Barriers and Drawbacks of the Assessment of Dental Fear, Dental Anxiety and Dental Phobia in Children: A Critical Literature Review

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Objective: *Dental anxiety, fear and phobia have different etiology, response patterns, time courses, and intensities that justify a clear distinction between these constructs. Differentiation of dental anxiety, fear or phobia in practice is a critical prerequisite for developing and implementing effective treatment for children. The aim of this study was to investigate whether current researches in the pediatric dentistry appropriately discriminate the central construct of dental anxiety, fear and phobia. We also highlighted the specific methodological issues in the assessment of these issues in pediatric dentistry.* ***Study design:*** *A systematic search was conducted in Pubmed/medline and Scopus for articles which assessed dental anxiety, fear or phobia in children.* ***Results:*** *104 research papers were included in the review that had made a distinction between dental anxiety, fear and phobia and had not used them interchangeably. Only five studies used different clinical measures or cut-offs to discriminate between dental anxiety, fear and phobia.* ***Conclusion:*** *The dental literature appears unable to capture and also measure the multi-sided construct of dental anxiety, fear and phobia and, therefore, there was a tendency to use them interchangeably.*

Key words: *Pediatric Dentistry; Phobia, Specific; Psychometrics*

INTRODUCTION

Disruptive behavior, and anxiety- and fear-related reactions are frequent encounters in pediatric dentistry and have major implications for the child, dental team and public health service providers [1, 2]. Dental anxiety, fear or phobia make the dental treatment time-consuming, costly and demanding for the clinician and the child, and have a strong negative impact on treatment outcome [1, 3].

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The primary step toward an adequate and effective treatment for children with dental anxiety, fear or phobia should include an accurate understanding of the child's problem using a proper screening scale. Dental fear, anxiety, phobia and behavior management problems (DBMP) are different concepts related to each other, but not identical, and can involve different physiological, cognitive, emotional and behavioral components. Besides, a child specifically afraid of injections or drilling may need a different management approach than a child mostly afraid of unknown people and an unfamiliar setting [4, 5]. Thus, the question of who is at risk for these problems, which methods would be most useful for which patients and delivered by which professionals are a number of critical issues that needs to be addressed in order to ensure the effectiveness of any treatment [6, 7].

Dental anxiety and fear vary across a continuum from very mild anxiety and fear to severe and debilitating dental phobia [5]. Children with low or moderate fear or anxiety can be effectively managed by establishing a trusting relationship, good communication skills, empathy, careful treatment and some basic non-pharmacological approaches. On the other hand, highly anxious/fearful or phobic children may require specific pharmacological support in addition to the use of behavior guidance strategies (i.e. behavioral guidance techniques, nitrous oxide sedation, intravenous sedation, and general anesthesia) [5, 6, 8-10].

Therefore, a brief review of the more clinically oriented conceptions may help to set some theoretical basis to understand and differentiate these phenomena in practice which is a critical prerequisite for studying and understanding the nature, prevalence and consequences of these common problems. Any definition should enable

the clinician to identify an individual within the domain that the definition addresses.

Anxiety represents a state when a child is evoked and prepared for something to happen. It is not attached to an object, rather it is a generalized response to an unknown threat or internal conflict and is associated with more abnormal conditions [8, 11]. Specifically, dental anxiety is defined as the response to a stressful stimulus that is specific to the dental context and its recognition should be established by reference to its origin. Dental anxiety is considered as an affective expression of a normal anxious state or as a pure and specific psychopathological condition. The practitioner should differentiate what is linked to a state condition (dental anxiety) from psychiatric disorder (Such as generalized anxiety or trait anxiety) [12-14].

Fear, on the other hand, is a reaction to a known, specific and real external threatening stimulus [11]. Dental fear is a normal emotional reaction to threatening stimuli in the dental situation [8, 13]. It can arise because of particular events like past trauma in the dental surgery (previous learning) or during other medical procedures (the generalization of fear) [15]. A practitioner should recognize that the fear of new and potentially threatening things and situations is a normal reaction for children [8, 16]. Avoidance reduces fear in children. Therefore, the first response to a feared object or stimulus is to avoid or escape the fearful situation [15]. In other words, the psychological and biological responses accompanying anticipation of encountering the fearful stimulus or situation can be termed the anxiety response. But, the consequences of encountering the stimulus or situation can be termed the fear response. At a more functional level, anxiety can be seen as preparing an individual for a fearful situation [17].

Phobia is more likely to be developed in children with exaggerated fear responses that persist even in safe settings [15]. Dental phobia represents a severe and special form of dental fear and is a persistent fear of clearly discernible, circumscribed objects or situations in dental setting [5, 17]. According to the criteria of DSM-V, dental phobia is characterized by marked and persistent fear of clearly discernible situations or objects which is unproportional to the dental situation, is unadaptive and is not age or stage appropriate, cannot be explained or reasoned away, is beyond voluntary control, and leads to avoidance of necessary dental treatment or enduring treatment only with dread [8]. Although one of the major criteria regarding dental phobia is the avoidance of dental care, many children are not allowed to avoid even if they would wish to [15]. Dentally phobic children who attend the dental appointments experience significant distress and exhibit poor compliance with dental procedures [19].

Therefore, the differences in etiology, response patterns, time courses, and intensities seem to justify a clear distinction between dental anxiety, fear and phobia. Dental practitioners should be efficient at detecting the presence of dental anxiety, fear, phobia or DBMP. It is therefore recommended to use a structured and psychometrically valid scale during clinical assessment [20]. The importance of any measure of child dental anxiety, fear and phobia is to give the clinicians and researchers the means to assess the subjective experience of dental fear and anxiety in an objective and consistent manner, and also to identify the relevant characteristics of the anxiety/fear-inducing situation [16]. A recent survey reported that the use of scales in clinical practice is limited and only 17% of dentists used child anxiety assessment questionnaires. Indeed, most dental practitioners attempt to subjectively evaluate the patients or obtain information from their patients which can be highly variable between dentists and from one patient to another [20].

Accordingly, the various problems surrounding the issue led us to ask the question of who should be considered to be dentally anxious, fearful or odontophobic? In addition, considering methodological issues with measurement of dental anxiety, fear and phobia; the question is raised whether current studies in pediatric dental literature appropriately measure and discriminate the central construct of dental anxiety, fear and phobia which may significantly affect the result of any given investigation. Furthermore, given the fact that the definition and construct of dental anxiety, fear and phobia are fundamentally different; is there any study that differentiated dental anxiety, fear and phobia based on the conceptual and theoretical underpinnings of each particular construct? Therefore, this works comprehensively reviews the principal issues and methodological pitfalls that are relevant to the assessment of dental anxiety, fear and phobia in children. Particularly, we will analyze which measures are used to assess each of the constructs, the degree of overlap in assessment of these distinct constructs, and the appropriateness of the measures used to assess each of the constructs.

There is a relatively new and ongoing discussion in the behavioral dentistry community about the need to study and address dental fear and anxiety as related but distinct emotions. We hope that the results of this review help researchers, clinicians, psychologists, service providers and epidemiologists to correctly recognize and assess dental anxiety, fear and phobia when undertaking studies. This paper will outline the steps that are needed to be taken in subject selection, measurement, and study design in order to create scientifically sound outcomes. The field of dental anxiety and fear and their assessment in dental patients will be reconsidered with dissemination of present research findings which can be incorporated into research in all related fields of dental fear and anxiety.

MATERIALS AND METHOD

Search strategy

A systematic search was conducted by a professional librarian with skills in informatics by searching electronic databases Pubmed/MEDLINE and Scopus for English language peer-reviewed articles published between 1986 and June 2015 using the search terms ((“dental anxiety” OR “dental phobia” OR “dental fear” OR “odontophobia” OR “dental distress” OR “dental stress” OR “dentist phobia” OR” dent* anxiety” OR “dent* phobia” OR “dent* fear”)) AND (“infant” OR “child” OR “adolescent” OR “children” OR “young” OR “young person” OR “minor” OR “paediatric” OR “pediatric”)). To ensure completeness, functional search characters were used to search for word variations, ‘‘dent*’’ was used to obtain results containing ‘‘dentist’’, dentists’’ and ‘‘dental’’. A database of the first search results was created and subsequent search results were entered and duplicate entries were removed.

After searching the databases, some pediatric and valid journals in this field including the International Journal of Paediatric Dentistry, Pediatric Dentistry, The Journal of Clinical Pediatric Dentistry, European Archives of Paediatric Dentistry, Journal of Dentistry for Children, and Community Dentistry and Oral Epidemiology were also hand searched. In addition, the reference lists of selected articles were manually searched in order to complement the search database.

Inclusion criteria

- Abstract available in English.
- Children aged 3–18 years old.
- Use of a measure/scale to assess dental anxiety, fear and phobia in patients.
- Participants with no confounding medical and/or psychological history and neuro-psychiatric disabilities.

Exclusion criteria

Papers fulfilling any of the below criteria were excluded:

- Exchangeable use of the words dental anxiety, fear and phobia. This will also exclude those studies that did not measure the construct they claim to measure.
- Mixed populations (unless specific data were available for the target age group).
- Letters to editor, presentations in conferences, case reports and unpublished papers.
- Use of only physiological measures (i.e heart rate etc.) as an indicator of dental anxiety, fear or phobia.

Data extraction

Initial selection was based on the titles and abstracts of the obtained studies. Two reviewers independently screened and identified studies against the selection criteria. Whenever fulfillment of these criteria was not clear from the abstract, the full text of study was obtained for verification. A third reviewer conducted a random check of approximately 10% of titles and abstracts to check reliability of initial screening. All papers that passed the abstract screening were retrieved in their complete forms, and data extraction was conducted.

A standardized data extraction form was developed, piloted and employed by two independent reviewers. Independent data extraction by two reviewers was performed for all eligible studies. Study authors were contacted for additional information when needed. Disagreements were resolved through discussion. If disagreement persisted, the judgment of a third reviewer was decisive.

The following data were then extracted from the articles using the data extraction form: Presence of definition for fear, anxiety or phobia and discrimination of these conditions; exchangeable use of these terms; year of publication, journal title, country and setting where the study was conducted (clinic, school, home etc.); study's main objectives, sample size, design and randomization; context including the type of dental procedure and interventions for reducing dental fear, anxiety or phobia; characteristics of participants including age, gender, previous dental experience; time of assessment of anxiety/fear/phobia (before, during and/or after treatment); properties of measurement tool including type and cut-off. The original validation papers for all of the measures identified within the review were consulted to collect information about their reliability and validity.

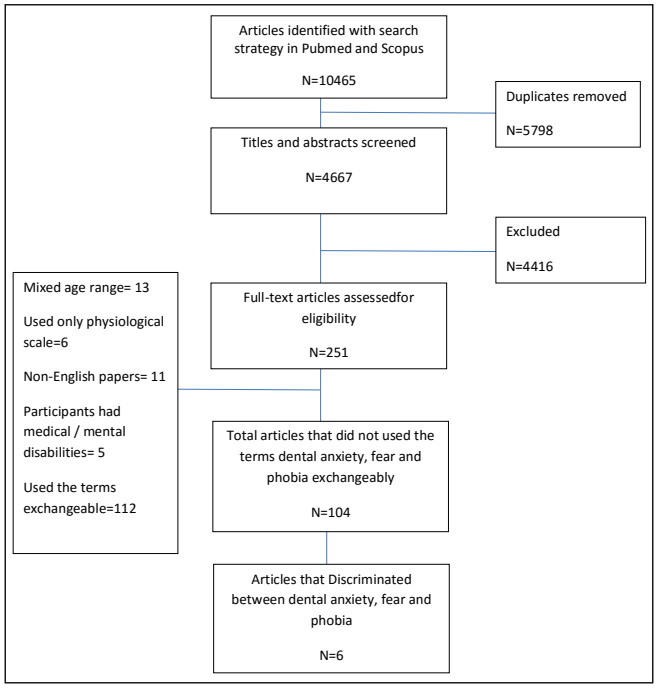
In the second stage, we sought those studies that differentiated dental anxiety, fear and phobia.

RESULTS

There was 85% agreement between reviewers for inclusion of papers when abstracts were reviewed and 90% agreement for inclusion when complete papers were reviewed.

Executing the search strategy initially yielded 4667 unique articles. Then, two of the authors (S.S and M.S) examined the titles and abstracts of these 4667 articles, and identified 251 articles that fulfilled the inclusion criteria. The 251 articles were reviewed independently by two of the authors (S.S and M.S) to ensure that they met all of the review criteria. Following the reviewers assessments, 147 of these 251 studies were eliminated because they failed to meet one or more of the review criteria leaving a total of 104 papers that met all of the study's criteria (Figure 1). The data extraction table for included studies is shown in Appendix 1.

Figure 1- Literature review flow diagram.



Characteristics of the final sample of studies

This final sample of 104 studies published from 1991–2015, with a median publication date of 2007. Eleven studies were published in the 1990s, 49 in the 2000s, and 44 studies were published since 2010. Forty four studies were conducted in Europe, 35 in Asia, nine in North America, seven in South America, three in Africa, three in Australia and three in other countries. The majority of articles (n = 73) reported the outcomes of cross-sectional studies. Three articles featured comparative or controlled cohort, and 24 articles reported on randomized controlled studies, and four consisted of a retrospective data analysis.

The study sample sizes ranged from 23 to 3597participants, with a median size of 89. The studies took place in a variety of settings including specialist dental centers, schools, and participants' homes. Seven of the studies were conducted in more than one setting (Appendix 1).

Discrimination between dental anxiety, dental fear and dental phobia

Dental fear, anxiety and phobia were studied in 24, 77 and three studies respectively. Six (5%) of these 104 studies included different clinical measures or cut-offs to discriminate between dental anxiety, fear or phobia. Only three (2.5%) studies provided a credible rationale for differentiation of dental anxiety from dental fear using two different scales. In these studies, the Child's Fear Survey Schedule-Dental Subscale (CFSS-DS) was used for dental fear and Clinical Anxiety Rating Scale (CARS), Venham Picture Test (VPT), Visual Analoug Scale (VAS) and State Trait Anxiety Inventory for Children (STAIC-S) for dental anxiety. One study differentiated dental anxiety from blood and injection phobia using Dental fear scale (DFS), and Injection Phobia Scale and Mutilation questionnaire for Blood injury fear and phobia, respectively. There were also two (1%) studies that differentiated dental anxiety from dental phobia using a cut-off point. They used Modified dental anxiety Scale (MDAS) and Modified child dental anxiety scale (MCDAS) for dental anxiety with a cut-off score above which children were considered to have dental phobia (Table 1) (Appendix 1 A).

Assessment measures

In the included studies, two self-styled tools and 24 established scales were used to assess dental anxiety, one scale was used to assess dental fear and two scales were used to assess injection phobia and blood phobia. One self-styled tool and four established measures were used to assess either dental anxiety or fear. Of the established scales, nine were psychometric tests, 10 were pictorial scales and four were of behavior rating scales. Eight other types of scales were also used in the studies which were not dentally specific (Table 2). As it is shown in Table 2, same measures were used for different constructs. The most widely used scale was the CFSS-DS which was used to assess both dental anxiety and dental fear (in 40 studies, 38%). MCDAS, DFS and CARS were also used to assess both dental anxiety and fear. The VPT was the second most used measure (in 13 studies, 12.5%) followed by the MCDASF (in 11 studies, 10.5%) (Appendix 1).

Time of assessment

Dental fear was most widely assessed at places other than dental environment (15 studies, 62%), before treatment (11 studies, 45%) and after treatment (5 studies, 20%) respectively. Dental anxiety was most widely assessed prior dental treatment (47 studies, 57%), at places other than dental environment (26 studies, 31%), during treatment (21 studies, 25%) and after treatment (18 studies, 21%) (Table 3) (Appendix 1).

Using parents/raters to assess children's dental fear/anxiety

The use of proxy in the assessment of child's dental fear was common and parents' rating of their children's dental fear was largely used in the included studies (9 studies, 38%). Dentists were used to assess children's dental fear in three (12%) studies. Children's self reports were used in 17 (70%) studies. However, dental anxiety was mostly assessed using children self reports (78 studies, 95%). Parental and dentists' rating of children's dental anxiety were used in 19 (23%) and 15 (18%) studies respectively. In overall, proxy method was mostly used in children aged 6-12 years. The CFSS-DS was widely used as a proxy measure of children's dental fear and anxiety. There were 18 (17%) studies in which it was filled in by parents to assess their children's dental fear and/or anxiety. The MCDAS, DFS and Venham's Rating of Clinical Anxiety were other scales by which parents/raters rated the children's dental anxiety or fear (Table 2 and 4) (Appendix 1).

Use of measures in children of different ages

The participants in the included studies were categorized into three age groups of 3-6, 6-12 and 12-18 years old. The most frequently used measure type for 3-6-year old children were pictorial scales. They were used in 21 (20%) studies of which the VPT was the most common scale used in seven (6%) studies. Psychometric scales were used in 16 (15%) studies and were second widely used measure types and parental version of CFSS-DS was in the first rank. Behavioral rating scales were used in 8 (8%) studies.

In children aged 6-12 years psychometric tests followed by pictorial scales were the most common scale types used for the assessment of dental anxiety and fear. They were used in 53 (50%) and 34 (33%) studies, respectively. Child and parental version of CFSS-DS were largely used in this age group. Behavioral rating scales were used in seven (6%) studies.

In 12-18-year-old age group, the same trend as previous age range was observed. Psychometric tests were used in 39 (38%) studies and followed by pictorial scales that were used in 13 (13%) studies. Interestingly, behavioral rating scales were not used in these children (Table 4) (Appendix 1).

Screening for children's background psychological problems

Of the 104 included studies, only 18 (17%) studies had screened and excluded those children with anxiety or other childhood-related disorders. Most of the reviewed studies did not report whether they controlled for probable psychological problems in the included children (Appendix 1).

Using various techniques for reduction of dental anxiety or fear

There were 19 (18%) studies which had incorporated different scales as outcome measures of the effects of different interventions on children's dental anxiety. These interventions included virtual reality, video modeling, ART, audiovisual distraction, preoperative information, viewing positive images, WAND and EDA. No study aimed at evaluating possible techniques for reduction or treatment of dental fear or phobia (Appendix 1).

Use of scales for treatment planning

None of the included studies attempt at using dental anxiety and fear scales to identify children with different treatment needs to establish tailored treatment plan and choose appropriate treatment.

Cut-off

In the included studies and among the scales incorporated, only CFSS-DS, MCDASf, CARS, MDAS, CDAS, DFS and MCDAS were used with cut-points. Each of these measures was applied with different cutoffs which are shown in Table 5 and Appendix 1.

DISCUSSION

In order to establish a reasonable relationship between etiology and clinical consequences of dental anxiety, fear and phobia, it is important to interpret these constructs at a formal theoretical level. First, if dental anxiety, fear and phobia are different, they should have different underlying conditions and be caused by different precipitating events. Second, activation of dental anxiety fear or phobia should have different consequences or cause different behaviors. If these two conditions are met, then dental anxiety, fear and phobia would be valuable and not redundant constructs. Otherwise, there is little value in having these separate constructs [18]. The present study provides an extensive review of the studies attempt at measuring dental anxiety, fear and phobia in children. Our findings can provide insights for researchers and clinicians who intend to evaluate children's dental anxiety, fear or phobia and may fill the existing knowledge gap about the methodological and theoretical issues in this field.

All together, there were 104 studies that at least apparently made a distinction between dental anxiety, fear and phobia and did not use them interchangeably. None of them have explicitly aimed to differentiate dental anxiety, fear and phobia. While different clinical measures or cut-off points were used in five studies to discriminate these constructs, the issues have not been successfully captured and defined. Surprisingly, of 34 studies in which dental fear, anxiety and phobia were clearly defined, 13 studies failed to adhere to these conceptual principles throughout the text and fell into the pitfall of using these concepts interchangeably.

Therefore, the dental literature appears to lack a clear understanding of the concepts of dental anxiety, fear and phobia. There was a tendency to ignore them empirically considering the subjective and multidimensional nature of these conditions. While a distinction between fear and anxiety is made in both clinical and preclinical psychology [11, 18], there is no consistency in the dental literature to characterize these constructions practically and beyond their subjective status. This deficiency has led to the current discrepancy and uncertainty in the clinical dental literature in which no clear distinction could be made between the different causes and differences of fear versus anxiety and the responses they are intend to generate in the dental setting. In order to enable the investigators to compare and integrate the results of different investigations; clear, consistent and theory based definitions of dental anxiety, fear and phobia should be provided.

Dental phobia

Although one study used a scale for assessment of blood and injection phobia, none of the reviewed studies have included a diagnostic assessment of dental phobia. Consequently, they might have failed to identify children with dental phobia. In addition, we did not find any scale that has been designed for, or at least has considered, the detection of dental phobia based on specific diagnostic criteria. Current scales either could not differentiate dental anxiety from fear. The use of cut-offs is naive and cannot differentiate dental fear, anxiety and phobia from each other. Therefore, it is not surprising that the correlates of dental anxiety, fear and phobia is lacking in the current available data [17]. Despite the recommended use of self-report measures to identify children who need special attention, and to assess symptom severity as well as treatment effects, the performance of self-report scales as a diagnostic tool for dental phobia have not been established, and the use of these scales for diagnostic purposes is problematic [21]. In addition, dental phobia has previously been considered to be a phobia of the dentist. However, the dentist has been found to be one of the least fear-evoking aspects of the dental situation. This may have led to significant under-reporting of the incidence of dental phobia in the literature [21].

Dental fear/anxiety vs. dental behavioral management problems (DBMP)

DBMP denote to externalizing behavioral problems related to the dental situation. Children with DBMP may or may not have behavior management problems in other situations [22]. DBMP represent uncooperative and disruptive behaviors resulting in the delay of treatment or rendering the treatment impossible [8].

The distinction between dental fear/anxiety and DBMP is important. DBMP are likely to be identified more easily by the practitioners than dental fear/anxiety. The presentation of dental fear/anxiety may vary from uncooperative behavior to being more passive and silent during the treatment, reflecting the differences in personality characteristics and etiology [8, 23]. It has been shown that there is an overlap in the symptoms of dental fear/anxiety and DBMP [22]. Thus, dental anxiety and fear are likely to be missed if the dentist only focuses on child cooperation or behavior during the treatment. Moreover, although DBMP is the defining feature of dental anxiety and fear, it is often associated with other disorders particularly specific phobias [19].

It has been noted that most referrals in pediatric dentistry are based on DBMP [22]. Therefore, in order to conduct a study related to dental fear/anxiety in children screening should be targeted toward dental fear/anxiety rather than inclusion of individuals based on a single characteristic namely uncooperative behavior. Most aspects of children's behavior in the dental environment are core aspects of clinical child psychology, and consequently theories and measures developed within that field have a strong potential to enrich studies of dental fear/anxiety and DBMP [22].

One measure for different constructs

As our review demonstrates, various measures were used to assess the level of dental anxiety or fear. The most striking result of this review is that same scales were used for different constructs and vice versa. Considering the conceptual shortcomings of exciting measures, it is difficult to explicitly say that which scale measure what identical construct. Beside, typically each instrument asks different questions based on various conceptual foundations, and the determination of dental anxiety, fear and phobia is derived from different ranges of possible answers. Consequently, the nature of generated scores and possible interpretation of conditions is rather dependent on issues such as scale construction and construct coverage, item weighting, placement of cut-points and measurement error [24]. Therefore, the level of agreement and concordance among different dental anxiety and fear scales should be assessed in order to interpret the results correctly and with a sufficient amount of certainty. However, even with high association between the scales, the use of different scales could result in identifying basically different people in the same study with the same population. It has been shown that the existing measures are inconsistent with only fair to moderate agreement in terms of classifying individual children as having high dental anxiety or fear [17, 24].

Because dental anxiety and fear can be measured for different purposes (e.g. clinical, service organization, survey or research), choosing the correct scale as an appropriate outcome measure is essential. In addition, considering the fact that dental anxiety, fear and phobia are fundamentally different constructs and may have different emotional, behavioral, cognitive and physiological components and response systems, one measure would never be appropriate for various purposes. Therefore, measurement of dental anxiety or fear should combine behavioral, self-report and physiological methods because neither the children's behavioral responses nor physiological responses are sufficient indices for their anxiety or fear [25]. Direct scaling or self-report techniques can provide qualitative and quantitative estimates of anxiety or fear. Behavioral and physiological techniques can be used in a repeated time sampling sequence throughout a clinical session to provide a comprehensive pattern of how anxiety parameters change throughout the situation [16].

Cut-off

Classification of children as having predefined amount of dental anxiety or fear (i.e. high, medium or low) by means of cut-points and categorizing continuous scale scores has been a dominant theme in the literature. Our review, surprisingly, revealed that different cut-points were adopted on an identical scale to define dental anxiety or fear. The CFSS-DS, MCDASf, CARS, CDAS, MCDAS, DFS and MDAS were used with different cut-points to measure the same issue. The use of different cut-points can alter the sensitivity and specificity of scales which in turn affects prevalence estimates and other related outcomes. Different cut-points on a scale may impact the interpretation of outcomes and affect the associations between dental anxiety/fear and individual factors like age and gender. Besides, the selection of cut-points is a fundamentally arbitrary exercise which exacerbates the discrepancy in the use of cut-points to determine dental anxiety or fear [24].

In epidemiological studies, one reason for the wide range of estimated prevalence of dental anxiety and fear in child populations might be related to the fact that the prevalence estimates would differ considerably depending upon the cut-point used to define a case of (high) dental fear or anxiety. It might also be an artifact of differences between the scales in terms of what they measure and how they measure dental anxiety and fear. Different prevalence estimates may also be due to the differences related to culture, study design and sampling methods [17, 22, 24]. Therefore, these results cannot be directly compared with each other since it is not clear whether these estimates reflect real differences among populations or whether they are methodological variations in origin. On the other hand, the interchangeable use of the terms of dental fear and anxiety in the literature makes the implications and interpretation of any given result much more problematic. As a result, it remains to be determined whether the mentioned construct is truly captured. Consequently, the scientific value of reporting prevalence estimates or any interpretation based on cut-points might be questionable. The use of distinct definitions and appropriate measurement tools will clearly influence estimates of the prevalence of these constructs and judgment of any given finding. Besides, reporting measures of central tendency (i.e. mean, median, mode) and the distribution of scores would solve many of the problems discussed here and allow for the comparability of scores from different studies [24].

In addition, equalizing the cut-points used to define dental anxiety or fear across different scales that might result in more comparable results has remained controversial and has been largely ignored. However, in the absence of a gold standard, identification of dental anxiety or fear is largely dependent on the content and the nature of the scale adopted to categorize the study participants which might fundamentally affect the outcomes of any investigation [24].

Therefore, there is still a need to further improve our understanding of the use of cut-off scores in epidemiological and clinical studies, as well as to establish and validate cut-off points differentiated by age, gender and informant (child's self-report or report by accompanying parent). Unfortunately, there is currently no research about the possible gender or age differences in the interpretation of particular items in the dental fear and anxiety scales [24]. Cognitive interviewing techniques that ask children to verbalize their thoughts whilst responding to questionnaire items, could be used to test how children of different ages are able to understand and complete measures of dental anxiety and fear [1]. However, previous reports support the use of age differentiated cut-off scores for both screening and clinical purposes. Lower cut-off scores has been suggested for older children compared to younger children [26].

Knowledge of the sensitivity and specificity of different ranges of scores will allow different applications based on the context for which the scales are used. The aim of any given study should be considered when choosing cut-offs to evaluate dental fear/anxiety. Lower cut-off scores are suitable where diagnostic sensitivity is the primary goal and also false positives are not a major concern. However, using standard cut-offs appears to apply too strict criteria (high specificity) for dental anxiety or fear leading to an underestimation of the prevalence of these problems in epidemiological studies. Furthermore, from a clinical perspective, a cost-effective individualized treatment strategy based on differential diagnosis of dental fear/anxiety is of great importance for both the patients and the practitioners. Thus, the focus should be on specificity using score levels near to standard cut-off point which might have high sensitivity and be more responsive to influences of age, gender, and purpose of the study [24, 26].

Utilizing proxy method for assessment of children's dental fear and anxiety

Based on the results reported in the reviewed studies, the proxy method was mostly used in children aged 6-12 years. Previous research has revealed that children aged eight years and older can reliably report all aspects of their health. On the other hand, children as young as three and four are capable to effectively communicate their emotional and physical experiences such as pain [1, 26, 27], and Children older than five are considered to be capable of reporting their fears and anxieties using questionnaires [28]. However, the reliability of parental reports has been questioned since the parents' assumption of their child's dental fear and anxiety is far from its real feature and often inappropriate [27]. The agreement between children's self-report and parental report of their children's level of dental anxiety\fear has been reported to be only poor to moderate regardless of using different types of questionnaires and different statistical methods to assess inter-rater agreement [28].

In our included studies, the use of proxy method in the assessment of children's dental fear was common and the parents' rating

of their children's dental fear was largely used. However, dental anxiety was mostly assessed using children's self-reports, and proxy report was not widely used. On the other hand, different respondents such as parents, clinicians or children themselves were used in questionnaire-based assessment of children's dental anxiety and fear. However, research on child psychology and psychopathology has shown that the agreement between informants (i.e. parent, teacher, clinicians) on children's problems and dysfunctions are not compatible with the children's own perceptions [26, 27]. The agreement has been reported to be weaker for internalizing (i.e. anxiety or depression) as compared with externalizing problems. This pattern may be explained by the fact that externalizing problems are more easy to characterize by observers (i.e. parents, clinicians and teachers) than internalizing or emotional problems [26]. Therefore, the current reliance on parental ratings of children's dental anxiety and fear is seriously undermined. For children 8 years of age and older, self-ratings should be considered as an essential and primary tool of assessment of dental anxiety and fear. However, for younger children and those unable to fill out a questionnaire the use of a proxy, preferably parent-reported method, is of primary importance.

In addition, using dentists' clinical observations for assessing children's dental anxiety/fear is not reliable. It has been noted that there is only poor to moderate agreement when dentists' ratings are compared to the child's own rating of anxiety or fear using different scales [1]. While children with dental anxiety and fear may be more likely to exhibit negative emotional and behavioral reactions within the dental environment, some children do not display overt presentations of anxiety and fear. On the other hand, behavioral reactions such as DBMP might be interpreted as manifestations of dental anxiety and fear [1]. Furthermore, a clinical diagnosis of dental fear and anxiety may be difficult to establish in children who have developed coping mechanisms. This may cause some bias in their subjective assessment as the rater might equate a child's dental fear and anxiety with the ability to accept treatment [29].

Scales for treatment planning

Ideally, dental fear and anxiety scales are designed to aid practitioners in choosing appropriate patient management techniques and treatment modalities. Unfortunately, none of the reviewed studies used dental anxiety and fear scales to identify children with different needs and establish or choose an appropriate treatment plan. Apparently, identification of treatment needs for children are often based on the subjective assessment of children's behaviors by dentists. Our results highlight an important issue that the practitioners should avoid grouping child patients with different level of dental fear and anxiety into one universal category. The treatment plan should be chosen based on the level of child's dental fear/anxiety and its underlying reasons, and child characteristics including age, temperament and developmental stage. However, deciding which interventions are appropriate for which patients and under what conditions is rarely addressed in the literature. Therefore, preoperative use of these scales would provide a quick impression of dental anxiety/fear level and differentiate their symptoms in order to provide more tailored treatment options [17, 30, 31].

On the other hand, little attention has been directed to the effects of interventions on child dental anxiety/fear. Only 19 studies incorporated scales as outcome measures of different methods for reduction of children's dental anxiety. While children's level of dental anxiety might affect their response to these interventions compared to non-anxious ones, only two studies have included children with high dental anxiety, and only in these studies a significant reduction in dental anxiety was observed. It is, therefore, possible that the remaining studies have encountered the floor effect problem and have failed to observe any actual benefits that might have occurred following an intervention, because they included participants without (or low levels of) dental anxiety. Therefore, studies on dental fear and anxiety should consider floor effect problem and attempt to differentiate children with and without dental anxiety/fear before any intervention is applied. Besides, all of these 19 studies failed to capture the differential effect of treatment modalities on pre-operative dental anxiety considering the fact that none of these studies included an appropriate control group (i.e. with different level of dental anxiety).

A consensus has not been achieved on the gold standard for assessing dental anxiety and fear in children underwent different therapeutic interventions. However, practitioners should select a measure which assess the specific component of dental anxiety/fear that is being manipulated [1]. For instance, if pharmacologic or relaxation procedures are being studied, assessment of the physiological responses may be appropriate.

Screening for possible existing disorders

The practitioners should be able to recognize and deal with dental patients who may suffer any psychiatric disorders in order to enhance patient's compliance and treatment. Children's personality or psychological problems might interact with dental anxiety/fear and exacerbate their disruptive behaviors in reaction to aversive events or stimuli [32]. Of the 104 included studies, only 17 studies had screened the children with anxiety disorders or other childhood-related disorders. Neuropsychiatric disorders constitute a substantial group of diagnoses affecting up to 5% of the child population. Therefore, it is important that practitioners are appropriately trained to use of screening tools of possible coexisting disorders. Specifically, children at risk of developing internalizing disorders including anxiety, depression and psychosomatic problems tend to score high on measures of dental fear/anxiety. Moreover, there might be a relationship between DBMP and externalizing disorders such as Oppositional Defiant Disorder and Conduct Disorder [33]. It is also likely that children with neuropsychiatric disorders exhibit dental fear/anxiety or DBMP as part of their diagnosis [22]. These children need special attention to overcome the challenges that they are faced in dental environment.

Time of assessment

The time point at which dental anxiety/fear is measured can affect the outcomes. It is also important to consider the time frame of the assessment in order to evaluate the dynamic process of change [7]. Based on our results, dental fear was most widely assessed at places other than dental environment (15 studies), before treatment (11 studies) and after treatment (5 studies). In addition, dental anxiety was most widely assessed prior dental treatment (47 studies), at places other than dental environment (26 studies), during treatment (21 studies) and after treatment (18 studies). Practitioners should keep in mind that pretreatment assessment of a child at home or waiting room is more likely to capture the child's anxiety rather than fear. Moreover, filling a dental fear questionnaire before treatment

may give false results as the child may experience anticipatory anxiety prior to treatment that would be expressed through the questionnaire instead of the fear relating to the dental procedure at the moment. However, the use of preoperative questionnaires is questioned especially in the dental situation since it is necessary to know why or when a child is over stimulated or unable to cope with an invasive dental treatment [32]. On the other hand, applying measures immediately after treatment might capture the child's dental fear. However, concurrent factors such as pain experience and dental environment may confound the child's response. Besides, a lower score would also be expected several hours after treatment [20]. Another problem relates to the use of single questions that leave the interpretation of fear and anxiety to the child. There were three studies in the included articles that had used only one single question to assess dental anxiety in children. It has been argued that this method easily leads to the inclusion of general concerns or worries in children's responses [21]. Assessment of anxiety after treatment is questionable since children who recovered after treatment may rate the treatment procedure more positively than they actually felt. Besides, it is not fully clear that changes in the psychological responses are related to changes in anxiety/fear or to a general arousal state. Therefore, because the timing of measurement may have influenced the results rather than treatment efficacy, future studies should attempt to standardize the assessment periods over the course of the treatment and follow-up. Use of a control group with no treatment allows for the evaluation of the changes observed through repeated measurement [7].

In addition, dental fear/anxiety scores might be higher in children in the school compared with children in clinical settings. This difference in levels of fear/anxiety is possibly related to the fact that phobic or highly fearful/anxious children are less likely to attend dental treatment, but they can be included to study in school-based samples. In addition, many of the children undergoing dental treatment may be recall patients who may have been coped with the situation. School samples offer the advantages of faster and easier data collection because the children can be surveyed in groups. In addition, school-based sample is assumed to be more representative because even dental avoiders are likely to attend school. On the other hand, most private practice patients have a long-standing relationship with their dentists which might result in less anxiety, whereas clinic patients would soon drop out if they were anxious about the situation.

Previous dental experience

The effect of confounding variables including previous experience of medical and dental treatment, anticipated treatment to be undertaken and whether the participants knew what treatment they could expect should be taken into account [34].

Anxiety is an unspecific feeling that requires no prior experience of the anticipated situation. In the case of dental anxiety, there is a feeling of apprehension of possible pain, discomfort or danger during dental treatment even when there is not a prior experience. In addition, there is a negative relationship between frequency of dental visits and dental anxiety and fear. A higher dental anxiety has been reported in children with no previous dental visits [35]. On the other hand, some studies have shown a strong associations between dental anxiety/fear and negative dental experiences [36]. It appears that the anticipation of dental situations might be more important to the anxious patient than the actual dental experience. Nevertheless, assessment of previous aversive experience needs to be extended with more comprehensive and detailed methodology in the future. The exact strength and nature of experiences, the number, and the combination of the experiences seem to have stronger associations with dental fear.

General anesthesia and other pharmacologic approaches in children with dental fear and anxiety

Surprisingly, our results showed that none of the included studies have used a scale to identify children who need general anesthesia. This could result in an overutilization of general anesthesia in child dental patients probably because of inaccurate diagnosis of the conditions. Ideally, only children suffering high dental anxiety or fear or those with diagnosed dental phobia should be referred to general anesthesia. The National Consensus Development Conference on Anesthesia and Sedation in the Dental Office noted that "behavioral approaches are often overlooked as effective mechanisms for relieving patient apprehension," and suggested that sedation and general anesthesia may be unnecessary in situations when psychological and behavioral approaches are effective [7].

Methodological issues

Focus on methodological issues in measuring dental anxiety or fear is rarely discussed. Different measurement techniques for assessing dental anxiety and fear including behavioral, projective, physiologic and psychometric methods are employed in children. Besides, each of these core principle techniques requires a different set of tools. Interestingly, inter-correlations between these different techniques are low. Considering that dental anxiety and fear are a multidimensional constructs, this poor correlation can be expected because theoretically each measurement technique captures a distinct part of the construct [17]. Furthermore, the correlation between measures that tap the same part of the construct can also never be high because different scales of same construct ask different questions and cover different contents, and their determination of dental anxiety or fear is based on different answers [13, 30]. Consequently, not only it demonstrates that the use of more than one questionnaire and/or measurement instruments is necessary, but it also highlights the overwhelming errors in substituting of the scales. Each questionnaire has its own restrictions and do not completely cover the concept of anxiety/fear [30].

In addition, intervention studies should consider the age, coping repertoire, and level of initial dental fear/anxiety as they interact with the effectiveness of interventions in children. In addition, the majority of researchers investigating dental anxiety and fear in children have used heterogeneous samples which make it difficult to compare the results across different studies to determine the most effective treatment strategies. Although randomized assignment is often suitable to control for such variations, matching the groups in terms of age and previous experience seems more important. Besides, the standardization of outcome measures would facilitate between-subject comparisons. The use of multivariate analysis could allow for the evaluation of factors which may contribute to the prediction of favorable outcomes. The co-variation among measures and across time periods of assessment would allow a better understanding of fear modification [7].

The use of statistical techniques to evaluate changes in clinical studies is controversial. It is generally mentioned that statistical significance in such designs may not have any practical significance. However, the current statistical advances make it possible to perform a profile analysis of concordance and de-synchrony between different measures of dental anxiety and fear. Multiple regression techniques would allow evaluating which measures most strongly predict which behaviors. The use of time series sequential analysis also allows examining the causal correlates between behaviors of the practitioner and patient.

Of further note, most of the studies in our review addressing the issue of prevalence were not based on large, representative and population-based samples. It is necessary to move from convenience to representative samples to understand potential differences in prevalence of dental anxiety/fear between cultures and within cultures over time and across dental practices. In addition, it is important to distinguish between dental anxiety and dental fear if the aim is to accurately study them. Therefore, inclusion of a referred patient sample is not ideal as most referrals are based on DBMP. In addition, most of the reviewed studies were comparative or correlational which have their intrinsic limitations. No extensive randomized controlled studies have been conducted among child dental patients considering the differential diagnosis of dental anxiety/fear/phobia and their specific management techniques. As a consequence, it is not clear whether treatments were appropriate for the patients' problem or even the outcomes were related to their characteristics. Moreover, longitudinal studies can describe patterns of change and establish the direction and extent of assumed causal relationships as well as risk predictors and age effects related to dental fear/anxiety. The principal disadvantage of this design is sample drop-outs over time which can result in unrepresentative findings and compromise a study's external validity [37].

Quality of current measures

Current dental anxiety and/or fear scales are different in nature and measure widely varying constructs using different methods. Unfortunately, it has been argued that the conceptual and theoretical underpinnings of the existing dental anxiety and fear scales are weak. In addition, each instrument asks different questions, and its determination of dental anxiety, fear and phobia is based on different answers [1, 17](Porritt, et al., 2013). Therefore, it is important to address the more fundamental question of what we are actually measuring or perhaps not measuring using the current dental fear and anxiety scales because any understanding of the nature, consequences and possible treatment of these conditions is dependent upon the scale that is used to measure the construct [24].

Summarizing the existing literature, we found the apparent lack of a comprehensive psychometric scale for dental fear, anxiety and phobia. Content validity and developmental validity of measures of dental anxiety and fear for children is questionable. In addition, the majority of existing scales do not fulfill the ideal statistical or clinical criteria which are required for psychometric scales [25]. A number of the measures used to assess children's dental anxiety and fear had been developed to assess dental anxiety/fear in adults. Therefore, psychometric quality of these scales is questionable particularly when used with children. Although current evidence suggests a considerable overlap between the presentation of anxiety/fear among children and adults, clearly there are developmental differences in anxiety/fear symptoms that need to be considered [1, 13].

The theoretical foundations of existing measures of dental fear and anxiety and the way they relate to the current conceptualization of disorders of emotion should be considered. Ideally, these instruments should all be based on explicit theoretical foundations and demonstrate good psychometric properties. Unfortunately, this is not the case [17]. Therefore, a lack of precise understanding and conceptual clarity in defining the core terms of anxiety, fear and phobia; a failure to consider the various aspects or components of their response system; and the weak conceptual and theoretical underpinnings of the existing scales are the most significant problems with measuring dental fear, anxiety and phobia. Although there is an overall consensus on these issues in the psychological literature, it appears that they are rarely addressed in dental literature [17].

Interestingly, the majority of current scales were predominantly validated in schools, not in the clinical setting considering that the child's response could be different in a clinical situation. They almost lack a report on the state of previous dental experience and the parent's expectation of the child's behavior. Most scales only provide an overall estimate of perceived discomfort without understanding the causes of this anxiety/fear. Current scales only include the most commonly feared items (injections, extraction) without considering other common dental procedures which might evoke anxiety/fear. In addition, the external validity or generalizability is almost lacking in the existing scales [25].

It has been argued that current scales of dental fear/anxiety fail to encompass new knowledge of the factors that contribute to dental anxiety and fear, particularly the role of negative thoughts in the maintenance of dental fear/anxiety. The scales are generally based on the behavioral manifestations of anxiety/fear or have used nonverbal tools such as pictures. In most cases, numerical estimates of anxiety/fear scores are obtained by differentially weighing the specific anxiety/fear behaviors and scoring their frequency. Behavioral approaches to anxiety/fear measurement may be operationally and objectively defined and a variety of external raters can be trained to use consistent criteria in assessing children's distress behaviors [16]. However, physiological and cognitive responses have been relatively ignored because children may not have a fully developed ability to recognize and interpret the physiological and cognitive manifestations of anxiety/fear. It is assumed that these scales measure anxiety/fear-related stimuli rather than anxiety/fear itself [38].

In addition, pictorial measures are rapidly administered, reliable and understandable to a broad age range. However, this technique has questionable reliability and validity due to difficulties in the interpretation of stories and the standardization of scoring. Only a weak correlation between drawing a picture and age, physiological response and behavior ratings has been establish. Its use is also limited because an expert is required to carry out the interview and score the tests [39].

How to choose an appropriate scale?

In order to choose an appropriate measure, the investigator or clinician should assess the instrument first to see whether the scale is valid and reliable. Appropriateness and acceptability of the instrument for the study should also be considered. Choice of a particular measure will depend on the purpose of the study and the particular aspect of dental fear/anxiety that will be assessed. It will also be determined by the type of information the researcher, healthcare

professional or epidemiologist would like to obtain from the assessment [1]. Longer measures with more questions provide a wider range of scores and are more sensitive to change over time or to variation between groups. If the purpose of assessment is to inform clinical treatment planning, it may be important to examine the factors that are contributing the maintenance of their anxiety/fear. Those scales which ask respondents to rate particular dental situations might be useful in planning interventions aimed at alleviating dental anxiety and fear [39]. In addition, the use of more than one questionnaire and/or other measurement instruments is advocated. For instance, due to general (non-dental) trait anxiety, negative reactions in the dental situation may occur and it may be valuable to include such aspect in empirical studies [30]. In addition, if the main purpose is to investigate the prevalence of dental anxiety/fear in a particular group or community, then a measure that has established cut-off points may be the priority choice. Besides, those scales which have clustered items based on factor analysis techniques and not just on the use of conceptual or logical grouping may help in assessing the treatment efficacy. The score changes per item on the scales may be effective for assessing the outcome of treatment for each child [1].

CONCLUSION

The findings of present study revealed that there was no single precise and convenient method to discriminate between dental fear, anxiety or phobia in pediatric dentistry and these terms are often confounded in pediatric dental literature. Defining these constructs from a clear and consistent theoretical perspective and establishing empirical and accurate diagnostic methods will enable the investigators and clinicians to appropriately assess dental fear, anxiety and phobia and interpret results of clinical investigations. However, there is no consistency in the dental literature to characterize these constructions practically beyond their subjective status. The dental literature appears unable to capture and also measure the multi-sided construct of dental anxiety, fear and phobia and there was a tendency to use them interchangeably. In addition, methodological issues in the assessment of dental anxiety, fear and phobia should be taken into account in order to obtain sound scientific results.

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APPENDIX

Table 1- Characteristics of studies which used different clinical measures or cut-offs to discriminate between dental anxiety, fear and phobia

Reference	Test for each construct		
	Dental fear	Dental anxiety	Dental phobia
Karibe et al. [37]	CFSS-DS	STAIC-S	
Lee et al.[38]	CFSS-DS	CARS	
Vika et al. [39]		DFS	Injection phobia Scale/Mutilation questionnaire for Blood injury fear and phobia
Holmes et al. [40]	CFSS-DS	VPT VAS	
Campbell et al. [41]		MCDAS Cut-off: dental anxiety>31 VAS	MCDAS Cut-off: dental phobia>40
Koroluk et al.[42]		MDAS Cut-off: MDAS≥13 anxiety	MDAS Cut-off: MDAS>19phobia

Table 2- Scales used in the included studies

Scale	Number of studies used each scale		
	For dental anxiety	For dental fear	For dental phobia
self-styled tools			
Single fear question	1		
Single anxiety question	2		
Psychometric tests			
CDAS (Corah Dental Anxiety Scale)	9		
MDAS (Modified Corah Dental Anxiety Scale)	5	2	
filled by parents	1		
MCDAS (Modified Child Dental Anxiety Scale)	2		
MCDAS filled by parents	1		
CFSS-DS (Child's Fear Survey Schedule-Dental Subscale)	8	11	
CFSS-DS filled by parents	9	8	
Modified CFSS-DS	1		
CFSS-DS short form	1		
DAQ (Dental Anxiety Questionnaire)	3		
DFS (Dental Fear Survey)	5	1	
ACDAS (Abeer Children Dental Anxiety Scale)	2		
MCDASF (Modified Child Dental Anxiety Scale-Face Version)	11		
CDFP (Children's Dental Fear Picture test)		1	
FIS (Facial Image Scale)	7		
VPT/VPS (Venham Picture Test)	11		
Modified VPT	3		
RMS-PS (RMS Pictorial Scale)	1		
Smiley faces programs (SFP)	2		
Drawing	1 (for distress)		
VAS (Visual Analogue Scale)	5		
VAS filled By parents	1		
Children anxiety and pain scale	1		
Behavior rating scales			
VSS (Verbal Skill Scale)	1		
FRS (Frankl Rating Scale)	1		
Modified Venham Score	1		
CARS (Venham's Rating Of Clinical Anxiety)	7	1	
Other scales			
DBS (Dental Belief Survey)	1		
SAM (Self Assessment Mannequin)	1		
STAI (State-Trait Anxiety Inventory)	4		
IDAF-4C+ (Index of Dental Anxiety and Fear)		1	
Spence Children's Anxiety Scale	1		
Global Mood Score	1		
Injection Phobia Scale			1 (for injection phobia)
Mutilation questionnaire for Blood injury fear and phobia			1 (for blood phobia)

Table 3- Time of assessment of dental anxiety and fear

Dental fear									Dental anxiety											
Before treatment			After treatment			At other places			Before treatment			During treatment			After treatment			At other places	
c	P	d	c	P	d	c	p	d	c	p	d	c	p	d	c	p	d	c	p
6	4	1	3	1	1	8	6	1	39	5	3	6	4	11	16	1	1	17	9

C: rated by child; p: rated by parent; d: rated by doctor/clinician

Table 4- Use of scales in different age groups

Scale	Age range		
	3-6	6-12	12-18
self-styled tools			
Single fear question			
Single anxiety question	2	3	2
5 point lickert			
Psychometric tests			
CDAS(corah dental anxiety scale)		2	7
MDAS(modified corah dental anxiety scale)		1	5
MDAS filled by parents		1	
MCDAS(modified child dental anxiety scale)	1	2	2
MCDAS filled by parents	1	1	
CFSS-DS	1	19	12
CFSS-DS filled by parents	12	18	3
Modified CFSS-DS	1		
CFSS-DS Short form		1	1
Modified corah anxiety scale questionnaire			
DAQ(Dental anxiety questionnaire)		2	2
DFS (Dental Fear Survey)		1	6
ACDAS		3	1
TOTAL	**16**	**53**	**39**
Pictorial scales			
MCDASF	3	8	4
MCDASF filled by parents		1	1
CDFP(Children's Dental Fear Picture test)	1	1	
FIS	1	7	1
VPT/VPS	7	6	3
Modified VPT	2	2	
RMS-PS	1	1	1
Smiley faces programmes (SFP)	1	2	2
Drawing	1	1	
Visual Analogue Scale (VAS)	1	1	
By parents	2	2	1
Children anxiety and pain scale	1	1	
TOTAL	**21**	**34**	**13**

Scale	Age range		
	3-6	6-12	12-18
Behavior rating scales			
VSS	1		
Frankl rating scale	1		
Modified Venhem score	1	1	
Venham's rating of clinical anxiety	5	6	
TOTAL	**8**	**7**	
Other scales			
Dental believe survey (DBS)			1
SAM	1		
State-Trait Anxiety Inventory (STAI)		4	4
IDAF-4C+		1	1
Spence Children's Anxiety Scale	1		
Global Mood Score	1	1	
Injection Phobia Scale			1
Mutilation questionnaire for Blood injury fear and phobia			1
TOTAL	**3**	**6**	**8**

Table 5- Cut offs used for each scale

CFSS-DS
High anxiety=38
Anxious> 36
Dental fear≥38
Dental fear≥39
High dental fear or phobia ≥39
Low anxious<32
Dental anxiety>32
Dental anxiety and fear ≥39
High dental fear ≥38
Dental anxiety>32, dental fear>38
dental anxiety≥39
Around 24.5= fear
Borderline anxious >32
32< dental fear
High fear >37
High anxiety >29
MCDASf
High anxiety>22
Severe anxiety ≥26
25-32 = very anxious, 33-40 = extremely anxious
Anxious >19, highly fearful>31
State anxiety > 19, severe phobic disorder > 31
CARS
7= anxiety
4-5= anxiety
MDAS
High anxiety≥19
High dental fear =19–25
Anxiety≥13, phobia >19
High dental fear 19–25
CDAS
Highly anxious≥15
Moderate anxiety: 9–12, high anxiety: 13–14, severe anxiety ≥15
High anxiety≥13
MCDAS
Anxious>19, Highly fearful>31
Dental phobia >31
DFS
Dental anxiety>59
Dental anxiety>60

Table S1- Data extraction table for included studies

Author	Country	Test(s) used	Cut off	N	Age (y)	Area assessed in the article: fear	anxiety	phobia	design	place	definition	differentiated	First experience	Report by:	Time of assessment	Type of treatment	Place of evaluation: Waiting room/ Operation room	Intervention	assessment of background psychological health
(Honkala 2014) [1]	Kuwait	1-a single-item dental fear question 2- MDAS 3- MCDAS(f)	2-high anxiety≥19 3- high anxiety >22	745	13-15	*			Cross sectional	School	No	Yes	N/I	Child	-	-	-	-	N/I
(El-Housseiny 2014) [2]	Saudi Arabia.	CFSS-DS	around 24.5 for fear	220	6-12	*			Cross sectional	Clinic	No	No	No(94%)	Child	Before/ After	Various	Waiting	-	N/I
(Guinot Jimeno 2014) [3]	Spain	1-MDAS 2-Venham Picture Test	-	34	6-8		*		Clinical Trial	Clinic	No	No	No	1-Parent 2-Child	2- Before 3- After	Restor-ative/ injection	2- Waiting 3- Opera-tion	Distrac-tion	N/I
(Aminabadi 2013) [4]	Iran	CARS	-	100	7-12	*			Cross sectional	Clinic	No	No	Yes	Dentist	During	pulpotomy	Operation	-	N/I
(Mustafa 2013) [5]	Bahrain	(MCDASf)	8 = not anxious, 9-16 = very slightly anxious, 17-24 = fairly anxious, 25-32 = very anxious, 33-40 = extremely anxious	125	5-18	*			Cross sectional	Clinic	No	No	No	Child	Before	Various	N/I	-	N/I
(Krikken 2013) [6]	The Neth-erlands	(CFSS-DS) on behalf	38 high anxiety	454	4-13	*			Cross sectional	School	No	No	No	Parent	-	-	-	-	N/I
(Srai 2013) [7]	UK	STAI	-	90	10-16	*			RCT	Clinic	No	No	N/I	Child	Before	Bonding	Waiting	Video	N/I
(Peretz 2013) [8]	Israel	1-DAS 2-DFS	-	130	7-18	*			Cross sectional	Clinic	No	No	No	Child	Before	Various	Waiting	-	N/I
(Jaakkola 2013) [9]	Finland.	Modi-fied Dental Anxiety Scale	High dental fear =19–25	777	18		*		Cross sectional	Home	Yes	No	N/I	Child	-	-	-	-	N/I
(Aminabadi 2013) [10]	Iran	1-CARS 2-VSS 3-FRS	1-(7) 2- 3-(6)	128	4-6	*			cross	clinic	No	No	Yes	1-Dentist 2- Dentist 3- Dentist	1-During 2- Before 3- During	Injection/ restoration	Operation	-	N/I
(Al-Namankany 2012) [11]	Saudi Arabia	1-CFSS-DS 2-ACDAS	1-Anxious> 36 2- Anxious≥26	165	6	*			Cross sectional	Clinic/ school	No	No	N/A	Child	Before	N/A	Waiting	-	N/I

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(Roshan 2012) [12]	India	Modified Venhem score	-	60	5-7		*		RCT	Clinic/ school	No	No	N/I	Dentist	Before/ During/ After	ART	Operation	-	N/I
(Carrillo-Diaz 2013) [13]	Spain	Index of Dental Fear and Anxiety (IDAF-4C+)	highly dentally fearful≥3	179	8-18		*		Cross sectional	Home	No	No	N/I	Child	-	-	-	-	N/I
(Aminabadi 2012) [14]	Iran	SCAS	-	117	4-6		*		Cross sectional	Clinic	No	No	Yes	Parent	Before	Filling	-	-	N/I
(Ramos-Jorge 2013) [15]	brazil	modified VPT	-	167	8-11		*		longitudinal	Clinic	Yes	No	Yes	Child	Before	Various	Waiting	-	N/I
(Aminabadi 2011) [16]	Iran	1-FIS 2-CARS		200	5-7		*		RCT	Clinic	No	No	Yes	1- Child 2- Dentist	1- During 2- During	Injection/ Filling	Operation	-	N/I
(de Menezes Abreu 2011) [17]	The Neth-erland	FIS	-	302	6-7		*		Cross sectional	School	Yes	No	N/I	Child	Before	Resto-ration/ evaluation	Waiting	-	N/I
(Suprabha 2011) [18]	India.	CFSS-DS	dental fear≥38	125	7-14	*			Cross sectional	Clinic	No	No	9 yes	Child	Before	Operative	N/I	-	N/I
(Ramos-Jorge 2011) [19]	Brazil.	Modified VPT	-	70	4-11		*		RCT	Clinic	No	No	21 yes	Child	Before/ After	Examina-tion	Waiting/ Operation	Photo-graph	N/I
(De Menezes Abreu 2011) [20]	Brazil.	FIS	-	302	6-7		*		RCT	School	Yes	No	N/I	Child	Before	Filling	Waiting	ART	N/I
(Aminabadi 2011) [21]	Iran	MCDASf	-	107	7-12		*		Cross sectional	Clinic	Yes	No	N/I	Child	Before	Filling	N/I	-	N/I
(de Menezes Abreu 2011) [22]	Brazil	FIS	-	244	6-7		*		RCT	School	No	No	N/I	Child	Before	Filling	Waiting	-	N/I
(Jones 2010) [23]	NZ	SFP/ MCDAS	-	206	5-13		*		Cross sectional	School	No	No	N/I	Child	-	-	-	-	N/I
(Aminabadi 2011) [24]	Iran	Drawing	84–129: average stress	54	4-11				RCT	Clinic	Yes	No	N/I	Child	After	Pulp therapy/ filling	Waiting	-	N/I
(Luoto 2010) [25]	Finland	single 5-point Likert-scale	-	2498	11-16	*			longitudinal	School	No	No	N/I	Child/ Parent	-	-	-	-	N/I
(Gustafsson 2010) [26]	Sweden	1-CFSS-DS/ 2-on behALF	Dental fear≥39	230	7.5-19	*			Cross	Clinic	No	No	No	1-Child 2- Parent	Before	N/I	N/I	N/I	N/I
(Sjogren 2010) [27]	Sweden.	CFSS-DS	Dental fear≥38	32	7-9	*			RCT	Clinic	No	No	No	Parent	Before/ After	Extraction	Waiting	-	N/I
(Al-Jundi 2010) [28]	Jordan	Global Mood Score	-	118	2-12		*		Cross sectional	Clinic	No	No	No	Dentist	Before/ After	General anesthesia	Waiting	-	N/I
(Krekmanova 2009) [29]	Sweden	CDAS		368	8-19		*		Cross sectional	Clinic	No	No	No	Child	Before	Check up	N/I	-	N/I

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											Yes	No	N/I	Child	Before	N/I	Waiting	Leaflet	N/I
(Olumide 2009) [30]	UK	FIS		50	8-12		*		RCT	Clinic									
(Tahmassebi 2009) [31]	UK	VPT	-	38	3-10		*		RCT	Clinic	No	No	Yes	Child	Before/ After	Injection	Operation	Wand	Yes
(Klaassen 2009) [32]	Nether-lands	CFSS-DS on behalf	high dental fear or phobia≥39	104	2-7	*			RCT	Home	No	No	No	Parent	Before/ After	General Anesthesia	N/A	-	N/I
(Hosey 2009) [33]	UK	MCDASF	Anxious >19/ highly fearful>31	138	5-10		*		RCT	Clinic/ home	No	No	No	Child	Before/ After	Extraction	N/A	-	Yes
(Tickle 2009) [34]	UK	5-point Likert single-item scale on behalf	-	799	5-9		*		Prospective	Home	No	No	No	Parent	-	N/A	N/A	-	N/I
(Howard 2009) [35]	UK	MCDASf	-	73	5-10		*		RCT	Clinic	No	No	No	Child	Before	Various	Operation	PALS	N/I
(Wogelius 2009) [36]	Denmark	CFSS-DS	-	143	6-14		*		Cross sectional	Home	No	No	N/A	Child	-	-	-	-	N/I
(Marsac 2008) [37]	USA	1-CFSS-DS	Anxiety>32 Dental fear ≥39	129	9-15		*		Cross sectional	Clinic	No	No	N/A	1-Child 2-Parent	1-Before 2-During	N/A	N/A	-	N/I
(Nuttall 2008) [38]	UK	Single question		3342	5-15		*		Cross sectional	Home	No	No	N/A	Parent	-	-	-	-	N/I
(Versloot 2008) [39]	Nether-lands.	CFSS-DS on behalf	low anxious<32	128	4-11		*		Cross sectional	Clinic	No	No	No	Parent	During	Injection	N/A	-	N/I
(Versloot 2008) [40]	Canada	CFSS on behalf	dental anxiety>32	147	4-11		*		RCT	Clinic	No	No	No	Parent	-	Injection	-	-	N/I
(Lee 2008) [41]	Taiwan	1-CFSS-DS	1-	247	2-10	*			Cross sectional	Clinic	Yes	Yes	No	1-Child 2-Dentist	1-Before 2-During	N/A	N/A	-	Yes
(Vika 2008) [42]	Norway	2-CARS 1-DFS 2-Injection Phobia Scale 3- Mutilation questionnaire for Blood injury fear and phobia	2- 4-5 1-dental anxiety ≥60	1385	18		*	*	Cross sectional	school	N	Yes	N/A	Child	-	-	-	-	N/I

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(Kuscu 2008)[43]	Turkey	1-CFSS-DS/ 2- FIS 3-STAI	1-dental anxiety and fear ≥39 2-non-anxious>0.37	41	9-13	*			RCT	Clinic	No	No	N/A	Child	Before	Injection	Operation	-	Yes
(Versloot 2008)[44]	Canada	CFSS-DS on behalf	dental anxiety ≥32	147	4-11	*			Cross sectional	Clinic	No	No	No	Parent	During	Injection	Waiting	-	N/I
(Prabhakar 2007)[45]	India	1-VPT 2-CARS	-	60	4-8	*			Cross sectional	Clinic	No	No	Yes	1-Child 2-Dentist	During	Various	N/A	Distraction	N/I
(Cinar 2007)[46]	Finland	MDAS	-	949	10-12	*			Cross sectional	School	No	No	N/A	Child	-	-	-	-	N/I
(Klaassen 2007)[47]	Netherlands	CFSS-DS on behalf	-	66	4-11		*		Cross sectional	Clinic	No	No	11 yes	Parent	Before	-	-		N/I
(Skaret 2007)[48]	Norway	DFS	-	1385	18		*		Cross sectional	School	No	No	N/A	Child	-	-	-	-	N/I
(Arnrup 2007)[49]	Sweden	CFSS-DS on behalf	high dental fear≥38	156	8-12	*			Cross sectional	Clinic	No	No	No	Parent	Before	N/A	-	-	Yes
(Leong 2007)[50]	UK	VPT	-	54	2-6	*			RCT	Clinic	No	No	N /A	Child	Before/ After	Extraction	Waiting	-	N/I
(Lee 2007)[51]	Taiwan	CFSS-DS on behalf	dental anxiety≥39	3597	5-8	*			Cross sectional	School	Yes	No	N/A	Parent	-	-	-	-	Yes
(Gazal 2007)[52]	Syria	MCSFS	-	201	2-12				RCT	Clinic	No	No	No	Dentist	Before/ After	General Anesthesia	Operation	-	N/I
(Ramos-Jorge 2006)[53]	Brazil	modified VPT	-	118	4-5	*			Cross sectional	Clinic	No	No	Yes	Child	N/A	Examination	-	-	N/I
(Cohen 2006)[54]	USA	1-Children anxiety and pain scale(CPAS)/ 2-VAS on behalf	-	44	3-7	*			Cross sectional	Clinic	No	No	25 yes	1-Child 2-Parent	1-Before /During/ After 2-Before/ After	Injection-restoration	1-Operation 2-Waiting		Yes
(Manepalli 2014)[55]	India	MCDASf	-	100	6-12		*		Cross sectional	Clinic	Yes	No	N/A	Child	Before/ After	Injection	Operation	-	N/I
(El-Housseiny 2014)[56]	Saudi Arabia.	CFSS-DS	-	200	6-12		*		Cross sectional	Clinic	No	No	N/A	Child	After	Visit	N/A		Yes
(Paryab 2013)[57]	Iran	MCDASF	Severe anxiety ≥26	150	6-12		*		Cross sectional	Clinic	No	No	No	Child	Before	Injection	Waiting		Yes
(Kuscu 2006)[58]	Turkey	1-CFSS-DS 2-VPT 3-FIS	1-dental anxiety and fear ≥39	34	7-11		*		Cross sectional	Clinic	No	No	No	Child	Before	Injection	N/I		N/I

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											No	No	Yes	1-Child 2-Dentist	1-Before/ After 2-During	Various	-	Music distraction	N/I
(Marwah 2005) [59]	India	1-VPT 2-CARS	-	40	4-8	*			Cross sectional	Clinic									
(Versloot 2005) [60]	Nether-lands	CFSS-DS	Anxiety>32	125	4-11	*			Cross sectional	Clinic	No	No	No	Parent	Before/ During	Injection			N/I
(Wogelius 2005) [61]	Denmark	CFSS-DS	Dental anxiety ≥38	1235	6-8	*			Cross sectional	Clinic	No	No	No	Parent	N/I	-			N/I
(Buchanan 2005) [62]	England	1- SFP 2-MCDAS 3-CFSS-DS	-	468	6-15	*			Cross sectional	School	No	No	N/I	Child	-	-			N/I
(Campbell 2005) [63]	U.K	1-MCDAS 2- VAS	1-anxiety>31 dental phobia>40	194	3-10	*	*		RCT	Clinic	No	No	No	1-Parent 2- Child	Before			GA	N/I
(Harman 2005) [64]	UK	1-MCDAS 2-STAI	-	40	6-17	*			Cross-sectional	Clinic	No	No	No	Child	Before	Various	Waiting		Yes
(Holmes 2005) [65]	U.K	1-VPT 2-CFSS-DS 3-VAS	2-significant dental fear>38	100	8-15	*	*	*	Cross-sectional	Clinic	No	Yes	No	1,2 - Child 3-Dentist	1- Before/ After 2- Before 3- During	Dental treatment	Waiting		Yes
(Nakai 2005) [66]	Japan	1-CFSS-DS	-	1916	8-15	*			Cross sectional	clinic /home/ school	No	No	-	Child	Before/ After	N/I	Waiting room		N/I
(Folayan 2004) [67]	Nigeria	CFSS-DS	-	84	8-13		*		Cross sectional	Clinic	Yes	No	Yes	Child	Before	-	Waiting room	-	N/I
(Peretz 2004) [68]	Israil	DAS	-	88	6-14		*		Cross sectional	Clinic	No	No	No	Child	Before	-	-	-	N/I
(Folayan 2004) [69]	Nigeria	CFSS-SF	-	74	8-13		*		Cross sectional	Clinic	No	No	N/I	child	Before / After	Various	Waiting	Behavior management	Yes
(Wogelius 2003) [70]	Denmark	CFSS-DS	anxiety >38	1493	6-8		*		Cross sectional	home	Yes	No	No	Parent	-	-	-	-	Yes
(Folayan 2003) [71]	Nigeria	1-short form of DFSS-DS	-	81	8-13		*		Cross sectional	Clinic	No	No	Yes	Child	Before	-	Waiting	-	Yes
(McComb 2002) [72]	USA	Modified CFSS-DS	-	76	39-71mth		*			Clinic	No	No	No	child	Before / after	various	-	-	N/I
(Aitken 2002) [73]	USA	1-VPT 2-MCAS	2- high anxiety>20)	45	4-6		*		RCT	Clinic	No	No	Yes	1-Child 2-Parent	1-Before/ After 2- Before/ After	Restor-ative	-	Music distrac-tion/ Behavior manage-ment	N/I

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(Peretz 2000) [74]	Israel	1-DAS 2-DFS	-	104	12-18	*				Clinic	No	No	No	Child	Before	-	Waiting	-	N/I
(Koroluk 2000) [75]	USA	MDAS	MDAS≥13 anxiety MDAS>-19phobia	61	14-16	*	*		Cross sectional	School home	No	Yes	No	Child	During	-		Sedation	N/I
(ten Berge 1999) [76]	Nether-land	CARS	0-3 low 4,5high fearfull	40	6-11	*			Cross sectional	Clinic	No	No	No	Dentist	Before/ after	-	-	-	N/I
(Kruger 1998) [77]	New Zealand	DAS	DAS ≥13 high Anxiety	649	15,18	*			Longitudinal	N/I	No	No	-	Child	-	-	-	-	N/I
(Klingberg 1998) [78]	Sweden	1-CFSS-DS 2-CDFP	CFSS-DS ≥38 significant dental fear	124	5-7/ 10-12	*				1-home 2-clinic	No	No	Yes	1-Parent 2-Dentist	-	-	-	-	N/I
(Skaret 1998) [79]	Norway	1-DFS 2-DBS	DFS>59 dental anxiety DBS>47 high dental anxiety	571	18	*				School	No	No	No	Child	-	-	-	-	N/I
(Cho 1998) [80]	-	VPT	-	32	6-12	*			Cross sectional	Clinic	No	No	25 no	child	Before/ after	Resto-ration		EDA	N/I
(Thomson 1997) [81]	New Zealand	CDAS	CDAS ≥13 High anxiety	691	15/18	*			Cohort	N/I	No	No	No	Child	-	-	-	-	N/I
(Klingberg 1995) [82]	Sweden	CFSS-DS	CFSS-DS ≥38 Clinical dental fear	3204	4-6 9-11	*				Home	No	No	No	Parent	Home	N/I	-	-	N/I
(Neverlien 1994) [83]	-	1-DAQ 2-CDAS	-	94	15-17	*				Home	No	No	No	Child	-	-	-	-	N/I
(Carson 1997) [84]	Brazil	DFS	60 high dental fear	1045	15-20	*				School	No	No	No	Child	-	Various	-	-	N/I
(Siegel 1992) [85]	U.S	SAM	-	60	3-6	*			-	Clinic	No	No	75 no	Child	Before/ after	Various	Waiting	Mask wearing	N/I
(Neverlien 1991) [86]	Norwey	1-CDAS 2-DAQ	-	163	10-12	*				School	No	No	No	Child	-	-	-	-	N/I
(Al-Namankany 2015) [87]	Saudi Arabia	1-ACDAS 2-VAS	ACDAS≥ 26dental anxiety	80	8-16	*			RCT	Clinic	Yes	No	Yes	Child	1-Before/ 2-before/ during	Various	Waiting	Video modeling	N/I

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(Hollis 2015) [88]	UK	MCDASF	-	106	8-16	*			Case control	Clinic	No	No	No	Child	-	-	Clinic	-	N/I
(Patel 2015) [89]	-	MCDASF	MCDASF ≥19 dental anxiety	132	7-16	*			Prospective	Clinic	No	No	-	Child Parent seprately	Before	-	Dental surgery	-	N/I
(Shetty 2015) [90]	India	1-RMS-PS 2-FIS 3-VPT	-	102	4-14	*			Cross sectional	Clinic	Yes	No	Yes	Child	N/I	-	-	-	Yes
(Soares 2015) [91]	Brazil	DAQ	-	101	6-16	*			Cross sectional	School	No	No	No	Child	Before	examination	-	-	N/I
(Viswanath 2015) [92]	India	MDAS	-	259	12-16	*			Cross sectional	School	No	No	-	Child	-	examination	-	-	N/I
(Al-Namankany 2014) [93]	UK	1-ACDAS 2-VAS	ACDAS >26 anxiety	68	6-12	*			RCT	Clinic	Yes	No	-	Child	1-Before/ After 2-Before/ during			1- video modeling	N/I
(Goyal 2014) [94]	India	CFSS-DS/The fear survey schedule for children(FSSFC)	-	400	12-15	*			Cross sectional	school and shops	Yes	No	-	Child	-	-	-	-	N/I
(Jaakkola 2014) [95]	Finland	MDAS	high dental fear (19–25) no- to moderate dental fear (5–18),	737	18	*			Prospective	home	Y	N	N	Child	-	-	home	-	N/I
(Karibe 2014) [96]	Japan	1-CFSS-DS 2-STAIC	-	40	Older than 6years	*	*	*	Cross sectional	clinic	No	Yes	No	Child	Before/ after	Various	Waiting	-	Yes
(Nigam 2013) [97]	India	VAS	-	250	3-5	*				Clinic	Yes	No	Yes	Dentist	During	examination	-	-	yes
(Asl Aminabadi 2012) [98]	Iran	MCDASF	MCDASF > 19 state anxiety > 31 severe phobic disorder	117	4-6	*			RCT	Clinic	Yes	Yes	No	Child	after	Various		Virtual reality	Yes
(Jafarzadeh 2011) [99]	Iran	CFSS-DS on behaf	CFSS-DS <25low fear CFSS-DS >37 high fear	200	6-12	*			Cross sectional	clinic	Yes	No	No	Parent	-	-	-	-	N/I

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(Freeman 2007) [100]	Scotland	VPT	-	-	5-17		*		RCT	clinic	No	No	No	Child	After	-	-	viewing positive images	N/I
(Topaloglu-Ak 2007) [101]	Turkey	VPT	-	518	6-7		*			clinic/ school	No	No	Yes	Child	After	Resto-ration	N/I	2-ART	N/I
(Guelmann 2005) [102]	USA	CFSS-DS	-	597	Mean age :11	*			Cohort	School	No	No	No	Child	-	examina-tion	school	-	N/I
(Raadal 2002) [103]		CFSS-DS	CFSS-DS >29 high anxiety	180	10 years old	*			follow-up study	home	No	No	No	Child	-	examina-tion	Home	-	N/I
(ten Berge 2002) [104]	Nether-land	CFSS-DS	-	322	4-11	*			Cross sectional	Home	N	N	no	Parent	-	-	-	-	N/I

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