Prevalence of dental anxiety in children and adolescents globally

Grisolia, Barbara Monteiro; Dos Santos, Ana Paula Pires; Dhyppolito, Izabel Monteiro; Buchanan, Heather; Hill, Kirsty; Oliveira, Branca Heloisa

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Prevalence of dental anxiety in children and adolescents globally: a systematic review with meta-analyses

SUMMARY

Background: dental anxiety (DA) negatively impacts oral health-related quality of life and patients with DA usually require more dental treatment time. Aim: to describe the global prevalence of DA in children and adolescents and to examine the influence of individual factors (age, sex and caries experience) and variables related to DA measurement on pooled prevalence. Design: systematic review with meta-analyses of observational studies published between 1985 and 2020 (Prospero CRD42014013879). Results: Searches yielded 1207 unique records; 224 full-text articles were screened and 50 studies were used in the qualitative and quantitative synthesis. No study was considered as having high methodological quality according to “The Joanna Briggs Institute assessment tool”. Overall pooled DA prevalence was 23.9% (95% CI 20.4,27.3). Pooled prevalence in preschoolers, school children and adolescents was: 36.5% (95% CI 23.8,49.2), 25.8% (95% CI 19.5,32.1) and 13.3% (95% CI 9.5,17.0), respectively. DA was significantly more prevalent in pre-school (one study) and school (two studies) children with caries experience and in female adolescents (one study). The scale used for DA assessment was shown to influence pooled prevalence in preschoolers and adolescents. Conclusion: DA is a frequent problem in 3-18 year-olds worldwide, more prevalent in school and preschool children than in adolescents.

Keywords: Dental Anxiety. Prevalence. Child. Child,Preschool. Adolescent.

INTRODUCTION

There is some uncertainty regarding the conceptualization of dental fear, dental anxiety and dental phobia in the scientific literature. Usually, dental fear (DF) is considered a normal emotional reaction to one or more specific threatening stimuli in relation to the dental situation, whereas dental anxiety (DA) is considered a state of apprehension, coupled with a sense of losing control, which is linked to a feeling that something dreadful is going to happen in relation to dental treatment. Dental phobia (DP) would correspond to an intense fear that interferes with the individual's functioning. Distinguishing DF from DP is challenging for dentists; phobia is a clinical diagnosis, not just marked fear. In epidemiological studies addressing the frequency and distribution of DA the terms DF, DA and DP are often used interchangeably.[1-3]

DA is a universal phenomenon that affects people of all ages across different countries.[4] The condition negatively impacts oral health-related quality of life in children and adults[5, 6] and may also impose a substantial burden to society. For example, it has been estimated that DA is likely to result in 74,000 disability-adjusted life years (DALYs) in the Dutch population ranking 16th in the country's DALYs.[7] Furthermore, dentists perceive anxious patients as more difficult to deal with and treating people with DA require more time. In addition, anxious patients usually delay dental treatment and routinely miss dental appointments which can lead to more complex treatment needs.[8] Not surprisingly, there is a positive strong association between the proportion of patients perceived as anxious by dentists and higher levels of work-related stress (i.e.,burnout).[9]

Estimates of DA prevalence in children and adolescents ranges from 5.7% to 20.2%[3, 4, 10, 11] and factors such as age, sex, cultural context, socioeconomic status, presence of dental caries, history of toothache and previous dental treatments seem to be associated with DA occurrence.[12-16] Additionally, DA prevalence estimates may be influenced by methods used to assess it. There is a large pool of multi-item self-report scales and single item questionnaires that can be used to measure DA in children and adolescents. These include: the Dental Fear Survey (DFS), the Venham Picture Test (VPT), the Children's Dental Fear Picture Test (CDFP), the Children's Fear Survey Schedule Dental Subscale (CFSS-DS) and its faces version ($CFSS\text{-}DS_f$), the Modified Child Dental Scale (MCDAS) and its faces version ($MCDAS_f$), the Dental Anxiety Question (DAQ), and the Facial Image Scale (FIS). All these measures except for VPT and FIS assess trait anxiety. Trait measures assess child's dental anxiety across a variety of dental contexts or procedures, whereas state measures, such as VPT and FIS, measure how the child feels at a specific moment in time.[17-19] Ideally, children should be asked to rate their own DA but sometimes, due to time constraints in large studies or when they are very young, caretakers have been employed as proxy respondents.[20, 21] Moreover, only instruments that have been demonstrated to be reliable and valid for the assessment of DA in the context of the study population should be used for outcome measurement in DA surveys.

Monitoring DA prevalence is very helpful for the organisation of dental services focused on patients' comfort and well-being.[8] It can also provide valuable information for professional and health consumer organizations to increase dentists' awareness about DA. There is a large body of scientific

information on this subject. Summarizing and critically appraising the quality of the available evidence using systematic, rigorous and transparent methods is a potent means of facilitating its use in clinical practice, policymaking, education and research. This systematic review with meta-analyses aims to describe the global prevalence of DA in children and adolescents. It also aims to examine the influence of individual factors and variables related to study design and instruments used to assess DA on the pooled estimates of DA.

MATERIAL AND METHODS

Protocol registration and review reporting

This review has been registered at the International prospective register of systematic reviews - PROSPERO (CRDxxxxxx). It follows the guidelines provided by The Joanna Briggs Institute Reviewers' Manual 2014 [22] for Systematic Reviews of Prevalence and Incidence Data and it is being reported according to the MOOSE guidelines.[23]

Study design

Systematic review of observational studies (cross-sectional and cohort) published between 1985 and 2020.

Eligibility criteria

Population

Children and adolescents (i.e., individuals ages three through 18 years).

Condition

Self-assessed or caretaker-assessed trait anxiety or state dental anxiety as measured by single-item questionnaires or multidimensional scales. Instruments used in the assessment of DA should be reliable and valid in the context of the study population. This means that when the instrument used in the study had been originally developed in a different cultural context or targeting a different age group, it should have been cross-culturally or age adapted. We included studies that used instruments that had not been submitted to a formal process of cross-cultural adaptation when authors provided some data regarding reliability and validity assessment performed along the study itself.

Context

No restrictions regarding sex, educational level, socioeconomic status, settings where data were collected, and methods used for participants' selection were applied.

Exclusion criteria

Studies where participants were selected based on some criteria that might interfere with DA prevalence (e.g., special needs patients or children with attention/behavioral and learning problems) were excluded.

Outcome

Primary outcome was overall dental anxiety prevalence. Secondary outcomes were prevalence of DA by age. The age groups were determined according to the definitions of preschool children, school children and adolescents provided in the MeSH/PubMed Database: three to five years of age, six to 12 years of age and 13 to 18 years of age, respectively. DA prevalence in each study was calculated as the number of participants with DA divided by the number of

participants analysed. When a study did not provide the number of participants analysed that had DA but classified participants into different groups according to the scores obtained using a given scale, we considered as having DA participants whose scores were more close to the cutoff point used to define the presence of DA by most of the authors that used that scale. For example, most researchers that used the CFSS-DS considered participants dentally anxious if they had a score of 38 or more. Thus, when we extracted data from Caprioglio 2009[19], Lin 2014[24] and Lalic 2015[25], we considered as having DA participants classified as having CFSS-DS scores higher than 39, equal to or higher than 37 and higher than 38, respectively.

Search strategy

The following databases were searched in June 2018 with no language limitation: MEDLINE via PubMed, EMBASE, WEB OF SCIENCE, CINAHL, SCOPUS, PsycINFO and LILACS. The search strategy was developed for MEDLINE and adapted for other databases (see Appendix). A librarian helped with developing the search strategy for EMBASE. Sources of grey literature were Open Grey and *CAPES Thesis Database.* We also performed a hand search of six dental journals: *Community Dentistry and Oral Epidemiology, International Journal of Paediatric Dentistry, Pediatric Dentistry, Journal of Dentistry for Children, Journal of Dental Research and Journal of the American Dental Association*, between 2010 and 2018. References of eligible studies that were included were checked to detect other potential studies. In May 2020 we updated the online search in MEDLINE via PubMed.

Data collection

All references were imported into a single library using EndNote Web™ (Clarivate Analytics, Philadelphia, PA, USA). Two investigators (BMG and IMD) independently examined the titles, keywords and abstracts of all records identified. There was no blinding related to authors' names, journals' titles and publication date. Data regarding characteristics of participants, recruitment procedures, settings, method of DA assessment, information related to dental experiences (e.g., dental caries status and whether participants had already visited the dentist or had experienced toothache) and number of participants with DA and total number of subjects in the study that were analysed were independently extracted by two trained reviewers (BMG and IMD) from the studies selected for inclusion. Any disagreement between the two reviewers during the process of identifying, screening, assessing for eligibility, excluding, and including studies was solved by consensus after discussion with a third reviewer (APPS or BHO). Whenever necessary authors were contacted by email and asked for additional information regarding their studies. Five studies (two in Hungarian, one in Dutch, one in Croatian and one in Danish) were translated into English using Google Translate® (Google LLC, Mountain View, CA, USA) in order to verify whether they fulfilled the inclusion criteria or not. At this point, if we had found that they should be included, we would have sent them for professional translation before data extraction. However, this was not necessary since none of them were considered eligible for the review.

Quality assessment

The methodological quality assessment tool that we used was "The Joanna Briggs Institute Critical Appraisal Checklist for Studies Reporting Prevalence Data" checklist[22]. It comprised eight domains: *"1- Was the sample*

representative of the target population? 2- Were study participants recruited in an appropriate way? 3- Was the sample size adequate? 4- Were the study subjects and settings described in detail? 5- Was the data analysis conducted with sufficient coverage of the identified sample? 6- Was the condition measured reliably? 7- Was there appropriate statistical analysis? 8- Were all the important subgroups' differences identified and accounted for (e.g., age, sex, caries experience, past dental visit experience and socioeconomic status)?". The answers to each question could be: Yes, No or Unclear. In order to be classified as presenting a high methodological quality a study should have a "yes" (positive) answer in all domains; a "no" (negative) answer in one domain was sufficient for classifying a study as presenting low methodological quality. Two reviewers (BMG and IMH) independently applied the methodological quality assessment tool to each included study. Then, they discussed their results and produced a summary methodological quality table. A third reviewer (BHO), an epidemiologist experienced in systematic reviews, revised it and made the necessary modifications with the agreement of one of the original reviewers.

Statistical analysis

All studies that provided sufficient data were included in the statistical analyses. The metaprop command in Stata 14.0 (StataCorp, College Station, TX, USA) was used for pooling the effect estimates because it implements procedures that are specific to binomial data and is appropriate for dealing with proportions. The metaprop routine entails the Freeman-Tukey double arcsine transformation procedure and DerSimonian-Laird random-effects model. Specifically, the Freeman-Tukey double arcsine procedure transforms

proportions from individual studies by stabilizing between-study variance. Subsequently, the DerSimonian-Laird random-effects model computes the weighted overall pooled estimates. Heterogeneity was quantified using the I^2 statistic, and its significance (i.e., whether the true effect in all studies is the same) was determined based on the accompanying Cochran Q test p value. I^2 values indicate the proportion of the observed variance that reflects real differences in effect size; increasing values represent greater amounts of heterogeneity: values of 25% to 50%, 50% to 75%, and 75% or more indicate low, moderate, and high levels of heterogeneity, respectively.[26]

In order to obtain the overall pooled DA prevalence in subjects three to 18 years of age we combined data from all included studies. Additionally, because we anticipated important differences in the prevalence of dental anxiety across age groups, we produced forest plots with studies that provided prevalence data by age, after classifying them by age group (preschoolers, school children and adolescents). Since I^2 within these age groups was still large, sensitivity and subgroup analyses were carried out to explore other potential sources of heterogeneity. In sensitivity analysis we removed one study at a time and estimated the pooled prevalence without that study. We had decided that if the new DA pooled prevalence lied outside the 95% CI of the original pooled DA prevalence we would exclude the study from the final analysis. However, this was not observed and no study was excluded. We also examined the impact of study quality on the effect measures by calculating separately pooled prevalence estimates from studies with representative and convenience samples within each age group. Additionally, the influence of the following study design factors on these

estimates was investigated: scale used for DA assessment (CFSS-DS, CFSS-DS_f, DAQ, DFS, $MCDAS_f$ and VPT), mode of questionnaire application (self-complete or interview) and type of respondent (children/adolescent or caretaker).

For subgroup analysis, we investigated whether the variables sex, dental caries experience (no caries versus one carious tooth/surface or more) and past dental visit experience (at least one dental appointment or none) had some influence on the pooled estimates of dental anxiety within age groups.

Methods for examining publication bias in meta-analysis of prevalence studies are not well established and it has been found that funnel plots may produce spurious asymmetry even when publication bias does not exist.[27] Moreover, when heterogeneity is large, asymmetry in the funnel plot may result not from a systematic under-reporting of negative trials but from an essential difference between smaller and larger studies that arises from inherent between-study heterogeneity.[28] Therefore, due to limited application and interpretability of results from publication bias analysis in prevalence studies, we have chosen not to conduct this analysis.

RESULTS

Characteristics of the included studies

After removal of duplicates and updating the searches yielded 1207 records; they had their titles and abstracts independently examined by two reviewers. Then, the same reviewers independently assessed 224 full-text articles for

eligibility. Finally, 50 studies (reported in 57 papers) were used in the qualitative and quantitative synthesis (Figure 1).

Included studies were from 21 different countries: Bosnia and Herzegovina[29, 30], Brazil[15, 20, 21, 31-45], Canada[46], China[24, 46-48], England[49], Greece[50], India[51], Iran[52, 53], Italy[19], Kuwait[54], Nepal[55], Netherlands[16, 56, 57], Norway[14, 58, 59], Romania[60], Saudi Arabia[5], Scotland[61], Serbian[25], Singapore[62, 63], Spain[64], Sweden[10, 65-70], and USA[71-74]. One study[75] included after the 2020 search update appears to be from Saudi Arabia; we emailed the authors asking for confirmation but they did not reply. Most of the included studies were cross-sectional (n=47), used convenience sampling methods (n=22) and performed data collection at dental clinics (n=23) or schools (n=25). Respondents to the questionnaires that were used to assess DA were the children/adolescents themselves (n=33) or their caretakers (n=16). In one study[29] it was unclear whether the respondents were the children or not. We sent messages by email to the main author asking for clarification but he did not reply.

Characteristics of the studies regarding study design, country and setting where data were collected, sample size, age range of the participants, scale used for DA assessment, and cutoff point used to determine the presence of DA are depicted in Table 1.

Quality assessment

The critical appraisal of the included studies showed that no study received a positive rating in all domains (Figure 2). Thus, none could be classified as having high methodological quality. The studies with the higher number of positive ratings were Menoncin[40] (n=7), followed by Barreto 2017[36], Lin

2014[24], Torriani 2014[15] and Wogelius 2013[73] (n=6). Overall, the domains with the higher number of positive and negative ratings were “description of study participants” (“*Were the study subjects and settings described in detail?”)* and “subgroup analyses” *(“Were all the important subgroups’ differences identified and accounted for?”),* respectively. Reliability of DA assessment and description of refusals or “not founds” among selected subjects were the items less frequently reported (higher number of “unclear” ratings). In 17 studies the sample was considered representative of the target population; 13 of these studies could be included in the meta-analysis of DA prevalence by age group. Eight, out of these 13 studies were with school children [20, 24, 33, 36, 40, 45, 73, 75], two were with preschool children [15, 41] and three were with adolescents [14, 59, 68].

DA Prevalence

Pooled DA prevalence estimated from all 50 studies was 23.9% (95% CI 20.4 to 27.3). Thirty-five studies provided data on DA prevalence by age group; among them four provided data on more than one age group: three on preschool and school children [42, 46, 51] and one on school children and adolescents [61]. The pooled prevalence of DA in preschoolers, school children and adolescents was: 36.5% (95% CI 23.8 to 49.2), 25.8% (95% CI 19.5 to 32.1) and 13.3% (95% CI 9.5 to 17.0), respectively. Statistically significant intra and inter-group heterogeneity was observed (Figure 3).

When we pooled DA estimates within each age group by type of sample (representative of the target population or not), we found pooled DA prevalence in studies with representative samples of: 23.4% (95% CI 21.8 to

25.0), 27.6% (95% CI 15.9 to 39.4) and 11.2% (95% CI 3.6 to 18.8) in preschoolers, school children and adolescents, respectively. In studies with convenience samples pooled DA prevalence were: 42.4% (95% CI 15.3 to 69.5), 22.6% (95% CI 15.1 to 30.1) and 19.1% (95% CI 16.2 to 22.0) in preschoolers, school children and adolescents, respectively.

The results of the analyses regarding the influence of instrument used for DA assessment, mode of application of the instrument and type of respondent on the pooled DA prevalence by age group are shown in Table 2.

Data on DA prevalence by sex was available from 12 studies: nine found higher frequencies of DA in female, six in school children [25, 29, 36, 40, 43, 61], two in preschoolers [15, 51] and one in adolescents [59]. Only one study found a statistically significant difference between DA prevalence in male and female [59]. The results of the meta-analyses of DA prevalence by sex are presented in Table 3.

Regarding DA prevalence by dental caries experience and past dental visit experience, six studies provided information: one in preschoolers and five in school children. Dental anxiety was significantly more frequent (one study only[15]) in preschool children who had at least one decayed, carious or extracted (dmfs) dental surface (21.9%; 95% CI 18.5 to 25.6) than in preschool children who were caries-free (12.2%; 95% CI 9.5 to 15.0). The same was observed in school children when we combined DA prevalence reported in two studies[33, 36] that compared school children with caries experience (i.e., at least one decayed, carious or extracted primary or permanent tooth) to school children without caries experience. Pooled DA

prevalence in this age group was 51.2% (95% CI 47.9 to 54.4) and 35.9% (33.0 to 38.8) in children with and without caries experience, respectively. We found no association between DA prevalence and past dental visit experience in preschool or school children. In preschoolers (one study only[15]) DA prevalence was 13.7% (95% CI 10.5 to 17.3) in children who had been to the dentist and 18.8% (15.9 to 21.8) in children who had never been to the dentist. In school children, the pooled DA prevalence[19, 36, 40, 45] of children who had been to the dentist and children who had never been to the dentist was 37.7% (95% CI 22.6 to 52.8) and 47.9% (95% CI 29.0 to 66.8), respectively.

Data on DA prevalence by socioeconomic status (SES) was provided in two studies with preschool children[15, 41] and four studies with school children[24, 36, 40, 61]. They used various SES indicators: mother's years of schooling, family income, private or public school attendance, participation in free school lunch program and national deprivation index). DA prevalence was found to be significantly higher in Brazilian preschoolers from families with low income[15, 41] and in Brazilian preschoolers whose mothers had lower schooling level[15]. In school children, DA prevalence was significantly higher in Brazilian children who attended public school (n=405; 63.2%) than in those who attended private school (n=338; 46.6%) [36] Other studies with school children that were conducted in China[24], Brazil[40] and Scotland[61] found no association between DA and socioeconomic status.

DISCUSSION

This systematic review of observational studies shows that DA is highly prevalent in children and adolescents globally. Children appear to be more frequently affected by the condition than adolescents; one out of five children present with DA. This finding underscore the need for health care providers to be prepared to meet the emotional needs of dentally anxious pediatric patients. It has been shown, for example, that simple measures such as an empathic communication style and appropriate level of physical contact accompanied by verbal explanation and reassurance, may elicit more cooperative behaviors in children during dental treatments.[76]

The onset and progression of DA is a subject that deserves more thorough investigation. It is generally assumed that the problem begins in childhood being triggered by unpleasant dental experiences or family / peer influence.[77, 78] Very few longitudinal studies have examined the age of onset of DA and changes that may occur in DA over time. In a sample of 799 British children the prevalence of DA increased significantly from 8.8% at 5 years to 14.6% at 9 years but most participants who were dentally anxious at 5 years were no longer anxious at 9 years of age.[78]In a Brazilian study with a two-year follow-up of 416 school-age children there was a small increase in DA prevalence from 6 (16%) to 8 (19%) years of age. Importantly, the majority of children who were anxious at baseline were no longer anxious after 2 years.[32] In a sample of 678 dentally anxious New Zealanders it was observed that one third first became dentally anxious during childhood or early adolescence, one third during late adolescence and one third during early adulthood. Moreover, DA prevalence remained stable between 15 and 18 years but increased significantly between 18 and 26 years of age.[77]

Although we found a significantly higher frequency of DA in younger children, we cannot rule out the possibility that this difference in DA prevalence between children and adolescents was caused by clinical (i.e., differences in characteristics of study populations and measurements) or methodological (i.e., differences in study design and methodological quality) heterogeneity. Only one[61] of the studies included in our meta-analyses assessed DA in both children and adolescents and a non-significant higher prevalence of self-reported DA was found in 12–16-year-old children ~~(30%, 95% CI 14 to 50)~~ in comparison to 7–11-year-old children ~~(15%, 95% CI 8 to 23)~~.

Most studies in our review had a cross-sectional design and used non-random sampling strategies to select participants. Only in preschoolers we observed that pooled DA prevalence estimate was substantially higher in non-representative samples than in representative ones. However, the confidence interval of DA pooled estimate in convenience samples of preschoolers is wide and overlap with the confidence interval of DA pooled estimate in representative samples making it difficult to draw conclusions on the effect of type of sample on the pooled DA prevalence in this age group. Considering that cross-sectional studies that are not population-based and do not use random sampling are highly susceptible to selection bias, caution is advised when extrapolating the results of our meta-analysis to other populations and settings.[79]

Another factor that may contribute to clinical heterogeneity in meta-analyses of observational studies is difference in measures used to assess the outcome. In our review, a wide range of DA assessment instruments was identified. In studies involving preschoolers or adolescents, up to three

different questionnaires were used, whereas in studies involving school children five types of questionnaires were used. CFSS-DS and DFS were the most used scales in samples of school children and adolescents, respectively. In preschoolers the distribution of studies by type of questionnaire was well balanced. However, when prevalence estimates in preschoolers were pooled by type of DA scale, a significantly higher pooled prevalence was found with VPT in comparison to CFSS-DS and DAQ. One possible explanation for this difference is that VPT measures state anxiety whereas CFSS-DS and DAQ measure trait anxiety.[17]

Importantly, not all measurement instruments used to assess DA in children tap into the same construct. Also, cutoff points for differentiating children with and without DA often are often arbitrarily determined. CFSS-DS, probably the most widely used measure of DA in young subjects, does not measure the cognitive, physiological, behavioural and emotional aspects of DA and has dental-specific items that represent specific moments of dental treatment but do not reflect aspects of DA. DFS is not a theoretically derived measure of DA and was not developed to produce a single score but researchers have almost universally summed up the 20 items of the scale to create a single score and an arbitrary cutoff point of 59-60 has been used to identify anxious individuals.[2] VPT is a pictorial “state” measure; some of the emotions displayed in its pictures are ambiguous and it does not have formally established cutoff points for defining DA presence.[17] These shortcomings do not mean that the scales used in the included studies cannot reliably distinguish dentally anxious from non-dentally anxious children and

adolescents[2] but this limitation should be taken into consideration when interpreting our findings.

The mode of application of the questionnaires in the primary studies, self-complete or interview, and the type of respondent, the children themselves or caretakers, varied and these may also help to explain the high rates of heterogeneity encountered. It has been shown that when CFSS-DS is applied to school children and their parents, parents estimate DA of their children higher than their children do.[38, 56] We also observed that in two studies with school aged children using the CFSS-DS, one in the USA [72] and the other in Sweden [67], DA prevalence was almost twice as high in the latter, where respondents were the caretakers, than in the former where respondents were the children themselves.

Nevertheless, in our meta-analyses, important differences in pooled DA prevalence estimates by type of respondent were noticed only in preschoolers; pooled DA prevalence was almost three times higher in studies where the respondents were children than in studies where the respondents were caretakers. This finding suggest that although young children may have difficulty in completing DA self-reporting items [17] using a proxy respondent for assessing DA in preschoolers may not be the best solution. In our research, whenever a study reported DA prevalence derived from children and caretakers' assessment, we chose data obtained from the children themselves.

As there is still some debate on whether the frequency of DA reporting in male and female differ, we examined whether the pooled estimates of DA within

age groups varied by sex. Previously published reviews concluded that DA prevalence is higher in girls than in boys. One combined the results of nine studies using the CFSS-DS for DA assessment, irrespective of age, and found pooled DA prevalence of 19.6% and 24.5% in males and females respectively.[3] The other used the vote counting approach and pointed out that among 14 studies ten found more dental anxiety in female than in male (eight based on mean scores and two based on prevalence).[1] In our review, we could only estimate pooled DA prevalence by sex in schoolchildren and preschoolers because only one study[59] reported DA prevalence in male and female adolescents. In both age groups evaluated we found no important differences between female and male regarding the prevalence of DA.

We also sought to evaluate the effect of caries experience, having ever been to the dentist and SES on the estimates of DA in preschoolers, school children and adolescents. Because of the paucity of data, we were able to combine in meta-analyses only data regarding dental caries experience and past dental visit in school children. We found that 6 to 12-year-old children with caries and those who had never been to the dentist had significantly higher DA prevalence. Nevertheless, since our data come from primary studies with a cross-sectional design these findings do not necessarily imply cause-effect relationships.[79].

The low quality of the reporting of the observational studies that we identified in the scientific literature and selected for inclusion is an important limitation of our review; future research on this subject should follow the STROBE Initiative recommendations (The Strengthening the Reporting of Observational Studies in Epidemiology) in order to facilitate the assessment of the studies'

strengths and weaknesses and of their generalizability.[80] Moreover, it is essential that instruments used for DA assessment have had their psychometric properties previously tested in the age group in which they are intended to be applied. In this review we included only studies that used questionnaires that were shown to be valid in the context of the study population. Also, data on factors that may potentially influence DA frequency in children and adolescents should be collected (e.g., prevalence of dental caries, previous experience with dental treatment and socioeconomic status) and analysed. Finally, population-based studies investigating more thoroughly reasons for differences in DA prevalence across age groups and between male and female should be encouraged.

BULLET POINTS

Why this paper is important to paediatric dentists

- The prevalence of dental anxiety in children is high and pediatric dentists need to prepare themselves to meet the emotional needs of their dentally anxious patients;
- Future studies on the epidemiology of dental anxiety in children and adolescents should follow STROBE guidelines and employ valid and reliable instruments for DA assessment in the respective age group.

REFERENCES

FIGURE LEGENDS

Figure 1 – PRISMA Flow diagram showing the process of identifying, screening, assessing for eligibility, excluding, and including studies.

Figure 2 - Quality assessment of the included studies + Yes, - No and ? Unclear.

Figure 3 – Meta-analysis of the prevalence of dental anxiety by age group (preschoolers, school children and adolescents).

Table 1 – Characteristics of the studies included in this systematic review

Study	Study design	Country	Setting	Sample size	Age range of participants	Scale used for DA assessment	Cutoff point
Aldadat 2018	Cross-sectional	Unclear	School	1546	06_12	CFSS-DS	>= 38
Baier 2004	Cross-sectional	USA	Private dental clinic	226	07_12	CFSS-DS	>=38
Bajric 2015	Cross-sectional	Bosnia and Herzegovina	University dental clinic	40	8	CFSS-DS	>=38
Barasuol 2017	Cross-sectional	Brazil	University dental clinic	168	06_12	DAQ	>=2
Barberio 2017	Cross-sectional	Brazil	University dental clinic	136	08_15	CFSS-DS	>=38
Barreto 2017	Cross-sectional	Brazil	School	1367	06_07	DAQ	>=2
Beena 2013	Cross-sectional	England	School	444	06_12	CFSS-DS	>=38
Caprioglio 2009	Cross-sectional	Italy	School	725	06_10	CFSS-DS$_f$	>39
Chellappah 1990	Cross-sectional	Singapore	School	505	10_14	CFSS-DS	>=42
Chhabra(a) 2012	Cross-sectional	India	University dental clinic	73	5	CFSS-DS	>38
Chhabra(b) 2012	Cross-sectional	India	University dental clinic	450	06_10	CFSS-DS	>38
Colares 2013	Cross-sectional	Brazil	Municipal Zoo	970	05_12	DAQ	>=2
Coric 2014	Cross-sectional	Bosnia and Herzegovina	School	114	07_15	CFSS-DS	>= 39
Gyergyay 2015	Cross-sectional	Romania	School	406	11_18	DFS	>=59
Honkala 2014	Cross-sectional	Kuwait	School	661	13_15	MCDAS$_f$	>22
Khanduri 2019	Cross-sectional	Nepal	University dental clinic	300	04_13	CFSS-DS	≥38
Kyritsi 2009	Cross-sectional	Greece	Public dental service	88	03_11	CFSS-DS	>=35
Klein 2015	Cohort	USA	Pediatric hospital	184	06_10	CFSS-DS	>=32
Klingberg 1994	Cross-	Sweden	University dental clinic	52	04_14	CFSS-DS	>=38

	sectional						
Klingberg 1995	Cross-sectional	Sweden	Public dental service	3166	4,5,6,9,10,11	CFSS-DS	>=38
Krikken 2012	Cross-sectional	Netherlands	School	325	07_11	CFSS-DS	>=32
Lalic 2015	Cross-sectional	Serbian	Public dental service	231	12	CFSS-DS	>38
Lee 2007	Cross-sectional	China	School	3597	05_08	CFSS-DS	>=39
Lima 2020	Cross-sectional	Brazil	School	1189	06_12	DAQ	>=2
Lima Silva 2017	Cross-sectional	Brazil	University dental clinic	115	05_11	CFSS-DS	>=38
Lin 2014	Cross-sectional	China	School	1542	11	CFSS-DS	>=37
Majstorovic 2014	Cross-sectional	USA	University dental clinic	93	06_14	CFSS-DS	>=38
Menoncin 2019	Cross-sectional	Brazil	School	731	8	DAQ	≥ 2
Merdad 2017	Cross-sectional	Saudi Arabia	School	1312	11_14	CFSS-DS	>=32
Milgrom 1992	Cross-sectional	Singapore	School	1564	13_15	DFS	>=60
Milgrom(a) 1994	Cross-sectional	Canada	Private dental clinic	99	4	CFSS-DS	*
Milgrom(b) 1994	Cross-sectional	China	Hospital	70	7	CFSS-DS	*
Muinelo-Lorenzo 2014	Cross-sectional	Spain	Public dental service	56	06_14	CFSS-DS	>=32
Oliveira 2009	Cross-sectional	Brazil	Public health service (immunization campaign)	1478	03_04	DAQ	>=2
Paryab 2013	Cross-sectional	Iran	University dental clinic	150	06_12	$MCDAS_f$	
Patel(a) 2015	Cross-sectional	Scotland	Public dental service	102	07_11	$MCDAS_f$	>=19
Patel(b) 2015	Cross-sectional	Scotland	Public dental service	30	12_16	$MCDAS_f$	>=19
Pedrotti 2015	Cross-	Brazil	University	51	06_12	VPT	*

	sectional		dental clinic				
Raadal 2002	Cohort	Norway	Public dental service	180	10	CFSS-DS	>29
Ramos Jorge 2006	Cross-sectional	Brazil	School	118	04_05	VPT	*
Reis(a) 2016	Cross-sectional	Brazil	University dental clinic	18	04_05	VPT	>=1
Reis(b) 2016	Cross-sectional	Brazil	University dental clinic	51	06_12	VPT	>=1
Salem 2012	Cross-sectional	Iran	University dental clinic	200	03_06	CFSS-DS	>=38
Schuch 2015	Cross-sectional	Brazil	School	1193	08_12	DAQ	>=3
Silveira 2017	Cross-sectional	Brazil	School	1202	08_12	DAQ	>=2
Skaret 1998	Cross-sectional	Norway	School	571	18	DFS	>=60
Soares 2020	Cohort	Brazil	School	416	07_09	DAQ	4
Stenebrand 2013	Cross-sectional	Sweden	School	216	15	DFS	>=60
Strom 2020	Cross-sectional	Norway	School	345	18	DFS	>=60
Ten Berge 2002	Cross-sectional	Netherlands	Private dental clinic	2144	04_11	CFSS-DS	>=37
Torriani 2014	Cohort	Brazil	Birth cohort	1129	4	DAQ	>=3
Versloot 2004	Cross-sectional	Netherlands	School	561	11	CFSS-DS	>=32
Wogelius 2003	Cross-sectional	Denmark	Public dental service	1281	06_08	CFSS-DS	>=38
Wu 2018	Cross-sectional	China	School	366	09_13	CFSS-DS	>=32

DA=Dental anxiety; CFSS-DS= Children's Fear Survey Schedule Dental Subscale; $CFSS\text{-}DS_f$ = faces version of the Children's Fear Survey Schedule Dental Subscale; DAQ= Dental Anxiety Question; DFS= Dental Fear Survey; $MCDAS_f$= faces version of the Modified Child Dental Scale; VPT= Venham Picture Test.

* No information available on cutoff point used for defining the presence of dental anxiety.

Table 2 - Pooled dental anxiety prevalence by instrument used to assess dental anxiety, mode of application of the questionnaire and type of respondent, within each age group

Age group	Number of studies	Number of participants	DA Prevalence (95% CI) *
PRESCHOOLERS			
Scale			
CFSS-DS	3	343	31.0 (3.8,58.2)
DAQ	2	2607	23.4 (21.8,25.0)
VPT	2	136	71.4 (64.0,78.9)
Mode of application			
Self-complete	5	1619	36.8 (16.1,57.4)
Interview	2	1496	31.4 (29.0,33.7)
Respondent			
Caretaker	5	2979	27.7 (16.6,38.8)
Child	2	136	71.4 (64.0,78.9)
SCHOOL CHILDREN			
Scale			
CFSS-DS	13	7080	19.4 (13.9,24.9)
$CFSS\text{-}DS_f$	1	725	25.9 (22.8,29.3)
DAQ	7	6266	38.5 (27.0,50.0)
$MCDAS_f$	2	252	21.6 (16.6,26.6)
VPT	2	102	23.5 (15.3,31.8)
Mode of application			
Self-complete	18	9980	24.5 (18.3,30.8)
Interview	6	4405	29.8 (16.2,43.5)
Unclear	1	40	22.5 (10.8,38.5)
Respondent			
Caretaker	7	4085	28.9 (14.4,43.3)
Child	17	10300	24.7 (17.3,32.2)
Unclear	1	40	22.5 (10.8,38.5)
ADOLESCENTS**			
Scale			
DFS	5	3102	11.4 (7.7,15.0)
$MCDAS_f$	2	691	19.1 (16.2,22.0)

* In all meta-analyses where 3 or more studies were pooled I^2 was estimated; all I^2 were greater than 89% and p-values were lower than 0.01. **In all studies with adolescents instruments used to assess dental anxiety were self-completed by the adolescents themselves.

Table 3 - Dental anxiety prevalence in each study that provided information on DA prevalence by sex and pooled dental anxiety prevalence by sex in preschool children and school children

Study	Age range (years)	Number of participants	DA Prevalence (95% CI)	
			Female	Male
PRESCHOOL CHILDREN				
Chhabra (a), 2012	5	73	8.6 (1.8;23.1)	7.9 (1.7;21.4)
Torriani, 2014	4	1129	17.4(14.3;20.9)	16.3 (13.5;19.5)
Pooled prevalence	**4-5**	**2404**	**16.5 (13.5; 19.5) I^2=n.a.**	**15.4 (12.6; 18.2) I^2=n.a.**
SCHOOL CHILDREN				
Wogelius, 2003	6-8	1281	5.7 (4.0;7.8)	5.7 (4.1;7.8)
Chhabra (b), 2012	6-10	450	6.0 (3.2;10.1)	6.4(3.6;10.4)
Beena, 2013	6-12	444	46.9 (40.2;53.6)	46.8 (40.1;53.6)
Pedrotti, 2015	6-12	51	28.6 (11.3;52.2)	20.0 (7.7;38.6)
Lalic, 2015	12	231	16.7 (10.5;24.6)	11.7 (6.4;19.2)
Barreto, 2017	6-7	1367	57.2 (53.3;61.0)	51.8 (48.0;55.5)
Caprioglio, 2009	6-10	725	30.0 (25.4;35.0)	21.8 (17.7;26.4)
Menoncin, 2019	8	731	56.3 (51.0;61.5)	54.5 (49.3;59.7)
Alsadat, 2018	06-12	1546	20.6 (17.7;23.7)	5.0 (3.6;6.8)
Pooled prevalence	**6-12**	**10840**	**29.7 (15.7;43.8) I^2=99.2%**	**24.8 (12.9;36.8) I^2=99.1%**
ADOLESCENTS				
Strom, 2020	18	345	13.1 (8.1;19.7)	4.5 (2.1;8.4)

95% CI = 95% confidence interval; I^2 = I^2 statistic for heterogeneity assessment.
I^2=n.a. means that I^2 could not be calculated because only two studies were combined.

APPENDIX- Search strategy developed for Medline via Pubmed

#1 disease frequency surveys [All fields] OR sectional studies [All fields] OR prevalence studies [All fields] OR cross-sectional studies [MeSH Terms] OR prevalence [Title/Abstract] OR prevalence [MeSH Terms]

#2 dental anxiety [MeSH Terms]) OR dental anx* [All fields] OR dental fear [All fields] OR dental phobia [All fields] OR odontophobia [All fields]

#3 child [MeSH Terms]) OR child* [Title/Abstract] OR pediatric [Title/Abstract]) OR paediatric [Title/Abstract]) OR adolescent [MeSH Terms]) OR adolescent [Title/Abstract]) OR minor [MeSH Terms]

#1 AND #2 AND #3

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