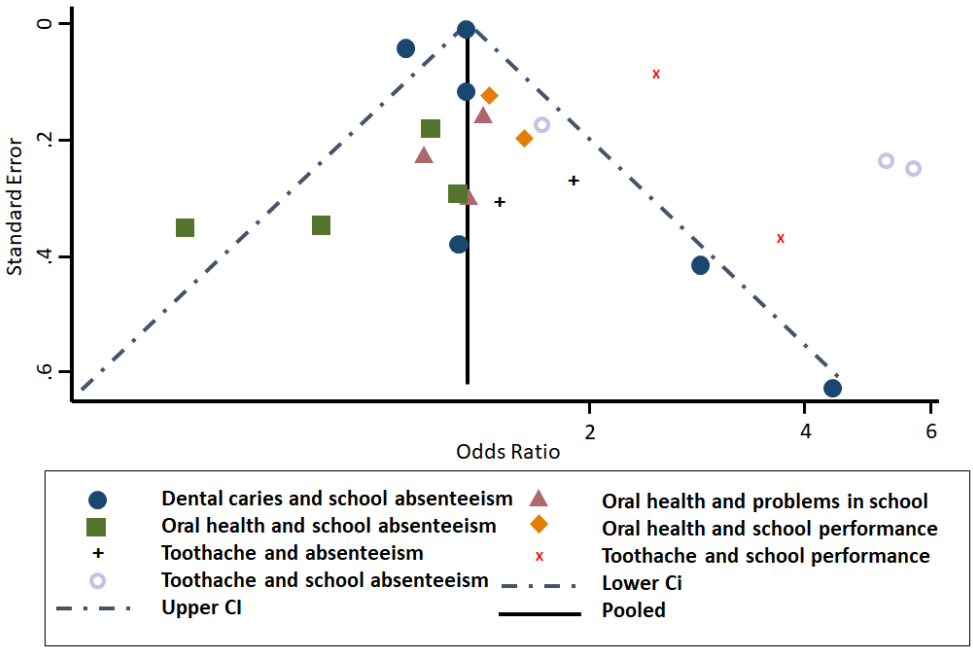



Figure 3. Funnel plot of publication bias.

### 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[21,25,26,49-52] satisfied 100% of the JBI Critical Appraisal checklist specific for prevalence studies, and just six produced results of between 90% and 75%[17,46-48,53,54] 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[36-39,41,45] satisfied 100% of the JBI Critical Appraisal checklist while the other six studies presented between 25% and 87.5%[16,35,40,42-44] 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[16,17,21,43,44].

It is worth noting the results of studies that evaluated toothache and school absenteeism in one Brazilian and one American article[49,52]. 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[49,52]. 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[25,26,52]. 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[21,48,52], also preventing the student from attending class[17,25,26,48].

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[17,21,50,53]. 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[21,53]. However, self-perception of oral health was associated with both academic performance and problems at school[17,50,53]. 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[17,50,53], 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[17,25,26,51,53]. Four adjusted the analysis for oral health variables[17,26,51,53], and only one of them adjusted for variables related to children's psychological disorders[53]. 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.

## References


1. Kassebaum NJ, Smith AGC, Bernabé E, Fleming TD, Reynolds AE, Vos T, et al. Global, Regional, and National Prevalence, Incidence, and Disability-Adjusted Life Years for Oral Conditions for 195 Countries, 1990-2015: A Systematic Analysis for the Global Burden of Diseases, Injuries, and Risk Factors. J Dent Res. 2017 Apr;96(4):380-387. doi: 10.1177/0022034517693566.
2. Dutra ER, Chisini LA, Cademartori MG, Oliveira LJC, Demarco FF, Correa MB. Accuracy of partial protocol to assess prevalence and factors associated with dental caries in schoolchildren between 8-12 years of age. Cad Saude Publica. 2018;34(4):e00077217. doi: 10.1590/0102-311x00077217. .
3. Costa F, Wendt A, Costa C, Chisini LA, Agostini B, Neves R, et al. Racial and regional inequalities of dental pain in adolescents: Brazilian National Survey of School Health (PeNSE), 2009 to 2015. Cad Saude Publica. 2021 Jun 25;37(6):e00108620. doi: 10.1590/0102-311X00108620.
4. Chisini LA, Collares K, Cademartori MG, de Oliveira LJC, Conde MCM, Demarco FF, et al. Restorations in primary teeth: a systematic review on survival and reasons for failures. Int J Paediatr Dent. 2018 Mar;28(2):123-139. doi: 10.1111/ipd.12346.
5. Chisini LA, Sarmento HR, Collares K, Horta BL, Demarco FF, Correa MB. Determinants of dental prosthetic treatment need: A birth cohort study. Community Dent Oral Epidemiol. 2021 Oct;49(5):394-400. doi: 10.1111/cdoe.12608.
6. Chisini LA, Sarmento HR, Horta BL, Demarco FF, Correa MB. Normative and subjective need for dental prosthesis: accuracy and agreement in a population based-study. Cad Saude Publica. 2021 Feb 10;37(2):e0052720. doi: 10.1590/0102-311X0052720.
7. Kassebaum NJ, Bernabé E, Dahiya M, Bhandari B, Murray CJ, Marcenes W. Global burden of untreated caries: a systematic review and metaregression. J Dent Res. 2015 May;94(5):650-8. doi: 10.1177/0022034515573272.
8. Bernabé E, Flores-Mir C, Sheiham A. Prevalence, intensity and extent of Oral Impacts on Daily Performances associated with self-perceived malocclusion in 11-12-year-old children. BMC Oral Health. 2007 May 16;7:6. doi: 10.1186/1472-6831-7-6.
9. Biazevic MG, Rissotto RR, Michel-Crosato E, Mendes LA, Mendes MO. Relationship between oral health and its impact on quality of life among adolescents. Braz Oral Res. 2008 Jan-Mar;22(1):36-42. doi: 10.1590/s1806-83242008000100007.
10. Bulgareli JV, Faria ET, Cortellazzi KL, Guerra LM, Meneghim MC, Ambrosano GMB, et al. Factors influencing the impact of oral health on the daily activities of adolescents, adults and older adults. Rev Saude Publica. 2018;52:44. doi: 10.11606/s1518-8787.2018052000042.
11. Freire Mdo C, Reis SC, Figueiredo N, Peres KG, Moreira Rda S, Antunes JL. Determinantes individuais e contextuais da cárie em crianças brasileiras de 12 anos em 2010 [Individual and contextual determinants of dental caries in Brazilian 12-year-olds in 2010]. Rev Saude Publica. 2013 Dec;47 Suppl 3:40-9. Portuguese. doi: 10.1590/s0034-8910.2013047004322.
12. Peres MA, Latorre MdRDO, Sheiham A, Peres KG, Barros FC, Hernandez PG, et al. [Effects of Social and biological factors on dental caries in 6-year-old children: a cross sectional study nested in a birth cohort in Southern Brazil]. Rev Bras Epidemiol. 2003;6(4):293-306. Portuguese. doi: 10.1590/S1415-790X2003000400004.
13. Reisine ST. The impact of dental conditions on social functioning and the quality of life. Annu Rev Public Health. 1988;9:1-19. doi: 10.1146/annurev.pu.09.050188.000245.
14. Silva JVd, Machado FCdA, Ferreira MAF. Social Inequalities and the Oral health in Brazilian Capitals. Cienc Saude Colet. 2015;20(8):2539-48. doi: 10.1590/1413-81232015208.12052014.

15. Jaggi A, Marya CM, Nagpal R, Oberoi SS, Kataria S, Taneja P. Impact of Early Childhood Caries on Oral Health-related Quality of Life Among 4-6-year-old Children Attending Delhi Schools: A Cross-sectional Study. Int J Clin Pediatr Dent. 2019 May-Jun;12(3):215-221. doi: 10.5005/jp-journals-10005-1626.

16. Blumenshine SL, Vann WF Jr, Gizlice Z, Lee JY. Children's school performance: impact of general and oral health. J Public Health Dent. 2008 Spring;68(2):82-7. doi: 10.1111/j.1752-7325.2007.00062.x.

17. Jackson SL, Vann WF Jr, Kotch JB, Pahel BT, Lee JY. Impact of poor oral health on children's school attendance and performance. Am J Public Health. 2011 Oct;101(10):1900-6. doi: 10.2105/AJPH.2010.200915.

18. Vasconcellos SS, Mattos CLG. [School absenteeism and its regulation]. In: Mattos CLG, Castro PA, organizers. [Ethnography and education: concepts and uses]. Campina Grande: EDUEPB; 2011. p.271-94. Available from: https://books.scielo.org/id/8fcfr. Portuguese.

19. Gift HC, Reisine ST, Larach DC. The social impact of dental problems and visits. Am J Public Health. 1992 Dec;82(12):1663-8. doi: 10.2105/ajph.82.12.1663.

20. Costa FDS, Costa CDS, Chisini LA, Wendt A, Santos IDSD, Matijasevich A, et al. Socio-economic inequalities in dental pain in children: A birth cohort study. Community Dent Oral Epidemiol. 2022 Oct;50(5):360-366. doi: 10.1111/cdoe.12660.

21. Piovesan C, Antunes JL, Mendes FM, Guedes RS, Ardenghi TM. Influence of children's oral health-related quality of life on school performance and school absenteeism. J Public Health Dent. 2012 Spring;72(2):156-63. doi: 10.1111/j.1752-7325.2011.00301.x.

22. Vasileva O, Balyasnikova N. (Re)Introducing Vygotsky's Thought: From Historical Overview to Contemporary Psychology. Front Psychol. 2019 Aug 7;10:1515. doi: 10.3389/fpsyg.2019.01515.

23. Esteban-Guitart M. The biosocial foundation of the early Vygotsky: Educational psychology before the zone of proximal development. Hist Psychol. 2018;21(4):384-401. doi: 10.1037/hop0000092.

24. Yasnitsky A. Vygotsky circle as a personal network of scholars: restoring connections between people and ideas. Integr Psychol Behav Sci. 2011 Dec;45(4):422-57. doi: 10.1007/s12124-011-9168-5.

25. Gradella CM, Bernabé E, Bönecker M, Oliveira LB. Caries prevalence and severity, and quality of life in Brazilian 2- to 4-year-old children. Community Dent Oral Epidemiol. 2011 Dec;39(6):498-504. doi: 10.1111/j.1600-0528.2011.00625.x.

26. Neves ETB, Firmino RT, Perazzo MD, Gomes MC, Martins CC, Paiva SM, et al. Absenteeism among preschool children due to oral problems. J Public Health-Heidelberg. 2015;24(1):65-72. doi: 10.1007/s10389-015-0697-0.

27. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021 Mar 29;372:n71. doi: 10.1136/bmj.n71. PMID: 33782057; PMCID: PMC8005924.

28. Moola S, Munn Z, Tufanaru C, Aromataris E, Sears K, Sfetcu R, et al.: Systematic reviews of etiology and risk 2017. In: Joanna Briggs Institute Reviewer's Manual. The Joanna Briggs Institute; 2020. Chapter 7. doi: 10.46658/JBIMES-20-08.

29. Borenstein M, Hedges LV, Higgins JPT, Rothstein HR. Introduction to Meta-Analysis. New York, NY: JohnWiley & Sons; 2009.

30. Chisini LA, Cademartori MG, Francia A, Mederos M, Grazioli G, Conde MCM, et al. Is the use of Cannabis associated with periodontitis? A systematic review and meta-analysis. J Periodontal Res. 2019 Aug;54(4):311-317. doi: 10.1111/jre.12639.

31. Chisini LA, Cademartori MG, Conde MCM, Costa FDS, Tovo-Rodrigues L, Carvalho RV, et al. Genes and SNPs in the pathway of immune response and caries risk: a systematic review and meta-analysis. Biofouling. 2020 Oct;36(9):1100-1116. doi: 10.1080/08927014.2020.1856821.

32. Chisini LA, Cademartori MG, Conde MCM, Tovo-Rodrigues L, Correa MB. Genes in the pathway of tooth mineral tissues and dental caries risk: a systematic review and meta-analysis. Clin Oral Investig. 2020 Nov;24(11):3723-3738. doi: 10.1007/s00784-019-03146-x.

33. Chisini LA, Cademartori MG, Conde MCM, Costa FDS, Salvi LC, Tovo-Rodrigues L, Correa MB. Single nucleotide polymorphisms of taste genes and caries: a systematic review and meta-analysis. Acta Odontol Scand. 2021 Mar;79(2):147-155. doi: 10.1080/00016357.2020.1832253.

34. DerSimonian R, Laird N. Meta-analysis in clinical trials. Control Clin Trials. 1986 Sep;7(3):177-88. doi: 10.1016/0197-2456(86)90046-2.

35. Astrøm AN, Okullo I. Validity and reliability of the Oral Impacts on Daily Performance (OIDP) frequency scale: a cross-sectional study of adolescents in Uganda. BMC Oral Health. 2003 Aug 28;3(1):5. doi: 10.1186/1472-6831-3-5.

36. de Paula JS, Ambrosano GM, Mialhe FL. Oral Disorders, Socioenvironmental Factors and Subjective Perception Impact on Children's School Performance. Oral Health Prev Dent. 2015;13(3):219-26. doi: 10.3290/j.ohpd.a32672.

37. de Paula JS, Lisboa CM, Meneghim Mde C, Pereira AC, Ambrosano GM, Mialhe FL. School performance and oral health conditions: analysis of the impact mediated by socio-economic factors. Int J Paediatr Dent. 2016 Jan;26(1):52-9. doi: 10.1111/ipd.12158.

38. Mohamed SAS, Baker SR, Deery C, Vettore MV. Are oral health conditions associated with schoolchildren's performance and school attendance in the Kingdom of Bahrain? A life-course perspective. Int J Paediatr Dent. 2022 Mar;32(2):127-143. doi: 10.1111/ipd.12803.

39. Darley RM, Karam SA, Costa FDS, Correa MB, Demarco FF. Association between dental pain, use of dental services and school absenteeism: 2015 National School Health Survey, Brazil. Epidemiol Serv Saude. 2021 Mar 12;30(1):e2020108. English, Portuguese. doi: 10.1590/S1679-49742021000100011.

40. Bernabé E, Tsakos G, Sheiham A. Intensity and extent of oral impacts on daily performances by type of self-perceived oral problems. Eur J Oral Sci. 2007 Apr;115(2):111-6. doi: 10.1111/j.1600-0722.2007.00440.x.

41. Jürgensen N, Petersen PE. Oral health and the impact of socio-behavioural factors in a cross sectional survey of 12-year old school children in Laos. BMC Oral Health. 2009 Nov 16;9:29. doi: 10.1186/1472-6831-9-29.

42. Kaewkamnerdpong I, Krisdapong S. Oral diseases associated with condition-specific oral health-related quality of life and school performance of Thai primary school children: A hierarchical approach. Community Dent Oral Epidemiol. 2018 Jun;46(3):270-279. doi: 10.1111/cdoe.12361.

43. Naidoo S, Chikte UM, Sheiham A. Prevalence and impact of dental pain in 8-10-year-olds in the western Cape. SADJ. 2001 Nov;56(11):521-3.

44. Pongpichit B, Sheiham A, Pikhart H, Tsakos G. Time absent from school due to dental conditions and dental care in Thai schoolchildren. J Public Health Dent. 2008 Spring;68(2):76-81. doi: 10.1111/j.1752-7325.2007.00051.x.

45. Mialhe FL, de Oliveira Júnior AJ, Junior MFS, Jamieson L, Neiva A, Soares GH. Oral Health Literacy, Sense of Coherence and Associations With Poor School Performance. J Sch Health. 2022 Nov;92(11):1106-1113. doi: 10.1111/josh.13223.

46. Gopalan T, Asokan S, John JB, Geetha Priya PR. School absenteeism, academic performance, and self-esteem as proxy measures of oral health status: A cross-sectional study. J Indian Soc Pedod Prev Dent. 2018 Oct-Dec;36(4):339-346. doi: 10.4103/JISPPD.JISPPD_217_18.

47. Karki S, Päkkilä J, Laitala ML, Humagain M, Anttonen V. Influence of dental caries on oral health-related quality of life, school absenteeism and school performance among Nepalese schoolchildren. Community Dent Oral Epidemiol. 2019 Dec;47(6):461-469. doi: 10.1111/cdoe.12485.

48. Pourhashemi SJ, Paryab M, Kheirandish K, Kharazi-Fard MJ. Oral health and school performance in elementary students: A cross-sectional study in a group of Iranian students, Tehran, Iran. J Oral Health Oral Epidemiol. 2015;4(2):64-70.

49. Guskuma RC, Lages VA, Hafner MB, Rando-Meirelles MPM, Cypriano S, Sousa MDLR, et al. Factors associated with the prevalence and intensity of dental pain in children in the municipalities of the Campinas region, São Paulo. Rev Paul Pediatr. 2017 Jul-Sep;35(3):322-330. doi: 10.1590/1984-0462/;2017;35;3;00001.

50. Jiang H, Petersen PE, Peng B, Tai B, Bian Z. Self-assessed dental health, oral health practices, and general health behaviors in Chinese urban adolescents. Acta Odontol Scand. 2005 Nov;63(6):343-52. doi: 10.1080/00016350500216982.

51. Krisdapong S, Prasertsom P, Rattanarangsima K, Sheiham A. School absence due to toothache associated with sociodemographic factors, dental caries status, and oral health-related quality of life in 12- and 15-year-old Thai children. J Public Health Dent. 2013 Fall;73(4):321-8. doi: 10.1111/jphd.12030.

52. Seirawan H, Faust S, Mulligan R. The impact of oral health on the academic performance of disadvantaged children. Am J Public Health. 2012 Sep;102(9):1729-34. doi: 10.2105/AJPH.2011.300478.

53. Guarnizo-Herreño CC, Wehby GL. Children's dental health, school performance, and psychosocial well-being. J Pediatr. 2012 Dec;161(6):1153-9. doi: 10.1016/j.jpeds.2012.05.025.

54. Guarnizo-Herreño CC, Lyu W, Wehby GL. Children's Oral Health and Academic Performance: Evidence of a Persisting Relationship Over the Last Decade in the United States. J Pediatr. 2019 Jun;209:183-189.e2. doi: 10.1016/j.jpeds.2019.01.045.

55. Agaku IT, Olutola BG, Adisa AO, Obadan EM, Vardavas CI. Association between unmet dental needs and school absenteeism because of illness or injury among U.S. school children and adolescents aged 6-17 years, 2011-2012. Prev Med. 2015 Mar;72:83-8. doi: 10.1016/j.ypmed.2014.12.037.

56. Baños García R, Leyva Madrigal A, Quintana Galende ML, de Armas Águila Y. [Ethnography and education: concepts and uses]. Educ Med Super. 2001;15(3):284-92. Spanish.

57. Besseling S, Ngonephady S, van Wijk AJ. Pilot survey on dental health in 5-12-year-old school children in Laos. J Investig Clin Dent. 2013 Feb;4(1):44-8. doi: 10.1111/j.2041-1626.2012.00136.x.

58. Brown RM, Canham D, Cureton VY. An oral health education program for Latino immigrant parents. J Sch Nurs. 2005 Oct;21(5):266-71. doi: 10.1177/10598405050210050401.

59. Butani Y, Gansky SA, Weintraub JA. Parental perception of oral health status of children in mainstream and special education classrooms. Spec Care Dentist. 2009 Jul-Aug;29(4):156-62. doi: 10.1111/j.1754-4505.2009.00086.x.

60. Colares V, Feitosa S. School performance of pre-school children with severe caries. Acta Scient Health Sci. 2003;25(2):129-34.

61. David J, Astrøm AN, Wang NJ. Prevalence and correlates of self-reported state of teeth among schoolchildren in Kerala, India. BMC Oral Health. 2006 Jul 3;6:10. doi: 10.1186/1472-6831-6-10.

62. de Paula JS, Mialhe FL. Impact of oral health conditions on school performance and lost school days by children and adolescents: What are the actual pieces of evidence? Braz J Oral Sci. 2013;12(3):189-98.

63. Detty AM, Oza-Frank R. Oral health status and academic performance among Ohio third-graders, 2009-2010. J Public Health Dent. 2014 Fall;74(4):336-42. doi: 10.1111/jphd.12063.

64. Edelstein B, Vargas CM, Candelaria D, Vemuri M. Experience and policy implications of children presenting with dental emergencies to US pediatric dentistry training programs. Pediatr Dent. 2006 Sep-Oct;28(5):431-7.

65. Feitosa S, Colares V, Pinkham J. The psychosocial effects of severe caries in 4-year-old children in Recife, Pernambuco, Brazil. Cad Saude Publica. 2005 Sep-Oct;21(5):1550-6. doi: 10.1590/s0102-311x2005000500028.

66. Freire MC, Sheiham A, Netuveli G. Relationship between height and dental caries in adolescents. Caries Res. 2008;42(2):134-40. doi: 10.1159/000121437.

67. Garg N, Anandakrishna L, Chandra P. Is there an Association between Oral Health Status and School Performance? A Preliminary Study. Int J Clin Pediatr Dent. 2012 May;5(2):132-5. doi: 10.5005/jp-journals-10005-1150.

68. Gherunpong S, Tsakos G, Sheiham A. A sociodental approach to assessing dental needs of children: concept and models. Int J Paediatr Dent. 2006 Mar;16(2):81-8. doi: 10.1111/j.1365-263X.2006.00701.x.

69. Halboub ES, Al-Maweri SA, Al-Jamaei AA, Al-Wesabi MA, Shamala A, Al-Kamel A, et al. Self-Reported Oral Health Attitudes and Behavior of Dental and Medical students, Yemen. Glob J Health Sci. 2016 Oct 1;8(10):56676. doi: 10.5539/gjhs.v8n10p143.

70. Honkala S, Honkala E, Newton T, Rimpelä A. Toothbrushing and smoking among adolescents--aggregation of health damaging behaviours. J Clin Periodontol. 2011 May;38(5):442-8. doi: 10.1111/j.1600-051X.2011.01709.x.

71. Jürgensen N, Petersen PE. Oral health behaviour of urban and semi-urban schoolchildren in the Lao PDR. Community Dent Health. 2011 Dec;28(4):280-5.

72. Kumar VS, Karuveettil V, Joseph J, Yeturu SK, Suseela RP, Janakiram C. Association of dental caries and oral health impact profile in 12-year-old school children: a cross-sectional study. J Clin Diagnostic Res. 2018;12(9):ZC12-5. doi: 10.7860/JCDR/2018/35029.11984.

73. Logan DE, Simons LE, Stein MJ, Chastain L. School impairment in adolescents with chronic pain. J Pain. 2008 May;9(5):407-16. doi: 10.1016/j.jpain.2007.12.003. Epub 2008 Feb 6.

74. Maharani DA, Adiatman M, Rahardjo A, Burnside G, Pine C. An assessment of the impacts of child oral health in Indonesia and associations with self-esteem, school performance and perceived employability. BMC Oral Health. 2017 Mar 21;17(1):65. doi: 10.1186/s12903-017-0358-5.

75. Mittal M, Dwivedi S, Vashishth P, Jaiswal D. Prevalence and impact of oral pain in 8 year-old children in india. J Oral Sci Oral Rehabil. 2012;2:37-40.

76. Muirhead V, Marcenes W. An ecological study of caries experience, school performance and material deprivation in 5-year-old state primary school children. Community Dent Oral Epidemiol. 2004 Aug;32(4):265-70. doi: 10.1111/j.1600-0528.2004.00147.x.

77. Muirhead VE, Locker D. School performance indicators as proxy measures of school dental treatment needs: a feasibility study. J Public Health Dent. 2006 Fall;66(4):269-72. doi: 10.1111/j.1752-7325.2006.tb04080.x.

78. Murray C, Densie IK, Morgan C. Dental attendance, perceptions of cost and self-care of school year 12 and 13 students: A focus on Southland, New Zealand. N Z Dent J. 2015 Dec;111(4):133-41.

79. Naavaal S, Kelekar U. School hours lost due to acute/unplanned dental care. Health Behavior and Policy Review. 2018;5(2):66-73. doi: 10.14485/HBPR.5.2.7.

80. Ng MW. Children with both poor oral health and general health may be more likely to have poor school performance. J Evid Based Dent Pract. 2011 Mar;11(1):69-70. doi: 10.1016/j.jebdp.2010.11.001.

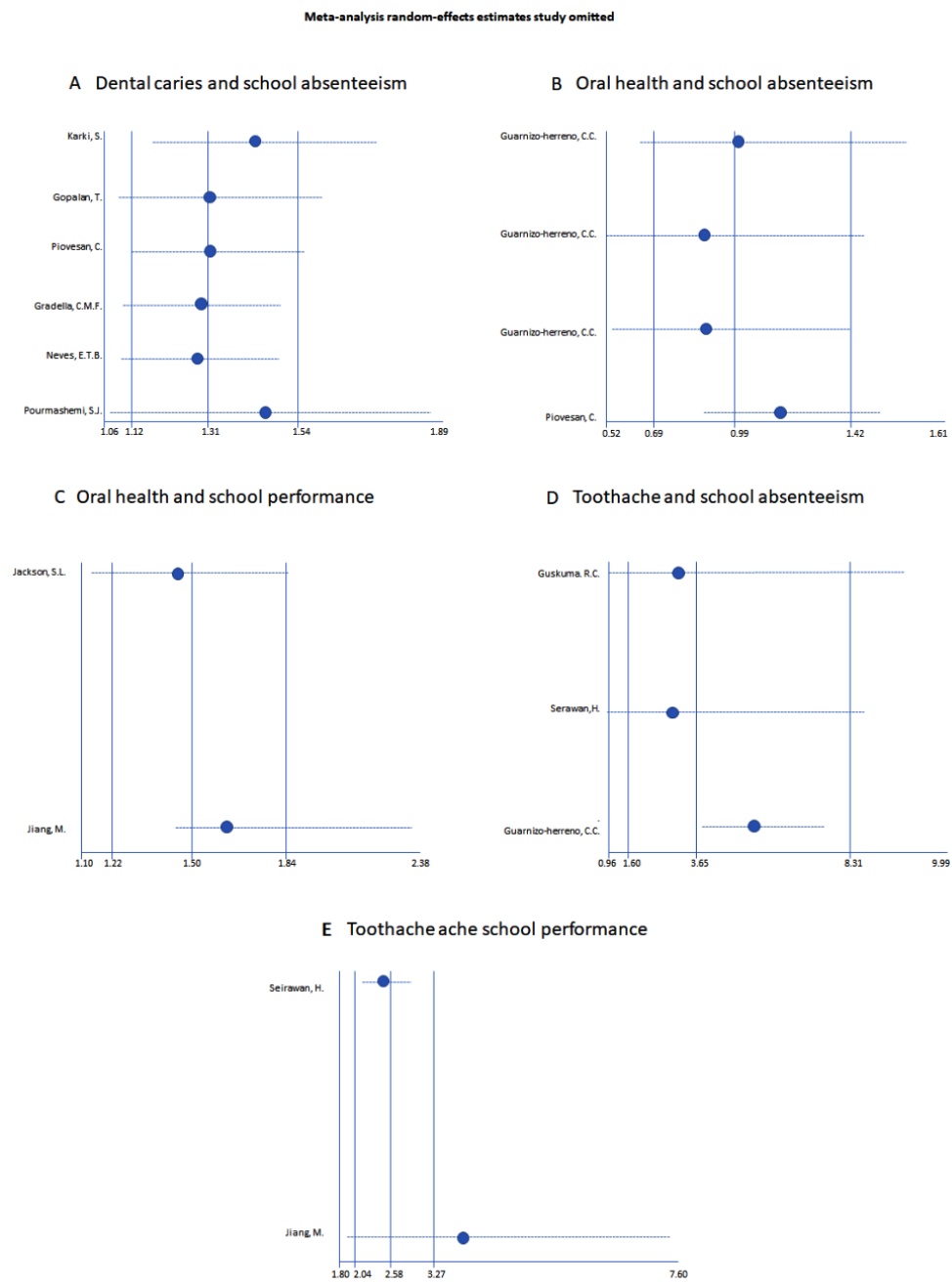
81. Pau A, Khan SS, Babar MG, Croucher R. Dental pain and care-seeking in 11-14-yr-old adolescents in a low-income country. Eur J Oral Sci. 2008 Oct;116(5):451-7. doi: 10.1111/j.1600-0722.2008.00563.x.

82. Petersen PE, Jiang H, Peng B, Tai BJ, Bian Z. Oral and general health behaviours among Chinese urban adolescents. Community Dent Oral Epidemiol. 2008 Feb;36(1):76-84. doi: 10.1111/j.1600-0528.2007.00375.x.

83. Petridou E, Athanassouli T, Panagopoulos H, Revinthi K. Sociodemographic and dietary factors in relation to dental health among Greek adolescents. Community Dent Oral Epidemiol. 1996 Oct;24(5):307-11. doi: 10.1111/j.1600-0528.1996.tb00867.x.

84. Pourat N, Nicholson G. Unaffordable dental care is linked to frequent school absences. Policy Brief UCLA Cent Health Policy Res. 2009 Nov;(PB2009-10):1-6.

85. Shaikh S, Siddiqui AA, Aljanakh M. School Absenteeism due to Toothache among Secondary School Students Aged 16-18 Years in the Ha'il Region of Saudi Arabia. Pain Res Treat. 2016;2016:7058390. doi: 10.1155/2016/7058390.




**Supplementary Figure 1.** Sensitivity analysis of included studies.

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| | | **TITLE** | |
| Title | 1 | Identify the report as a systematic review. | 1 |
| ABSTRACT | | | |
| Abstract | 2 | See the PRISMA 2020 for Abstracts checklist. | 1 |
| | | **INTRODUCTION** | |
| Rationale | 3 | Describe the rationale for the review in the context of existing knowledge. | 2 |
| Objectives | 4 | Provide an explicit statement of the objective(s) or question(s) the review addresses. | 2 |
| | | **METHODS** | |
| Eligibility criteria | 5 | Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses. | 3 |
| Information sources | 6 | Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted. | 3 |
| Search strategy | 7 | Present the full search strategies for all databases, registers and websites, including any filters and limits used. | Table 1 |
| Selection process | 8 | Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process. | 3/4 |
| Data collection process | 9 | Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process. | 4 |
| Data items | 10a | List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect. | 4/5 |
| | 10b | List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information. | - |
| Study risk of bias assessment | 11 | Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process. | 4 |
| Effect measures | 12 | Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results. | 4/5 |

Continue

Continuation

| | | | |
|---|---|---|---|
| Synthesis methods | 13a | Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)). | 4/5 |
| | 13b | Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions. | 4/5 |
| | 13c | Describe any methods used to tabulate or visually display results of individual studies and syntheses. | 4/5 |
| | 13d | Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used. | 4/5 |
| | 13e | Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression). | 4/5 |
| | 13f | Describe any sensitivity analyses conducted to assess robustness of the synthesized results. | 4/5 |
| Reporting bias assessment | 14 | Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases). | - |
| Certainty assessment | 15 | Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome. | 4/5 |
| | | **RESULTS** | |
| Study selection | 16a | Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram. | 5 |
| | 16b | Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded. | Table 2 |
| Study characteristics | 17 | Cite each included study and present its characteristics. | Table 3 |
| Risk of bias in studies | 18 | Present assessments of risk of bias for each included study. | Table 3 |
| Results of individual studies | 19 | For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots. | Table 3 |
| Results of syntheses | 20a | For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies. | 5 |
| | 20b | Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect. | 5/6/7 |
| | 20c | Present results of all investigations of possible causes of heterogeneity among study results. | 5/6/7 |
| | 20d | Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results. | 5/6/7 |
| Reporting biases | 21 | Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed. | 5/6/7 |
| Certainty of evidence | 22 | Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed. | - |

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| | | | |
|---|---|---|---|
| **DISCUSSION** | | | |
| Discussion | 23a | Provide a general interpretation of the results in the context of other evidence. | 9 |
| | 23b | Discuss any limitations of the evidence included in the review. | 10 |
| | 23c | Discuss any limitations of the review processes used. | 10 |
| | 23d | Discuss implications of the results for practice, policy, and future research. | 10 |
| **OTHER INFORMATION** | | | |
| Registration and protocol | 24a | Provide registration information for the review, including register name and registration number, or state that the review was not registered. | 3 |
| | 24b | Indicate where the review protocol can be accessed, or state that a protocol was not prepared. | - |
| | 24c | Describe and explain any amendments to information provided at registration or in the protocol. | 3 |
| Support | 25 | Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review. | 11 |
| Competing interests | 26 | Declare any competing interests of review authors. | 10 |
| Availability of data, code and other materials | 27 | Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review. | - |