

# Correlation between the event of the COVID-19 pandemic and symptoms of anxiety, depression and temporomandibular disorder in university students: cross-sectional study

*Correlação entre o evento da pandemia de COVID-19 e sintomas de ansiedade, depressão e de disfunção temporomandibular em estudantes universitários: estudo transversal*

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## ABSTRACT

**BACKGROUND AND OBJECTIVES:** The COVID-19 pandemic has been shown to be a probable aggravator of psychological responses such as anxiety and depression. This study aimed to assess the correlation between symptoms of anxiety and depression during the COVID-19 pandemic and the existence of symptoms associated with temporomandibular dysfunction (TMD) in a Brazilian university population.

**METHODS:** This epidemiological, cross-sectional clinical study evaluated its variables of interest using the COVID-19 Fear Scale, Hospital Anxiety and Depression Scale (HADS-A and HADS-D), Diagnostic Criteria for Temporomandibular Dysfunction (DC/TMD) and Oral Behavior Checklist (OBC) questionnaires.

**RESULTS:** A total of 373 participants (females = 273) with a mean age of 23.8±5.45 years were included in this study. In ad-

dition, 78.2% of participants with anxiety symptoms and 54.5% of participants with depression symptoms reported a high level of TMD-related parafunction ( $p<0.01$ ). The presence of anxiety symptoms increased the odds of developing intense fear of COVID-19 by 14.9 times ( $p<0.001$ ) and the odds of developing moderate fear of COVID-19 by 3.5 times ( $p<0.001$ ). The presence of an intense fear of COVID-19 increased the chances of developing anxiety symptoms by 17.15 times ( $p<0.001$ ), while the presence of a moderate fear increased these chances by 3.12 times ( $p<0.001$ ). In addition, the presence of intense ( $p=0.01$ ) or moderate ( $p=0.018$ ) COVID-19 fears increased the odds of developing TMD-related pain symptoms by 2.47 and 1.84 times, respectively, in this population.

**CONCLUSION:** The presence of painful TMD symptoms was possibly influenced by fear of COVID-19. This, in turn, was related to the presence of anxiety and depression symptoms reported by the target population of this study.

**Keywords:** Anxiety, COVID-19, Depression, Temporomandibular joint dysfunction syndrome.

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## HIGHLIGHTS

- 78.2% of participants with symptoms of anxiety and 54.5% of participants with symptoms of depression reported a high level of parafunction, while 71.5% of participants who reported painful TMD symptoms had symptoms of anxiety and 52% of depression.
- The presence of anxiety symptoms was more prevalent than depression among participants with painful symptoms associated with TMD.
- This study has provided insights into the impact of the COVID-19 pandemic on painful TMD symptoms in university students and the influence of psychological factors such as anxiety and depression.
- The results observed in this study indicate consequences that may perpetuate after the COVID-19 pandemic period and instigate further studies.

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## RESUMO

**JUSTIFICATIVA E OBJETIVOS:** A pandemia de COVID-19 mostrou-se um provável agravante de respostas psicológicas como ansiedade e depressão. Este estudo teve como objetivo avaliar a correlação entre sintomas de ansiedade e depressão durante o período da pandemia de COVID-19 e a existência de sintomas associados à disfunção temporomandibular (DTM) em uma população universitária brasileira.

**MÉTODOS:** Este estudo clínico epidemiológico e transversal avaliou as suas variáveis de interesse por meio dos questionários Escala de Medo do COVID-19, Escala Hospitalar de Ansiedade e Depressão (HADS-A e HADS-D), Critérios Diagnósticos para Disfunção Temporomandibular (DC/DTM) e *Checklist* de Comportamentos Orais (OBC).

**RESULTADOS:** Ao todo, 373 participantes (sexo feminino = 273), com média de idade de 23,8±5,45 anos foram incluídos neste estudo. Ademais, 78,2% dos participantes com sintomas de ansiedade e 54,5% dos participantes com sintomas de depressão reportaram alto nível de parafunção relacionada à DTM ( $p<0,01$ ). A presença de sintomas de ansiedade aumentou em 14,9 vezes as chances de desenvolvimento de um quadro de

medo intenso do COVID-19 ( $p < 0,001$ ) e de um quadro de 3,5 vezes nas chances de desenvolvimento de medo moderado do COVID-19 ( $p < 0,001$ ). A presença de um medo intenso do COVID-19 aumentou em 17,15 vezes as chances de desenvolvimento de sintomas de ansiedade ( $p < 0,001$ ), enquanto a presença de um medo moderado aumentou essas chances em 3,12 vezes ( $p < 0,001$ ). Ademais, a presença de medos intensos ( $p = 0,01$ ) ou moderados ( $p = 0,018$ ) do COVID-19 aumentou 2,47 e 1,84 vezes, respectivamente, as chances de desenvolvimento de sintomatologias dolorosas relacionadas à DTM nessa população.

**CONCLUSÃO:** A presença de sintomatologia dolorosa da DTM foi possivelmente influenciada pelo medo do COVID-19. Isso, por sua vez, esteve relacionado à presença de sintomas de ansiedade e de depressão, reportados pela população-alvo deste estudo.

**Descritores:** Ansiedade, COVID-19, Depressão, Síndrome da disfunção da articulação temporomandibular.

## INTRODUCTION

The SARS-CoV-2 (COVID-19) virus was first detected in China in December 2019. The spread of the virus and the health impact severity led the World Health Organization (WHO) to officially announce a pandemic caused by the virus in March 2020. As a strategy to control the spread of the virus, measures of confinement and social distancing were recommended to the population in an attempt to contain the spread and contagion<sup>1,2</sup>. Faced with this scenario, different sectors have adjusted to the security protocols, respecting social distancing and isolation. These include schools and universities<sup>3-6</sup>, for which the cancellation of face-to-face classes and the implementation of the distance learning model have allowed students and academics to adapt to the training process<sup>4,7</sup>.

The social isolation and confinement measures adopted have been extremely important in reducing cases and contamination by the virus. On the other hand, there has been a negative impact on the mental health of the world population exposed to the pandemic. Among the main symptoms, there is a greater susceptibility to triggering symptoms of depression, irritability, anxiety, stress and insomnia<sup>3,8,9</sup>.

With the impact on mental health during the pandemic intensifying symptoms and conditions of stress, anxiety and depression throughout the population<sup>10-17</sup>, it is estimated that some comorbidities, such as the presence of painful symptoms related to temporomandibular joint dysfunction (TMD), may be associated with this scenario<sup>18-20</sup>.

TMD dysfunctions<sup>10</sup> have a multifactorial, complex etiology, described by local and systemic characteristics, mainly involving the occlusal condition of the dentition, mechanical trauma, parafunctional activities and emotional stress conditions, such as anxiety and depression<sup>11-14</sup>.

It is estimated that due to the restriction of social interaction during the pandemic, the university population also suffered emotional and psychological changes<sup>8</sup>. Recent studies reinforce this by describing the university context during the pandemic as a stressful environment for undergraduates<sup>9,11</sup>; one factor that

stands out is the demand to perform new responsibilities, but their impact increases levels of stress, anxiety and even the development of traits of depression<sup>17</sup>. Given the situation of stress and fear generated by the COVID-19 pandemic, this scenario could be potentiated and trigger new cases of TMD, as well as aggravating symptoms that are already present<sup>18,21</sup>.

The aim of this study was to assess the correlation between symptoms of anxiety and depression during the COVID-19 pandemic and the existence of symptoms associated with TMD in a Brazilian university population.

## METHODS

This study followed the recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.

This study was approved by the Human Research Ethics Committee of the Federal University of Alfenas (*Universidade Federal de Alfenas - UNIFAL*), Brazil (Opinion Number 4.475.702). This epidemiological, cross-sectional clinical study involved 373 undergraduates from the same university. The criterion for excluding participants was based on those who were not enrolled at the university or were under 18 years of age.

The sample calculation for this study was based on a known population of 5,500 UNIFAL students, with a 95% confidence interval (CI) and a 5% margin of error (ME). A minimum sample size of 360 students was estimated.

All participants were informed about the study and signed the Free and Informed Consent Term (FICT), authorizing data collection.

### Questionnaires and parameters analyzed

Data was collected during the period of social isolation in Brazil. Participants were recruited via an invitation sent to the academic institutional e-mail address and the questionnaires were virtually filled, using the Google Forms tool. A control strategy was applied to fill in the form to avoid duplication (by registering an individual).

After signing the virtual consent form, participants completed a form with demographic variables: gender and age; and socio-educational variables: undergraduate degree (tabulated and categorized by area of knowledge) and whether or not they were participating in the Emergency Remote Learning (*Ensino Remoto Emergencial - ERE*) program during the COVID-19 pandemic. Participants were also asked to complete the COVID-19 Fear Scale<sup>22</sup>, which investigates impact on sleep, feelings of fear or nervousness, as well as daily activities during the pandemic. Anxiety and depression variables were accessed through the Hospital Anxiety and Depression Scale (HADS-A and HADS-D)<sup>23</sup> questionnaire, which accesses mood changes, feelings of panic, self-care, relaxation, worry or happiness reported by participants. Finally, the questionnaires aimed at TMD and the existence of associated symptoms accessed by the Diagnostic Criteria for Temporomandibular Dysfunctions (DC/TMD), Axis I: TMD Pain Screening, and Axis II: Oral Behaviors Checklist (OBC)<sup>24</sup>, which investigate the occurrence of pain in the face or Tempo-

mandibular Joint, altered masticatory function and the presence of parafunctional habits. All the questionnaires and scales in this study were validated in Portuguese and applied following the guidelines of their authors.

**Statistical analysis**

Descriptive statistical analysis of the variables was carried out using frequency or percentage distribution. The association between the variables collected by the questionnaires applied was calculated using the Chi-square test. Multinomial Logistic Regression (TMD pain symptomatology) and Binomial Logistic Regression (Fear of COVID-19) were applied to develop models of the variables that met the Chi-square test response criterion ( $p < 0.05$ ). The dependence between the variables analyzed was reported using odds ratios (OR). A 95% confidence interval (CI) was applied and all analyses were carried out using Jamovi statistical software version 1.6<sup>25</sup>.

**RESULTS**

This study involved 373 students - 273 females and 100 males. The mean age of the participants was  $23.8 \pm 5.45$  years. There was no significant difference between the genders in the presence of TMD pain ( $p = 0.799$ ), anxiety ( $p = 0.058$ ) and depression ( $p = 0.085$ ). The levels of anxiety ( $p = 0.413$ ), fear of COVID ( $p = 0.944$ ), TMD pain ( $p = 0.297$ ) or the presence of parafunctions ( $p = 0.129$ ) were not associated with the area of knowledge. On the other hand,

there was an association between the areas of knowledge and the presence of symptoms of depression in the students ( $\chi^2 = 9.09$ ;  $p = 0.011$ ), with 64.7% of the participants in the area of human sciences and languages having depressive symptoms (Table 1).

**Associative analysis - bivariate**

The variable “fear of COVID-19” was categorized into three levels: “great fear”, “moderate fear” and “little fear”. The association analysis showed that 92.5% of participants with “a lot of fear of COVID-19” had anxiety symptoms (HADS-A -  $\chi^2 = 52$ ;  $p < 0.001$ ). Similarly, 64.2% of participants with “a lot of fear of COVID-19” showed symptoms of depression (HADS-D -  $\chi^2 = 17.3$ ;  $p < 0.001$  - table 2).

The presence of painful TMD symptoms was also associated with the presence of anxiety ( $\chi^2 = 10.1$ ;  $p = 0.001$ ) and depression ( $\chi^2 = 9.67$ ;  $p = 0.002$ ) symptoms in this study (Table 3). Thus, 71.5% of the participants with painful TMD symptoms also had anxiety symptoms, while the absence of painful symptoms was also related to the absence of depressive symptoms in 64.8% of the participants (Table 3).

When evaluating the questions addressed by the DC/TMD in the last four weeks (headache in the temporal region, pain or stiffness in the jaw, pain when chewing hard or consistent food, pain when opening the mouth or moving the jaw, as well as pain when clenching, grinding teeth, chewing gum, talking, kissing or yawning), an association was observed between the presence of headache in the temporal region and anxiety symptoms

**Table 1.** Association between areas of knowledge and the presence of symptoms of anxiety or depression according to HADS (n=373).

Areas of knowledge	HADS-A		Total	p-value†	HADS-D		Total	p-value†
	Anxiety	Absence of anxiety			Depression	Absence of depression		
Biological and health sciences	142	100	242		91	151	242	
% <sub>a</sub>	58.7%	41.3%	100.0%		37.6%	62.4%	100.0%	
Exact sciences and engineering	58	39	97		39	58	97	
% <sub>a</sub>	59.8%	40.2%	100.0%		40.2%	59.8%	100.0%	
Human sciences and languages	24	10	34		22	12	34	
% <sub>a</sub>	70.6%	29.4%	100.0%		64.7%	35.3%	100.0%	
Total	224	149	373	0.413ns	152	221	373	0.011*
% <sub>a</sub>	60.1%	39.9%	100.0%		40.8%	59.2%	100.0%	

HADS = Hospital Anxiety and Depression Scale; <sub>a</sub> = values expressed as percentages in line; † = Chi-squared test; \*Significant =  $p < 0.05$ ; ns = not significant; active =  $p > 0.05$ .

**Table 2.** Association between results obtained from the COVID-19 Fear Questionnaire and HADS (n=373).

COVID fear	HADS-A		Total	p-value†	HADS-D		Total	p-value†
	Anxiety	Absence of anxiety			Depression	Absence of depression		
High fear	49	4	53		34	19	53	
% <sub>a</sub>	92.5%	7.5%	100.0%		64.2%	35.8%	100.0%	
Mild fear	105	47	152		64	88	152	
% <sub>a</sub>	69.1%	30.9%	100.0%		42.1%	57.9%	100.0%	
Low fear	70	98	168		54	114	168	
% <sub>a</sub>	41.7%	58.3%	100.0%		32.1%	67.9%	100.0%	
Total	224	149	373	<.001*	152	221	373	<.001*
% <sub>a</sub>	60.1%	39.9%	100.0%		40.8%	59.2%	100.0%	

HADS = Hospital Anxiety and Depression Scale; <sub>a</sub> = values expressed as percentages in line; † = Chi-squared test; \*Significant =  $p < 0.05$ .

**Table 3.** Association between results obtained from the TMD Pain Screening Questionnaire and HADS (n=373).

TMD pain	HADS-A		Total	p-value†	HADS-D		Total	p-value†
	Anxiety	Absence of anxiety			Depression	Absence of depression		
Absent	136	114	250		88	162	250	
	% <sub>a</sub>	54.4%	45.6%	100.0%	35.2%	64.8%	100.0%	
Present	88	35	123		64	59	123	
	% <sub>a</sub>	71.5%	28.5%	100.0%	52.0%	48.0%	100.0%	
Total	224	149	373	0.001*	152	221	373	0.002*
	% <sub>a</sub>	60.1%	39.9%	100.0%	40.8%	59.2%	100.0%	

HADS = Hospital Anxiety and Depression Scale; <sub>a</sub> = values expressed as percentages in line; † = Chi-squared test; \*Significant = p<0.05.

( $x^2=43.8$ ;  $p<0.001$ ) and depression ( $x^2=38.5$ ;  $p<0.001$ ) reported by the participants. There was no statistically significant association ( $p>0.05$ ) for the other variables mentioned.

Finally, the presence of parafunctions (OBC) showed an association with both the COVID-19 Fear Scale ( $x^2=20.5$ ;  $p<0.001$  - table 4) and the presence of anxiety ( $x^2= 40.8$ ;  $p<0.001$ ) and depression ( $x^2=23.5$ ;  $p<0.001$ ) symptoms assessed by HADS (Table 5).

**Multivariate analysis**

**Multinomial Logistic Regression Model**

Odds ratios (OR) were estimated by the logistic regression model for statistically significant variables. Table 6 shows a multinomial logistic regression of the correlation between the results obtained by HADS (independent variable) and the COVID-19 Fear Scale (dependent variable -  $R^2=0.0794$ ). This analysis showed that

the presence of anxiety symptoms could increase the chances of developing intense fear of COVID-19 by 14.9 times ( $p<0.001$ ). Similarly, the confirmation of anxiety symptoms was related to a 3.5-fold increase in the chances of developing moderate fear of COVID-19 ( $p<0.001$  - table 6).

Table 7 shows the binomial logistic regression of the correlation between the results obtained by the COVID-19 Fear Scale (independent variable) and HADS-A (dependent variable) ( $R^2=0.114$ ). From this analysis, it was also observed that the presence of an intense fear of COVID-19 increased the chances of developing anxiety symptoms by 17.15 times ( $p<0.001$ ), while the presence of a moderate fear increased these chances by 3.12 times ( $p<0.001$ ).

Similarly, table 8 shows the binomial logistic regression of the correlation between the results obtained by the COVID-19 Fear

**Table 4.** Association between OBC scores and Fear of COVID (n=373).

OBC	COVID fear			Total	p-value†
	High fear	Mild fear	Low fear		
High parafunction	33	77	55	165	
	% <sub>a</sub>	20.0%	46.7%	33.3%	100.0%
Low parafunction	19	74	107	200	
	% <sub>a</sub>	9.5%	37.0%	53.5%	100.0%
Absence of parafunction	1	1	6	8	
	% <sub>a</sub>	12.5%	12.5%	75.0%	100.0%
Total	53	152	168	373	<.001*
	% <sub>a</sub>	14.2%	40.8%	45.0%	100.0%

OBC = Oral Behavior Checklist; <sub>a</sub> = values expressed as percentages in line; † = Chi-squared test; \*Significant = p<0.05; ns = not significant; active = p>0.05.

**Table 5.** Association between OBC scores and HADS (n=373).

OBC	HADS-A		Total	p-value†	HADS-D		Total	p-value†
	Anxiety	Absence of anxiety			Depression	Absence of depression		
High parafunction	129	36	165		90	75	165	
	% <sub>a</sub>	78.2%	21.8%	100.0%	54.5%	45.5%	100.0%	
Low parafunction	92	108	200		59	141	200	
	% <sub>a</sub>	46.0%	54.0%	100.0%	29.5%	70.5%	100.0%	
Absence of parafunction	3	5	8		3	5	8	
	% <sub>a</sub>	37.5%	62.5%	100.0%	37.5%	62.5%	100.0%	
Total	224	149	373	<.001*	152	221	373	<.001*
	% <sub>a</sub>	60.1%	39.9%	100.0%	40.8%	59.2%	100.0%	

HADS = Hospital Anxiety and Depression Scale; OBC = Oral Behavior Checklist; <sub>a</sub> = values expressed as percentages in line; † = Chi-squared test; \*Significant = p<0.05; ns = not significant; active = p>0.05.

**Table 6.** Logistic regression between results obtained from the COVID-19 Fear Scale and HADS questionnaires (n=373).

COVID-19 Fear Scale	Variable	EV (SE)	p-value	OR [CI 95%]
High fear - Low fear	(Intercept)	-3.230 (0.512)	<.001*	0.0395 [0.0145; 0.108]
	HADS-D:			
	Depression – Absence of depression	0.265 (0.374)	0.479ns	1.3028 [0.6261; 2.711]
Mild fear - Low fear	HADS-A:			
	Anxiety - Absence of anxiety	2.701 (0.578)	<.001*	14.8904 [4.7933; 46.257]
	(Intercept)	-0.714 (0.179)	<.001*	0.4898 [0.3446; 0.696]
	HADS-D:			
	Depression – Absence of depression	-0.219 (0.280)	0.435ns	0.8037 [0.4640; 1.392]
	HADS-A:			
	Anxiety - Absence of anxiety	1.250 (0.275)	<.001*	3.4895 [2.0343; 5.986]

HADS = Hospital Anxiety and Depression Scale; EV = estimate; OR = odds ratio; SE = standard error; CI = confidence interval; p (probability value); \*Significant = p<0.05; ns = not significant; active = p>0.05.

**Table 7.** Logistic regression between results obtained from the COVID-19 Fear Scale questionnaire in HADS-A (n=373).

Variable	EV (SE)	p-value	HADS-A OR [CI 95%]
Intercept	-0.336 (0.156)	0.032*	0.714 [0.526; 0.971]
COVID Fear:			
High fear - Low fear	2.842 (0.543)	<.001*	17.150 [5.916; 49.717]
Mild fear - Low fear	1.140 (0.235)	<.001*	3.128 [1.973; 4.959]

HADS = Hospital Anxiety and Depression Scale; EV = estimate; OR = odds ratio; SE = standard error; CI = confidence interval; p (probability value); \*Significant = p<0.05; ns = not significant; active = p>0.05.

Scale (independent variable) and HADS-D (dependent variable -  $R^2=0.0341$ ). From this analysis, it was observed that the presence of an intense fear of COVID-19 increased the chances of developing depressive symptoms by 3.77 times (p<0.001). Finally, table 9 correlates the relative results of the COVID-19 Fear Scale, HADS-A and HADS-D (independent variables) and

the TMD Pain Screening (dependent variable) using the binomial logistic regression model ( $R^2=0.0464$ ). In this case, the application of the model showed that the presence of intense (p=0.01) or moderate (p=0.018) fears of COVID-19 would increase the chances of developing TMD-related pain symptoms in this population by 2.47 and 1.84 times, respectively.

**Table 8.** Logistic regression between results obtained from the COVID-19 Fear Scale questionnaire in HADS-D (n=373).

Variable	EV (SE)	p-value	HADS-D OR [CI 95%]
Intercept	-0.747 (0.165)	<.001*	0.474 [0.343; 0.655]
COVID Fear:			
High fear - Low fear	1.329 (0.331)	<.001*	3.778 [1.976; 7.223]
Mild fear - Low fear	0.429 (0.233)	0.066ns	1.535 [0.973; 2.424]

HADS = Hospital Anxiety and Depression Scale; EV = estimate; OR = odds ratio; SE = standard error; CI = confidence interval; p (probability value); \*Significant = p<0.05; ns = not significant; active = p>0.05.

**Table 9.** Logistic regression between results obtained from the HADS questionnaires and the COVID-19 Fear Scale for TMD Pain Screening (n=373).

Variables	EV (SE)	p-value	TMD Pain Screening OR [CI 95%]
Intercept	-1.470 (0.224)	<.001*	0.230 [0.148; 0.357]
HADS-A:			
Anxiety - Absence of anxiety	0.259 (0.289)	0.371ns	1.296 [0.735; 2.284]
HADS-D:			
Depression – Absence of depression	0.445 (0.262)	0.089ns	1.561 [0.934; 2.609]
COVID Fear:			
High fear - Low fear	0.906 (0.352)	0.010*	2.475 [1.242; 4.932]
Mild fear - Low fear	0.611 (0.258)	0.018*	1.842 [1.112; 3.053]

HADS = Hospital Anxiety and Depression Scale; EV = estimate; OR = odds ratio; SE = standard error; CI = confidence interval; p (probability value); \*Significant = p<0.05; ns = not significant; active = p>0.05.



## DISCUSSION

This study involved 373 university students, 273 (73.2%) of whom were female and 100 (26.8%) male, with a mean age of  $23.8 \pm 5.4$  years. Similar results in terms of participation between the genders are reported by two previous studies<sup>12,19</sup> in similar investigations in Brazil. Both studies reported a higher prevalence of females, 79% and 77% respectively. These data reflect the current scenario of the Brazilian university population, with the majority of students in higher education being women, aged between 19 and 24<sup>26</sup>.

In addition, 64.7% of students in the area of Human Sciences and Languages reported the presence of depressive symptoms in the population evaluated, compared to 40.2% in the area of Exact Sciences and Engineering and 37.6% in the area of Health and Biological Sciences ( $p=0.011$  - table 1). In addition to the high percentages observed in the population as a whole, the higher prevalence of depressive symptoms in students from the Human Sciences and Languages area compared to the other areas is noteworthy, leading to the need for further research on the subject.

Analysis of the associations between fear of COVID-19 and the presence of symptoms related to anxiety and depression indicated that 92.5% of participants who reported being “very afraid of COVID-19” had symptoms of anxiety ( $p<0.01$ ), while 64.2% of participants who reported being “very afraid of COVID-19” had symptoms of depression ( $p<0.01$ ) (table 2). Factors such as excessive media information, the unpredictability of viral action in each organism, the relationship between comorbidities and worsening of the disease and the fact that this is a virus that has never been treated by public health before were the main causes of the development of COVID-19 fear up until the time of this study<sup>8</sup>.

In addition, one study<sup>17</sup> reported that all participants reported an increase in anxiety symptoms due to the social isolation generated by the COVID-19 pandemic. Furthermore, 65% of them reported a history of anxiety and described the moment as “a worsening in this period”. Depression was present in 12.43% of participants and 13.46% reported feeling “great distress” during different times of the day.

On the other hand, no correlation was found between ERE students and the presence of anxiety symptoms ( $p=0.28$ ) and/or depression ( $p=0.869$ ). This result can be explained by the fusion of different teaching methodologies during remote classes<sup>6</sup>. One study<sup>27</sup> emphasized the importance of recorded classes, allowing students to choose the best time to study. In medical and health courses, the main disadvantage would be the impossibility of practicing the theory studied<sup>28</sup>.

It should also be noted that there was no association between the areas of knowledge of the undergraduate programs included and the presence of fear of COVID-19 ( $p=0.944$ ), anxiety symptoms ( $p=0.413$ ), TMD pain symptoms ( $p=0.297$ ) or the presence of TMD-related parafunction ( $p=0.129$ ) in this study. Studies on more restricted populations<sup>11,19</sup>, such as dental students, have reported an impact on the prevalence of TMD symptoms, anxiety and depression in this

specific group, although the same was not diagnosed in the present study.

Furthermore, there was no correlation between gender and the presence of TMD pain symptoms ( $p=0.799$ ), anxiety symptoms ( $p=0.058$ ) and/or depression ( $p=0.085$ ) in this study. On the other hand, the majority of studies in the literature<sup>4,19,29</sup> report a higher prevalence of TMD symptoms in female patients, with a prevalence of two to nine times higher in this population when compared to males<sup>30,31</sup>. This result corroborates what was reported by a study<sup>12</sup> prior to the COVID-19 pandemic period.

A possible cause and effect relationship was also observed by the Oral Behaviors Checklist (OBC) and the COVID-19 Fear Scale (Table 4). In this analysis, 75% of participants who reported “not afraid or just apprehensive” of COVID-19 did not report the presence of TMD-related parafunction. In addition, one study<sup>18</sup> evaluated the effect of the pandemic on the possible prevalence and worsening of TMD and bruxism symptoms in individuals from two different countries, Israel and Poland. An increase in bruxism symptoms was observed during the pandemic and, according to this study, psychological factors can trigger and intensify TMD symptoms and the occurrence of parafunctions. These factors may modulate the participants’ psycho-emotional state, influencing their coping strategies during the COVID-19 pandemic and, in turn, increasing the prevalence of bruxism and painful TMD symptoms.

What’s more, the results obtained by OBC also indicate a correlation with the results obtained by HADS-A and HADS-D (Table 5). Thus, 78.2% of participants with symptoms of anxiety and 54.5% of those with symptoms of depression had a high level of parafunctions ( $p<0.01$ ). Similar findings in another study<sup>19</sup> reinforce that parafunctional habits are activities with repeated contractions of the jaw muscles, which can result in muscle overload, local ischemia and pain. Thus, the frequency of oral parafunctional behaviors is increased in patients with anxiety symptoms. Since high levels of anxiety have been shown to play a crucial role in the occurrence of parafunctions, resulting in pain, these anxiety levels should be monitored<sup>19,32</sup>. This study also showed how the fear generated by the COVID-19 pandemic influenced painful symptoms related to TMD. Thus, participants who reported greater fear of COVID-19 also had higher rates of parafunction, while those with less fear had lower rates of parafunction, or even absence of this disorder. The results of this research corroborate other findings described by recent studies on an axis created by fear of the COVID-19 pandemic, anxiety, depression, parafunction and painful symptoms related to TMD<sup>7,15,17,18,20,32,33</sup>.

Other associations were also observed in the assessments of the relationship between anxiety, depression and the presence of TMD pain (table 3) in this study. Thus, 71.5% of the participants who reported painful TMD symptoms had symptoms of anxiety and 52% of depression. This could be explained by the fact that psychological factors are capable of producing parafunctional oral habits which are associated with a lower pain threshold, affecting the sensitivity of the masticatory muscles<sup>18,33</sup>. The same could explain an association observed

between headache in the temporal region and the presence of anxiety and depression symptoms reported in this study. Therefore, as a TMD-related symptom, headache is associated with stressful, serious and frequent life events, which may be related to the presence of anxiety and depression<sup>34</sup>.

Based on the findings of this study and through the logistic regression models that were analyzed, a correlation was observed between the presence of symptoms of anxiety and depression with fear of COVID-19, in a bidirectional way (Tables 6, 7 and 8). Finally, it should be noted that the presence of intense or moderate COVID-19 fears was strongly related to the development of painful symptoms related to TMD (Table 9), reinforcing other findings during the pandemic period<sup>7,15,17,18,20,32,33</sup>.

The limitations of this study were related to the barriers established by social distancing in the COVID-19 pandemic. The possible bias in the selection of participants, through recruitment by institutional email, may have excluded students without access to the internet or a computer during the period. In addition, the adaptation of paper questionnaires to online format is also a concern raised by some studies<sup>35,36</sup>. It was therefore a concern of this study to use questionnaires adapted for the Brazilian Portuguese language and to maintain the greatest similarity when adapting them for the online format. Finally, by analyzing the answers given via HADS, it was possible to identify the participants' need for psychological support. If so, an e-mail was sent asking if the student felt they needed this support, along with a link to the university's Office of the Dean for Community and Student Affairs (*Pró-Reitoria de Assuntos Comunitários e Estudantis*). Based on the evaluation of the DC/TMD answers, it was possible to identify the possibility of TMD treatment. If so, the participant was referred for diagnosis and treatment in an extension project developed at the institution: "Occlusion and Temporomandibular Dysfunction".

## CONCLUSION

This study concluded that the presence of painful TMD symptoms was possibly influenced by fear of COVID-19. This, in turn, was related to the presence of anxiety and depression symptoms reported by the target population of this study.

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Statistical Analysis, Data Collection, Conceptualization, Project Management, Research, Methodology, Writing - Preparation of the Original, Writing - Review and Editing, Validation

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