

## **Association of depression and anxiety with different aspects of dental anxiety in pregnant mothers and **their partners****

**Running head:** Dental anxiety, depression and anxiety

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## **Abstract**

### **Objectives**

The aim was to confirm the factor structure of Modified Dental Anxiety Scale (MDAS) and to investigate if the association of these factors with general anxiety and depression varied across gender.

### **Methods**

The FinnBrain Birth Cohort Study ([www.finnbrain.fi](http://www.finnbrain.fi)) data from the first collection point at gestational week 14 was used. Of the invited participants (n=5790) 3808 (66%) expectant mothers and 2623 fathers or other partners of the mother agreed to participate, and 3095 (81.3%) mothers and 2011 (76.7%) fathers returned the self-report questionnaire. Dental anxiety was measured with the MDAS, general anxiety symptoms with Symptom Checklist-90 (anxiety subscale) and depressive symptoms with the Edinburgh Postnatal Depression Scale. Multiple group confirmatory factor analysis (MGCFA) was conducted to test the equivalence of the factor structure and multiple group SEM (MGSEM) to test the configural invariance (unconstrained model) and metric invariance (structural weights model), across genders.

### **Results**

Of those consenting 3022 (98%) women and 1935 (96%) men answered the MDAS. The MGCFA indicated good convergent validity for the two-factor model for MDAS, but somewhat low discriminant validity (factors demonstrated 72% shared variance). The MDAS items loaded clearly higher for the assigned factor than to the other factor (differences in loadings  $>0.2$ ), indicating that the 2-factor model has merit. According to the final MGSEM model, anxiety symptoms were directly related to anticipatory dental anxiety, but not to treatment-related dental anxiety

### **Conclusions**

**When assessing dental anxiety with MDAS**, considering also its two factors may help **clinicians** in understanding the nature of patient's dental anxiety.

## Introduction

Dental anxiety has been suggested to have exogenous and endogenous sources<sup>1</sup> and this has been supported by evidence<sup>2</sup>. The term ‘exogenous’ refers to external sources such as direct experiences, vicarious learning or informational pathway<sup>3</sup>. Besides the classic conditioning from previous experiences of dental treatment cognitive aspects play an important role in the etiology of dental anxiety<sup>4</sup>. The term ‘endogenous’ refers to internal reasons, such as personality traits or psychiatric symptoms, such as anxiety or depression. Endogenous sources have been referred as ‘constitutional vulnerability to (dental) anxiety disorders’<sup>4-7</sup>. Anxiety disorders or symptoms have been consistently associated with dental anxiety, and some gender differences have been reported<sup>8-19</sup>. Findings on the association of dental anxiety with depression or depressive symptoms are inconsistent, and there are sex differences. Over half of the studies did not find the association<sup>7,10,13,14</sup>, one study found association among both genders<sup>8</sup> and in other studies the association was only found either among women<sup>17,18</sup> or among men<sup>15,16</sup>. However, most studies have been conducted either on clinical samples of dental patients<sup>9,10,14,19</sup> or among dental patients with high dental anxiety<sup>8,11,12,17</sup>. Hence the study of these relationships by gender is compromised to some extent by use of ‘censored’ samples; that is, studying only persons with a narrow range of dental anxiety values and difference at population level need further studies.

Two components, anticipatory and treatment related dental anxiety, conforming to the exogenous and endogenous origin of dental anxiety have been reported for two measures of dental anxiety i.e. Modified Dental Anxiety Scale (MDAS) in Chinese population<sup>20</sup> and Modified Children Fear Survey Schedule in Finnish child population<sup>21</sup>. The two components of MDAS have been suggested to be associated with depression and general anxiety at different degrees<sup>18,22</sup>. It may be possible that personality components such as general anxiety may impinge on dental anxiety. In this case, anticipatory dental anxiety, compared with treatment-related dental anxiety, might be more strongly associated with endogenic sources of dental anxiety, such as depression and general anxiety. A two factor solution of MDAS might help in understanding possible endogenous sources of dental anxiety. This hypothesized formulation could assist clinicians identify patients that may have a vulnerability to other mental health problems such as anxiety and depressive disorders<sup>4-7</sup>. However, we could not identify studies reporting on the associations of anticipatory and or treatment-related dental anxiety with symptoms of depression and anxiety. Thus, our aim was first to confirm the

factor structure of MDAS in another population and, secondly, to investigate if the association of MDAS factors with general anxiety and depression varied across gender.

## Methods

This study was a part of a large FinnBrain Birth Cohort Study ([www.finnbrain.fi](http://www.finnbrain.fi)), which aims to study prospectively the effects of prenatal stress and early life stress exposure on child brain development and health. It was undertaken with the understanding and written consent of each participant and according to the ethical principles of the World Medical Association Declaration of Helsinki. The study was approved by the ethics committee of the Hospital District of Southwest Finland. The study used personal recruitment in ultrasonography appointments that are offered free of charge for every pregnant mother in Finland by municipal maternity clinics during the first trimester of the pregnancy (gestational week 12) in the South-Western Hospital District and the Åland Islands in Finland in 2011–2015. Of those informed about the study ( $n=5790$ ), a total of  $n=3808$  (66%) expectant mothers and  $n=2623$  fathers or other partners of the mother decided to participate, expecting 3837 children (twins included). The parents gave written informed consent on their own and on their child's behalf. The study will continue for several decades and combine questionnaire data, biological samples and registry data. Details of the cohort profile and methods used are presented in Karlsson et al.<sup>23</sup>.

This study used the data from the first data collection point at gestational week (gwk) 14. Of those who agreed to participate (3808 mothers and 2623 fathers), 3095 (response rate 81.3%) mothers and 2011 (76.7%) fathers returned the questionnaire at gwk 14. The participants completed a set of postal or email self-report questionnaires in Finnish or Swedish. Reminders were sent to those who had not returned the questionnaire, first two weeks and second three weeks after sending the questionnaire. In this study, we used data on dental anxiety, anxiety, depression and background information.

Dental anxiety was measured with the Modified Dental Anxiety Scale (MDAS). It is a valid (concurrent and discriminant) and widely used five-item instrument for self-rating dental anxiety translated also to Finnish<sup>24-26</sup>. MDAS has shown high internal consistency (Cronbach's alpha = 0.93) and reliability over time (intraclass correlation coefficient = 0.93)<sup>24</sup>. The questions in the MDAS are: (item 1) if you went to your dentist for treatment tomorrow, how would you feel; (item 2) if you were sitting in the waiting room (waiting for treatment), how would you feel; (item 3) if

you were about to have a tooth drilled, how would you feel; (item 4) if you were about to have your teeth scaled and polished, how would you feel; and (item 5) if you were about to have a local anesthetic injection in your gum, above an upper back tooth, how would you feel? Each item has five response options, ranging from 1 (not anxious) to 5 (extremely anxious), with the range for the total sum score being 5–25. The cut-off point for high dental anxiety is 19 and the cut-off point for low dental anxiety is 10<sup>27</sup>. The MDAS has also been suggested to comprise the two separate factors of anticipatory dental anxiety (items 1 and 2; score range = 2–10) and treatment dental anxiety (items 3, 4, and 5; score range = 3–15)<sup>20</sup>.

General anxiety symptoms were measured with validated Symptom Checklist -90 (SCL-90, anxiety subscale with Cronbach's alpha = 0.89)<sup>28-30</sup>. It consists of 10 items scored on a 5-point Likert scale (from 0 to 4). The Edinburgh Postnatal Depression Scale (EPDS) was used to assess depressive symptoms. EPDS is a widely-used and studied questionnaire with varying but mostly high sensitivity and specificity, valid to screen both pre- and postnatal depressive symptoms<sup>31,32</sup>, also among fathers<sup>33,34</sup>, and consists of 10 questions scored on a 4-point Likert scale (from 0 to 3) For EPDS, a sum score (scale 0–30) was used. Mean levels for EPDS and SCL-90 are presented in Karlsson et al.<sup>23</sup> If there were  $\leq 30\%$  missing items for the MDAS, SCL-90 or EPDS, they were replaced with the mean value of other items of that respondent. Of the background information, we used age in years and gender. As women consistently report higher levels dental anxiety<sup>35,36</sup>, and there have been gender differences in the association between dental anxiety and general anxiety<sup>15</sup> and especially between dental anxiety and depression<sup>15-18</sup> analyses were also stratified by gender.

Multiple group confirmatory factor analysis (MGCFA) was conducted to test the equivalence of the factor structure by gender (configural invariance). To assess invariance with respect to factor loadings (metric invariance), a nested model with parameters constrained to be identical between genders was compared to a model where parameters were unconstrained. To assess scalar invariance, a nested model with both loadings and intercepts constrained to be identical between genders was also compared to the unconstrained model. In the analysis, items were not allowed to load on more than one factor, nor were their error terms allowed to correlate. The fit indices used were the normed chi-square ( $\chi^2/\text{df}$ ), comparative fit index (CFI) and root mean square error of approximation (RMSEA). Values  $\chi^2/\text{df} < 5$ , CFI  $> 0.90$  and RMSEA  $< 0.08$  indicate reasonably close fit, and values  $\chi^2/\text{df} < 2$ , CFI  $> 0.95$  and RMSEA  $< 0.05$  indicate very close fit<sup>37,38</sup>. For loadings, standardized estimates (which can be interpreted similarly as correlation coefficients) were calculated.

Pearson correlation coefficients between the dental anxiety total score and the treatment-related and anticipatory factor scores, anxiety and depression were calculated separately for women and men. Structural equation modeling (SEM) was used to assess the interrelationships among anxiety, depression, and dental anxiety treatment-related and anticipatory factor scores. The hypothetical model to be tested is presented in Figure 1. We conducted multiple group SEM (MGSEM) to test the configural invariance (unconstrained model) and metric invariance (structural weights model); that is, to determine whether the structure and parameters were equivalent across genders. In the analysis, error terms of items were not allowed to correlate. All analyses were conducted using IBM SPSS Statistics 25 and IBM SPSS Amos software. Alpha was set at 0.05 (2-sided).

## Results

Of those returning the questionnaires at gwk 14, 3022 (98%) women and 1935 (96%) men answered the MDAS questionnaire. In mothers the response rate was 53.5% of the invited mothers, but the exact number of invited fathers-to-be is not available. The mean (SD) age of the women was 30.9 (4.5) and the range was 17.6–46.5 years. The mean (SD) age of the men was 32.6 (5.3) and the range was 17.1–61.0 years. Women had higher dental anxiety scores than men (Table 1).

According to the MGCFA, the two-factor model for MDAS seemed to satisfy a reasonable fit of the data (Figure 2). All of the indicators had high standardized loadings on the factor they were assumed to load, which indicates good convergent validity. Correlation between the factors was high, which indicates somewhat low discriminant validity (72% shared variance). However, the items had higher loadings for that factor that they “belonged to” than for the other factor (differences in loadings  $>0.2$ ), indicating that the 2-factor model can be accepted.

The MGCFA revealed very close fit in two of the used three indices for the unconstrained model, indicating configural invariance; that is, the same factor structure across genders (Table 2). The difference between the unconstrained model and the nested model with constrained factor loadings was not statistically significant, indicating gender invariance in factor loadings. The difference between the unconstrained model and the nested model with constrained factor loadings and intercepts was statistically significant, indicating a lack of scalar invariance. In general, this means that both the factor structure and the factor loadings were identical, but the responses to each dental anxiety item varied between genders.

The correlations among general anxiety, depression and dental anxiety and its factors varied by gender (Table 3).

The MGSEM revealed very close fit in one and close fit in another of the used three indices for the unconstrained model indicating the same structural model for both genders (Table 4). The difference between the unconstrained model and the structural weights model was statistically significant, indicating lack of invariance between genders with respect to parameters. These indicate the same structural model but different estimates by gender.

According to the final model, generalised anxiety symptoms were directly related to anticipatory dental anxiety, but not to treatment-related dental anxiety (Figure 2). The association between generalised anxiety and anticipatory dental anxiety was slightly stronger among men than among women. Depressive symptoms were directly related to both anticipatory and treatment-related dental anxiety. Among women, the association between depression and anticipatory dental anxiety was stronger than among men.

## **Discussion**

The two-factor structure with anticipatory and treatment related dental anxiety was confirmed for the Modified Dental Anxiety Scale. Data supported the hypothesized model. Anticipatory dental anxiety was more strongly associated with depressive and anxiety than the treatment related dental anxiety. The strength of these associations varied between genders.

The strength of this study is its use of a representative population sample, though limited by age group and to families expecting a baby. Thus, findings should be treated with caution when generalizing to the wider population. The use of continuous variables in assessing depressive and anxiety symptoms is also a strength, given that previous population studies have used dichotomized variables at clinical diagnosis level<sup>6,7</sup>. On the other hand, using continuous variables may mean skewed distributions, which still may have linear associations, or it may lead to heteroscedasticity (variance of the error terms vary). Heteroscedasticity does not affect the values of regression coefficients, but may produce less precise p-values.<sup>39,40</sup> Replacing the missing values with mean values may reduce variance, but in our data there were so few missing values that it would not

affect the findings; in MDAS items, 28 mothers and 23 fathers had one missing value that was replaced. In the MGSEM, the fit level as reflected by CFI was good, but not very good<sup>36,37</sup>. This is probably due to error terms that were not allowed to correlate, which would improve model fit, but such correlations would be very difficult to interpret and this way it is easier for others to replicate the analysis.

Despite the further support for the two-factor model of MDAS reported previously<sup>20</sup> the lack of discriminant validity in CFA means that the factors are not entirely separate constructs. However, the differences in loadings to the two factors indicate that it is acceptable also to use them in analyses separately. The factor loadings were similar in gender-specific analyses, but the scale in answers to dental anxiety questions differed between genders. This probably not due to features of the questionnaire, but indicates that women and men have different levels of dental anxiety, as reported also in other populations studies<sup>35,36</sup>. Thus, the same two-factor structure can be used for both genders. The two factors might also have clinical significance. For example, they might help the clinicians to tailor their treatment with patients in response to different forms of dental anxiety.

The MGSEM analyses indicate support to the theory of exogenous and endogenous origin of dental anxiety and constitutional vulnerability<sup>1,4-9</sup>. Anticipatory dental anxiety was more strongly associated with depression and anxiety than treatment related anxiety. The association of depression and anxiety with the two factors differed, also by gender. Depression was directly related to both anticipatory and treatment-related dental anxiety and more strongly among women than among men. Anxiety was directly associated only with anticipatory dental anxiety which in turn was associated with treatment-related dental anxiety. This was more strongly associated among men than women. In a previous study among Finnish University students' anxiety and depression showed bivariate crude association with both factors among women but only with anticipatory anxiety among men<sup>18</sup>.

## **Conclusion**

Empirical support for the hypothesised model suggests that the MDAS with its anticipatory and treatment related factors may capture dental anxiety originating from different sources referred to as exogenous and endogenous. These findings may have clinical relevance in helping clinicians understand the origins of dental anxiety and in planning the treatment for their patients who are dentally anxious. **For example, if a patient scores higher on the anticipatory dental anxiety factor**



items than in the treatment related dental anxiety factor items, patient might also have other anxieties needing attention, while a patient scoring high on treatment related items might be helped by anxiety management in dental office. However, this or similar models need to be tested in further samples and possibly using other existing measures of dental anxiety. **Most important is to assess patients' dental anxiety.**

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Figure 1. Hypothetical and the final model with standardized estimates for women/men based on for associations between anxiety, depression and anticipatory and treatment-related dental anxiety.

Figure 2. Factor structure and loadings for MDAS.

Table 1. Descriptive statistics of dental anxiety (MDAS) total score (scale 5–25) and treatment-related (scale 3–15) and anticipatory (scale 2–10) factor scores, anxiety (SCL, scale 0–40) and depression (EPDS, scale 0–30).

	Women			Men		
	n	Mean (SD)	Md (Q <sub>1</sub> -Q <sub>3</sub> )	n	Mean (SD)	Md (Q <sub>1</sub> -Q <sub>3</sub> )
MDAS total sum	3022	10.6 (4.7)	9 (7–13)	1935	9.1 (4.1)	8 (6–11)
MDAS: treatment	3006	7.0 (3.0)	6 (5–9)	1918	5.9 (2.6)	6 (4–7)
MDAS: anticipatory	3010	3.6 (2.0)	3 (2–4)	1929	3.2 (1.7)	2 (2–4)
SCL	3021	3.3 (3.9)	2 (0–5)	1931	2.5 (3.5)	1 (0–4)
EPDS	3021	5.2 (4.0)	4 (2–7)	1934	3.7 (3.4)	3 (1–6)

Table 2. Multiple group confirmatory factor analysis (MGCFA) fit indices for the unconstrained model and models with constrained factor loadings and constrained loadings and intercepts, on the MDAS 2-factor structure (gender specific data).

Model	$\chi^2$	df	$\chi^2/df$	CFI	RMSEA	p
1) Unconstrained	84.35	8	10.54	0.996	0.043	
2) Constrained factor loadings	90.98	11	8.27	0.996	0.038	
Difference (1 vs. 2)	6.63	3				0.085
3) Constrained loadings & intercepts	379.54	16	23.72	0.980	0.067	
Difference (1 vs. 3)	295.19	8				<0.001

Table 3. Pearson correlation coefficients between dental anxiety (MDAS) total score and treatment-related and anticipatory factor scores, anxiety (SCL) and depression (EPDS) among women (upper triangle *in italics*, n=3022) and men (lower triangle, n=1935).

	MDAS total score	MDAS treatment	MDAS anticipatory	SCL	EPDS
MDAS total score		<i>0.961</i>	<i>0.914</i>	<i>0.215</i>	<i>0.254</i>
MDAS treatment	0.960		<i>0.766</i>	<i>0.212</i>	<i>0.256</i>
MDAS anticipatory	0.907	0.754		<i>0.189</i>	<i>0.217</i>
SCL	0.183	0.170	0.177		<i>0.647</i>
EPDS	0.215	0.212	0.193	0.642	



Table 4. Fit indices for the unconstrained and structural weights models based on multiple group structural equation model (MGSEM) on associations between anxiety, depression and anticipatory and treatment-related dental anxiety (gender specific data).

Model	$\chi^2$	df	$\chi^2/\text{df}$	CFI	RMSEA	p
Unconstrained	5391.93	538	10.02	0.902	0.042	
Constrained structural weights	6192.98	559	11.08	0.887	0.044	
Difference	801.05	21				<0.001