

Dental Fear and Caries in 6- to 12-Year-Old Children: a Systematic Review and Meta-analysis

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Objective: To investigate the relationship between dental fear and dental caries in children aged 6 to 12 years in a systematic review and meta-analysis.

Methods: Systematic review search terms were selected according to medical subject headings (MeSH) or non-MeSH. An electronic search of studies published in English assessing the relationship between dental fear (children's fear survey schedule-dental subscale) and dental caries (DMFT or dmft index) was carried out of the Scopus, Web of Science, PubMed, Embase, Cochrane and Proquest databases up to March 2022. Of 5,759 articles retrieved initially, 16 were eligible for inclusion in the study, and 5 of these were included in the quantitative analysis. The quality of studies was evaluated based on the Newcastle-Ottawa scale. Begg tests were employed to assess the publication bias.

Results: According to the meta-analysis, the results revealed no statistically significant difference in mean of DMFT score in low and high fear score groups, with a mean difference of 1.28 (95% confidence interval -0.132 to 2.693) ($P = 0.076$). A statistically significant difference was found in the mean dmft score for the low and high fear score groups, with a mean difference of 0.227 (95% confidence interval 0.058 to 0.395) ($P = 0.008$). The mean dmft was significantly higher in the high fear score group.

Conclusion: Dental fear has a significant relationship with caries in primary teeth, but not in permanent teeth.

Keywords: behaviour control, child, dental anxiety, dental caries, dental fear
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Dental fear or anxiety in children is one of the most common problems around the world. It is defined as the abnormal fear of visiting the dental practitioner for preventive care or therapy and unwarranted anxiety over dental procedures. The relationship between den-

tal fear and a lack of cooperation in dental situations is not straightforward. Dental fear has been observed in most but not all children with behaviour management problems.^{1,2} It may create some barriers in receiving dental care and cause problems for both dental practitioners and parents.³

According to studies, fear due to dental treatments can continue until adolescence, leading to avoidance of regular dental visits.⁴ Fear can reduce a child's cooperation and cause dental treatment to be delayed. As a result, dental caries and abscesses occur more frequently, and this poor oral health increases the child's anxiety and fear, creating a vicious cycle. Finding the causes of this cycle and stopping it as soon as possible will benefit the child. Thus, it is crucial to identify children who experience dental fear and make specific arrangements for them.^{5,6}

Various tools have been provided to evaluate dental fear in children. The children's fear survey sched-

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ule-dental subscale (CFSS-DS) is a well-known psychometric scale that was developed in 1982 to evaluate children's fear of dentistry. The validity and reliability of the tool have been reported to be very good.⁷⁻⁹ The tool has a better performance compared to other scales such as Veenha Picture Test and Dental Anxiety Test in some studies^{3,7,10}.

The indexes approved by the World Health Organization to measure dental caries in permanent and primary teeth, respectively, are the Decayed, Missing and Filled Teeth (DMFT) and dmft. Individual DMFT and dmft values are the sum of the number of decayed, missing due to caries and filled) teeth in the permanent and primary teeth, respectively.³

The relationship between dental fear and dental caries in children remains controversial. Some studies have confirmed the existence of a relationship between dental fear and dental caries^{3,7,11}, whereas others found no relationship.¹²⁻¹⁴ The age of the child plays an important role in controlling anxiety and accepting treatment, and long-term studies have shown that as the child's age increases, their fear and anxiety decrease.^{15,16} Since most of the studies conducted in this field involved children aged from 6 to 12 years, the present study was conducted with the aim of summarising the results of these previous studies and investigating the relationship between dental fear and dental caries in children aged from 6 to 12 years in a systematic review and meta-analysis.

Materials and methods

This systematic review was performed according to the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) guidelines.

Search strategy

According to the Cochrane guidance, in this systematic review, studies were included that assessed dental caries (outcome) in children aged 6 to 12 years (population) who had dental fear (exposure) compared to children without dental fear (comparison).

The key terms were selected based on the medical subject headings (MeSH) and non-MeSH terms in simple terms or combinations. The searched databases included Proquest, Cochrane, Embase, Scopus, Web of Science and PubMed. Electronic database searches were conducted using the following combination of key search terms: (dental fear or dental anxiety or odontophobia or dental phobia) And (child or children or primary teeth or deciduous teeth or pediatric dentistry

or pediatric or dentistry for children or pedodontics) And (dental caries or dental decay or carious lesion or carious dentin or dental white spot or early childhood caries or tooth decay or severe early childhood caries or caries or baby bottle caries or decay).

The inclusion criteria were studies published in English that assessed the relationship between dental caries and dental fear in children according to the PECO question, and cross-sectional or case-control studies with full texts available and that were published up to March 2022.

The exclusion criteria were other types of studies, such as case reports, letters to the editor, pilot studies, cohort studies, historical reviews and studies published in languages other than English, as well as studies in which the children had any systemic or developmental disease such as molar incisor hypo-mineralisation (MIH), in order to minimise the effect of confounding factors.

Resource selection

First, article topics were reviewed independently by two authors (NA and SAS) according to the developed search strategy. The abstract and full texts of the articles were reviewed. Finally, hand searching was performed by checking the references of articles included in the studies and hand-searching key journals. The correlation coefficients between the two researchers' data were 0.93 and 1.00 in the abstracts and full texts, respectively. Any disagreement between the two researchers was resolved by a third researcher (FN).

Data extraction

Two researchers (NA and SAS) independently extracted data from different studies. The variables included the author's name, publication year, the age and sex of children, sample size, type of study, prevalence of dental caries (according to the DMFT or dmft index or the International Caries Detection & Assessment System [ICDAS]), dental fear assessment tools, prevalence of dental fear and a brief conclusion of each study. Different tools were used to assess dental fear in children such as CFSS-DS¹⁷⁻¹⁹, dental fear visual analogue scale (DFVAS)²⁰, dental fear scale (DFS)¹³ and questionnaires²¹, which were reported in the evidence table (Table 1).

Risk of bias assessment

The Newcastle-Ottawa scale (NOS) was used to assess cross-sectional and case control studies. Each study was

Table 1 Main characteristics of studies included in the systematic review.

Study	Sample	Age, y	Sex (M/F)	DMFT		dmft	Dental fear instruments	Dental fear	Conclusion
				%	Mean				
Buldur ^{27*}	583	3–13	286/297	NR	6.00	NR	CFSS-DS/Frankl behaviour score	Mean Frankl behaviour score 3.0 (SD 1.0)	Dental anxiety was associated with dental caries
Yahyaoglu et al ^{23*}	810	6–12	408/402	NR	1.57	4.64	CFSS-DS	Mean CFSS-DS value 24.00 ± 7.99	Anxiety and dental caries were associated
Beena ^{26*}	444	6–12	220/224	NR	0.58	4.4	CFSS-DS	Overall mean CFSS-DS score 37.0 ± 8.89	No significant correlation
Son et al ^{25*}	132	7	77/55	NR	NR	6.71	CFSS-DS	Prevalence of dental fear 34.85%.	No correlation
Patcharaphol ^{24*}	212	12	146/66	NR	2.14	NR	CFSS-DS	Mean CFSS-DS value 31.38 ± 10.45	Patients with dental anxiety had more decayed teeth
Alsadat et al ³	1546	6–12	798/748	51.8	NR	NR	CFSS-DS	23.50%: CFSS-DS score ≥ 32 12.50%: score > 38	Dental fear has a direct relationship with decayed permanent teeth
Nguyen et al ⁷	900	8–10	427/473	89.8	NR	NR	CFSS-DS	Mean CFSS-DS score 20.8 ± 9.1	Dental fear is related to the oral health care system
Laureano et al ¹²	466	8–10	207/259	88.84 (ICDAS > 0)	NR	NR	CFSS-DS	Mean total CFSS-DS score 29.97	No significant correlation
Pichot et al ²⁰	2734	6–12	1,419/1,315	53.59	NR	NR	DF-VAS	5% of 9- to 12-year-olds had high scores (DF-VAS > 6)	Children with lower levels of dental fear had less experience of caries
Folayan et al ¹⁸	450	6–12	222/228	4.9	NR	NR	CFSS-DS	Mean CFSS-DS score 38.6 ± 14.4	Children who had caries had higher anxiety
Olak et al ¹⁹	344	8–10	188/156	93	NR	NR	CFSS-DS	General fear of dentistry 6.1%	Dental fear is significant predictor of dental caries
Saber and Awad ¹⁷	250	6–12	122/128	NR	1.46	6.62	CFSS-DS	Mean CFSS-DS score 20.9 ± 11.84	Fear may have an impact on scores for caries
Prathima et al ¹³	400	6–12	200/200	NR	1.89	NR	Dental fear scale (DFS)	Low to moderate dental fear 46%; high dental fear 72%	No association
Panda et al ¹¹	798	8–10	238/560	NR	1.58	NR	CFSS-DS	Mean fear score 36	Children with dental fear were 1.8 times more likely to have an untreated carious tooth
Patır Münevveroğlu et al ²¹	200	6–12	102/98	NR	NR	3.52	Questionnaire	Fears were related to injection (60%), tooth extraction (50%), restorations (3.6%) and the sight of dental instruments (40%)	Dental fear likely predicts dental caries
Varmazyar et al ¹⁴	185	6–12	83/102	NR	NR	(dmft/DMFT) 3.93	CFSS-DS	CFSS-DS > 38: 26.48%	No correlation

*Studies included in the meta-analysis.

NR, not reported.

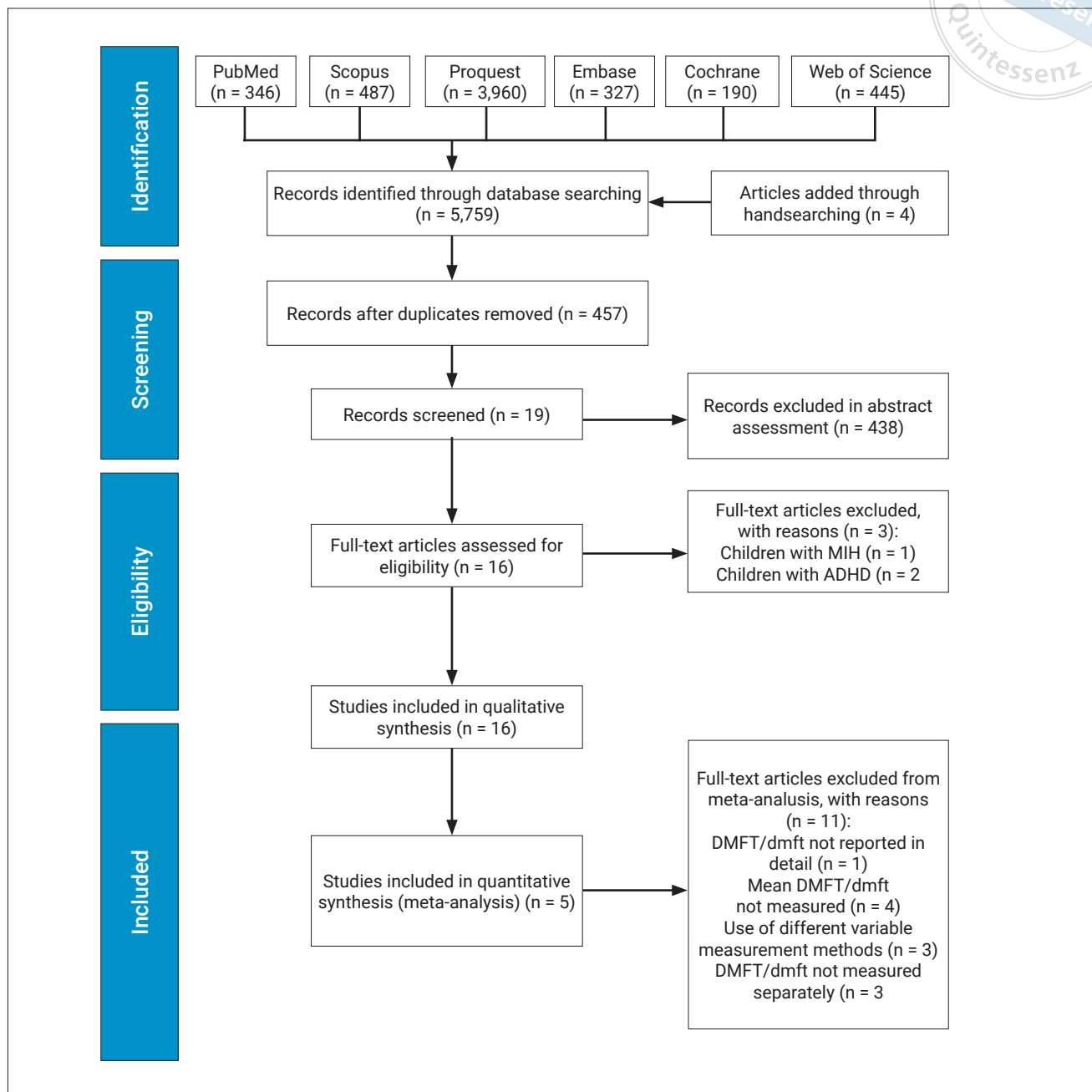


Fig 1 Flow diagram of the search strategy.

evaluated for inner-methodological risk of bias. The quality of the articles was scored by two researchers (NA and AS). In the event of disagreement between the two researchers, a third person provided their opinion (FN). Studies were rated as being of low, moderate and high quality according to the NOS scores < 5, 5 to 7 and > 7, respectively.

Statistical analysis

A meta-analysis was carried out to determine the existence of dental fear in children aged 6 to 12 years and its relationship with dental caries using Comprehensive Meta-Analysis software (version 2, BioStat, Orlando, FL, USA). For statistical analysis, the standard mean difference of the continuous data was determined at a 95%

confidence interval. The P value and I^2 statistic were used to analyse heterogeneity in the studies. Thus, $P < 0.05$ or $I^2 > 50\%$ showed heterogeneity. If there was no heterogeneity, the fix model was used; otherwise, the random model was utilised.

To estimate the mean difference and depict the results of the meta-analysis, a forest plot was employed. Publication bias was assessed using a Begg test.²²

Results

There are many articles available regarding dental fear in children and its relationship with dental caries; however, due to not meeting the inclusion criteria, many of them were excluded from the present study.

Study selection

A total of 5,759 studies were obtained through searching six databases (PubMed, Scopus, Web of Science, Embase, Cochrane and Proquest) and manual searching was performed using other sources available online. After exclusion of duplicate and irrelevant studies through title screening, the abstracts of 457 articles were analysed. Finally, 19 articles underwent full-text analysis, and 3 of these were excluded due to their inclusion of hyperactive children and children with molar incisor hypomineralisation (Fig 1).

Hence, 16 studies were included in the systematic review that met the inclusion criteria and obtained scores higher than 5 in the quality assessment. Five of these were included for meta-analysis due to their similarity in the method of measuring dental fear and dental caries variables (Table 1).

Risk of bias

The NOS assessment scale is a star rating system with eight items that assigns a maximum of nine stars to three domains, namely selection (four stars), comparability (two stars) and exposure in cross-sectional studies (three stars). Studies are rated from 0 to 9, with 0 to 5 corresponding to poor quality, 5 to 7 to moderate quality, and > 7 equating to good/high quality. The studies differed in quality; four were of moderate quality, and twelve were of high quality (Table 2).

Study characteristics

Of the 16 articles included in the systematic review, 11 could not be included in the meta-analysis. In the study conducted by Saber et al¹⁷, the mean of DMFT/dmft was

not reported in detail (the standard deviation [SD] was not reported). The studies by Alsadat et al³, Panda et al¹¹ and Folayan et al¹⁸ did not report the mean values of DMFT or dmft indexes. Nguyen et al⁷, Olak et al¹⁹ and Varmazyar et al¹⁴ reported caries of primary and permanent teeth together as a dmft/DMFT index, and these studies were therefore also not included in the meta-analysis, and neither was the study by Laureano et al¹², in which the International Caries Detection and Assessment (ICDAS) index was used to assess dental caries and severity.

Prathima et al¹³, Pichot et al²⁰ and Patir et al²¹ employed different criteria for measuring the variables of dental fear or dental caries, and were therefore also excluded from the meta-analysis. Parthima et al¹³ and Pichot et al²⁰ used the dental fear scale (DFS) and dental fear-visual analogue scale (DF-VAS), respectively, to assess children's dental fear, whereas Patir et al²¹ investigated dental fear using a questionnaire.

Finally, five studies were included in the meta-analysis for quantitative analysis.²³⁻²⁷ In these studies, the CFSS-DS index was used to assess the severity of children's dental fear, which was categorised as low or high. Dental caries was reported as mean DMFT and dmft.

Quantitative analysis

Relationship between dental fear and DMFT

Four studies with a similar methodology evaluated the relationship between dental caries in permanent teeth and children's dental fear.^{23,24,26,27} They used the CFSS-DS index to assess the severity of children's level of dental fear, which was categorised as low or high.^{23,24,26,27} Dental caries was reported as mean DMFT and SD. The heterogeneity showed $P > 0.001$ and $I^2 = 98.886\%$, and a random-effects model was used for meta-analysis.^{23,24,26,27} The results revealed no statistically significant difference in mean DMFT score in the low and high fear groups, with a mean difference of 1.28 (95% confidence interval [CI] -0.13 to 2.69) ($P = 0.08$); thus, the mean DMFT was not statistically different in the high and low fear groups.^{23,24,26,27} Figure 2 shows the forest plot for DMFT. According to the Begg test, there was no publication bias in the evaluation of the relationship between DMFT and dental fear ($P = 0.24$).

Relationship between dental fear and dmft

Three studies with a similar methodology evaluated the relationship between dental caries in primary teeth and children's dental fear.^{23,25,26} In these studies, the CFSS-



Table 2 Quality of evidence of included studies based on the Newcastle-Ottawa scale (NOS). A study can be awarded a maximum of one star for each numbered item within the Selection and Exposure categories. A maximum of two stars can be given for Comparability.

Category		Yahyaoglu et al ²³	Beena ²⁶	Son et al ²⁵	Buldur ²⁷	Patcharaphol ²⁴	Alsadat et al ³	Nguyen et al ⁷
Selection	Case definition	*	*	*	*	*	*	*
	Representativeness of the cases	*	-	*	-	*	*	*
	Selection of Controls	*	*	*	*	*	*	*
	Definition of Controls	*	*	*	*	*	-	*
Comparability	Comparability of cases and controls	**	*	**	*	*	-	-
Exposure	Non-response rate	-	*	*	*	*	*	*
	Ascertainment of the exposure	*	*	*	*	*	*	*
	Same method for cases and controls	*	*	*	*	*	*	*
Final judgment	8*	7*	9*	7*	8*	6*	7*	6*

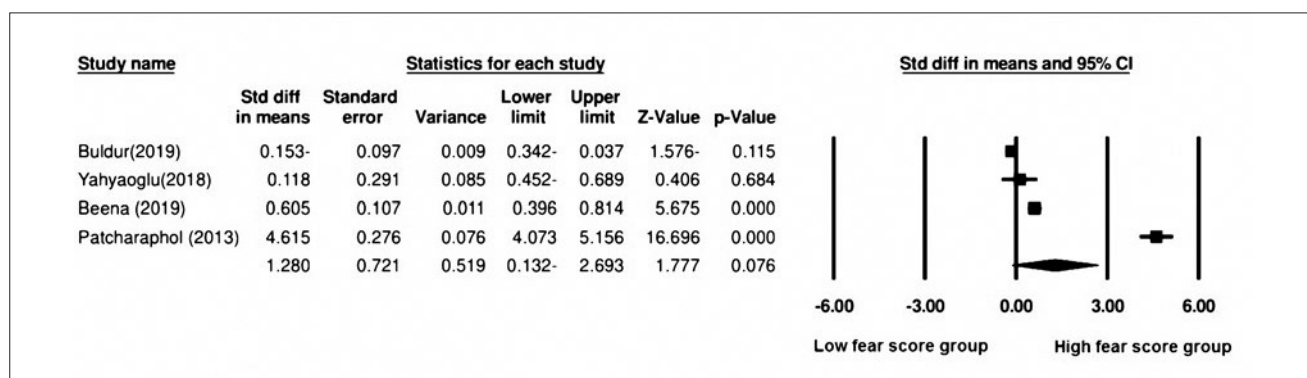


Fig 2 Forest plot of the DMFT index.

DS index was used to assess the severity of children’s fear, which was categorised as low or high, and dental caries was reported as mean dmft and SD.^{23,25,26} The heterogeneity showed $P = 0.418$ and $I^2 = 0.000$, so a fixed model was used for meta-analysis.^{23,25,26} The results revealed a statistically significant difference in mean dmft score in the low and high fear groups, with a mean difference of 0.23 (95% CI 0.06 to 0.39) ($P = 0.008$); thus, the mean dmft was significantly higher in the high fear group.^{23,25,26} Figure 3 shows the forest plot for dmft. According to the Begg test, there was no publication bias in the evaluation of the relationship between dmft and dental fear ($P = 0.30$).

Discussion

The several determinant variables and risk factors for dental caries among children can be categorised as individual, parental and environmental factors. Dental fear and anxiety are considered one of the most important individual factors, and are one of the reasons for avoiding attending regular dental visits. Negative behaviours

during dental visits may cause dental treatment to be delayed. This in turn may lead to the progression of dental caries and its subsequent consequences, such as severe dental pain and dental abscesses. This causes children who have a history of toothache to refer to the dental practitioner and increases the fear of dentistry in children, thus creating a vicious cycle whereby the child’s oral health will worsen and their dental fear will increase. As such, it can be very helpful to consider preventive measures and plans in this regard.^{28,29}

The present study aimed to review the results of studies conducted on the relationship between fear and dental caries to achieve a conclusion on this topic. Of the 16 studies included in the systematic review, 5 were summarised through meta-analysis in quantitative manner.²³⁻²⁷ The results of this meta-analysis showed that the relationship between dental fear (CFSS-DS) and caries in primary teeth (dmft) was significant; however, the relationship was not significant in permanent teeth (DMFT). In early childhood, children do not have enough understanding in the dental environment and usually feel afraid. This makes them avoid attending

	Olak et al ¹⁹	Saber and Awad ¹⁷	Prathima et al ¹³	Laureano et al ¹²	Pichot et al ²⁰	Folayan et al ¹⁸	Varmazyar et al ¹⁴	Patir Münevveroğlu et al ²¹	Panda et al ¹¹
	*	*	*	*	*	*	*	*	*
	*	*	*	*	*	-	-	*	*
	*	*	*	*	*	*	*	*	*
	*	-	*	*	*	-	*	*	*
	*	-	*	*	*	*	*	*	*
	-	-	*	*	*	*	*	*	-
	*	*	*	*	*	*	*	*	*
	-	*	*	-	*	*	*	*	*
	5*	8*	7*	8*	6*	7*	8*	7*	

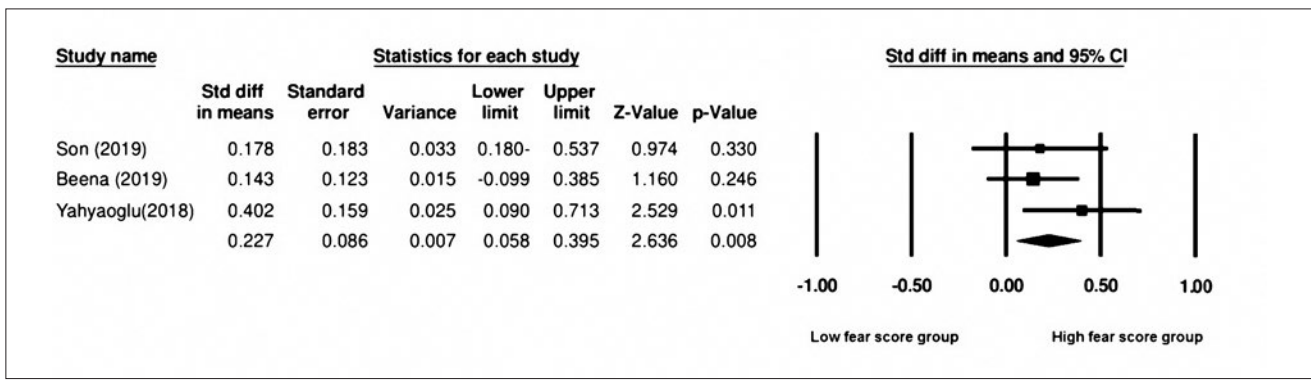


Fig 3 Forest plot of the dmft index.

the practice on a regular basis, and thus endangers their oral health. As a result, dental fear has a significant relationship with caries in primary teeth (dmft).

Permanent teeth erupt as children get older, usually when they reach the age of around 6 to 7 years. Thus, permanent teeth have been exposed to cariogenic substances for less time than primary teeth. On the other hand, as children get older, their level of cooperation in the dental environment increases, meaning their dental visits will be more regular. Oral hygiene is also better in older children. As a result, no significant relationship can be found between dental fear and dental caries in permanent teeth (DMFT).

Contradictory results have been shown by different studies in the field of dental fear and caries. Many studies have confirmed the relationship^{3,7,11,17-21,23,27}, whereas others did not find any relationship between dental fear and caries.^{12-14,25,26}

Saber et al¹⁷ reported a significant relationship between fear (CFSS-DS index) and caries in primary teeth (dmft index); however, no significant relationship was found between dental fear (CFSS-DS) and caries in per-

manent teeth in children (DMFT). This may be due to parents neglecting their child's oral and dental hygiene.

Olak et al¹⁹ found that dental fear in children is associated with their previous dental experience and their parents' dental fear. Their results also revealed a relationship between dental caries (DMFT/dmft) in children and dental fear.¹⁹ In this study, caries affecting the primary and permanent teeth were related to the first dental visit, which is extremely important and should be done as a simple and regular examination to familiarise the child with the dental environment.¹⁹

In the study by Patir et al²¹, a significant difference was observed between primary and permanent dental caries and dental fear, and the age of children who were afraid of attending the dental practice was significantly lower. Similarly, in the present study, the relationship between dental fear and caries in primary teeth was significant, which indicates that children with dental fear are often younger.

In some studies, unlike in the present study, no significant relationship was found between dental fear and caries (DMFT/dmft) in children.^{12,14} This seems to



be due to caries in primary and permanent teeth being reported together as a dmft/DMFT index in the study conducted by Varmazyar et al¹⁴. Moreover, Laureano et al¹² used the ICDAS index to assess dental caries. This is a more recent visual method and seeks to detect caries lesions in their earliest stages. The ICDAS criteria are a clinical scoring system for use in dental education, clinical practice, research and epidemiology. These criteria support and enable personalised total caries management to improve long-term health outcomes.³⁰ The ICDAS index in the study conducted by Laureano et al¹² did not report caries affecting primary and permanent teeth separately. If the primary and permanent teeth caries index was considered separately, it would be associated with dental fear.

In two other studies, unlike the present study, no significant relationship was reported between dental fear and caries in children.^{25,26} This may be due to the inclusion criteria for these two studies. The children included in these studies referred to their dental practitioner for regular dental examinations without any history of toothache.^{25,26} This regular examination led to low dental fear and low dental caries in children.

A lack of effective communication between the child and the dental practitioner in the first years of the child's life can cause dental fear in children. This fear can prevent them from attending regular dental examinations, and this in turn may lead to the progression of dental caries, pain and abscesses.³¹

The relationship between dental fear and dental caries in younger children is more obvious, perhaps due to the fact that younger children are less socially developed. Thus, the effect of dental fear is more obvious in primary teeth than permanent teeth which erupt at older ages.

One of the limitations of the present study is the inconsistency of the indexes used in different studies, which meant it was not possible to consider many studies in the meta-analysis. As such, it is necessary to conduct more studies in this field to obtain a more definitive result regarding the relationship between caries and dental fear.

Conclusion

Dental fear has a significant relationship to caries in primary teeth, but not to those in permanent teeth. In the qualitative review of studies, the effect of fear on caries in primary teeth was more obvious than that for permanent teeth.

Conflicts of interest

The authors declare no conflicts of interest related to this study.

Author contribution

Dr Narjes Amrollahi contributed to the data collection, analysis and manuscript draft; Dr Sayed Ali Shahshahan contributed to the data interpretation and manuscript revision; Dr Firoozeh Nilchian contributed to the study design and supervision; Dr Mohammad Javad Tarrahi contributed to the study conception and supervision, data interpretation and statistical analysis.

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