

Is dental anxiety an aetiologic factor in poor dental attendance?

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Aim and objectives: There is a growing awareness in research and clinical dentistry on how dental anxiety might impact on dental attendance. The authors propose a theory-driven approach to selecting and testing effects to examine the impact of dental anxiety on poor dental attendance. **Design:** Using data from Australia's National Survey of Adult Oral Health (n=12,392 adults) and supported by a Directed Acyclic Graph, an aetiologic multivariate model was used to measure the effect of dental anxiety on dental attendance (a composite measure of reason for visiting, frequency of visiting or time since last visit). **Results:** Dental anxiety was a determinant in poor dental attendance although its effect varied between sexes. Among females, dental anxiety was associated with a 1.61-fold greater odds of poor dental attendance (95% CI 1.41-1.84), while among males, dental anxiety was associated with only a 1.21-fold greater odds of poor dental attendance (95% CI 1.02-1.42). **Conclusion:** The findings suggest that dental anxiety is an aetiologic factor in poor dental attendance among Australian adults.

Key words: Dental anxiety, attendance, longitudinal data, access

INTRODUCTION

Poor dental attendance involves both problem-based dental service utilisation and infrequent use of dental services (Spencer *et al.*, 2007). It has been associated with lower socioeconomic status (Peres *et al.*, 2007), poor self-rated oral health (Okunseri *et al.*, 2008), perceived need for dental care (Astrom and Kida, 2007), being male (Lo *et al.*, 2001) and being from an ethnic minority background (Edmunds, 2006). Outcomes of poor dental attendance include untreated dental disease (Brennan *et al.*, 2007) and poor oral health-related quality of life (Fernandes *et al.*, 2006).

Dental anxiety, the heightened dread of visiting the dentist that precedes dental fear, is also associated with poor dental attendance (Armfield *et al.*, 2007; Schuller *et al.*, 2003). Individuals with dental anxiety are at higher risk of tooth decay and poorer oral function (Armfield *et al.*, 2009; Hagglin *et al.*, 1996; Schuller *et al.*, 2003). This is of concern given that high dental anxiety is a reasonably common phenomenon in Western societies, affecting around 16-20% of people (Armfield *et al.*, 2006; Locker *et al.*, 1999; Skaret *et al.*, 1998).

Although it has been described for centuries, it is only in the last few decades that dental anxiety and, more specifically, its relationship with dental attendance has been accorded special interest in the literature. There are numerous descriptive reports on the frequency and distribution of dental anxiety and dental attendance (Chanpong *et al.*, 2005; McGrath and Bedi, 2004; Nicolas *et al.*, 2007; Pohjola *et al.*, 2007; Sohn *et al.*,

2005). More recently, longitudinal studies have studied the natural history of the condition and more specifically the trajectories of dental anxiety (Thomson *et al.*, 2009). Nevertheless, a greater understanding of the pathways through which dental anxiety might have an impact on dental attendance may allow more relevant policies to be developed, which may, in turn, lead to a reduction in dental anxiety/dental attendance disparities at a population level.

Using data from Australia's second National Survey of Adult Oral Health (NSAOH; Slade *et al.*, 2007), the aims of this analysis were to: develop a theory-driven causal model of dental anxiety and dental attendance and; determine if dental anxiety is an aetiologic factor in poor dental attendance among Australians aged 18+ years.

MATERIAL AND METHOD

Data were obtained from adults aged 18+ years who had participated in the telephone interview component of NSAOH. Participation rates varied by location, socio-economic levels, and between survey components (Mejia *et al.*, 2007). A thorough evaluation of potential biases due to non-participation using population benchmarks and small area socio-economic indicators revealed that the degree of bias present in most estimates was of low magnitude and provided sufficient evidence on the validity of estimates using NSAOH data (Mejia *et al.*, 2007).

Sampling

NSAOH utilised a three-stage, stratified clustered probability sampling design to select one adult per sampled household. The first stage selected postcodes, the second stage selected households within sampled postcodes and the third stage selected one adult from each sampled household.

Computer-assisted telephone interview (CATI)

The interview consisted of 79 questions, based on those used in previous National Dental Telephone Interview Surveys conducted by the Australian Research Centre for Population Oral Health (Carter *et al.*, 1994; Carter and Stewart, 2002; Carter and Stewart, 2003).

Poor dental attendance

Poor dental attendance was a composite item reflecting any one of three different aspects of dental attendance. Participants were considered to have poor dental attendance if they indicated that their usual reason for visiting a dental professional was for a dental problem, they last visited a dental professional five years or more previously, or if they sought care from a dental professional less than once per year, on average.

Dental anxiety

Dental anxiety was measured by the question "Would you feel afraid or distressed when going to the dentist?", with dental anxiety indicated by a response of 'a little', 'moderately', 'very' or 'extremely'.

Aetiological model

Causal models are widely used in the literature; in particular, potential outcome models, sufficient-component causal models, graphical causal models, and structural equation models (SEM) (Greenland and Brumback, 2002). Although the use of SEM is increasing in the dental literature, it depicts detailed quantitative assumptions, whereas graphical causal models provide a depiction of the qualitative assumptions behind causal analysis (Greenland and Brumback, 2002). In this study, we used Directed Acyclic Graphs (DAGs), a graphical causal model. DAGs are used in epidemiology to aid the study of causal effects, and are particularly useful for confounder identification. Traditional epidemiologic criteria for considering multiple confounders simultaneously may be inadequate, yet DAGs complement these analyses because they do not incorporate the strong parametric assumptions of traditional statistical models; similar to these conventional models, some assumptions regarding causation, selection, and measurement may be of unknown validity (Greenland *et al.*, 1999).

To determine if dental anxiety was an aetiological factor in poor dental attendance, we began by developing a DAG (Figure 1). Following published guidelines (Greenland *et al.*, 1999), the potential confounders included in the figure reflect causal assumptions and relationships between variables as

reported in the literature. For example, the effect of lower education on poor self-rated oral health is reported in the literature (Sanders and Spencer, 2004). The DAG thus shows an arrow beginning in education and pointing towards self-rated oral health to indicate the direction of the relationship. The arrow relating age and education clearly indicates that with age the level of education varies (i.e., it is impossible that education will cause age to change). As indicated by the arrow from residential location to dental attendance, dwellers of remote areas are less likely to have dental visits in the previous year than persons from rural or urban locations (Stewart *et al.*, 1998). The relationships all show directionality indicating the cause and the effect in order to maintain the acyclic nature of the graph. Other factors included were based on those widely reported in the literature to be associated with dental anxiety or poor dental attendance (Armfield *et al.*, 2006; Carter and Stewart, 2003; Pau *et al.*, 2007; Pohjola *et al.*, 2007; Roberts-Thomson and Slade, 2008). Initially, the causal structure included both measured and unmeasured CATI variables that fitted with published theoretical underpinnings of dental anxiety and poor dental attendance, but Figure 1 was later simplified to include only potential causal paths which included measured CATI variables. Multivariate models were then developed to estimate effects in the DAG.

Aetiological models differ from prediction models in that only postulated causal factors (in this case, dental anxiety) are entered, along with any confounders, as opposed to prediction models where both indicators and risk factors are employed (Beck *et al.*, 1992). The strategy used aimed to measure all relevant confounders, and adjust for them during analyses, so that the no-confounding assumption was plausible (Rothman and Greenland, 1998, pp. 363–365). The non-confounding assumption holds that other unmeasured determinants of dental attendance were balanced between people suffering from dental anxiety and those not suffering from dental anxiety. Under this assumption, the measure of association between dental anxiety and poor dental attendance obtained from the multivariate regression model estimates the causal effect of anxiety. The regression function or averages that are contrasted are assumed to have occurred in the same population under different conditions (i.e., counterfactual).

Statistical analyses

Because of the differences in the probability of participation, data were weighted during analyses to ensure estimates were generalisable to the Australian population from which survey participants were selected. Weights were calculated to reflect probabilities of selection and to adjust for different participation rates across postcodes, and among age and sex categories. The univariate and bivariate distributions of poor dental attendance and dental anxiety were determined, producing weighted population estimates. The potential for effect measure modification was also determined and differences between strata evaluated by examining the overlap of confidence intervals; only sex was identified as an effect measure modifier. To evaluate the potential for confound-

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ing, we examined the bivariate distribution of the remaining independent variables with dental anxiety among those without poor dental attendance. We then examined the relationship between dental attendance and each independent variable conditional on 'no dental anxiety'.

Based on the bivariate relationships and the DAG, variables were selected for the initial (full) unconditional logistic regression model. A backward elimination approach for model selection was used in order to avoid the changes in estimates that depend on covariates previously introduced in the model. We began by evaluating the interaction term (sex by dental anxiety) through both a likelihood ratio Chi-squared test with one degree of freedom and a Wald test using the Z statistic. Confounding was evaluated by dropping one variable at a time and by comparing changes in effect estimates for dental attendance and precision of its confidence intervals. Confounding was measured by the change-in-estimate approach. This approach calculates the relative change in parameter estimates for dental attendance in the reduced model compared to the full model. A change of 10% or more is deemed as being meaningful. Changes in the precision of the estimates (measured by the width of the confidence intervals) were also considered when deciding the variables to be included in the model (Rothman and Greenland, 1998, pp. 255-259). Thus, beyond significance testing, magnitude of effect and precision were important determinants of model specification. Because the interaction term was confirmed to

be significant and therefore remained in the model, adjusted odds ratios were calculated separately for males and females. SUDAAN software (Research Triangle Institute, Research Triangle Park, NC) was used for the analysis.

Ethical approval

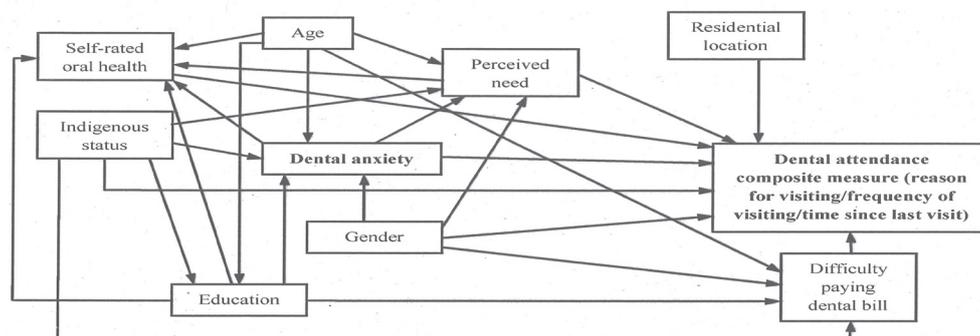
Ethical approval was obtained from the University of Adelaide's Human Research Ethics Committee, and participants provided verbal consent prior to answering questions.

RESULTS

In total, there were 28,812 in-scope telephone numbers sampled, of which 14,123 adults (aged 18+ years) completed the telephone interview. Approximately 43% of the total sampled individuals, or 12,392 participants, had non-missing data for all variables used in this analysis. Just over 42% of the adult population had some degree of dental anxiety and 58% had poor dental attendance (Table 1).

Eight characteristics were included in the final DAG (Figure 1). The percentage of Australian adults with dental anxiety was elevated among people with poor dental attendance, and among several population groups classified according to demographics and indicators of access to dental care: 45-54 year-olds, females, Indigenous Australians, people who reported they would struggle to pay a Au\$100 dental bill, people who reported that cost prevented them from receiv-

Figure 1. Directed Acyclic Graph of factors associated with dental anxiety and dental attendance



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Table 1. Percentages of 18+ year old NSAOH participants by dental anxiety and poor dental attendance (composite measure) (95% CI in brackets)

	% of people	% of people reporting anxiety ('little to extreme')	% of people reporting poor dental attendance ^a
Dental Anxiety			
Not at all	57.5 (56.3–58.7)	-	53.4 (51.7–55.1)*
A little to extreme	42.5 (41.3–43.8)	42.5 (41.3–43.8)	64.2 (62.3–66.1)
Dental Attendance			
Poor dental attendance ^a	58.0 (56.6–59.4)	47.0 (45.5–48.5)*	58.0 (56.6–59.4)
	42.0 (40.6–43.4)	36.2 (34.4–38.0)	-

*P<0.05

^aComposite 'poor dental attendance' variable: responses of 'Dental problem' to the item 'Is your usual reason for visiting a dental professional for check-ups or when you have a dental problem?', '5 years or more' to the item 'How long ago did you last visit a dental professional about your teeth, dentures or gums?' or 'Less than once per year' to the item 'How often on average do you seek care from a dental professional?'.

Table 2. Percentages of 18+ year old NSAOH participants by demographic and socio-economic status (95% CI in brackets)

	% of people	% of people reporting anxiety ('little to extreme')	% of people reporting poor dental attendance ^a
Demographic			
Age-group			
18–24 years	13.5 (12.5–14.7)	32.2 (28.6–36.1)*	55.0 (51.1–58.9)*
25–34 years	19.9 (18.8–21.0)	42.5 (39.6–45.4)	67.4 (64.5–70.1)
35–44 years	20.7 (19.8–21.7)	46.8 (44.5–49.2)	61.4 (59.0–63.7)
45–54 years	18.8 (17.8–19.8)	47.9 (45.3–50.6)	55.5 (52.7–58.3)
55–64 years	13.7 (12.9–14.5)	47.4 (44.3–50.4)	53.2 (50.4–56.0)
65–74 years	7.7 (7.2–8.3)	37.1 (34.2–40.1)	54.7 (51.3–58.0)
75+ years	5.7 (5.1–6.2)	29.0 (25.7–32.5)	48.6 (44.3–52.9)
Sex			
Male	50.0 (48.8–51.1)	34.3 (32.6–36.0)*	63.6 (61.6–65.4)*
Female	50.0 (48.9–51.2)	50.7 (49.3–52.1)	53.0 (51.2–54.7)
Residential location			
Capital city	65.5 (64.5–66.4)	42.3 (40.7–43.8)	54.2 (52.3–56.0)*
Other	34.6 (33.6–35.5)	43.0 (41.0–45.0)	66.0 (63.8–68.1)
Indigenous status			
Indigenous	1.4 (1.1–1.7)	53.8 (43.6–63.8)*	71.5 (60.2–80.6)*
Non-Indigenous	98.6 (98.3–98.9)	42.3 (41.0–43.5)	58.1 (56.6–59.5)
Socio-economic status			
Highest qualification			
University degree			
Non-University degree	32.8 (31.3–34.3)	43.6 (41.5–45.7)	48.9 (46.8–51.1)*
Eligibility for public dental care	67.2 (65.7–68.7)	42.1 (40.7–43.6)	62.8 (61.2–64.3)
Eligible	23.2 (22.1–24.5)	44.3 (42.2–46.5)	69.5 (67.4–71.5)*
Ineligible	76.8 (75.6–77.9)	42.0 (40.6–43.4)	54.8 (53.2–56.4)
Dental insurance			
Insured	47.0 (45.4–48.6)	42.2 (40.6–43.9)	42.7 (41.0–44.4)*
Not insured	53.0 (51.4–54.6)	43.1 (41.4–44.7)	71.8 (70.3–73.3)
Trouble paying \$100 dental bill			
Yes	16.8 (15.9–17.8)	48.4 (45.6–51.1)*	75.5 (73.0–77.8)*
No	83.2 (82.2–84.1)	41.4 (40.0–42.8)	54.7 (53.2–56.2)
Cost prevents dental care			
Yes	21.6 (20.4–22.9)	54.1 (51.3–56.8)*	68.9 (66.1–71.6)*
No	78.4 (77.1–79.6)	37.8 (36.2–39.4)	40.7 (39.1–42.4)

^aComposite 'poor dental attendance' variable: responses of 'Dental problem' to the item 'Is your usual reason for visiting a dental professional for check-ups or when you have a dental problem?', '5 years or more' to the item 'How long ago did you last visit a dental professional about your teeth, dentures or gums?' or 'Less than once per year' to the item 'How often on average do you seek care from a dental professional?'.

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Table 3. Percentages of 18+ year old NSAOH participants by self-perceived oral health and dental visiting behaviour (95% CI in brackets)

	% of people	% of people reporting anxiety ('little to extreme')	% of people reporting poor dental attendance ^a
Self-perceived oral health			
Self-perceived need for extraction or restorations			
Yes	32.9 (31.8–34.1)	53.0 (51.0–54.9)*	78.3 (76.6–79.9)*
No	67.1 (65.9–68.2)	37.4 (36.0–38.8)	48.4 (46.8–50.0)
Self-perceived need for restorations			
Yes	29.4 (28.4–30.5)	53.2 (51.1–55.3)*	78.7 (77.0–80.4)*
No	70.6 (69.5–71.6)	38.0 (36.5–39.4)	49.4 (47.7–51.0)
Self-rated oral health			
Excellent, very good, good	83.0 (82.0–83.9)	39.0 (37.6–40.4)*	53.3 (51.8–54.8)*
Fair, poor	17.0 (16.1–18.0)	59.7 (57.1–62.3)	82.4 (80.3–84.3)
Dental visiting behaviour			
Last visit private dentist			
Yes	86.5 (85.4–84.5)	42.6 (41.3–43.9)	85.2 (82.4–87.5)*
No	13.5 (12.5–14.6)	42.8 (39.6–46.2)	53.8 (52.3–55.2)
Have dentist usually attend			
Yes	78.9 (77.6–80.1)	41.5 (40.0–42.9)	45.0 (43.4–46.6)*
No	21.1 (19.9–22.4)	44.1 (41.4–46.9)	85.7 (83.6–87.5)
Avoid care due to cost			
Yes	31.9 (30.7–33.1)	53.4 (51.5–55.4)*	79.4 (77.7–81.0)*
No	68.1 (66.9–69.3)	37.4 (35.9–38.9)	48.3 (46.7–49.9)

*P<0.05

^aComposite 'poor dental attendance' variable: responses of 'Dental problem' to the item 'Is your usual reason for visiting a dental professional for check-ups or when you have a dental problem?', '5 years or more' to the item 'How long ago did you last visit a dental professional about your teeth, dentures or gums?' or 'Less than once per year' to the item 'How often on average do you seek care from a dental professional?'.

ing required dental care, people who perceived a need for extractions or restorations, people who rated their oral health as 'fair or poor', and people who reported that they avoided dental care because of cost (Table 2 and Table 3). Some of those characteristics were associated with poor dental attendance: Indigenous identity, difficulty paying a Au\$100 dental bill, dental care that could not be afforded, perceived need for extractions or restorations, 'fair or poor' self rated oral health and avoidance of dental care due to cost. However, there were additional groups that reported relatively poor dental attendance: 25–34 year-olds, males, people living outside capital cities, people who did not have a University degree, people who were eligible for public dental care, people who did not have dental insurance, people who last visited a private dentist, and people who did not have a dentist that they usually attended.

The crude association, expressed as an odds ratio (OR), between dental anxiety and poor dental attendance was 1.75. When stratified by sex, males showed a crude OR of 1.49 and females of 2.00. In the logistic regression model (Table 4), dental anxiety had a positive coefficient, indicating that dental anxiety was associated with greater log(odds) of poor dental

attendance after adjusting for other covariates. When the significant sex by dental anxiety interaction was accounted for, females with dental anxiety had 1.61 times the odds of having poor dental attendance than females with no anxiety, while males with dental anxiety had 1.21 times the odds of having poor dental attendance relative to non-anxious males.

DISCUSSION

In this representative sample of adult Australians, dental anxiety was found to be an aetiological factor in poor dental attendance, with the magnitude of this difference being greater among females. While a positive association is not surprising, the novelty of this result is that it was observed after adjusting for an extensive range of covariates that are known to influence dental attendance, and it can be generalised to the Australian adult population.

While the representativeness of this sample is a strength of the study, a weakness is the cross-sectional design that is needed for health surveys. Specifically, it is possible that anxiety develops as a consequence of poor dental attendance.

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Table 4. Multivariate model of 18+-year-old NSAOH participants with poor dental attendance

	Beta Coefficient (95% CI)
Dental anxiety A little to extreme	0.48 (0.34, 0.61)
Sex Male	0.67 (0.53, 0.81)
Interaction Male x A little to extremely anxious	-0.29 (-0.50, -0.07)
Age-group	
18–24 years	0.09 (-0.15, 0.33)
25–34 years	0.80 (0.56, 1.03)
35–44 years	0.45 (0.24, 0.66)
45–54 years	0.20 (-0.02, 0.42)
55–64 years	0.11 (-0.11, 0.32)
65–74 years	0.18 (-0.04, 0.39)
Highest Qualification University degree	-0.51 (-0.61, -0.04)
Trouble paying Au \$100 dental bill Yes	0.78 (0.63, 0.93)
Self-perceived need for extraction or restorations Yes	1.05 (0.94, 1.16)
Self-rated oral health Excellent, very good, good	0.91 (0.76, 1.06)

Referent categories: No dental anxiety, female, 75+ years of age, no university degree, no trouble paying Au \$100 dental bill, no self-perceived need for extraction, self-rated health fair or poor.

Nevertheless, this study was designed around an equally valid hypothesis that assumes directionality of the relationship between these factors, that is, that dental anxiety leads to dental avoidance or poor dental attendance. The best way to resolve question would be through a life-course study, yet cohorts for such studies typically are limited to one hospital or city, which limits capacity to generalise results to a population.

Our result, coupled with other evidence that dental anxiety is associated with poorer oral health (Armfield *et al.*, 2009; Hagglin *et al.*, 1996; Schuller *et al.*, 2003), suggests that interventions are needed to improve the pattern of dental attendance among anxious people. For this to occur there needs to be a better understanding of the complex phenomena of dental anxiety and ways it might be ameliorated.

That the aetiological effect of dental anxiety on dental attendance was stronger among females than males is novel, and raises the question of ‘why?’ Females are, in general, more anxious than males (Stinson *et al.*, 2007), but this does not in itself explain why the association between anxiety and attendance is stronger for females. It is plausible that the ‘dangerous’ and ‘uncontrollable’ elements of dental anxiety

might occur to a greater degree among females than males, an argument supported by Locker and Liddell, who hypothesised that gender differences in regard to dental anxiety could be due to differences in the perception of meaning of anxiety-causing experiences (Liddell and Locker, 1997). Although women showed more anxiety about pain on all sub-scales used in their study, an evaluation of predictors of dental anxiety showed that painful experiences were more important to men and that intolerance of pain was a significant predictor of dental anxiety for men alone. Their findings suggested that there may be heterogeneity in types of dental anxiety, and that dental anxiety may mean different things to males and females. However, it is also important to bear in mind that females may be more willing to express their anxiety than males (Pierce and Kirkpatrick, 1992), and that there may be, in fact, no difference in dental anxiety.

It is important to consider the public health implications of our findings. There is evidence of chairside efficacy of cognitive-behavioural approaches in reducing anxiety (Norton and Price, 2007), but their impact on dental anxiety at a population level is unknown. A more cost-effective and pragmatic approach could be a public health intervention that involves

early childhood dental experiences in school dental services, with the literature indicating that dental anxiety develops early in life (Locker *et al.*, 2001) and is therefore an antecedent to dental visiting patterns. A public health intervention that was equally effective in reducing anxiety in males and females would, based on these results, have a greater impact on dental attendance among women than men. However, in Australia, as in most other countries, it is males who have lower rates of favourable dental attendance. Paradoxically, a successful intervention that reduced anxiety equally for males and females may therefore widen the gender gap in patterns of dental attendance. Instead, a practical implication of this study is that population-based efforts to alleviate dental anxiety may need to be designed differently for the two genders.

CONCLUSIONS

In conclusion, our findings indicate, albeit using a cross sectional design, that dental anxiety is likely to be an aetiologic factor in poor dental attendance among Australian adults. There may be heterogeneity in exposure to the antecedents of dental anxiety that account for the stronger effect of dental anxiety on dental attendance observed for females compared with males. However, further studies in other populations are required to establish the causal role of dental anxiety, as our results can only be generalised to the Australian population. Dental anxiety may need to be designed differently for the two genders.

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