

Avoidance of dental visits: the predictive validity of three dental anxiety scales

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The purpose of this study was to determine the sensitivity, specificity, positive and negative predictive values for Corah's Dental Anxiety Scale (DAS) and two modified versions of it (MDAS; MDAS/4). A questionnaire was mailed to a simple random sample of 1,190 25-year-old residents in the west of Norway in 1997. Half the sample received DAS, the other half MDAS. The response rate after one reminder was 62%. The respondents completed the scales, gave demographic particulars and answered one question about dental visiting habits during the last 5 years plus an open-ended question about reasons for non-attendance. Using the answers to the latter question as validating criterion, it was found that, for all scales, sensitivity decreased while specificity improved when changing from a liberal to a stringent cut-off point. The scales gave low positive predictive values (≤ 0.26), but high negative predictive values (≥ 0.98). Since DAS and MDAS/4 gave almost identical findings, the two samples were combined. At a cut-off point ≥ 13 sensitivity was 0.83, specificity 0.84, positive predictive value 0.18 and negative predictive value 0.99. The corresponding estimates when the cut-off point was ≥ 15 were 0.67, 0.90, 0.22 and 0.98. It is concluded that, in this test, DAS and the two versions of MDAS gave acceptable, or near acceptable sensitivity, specificity and negative predictive values, but far too low positive predictive values to be useful for prediction at the individual level. □ *Dental anxiety; indices; predictive value; sensitivity; specificity*

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The Likert-type Corah Dental Anxiety Scale has 4 items (1). It was designed to measure the degree of anxiety associated with dental treatment on a scale from 4 (no anxiety) to 20 (high anxiety). It has been widely used both for survey (e.g. 2–10) and clinical purposes (e.g. 11–15), but it has been criticized for not covering all aspects of dental fear (for review see (16)) and because its response alternatives differ between items (17). Alternative scales have been proposed to reduce these shortcomings (16, 17), one of them being the Modified Dental Anxiety Scale introduced by Humphris et al. (17). They standardized the responses and added a fifth item concerning anesthetic injection to the ones used by Corah (1) (Table 1). This meant that MDAS could take on values from 5 (no anxiety) to 25 (high anxiety). The reliability and validity of DAS (1, 18) and MDAS have been reported to be acceptable (17). However, when used to discriminate between highly and less anxious individuals, comparisons of mean scores have been reported (1, 13, 16–19). Because large and highly statistically significant mean differences were found, it was concluded that the anxiety scales are useful for clinical purposes as well as to assess the prevalence of dental fear likely to be associated with avoidance of dental treatment. At the same time it has been reported that high scores of dental anxiety do not necessarily lead to avoidance of dental treatment or result in irregular dental attendance (21, 22). Although an association has been observed between anxiety scale score and the frequency of dental visits, the explained variance has tended to be low (4, 8, 22). These findings suggest that the level of sensitivity (SENS), specificity (SPEC), positive

and negative predictive values (PPV/NPV) using DAS and MDAS may not be as satisfactory as differences in mean scores between anxious patients and less anxious patients, or as the estimates of sensitivity (0.85) and specificity (0.91) reported by Humphris et al. (17) seem to indicate. However, we found no reports to verify or refute this supposition. For this reason it was decided to determine the sensitivity, specificity, positive and negative predictive values for Corah's Dental Anxiety Scale (1) and for two versions of the Modified Dental Anxiety Scale (17) using self-reported reasons for not visiting a dentist during the last 3 years as validating criterion.

Material

A simple random sample of 1,190 25-year-old subjects (born 1972) was drawn by the Directorate of Taxes from a population of 13,550 persons (sampling fraction 8.8%) resident in 3 Norwegian counties (Rogaland, Hordaland, Sogn & Fjordane) on 1st January 1997. Twenty-three subjects were lost: 15 because of wrong address, 5 lived abroad, 2 because of mental retardation and one did not understand Norwegian. Seven-hundred-and-thirty-six subjects had answered after one reminder (62%). The response rate was significantly higher among females (66%) than among males (56%) ($\chi^2 = 12.34$, 1 df, $P < 0.001$) and among persons with college or university education than among people who had only completed primary school ($P < 0.001$).

Table 1. Dental Anxiety Scales (1, 17).

Q	Corah's Dental Anxiety Scale (DAS)	Modified Dental Anxiety Scale (MDAS)
1.	If you had to go to the dentist tomorrow, how would you feel? (1) Look forward to it as a reasonably enjoyable experience (2) I wouldn't care one way or the other (3) I would be a little uneasy about it (4) I would be afraid that it would be unpleasant and painful (5) I would be very frightened of what the dentist might do	If you went to your dentist for treatment tomorrow, how would you feel? (1) Not anxious (2) Slightly anxious (3) Fairly anxious (4) Very anxious (5) Extremely anxious
2.	When you are waiting in the dentist's office for your turn in the chair, how do you feel? (1) Relaxed (2) A little uneasy (3) Tense (4) Anxious (5) So anxious that I sometimes break out in a sweat or almost feel physically sick	If you were sitting in the waiting room (waiting for treatment), how would you feel? (Same alternatives as Q.1)
3.	When you are in the dentist's chair waiting while he gets his drill ready to begin working on your teeth, how do you feel? (Same alternatives as Q.2)	If you were about to have a tooth drilled, how would you feel? (Same alternatives as Q.1)
4.	You are in the dentist's chair to have your teeth cleaned. While you are waiting and the dentist is getting out the instruments which he will use to scrape your teeth around the gums, how do you feel? (Same alternatives as Q.2)	If you were about to have your teeth scaled and polished, how would you feel? (Same alternatives as Q.1)
5.	Not applicable	If you were about to have a local anaesthetic injection in your gum, above an upper back tooth, how would you feel? (Same alternatives as Q.1)

Methods

Two questionnaires were used. One randomly selected half of the sample received a questionnaire containing a translation into Norwegian of the original DAS (1, 23), the other half, a translated and back-translated version of MDAS (17). The mail questionnaire, accompanied by an explanatory letter and a self-addressed and pre-paid envelope for the reply, was posted in March 1997. To promote participation and to contain costs, the subjects were invited to write sender and address on the envelope, thereby entering the draw of a return voyage for two between Bergen (Norway) and Newcastle (England). The survey team promised to separate the completed questionnaire and the envelope immediately on receipt and before looking at the answers (556 of 736 joined the lottery). Those who had not answered within 14 days received a reminder comprising letter, questionnaire and stamped addressed envelope.

Questionnaire

The self-administered postal questionnaire contained questions with fixed response alternatives and graphic rating scales. It was considered unnecessary to pre-test the questionnaire because the scales and questions had been used successfully on previous occasions. In addition to demographic information and the respective dental anxiety scales (Table 1), the questionnaire contained questions about eating and dietary habits, dental health

behavior, extractions during the last 5 years, satisfaction with teeth, belief in keeping teeth for life, perceived risk of contracting tooth decay and gum disease in the future, ability to cope with 10 life events, and self-assessed general health. This paper is based on the information derived from the dental anxiety scales, questions about regular dental attendance—at least once a year—during the last 5 years ($n = 723$), and reasons for non-attendance. The most important reason for non-attendance during the last 3 years was ascertained by an open-ended question ($n = 105$). It was decided to employ an open-ended question because Schuman and Scott (24) have found that the frequency distribution of subjects according to reply differed significantly when comparing open-ended and closed questions, and when rare response alternatives were provided. The respondents' reasons for non-attendance were dichotomized into "fear/anxiety" versus "other" and used as validating criterion (Table 3).

The two cut-off points used for DAS and MDAS/4 scores were ≥ 13 and ≥ 15 (18); for MDAS (5 items) it was ≥ 16 to correspond with DAS ≥ 13 , and ≥ 19 as determined by Humphris et al. (17).

Statistical analyses

The data were computerized and proof-read. Analyses were done using the Statistical Package for Social Science (SPSS, version 6.1). Chi-squared tests (with Yates's continuity correction) were used to compare the distribu-

Table 2. 2 × 2 table showing the layout for validation and the formulas for determining sensitivity, specificity, positive and negative predictive values.

Cut-off points	Reason for non-attendance		Total
	Anxiety/fear	Other	
≥13	True positive TP	False positive FP	TP + FP
<13	False negative FN	True negative TN	FN + TN
Total	TP + FN	FP + TN	TP + FP + FN + TN

Formulas: SENS = TP/(TP + FN)
 SPEC = TN/(FP + TN)
 PPV = TP/(TP + FP)
 NPV = TN/(FN + TN)

tion of subjects on categorical variables. The layout and the formulas used to estimate sensitivity, specificity, positive predictive value and negative predictive value are given in Table 2. Exact or approximate 95% confidence limits for sensitivity, specificity, positive and negative predictive values were either obtained directly or by interpolation from scientific tables (25). A one-tailed *t*-test was used to assess whether or not the observed values fell significantly below specified standards (26). The standard used was a sensitivity of 0.75 or higher and a specificity of at least 0.85 or higher as suggested by Stamm et al. (27). The same criteria were adopted for PPV and NPV.

Using Cronbach's alpha (28), the internal consistency of DAS, MDAS and MDAS/4 were found to be 0.91, 0.89 and 0.92, respectively. Inter-item correlations gave Pearson's *r* between 0.59 and 0.92, except for item 5 of MDAS(0.35–0.51). The level of significance was set at 5%.

Results

The prevalence of dental anxiety was 17% (59/346) for DAS ≥ 13 and 19% (67/358) for MDAS/4 ≥ 13. For DAS or MDAS/4 ≥ 15, it was 9% (30/346) and 14% (49/358), respectively. For MDAS ≥ 17 or ≥19, the prevalence was found to be 17% (60/357) and 12% (42/357). The mean MDAS/4 was 9.0 (*s* = 3.97; *n* = 704) and females (9.7; *n* = 363) scored significantly higher than males (8.2; *n* = 336) (*P* < 0.001).

Sixty-two percent (448/723) of the respondents reported annual dental visits during the last 5 years. One-hundred-and-five participants had not been to the dentist during the last 3 years; of these, 24 gave dental anxiety as their reason for non-attendance.

Table 3 indicates that, for DAS, MDAS/4 and MDAS, sensitivity decreased from 0.79–0.90 to 0.57–0.70, while specificity improved slightly from 0.83–0.86 to 0.88–0.93 when changing from the lower to the higher cut-off points. The scales gave high negative predictive values (≥0.98), but low positive predictive values (≤0.26). Positive predictive values from 0.17 to 0.26 (Table 3) means that 1 in 5 to 1 in 4 of the persons identified as positive by the scales were true positives given the criteria of this study.

Since DAS and MDAS/4 gave comparable prevalence scores and mean severity scores, the two samples were combined to increase the number of observations. At a cut-off point of MDAS/4 ≥ 13, the sensitivity was 0.83, the specificity 0.84, PPV 0.18 and NPV 0.99. The corresponding estimates when the cut-off point was ≥15 were 0.67, 0.90, 0.22 and 0.98. The 95% confidence intervals for SENS and PPV were relatively wide for MDAS/4 (*n* = 605) (Table 3) because only 24 of the 105 subjects gave dental anxiety as their reason for not having visited a dentist during the last 3 years.

When comparing the observed estimates with the standard (*vide supra*) using a one-tailed *t*-test as described

Table 3. The number of subjects, sensitivity (SENS), specificity (SPEC), positive predictive value (PPV) and negative predictive value (NPV) according to anxiety scale and cut-off score. The 95% confidence limits (CL) are given for MDAS/4. Validation criterion: Dental anxiety given as the reason for no dental visits during the last three years.

Anxiety scale	Cut-off score	Number of subjects*				SENS	SPEC	PPV	NPV
		TP	FP	FN	TN				
DAS	≥13	9	40	1	237	0.90	0.86	0.18	0.99
MDAS/4†	≥13	11	52	3	252	0.79	0.83	0.17	0.99
MDAS	≥16	12	53	2	250	0.86	0.83	0.18	0.99
DAS	≥15	7	20	3	257	0.70	0.93	0.26	0.99
MDAS/4	≥15	9	38	5	266	0.64	0.88	0.19	0.98
MDAS	≥19	8	32	6	271	0.57	0.89	0.20	0.98
MDAS/4‡)	≥13	20	92	4	489	0.83	0.84	0.18	0.99
95% CL						(0.63; 0.95)	(0.81; 0.87)	(0.11; 0.26)	(0.98; 1.00)
MDAS/4	≥15	16	58	8	523	0.67	0.90	0.22	0.98
95% CL						(0.45; 0.84)	(0.87; 0.92)	(0.13; 0.33)	(0.97; 0.99)

* TP = true positive; FP = false positive, FN = false negative; TN = true negative

† Four item scale

‡ All subjects by converting DAS to MDAS/4

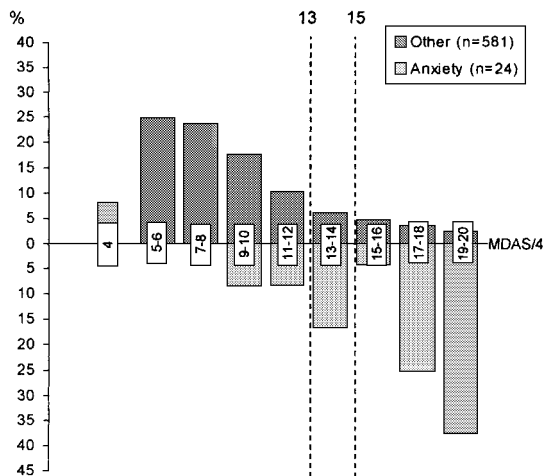


Fig. 1. Frequency distribution (%) of subjects who gave anxiety as the reason for not having visited a dentist during the last 3 years ($n = 24$) and for the remaining respondents ($n = 581$) according to their score on the Modified Dental Anxiety Scale (MDAS/4).

by Thorner and Remein (26), it was found that only the PPV estimates fell significantly below the required level ($P < 0.01$). The extensive overlap of the frequency distribution according to MDAS/4 score for subjects who gave anxiety as the reason for not seeing a dentist during the last 3 years (mean = 16.5; $s = 3.4$; $n = 24$) and the corresponding distribution for the remaining subjects (mean = 6.8; $s = 3.8$; $n = 581$) (Fig. 1) tends to explain why the positive predictive values were low (Table 3). Given the requirements adopted for the present investigation, dental anxiety as a reason for not seeing a dentist during the last 3 years would have needed to be about 38% (280/736), not 4% (24/736).

Discussion

The dental anxiety scales employed in this investigation have been shown to give reliable and valid results in the original (1, 17, 18), and, according to Schwarz and Birn (4), in a number of translated versions. The Norwegian translations of the scales used in this study showed comparable and high inter-item correlation and internal consistency.

Females and persons with higher education were over-represented among the respondents. If, and to what extent this non-response bias may have affected our results, is difficult to determine. Since mean anxiety scores were higher among females than among males, the response bias is likely to have increased the number of persons who gave anxiety as their reason for not having seen a dentist during the last 3 years. The higher response rate among individuals who had completed a college or university education is unlikely to have influenced the results as there was no statistically significant association between education and dental anxiety scale score in this group of 25-year-

old Norwegians (Spearman's rank correlation coefficient equalled -0.07).

To avoid any bias due to inclusion or omission of possible response alternatives (24), an open-ended question was used to ascertain the reasons for not visiting a dentist during the previous 3 years. Twenty-three percent of the 105 respondents who had not visited a dentist for 3 years gave fear/anxiety as their reason for non-attendance. This compared with 17% in 1994 when a sample of 23–24-year-olds in Trøndelag, Norway, were given 11 response alternatives to choose from when asked why they had not visited a dentist during the last 12 months (29). Despite questionable validity and reliability of questions about dental visiting habits (30), it seems reasonable to assume that the responses to the open-ended question used here provided an acceptable and realistic validating criterion for testing the performance of dental anxiety scales as far as prediction of avoidance of dental treatment is concerned.

The primary reason for combining the subjects completing DAS and MDAS/4 into one group ($n = 605$) was the limited number of persons who gave fear/anxiety as the most important reason for not visiting a dentist during the last 3 years (Table 3). Other reasons were that there was no significant difference in the percentage of subjects whose reason for non-attendance was anxiety ($\chi^2 = 0.14$, 1 df, $P > 0.70$), and that the findings (Table 3) were identical with and without adjustment to convert DAS scores into MDAS/4 scores or vice versa.

Stamm et al. (27) stated that to be useful a working model should produce a sensitivity of 0.75 or higher, and a specificity of at least 0.85 or higher. They quoted no criteria for positive and negative predictive values, but it seems reasonable to require that corresponding criteria should apply to the predictive values. If this is accepted, then the level of sensitivity and specificity as well as the negative predictive values reported in Table 3 approached or satisfied the stipulated requirements, but the positive predictive values were far and significantly below (≤ 0.26). This does not seem unreasonable considering the relationship between true prevalence of a phenomenon, SENS, SPEC, PPV, and NPV as described by Vecchio (31) and Hanlon & Pickett (32).

The low positive predictive values are also associated with the fact that 41% of the subjects ($n = 125$) whose MDAS/4 score was ≥ 13 had visited a dentist regularly once a year during the last 5 years as compared with 67% of those whose MDAS/4 score was < 13 ($n = 576$). It was 37% ($n = 78$) and 65% ($n = 623$), respectively, when the cut-off point was 15. This confirms that a sizable proportion of the respondents who had scored high on the dental anxiety scales, had controlled their fear of dental treatment and visited a dentist regularly during the last 5 years (Fig. 1) (20, 21, 33). This supposition is also supported by the fact that DAS explained a relatively low proportion of the variance in the frequency of dental attendance among Norwegian adults (8). Another explanation for the low positive predictive values observed in

this study may be the limited number of subjects ($n = 24$) who gave anxiety as the reason for not seeing a dentist during the last 3 years.

As in a number of previous studies (e.g. 1, 13, 16–18, 19), there was a highly significant difference between subjects who had, and had not, visited a dentist during the last 3 years. Thus, confirming satisfactory discrimination at group level between subjects whose level of anxiety had deterred them from seeking dental care and persons who either were less fearful or who were able to control their anxiety.

Based on these results it may be concluded that Corah's Dental Anxiety Scale and the two versions of the Modified Dental Anxiety Scale gave acceptable or near acceptable sensitivity, specificity and negative predictive values for groups, depending on cut-off point, but far too low positive predictive values to be useful for prediction at the individual level. Confirmation is, however, necessary before drawing definite conclusions because of the limited number and age range of respondents who gave anxiety as their reason for not visiting a dentist during the last 3 years.

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