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ABSTRACT

Most studies examining the origins of dental fear and anxiety have relied on cross-sectional data. These are subject to several problems, such as recall and uncertainty concerning temporal relationships. This paper uses longitudinal data from the Dunedin Multidisciplinary Health and Development Study to assess risk factors for the development of dental anxiety in persons between the ages of 18 and 26 years. It was hypothesized that psychological factors would be as important as conditioning experiences in the genesis of dental anxiety over this period. The eight-year incidence of dental anxiety was 16.5%. Five variables entered models predicting onset: multiple fears, symptoms of substance dependence, previous experience of invasive dental treatment, dental visiting pattern, and the extraction of one or more teeth. Separate analyses for those avoiding and those using dental services resulted in different explanatory models. These results indicated that both psychological and conditioning variables contributed to the development of dental anxiety in this population of young adults.

KEY WORDS: dental anxiety, etiology, conditioning, psychological factors.

Psychological Disorder, Conditioning Experiences, and the Onset of Dental Anxiety in Early Adulthood

INTRODUCTION

It is now generally accepted that individuals with dental fear differ in terms of the origins of their fears of dental treatment (Milgrom *et al.*, 1985). Weiner and Sheehan (1990) suggested that dental anxiety may be exogenous or endogenous. In the former, it is the result of direct or indirect conditioning experiences, while in the latter it is a component of a constitutional vulnerability to anxiety disorders that manifests as general anxiety states, mood disorders, and multiple severe fears.

Numerous studies have provided evidence in support of the role of conditioning *via* aversive treatment experiences in the development of dental fear or anxiety (Kleinknecht *et al.*, 1973; Berggren and Meynert, 1984; Ost and Hugdahl, 1985; Davey, 1989; Milgrom *et al.*, 1995; Locker *et al.*, 1996; Poulton *et al.*, 1997). Others provide support for the view that, for a subgroup, anxieties about dental treatment are linked to broader psychological problems (Fiset *et al.*, 1989; Moore *et al.*, 1991; Roy-Byrne *et al.*, 1994).

However, almost all etiological studies of dental fear and anxiety have used cross-sectional designs. Since these rely on retrospective self-reports, problems with recall and retrospective re-interpretation mean that there is some uncertainty about the precise causal role of negative conditioning experiences and family influences (Kent, 1997). In addition, cross-sectional studies are unable to determine temporal relationships of cause and effect, so it is unclear whether the psychological problems documented by Fiset *et al.* (1989), Moore *et al.* (1991), and Roy-Byrne *et al.* (1994) preceded or followed the development of dental anxiety. Since fears and phobias can predispose individuals to other psychological disorders (Noyes *et al.*, 1996), both are equally plausible. The solution to these problems is the use of longitudinal study designs.

The longitudinal studies conducted to date (Murray *et al.*, 1989; Locker and Liddell, 1995; Thomson *et al.*, 1997; Poulton *et al.*, 1997; Hagglin *et al.*, 1999) have largely been concerned with measuring the incidence of dental anxiety in individuals at different ages. Poulton *et al.* (1997), however, examined the role of potential risk factors in the development of dental fear. In his birth cohort study, DMFT scores at age 15 were used as an index of aversive treatment experience and were significantly and specifically related to the onset of dental fear at age 18.

This paper uses data from the same birth cohort study to examine the incidence of dental anxiety in individuals between the ages of 18 and 26, and the etiological role of psychological disorders and dental treatment experiences. Since the period of transition from late adolescence into early adulthood is characterized by considerable social, emotional, and cognitive change (Newman *et al.*, 1996), it was hypothesized that psychological factors would be as important as conditioning experiences in the genesis of dental anxiety.

MATERIALS & METHODS

Study Procedures

Data were obtained from the Dunedin Multidisciplinary Health and Development Study (DMHDS). This is a birth cohort study of 1661 children who were born

and assessed at the Queen Mary Hospital, Dunedin, New Zealand, between April, 1972, and March, 1973, (Silva and Stanton, 1996). At the first follow-up at age 3 years, 1037 entered the longitudinal phase of the study. There were no differences between those who did and those who did not enter the study on several measures assessed at birth.

The health and development of Study members were assessed every two years between the ages of 3 and 15 and again at 18, 21, and 26. At the dental examination conducted at 18 and 26, information on dental anxiety and dental utilization was collected. Details of the data obtained at each assessment are reported in Silva and Stanton (1996).

Ethical approval for the study was obtained from the Ethics Committee of New Zealand's Southern Regional Health Authority. Study members signed an informed consent statement approved by that committee.

Measures

Dental Anxiety

Dental anxiety was measured by means of the Dental Anxiety Scale (DAS) (Corah, 1969; Corah *et al.*, 1978). Summing the response codes to its four items gives a score ranging from 4 to 20. Incident cases were those with scores of 12 or less at 18 but a score of 13 or more at 26.

Psychological Disorder

For individuals at age 18, psychological health was measured according to the Diagnostic Interview Schedule (DIS) (Robins *et al.*, 1981). This was developed by the US National Institute of Mental Health and allows lay interviewers to document psychiatric symptoms and make diagnoses based upon DSM-III-R criteria (Chapman, 1997). Diagnoses of psychological disorders are based on the presence of a minimum number of symptoms over the previous year, impairment in daily functioning, and help-seeking or police contact. The disorders assessed by the schedule for which symptom scores and diagnoses were available were: generalized anxiety, major depressive episode, conduct disorder, agoraphobia, social phobia, simple phobia, obsessive compulsive disorder, and substance (alcohol, cannabis) dependence. Here, symptom scores rather than diagnoses were used, since these maximized the amount of information included in the analysis (McGee *et al.*, 1996).

Dental Visits and Treatment Experience between the Ages of 18 and 26

Data on dental visits by individuals between the ages of 18 and 26 yrs were used to assign Study members to one of two groups: those who had not visited a dentist (avoiders) and those who had made at least one visit (utilizers). The dental examinations at ages 18 and 26 were conducted by calibrated dental examiners. A missing and filled tooth surface score (MFS) greater than zero at age 18 was used as an indicator of previous experience with invasive dental treatment. The number of teeth lost between 18 and 26 was calculated, along with the number of restorations placed in previously sound tooth surfaces.

Data Analysis

The analysis was limited to those who were not dentally anxious at age 18. Incident and non-incident cases were compared for differences in DIS symptom scores at 18, and dental visiting patterns and dental treatment experiences between 18 and 26. The significance of differences was tested by Chi-square tests or *t* tests. Where applicable, relative risks (RR) and 95% confidence

intervals were calculated. Multivariate analyses were undertaken by logistic regression analysis. Stratification analysis was undertaken to assess the effects of combinations of risk factors on the incidence of dental anxiety.

RESULTS

Response

Follow-up rates among the living cohort of Study members were 97% at 18 and 96% at 26. Complete data were available for 784 individuals. Of these, 53% were male and 47% female.

Incidence of Dental Anxiety

Of those not anxious at age 18 ($n = 705$), 16.5% became anxious by 26. Incidence rates among males and females were 14.7% and 18.4%, respectively (NS: Chi-square test). The mean increase in DAS scores for all incident cases was 6.2 (SD = 2.5), and 82.5% increased their score by at least four points. Of 31 subjects with DAS scores of 11 or 12 at baseline, nine increased by only one or two points. If these subjects are excluded on the grounds that they may be misclassified as incident cases, the incident rate falls to 14.8%.

Prevalence of Psychological Disorder at Age 18 Years

The most common psychiatric symptoms at 18 related to anxiety, substance dependence, and social phobia, while the least common were symptoms of depression and agoraphobia (Table 1). Women had higher scores than men for depression, generalized anxiety disorder, agoraphobia, and simple phobia, while men had higher scores for conduct disorder and substance dependence. A similar pattern was observed with respect to the proportions with symptom scores greater than zero, except that there were no gender differences for major depressive episode.

Dental Visits and Treatment Experience

At 18, 89.2% of Study members had an MFS score of 1 or more. Between the ages of 18 and 26, 89.2% visited the dentist at least once, 61.4% had one or more restorations placed in previously sound tooth surfaces, and 9.8% had at least one tooth extracted.

Psychological Disorders and the Onset of Dental Anxiety

Incident cases had significantly higher scores than non-incident cases for major depressive episode, generalized anxiety, simple phobia, and substance dependence (Table 2). When the proportions with one or more symptoms were examined, incidence was higher among those with one or more symptoms of depression than among those without (20.0% vs. 14.5%; $p < 0.05$; RR = 1.4). Incidence was also higher among those with agoraphobic symptoms (23.3% vs. 14.8%; $p < 0.05$; RR = 1.6), symptoms denoting simple phobia (23.9% vs. 11.9%; $p < 0.0001$; RR = 2.0), and symptoms of substance dependence (19.0% vs. 12.5%; $p < 0.05$; RR = 1.5).

Other Predictors of Dental Anxiety Onset

Those with experience of invasive dental treatment prior to 18 were more likely to be incident cases than those without (17.5% vs. 8.0%; $p < 0.05$; RR = 2.2). The incident rate was higher among dental avoiders than among dental utilizers (39.7% vs. 14.2%; $p < 0.001$; RR = 2.8) and among those who had one or more teeth extracted than among those who did not (23.9% vs. 13.0%; $p < 0.05$; RR = 1.8). There was no

Table 1. Mean Symptom Scores and Percent with Symptom Scores Greater than Zero: All Study Members and by Gender

	Mean Symptom Scores (SD)			Percent with Score > 0		
	All (n = 705)	Males (n = 371)	Females (n = 334)	All (n = 705)	Males (n = 371)	Females (n = 334)
Major depressive disorder (0-62) ^a	5.6 (9.9)	3.9 (8.6)	7.5 ^b (11.0)	34.0	25.9	44.0 ^d
Conduct disorder (0-36)	1.4 (2.6)	1.9 (3.2)	0.7 ^b (1.5)	41.7	50.9	32.3 ^d
Generalized anxiety disorder (0-50)	9.1 (8.7)	7.6 (7.6)	10.7 ^b (9.4)	80.7	78.2	83.8
Agoraphobia (0-10)	0.5 (1.0)	0.3 (0.9)	0.6 ^b (1.2)	19.5	14.9	26.6 ^c
Social phobia (0-18)	1.3 (1.7)	1.2 (1.6)	1.4 (1.9)	46.1	46.3	45.8
Simple phobia (0-18)	1.1 (1.8)	0.8 (1.3)	1.5 ^b (2.1)	38.7	32.5	45.5 ^c
Substance dependence (0-100)	6.3 (9.4)	8.1 (10.7)	4.3 ^b (7.3)	60.4	69.3	51.2 ^d
Obsessive-compulsive disorder (0-14)	1.1 (1.5)	1.1 (1.5)	1.1 (1.6)	40.7	39.3	42.2

^a Lower and upper limits of symptom scale. Gender differences in means significant by *t* tests.

^b *p* < 0.001. Gender differences in proportions significant by chi-square tests.

^c *p* < 0.001.

^d *p* < 0.0001.

difference between incident and non-incident cases in the number of previously sound surfaces that had been filled between the ages of 18 and 26.

Independent Predictors of the Incidence of Dental Anxiety

In the logistic regression analyses, models were constructed for all Study members and separately for those who had and had not visited the dentist. In an initial model including all Study members, DIS symptom scores for depression, generalized anxiety disorder, simple phobia, agoraphobia, and substance dependence were entered along with previous experience of invasive treatment and dental visiting pattern. Three variables had independent effects. Incident cases were more likely to have had invasive dental treatment prior to 18 (*p* < 0.05; OR = 2.5) and to have avoided the dentist during the eight-year observation period

Table 2. Mean (SD) DIS Symptom Scores for Incident and Non-incident Cases

Symptom Scale	Incident Cases (n = 114)	Non-incident Cases (n = 591)	<i>p</i> ^a
Major depressive episode	8.0 (12.8)	5.3 (9.4)	< 0.05
Conduct disorder	1.6 (2.7)	1.3 (2.5)	NS
Generalized anxiety	11.7 (9.7)	8.6 (8.4)	< 0.01
Agoraphobia	0.6 (1.1)	0.4 (1.0)	NS
Social phobia	1.6 (1.9)	1.3 (1.7)	NS
Simple phobia	2.0 (2.3)	0.9 (1.6)	< 0.001
Substance dependence	7.8 (11.1)	5.9 (9.0)	< 0.05
Obsessive-compulsive disorder	1.2 (1.7)	1.1 (1.5)	NS

^a *p*-values obtained from *t* tests.

(*p* < 0.0001; OR = 4.7). At age 18, they had more symptoms of simple phobia (*p* < 0.0001; OR = 1.3). This analysis was repeated including variables denoting tooth loss and restorations placed in previously sound surfaces. The former had a significant effect but the latter did not (Table 3). The variables denoting dental visiting pattern and simple phobia retained their significant effects. Invasive dental treatment prior to age 18 failed to reach significance, even though its odds ratio was 2.3.

Only one variable entered the model for avoiders: symptoms of substance dependence at 18 years (*p* < 0.05; OR = 1.1). Three variables entered the model for utilizers: simple phobias at 18 (*p* < 0.0001; OR = 1.3), invasive treatment prior to 18 (*p* < 0.05; OR = 3.7), and tooth loss between 18 and 26 (*p* < 0.05; OR = 2.1). Sensitivity and specificity statistics were

36.0% and 88.9% and 8.0% and 98.7%, respectively.

Although incidence rates did not differ by gender, the four regression analyses were repeated with gender included as a predictor variable. Gender was not significant in any of the models, and parameter estimates changed only marginally.

Independent and Joint Effects of Risk Factors

The stratification analysis was confined to dental utilizers. These were allocated to one of six groups based on their exposure to conditioning experiences (no exposure, invasive dental treatment prior to 18, exposure to invasive dental treatment prior to 18 and loss of one or more teeth between 18 and 26) and symptoms of simple phobia at 18 (none, one, or more). Incidence rates for these groups showed a marked dose response effect (Table 4). Those with all three risk factors had ten times the risk of becoming dentally anxious than those

without. Analysis of these data also suggests that symptoms of simple phobia increased vulnerability to dental anxiety onset, given exposure to dental conditioning experiences.

DISCUSSION

The incidence of dental anxiety among these young adults was high, at 16.5%. There are no other studies of the incidence of dental anxiety at this point in the life-course against which this estimate can be compared. The mean increase in DAS scores was large and suggested that we have documented a real increase in dental anxiety rather than unreliability in the measure used.

Several psychological symptom scores derived from the DIS were associated with the onset of dental anxiety. Three pertained to anxiety disorders, one a mood disorder, and the other a substance dependence disorder. Experience of invasive dental treatment prior to 18, the dental visiting pattern between 18 and 26, and having one or more teeth extracted between 18 and 26 were also predictive of onset. In multivariate analyses, two of the symptom scores and the three dental variables entered one or more of the three models constructed. Consequently, both psychological and conditioning variables were important in terms of predicting the development of dental anxiety in these young adults.

In the model including all Study members, the strongest predictor of the onset of dental anxiety was avoidance of dental care (OR = 5.1). This finding can partly be explained by the "vicious cycle" of dental avoidance-dental anxiety suggested by Berggren (1984). Here, dental avoidance leads to a real or perceived deterioration in dental health that gives rise to feelings of guilt, embarrassment, and inferiority. In turn, these feelings lead to the development of dental anxiety, and this exacerbates the avoidance of dental care. Moreover, avoidance of dental treatment prevents exposure to the anxiety-provoking situation and subsequent habituation.

For a better assessment of the roles of direct conditioning experiences, we undertook separate analyses for "avoiders" and "utilizers". Of interest was the fact that different variables entered the models. The best model for "avoiders" contained only one variable, symptoms of substance dependence disorder. This measures the excessive and problematic use of alcohol and the use of recreational drugs. Such symptoms may not have a direct effect on the development of dental anxiety but may be indicative of broader and relatively severe psychological disorder. Several studies have shown that alcohol abuse is a common complication of social phobias and other anxiety disorders (Noyes *et al.*, 1996) or externalizing problems (Newman *et al.*, 1996). However, the most important point is that prior invasive dental treatment, a variable assumed to document direct conditioning experiences, did not enter this model.

By contrast, the model for "utilizers" included two variables relating to conditioning experiences: invasive dental treatment prior to age 18, and loss of one or more teeth between the ages of 18 and 26 years. It also included one psychological variable, the number of symptoms related to simple phobias.

Table 3. Independent Predictors of the Onset of Dental Anxiety: Results of the Logistic Regression Analysis for All Study Members (n = 705)

Independent variable ^a :	Dependent variable: Incident case (Yes = 1; No = 0)			
	B	Wald	P	Odds Ratio (95% CI)
Dental visiting pattern (No dental visits = 1; One or more dental visits = 0)	1.6278	28.84	<0.0001	5.1 (2.9-9.3)
Invasive dental treatment prior to age 18 (Yes = 1; No = 0)	0.828	3.31	0.06	2.3 (0.95-5.6)
Tooth extracted between ages of 18 and 26 (Yes = 1; No = 0)	0.7312	5.10	<0.05	2.1 (1.2-4.2)
Symptoms of simple phobia at 18	0.2585	17.06	<0.0001	1.3 (1.2-1.5)
Generalized anxiety symptoms at 18	0.0012	0.004	NS	1.0
Symptoms of depression at 18	0.0122	1.01	NS	1.0
Symptoms of substance dependence at 18	0.0041	0.13	NS	1.0
Symptoms of agoraphobia at 18	0.0080	0.005	NS	1.0
Number of FS increments between 18 and 26	-0.0013	0.003	NS	1.0
Constant	-3.2060	47.51	<0.0001	

^a Unless otherwise indicated, variables entered as continuous variables. Model chi-square = 63.3; p < 0.0001. Sensitivity: 9.7%. Specificity: 98.4%.

This variable was constructed by a count of the numbers of objects or situations (heights, seeing blood, animals, thunder) that were reported by Study members as creating strong unreasonable fear and avoidance. As such, it is similar to other measures of general fearfulness but taps the more extreme end of the scale. Stratified analysis indicated that these more general fears substantially increased the risk of dental anxiety among those exposed to dental conditioning experiences.

Taken together, these results support Weiner and Sheehan's (1990) typology of exogenous and endogenous dental anxiety. In the former, conditioning experiences alone may give rise to dental anxiety, with multiple fears appearing to increase substantially the vulnerability of individuals to these direct conditioning experiences. In the latter, direct conditioning does not play a prominent etiological role. Here, the onset of dental anxiety may be more closely associated with underlying disorders co-morbid with substance dependence.

Table 4. Incidence Rates and Relative Risks by Exposure Status (Study members with one or more dental visits only)

Conditioning Experiences:	N	Symptoms of Simple Phobia:				
		None %	RR ^a	One or More %	RR ^a	
None	41	4.9	1	26	3.8	0.8
Invasive dental treatment before age 18	302	10.3	2.1	192	20.3	4.1
Invasive dental treatment before age 18 and loss of one or more teeth between 18 and 26	40	12.5	2.6	26	42.3	10.3

^a Relative risk.

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