Structural relationships of dental anxiety, mood, and general anxiety

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The aim of this study was to explore the structural relationships between dental anxiety, mood, and general anxiety among 220 dentally anxious patients who participated in a clinical study. A structural equation modeling analysis (SEM) was applied by using the LISREL program on the hypothesized latent variables dental anxiety, mood, and general anxiety, which were measured by means of several psychometric tests. The final model showed that mood and general anxiety had positive factor loadings on dental anxiety. However, the impact of the general anxiety latent variable was not significant as compared with the mood factor. Another finding was that the residual variance for the latent variable dental anxiety was 0.68, indicating that a major portion of the variance is still unexplained by the tested variables. In conclusion, this study showed a relationship between dental anxiety, general anxiety, and mood among dentally anxious patients. □ *Behavioral dentistry; dental anxiety; psychological distress; psychometrics; structural equation modeling*

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In the literature, dental anxiety has been shown to correlate with several different factors, such as general anxiety, specific phobias, mood, and distress traits (1–7). In addition, specific factors associated with dentistry are well-known background variables and covariables for initiating and maintaining high levels of dental anxiety, in which interaction with the dentist, pain, avoidance behavior, and oral health status are such significant common factors (8–12). Clinical studies have also pointed out socioeconomic variables, such as educational level, social class, and income, as potential risk factors (13–17). Thus, it is important in dental anxiety research not only to measure level of dental anxiety but also to include measurements of emotional, social, and somatic factors and effects. On the basis of systems-oriented models in psychosomatic research (18, 19) Berggren (1) has presented a vicious cycle of dental anxiety, in which a high level of dental anxiety, regardless of etiologic components or cause, may lead to avoidance of dental care. A change in dental visiting habits may, over time, cause the dental health status to deteriorate, which in turn, not surprisingly, often gives rise to feelings of inferiority, shame, and guilt. Researchers from different countries and clinical centers have discussed and confirmed this model (3, 8), and de Jongh et al. (20) have added a cognitive factor as well.

The purposes of this study were to explore the structural relationships between dental anxiety, mood, and general anxiety by using a Structural Equation Modeling (SEM) approach. The SEM method is a comprehensive statistical approach to testing hypotheses about relations among observed and latent variables and enables one to apply multiple indicators that measure a specific characteristic, which in itself is or may not be directly measured (latent) (21). Such indicators may be psychometric scales that have been developed in the behavioral and social sciences in order to obtain and analyze individuals' perceptions on various topics and situations. In this study three properties were hypothesized and measured indirectly with different psychometric scales. Thus, dental anxiety was measured with the Dental Anxiety Scale, the Dental Fear Survey with its subdimensions, and the Dental Beliefs Survey. General anxiety was captured by the State-Trait Anxiety Inventory and the Geer Fear Scale, whereas mood was subsumed by the Mood Adjective Checklist. The aim of this study was to explore the relationships between dental anxiety, general anxiety, and mood.

Materials and methods

Patients

The subjects included were 220 adult patients applying for treatment of severe dental anxiety at the specialized Dental Fear Research and Treatment Clinic (DFRTC) at the Faculty of Odontology, Göteborg University, Göteborg, Sweden. The patients were either referred by dentists or physicians (29%) or self-referred by means of contacts by the patients directly to the DFRTC (71%). The patients were asked to participate in a controlled clinical study for treatment of their dental anxiety. The inclusion criteria, screening process, and dropout analysis have been presented elsewhere (22, 23).

Instruments

A structured interview and questionnaires were included for background data of dental visiting habits, dental health status, dental anxiety, general fearfulness, and mood and distress.

Table 1. Descriptive statistics of patients with regard to age, sex, and last dental visit (means and standard deviations (*s*)). Significance testings with the *t* test with regard to differences between sexes

	Men	Women	Total	*t* value	*P* value
No. of patients	59	161	220	NA*	NA
Age (years)	34.4 (10.2)	31.8 (8.5)	32.5 (9.0)	1.7	0.090
Last dental visit (years)	12.9 (9.5)	11.3 (8.2)	11.8 (8.6)	1.1	0.283

* NA = not applicable.

The background variables were sex, age, education, marital status, and time since last regular dental visit.

Aspects of dental anxiety were captured by means of the Dental Anxiety Scale (DAS), the Dental Fear Survey (DFS), and the Dental Beliefs Survey (DBS). DAS consists of four questions that assess dental anxiety. Each question has a scale from 1 (no fear) to 5 (extreme fear), thus giving sum scores from 4 to 20, of which 13 or more is considered high dental anxiety (24, 25). DFS is a 20-item test of different aspects of dental anxiety with a scale from 1 (no fear) to 5 (extreme fear) and sum scores between 20 and 100. Considered highly dentally anxious are those with scores greater than 75. The different dimensions of dental anxiety as measured with the DFS have been shown to be fear of specific situations, physiologic arousal, anticipatory anxiety, fear of needles, and fear of drilling (26–29). In the present analysis three dimensions—fear of specific situations (DFS-S), physiologic arousal (DFS-P), and anticipatory anxiety (DFS-A)—were used to capture all 20 items. The DBS has 15 questions concerning patients' attitudes to and beliefs on the interaction between patients and dentists (30). The items range from 1 to 5 and sums up to 15 (highly positive beliefs) to 75 (highly negative beliefs).

General anxiety and fearfulness were measured with the State-Trait Anxiety Inventory (STAI-S and STAI-T, respectively) and the Geer Fear Scale (GFS). STAI-S assesses situational and short-term anxiety, whereas STAI-T captures anxiety levels that are more stable over time (31). These scales each have 20 items with choices from 1 (no anxiety) to 5 (high anxiety) and with sums of scores from 20 to 100. GFS is a modified 22-item scale from the original Fear Survey Schedule-II, which measures number and levels of specific fears or phobias (32). The items have a scale from 1 (no fear) to 7 (terrified).

Mood was measured with the Mood Adjective Checklist (MACL) (33). The MACL has been used in our previous clinical studies of dental fear patients and has proved to be a valid instrument and indicator of emotional reactions to a dental appointment. The original version has six dimensions; however, in this analysis we used two dimensions to describe patients' mood. Hedonic tone and relaxation refer to the degree of pleasantness/unpleasantness and relaxation/tension, respectively. Mood is measured from 1 (low/negative) to 4 (high/positive) in the different dimensions. In the present analysis the scoring was reversed.

Statistics

In the behavioral and social sciences advanced multivariate statistical methods are used to discover correlations and structures between variables, since uni- or bivariate or multivariable analysis of variance or regression may lack the power to detect and elucidate possible associations and hierarchical relationships (21). Such a powerful method is the structural equation modeling analysis (SEM), which can be used to test how observed variables in a measurement model correlate with latent variables and also to specify and test relationships among latent variables. With the SEM method the number of factors and pattern of loadings are specified in advance on the basis of prior knowledge of the factor structure and relationships among the observed variables. This knowledge may come from theory and previous research. In this

Table 2. Mean and standard deviation levels of dental anxiety, mood, and general anxiety. Differences between sexes were tested with the *t* test

	Men	Women	Total	*t* value	*P* value
DAS	16.3 (2.0)	17.4 (2.1)	17.2 (2.2)	3.6	<0.000
DFS	74.1 (12.9)	80.5 (10.8)	78.8 (11.7)	3.7	<0.000
DFS-A	33.4 (7.0)	36.6 (5.9)	35.7 (6.4)	3.3	<0.001
DFS-P	17.0 (3.5)	19.2 (3.1)	18.6 (3.3)	4.7	<0.000
DFS-S	20.2 (4.4)	21.0 (3.7)	20.8 (3.9)	1.3	0.184
DBS	34.0 (13.3)	40.5 (13.8)	38.7 (13.9)	3.1	0.002
STAIS	37.8 (9.2)	42.7 (12.6)	41.4 (11.9)	2.8	0.006
STAIT	38.2 (12.0)	41.0 (12.3)	40.2 (12.2)	1.4	0.178
GFS	71.0 (19.6)	88.6 (25.7)	83.8 (12.2)	4.7	<0.000
MOOD(r)	2.8 (0.8)	3.1 (0.7)	3.0 (0.7)	2.1	0.037
MOOD(h)	2.0 (0.7)	2.2 (0.7)	2.1 (0.7)	1.9	0.058

Table 3. Structural relationship models with LISREL solutions such as chi-square values, degrees of freedom, goodness-of-fit-indices (GFI, AGFI), and root mean square error of approximation (RMSEA)

Models	Chi-square	df	*P* value	GFI	AGFI	RMSEA
Model A: Measurement model of dental anxiety with observed variables DAS, DFS-A, DFS-P, DFS-S, DBS	10.2	5	0.07090	0.98	0.94	0.069
Model B: Measurement model of general anxiety and mood with observed variables STAIS, STAIT, GFS, MOOD(h), MOOD(r)	19.4	4	0.00064	0.96	0.83	0.152
Model C: Structural model with dental anxiety, general anxiety and mood	71.7	32	0.00000	0.92	0.86	0.086
Model C^1: Model C after adjustment in accordance with modification indices with regard to error variance between STAIT, GFS, and MOOD(h)	41.8	30	0.07501	0.95	0.91	0.048

manner models are formed and then tested by means of a statistical computer program in a SEM analysis, in which estimation is made with maximum likelihood methods among other estimation techniques. The model fitting also results in measures of goodness-of-fit indices for the hypothesis testing. In this exploration the SEM models were tested by using the computer program LISREL 8.3, which displays several fit indices such as the Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), root mean square error of approximation (RMSEA), and a chi-square test statistic (34). The former two indices should reach values >0.9, with possible values ranging between 0 and 1.0, RMSEA < 0.05, and the *P* value of the chi-square number >0.05, for a statistically acceptable model.

The SEM analysis included separate Confirmatory Factor Analysis (CFA) for each measurement model, specifically for dental anxiety, mood, and general anxiety. The results of the CFAs were used for the initial structural modeling. Modification indices given from the LISREL output and theoretical assumptions guided subsequent changes in the models to achieve a final model of statistical and theoretical plausibility.

In addition, descriptive statistics, independent *t* tests, and the Spearman correlation analysis were used in the statistical analyses.

Results

Descriptive data of included variables are shown in Tables 1 and 2. The number of patients was 220; however, due to some missing values in different variables and among different individuals, the degrees of freedom vary between the analyses. These differences did not have a significant impact on the results. On average, the patients had not been subjected to dental care for more than 11 years. No significant difference with regard to sex was found for the patients' age at the start of the study or reported time of avoidance of dental visits.

For most variables women reported higher levels of dental anxiety, general anxiety, and mood, although differences for DFS-S, STAIT, and MOOD (h) were not statistically significant (Table 2).

The initial inspection of the variables under study showed skewed distributions for some variables. Multivariate normality was achieved by transforming the data into normal scores for the LISREL analyses. Table 3 shows the different models that were tested by the LISREL program. Model A included the hypothesized latent variable dental anxiety inferred from the observed variables DAS, DFS-A, DFS-P, DFS-S, and DBS and tested in a CFA. This model showed acceptable properties from a statistical point of view with a nonsignificant *P* value and Goodness-of-Fit Indices >0.9, although RMSEA was greater than 0.05. Model B tested the relationships between general anxiety and mood as a two-factor model with GFS, STAIS and STAIT, and MACL (h) and MACL (r), respectively. This model was found to have less statistical fit, however reasonable from a theoretical point of view. These two models were then merged in a SEM analysis in accordance with Model C. The structural relationship between the constructs of dental anxiety, general anxiety, and mood was based on the correlation analyses for directions of pathways. This model fit had an acceptable GFI; however, the other test statistics showed close to acceptable statistical values except for the highly significant chi-square probability level. The modification indices indicated a substantial improvement in model fit if a subsequent respecification of the model included covariance terms between the error variance of STAIT and GFS, and STAIT and MOOD (h), respectively. Thus, Model C^1, which is the final model, was tested, and a clear improvement in the test-statistics was obvious, as shown in Table 3 and Fig. 1. As depicted in the figure, the standardized factor loadings between the latent and observed variables range between 0.40 and 0.99. The *t* values of the factor loadings were all significant. However, the *t* value of the error term of STAIS was not significant ($t = 0.05$, $P < 0.05$). The loadings and *t* values of mood and general anxiety on dental anxiety were 0.46, 0.17, and 3.96, 1.71, respectively.

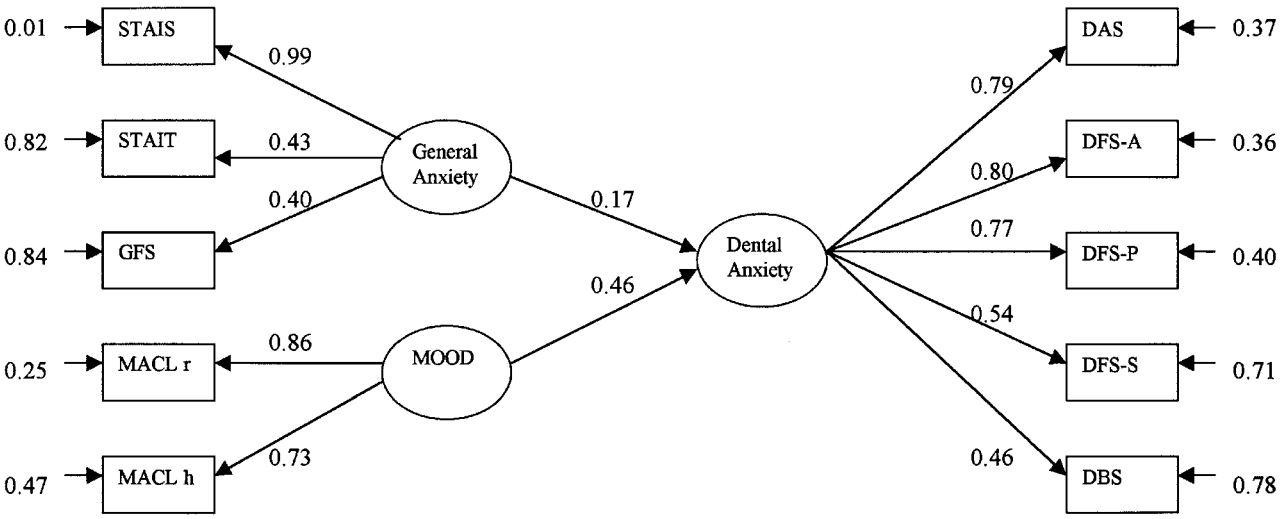

Fig. 1. Structural equation model C[1] with standardized factor loadings between the latent variables dental anxiety, mood, general anxiety, and the observed variables the Dental Anxiety Scale, the Dental Fear Survey dimensions anticipatory anxiety, physiologic arousal, and specific situations, the Dental Beliefs Survey, State-Trait Anxiety Inventory, Geer Fear Scale, and Mood Adjective Checklist. Error variances are shown except for the latent variable dental anxiety, which is 0.68, and error covariances between GFS and STAIT and MOOD (h) and STAIT, with 0.26 and 0.20, respectively.

Discussion

The aim of this study was to explore the relationships between dental anxiety, mood, and general anxiety by using a Structural Equation Modeling approach. We have shown that, among patients reporting severe dental fear and avoidance behavior of dental care, there was a significant association and clear impact of psychological distress, as measured by means of mood and general anxiety on dental anxiety. Moreover, these results have been shown more extensively than in previous research by using, at least in the dental behavioral area, a relatively new statistical method such as the structural equation modeling technique (21). However, this study has shortcomings, such as the small sample size included, indicating precautions when interpreting the results, but since this study is a controlled clinical study, larger sample sizes than the present may be difficult to achieve from a practical point of view.

Previous clinical and epidemiological research have indicated an association between dental anxiety, general fears, and mood by correlational and regression analyses (1–5, 7, 14). The present study built on these results, and by means of a step-by-step analysis the relationships between these anxiety and emotional states were shown. However, several important findings should be pointed out. First, the impact of general anxiety on dental anxiety was low and statistically nonsignificant, with a factor loading of 0.17 ($P > 0.05$). Second, low mood levels predict high dental anxiety, with a statistically significant loading. Third, despite the overall acceptable structural model between dental anxiety and general anxiety and mood, the error variance term of dental anxiety was 0.68. This clearly indicates that a major portion of the variance of dental anxiety is, indeed, unexplained. In the literature several factors have been found to be associated with dental anxiety besides general anxiety and mood. Such factors are suggested to be, for example, dental health, pain, avoidance behavior, and previous dental experiences (9–17). The present study is the first part of a series of structural equation modeling analyses of dental anxiety and concomitant factors, which further may show other important aspects besides psychological distress.

Psychometric scales have been developed in the behavioral and social sciences, to obtain and analyze individuals' perceptions on various topics and situations. Several psychometric tests may capture different aspects of the same concept, such as perception of pain or quality of life. By using the SEM method, a hypothesized concept may be analyzed and estimated statistically by including multiple indicators or variables to achieve a more plausible and reliable model for study. In this study three properties were hypothesized and measured indirectly by different psychometric scales. Dental anxiety was measured with the Dental Anxiety Scale, the Dental Fear Survey with its subdimensions, and the Dental Beliefs Survey. General anxiety was captured by the State-Trait Anxiety Inventory and the Geer Fear Scale, whereas mood was subsumed by the Mood Adjective Checklist. All these scales are used widely within psychological, social, and medical research, and the validity and reliability of these scales have been shown in different research areas (24–26, 29–32). The SEM method has several positive features as compared with other multivariate statistical methods, such as multiple linear regression and multivariate analysis of variance. The SEM approach includes a broad range of test

instruments, which will improve the area under study as compared with a single measurement. Another advantage of the SEM method is the approximation and magnitude of measurement error for each observed variable and dependent latent variable, which may not be estimated with the above-mentioned more traditional techniques. Moreover, these tests (Anova and regression) cannot include or model latent variables but are limited to a single outcome (35). The directional relations between variables—that is, in what order one variable may influence another variable—can be specified in Anova and multiple regression models but cannot be statistically tested; this is performed in SEM analysis.

In conclusion, this explorative study showed a structural relationship between dental anxiety, general anxiety, and mood in a clinical sample of dentally anxious patients. Furthermore, the emotional state of mood associated with dental care showed a clear impact on level of dental anxiety. The study also showed the possibilities and advantages of using a structural equation modeling method in detecting and estimating the variance–covariance structures among multiple measurement variables.

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