Association between depressive symptoms and temporomandibular disorders among students

Associação entre sintomas depressivos e disfunção temporomandibular entre estudantes

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ABSTRACT
To evaluate the association between depressive symptoms and the severity of temporomandibular disorders (TMD). This cross-sectional study (763 students) used the Fonseca Anamnestic Index and Axis II of the Research Diagnostic Criteria for TMD. Pearson’s correlation test was applied to evaluate associations of sociodemographic and clinical characteristics with TMD (p ≤ 0.05). Multinomial logistic regression was performed to adjust for confounding variables. The prevalence of signs and symptoms of TMD among the participants was 63.8% (47.6% had signs and symptoms of depression). Students with moderate depressive symptoms were 5.11 times more likely to develop severe TMD symptoms (p < 0.001). Students with severe depressive symptoms were 12.51 times more likely to develop signs and symptoms of TMD (p < 0.001). There was a significant association between depressive symptoms and signs and symptoms of TMD. The greater the severity of symptoms of depression, the higher the risk of developing signs and symptoms of TMD.

Keywords: diagnosis, temporomandibular joint disorders, depression, students, signs and symptoms, risk.

RESUMO
Avaliar a associação entre sintomas depressivos e a gravidade das disfunções temporomandibulares (DTM). Este estudo transversal (763 estudantes) utilizou o Fonseca Anamnestic Index e o Eixo II do Research Diagnostic Criteria for TMD. O teste de correlação de Pearson foi aplicado para avaliar associações de características sociodemográficas e clínicas com DTM (p ≤ 0,05). A regressão logística multinomial foi realizada para ajustar as variáveis de confusão. A prevalência de sinais e sintomas de DTM entre os participantes foi de 63,8% (47,6% tinham sinais e sintomas de depressão). Os alunos com sintomas depressivos moderados tinham 5,11 vezes mais probabilidade de desenvolver sintomas graves de DTM (p < 0,001). Os alunos com sintomas depressivos graves tinham 12,51 vezes mais chances de desenvolver sinais e sintomas de DTM (p < 0,001). Houve uma associação significativa entre sintomas depressivos e sinais e sintomas de DTM. Quanto maior a gravidade dos sintomas de depressão, maior o risco de desenvolver sinais e sintomas de DTM.

Palavras-chave: diagnóstico, distúrbios da articulação temporomandibular, depressão, estudantes, sinais e sintomas, risco.
1 INTRODUCTION

Temporomandibular disorders (TMD) are usually described as a subclass of musculoskeletal disorders that cause nondental pain in the orofacial region and are included in the newly recommended Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) (Schiffman et al., 2014). A large population-based study using the RDC/TMD reported an estimated prevalence of painful TMD (myalgia and/or arthralgia) of 36% among adults aged 20-49 years (Progiante et al., 2015). In contrast, although more than 50% of students are believed to experience one or more signs of TMD, only 3.6-7% of them will seek medical intervention (Goyatá et al., 2010; Oliveira et al., 2006).

Pain is the most common symptom of TMD and is usually concentrated at the muscle joint during mastication, altering the function of the stomatognathic system (Furquim et al., 2015; Afari et al., 2014; Lim et al., 2011). There is a set of symptoms and conditions for the diagnosis of TMD, including fibromyalgia, generalized chronic pain, chronic fatigue syndrome, and irritable bowel syndrome (Afari et al., 2014; Lim et al., 2011). Compared to other clinical conditions, these disturbances are commonly associated with anxiety, depression, stressful life events, and psychological trauma that can cause psychiatric disorders (Afari et al., 2014; Lim et al., 2011; Gameiro et al., 2006).

On the other hand, stress and depression may result in muscular hyperactivity, inducing secondary alterations in the temporomandibular joint. The intra-articular pressure in this joint may increase, which results in biomechanical changes (Furquim et al., 2015; Afari et al., 2014; Lim et al., 2011; Gameiro et al., 2006). To date, there is evidence of a greater contribution of the psychological and global symptoms domains to the first onset of TMD, while pain amplification is associated with prognosis (Meloto et al., 2019).

Studies have demonstrated that the level of depression is higher among university students than in the rest of the population (Gameiro et al., 2006; Lim et al., 2011). University life involves an overload of tasks and expectations that increase anxiety and depression symptoms in this population which, in turn, can cause TMD. Hence, TMD could be associated with depressive symptoms (Calixtre et al., 2014; Bonjardim et al., 2005). However, no study has associated the level of depressive symptoms with the severity of the signs and symptoms of TMD.

The objective of this study was to examine possible associations between depressive symptoms and the severity of the signs and symptoms of TMD in a random sample of university
students in a city in northeastern Brazil. The main study hypothesis was that depression plays a significant role in the etiopathogenesis of TMD in university students. An additional hypothesis was that different levels of depression are associated with the severity of TMD.

2 MATERIALS AND METHODS

2.1 STUDY DESIGN

This cross-sectional study was performed at the Faculty of Science and Technology, a private university in the city of Caxias, Maranhão, Brazil. Male and female students were selected by simple random sampling among those enrolled in general courses if they were taking at least one university course and were between 18 and 45 years old. Students who were pregnant and/or currently undergoing orthodontic treatment were excluded. The sample size was calculated based on a prevalence of TMD of 28% among university students (Goyatá et al., 2010). Given the population of 2,392 students registered in all courses in 2015 and assuming a 3% margin of error, a 95% confidence level, and a 10% loss, a sample size of 760 students was estimated.

2.2 STUDY VARIABLES

The symptoms of TMD measured by the Fonseca Anamnestic Index were the dependent variable. This Brazilian questionnaire developed in Portuguese was used by Sousa et al. (2021) to evaluate the presence of severe signs and symptoms of TMD. It is composed of 10 questions that assess the presence of TMD pain at the base of the neck while chewing, the presence of headaches and disordered movement, parafunctional habits (grinding and gnashing of teeth), the presence of noise and occlusion, and emotional stress. Each question can be answered ‘yes’ (10 points), ‘sometimes’ (5 points), or ‘no’ (0 points). The total score indicates the absence of TMD (final score between 0 and 15), mild TMD (final score between 20 and 40), moderate TMD (final score between 45 and 65), or severe TMD (final score between 70 and 100) (Fonseca, 1994). We also used Axis II of the RDC/TMD for the assessment of emotional states. Axis II consists of 31 questions in four physical and psychosocial dimensions, including the degree of depression. Regarding the signs and symptoms of depression, the results are interpreted as normal (score < 0.535), moderate (≥ 0.535 and < 1.105), and severe (≥ 1.105) (Reiter et al., 2015).

The independent variables included sex (male and female), age (continuous and dichotomized as ≥ 22 and < 22 years), and socioeconomic class (categories A and B, C, and D
and E) measured by the Brazilian Criteria of Economic Classification created by the Brazilian Association of Research Companies (ABEP), which considers the ownership of goods and the educational level of the head of the household. Socioeconomic classes A and B are the most affluent, C is considered the middle class, and classes D and E are the least privileged (ABEP, 2015).

2.3 STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS 18.0 for Windows (IBM Corporation, Armonk, NY, USA). Univariate analysis was used to examine sociodemographic characteristics, clinical signs and symptoms of TMD, and depression. For bivariate analysis of the data, Pearson’s chi-squared test was applied to measure the strength of the associations between sociodemographic status and clinical characteristics of students with TMD. The significance level was set at \( p < 0.05 \). Multinomial logistic regression (MLR) analysis (Hamilton et al., 1993) was used to obtain odds ratios (OR) and 95% confidence intervals (CI), adjusted for the confounding variables (sex, age group, and socioeconomic class). This method permits the calculation of ORs because the signs and symptoms of TMD are a dependent variable with more than two categories. Each category was compared to the reference category in a single process. In this study, data of university students without TMD (reference category) were compared to those of students with mild, moderate, and severe TMD. The criterion for the inclusion of variables in the MLR model was the finding of significant associations between TMD and the independent variables in the bivariate analysis at \( p < 0.20 \) (Hosmer and Lemeshow, 2000). In the multivariate analysis, the null hypothesis was rejected when \( p > 0.05 \).

2.4 ETHICS PROCEDURES

The Research Ethics Committee of the Hospital of the University of Maranhao approved this study (protocol number 42793015.5.0000.5.5086).

3 RESULTS

Of the 822 students invited to take part in the study by drawing lot, 763 agreed to participate after the purpose of the study had been explained. The mean age was 22 ± 5.31 years.
and 63.7% of the participants were female (Table 1). Most students belonged to socioeconomic classes C (49.3%) and B (36.3%), and only 3.1% belonged to class A (Table 1).

Table 1. Sociodemographic characteristics, depression, and temporomandibular disorders (TMD) among university students.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>277</td>
<td>36.3</td>
</tr>
<tr>
<td>Female</td>
<td>486</td>
<td>63.7</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 22 years</td>
<td>292</td>
<td>38.3</td>
</tr>
<tr>
<td>≥ 22 years</td>
<td>471</td>
<td>61.7</td>
</tr>
<tr>
<td>Socioeconomic class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1 and A2</td>
<td>24</td>
<td>3.1</td>
</tr>
<tr>
<td>B1 and B2</td>
<td>277</td>
<td>36.3</td>
</tr>
<tr>
<td>C1 and C2</td>
<td>376</td>
<td>49.3</td>
</tr>
<tr>
<td>D/E</td>
<td>86</td>
<td>11.3</td>
</tr>
<tr>
<td>Depression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>400</td>
<td>52.4</td>
</tr>
<tr>
<td>Moderate</td>
<td>163</td>
<td>21.4</td>
</tr>
<tr>
<td>Severe</td>
<td>200</td>
<td>26.2</td>
</tr>
<tr>
<td>TMD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>276</td>
<td>36.2</td>
</tr>
<tr>
<td>Mild</td>
<td>284</td>
<td>37.2</td>
</tr>
<tr>
<td>Moderate</td>
<td>154</td>
<td>20.2</td>
</tr>
<tr>
<td>Severe</td>
<td>49</td>
<td>6.4</td>
</tr>
</tbody>
</table>

N = sample
Socioeconomic classes: A and B (most affluent), C (middle class), and D and E (least privileged)
Source: Prepared by the authors

The prevalence of signs and symptoms of TMD was 63.8% (n = 487). Of these, 37.2% (95% CI 33.8–40.7%) were classified as mild, 20.2% (95% CI 17.3–23.0%) as moderate, and 6.4% (95% CI 4.7–9.2) as severe (Table 2). The signs and symptoms most frequently reported by the participants were fatigue and pain when chewing (27.5%) and recurrent headaches (27.5%). The least commonly reported symptom was difficulty with lateral jaw movement (5.9%). Signs and symptoms of depression were present in 47.6% (n = 363) of the students and were classified as severe in 26.2% (n = 200).
The presence of signs and symptoms of TMD was significantly associated with female sex ($p < 0.001$), age $> 22$ years ($p = 0.02$), and the presence of signs and symptoms of depression ($p < 0.001$) (Table 3).

Table 3. Sociodemographic and depressive characteristics of university students according to the severity of signs and symptoms of temporomandibular disorders (TMD).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Absent TMD</th>
<th>Mild TMD</th>
<th>Moderate TMD</th>
<th>Severe TMD</th>
<th>$p^*$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>127</td>
<td>45.8</td>
<td>97</td>
<td>35.0</td>
<td>42</td>
</tr>
<tr>
<td>Female</td>
<td>149</td>
<td>30.7</td>
<td>187</td>
<td>38.5</td>
<td>112</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 22 years</td>
<td>93</td>
<td>31.8</td>
<td>128</td>
<td>43.8</td>
<td>53</td>
</tr>
<tr>
<td>≥ 22 years</td>
<td>183</td>
<td>38.9</td>
<td>156</td>
<td>33.1</td>
<td>101</td>
</tr>
<tr>
<td>Socioeconomic class</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1 and A2</td>
<td>11</td>
<td>45.8</td>
<td>08</td>
<td>33.3</td>
<td>3</td>
</tr>
<tr>
<td>B1 and B2</td>
<td>97</td>
<td>35.0</td>
<td>112</td>
<td>40.4</td>
<td>57</td>
</tr>
<tr>
<td>C1 and C2</td>
<td>142</td>
<td>37.8</td>
<td>132</td>
<td>37.2</td>
<td>21</td>
</tr>
<tr>
<td>D and E</td>
<td>26</td>
<td>30.2</td>
<td>32</td>
<td>37.2</td>
<td>21</td>
</tr>
<tr>
<td>Depression</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>199</td>
<td>49.8</td>
<td>137</td>
<td>34.2</td>
<td>53</td>
</tr>
<tr>
<td>Moderate</td>
<td>45</td>
<td>27.6</td>
<td>68</td>
<td>41.7</td>
<td>37</td>
</tr>
<tr>
<td>Severe</td>
<td>32</td>
<td>16.0</td>
<td>79</td>
<td>39.5</td>
<td>64</td>
</tr>
</tbody>
</table>

*Pearson’s chi-squared test
$N =$ sample

Socioeconomic classes: A and B (most affluent), C (middle class), and D and E (least privileged)
Source: Prepared by the authors
The MLR analysis adjusted for demographic characteristics (sex and age) showed that females were 1.87 times (95% CI 1.20–2.93) more likely to develop moderate and 2.25 times (95% CI 1.07–4.71) more likely to develop severe signs and symptoms of TMD than males (both \( p < 0.05 \)). Students with moderate depressive symptoms were 5.11 times (95% CI 2.14–12.21) more likely to have signs and symptoms of severe TMD than students without depressive symptoms; this likelihood increased to 12.51 (95% CI 5.58–28.08) if the student had severe depressive symptoms (both \( p < 0.001 \)) (Table 4).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mild TMD OR (95% CI)</th>
<th>Moderate TMD OR (95% CI)</th>
<th>Severe TMD OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1.40 (0.98-1.99)</td>
<td>1.87 (1.20-2.93)**</td>
<td>2.25 (1.07-4.71)*</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>1.0</td>
<td>0.93 (0.60-1.44)</td>
<td>0.98 (0.51-1.91)</td>
</tr>
<tr>
<td>≥ 22 years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 22 years</td>
<td>1.51 (1.06-2.15)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Depression</strong></td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Absent</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>2.08 (1.34-3.23)**</td>
<td>3.05 (1.79-5.21)**</td>
<td>5.11 (2.14-12.21)**</td>
</tr>
<tr>
<td>Severe</td>
<td>3.37 (2.11-5.40)**</td>
<td>6.82 (4.03-11.55)**</td>
<td>12.51 (5.58-28.08)**</td>
</tr>
</tbody>
</table>

OR: odds ratio; CI: confidence interval. *\( p < 0.05 \), **\( p < 0.01 \), ***\( p < 0.001 \).

Source: Prepared by the authors

4 DISCUSSION

Signs and symptoms of depression, assessed by Axis II of the RDC, were common (47.6%) in the sample studied. This finding is striking given the age of the sample (mostly young people), although it is similar to other studies involving Polish (Wieckiewicz et al., 2014), East Indian (Iqbal et al., 2013), and Chinese students (Minghelli et al., 2014). In addition, most of the students with signs and symptoms of depression (26.2% of the population studied) reported severe depressive symptoms, a percentage that is almost double that found by Iqbal et al. (2013).

In this study, students with moderate and severe depressive symptoms were at increased odds of worsening of TMD symptoms, confirming our hypothesis. The associations between depressive symptoms and the severity of TMD signs and symptoms have so far been unknown, although many studies have demonstrated an association between depression and TMD (Guarda-Nardim et al., 2012; Calixtre et al., 2014; Wieckiewicz et al., 2014; Reiter et al., 2015; Wu et al., 2021; Srivastava et al., 2021). On the other hand, a study with dental students did not find an
association between depressive symptoms and TMD (Lovgren et al., 2018), probably because of the small sample size (only 54 students).

University students are exposed to many stressful events related to leaving their homes and families for the first time, living with other students, reduced supervision by adults, and a greater responsibility of contributing to social roles (Minghelli et al., 2014; Kuman et al., 2021). These changes can increase the risk of depression if not properly managed and discussed (Brondani et al., 2014).

According to List and Jensen (2017), the psychoemotional mechanisms involved in the pathophysiology of TMD remain controversial, although negative emotions can favor the occurrence of pain. When damage is unpredictable, pain plays a key role in the preservation of tissue integrity, serving as a sensory monitoring mechanism to detect an increased threat. However, the expectation of pain can increase sensitivity to it. The experience of stressful situations is also correlated with the secretion of hormones and neurotransmitters that modulate pain and muscle tone, including dopamine, a fact that explains the higher prevalence of signs and symptoms of TMD among females (Gameiro et al., 2006; List and Jensen, 2017).

The prevalence of TMD of 63.8% observed in this study is similar to that reported by Oliveira et al. (2006) for Brazilian students using the same instrument. In contrast, the prevalence of TMD was lower among Jordanian (46.8%) (Habib et al., 2015), Indian (54.84%) (Modi et al., 2012), and Portuguese students (42.2%) (Minghelli et al., 2014). These differences can be explained by ethnicity, sample size, and the instrument used to measure TMD.

In the present study, mild signs and symptoms of TMD were the most frequent, followed by moderate and severe signs and symptoms. This finding agrees with the results of previous studies on university students (Oliveira et al., 2006; Minghelli et al., 2014; Habib et al., 2015; Modi et al., 2012). One of the symptoms commonly reported by the participants was frequent muscular pain when chewing. This symptom was also found in studies conducted by Rayalat et al. (2009) on 1,103 Jordanian students and by Minghelli et al. (2014) on 1,493 Portuguese students. Among TMD symptoms, pain deserves special attention because it is related to functional damage to the temporomandibular joint (Habib et al., 2015). This characterizes a myogenic TMD that is caused by excessive tension in the chewing muscles and will likely result in comorbidities such as myalgia and psychological disorders (Furquim et al., 2015; Gameiro et al., 2006; Wieckiewicz et al., 2014; Minghelli et al., 2014; Karibe et al., 2014; Daham et al.,
Another symptom frequently reported in this study was headache. Wieckiewicz et al. (2014) also found headache in 40% of the sample. Similarly, Minghelli et al. (2014) who studied 1,493 students found symptoms of headache in 75.4%. In another study of 180 patients with TMD, headache was associated with an increased severity of TMD and a higher prevalence of psychological dysfunctions (Dahan et al., 2014). One possible explanation for the association between TMD and headache is that the latter is related to muscle activity, given the anatomical link between the temporomandibular joint and the head and cervical muscles (Minghelli et al., 2014).

The finding that women were significantly more affected by TMD symptoms than men also agrees with other studies (Minghelli et al., 2014; List and Jensen, 2017; Bonjardim et al., 2009). The high prevalence of TMD in women may be due to physiological characteristics, particularly hormonal variations and the structure of connective and muscle tissue (Bonjardim et al., 2009). However, emotional factors can also contribute to the higher prevalence since women are more susceptible to psychological disorders such as stress and depression (Wieckiewicz et al., 2014; Magalhães et al., 2014; Tosato et al., 2015).

Researchers have sought to develop instruments that are more applicable to TMD, considering that it is a chronic and multifactorial condition, in an attempt to gather the main clinical findings, enabling epidemiological and population studies. In the present study, the Fonseca Anamnestic Index and the RDC/TMD Axis II questionnaire were used. These instruments provide simple, reliable, and highly reproducible measures for the diagnosis of TMD. The simplicity of the Fonseca Anamnestic Index favors its use in population and epidemiological studies. The instrument has been found to be highly accurate in patients with TMD and has shown a 95% correlation with the Helkimo Clinical Dysfunction Index (Karibe et al., 2014).

The strengths of this study include the large number of participants, the randomized sample selection, the statistical methodology used for data analysis (MLR), and the use of validated protocols to assess TMD and depression symptoms. However, the cross-sectional design of the study was a limitation since it does not permit to show causality between depression and TMD. Future studies should examine the causal link between TMD and depression, evaluating psychological and physical aspects, in order to facilitate the adoption of effective interventions by multidisciplinary teams.
5 CONCLUSION

The findings of this study demonstrate that the presence of signs and symptoms of TMD is significantly associated with symptoms of depression in students. The greater the severity of depressive symptoms, the higher the risk of developing signs and symptoms of TMD.

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