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ORIGINAL ARTICLE

A cross-sectional study of the association between anxiety and temporomandibular disorder in Australian chiropractic students

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Objective: This study examined the association between anxiety and temporomandibular disorder (TMD) in Australian chiropractic students, particularly its effect on quality of life.
Methods: Chiropractic students ($n = 185$) completed online surveys, including the Oral Health Impact Profile for TMDs (OHIP-TMD) and the Patient-Reported Outcomes Measurement Information System (PROMIS) questionnaire. The OHIP-TMD psychometric properties were assessed using principal component analysis. Linear regression models were used to examine demographic predictors for anxiety and TMD. A general linear model assessed the association between anxiety and the psychosocial and function scales identified through analysis of the OHIP-TMD questionnaire.
Results: The mean value for the OHIP-TMD and PROMIS was 1.3 (SD = 0.7) and 9.5 (SD = 4.1), respectively. Women reported significantly lower quality of life (QoL) related to TMD symptoms ($p = 0.006$) and that QoL related to TMD symptoms increased significantly as students progressed through the course ($p = .025$). Lower levels of anxiety were significantly associated with male gender ($p = .000$), employment ($p = .008$), higher program levels ($p = .003$), and having children ($p = .005$). General linear model analysis revealed that increased anxiety was significantly associated with higher levels of oral physical function impairment ($p = .003$) and elevated psychosocial distress ($p = .0001$).
Conclusion: Anxiety was significantly associated with psychosocial distress and oral physical function impairment in university chiropractic students. In addition to impacting on oral health-related QoL, anxiety also affects students' engagement with learning and academic performance. It would therefore be beneficial to implement strategies that mitigate students' anxiety levels.

Key Indexing Terms: Chiropractic; Education; Temporomandibular Joint Disorders; Anxiety; Pain; Oral Health

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INTRODUCTION

The temporomandibular joint comprises the mandibular condyle, which inserts into the mandibular fossa of the temporal bone, and the masticatory muscles, which are primarily responsible for the movement of this articulation.[1] Temporomandibular disorders (TMD) include many clinical conditions involving the masticatory musculature, the joint itself, and the associated structures, or may comprise all of them. The common signs and symptoms related to TMD often implicate jaw movements (opening and closing) and periauricular pain.[1] The expression of these symptoms is often used to establish the prevalence of TMD.[2] Population-based studies report that 10% to 15% of adults experience TMD, and it is more frequently encountered in women.[3]

The etiology of TMD is multidimensional and may include biological, biomechanical, neuromuscular, and biopsychosocial causes.[4] Numerous factors that contribute to TMD can be classified into (1) predisposing factors that increase the risk of developing the disorder by harmfully influencing the masticatory complex and may include systemic conditions (inflammatory conditions or nutritional and metabolic disorders) and psychological, structural (occlusal discrepancies, postural abnormalities, skeletal deformation), and genetic factors; (2) initiating factors that are responsible for its inception, such as trauma and joint structures overloading; and finally (3) perpetuating factors that impede the resolution or enhance the progression of TMDs, which include mechanical and muscular stress and metabolic problems.[5] These risk factors were later summarized in a review that abridged 8 years of data obtained from the Orofacial Pain: Prospective Evaluation and Risk Assessment study.[6]

Oral health–related quality of life (OHRQoL) is a multidimensional concept that incorporates the patients' subjective evaluation of their functional (eating, sleeping, talking) and emotional well-being and their expectations and satisfaction with oral health management.[7,8] Knowledge of the patients' OHRQoL allows patient management to shift from a purely medical-dental approach to a more patient-centered approach.[8] Previous studies have documented that OHRQoL is more impaired in patients with TMD in comparison to the general population.[9] Particular TMD symptoms that substantially impaired quality of life included periarticular pain and jaw movement restriction.[10]

Studies have demonstrated that anxiety increases the risk of experiencing TMD.[11,12] Undertaking a university course often elicits a high degree of anxiety in students.[13,14] Given the relationship between anxiety and TMD, it would be anticipated that university students are especially susceptible to developing TMD.

Previous research has shown that chiropractic students report high levels of stress,[15] which suggests that they might be more likely to experience TMD. Understanding the impact of TMD on chiropractic students' quality of life, and the extent to which anxiety influences it, could lead to the identification of interventions that might be implemented to address these issues. However, to our knowledge, no previous studies have examined either anxiety or TMD in chiropractic students. The primary purpose of this study, therefore, was to examine the association between anxiety and TMD in Australian chiropractic students, particularly in terms of its effect on quality of life. We hypothesized that higher levels of anxiety would lead to higher levels of TMD dysfunction.

METHODS

The study involved a cross-sectional survey. Ethical approval was obtained from the Murdoch University Human Research Ethics Committee (approval number 2017/209).

Survey Instruments

Information about TMD symptoms was collected through the use of the Oral Health Impact Profile for TMDs (OHIP-TMD).[16] The questionnaire was adapted from the original OHIP-49 developed by Slade and Spencer[17] and was designed to assess the impact of chronic oral conditions on individuals. The OHIP-TMD represents a condition-specific instrument and comprises 22 items that assess functional limitations, physical pain and disability, psychological discomfort and disability, social disability, and handicap. Each item is rated on a 5-point scale, ranging from never to very often (scored 0–4). The instrument's score is derived by summing the responses and then dividing by the total number of items. Higher values reflect lower levels of quality of life. This instrument's psychometric properties have been previously validated.[18]

The Patient-Reported Outcomes Measurement Information System (PROMIS) has developed multiple self-reported measures for adults of physical, mental, and social health (www.nihpromis.org). The short form was used to report symptoms of anxiety levels. The questionnaire is a valid measure, which has demonstrated adequate levels of internal consistency, test-retest reliability, and construct validity.[19] It consists of 4 items that evaluate self-reported levels of fear, anxious-worry, and hyperarousal. Responses are rated on a 5-point scale, ranging from never to always (scored 1–5). The total scale is calculated through aggregating the responses. Higher values indicate higher levels of anxiety.

Finally, demographic details were captured through 8 questions that enquired about age, gender, year of study, current employment, living arrangements, having children, relationship status, and experiencing physical trauma to the face or jaw in the last month.

Participants

Participants were recruited from a convenience sample of chiropractic students across all year levels at a western Australian university. Staff members publicized the study through announcements during lectures and emails distributed at weekly intervals over a 1-month period. The announcements and emails provided a link to an online survey. After following the link, students were directed to read an information letter that explained that participation was voluntary and that participation or nonparticipation would not affect their grades or relationships with staff members. All responses were anonymous, and completion of the survey was used to mark consent.

Sample Size

There are 501 chiropractic students, among which 52% are female, at the university in which this study was undertaken. Given a 95% confidence interval and 5% margin of error, 108 completed questionnaires would be required to generalize the findings of this study to the population of chiropractic students within the university.

Data Analysis

Data were imported from a survey instrument (Survey Monkey, San Mateo, CA) and analyzed using statistical software (SPSS v.24; IBM, Armonk, NY). Following the survey implementation, the psychometric properties of the adapted OHIP-TMD questionnaire were examined by using principal component analysis with an oblimin rotation, which identified 4 strong loading factors:

- Factor 1 (items 5, 9, 11, and items 14–22) related to a construct reflecting psychosocial issues regarding OHR-QoL,
- Factor 2 (items 1–4 and items 6–7) related to a construct reflecting physical function issues related to TMD,
- Factor 3 (items 8 and 10) related to a construct reflecting dental issues,
- Factor 4 (items 12 and 13) related to a construct reflecting eating handicap.

Table 1 - Pattern Matrix of the OHIP-TMD Questionnaire

Over the last month:	Components			
	1	2	3	4
1. Have you had difficulties chewing any foods?		.786		
2. Have you had difficulties in opening and closing your mouth?		.830		
3. Have you had any painful aching in your mouth?		.863		
4. Have you had a sore jaw?		.844		
5. Have you had headaches?	.542			
6. Has it been uncomfortable to eat any foods?		.747		
7. Have you felt that your speech was painful because of problems with your teeth, mouth, dentures, or jaws?		.487		
8. Have you been worried by dental problems?			.817	
9. Have you been self-conscious?	.598			
10. Have you had dental problems that have made you miserable?			.838	
11. Have you felt tense because of problems?	.627			
12. Have you had to avoid eating some foods?				−.799
13. Have you had to interrupt meals?				−.752
14. Has your sleep been interrupted?	.666			
15. Have you been upset?	.869			
16. Has it been difficult to relax?	.798			
17. Have you felt depressed?	.832			
18. Has your concentration been affected?	.733			
19. Have you been a bit irritable with other people?	.816			
20. Have you had difficulties doing your usual jobs?	.737			
21. Has life in general been less satisfying?	.825			
22. Have you been unable to work to your full capacity?	.764			

% of explained variance: 65.43%

Table 1 displays the item loadings for each of the factors. Items were grouped into scales according to their factors' loading. The scales' homogeneity and internal consistency were analyzed by using the corrected item-total correlations and Cronbach's α respectively.[20] The corrected item-total correlations ranged from 0.29 to 0.81, and the Cronbach's α values for the psychosocial aspect, function, dental issues, and eating handicap scales were, respectively, 0.93, 0.90, 0.68, and 0.79, which indicated acceptable internal consistency.[20]

The next line of analysis involved building separate linear regression models for anxiety and TMD symptoms to examine the association between each construct and demographic variables. The regression was run using the standard method of simultaneously entering all independent variables. The demographic variables entered into the models included age (continuous values); relationship status (long term = 1; other = 0); gender (male = 0; female = 1); year of program (ranging from 1st year = 0, through to 5th year = 4); have children (no = 0; yes = 1); and currently employed (no = 0; yes = 1). Regression assumptions were assessed during the analysis process. Residuals were used to check for the independence of observations using the Durbin-Watson statistic with values of 1.999 and 1.998. Residuals normality was verified with a *P-P* plot. A scatter plot of the unstandardized residuals was used to validate homoscedasticity. Multicollinearity was checked with the variance inflation factor values, which should be inferior to 10.

Finally, a general linear model was used to assess the association between anxiety and the psychosocial and function scales that were identified through the principal components analysis of the OHIP-TMD questionnaire. Factors 3 and 4 were omitted from the general linear model analysis on the basis that they each contained only 2 items and hence may not be reliable scales.[21] The general linear model was the preferred analytical approach since it adjusts for covariance between dependent variables, and we assumed a priori that the psychosocial and physical function dependent variables would be correlated to some extent.

RESULTS

Completed questionnaires were returned by 185 chiropractic students, giving a response rate of 36.93%. Table 2 displays the respondents' demographic characteristics. Almost two-thirds of the respondents were female (64.3%). The respondents on average were aged 23.4 (SD = 4.7) years (range, 18–44). Most respondents were not in a long-term relationship (70.1%), and less than 1 in 8 had children (7.0%). The majority of the respondents were currently employed (74.1%).

Table 3 displays the frequencies for items pertaining to oral physical function issues that tend to be specifically related to TMD. The 2 issues of most concern were experiencing a sore jaw (12.4%) and painful aching in the mouth (9.6%), whereas the issues of least concern were

Table 2 - Demographic Characteristics, $n = 185$

	Female, %	Children, %	Relationship, %	Employed, %	Trauma, %
Total	64.3	7.0	29.7	74.1	2.2
Year 1	14.6	1.6	3.8	12.4	0
Year 2	11.9	2.2	3.3	11.4	0
Year 3	21.6	2.2	9.8	27.0	1.6
Year 4	8.7	0.5	8.2	14.1	0.5
Year 5	7.0	0	4.3	8.7	0

difficulties chewing foods (96.7%) and finding it uncomfortable to eat food (97.8%).

The mean value for the OHIP-TMD was 1.3 (SD = 0.7). Linear regression demonstrated that females reported significantly lower quality of life related to TMD symptoms and that quality of life related to TMD symptoms increased significantly as students progressed through the course ($R^2 = .086$, $F[6,174] = 2.618$ [$p = .019$]) (Table 4).

The mean value for the PROMIS was 9.5 (SD = 4.1). Linear regression indicated that significantly lower levels of anxiety were associated with male gender, current employment, higher program levels, and having children ($R^2 = .165$, $F[6,174] = 5.738$, [$p < .000$]) (Table 5).

Finally, the general linear model analysis revealed that increased anxiety was significantly associated with higher levels of oral physical function impairment and elevated psychosocial distress (Table 6).

DISCUSSION

The results of our study highlight that anxiety was associated with oral-related physical function and psychosocial distress in Australian chiropractic students. Our findings also highlight that chiropractic students reported anxiety at a level that is likely to impact on their engagement with learning and academic performance.[22,23]

This study appears to have been the only study, to our knowledge, that has used statistical procedures to examine the structure of the OHIP-TMD. While the developers of the instrument suggested that the questionnaire contains 7 domains, our findings indicated that the OHIP-TMD consisted of 4 factors (Table 1). Also, of the factors we identified, only 2 factors contained a sufficient number of items required to form reliable scales. Hence, further studies are warranted to consolidate the psychometric properties of the OHIP-TMD.

The mean value chiropractic students reported for the OHIP-TMD was 1.3, which corresponds to oral health impacting on quality of life about once every 2 days.[24] In contrast, people who have been diagnosed with TMD report between 15 and 30 oral health impacts on quality of life per day.[24] This difference in oral health impacts between TMD patients and our study population suggests that TMD is a relatively minor issue for Australian chiropractic students.

Numerous previous studies conducted in the general population have shown an association between higher levels of anxiety and TMD.[12,25,26] The present study's findings consolidate evidence that support the significant association between psychosocial factors and the development of TMD. Based on normative values, the level of anxiety our respondents experienced was indicative of a mild impairment.[27]

The results of this study also demonstrated that anxiety decreased significantly as students progressed through the course and that females experienced considerably higher levels of anxiety. These findings suggest that 1st-year female chiropractic students are the student group who might benefit the most from the implementation of anxiety mitigation strategies.[28,29] Students transitioning to university life naturally face many stressors.[30] That said, anxiety levels across the first 3 years of the student cohort were above typical general population levels. Hence, it would be especially worthwhile to implement anxiety coping interventions to students in the first 3 years of their undergraduate training.

The effectiveness of psychological interventions to reduce anxiety in university students was examined in a recent systematic review.[31] It concluded that cognitive, behavioral, and mindfulness interventions significantly reduced anxiety levels. Universities should consider making such interventions widely available to students, particularly as numerous studies have shown that elevated

Table 3 - Frequencies for Items Pertaining to Oral Physical Function Issues Related to TMD

Over the last month:	Often/ Very Often, %	Occasionally/ Hardly Ever/ Never, %
Have you had difficulties chewing any foods?	3.3	96.7
Have you had difficulties in opening and closing your mouth?	5.4	94.6
Have you had any painful aching in your mouth?	9.6	90.4
Have you had a sore jaw?	12.4	87.6
Has it been uncomfortable to eat any foods?	2.2	97.8
Have you felt that your speech was painful because of problems with your teeth, mouth, dentures or jaws?	8.1	91.9

Table 4 - Regression Analysis for the Predictors of OHRQoL

			95% Confidence Interval	
	β	*p* Value	Lower Bound	Upper Bound
Year of study	−0.094	**.025**	−0.17	−0.012
Gender	0.30	**.006**	0.088	0.511
Age	0.09	.56	−0.02	0.038
Having children	−0.156	.541	−0.657	0.346
Being in a relationship	−0.049	.689	−0.292	0.193
Working	−0.085	.468	−0.317	0.146

Bold values are significant at $p < 0.05$

Table 5 - Regression Analysis for the Predictors of Anxiety

			95% Confidence Interval	
	β	*p* Value	Lower Bound	Upper Bound
Year of study	−0.703	**.003**	−1.167	−0.238
Gender	2.242	**.000**	1.036	3.447
Age	0.116	.166	−0.049	0.281
Having children	−4.076	**.005**	−6.93	−1.223
Being in a relationship	0.412	.556	−0.968	1.792
Working	−1.805	**.008**	−3.122	−0.487

Bold values are significant at $p < 0.05$

Table 6 - Relationship Between Anxiety (PROMIS) and OHIP-TMD Subscales

PROMIS	OHIP-TMD Subscales	*p Value*	Partial η^2
Anxiety	Psychosocial	**.000**	0.696
	Function	**.003**	0.192

Bold values are significant at $p < 0.05$

anxiety in students is associated with decreased engagement, lower grades, and increased suicidal ideation.[32–34] A major stressor for 1st-year students is the uncertainty surrounding their academic performance; therefore, another intervention at the unit level would be regular assessment and guidance.[35]

Finally, our study extends previous research that examined chiropractic students' psychosocial well-being. Prior studies have found that chiropractic students experience higher levels of depression and perceived stress in comparison to the general population.[36,37] The results of this study build on the extant literature through demonstrating that chiropractic students also report higher levels of anxiety than does the population in general.

Limitations

The present study was conducted in a single Australian university, and it is unclear if our results can be generalized to other chiropractic student cohorts. In addition, compared to the entire student cohort in which this study was conducted, our study population was disproportionately comprised of females and 3rd-year students. Notwithstanding these constraints, we used standardized instruments with robust psychometric properties, and the number of respondents exceeded the required sample size, which provides tentative support for the generalizability of this study's results.

CONCLUSION

Our findings demonstrate that anxiety was significantly associated with oral physical function impairment and psychosocial distress in chiropractic students. In addition to impacting on OHRQoL, anxiety also affects students' engagement with learning and academic performance.[38] The level of anxiety exhibited by the cohort of students in this study suggests that it would be beneficial to implement anxiety reduction interventions, which would also likely result in the mitigation of TMD symptoms.

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No funding was received for this study, and the authors have no conflict of interests to declare related to this research and the content of the manuscript.

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Author Contributions

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