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A prospective study of dental anxiety in a cohort of children followed from 5 to 9 years of age

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Background. The development of dental anxiety in children is poorly understood.

Aims. The aims of this study were to measure changes in dental anxiety over time and to examine the relationship between anxiety, dental care, and other factors.

Design. A prospective cohort study of children in the north-west of England followed from 5 to 9 years of age. The participants were clinically examined and their parents completed the same questionnaire at 5 and 9 years.

Results. The majority (54.3% $N = 38$) of participants who were anxious at 5 years were no longer anxious at 9 years, but a large proportion of children who were anxious at 5 remained anxious at 9 years of age (45.7% $N = 32$). During the follow-up period, a larger proportion of children developed anxiety (11.7% $N = 85$) than the proportion of children who were reported as being anxious at baseline (8.8% $N = 70$). At 9 years of age, dental anxiety was significantly associated with girls; parental anxiety; a history of extraction; and irregular, asymptomatic dental visiting. These factors were also significantly associated with dental anxiety at 5 years old.

Conclusions. Dental anxiety was cumulative in the study population over time, and its development influenced by multiple variables. Results suggest that adverse conditioning and vicarious learning are both important in the development of this condition.

Introduction

Dental anxiety is a common condition; it is estimated that 6–15% of people avoid regular dental care because of dental anxiety or phobia[1]. Dental anxiety is most likely to start in childhood; in a study of 1420 adults, over half of participants who were dentally anxious reported that they developed the condition in childhood[2]. The aetiology of dental anxiety in children is poorly understood; but three main mechanisms have been postulated for how the condition is initiated:

Direct conditioning whereby an early, negative dental experience induces the acquisition of dental fear and anxiety[2–5]. Other studies provide indirect support by demonstrating that children with high levels of dental anxiety have received more extensive dental treatment[6–10].

Vicarious learning whereby negative personal experiences or possibly frightening, stereotypical views about dentistry common in popular culture are relayed to children through family members or peers[11–13].

Personality traits whereby some individuals are inherently and generically nervous or anxious, and as a result have a greater predisposition to develop dental anxiety[14–16].

Once acquired, the behaviour of dental anxiety over time, for example, its progression or possible attenuation, is also not clear. There are concerns, however, that this condition tends to be refractory in nature and once developed in childhood can persist into adulthood[2,17]. It is not possible to predict whether dental anxiety in early childhood may be resolved or

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modulated as the child matures. Longitudinal studies of dental anxiety are rare in the literature; Murray *et al.*[18] and Poulton *et al.*[19] examined the longitudinal association between dental anxiety and dental treatment in older children, and adolescents and young adults, but we have little information on how dental fear and anxiety behave over time in young children.

This paper reports the findings of a prospective study that followed a cohort of children from 5 to 9 years of age. The objectives were to measure changes in the anxiety status of this cohort and to examine the relationship between anxiety status and dental care received, dental visiting, and parental anxiety during this period.

Methods

This study followed a cohort of 1404 children recruited at 5 years of age for whom data were recorded by clinical examination and a parentally completed questionnaire. These children were recruited from the whole population of 1745 5-year-old children attending state primary schools in the district of Chester and Ellesmere Port in the north-west of England. The clinical examination was undertaken by trained and calibrated examiners using a national caries diagnostic protocol and national standards for examiner agreement[20]. Participant's dmft values for the primary dentition were recorded. The parentally completed questionnaire recorded the dental attendance behaviour, and children were categorized into regular, asymptomatic dental attenders or irregular, symptomatic attenders. The questionnaire also incorporated a measure of dental anxiety; parents were asked to assess their child's dental anxiety on a 5-point Likert single-item scale with verbal anchors ranging from 'very relaxed' to 'very anxious' about dental treatment. Children whose parents reported them to be 'fairly' or 'very anxious' were categorized as anxious. Those children whose parents described them as being 'very' or 'fairly relaxed', or that they were 'neither relaxed nor anxious' about dental treatment, were classified as non-anxious. Parental dental anxiety was recorded using the same 5-point Likert scale, and parents were categorized as being anxious or not anxious in the same way as children.

The cross-sectional findings when the children were 5 years old have been reported elsewhere[5]. Four years later when the participants were 9 years old, letters were sent to all parents inviting them to enter their child into the second phase of the study. The children for whom consent was given received a clinical examination by a single examiner using the same national diagnostic protocol and calibrated to the same national standard used at baseline[20]. The original protocol for 5-year-olds made the explicit assumption that all missing teeth were extracted because of caries. Because of concerns about miscoding exfoliated and extracted primary teeth, recording of extraction and exfoliation of the primary teeth when the children were 9 years old was undertaken by the examiner providing a clinical opinion on whether or not any missing first primary molars had been lost because of exfoliation or extraction. The examiner was blind to the baseline anxiety status of each child. Caries experience in the permanent dentition was also recorded. Parents were asked to complete the same questionnaire used at baseline. Both children and parents were classified as anxious and non-anxious, and children's dental visiting behaviour was classified, using the same methods employed at baseline. Children were also categorized according to their extraction history into those who had an extraction before 5 years of age and those who had had an extraction (in either the primary or permanent dentition) between 5 and 9 years of age.

Analyses were completed using SPSS version 14 on data captured from both methods of assessing extractions in the primary dentition at 9 years of age. Here, data are presented using the examiner's clinical judgement of extraction, as the prevalence figures for extraction measured according to the national protocol (in which any missing primary molar teeth are coded as extracted) were considered to be high when compared to the statistics for 8 year-olds reported in the 2003 UK Child Dental Health Survey[21]. Analysis consisted of cross-tabulations, with McNemar tests for paired data, to examine bivariate relationships between dental anxiety at 5 and 9 years of age, and between dental anxiety and potential risk factors. Backwards stepwise logistic regression

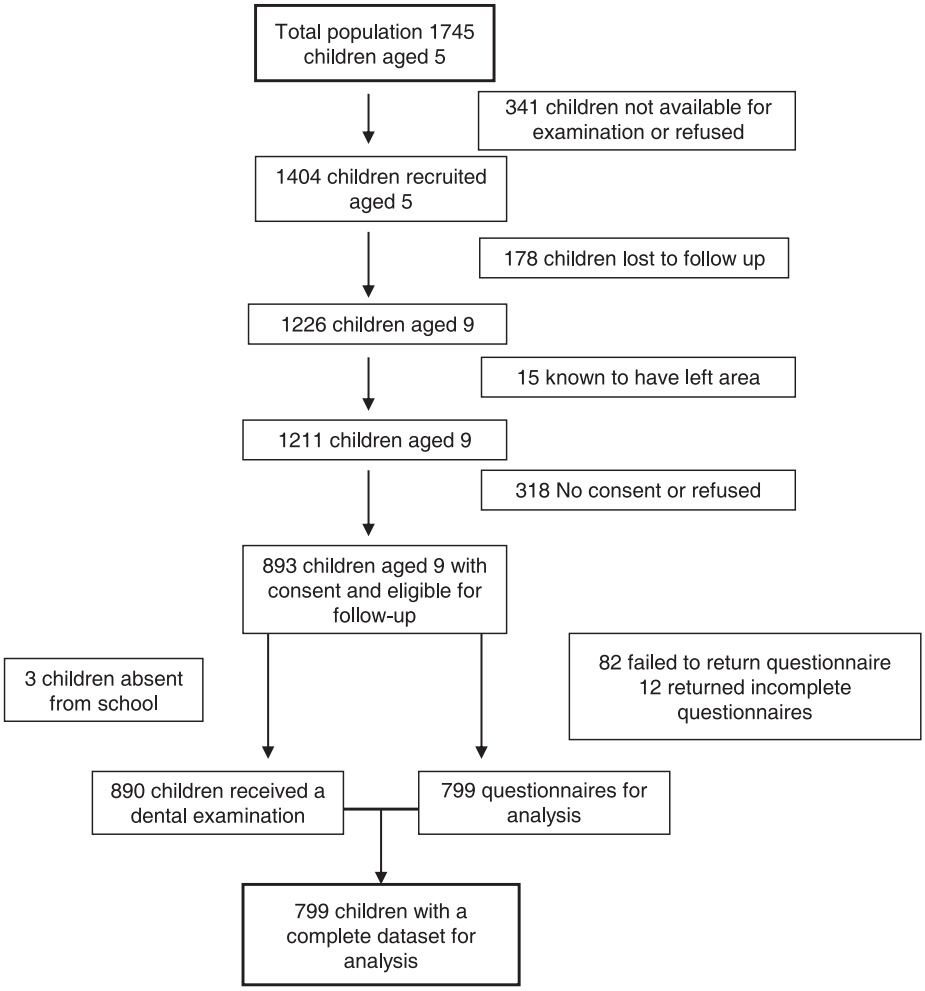

Fig. 1. Flow diagram of children through study.

was used to identify the principal variables predicting children's anxiety status at 9 years of age. The dependent variable in the regression model was anxiety status at 9 years old. Independent variables included gender, baseline anxiety status at 5 years old (to capture the longitudinal change in anxiety status), whether or not a child had an extraction of either a primary or permanent tooth (as a measure of potentially traumatic treatment), the anxiety status of participants' parents at 9 years of age, and reported dental visiting behaviour at 9 years old. A second stepwise analysis was undertaken that included whether or not children had received restorative treatment as an independent variable, to determine if this clinical intervention was associated with development of dental anxiety.

Results

A flow diagram describing the follow-up of the cohort is provided in Fig. 1. Of the 1404 children examined when they were 5 years of age, 193 (13.8%) were lost to follow-up or had left the area, and the parents of a further 318 (22.7%) failed to provide consent for an examination when their children were 9 years old, leaving 893 children in the study. Of these, a final total of 799 participants had clinical examinations and parentally completed questionnaires at both 5 and 9 years. This represents a response rate of available children at 9 years old of 65.7%, but only 56.8% of the children included in the study at 5 years old were available for analysis at the four year follow-up. Table 1 compares the characteristics

Table 1. Comparison of baseline characteristics of followed-up children with those lost to follow-up.

	Cohort examined at 9 years old (N=799)	Children examined at 5 and lost to follow-up (N=605)
Gender (*N* % males)	400 (50.1)	335 (55.4)*
Mean dmft (SD)	0.19 (2.13)	1.77 (2.97)**
Mean mt (SD)	0.22 (1.05)	0.38 (1.40)**
Children parentally judged as anxious at 5 years old (*N* %)	70 (8.8)	81 (13.4)**
Participant's parent reporting their own anxiety when their child was 5 years old (*N* %)	192 (24.1)[1]	185 (30.6)***
Reported as being irregular, symptomatic attender at 5 years old (*N* %)	86 (11.2)[2]	140 (23.1)**

*$P < 0.05$; **$P < 0.001$; ***$P < 0.01$.
[1]Due to item non-response, denominator is 797.
[2]Due to item non-response, denominator is 766.

Table 2. Prevalence of dental anxiety and risk factors in the cohort of participants at 5 and 9 years of age.

	5 years of age *N* (%)	9 years of age *N* (%)
Number an percentage of girls who were anxious as a proportion of all girls[1]	39 (9.8)	73 (18.3)*
Parentally reported anxiety of the child[2]	70 (8.8)	117 (14.6)*
Reported anxiety of parents[2]	192 (24.0)	179 (22.4)
History of extraction (in either the primary or permanent dentition in participants at 9 years of age)[2]	54 (6.8)	342 (42.9)*
History of regular, asymptomatic attendance[3]	680 (88.8)	753 (94.1)*

*McNemar test $P < 0.001$
[1]Denominator is 399
[2]Due to item non-response, denominator is 797.
[3]Due to item non-response, denominator is 766.

of the population available for analysis at 9 years of age with the children who were lost to follow-up between 5 and 9 years of age using baseline data collected when the children were 5-years-old. Children examined at 9 years old had significantly fewer males, significantly less caries, significantly fewer extractions, a significantly lower prevalence of irregular symptomatic dental visiting; their parents had significantly higher levels of dental anxiety and the children examined at 9 years old had a significantly lower prevalence of dental anxiety at baseline than those lost to follow-up.

Table 2 compares the characteristics of the study cohort at 5 and 9 years of age. The prevalence of dental anxiety increased significantly in this cohort during the 4 year follow-up period from 8.8% at 5 years to 14.6% at 9 years old. In contrast, the anxiety levels reported by parents did not show a significant change over the 4-year period: 24.0% at 5 years of age and 22.4% 4 years later. A reported behaviour of regular, asymptomatic dental visiting was the norm (88.8% at 5 years old and 94.1% at 9 years old), but there was a highly significant increase in the number of children experiencing an extraction, 6.8% at 5 years and 42.9% at 9 years of age. Although there was an increase in prevalence of anxiety in boys between the ages of 5 and 9 years (7.8–11%), there was a much larger, highly significant increase in anxiety among girls over the 4 years (9.8–18.3%). The changes in prevalence of dental anxiety between 5 and 9 years of age in the study cohort are compared in more detail in Table 3. Anxiety was not stable over time; half (54.3%, $N = 38$) of the children who were anxious at 5 years were no longer anxious at 9 years of age, and 11.7% ($N = 85$) of children who were not anxious at 5 years, were recorded as being anxious at 9-years-old.

Table 4 presents the outcomes of a backward stepwise logistic regression, with the dependent

Table 3. Anxiety status of children in the cohort at 5 and 9 years of age.

Dental anxiety status at 9 years of age	Dental anxiety status at 5 years of age		
	Not anxious	Anxious	Total
Not anxious *n* (%)	642 (94.4)	38 (5.6)	680 (85.3)
Anxious *n* (%)	85 (72.6)	32 (27.4)	117 (14.7)
Total *n* (%)	727 (91.2)	70 (8.8)	797*

McNemar test $P < 0.001$, *denominator 797 due to item non-response.

variable parentally reported anxiety status of their children at 9 years of age. After controlling for covariates, the girls had almost twice the odds of boys for being dentally anxious. Children whose parents were anxious were more likely to be reported as anxious (odds ratio 3.79, 95% CI 2.54–6.20) than children whose parents did not describe themselves as dentally anxious. Children who had a history of extraction had more than twice the odds of being anxious at 9 years than those who had never had an extraction (odds ratio 2.10, 95% CI 1.30–3.33). A history of dental anxiety at 5 years of age was the strongest predictor for having dental anxiety at 9 years; children who were anxious at 5 had over five times greater odds of being anxious at 9, than children who were not anxious at 5 (odds ratio 5.70, 95% CI 3.24–10.10). A reported history of irregular, symptomatic visiting was also significantly (odds ratio 2.81, 95% CI 1.38–5.71) associated with anxiety. A second logistic regression analysis showed that in children categorized with no history of extraction ($N = 475$), a history of restorative care was not associated with dental anxiety at 9 years of age.

Discussion

This prospective cohort study followed up children between the ages of 5 and 9 years old attending state schools in the north-west of England. In the cross-sectional analyses when the participants were 5 years old[5], strong associations were found between dental anxiety and a history of extraction, an irregular symptomatic attendance pattern, and parents reporting that they themselves were anxious about dental care. At 9 years of age, similar associations were found; parentally reported development of dental anxiety was strongly associated with parental levels of dental anxiety, female gender, history of irregular, symptomatic dental attendance, and a history of extraction. There was no association between dental anxiety and a history of restorative care at either 5 or 9 years of age. The results are broadly in line with the findings of Poulton *et al.*[19] in a long-term cohort study of older age groups who reported that the early onset of dental anxiety was related to negative conditioning experiences, service use patterns. and also stress reactive personality and specific beliefs about health professionals.

The study had some weaknesses; a large number of children were lost to follow-up and the children who were lost to follow-up also had a higher prevalence of the risk factors associated with dental anxiety at baseline. Additionally, the prevalence of dental anxiety at 5 years old in the cohort was 8.8% ($N = 70$); however, in the total population ($N = 1404$) it was 10.8%[5]. Therefore, the prevalence of anxiety reported for the cohort examined at 9 years old is likely to underestimate that of the reference population. This is supported by the 2003 UK Child Dental Health Survey[21],

Table 4. Results of a backward stepwise logistic regression, with parentally reported dental anxiety status at 9-years-old as the dependent variable.

Independent variables in the equation	Odds ratio	Upper and lower 95% confidence intervals
Gender	1.70	1.09, 2.64
Child reported as dentally anxious at 5 years old	5.70	3.24, 10.10
Parents dentally anxious when their child was 9 years old	3.79	2.54, 6.20
History of extraction	2.10	1.30, 3.33
Reported history of irregular, symptomatic attendance at 9 years old	2.81	1.38, 5.71

which reported that 22% of 5-year-olds, 25% of 8-year-olds, and 28% of 12-year-olds had some anxiety about attending the dentist. This large difference could be due in part to different methods of measurement. Our assessment of dental anxiety was limited; however, the measure used was compared to a concurrently parentally completed version of the Dental Subscale of the Children's Fear Survey Schedule (15 items)[22,23] using Spearman's rank correlation. There was a highly significant positive correlation between the scores of the two scales (Spearman's rho = 0.7, $P < 0.001$). Therefore, the single-item scale related well to the multi-item scale, providing some evidence of the validity of the Likert scale. Measurement of children's dental anxiety in prospective studies represents a considerable challenge for researchers. At 5 years old, children are not sufficiently mature to provide a valid and reliable self-assessment of their anxiety, and although some work has been completed in this field, it is in its early stages[24]. Parentally assessed measures can also be problematical, as the literature is not well enough developed to provide clarity on whether or not a parent's judgement of their child's dental anxiety agrees with the child's subjective assessment. In this study, a pragmatic decision was taken to use the same parentally judged measure at 5 and 9 years to enable comparison. Future longitudinal studies should consider using multiple measures and employ latent variable models during the period of follow-up.

This study provides information on the behaviour of dental anxiety in young children over time. The condition in young children is not fixed and intractable, indeed the majority ($N = 38$, 54.3%) of participants who were dentally anxious at 5 years were no longer anxious at 9 years of age. This may be explained by the cognitive development of children during the 4-year period under study. However, a large proportion of children who were dentally anxious at 5 remained anxious at 9 years of age ($N = 32$, 45.7%), and the presence of dental anxiety at 5 years was the strongest predictor for children reported as being dentally anxious at 9 years old. During the 4-year follow-up period, a larger proportion of children developed anxiety ($N = 85$, 10.7%) than the proportion of children who reported as being anxious at baseline ($N = 70$, 8.8%). So, although some children lose their dental anxiety, a sizeable proportion retains their dental anxiety and this group is added to by new cases resulting in a net increase in prevalence in this population at 9 years of age.

The findings of this study suggest that the aetiology of dental anxiety in young children is multifactorial, providing some support for all three theoretical mechanisms for the acquisition of dental anxiety. The strong and persistent association between dental anxiety and dental extraction agrees with the findings of other studies and suggests that direct conditioning is strongly implicated in the development of early onset dental anxiety[4,10,13,18]. Extraction was chosen as an index treatment because of its significant impact on young children[25]. Some 60% of children who were not dentally anxious at 5 years, but who became anxious during the follow-up period had one or more extractions during this period. Like any non-randomized study, the results of this observational study could be strongly influenced by uncontrolled confounders and by selection bias. For example, dentists could be more likely to select anxious children for extraction under general anaesthesia because they cannot tolerate restorative care. Recent research in the UK[26] reports a strong and widely-held belief among general dental practitioners that traumatic treatments directly cause dental anxiety and dental phobia in young children. This work also found that these beliefs influenced practise; dentists were reluctant to perform clinical interventions on very young children practising according to the psychological concept of latent inhibition[27]. This is a series of positive or neutral dental experiences which may protect the patient against the development of traumatic associations or negative experiences. It is interesting to note that no relationship was found between anxiety and a history of restorative care at both 5[5] and 9 years of age. This may be explained by the approach taken to restoration of the primary dentition by many general dental practitioners in England who tend to favour atraumatic restorative technique[28,29]. Use of this technique has been demonstrated to be less distressing

than traditional approaches to restorative care[30], perhaps explaining why no link was found with restorative treatment and dental anxiety. An additional explanation may be that the exposure time of receiving restorative treatment is greater and therefore provides a habituating experience.

Parental anxiety had a strong association with participants' dental anxiety, suggesting that vicarious learning is also important in the development of early onset dental anxiety. This consistent association at 5[5] and 9 years of age might be explained by anxiety 'transferring' between parent and child. However, the data presented cannot establish the direction of this effect; is it conveyed from parent to child as a form of learnt behaviour[31], or could the anxiety and dental experiences of a child influence their parent? A reported behaviour of symptomatic, irregular dental visiting was strongly associated with reported dental anxiety at 5 years[5]; this relationship was also found at 9 years of age and was also reported in the UK 2003 Child Dental Health Survey[21]. Whether this association is due to parents' reticence to take their child to a dentist because of their own dental anxiety or whether a child's unfamiliarity with dental procedures, perhaps supplemented with received negative information of dental experiences, induces dental anxiety is unknown. Again, these findings indicate the importance of the concept of latent inhibition and suggest strategies to promote early and regular, asymptomatic dental visiting should be pursued. The findings of the study also tentatively suggest that personality traits or psychodynamic factors have a role in the aetiology of dental anxiety[32], as 13.1% of children with no history of extraction were reported as being dentally anxious at 9 years old. This might reflect a constitutional vulnerability to developing dental anxiety in certain individuals. Further investigation is required to deepen our understanding of the relationship between certain personality traits and the onset of dental anxiety.

Dental anxiety is an important factor to consider when managing the dental care of young children; it presents a challenge to dentists[33] and can be a possible consequence of adverse dental experiences. The condition was cumulative in this population and its development was influenced by many factors. To help dentists provide high-quality care and minimize the chance of children developing dental anxiety, behavioural scientists need to give high priority to undertaking prospective cohort studies in different populations in order to develop our understanding of the risk factors for this important condition. In observational studies, however, the risk of bias and uncontrolled confounding is ever present. There has been a recent debate on how best to manage the dental treatment of young children with calls for randomized control trials in this field[34,35]. Any such trials should include dental anxiety as an outcome measure as part of the assessment of the impact of different treatment regimes on children's quality of life.

What this paper adds

- This is one of the few prospective studies of dental anxiety in the literature.
- It shows that the majority of children who are dentally anxious in early childhood lose their anxiety, but children are susceptible to developing dental anxiety throughout childhood leading to a net increase in the number of dentally anxious children in the population at 9 years of age.
- Female gender, parent's levels of dental anxiety, traumatic dental treatments, and irregular visiting patterns are all significantly associated with anxiety; however, a small number of children seem to be inherently dentally anxious. These findings add support to all three theoretical explanations for the aetiology of dental anxiety: vicarious learning, conditioning, and personality traits, suggesting that the aetiology of dental anxiety is multifactorial.

Why this paper is important to paediatric dentists

- Paediatric dentists perform surgical interventions on young children every day of their working lives, and effective patient management is critical if they are to perform their job to a high standard.
- Paediatric dentists need to understand the causes of dental anxiety in children and its development over time to effectively manage the care of their patients and to minimize the risks of their patients developing dental anxiety.

References

1 Eli I. *Oral Psychophysiology: Stress Pain and Behaviour in Dental Care*. Boca Raton, FL: CRC Press, 1992.
2 Locker D, Liddell A, Dempster L, Shapiro D. Age of onset of dental anxiety. *J Dent Res* 1999; **78**: 790–796.
3 Rachman S. *Fear and Courage*, 2nd edn. New York: Freeman, 1990.
4 Locker D, Shapiro D, Liddell A. Negative dental experiences and their relationship to dental anxiety. *Community Dent Health* 1996; **13**: 86–92.

5 Milsom K, Tickle M, Humphris GM, Blinkhorn AS. The relationship between anxiety and dental treatment experience in 5-year-old children. *Br Dent J* 2003; **194**: 503–506.

6 Jong de A, Muris P, Horst ter G, Duyx M. Acquisition and maintenance of dental anxiety: the role of conditioning experiences and cognitive factors. *Behav Res Ther* 1995; **33**: 205–210.

7 Milgrom P, Mancl L, King B, Weinstein P. Origins of childhood dental fear. *Behav Res Ther* 1995; **33**: 313–319.

8 Kruger E, Thomson WM, Poulton R, Davies S, Brown R, Silva P. Dental caries and changes in dental anxiety in late adolescence. *Community Dent Oral Epidemiol* 1998; **26**: 355–359.

9 Alvesalo I, Murtomaa H, Milgrom P, Honkanen M, Karjalainen M, Tay KM. The dental fear survey schedule: a study with Finnish children. *Int J Paed Dent* 1993; **3**: 193–198.

10 Karjalainen S, Olak J, Söderling E, Pienihäkkinen K, Simell O. Frequent exposure to invasive medical care in early childhood and operative dental treatment associated with dental apprehension of children at 9 years of age. *Eur J Paediatr Dent* 2003; **4**: 186–190.

11 Bernstein DA, Kleinknecht RA, Alexander LD. Antecedents of dental fear. *J Public Health Dent* 1979; **39**: 113–124.

12 Klingberg G, Berggren U, Carlsson SG, Noren JG. Child dental fear: cause-related factors and clinical effects. *Eur J Oral Sci* 1995; **103**: 405–412.

13 Ten Berge M, Veerkamp JS, Hoogstraten J. The etiology of childhood dental fear: the role of dental and conditioning experiences. *J Anxiety Disord* 2002; **16**: 321–329.

14 Klepac RK, Dowling J, Hauge G. Characteristics of clients seeking therapy for the reduction of dental avoidance: reactions to pain. *J Behav Ther Exp Psychiatry* 1982; **13**: 293–300.

15 Frazer M, Hampson S. Some personality factors related to dental anxiety and fear of pain. *Br Dent J* 1988; **165**: 436–439.

16 Schuurs AH, Duivenvoorden HJ, Makkes PC, Thoden van Velzen SK, Verhage F. Personality traits of patients suffering extreme dental anxiety. *Community Dent Oral Epidemiol* 1988; **16**: 38–41.

17 Lindsay SJ, Humphris G, Barnby GJ. Expectations and preferences for routine dentistry in anxious adult patients. *Br Dent J* 1987; **163**: 120–124.

18 Murray P, Liddell A, Donahue J. A longitudinal study of the contribution of dental experiences to dental anxiety in children between 9 and 12 years of age. *J Behav Med* 1989; **12**: 309–320.

19 Poulton R, Waldie KE, Thomson WM, Locker D. Determinants of early- *vs* late-onset dental fear in a longitudinal–epidemiological study. *Behav Res Ther* 2001; **39**: 777–785.

20 Mitropoulos CM, Pitts NB, Deery C. British Association for the Study of Community Dentistry criteria for the standardised clinical assessment of dental health (1992/3) In: *BASCD Trainer's Pack for Caries Prevalence Studies 1992/3*. Dundee: University of Dundee, 1992.

21 Lader D, Chadwick B, Chestnutt I, *et al*. *Children's Dental Health in the United Kingdom, 2003. Summary Report Office for National Statistics*. London: Office for National Statistics, 2004. [WWW document]. URL: http://www.statistics.gov.uk/CHILDREN/dentalhealth/downloads/cdh_Summary.pdf (accessed: 9 March 2009).

22 Milgrom P, Jie Z, Yang Z, Tay KM. Cross-cultural validity of a parent's version of the Dental Fear Survey Schedule for children in Chinese. *Behav Res Ther* 1994; **32**: 131–135.

23 ten Berge M, Hoogstraten J, Veerkamp J, Prins P. The Dental Subscale of the Children's Fear Survey Schedule: a factor analytic study in The Netherlands. *Community Dent Oral Epidemiol* 1998; **5**: 340–343.

24 Humphris GM, Milsom K, Tickle M, Blinkhorn A, Holbrook H. (A new anxiety scale for 5-year-old children (DA5): description and concurrent validity. *Health Educ J* 2002; **61**: 5–19.

25 Bridgman CM, Ashby D, Holloway PJ. An investigation of the effects on children of tooth extraction under general anaesthesia in general dental practice. *Br Dent J* 1999; **186**: 245–247.

26 Threlfall AG, King D, Milsom KM, Blinkhom AS, Tickle M. General dental practitioner's views on dental general anaesthesia services. *Community Dent Health* 2007; **24**: 93–96.

27 Davey GC. Dental phobias and anxieties: evidence for conditioning processes in the acquisition and modulation of a learned fear. *Behav Res Ther* 1989; **27**: 51–58.

28 Threlfall AG, Pilkington L, Milsom KM, Blinkhorn AS, Tickle M. General dental practitioners' views on the use of stainless steel crowns to restore primary molars. *Br Dent J* 2005; **199**: 453–455.

29 Tickle M, Threlfall AG, Pilkington L, Milsom KM, Duggal MS, Blinkhorn AS. Approaches taken to the treatment of young children with carious primary teeth: a national cross-sectional survey of general dental practitioners and paediatric specialists in England. *Br Dent J* 2007; **203**: E4.

30 Schriks MC, van Amerongen WE. Atraumatic perspectives of ART: psychological and physiological aspects of treatment with and without rotary instruments. *Community Dent Oral Epidemiol* 2003; **31**: 15–20.

31 Klingberg G, Berggren U, Carsson S, Noren J. Child dental fear: cause related factors and clinical effects. *Eur J Oral Sci* 1995; **103**: 405–412.

32 Freeman RA. Psychodynamic understanding of the dentist–patient interaction. *Br Dent J* 1999; **186**: 503–506.

33 American Academy of Pediatric Dentistry Clinical Affairs Committee–Behavior Management Subcomittee; American Academy of Pediatric Dentistry Council on Clinical Affairs–Committee on Behavior Guidance. Guideline on behavior guidance for the pediatric dental patient. *Pediatr Dent* 2005–2006; **27**: 92–100.

34 Duggal M. Providing children with the quality dental care they deserve. *Community Dent Health* 2006; **23**: 66–68.

35 Tickle M. Improving the oral health of young children through an evidence-based approach. *Community Dent Health* 2006; **23**: 2–4.