

# Did Perceived Stress Influence Possible Sleep Bruxism and Awake Bruxism in Dentistry Students During COVID-19 Pandemic? A Web-Based Cross-Sectional Study

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Academic Editor: Alidianne Fábria Cabral Cavalcanti

Received: February 25, 2024 / Review: April 28, 2024 / Accepted: May 12, 2024

**How to cite:** Souza SLX, Cavalcanti AL. Did perceived stress influence possible sleep bruxism and awake bruxism in dentistry students during COVID-19 pandemic? A web-based cross-sectional study. *Pesqui Bras Odontopediatria Clín Integr.* 2024; 24:e240032. <https://doi.org/10.1590/pboci.2024.059>

## ABSTRACT

**Objective:** To assess the influence of perceived stress during the COVID-19 pandemic over awake bruxism (AB) and sleep bruxism (SB). **Material and Methods:** Observational web-based research carried out in a state in the Brazilian Northeast. The sample was composed of dental students from seven faculties, divided into three groups: beginning (1-4 semesters), middle (5-7), and end (8-10). An online questionnaire was constructed: Socio-demographic, Perceived Stress Scale (PSS-10), Self-reported AB and SB, and COVID-19 Fear Scale. Data were collected from April to June 2021 by sending the questionnaire through WhatsApp®, e-mail, and Instagram®. After bivariate analyses, a multiple logistic regression model was performed to discriminate variables for perceived stress and AB and SB. Hosmer and Lemeshow and chi-square tests were used to check the model's goodness of fit. **Results:** A total of 391 dental students participated in this research – most women (69.8%), unmarried (69.8%), family income less than three minimum wages (60.9%), self-reported physical activity (63.3%). Perceived stress was low to moderate (72.1%), SB was 39.6%, AB was 49.6%, and low COVID-19 fear was 81.1%. COVID-19 fear (3.03), being female (2.47), and using psychotropic (2.53) increases the chance of being stressed. Perceived stress can predict AB in models 1 (p=0.008) and 4 (p=0.039). There was no significance for perceived stress and SB. **Conclusion:** Perceived stress during the COVID-19 pandemic influenced awake bruxism.

**Keywords:** Tooth Diseases; Coronavirus Infections; Students, Dental; Stress, Psychological.

## Introduction

Stress is how the human body reacts to external changes, not just with a stimulus or a response, but a valid process by which environmental threats and challenges are dealt with, which can have a positive or negative meaning depending on the particular way of dealing with it [1]. It has become an exciting field of study because it has a significant social and financial impact and influences people's health and well-being [2].

The stressful nature of dental school starts early, passing through various stages of the course, from the beginning with theoretical studies until the practical lessons with patient care and, finally, the graduation with professional life perspectives [2,3]. Graduate students are usually in a transitional period between adolescence and adult life, full of need to achieve academic goals, a lot of learning to be memorized, and routine change, in addition to the requirement of good time management between studies and personal life, often resulting in higher levels of stress [4]. Dental students are perhaps even more affected in their immediate and distant future regarding various unlearned manual and cognitive skills [5].

One of the manifestations of stress is Bruxism, either sleep bruxism (SB) or awake bruxism (AB) [6,7], two different behaviors – SB is a masticatory muscle activity during sleep regulated by the central nervous center without necessarily having dental contact [7,8]. On the other hand, AB is a masticatory muscle activity performed when the individual is awake, characterized by repetitive or continuous contact of the teeth and/or moving it laterally or in propulsion [7,9].

In December 2019, the first contamination case by a new Coronavirus was confirmed in Wuhan, China: COVID-19, with symptoms such as acute respiratory infection, fever, muscle and headache, and loss of smell and taste. It has been proven highly infectious and quickly spread to other countries worldwide, leading the World Health Organization (WHO) to declare a pandemic on March 11, 2020 [10]. With the decree of social isolation in several countries, numerous sectors considered non-essential paralyzed their activities, including the educational sector, which suspended its face-to-face theoretical, laboratory, and clinical education, giving way to remote teaching [5,11-13].

Measures adopted by governments in many countries were aimed at controlling the spread of infection and seeking an efficient vaccine, often leaving aside all the psychological problems that the pandemic brought with it [14]. The pandemic had not only physical but also mental and well-being consequences for people, as it got with it a high load of stress to the daily routine, mainly due to the imposed need for social isolation – changes in habits and personal life routine, professional, social; concerns about the health system, vaccination, fear of death from COVID-19 [15].

Given this background, assessing the reciprocal influence of stress, sleep bruxism and awake bruxism in graduate students are essential to raising awareness and helping them to cope. Additionally, this could contribute to making wise decisions attempting to prevent and manage stress and bruxism while positively impacting academic performance and professional lives. Knowing the consequences brought about by the pandemic decreed by WHO due to the spread of COVID-19, especially in the educational sector with the suspension of classes, this study aimed to assess if the perceived stress during the COVID-19 pandemic influenced Bruxism in dentistry students. The hypothesis tested was that perceived stress could contribute to AB and SB.

## Material and Methods

The present study adheres to the STROBE (Strengthening the Reporting of Cross-Sectional Studies) statement [16].

### Ethical Considerations

The research was approved by the Ethics and Human Research Committee of the Universidade Estadual da Paraíba (Protocol 4.323.693), which endorses the Helsinki Declaration on ethical principles for medical research involving human subjects. Informed consent was obtained from all the participants.

### Study Design and Scenario

This is an observational, cross-sectional, and descriptive-analytical web-based research. The research questionnaire addresses sociodemographic characteristics, academic context, behavioral circumstances, perceived stress, self-reported awake and sleep bruxism, and COVID-19 fear. The web-based questionnaire was available for volunteers during the pandemic from April to June 2021.

The research was carried out in Paraíba, a state in the Brazilian Northeast region. The estimated population is 4,030,961 inhabitants and a population density of 66.70 inhabitants/km<sup>2</sup>. Its Human Development Index (HDI) is 0.658, with a monthly household per capita of R\$ 1,450.00 and a Gini index of 0.559. This socioeconomic scenario evidenced the sixth most unequal state in terms of income distribution in Brazil.

Paraíba has 16 faculties of Dentistry distributed in 15 different higher education institutions, of which 12 are private and four are public. The teaching-learning process in these institutions was based on a face-to-face format and probably suffered from the need for social isolation imputed by the COVID-19 pandemic. This circumstance forced the abrupt cessation of practical and clinical activities and restricted teaching and learning activities to online/remote resources.

### Sampling

Dentistry students from three private and four public institutions participated in this research. They were divided into three groups, considering the stage of the course: Beginning (1 to 4 semesters), Middle (5 to 7 semesters), and End (8 to 10 semesters). This division was because these groups were exposed to different expectations and circumstances.

Based on the effect size and absolute precision of the prevalence study, the sample size was calculated considering the study of Serra-Negra et al. [17], whose prevalence was found to be 21.5% for SB. In such mathematical conditions, the required sample size was 391 volunteers.

The sampling procedure began considering the use of the exponential non-discriminative snowball recruitment technique – the subsequent set to the indications of the first participants in the study is to request, from these nominees, information about other members of the population of interest to the research that, in turn, indicate new participants and so on via WhatsApp®. After initiating this process and exhausting sampling opportunities, the questionnaire was distributed by e-mail, and then by Instagram® using student lists provided by participating universities. To be eligible, students must be regularly enrolled in a public or private dental faculty, be over 18 years old, and must be attending classes.

### Research Instruments

A questionnaire was constructed with four different instruments:

- Instrument 1 – Questions regarding socio-demographic information, academic context, and behavioral circumstances: Age (years), sex (male, female), marital status (married, unmarried), family income (less than 3 Brazilian minimum wage, more than 3 Brazilian minimum wage), type of institution (public, private),

witch semester (beginning 1-4; middle 5-7; end 8-10), financial aid (no, yes), the practice of physical activity (no, yes), psychotropic use (no, yes), and name of the psychotropic (open answer).

- Instrument 2 – Perceived Stress Scale (PSS-10): Comprises a questionnaire with ten questions, translated and validated for university students [18]. The sum of the answers of 10 domains provides a scale that ranges from 0 to 40. The scale was classified into three categories: Low Stress: 0-13 points; Moderate Stress: 14-26 points; High Stress: 27-40 points. A dummy variable was created: low to moderate stress and high stress.
- Instrument 3 – Self-reported awake and sleep Bruxism: Comprises a questionnaire with six items assessing awake and sleep bruxism [3,7]. The answers were dichotomized, with "yes" and "no", considering that:
  - If "yes" to any of the first four questions, possible sleep bruxism was considered.
  - If "yes" to any of the last two questions, possible awake bruxism was considered.
- Instrument 4 – COVID-19 Fear Scale: The questionnaire was translated and validated for use in Brazil [19]. It consists of seven questions answered on the Likert-type scale, with response possibilities from 1 (strongly disagree) to 5 (totally agree). The scale ranged from 7 to 35 points and was divided into three categories: Low Fear: 7-19 points; Moderate Fear: 20-26 points; High Fear: > 27 points. A dummy variable was created: low COVID-19 fear and moderate to high COVID-19 fear.

#### Data Collection

Data were collected during the COVID-19 pandemic through an online questionnaire with four instruments, the informed consent form, the time to complete the questionnaire (five minutes), and a brief explanatory text of the research. This questionnaire was available on the Google Forms® platform (Google Inc., Menlo Park, CA, USA).

The researcher asked professors from the selected faculties to share the questionnaire link with their students via WhatsApp® (WhatsApp Inc., Mountain View, CA, USA) in April 2021 (twice, every fifteen days). The second attempt to contact the students was made by e-mailing students from public faculties with the link to the questionnaire in May 2021 (twice, every fifteen days). The last attempt at recruitment was made through Instagram® (Instagram Inc., Menlo Park, CA, USA) directly, with each student not yet participating in June 2021.

#### Statistical Analysis

Statistical analyses were carried out using the Statistical Package for Social Sciences (SPSS) software version 23.0 (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, New York, USA) and MedCalc for Windows, version 19.4 (MedCalc Software, Ostend, Belgium). Statistical analysis establishes 0.05 as the level of significance.

Dependent and independent variables were classified as dichotomous. The dependent variables were perceived stress, awake bruxism, sleep bruxism, and COVID-19 fear. The independent variables were sex, marital status, family income, type of institution, financial aid, physical activity, and psychotropic use.

The normality and homogeneity of continuous variables were tested using the Shapiro-Wilk and the Levine tests, respectively. Age was the unique continuous variable and did not follow the Gaussian distribution. This variable was expressed as median and interquartile ranges.

The Chi-squared test was used to assess group differences across the stage of the course for dependent and independent variables. The Spearman correlation test was used to investigate a possible correlation between perceived stress and awake bruxism, perceived stress and sleep bruxism, and awake bruxism and sleep bruxism.

The multiple logistic regression model was performed to discriminate explanatory variables for perceived stress in dentistry students and for awake and sleep bruxism. Three explanation models were made to verify the relative influence of each independent variable according to the stage of dental school: Model 1 (beginning of the course), Model 2 (middle of the course), Model 3 (end of the course), and Model 4 (all sample). Collinearity tests were used to detect redundant information among variables (all variables had a tolerance above 0.1, and the variance inflation factor was lower than 10). The models used the enter method and established the 5% significance level. Hosmer-Lemeshow and chi-square tests were used to check the model's goodness of fit. The models' predictive power and discriminatory ability were scored using the area under the curve (AUC) of the Receiver Operating Characteristic (ROC) curve.

## Results

A total of 391 dentistry students completed the questionnaires. Most of the students were women (69.8%), unmarried (69.8%), around 22 years old, and with family incomes below three minimum wages (60.9%). No significant differences were observed in marital status and sex among students at the beginning, middle, and end of the course. However, students' family income at the end of the course tends to be higher than the three minimum wages ( $p=0.000$ ). Of the sample, 42.0% attended private institutions, and most received financial aid to cover their college tuition (Table 1).

In terms of behavioral circumstances, self-reported physical activity was prominent (63.2%), whereas psychotropic use was less common (8.7%) (Table 1). The psychotropics commonly reported by students included anxiolytics, antidepressants, stimulants (Methylphenidate), mood stabilizers (Lithium carbonate), neuroleptics, anticonvulsants, and hypnotics.

**Table 1. Sociodemographic characteristics, academic context, and behavioral circumstances according to the stage of dental school.**

Variables	Stage of Dental School			p-value	Overall N (%)
	Beginning N (%)	Middle N (%)	End N (%)		
<b>Sociodemographic Characteristics</b>					
Sample Size	133 (34.0)	118 (30.2)	140 (35.8)		391 (100.0)
Age, yr – Median (IQR) <sup>κ</sup>	20 (3.0)	22 (2.0)	25 (3.0)	0.000 <sup>α</sup>	22 (4.0)
<b>Sex</b>					
Male	40 (30.1)	41 (34.7)	37 (26.4)	0.349 <sup>£</sup>	118 (30.2)
Female	93 (69.9)	77 (65.3)	103 (73.6)		273 (69.8)
<b>Marital Status</b>					
Unmarried	98 (73.7)	85 (72.0)	90 (64.3)	0.197 <sup>£</sup>	273 (69.8)
Married	35 (26.3)	33 (28.0)	50 (35.7)		118 (30.2)
<b>Income (Brazil)</b>					
< 3 Minimum Wage	95 (71.4)	81 (68.6)	62 (44.2)	0.000 <sup>£</sup>	238 (60.9)
> 3 Minimum Wage	38 (28.6)	37 (31.4)	78 (55.7)		153 (39.1)
<b>Academic Context</b>					
<b>Type of Institution</b>					
Public	88 (66.7)	59 (51.8)	77 (55.0)	0.040 <sup>£</sup>	224 (58.0)
Private	44 (33.3)	55 (48.2)	63 (45.0)		162 (42.0)

Financial Aid <sup>¶</sup>					
Yes	34 (77.3)	33 (60.0)	42 (66.7)	0.049 <sup>£</sup>	109 (67.3)
No	10 (22.7)	22 (40.0)	21 (33.3)		53 (32.7)
Behavioral Circumstances					
Physical Activity					
Yes	86 (64.7)	68 (57.6)	93 (66.4)	0.313 <sup>£</sup>	247 (63.2)
No	47 (35.3)	50 (42.4)	47 (33.6)		144 (36.8)
Psychotropic Use					
Yes	8 (6.8)	13 (11.0)	12 (8.6)	0.490 <sup>£</sup>	34 (8.7)
No	124 (93.2)	105 (89.0)	128 (91.4)		357 (91.3)

<sup>\*</sup>The age was expressed in the median and interquartile range (IQR) because of the non-Gaussian distribution of data; <sup>¶</sup>Financial aid considered only students who belong to private institutions; <sup>£</sup>p-value provided by Kruskal-Wallis test; <sup>£</sup>p-value provided by the Chi-Square test. The beginning of the course represents the 1 to 4 semesters, the middle of the course 5 to 7 semesters, and the end of the course 8 to 10 semesters.

The perceived stress was high in 27.9% of the sample, with no significant differences across the course stages. Self-reported awake and sleep bruxism has an overall prevalence of 49.4% and 39.6%, respectively. COVID-19 Fear was mostly low (81.1%). Awake bruxism was less frequent at the beginning of the course compared to the middle and the end of the course ( $p=0.007$ ) (Table 2).

**Table 2. Perceived stress, awake bruxism, sleep bruxism, and COVID-19 fear according to the stage of dental school.**

Variables	Stage of Dental School			p-value	Overall N (%)
	Beginning N (%)	Middle N (%)	End N (%)		
Perceived Stress					
Low to Moderate	89 (66.9)	88 (74.6)	105 (75.0)	0.256 <sup>£</sup>	282 (72.1)
High	44 (33.1)	30 (25.4)	35 (25.0)		109 (27.9)
Awake Bruxism					
Yes	51 (38.3)	66 (55.9)	76 (54.3)	0.007 <sup>£</sup>	193 (49.4)
No	82 (61.7)	52 (44.1)	64 (45.7)		198 (50.6)
Sleep Bruxism					
Yes	46 (34.6)	52 (44.1)	57 (40.7)	0.293 <sup>£</sup>	155 (39.6)
No	87 (65.4)	66 (55.9)	83 (59.3)		236 (60.4)
COVID-19 Fear					
Low	106 (79.7)	95 (80.5)	116 (82.8)	0.787 <sup>£</sup>	317 (81.1)
Moderate to High	27 (20.3)	23 (19.5)	24 (17.2)		74 (18.9)

<sup>£</sup>p-value provided by Chi-Square test; The beginning of the course represents the 1 to 4 semesters, the middle of the course 5 to 7 semesters, and the end of the course 8 to 10 semesters.

The bivariate analysis of perceived stress according to the stage of dental school is presented in Table 3. The perceived stress was influenced by sex ( $p=0.004$ ), marital status ( $p=0.030$ ), income ( $p=0.045$ ), and psychotropic use ( $p=0.013$ ) in the middle of dental school. At the beginning of dental school, only psychotropic use significantly affected the perceived stress ( $p=0.027$ ).

Table 4 provides the bivariate analysis of awake bruxism according to the stage of dental school. The type of institution showed a certain trend toward significance level ( $p=0.058$ ) at the beginning of the course. Marital status was relevant for the middle ( $p=0.025$ ), whereas sex was significant for the end of the course ( $p=0.019$ ).

The bivariate analysis of sleep bruxism according to the stage of dental school is shown on Table 5. Table 6 exhibits a bivariate analysis of COVID-19 fear according to the stage of dental school. However, no significant association can be proved.

**Table 3. Bivariate analysis of perceived stress according to the stage of dental school.**

Variables	Stage of Dental School								
	Beginning Perceived Stress			Middle Perceived Stress			End Perceived Stress		
	Low to Moderate N (%)	High N (%)	p-value	Low to Moderate N (%)	High N (%)	p-value	Low to Moderate N (%)	High N (%)	p-value
<b>Sociodemographic Characteristics</b>									
Age, yr – Median (IQR) <sup>κ</sup>	20 (3)	20 (3)	0.795 <sup>α</sup>	22 (2)	22 (2)	0.970 <sup>α</sup>	24 (3)	24 (2)	0.400 <sup>α</sup>
<b>Sex</b>									
Male	31 (34.8)	9 (20.5)	0.082 <sup>ℓ</sup>	37 (42.0)	4 (13.3)	0.004 <sup>ℓ</sup>	31 (29.5)	6 (17.1)	0.150 <sup>ℓ</sup>
Female	58 (65.2)	35 (79.5)		51 (58.0)	26 (86.7)		74 (70.5)	29 (82.9)	
<b>Marital Status</b>									
Unmarried	65 (73.0)	33 (75.0)	0.809 <sup>ℓ</sup>	68 (77.3)	17 (56.7)	0.030 <sup>ℓ</sup>	68 (64.8)	22 (62.9)	0.839 <sup>ℓ</sup>
Married	24 (27.0)	11 (25.0)		20 (22.7)	13 (43.3)		37 (35.2)	13 (37.1)	
<b>Income (Brazil)</b>									
< 3 Minimum Wage	62 (69.7)	33 (75.0)	0.521 <sup>ℓ</sup>	56 (63.6)	25 (83.3)	0.045 <sup>ℓ</sup>	49 (46.7)	13 (37.1)	0.326 <sup>ℓ</sup>
> 3 Minimum Wage	27 (30.3)	11 (25.0)		32 (36.4)	5 (16.7)		56 (53.3)	22 (62.9)	
<b>Academic Context</b>									
<b>Type of Institution</b>									
Public	56 (63.6)	32 (72.7)	0.296 <sup>ℓ</sup>	46 (53.5)	13 (46.4)	0.516 <sup>ℓ</sup>	56 (53.3)	21 (60.0)	0.492 <sup>ℓ</sup>
Private	32 (36.4)	12 (27.3)		40 (46.5)	15 (53.6)		49 (46.7)	14 (40.0)	
<b>Financial Aid<sup>η</sup></b>									
Yes	24 (75.0)	10 (83.3)	0.497 <sup>ℓ</sup>	26 (65.0)	7 (46.7)	0.358 <sup>ℓ</sup>	32 (65.3)	10 (71.4)	0.726 <sup>ℓ</sup>
No	8 (25.0)	2 (16.7)		14 (35.0)	8 (53.3)		17 (34.7)	4 (28.6)	
<b>Behavioral Circumstances</b>									
<b>Physical Activity</b>									
Yes	60 (67.4)	26 (59.1)	0.345 <sup>ℓ</sup>	35 (39.8)	15 (50.0)	0.328 <sup>ℓ</sup>	71 (67.6)	22 (62.9)	0.605
No	29 (32.6)	18 (40.9)		53 (60.2)	15 (50.0)		34 (32.4)	13 (37.1)	
<b>Psychotropic Use</b>									
Yes	3 (3.4)	6 (13.6)	0.027 <sup>ℓ</sup>	6 (6.8)	7 (23.3)	0.013 <sup>ℓ</sup>	9 (8.6)	3 (8.6)	1.000 <sup>ℓ</sup>
No	86 (96.6)	38 (86.4)		82 (93.2)	23 (76.7)		96 (91.4)	32 (91.4)	

<sup>κ</sup>The age was expressed in the median and interquartile range (IQR) because of the non-Gaussian distribution of data; <sup>η</sup>Financial aid considered only students who belong to private institutions; <sup>α</sup>p-value provided by Kruskal-Wallis test; <sup>ℓ</sup>p-value provided by the Chi-Square test; The beginning of the course represents the 1 to 4 semesters, the middle of the course 5 to 7 semesters, and the end of the course 8 to 10 semesters.

**Table 4. Bivariate analysis of awake bruxism according to the stage of dental school.**

Variables	Stage of Dental School								
	Beginning Awake Bruxism			Middle Awake Bruxism			End Awake Bruxism		
	No N (%)	Yes N (%)	p-value	No N (%)	Yes N (%)	p-value	No N (%)	Yes N (%)	p-value
<b>Sociodemographic Characteristics</b>									
Age, yr – Median (IQR) <sup>κ</sup>	20 (3)	20 (2)	0.132 <sup>α</sup>	21 (2)	22 (2)	0.672 <sup>α</sup>	24 (3)	24 (4)	0.689 <sup>α</sup>
<b>Sex</b>									
Male	24 (29.3)	16 (31.4)	0.797 <sup>£</sup>	14 (35.0)	27 (34.6)	0.967 <sup>£</sup>	23 (35.9)	14 (18.4)	0.019 <sup>£</sup>
Female	58 (70.7)	35 (68.6)		26 (65.0)	51 (65.4)		41 (64.1)	62 (81.6)	
<b>Marital Status</b>									
Unmarried	60 (73.2)	38 (74.5)	0.865 <sup>£</sup>	34 (85.0)	51 (65.4)	0.025 <sup>£</sup>	42 (65.6)	48 (63.2)	0.762 <sup>£</sup>
Married	22 (26.8)	13 (25.5)		6 (15.0)	27 (34.6)		22 (34.4)	28 (36.8)	
<b>Income (Brazil)</b>									
< 3 Minimum Wage	60 (73.2)	35 (68.6)	0.573 <sup>£</sup>	30 (75.0)	51 (65.4)	0.287 <sup>£</sup>	24 (37.5)	38 (50.0)	0.138 <sup>£</sup>
> 4 Minimum Wage	22 (26.8)	16 (31.4)		10 (25.0)	27 (34.6)		40 (62.5)	38 (50.0)	
<b>Academic Context</b>									
<b>Type of Institution</b>									
Public	49 (60.5)	39 (76.5)	0.058 <sup>£</sup>	21 (55.3)	38 (50.0)	0.596 <sup>£</sup>	39 (60.9)	38 (50.0)	0.195 <sup>£</sup>
Private	32 (39.5)	12 (23.5)		17 (44.7)	38 (50.0)		25 (39.1)	38 (50.0)	
<b>Financial Aid<sup>η</sup></b>									
Yes	25 (79.8)	9 (75.0)	0.162 <sup>£</sup>	10 (58.8)	23 (60.5)	0.863 <sup>£</sup>	15 (60.0)	27 (71.1)	0.290 <sup>£</sup>
No	7 (21.2)	3 (25.0)		7 (41.2)	15 (39.5)		10 (40.0)	11 (28.9)	
<b>Behavioral Circumstances</b>									
<b>Physical Activity</b>									
Yes	54 (65.9)	32 (62.7)	0.715 <sup>£</sup>	24 (60.0)	44 (56.4)	0.709 <sup>£</sup>	47 (73.4)	46 (60.5)	0.107 <sup>£</sup>
No	28 (34.1)	19 (37.3)		16 (40.0)	34 (43.6)		17 (26.6)	30 (39.5)	
<b>Psychotropic Use</b>									
Yes	6 (7.3)	3 (5.9)	0.749 <sup>£</sup>	5 (12.5)	8 (10.3)	0.713 <sup>£</sup>	4 (6.2)	8 (10.5)	0.368 <sup>£</sup>
No	76 (92.7)	48 (94.1)		35 (87.5)	70 (89.7)		60 (93.8)	68 (89.5)	

<sup>κ</sup>The age was expressed in the median and interquartile range (IQR) because of the non-Gaussian distribution of data; <sup>η</sup>Financial aid considered only students who belong to private institutions; <sup>α</sup>p-value provided by Kruskal-Wallis test; <sup>£</sup>p-value provided by the Chi-Square test; The beginning of the course represents the 1 to 4 semesters, the middle of the course 5 to 7 semesters, and the end of the course 8 to 10 semesters.



**Table 5. Bivariate analysis of sleep bruxism according to the stage of dental school.**

Variables	Stage of Dental School								
	Beginning Sleep Bruxism			Middle Sleep Bruxism			End Sleep Bruxism		
	No N (%)	Yes N (%)	p-value	No N (%)	Yes N (%)	p-value	No N (%)	Yes N (%)	p-value
<b>Sociodemographic Characteristics</b>									
Age, yr – Median (IQR) <sup>κ</sup>	20 (3)	20 (2)	0.853 <sup>α</sup>	21.5 (2)	22 (2)	0.927 <sup>α</sup>	24 (3)	24 (3)	0.089 <sup>α</sup>
<b>Sex</b>									
Male	31 (35.6)	9 (19.6)	0.055 <sup>ℓ</sup>	24 (36.4)	17 (32.7)	0.678 <sup>ℓ</sup>	26 (31.3)	11 (19.3)	0.113 <sup>ℓ</sup>
Female	56 (64.4)	37 (80.4)		42 (63.6)	35 (67.3)		57 (68.7)	46 (80.7)	
<b>Marital Status</b>									
Unmarried	63 (72.4)	35 (76.1)	0.685 <sup>ℓ</sup>	50 (75.8)	35 (67.3)	0.310 <sup>ℓ</sup>	48 (57.8)	42 (73.7)	0.054 <sup>ℓ</sup>
Married	24 (27.6)	11 (23.9)		16 (24.2)	17 (32.7)		35 (42.2)	15 (26.3)	
<b>Income (Brazil)</b>									
< 3 Minimum Wage	63 (72.4)	32 (69.6)	0.729 <sup>ℓ</sup>	49 (74.2)	32 (61.5)	0.140 <sup>ℓ</sup>	38 (45.8)	24 (42.1)	0.667 <sup>ℓ</sup>
> 4 Minimum Wage	24 (27.6)	14 (30.4)		17 (25.8)	20 (38.5)		45 (54.2)	33 (57.9)	
<b>Academic Context</b>									
<b>Type of Institution</b>									
Public	54 (62.8)	34 (73.9)	0.196 <sup>ℓ</sup>	34 (53.1)	25 (50.0)	0.740 <sup>ℓ</sup>	44 (53.0)	33 (57.9)	0.568 <sup>ℓ</sup>
Private	32 (37.2)	12 (26.1)		30 (46.9)	25 (50.0)		39 (47.0)	24 (42.1)	
<b>Financial Aid<sup>η</sup></b>									
Yes	26 (81.2)	8 (66.7)	0.274 <sup>ℓ</sup>	17 (56.7)	16 (64.0)	0.812 <sup>ℓ</sup>	29 (74.4)	13 (54.2)	0.224 <sup>ℓ</sup>
No	6 (18.8)	4 (33.3)		13 (43.3)	9 (36.0)		10 (25.6)	11 (45.8)	
<b>Behavioral Circumstances</b>									
<b>Physical Activity</b>									
Yes	57 (65.5)	29 (63.0)	0.777 <sup>ℓ</sup>	28 (42.4)	22 (42.3)	0.990 <sup>ℓ</sup>	58 (69.9)	35 (61.4)	0.297
No	30 (34.5)	17 (37.0)		38 (57.6)	30 (57.7)		25 (30.1)	22 (38.6)	
<b>Psychotropic Use</b>									
Yes	6 (6.9)	3 (6.5)	0.935 <sup>ℓ</sup>	7 (10.6)	6 (11.5)	0.872 <sup>ℓ</sup>	4 (4.8)	8 (14.0)	0.056 <sup>ℓ</sup>
No	81 (93.1)	43 (93.5)		59 (89.4)	46 (88.5)		79 (95.2)	49 (86.0)	

<sup>κ</sup>The age was expressed in the median and interquartile range (IQR) because of the non-Gaussian distribution of data; <sup>η</sup>Financial aid considered only students who belong to private institutions; <sup>α</sup>p-value provided by Kruskal-Wallis test; <sup>ℓ</sup>p-value provided by the Chi-Square test; The beginning of the course represents the 1 to 4 semesters, the middle of the course 5 to 7 semesters, and the end of the course 8 to 10 semesters.

**Table 6. Bivariate analysis of COVID-19 fear according to the stage of dental school.**

Variables	Stage of Dental School								
	Beginning COVID-19			Middle COVID-19			End COVID-19		
	Low N (%)	Moderate to High N (%)	p-value	Low N (%)	Moderate to High N (%)	p-value	Low N (%)	Moderate to High N (%)	p-value
<b>Sociodemographic Characteristics</b>									
Age, yr – Median (IQR) <sup>κ</sup>	20 (3)	20 (3)	0.878 <sup>α</sup>	22 (2)	21 (3)	0.814 <sup>α</sup>	24 (2)	24 (4)	0.853 <sup>α</sup>
<b>Sex</b>									
Male	34 (32.1)	6 (22.2)	0.319 <sup>£</sup>	35 (36.8)	6 (26.1)	0.331 <sup>£</sup>	33 (28.4)	4 (16.7)	0.233 <sup>£</sup>
Female	72 (67.9)	21 (77.8)		60 (63.2)	17 (73.9)		83 (71.6)	20 (83.3)	
<b>Marital Status</b>									
Unmarried	77 (72.6)	21 (77.8)	0.588 <sup>£</sup>	71 (74.7)	14 (60.9)	0.184 <sup>£</sup>	76 (65.5)	14 (58.3)	0.504 <sup>£</sup>
Married	29 (27.4)	6 (22.2)		24 (25.3)	9 (39.1)		40 (34.5)	10 (41.7)	
<b>Income (Brazil)</b>									
< 3 Minimum Wage	73 (68.9)	22 (81.5)	0.195 <sup>£</sup>	65 (68.4)	16 (69.6)	0.915 <sup>£</sup>	50 (43.1)	12 (50.0)	0.536 <sup>£</sup>
> 4 Minimum Wage	33 (31.1)	5 (18.5)		30 (31.6)	7 (30.4)		66 (56.9)	12 (50.0)	
<b>Academic Context</b>									
<b>Type of Institution</b>									
Public	69 (65.7)	19 (70.4)	0.647 <sup>£</sup>	51 (54.8)	8 (38.1)	0.165 <sup>£</sup>	65 (56.0)	12 (50.0)	0.589 <sup>£</sup>
Private	36 (34.3)	8 (29.6)		42 (45.2)	13 (61.9)		51 (44.0)	12 (50.0)	
<b>Financial Aid<sup>η</sup></b>									
Yes	27 (75.0)	7 (87.5)	0.690 <sup>£</sup>	25 (60.5)	8 (61.5)	0.378 <sup>£</sup>	31 (60.8)	11 (91.7)	0.090 <sup>£</sup>
No	9 (25.0)	1 (12.5)		17 (40.5)	5 (38.5)		20 (39.2)	1 (8.3)	
<b>Behavioral Circumstances</b>									
<b>Physical Activity</b>									
Yes	70 (66.0)	16 (59.3)	0.511 <sup>£</sup>	54 (56.8)	14 (60.9)	0.726 <sup>£</sup>	75 (64.7)	18 (75.0)	0.329
No	36 (34.0)	11 (40.7)		41 (43.2)	9 (39.1)		41 (35.3)	6 (25.0)	
<b>Psychotropic Use</b>									
Yes	6 (5.7)	3 (11.1)	0.314 <sup>£</sup>	11 (11.6)	2 (8.7)	0.692 <sup>£</sup>	8 (6.9)	4 (16.7)	0.126 <sup>£</sup>
No	100 (94.3)	24 (88.9)		84 (88.4)	21 (91.3)		108 (93.1)	20 (83.3)	

<sup>κ</sup>The age was expressed in the median and interquartile range (IQR) because of the non-Gaussian distribution of data; <sup>η</sup>Financial aid considered only students who belong to private institutions; <sup>α</sup>p-value provided by Kruskal-Wallis test; <sup>£</sup>p-value provided by the Chi-Square test; The beginning of the course represents the 1 to 4 semesters, the middle of the course 5 to 7 semesters, and the end of the course 8 to 10 semesters.

The multiple logistic regression models for explaining perceived stress in dentistry students is summarized in Table 7. Overall statistics (Chi-square test) and the Hosmer-Lemeshow test demonstrate the goodness of fit of the four proposed models. In Models 1 (Beginning of the course) and 3 (End of the course), only COVID-19 fear

could explain the perceived stress. As a predictor, COVID-19 fear was responsible for 5.61 and 3.40 times increase in the chance of being stressed at the beginning and final of the course, respectively. In Model 2, being female and using psychotropics increased the likelihood of feeling stressed, whereas a high-income level (more than three minimum wages) was a protective factor. The chance of feeling stressed is reduced by 68% if the student has a family income higher than three minimum wages in Model 2. Model 4 summarizes that being female, using psychotropics, and having moderate to high COVID-19 fear explain the perceived stress in dentistry students.

**Table 7. Multiple logistic regression models for perceived stress in dentistry students.**

Variables (Reference)	Model 1 (Beginning)			Model 2 (Middle)			Model 3 (End)			Model 4 (Overall)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Sex (Female)	1.91	(0.76-4.80)	0.168	5.71	(1.63-20.0)	0.006	2.09	(0.75-5.81)	0.158	2.47	(1.39-4.39)	0.002
Income (More than 3 MW)	0.89	(0.36-2.23)	0.811	0.32	(0.09-0.87)	0.032	1.73	(0.74-4.02)	0.202	0.84	(0.51-1.36)	0.475
Type of Institution (Private)	0.63	(0.25-1.55)	0.312	1.04	(0.39-2.77)	0.935	0.72	(0.31-1.65)	0.433	0.68	(0.41-1.12)	0.125
Physical Activity (Yes)	0.96	(0.41-2.23)	0.923	0.52	(0.20-1.39)	0.195	0.77	(0.32-1.80)	0.544	0.74	(0.45-1.19)	0.214
Psychotropic Use (Yes)	4.33	(0.90-20.9)	0.071	6.91	(1.63-29.17)	0.009	0.92	(0.22-3.90)	0.912	2.53	(1.18-5.43)	0.017
COVID-19 Fear (Moderate-High)	5.61	(2.18-14.4)	0.000	1.36	(0.42-4.35)	0.609	3.40	(1.29-8.94)	0.013	3.03	(1.75-5.25)	0.000
<b>Statistics</b>												
Overall Statistics	23.02 (0.001)			22.17 (0.001)			10.72 (0.040)			38.45 (0.000)		
Hosmer–Lemeshow test	0.141			0.794			0.424			0.354		
Nagelkerke R Square	0.222			0.263			0.109			0.137		

Model 1 represents students at the beginning of the course (1 to 4 semesters; n=133), Model 2 represents students in the Middle of the course (5 to 7 semesters; n=118), Model 3 represents students at the End of the course (8 to 10 semesters; n=140), and Model 4 represents the overall sample of students (N=391). MW represents Minimum wage. The logistic regression model considered the Presence of Perceived Stress as the reference variable. The constant was included in the equation but suppressed in the table representation. Residuals were normally distributed. No case of residual outliers was found considering the established  $\pm 1.5$  standard deviation. Explanatory variables have no multicollinearity (tested by the Tolerance and Variation Inflation Factor).

The discriminatory ability to predict or explain the perceived stress in Table 7 was proven in Figure 1. Specifically, the area under the curve (AUC) and 95% confidence interval higher than 0.50 in the Models indicate that logistic regressions correctly classify positive and negative cases.

Table 8 shows that perceived stress can predict awake bruxism in Models 1 and 4. Despite the appropriate goodness of fit of these Models, the explicative power (evidenced by the Nagelkerke R Squared) and low 95% confidence intervals of AUC in the ROC analysis demand caution in the interpretation of data. In the scenario proposed in this research, perceived stress did not influence sleep bruxism.

A significant correlation between sleep and awake bruxism in all proposed models is demonstrated in Table 9. An AUC higher than 0.5 validates the model regarding the class separation capacity.

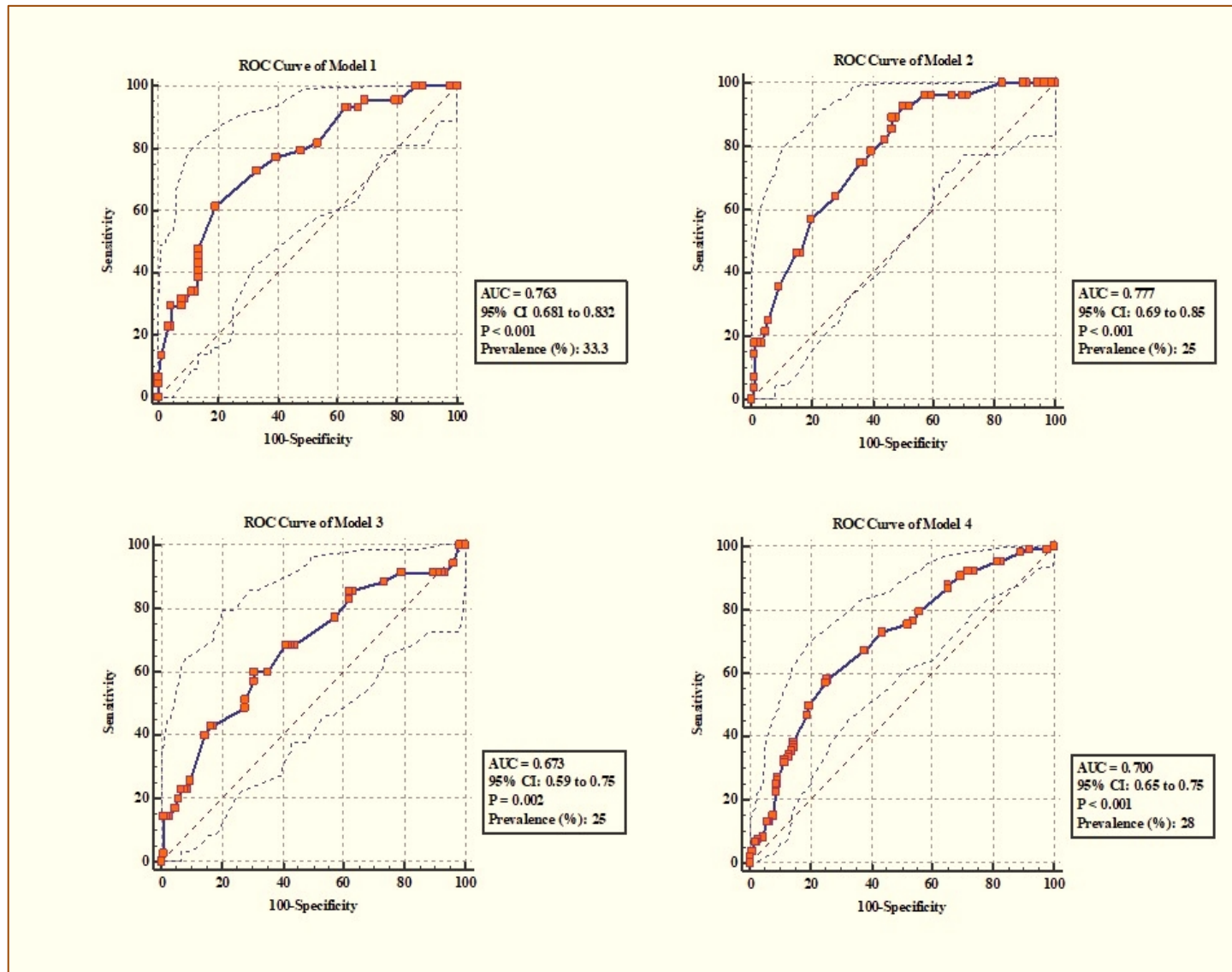


Figure 1. Discriminatory power of the proposed models for perceived stress in dentistry students.

**Table 8. Logistic regression models for correlates awake and sleep bruxism with perceived stress in dentistry students.**

	Variables	Model 1 (Beginning)			Model 2 (Middle)			Model 3 (End)			Model 4 (Overall)		
		OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Awake Bruxism	Perceived Stress	2.76	(1.31-5.81)	0.008	1.51	(0.54-3.53)	0.346	1.16	(0.54-2.52)	0.695	1.60	(1.03-2.50)	0.039
	Statistics												
	Overall Statistics	7.214 (0.007)			0.904 (0.342)			0.154 (0.695)			4.316 (0.038)		
	Nagelkerke R Square	0.072			0.01			0.001			0.02		
	ROC Analysis AUC (95% CI)	0.61 (0.51-0.71)			0.50 (0.40-0.61)			0.50 (0.40-0.60)			0.55 (0.50-0.61)		
Sleep Bruxism	Perceived Stress	2.02	(0.96-4.27)	0.066	0.80	(0.34-1.86)	0.604	1.32	(0.61-2.85)	0.488	1.29	(0.82-2.02)	0.270
	Statistics												
	Overall Statistics	3.376 (0.066)			0.271 (0.602)			0.480 (0.488)			1.212 (0.27)		
	Nagelkerke R Square	0.035			0.03			0.005			0.004		
	ROC Analysis AUC (95% CI)	0.61 (0.51-0.71)			0.50 (0.40-0.61)			0.50 (0.40-0.60)			0.50 (0.44-0.56)		

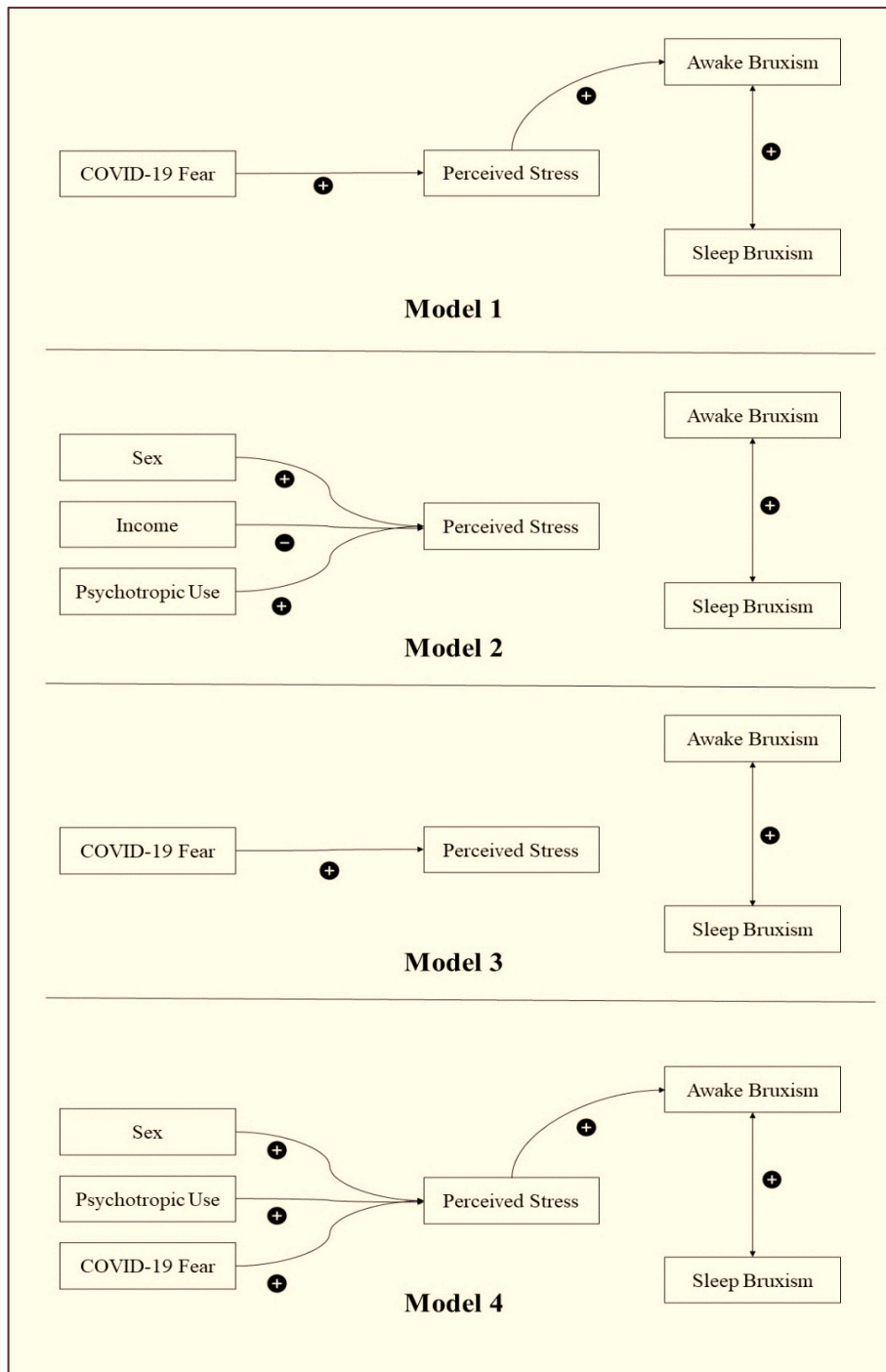
Model 1 represents students at the beginning of the course (1 to 4 semesters; n=133). Model 2 represents students in the Middle of the course (5 to 7 semesters; n=118), Model 3 represents students at the End of the course (8 to 10 semesters; n=140), and Model 4 represents the overall sample of students (N=391). The logistic regression model considered the Presence of Awake Bruxism and Sleep Bruxism as the reference variable. The constant was included in the equation but suppressed in the table representation. Residuals were normally distributed. No case of residual outliers was found considering the established ±1.5 standard deviation. Explanatory variables have no multicollinearity (tested by the Tolerance and Variation Inflation Factor).

**Table 9. Logistic regression models for correlates awake and sleep bruxism.**

	Variable	Model 1 (Beginning)			Model 2 (Middle)			Model 3 (End)			Model 4 (Overall)		
		OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Awake Bruxism	Sleep Bruxism	0.268	(0.13-0.57)	0.001	0.195	(0.09-0.44)	<0.001	0.159	(0.07-0.35)	<0.001	0.201	(0.13-0.31)	<0.001
	Statistics												
	Overall Statistics	12.227 (0.000)			17.234 (0.000)			24.690 (0.000)			55.356 (0.000)		
	Nagelkerke R Square	0.121			0.182			0.218			0.179		
	ROC Analysis AUC (95% CI)	0.65 (0.55-0.75)			0.69 (0.59-0.78)			0.70 (0.62-0.79)			0.68 (0.63-0.74)		

Model 1 represents students at the beginning of the course (1 to 4 semesters; n=133). Model 2 represents students in the Middle of the course (5 to 7 semesters; n=118), Model 3 represents students at the End of the course (8 to 10 semesters; n=140), and Model 4 represents the overall sample of students (N=391). The logistic regression model considered the Presence of Awake Bruxism as the reference variable. The constant was included in the equation but suppressed in the table representation. Residuals were normally distributed. No case of residual outliers was found considering the established ±1.5 standard deviation. Explanatory variables have no multicollinearity (tested by the Tolerance and Variation Inflation Factor).

Figure 2 summarizes the theoretical conclusions that arise from this research. Overall, variables such as sex, psychotropic use, and COVID-19 fear can influence perceived stress, thereby increasing the chance of having awake bruxism. A relationship exists between self-reported awake and sleep bruxism, but the casual path cannot be inferred.



Model 1 represents students at the beginning of the course (n=133). Model 2 represents students in the Middle of the course (n=118), Model 3 represents students at the End of the course (n=140), and Model 4 represents the overall sample of students (N=391).

**Figure 2. Theoretical model of undergraduate students feeling stressed and with bruxism.**

## Discussion

Overarching principles of sleep and awake bruxism figure the stress as the primary source of their incidence and severity, especially in individuals with lower coping skills [20]. During the pandemic, it was clear that several social aspects of daily life were modified drastically, imposing an overwhelming scenario of stress [2,15,21]. Considering the traditional path of sleep and awake bruxism seems reasonable to hypothesize that the peculiarity of stress events during COVID-19 can be a contributory factor for bruxism events. Until now, there

is still a lack of data about this question. To overcome this scientific gap, our study's new and most exciting finding demonstrates that perceived stress can contribute to Awake Bruxism (AB) and Sleep Bruxism (SB) in dentistry students.

The COVID-19 pandemic implemented new academic circumstances, especially in dentistry, changing study protocols and implementing an online period of classes, leaving a shortage of experience in laboratory and clinical practices. Thus, dentistry students represent a proper population to assess the influence of the COVID-19 pandemic when considering perceived stress and its possible associations with AB and SB [1]. Furthermore, this population was divided into groups that could represent stages of dental school with their specific challenges and circumstances. The beginning (1 to 4 semesters) represents the phase of expectations regarding the newness of life transition from adolescence to adulthood. The middle (5 to 7 semesters) is when clinical practice usually begins with the first contact with patients. The end (8 to 10 semesters) is when they complete the graduation cycle and professional life begins [17].

The sample was collected from seven different Dentistry faculties in a state in Northeast Brazil, a region known for its educational profile that draws students from various places. The state had, during the collected data months of April to June 2021, 2.816 COVID-19 deaths (0.070% of its population) and 36.535 positive cases (0.91% of its population). Despite data collection limitations enforced by the pandemic, evidence demonstrates that data originating from paper-and-pencil and computerized survey models are equivalent [22]. Moreover, self-reported assessment of possible AB and SB is still the primary tool in bruxism research and clinical practice [8], mainly if associated with some psychological conditions, such as stress, since it has validated methods of measurement [7].

The academic environment generates stress due to the changing routine and the growing demand for study, especially in dental school, where aspects of dealing with patients and other essential skills are needed [2]. In our research, a gradual increase in perceived stress was observed during dental school, confirming the findings of Gorter et al. [23]. This can be explained by the increase in demands during the course, the passage of an exclusively theoretical basis for a laboratory beginning and practice with patients until the end of the course and the need to deal with the uncertainty of the future market. Allied to this gradual increase, there was a total prevalence of low to moderate stress of 72.1%, especially at this time, undoubtedly due to all the problems that involved teaching dentistry students regarding the COVID-19 pandemic and its challenges to return to academic activities safely [24,25].

Creating a dummy variable in the perceived stress resulted in low to moderate and high stress. The decision to merge low and moderate stress was related to the lack of enough cases with low stress, which could negatively influence the robustness of the model. Besides, this finding shows that in our study's reality, students have higher stress levels when compared with other realities [2,15]. The same though resulted in the creation of a dummy variable in the COVID-19 fear of moderate to high fear.

The prevalence of self-reported bruxism has increased over the years in dentistry students, as Granada and Hicks [26] showed in their study between 1966 and 2002 – from 5.1% to 22.6%. Our study showed a prevalence of AB of 49.4% and SB of 39.6%, both high, even if compared to more recent prevalence studies [6,13,21]. Notably, stress plays an essential role in the manifestation of bruxism, which can be observed in our research at the beginning of the course, where stress, through multivariate analysis, has a significant influence over AB. It can be hypothesized that the beginning of the course requires a period of adaptation to a new social context and life demands, adjusting to a new group of friends, and sometimes being away from the family [24]. Also, in the beginning, dentistry students do not have the same information about dentistry issues as students

at the middle and end of the course, resembling non-specialist people [1]. Although, at the beginning of the course, there was still no concern about the interruption of clinical activities due to the COVID-19 pandemic, there may have been stress-generating factors due to the difficulty of internet connectivity to attend online classes and adapting to the new online assessment format [11].

In this research, perceived stress did not influenced SB, supporting the idea that SB and AB can have different etiologies [27]. Indeed, Dal Fabbro and Lavigne [8] shows how sleep-related breathing disorders can play a role to SB. On the other hand, it has been demonstrated that the presence of AB and SB is frequent, and that SB may increase the odds for AB and vice versa [17], as we found.

The multiple logistic regression was the statistical model that better fits our investigation because it can provide a broader perspective about what variable truly influences the primary outcome, perceived stress. The statistics summary at the bottom of Table 7 proves the reliability of each model, which can be demonstrated by a Hosmer-Lemeshow p-value above 0.05 and an overall statistics p-value lower than 0.05. The validation of each model (1 through 4) can be established by the high discriminatory power of the ROC curve, with AUC higher than 0.673 and a p-value lower than 0.002.

Regarding sex, we observed that women had 2.47 times the chance to be more stressed than men. Women are more stressed because they are more open to answering questions about themselves and showing their vulnerabilities [11]. Both have different ways of reacting to stress: women usually internalize, and men externalize their reactions [12]. This statistical difference can also be explained by the fact that more women than men participated in our research (273 versus 118). Moreover, women might have increased their domestic workload daily, which changed their routine during the COVID-19 pandemic [13].

Changes and challenges imposed by the pandemic on the teaching of dentistry have certainly impacted students' mental health and increased the use of psychotropic substances, often self-medicating [15,28]. We found an increase of 2.53 times in the chance of being stressed in dental students who used psychotropics, denoting the suffering with the necessary adaptation on the continuity of the educational process, learning with online classes, and loss of laboratory practices and clinics [25].

Overall, COVID-19 fear increased 3.03 times the chance of perceived stress in dentistry students. After the pandemic was established, dental schools in Brazil stopped their activities. Even with the best efforts and intentions of the faculties that tried to return their classes and practices as soon as they could understand and address the safety requirements, dentistry students could not go forward in their graduation without hands-on practice, which meant that curricular activities had to be postponed or reorganized [11]. This uncertainty probably led to high levels of stress. Also, gaining practical skills seemed to be the reason for great concern among dental students once only theoretical classes moved online [5,29].



The major limitation of this work was that it was carried out in a particular population, and the results may not be reliable to extrapolate to the general population. The study's cross-sectional design does not allow the researcher to follow up on the results in different pandemic stages. Also, the prevalence of SB and AB should be interpreted with caution because of the variety of criteria, diagnosis methods, and population among studies.

## Conclusion

The COVID-19 pandemic resulted in changes in the lives of dental students for some time. A new study routine had to be adopted, and the possibility of delay in graduation and uncertainty in the future increased stress levels, which led stress to have an influence of increase the occurrence of awake bruxism. Preventive measures should be adopted to minimize the long-lasting consequences of the pandemic.



## Authors' Contributions

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ALC		<a href="https://orcid.org/0000-0003-3572-3332">https://orcid.org/0000-0003-3572-3332</a>	Conceptualization, Methodology, Formal Analysis, Data Curation, Writing - Review and Editing, Supervision and Project Administration.
All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.			

## Financial Support

National Council for Scientific and Technological Development (CNPq) – Research Productivity Scholarship (Process Number 306774/2022-4).

## Conflict of Interest

The authors declare no conflicts of interest.

## Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

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