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Manifestation of stress and anxiety in the stomatognathic system of undergraduate dentistry students

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Abstract

Objective: To assess the relationship between psychoemotional state and signs of oral cavity occlusal and nonocclusal parafunctions, together with masseter muscle tone, in undergraduate dentistry students.

Methods: The study population comprised first and fifth grade dentistry students who were investigated using psychological and health questionnaires, and stomatological examination with electromyography of the masseter muscles. Differences in variables between first and fifth grade students were analysed using Student's *t*-test or χ^2-test and Pearson's correlation coefficient was used to analyse associations between variables.

Results: A total of 113 students (52 first-grade, mean age 20 years; and 61 fifth-grade, mean age 23.6 years) were included. Older age was associated with lower level of perceived stress and anxiety. Moreover, a significant positive relationship was observed between level of perceived stress and anxiety and tone of both masseter muscles.

Conclusions: Increased psychoemotional burden and increased rates of experienced anxiety were associated with growth of masseter muscle tone in this study population.

Keywords

Stress, anxiety, temporomandibular disorder (TMD), electromyography, masseter muscle, dental students

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Introduction

According to Lazarus and Folkman, the definition of stress is 'a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being'.[1] Whereas Spielberger described anxiety as a transient condition, caused by a particular situation of a given individual, characterized by feeling of concern and tension, interacting with the activation of the autonomic nervous system.[2]

Among the medical professions, dentistry is suggested to be the most stressful.[3] Psychoemotional factors have been well proven to play a significant, causative role in the development of many so called civilization diseases, such as high blood pressure, heart disease, diabetes mellitus and temporomandibular disorder (TMD).[4–9] According to the World Health Organization, temporomandibular disorders are the third most common reason, after caries and paradontopathy, for referral to a dental office.[10]

Temporomandibular disorder is on the rise among the populations of industrialized countries,[8,11] and numerous factors play a causative role in the aetiology of TMD. The effects of 'civilizational stress' (the stressful conditions of life), are understood to manifest in the development of certain oral parafunctions, such as teeth grinding, bruxism or cheek biting.[4] Eventually, all of those parafunctional activities may cause increased masticatory muscle tone and promote its intensification, which induces an escalation in TMD symptoms, including face muscular pain, headaches, and temporomandibular joint movement disorder or crackling. Furthermore, increased tone of the masseter muscle itself is one of the symptoms of TMD.[4,9]

Student populations are being placed under a greater level of stressful situations than the average representative of society, with the most common stressors including: coping with exams and grading, limited free time, long teaching hours, high workload and high competitivity. Numerous research studies have shown that levels of stress among dental students are significantly higher than in students from different disciplines, not only medical.[6,11–18]

The aim of the present study was to assess the relationship between the psychoemotional state of dental students and manifestations of occlusal and nonocclusal parafunctions in the oral cavity tissues, together with the tone of the masseter muscles. The study was performed using specific stages of investigation: assessment of the psychoemotional state of the subjects; clinical evaluation of the presence of parafunctional symptoms in the oral cavity; examination of the masseter muscle tone; and assessment of relationships between the examined parameters.

Subjects and methods

Study population

This observational study comprised a population of first grade and fifth grade (last year of study in the Polish education program) dentistry student volunteers from the Department of Dentistry, Wroclaw Medical University, Poland, and was conducted during October and November 2017. Students with a beard were excluded from study entry. The study was approved by Wroclaw Medical University Bioethical Commission, and verbal informed consent to take part in the study was provided by all of the participants. Data were obtained via questionnaires and clinical examination, and were statistically analysed for between-group differences and correlations.

Psychoemotional assessment

The psychoemotional state of each student was assessed using a questionnaire composed of two parts. The first part of the survey comprised two psychological instruments: The Perceived Stress Scale (PSS)-10 by Cohen, Kamarch and Mermelstein[19] and the Hospital Anxiety and Depression Scale (HADS) by Zigmond and Snaith.[20]

The PSS-10 is a self-reported questionnaire to measure the level of psychological stress, and is widely used to evaluate the subjective stressfulness of situations and the effectiveness of stress-reducing actions. The Polish 10-item version of the shortened 10-item PSS-10 questionnaire was used in the present study.[21] The scale comprises 10 questions scored from 0 (never) to 4 (very often), with a maximum number of 40 points and a minimum of 0. Points are assigned to three groups: low, 0–13 points; medium, 14–19 points; and high, 20–40 points, with higher scores representing higher stress levels. The PSS-10 has been shown to predict objective biological markers of stress and an increased risk for disease among people with higher perceived stress levels.[19,21] According to published meta-analyses of studies of stress among dental students, the PSS was used to assess psychological aspects of stress in about 20.5% of all the studies.[13–15]

The HADS is commonly used by clinicians to determine levels of anxiety and depression in non-psychiatric patients and healthy adults, and is widely used as a screening test for mood and anxiety disorders.[22] The HADS has a good reliability and validity confirmed in many studies.[22] The HADS questionnaire comprises 14 items, half of which relate to anxiety (HADS-A) and half to depression (HADS-D). Responses are ranked from 0 to 3, so that results for either subscale (anxiety or depression) vary from 0 to 21 points. Scored points divide respondents into three groups: normal, 0–7 points; borderline abnormal, 8–10 points; and abnormal, 11–21 points.[20,23] In the present study, students were evaluated using the HADS-A subscale only.

In the second part of the survey, students were questioned about demographic data and subjective complaints concerning their stomatognathic system, namely, perceived temporomandibular joint pain, bruxism and teeth grinding, and increased tension of the masticatory muscles.

Clinical evaluation

Each participant underwent an intraoral investigation to evaluate the presence (or lack) of occlusal and nonocclusal parafunction symptoms observed in hard and soft oral cavity tissues, such as tooth wear, gingival recessions, tongue crenations and linea alba or signs of cheek biting (uni- or bilateral).

Tooth wear is described in the literature as clearly demarcated, shiny surfaces on the occlusal surfaces of the tooth, that are worn out.[24,25] In the current study, tooth wear was assessed according to the Tooth Wear Index (TWI) criteria, introduced by Smith and Knight in 1984.[26] A lack of tooth wear was considered only when the subject obtained a TWI score of 0. Student participants with TWI scores between 1 and 4 were classified as having diagnosed tooth wear.

Gingival recessions are described as apical gingival displacement associated with unveiling of the enamel-cement junction line, and is often accompanied by unveiling of the tooth root. The present study employed previously published gingival recession evaluation criteria to diagnose the presence of the pathology.[27]

Tongue crenations, also known as tongue impressions or scalloped tongue, are characterized by the presence of indentations along the lateral borders and tip of

the tongue, as the result of compression of the tongue against adjacent teeth, and are often delimited by a white, wavy, crenated hyperkeratotic edge.[28] Subjects were categorized according to the presence or absence of such uni- or bilateral lesions on the tongue mucosa.

Linea alba is a white lesion on the oral mucosa of the cheeks, often bilateral, located at the height of the occlusal surface of the teeth. As the name suggests, it is a white, sometimes wavy, line about 1–2 mm wide, that extends horizontally from the second molar to the canine. It is formed in response to chronic injuries and/or biting of the mucous membrane of the cheek.[29] Again, subjects were categorized according to the presence or absence of such uni- or bilateral changes to the buccal mucosa.

At the end of the clinical investigation, the tone of the right and left masseter muscle (μV) was measured by surface electromyography (EMG) using a Clinical DTS EMG device (Noraxon, Scottsdale, AZ, USA). Surface EMG is a non-invasive method that measures and analyses the electrical signal of a muscle during its activation, whether activation is intentional or not. Contraction of a muscle fibre is possible when the action potential of a motoneuron reaches the moment of depolarisation. Depolarisation itself generates an electromagnetic field and the potential is measured as voltage. Depolarisation that spreads along the muscle fibre is the muscle action potential.[22,30,31] During the clinical examination, two disposable silver (Ag/AgCl) unipolar electrodes were placed on the skin overlying the centre, and in line with, the masseter muscle fibres. Measurements were performed for 20 s during physiological resting position of the mandible.

Statistical analyses

Data are presented as mean ± SD or *n* (%) prevalence. Between-group differences were analysed using the parametric Student's *t*-test or nonparametric χ^2-test, as appropriate, and associations between parameters were analysed using Pearson's correlation coefficient. Statistical analyses were performed using Epi Info™ 7 software, version 7.1.1.14 (Centers for Disease Control and Prevention, Atlanta, GA, USA; http://www.cdc.gov/epiinfo/), and a P value ≤ 0.05 was considered to be statistically significant. P values between 0.05 and 0.1 were considered to have a possible tendency for statistical significance, and values ≥ 0.1 were determined as nonsignificant.

Results

The study included a total of 52 first grade students (comprising 87% of the student year) and 61 fifth grade students (comprising 100% of the student year). The first-grade group included 14 male and 38 female students (mean age, 20 ± 1.2 years) and the fifth-grade group included 19 male and 42 female students (mean age, 23.6 ± 0.9 years). The first-grade student group was significantly younger than the fifth-grade group ($P < 0.05$). Summaries of clinical and psychoemotional findings are presented in Tables 1 and 2.

Statistically significant differences were observed between first and fifth-grade dentistry students in terms of muscle tone in both masseters, and numbers of participants with perceived temporomandibular joint pain, self-declared bruxism, and symptoms of tooth wear (all $P < 0.05$; Table 1). The between-group difference in number of students with linea alba tended towards statistical significance ($P = 0.09$). Mean values for PSS-10 and HADS-A psychological test scores also differed significantly between the two groups ($P < 0.05$; Table 2).

The calculated mean values for PSS-10 scores placed the first-grade students in the category of high levels of perceived stress (mean score, 21 ± 6.5) and

Table 1. Distribution of clinical findings in 113 first and fifth-grade dentistry students.

Parameter	Study group			Statistical significance
	First grade $n = 52$	Fifth grade $n = 61$	All students $n = 113$	
Mean right masseter tone, μV	64.8 ± 2.6	66.3 ± 11.6	65.6 ± 7.1	$P = 0.001$
Mean left masseter tone, μV	64.8 ± 3.0	66.8 ± 11.5	65.8 ± 7.3	$P = 0.004$
Perceived temporomandibular joint pain	4 (8)	24 (39)	28 (25)	$P < 0.001$
Self-observed bruxism	7 (13)	19 (31)	26 (23)	$P = 0.026$
Gingival recessions	15 (29)	13 (21)	28 (25)	NS
Tooth wear symptoms	11 (21)	26 (43)	37 (33)	$P = 0.015$
Linea alba	27 (52)	22 (36)	49 (43)	$P = 0.090$*
Crenated tongue	16 (31)	12 (20)	28 (25)	NS

Data presented as mean ± SD, or *n* (%) prevalence.
*Possible tendency towards statistical significance.
NS, no statistically significant between-group difference ($P \geq 0.1$).

Table 2. Distribution of PSS-10 and HADS-anxiety scores amongst 113 dentistry students.

Parameter	Study group			Statistical significance
	First grade $n = 52$	Fifth grade $n = 61$	All students $n = 113$	
PSS-10 score	21 ± 6.5	17 ± 6.7	19 ± 6.6	$P = 0.032$
Low score, 0–13 points	8 (15)	19 (31)	27 (24)	$P = 0.035$
Medium score, 14–19 points	15 (29)	18 (29.5)	33 (29)	NS
High score, 20–40 points	29 (56)	24 (39.5)	53 (47)	$P = 0.017$
HADS-Anxiety score	10 ± 3.7	8 ± 3.7	9 ± 3.7	$P = 0.009$
Normal score, 0–7 points	14 (27)	30 (49)	44 (39)	$P = 0.008$
Borderline score, 8–10 points	19 (36.5)	17 (28)	36 (32)	NS
Abnormal score, 11–21 points	19 (36.5)	14 (23)	33 (29)	$P = 0.049$

Data presented as mean ± SD, or *n* (%) prevalence.
PSS, Perceived Stress Scale; HADS, Hospital Anxiety and Depression Scale.
NS, no statistically significant between-group difference ($P \geq 0.1$).

fifth-grade students in the category of medium levels of perceived stress (mean score, 17 ± 6.7). Moreover, statistically significant differences between first and fifth-grade students were observed in the proportions of students with low ($P = 0.035$) and high ($P = 0.017$) PSS-10 scores (Table 2).

The mean HADS-A scores were significantly higher in first-grade students (10 ± 3.7 points) compared with fifth-grade students (8 ± 3.7 points; $P = 0.009$; Table 2). The mean values in both groups placed the students in the borderline anxiety category for the HADS-A test.

To investigate the relationships between psychoemotional state and examined parameters, the study population was divided into appropriate sub-groups according to low, medium and high levels of perceived stress according to PSS-10 scores, and normal, borderline or abnormal HADS-A scores (Tables 3–6).

Table 3. Distribution of study parameters in 113 dentistry students categorized according to Perceived Stress Scale (PSS)-10 scores.

Parameter	Study group			Statistical significance
	Low PSS-10 $n = 27$	Medium PSS-10 $n = 33$	High PSS-10 $n = 53$	
Age, years	22.4 ± 1.9	21.5 ± 2.1	21.0 ± 1.8	$P = 0.002$
Perceived temporomandibular joint pain	9 (33)	8 (24)	13 (25)	NS
Self-observed bruxism	6 (22)	8 (24)	12 (23)	NS
Tooth wear symptoms	9 (33)	16 (48)	29 (55)	NS
Linea alba	15 (56)	14 (42)	30 (57)	NS
Crenated tongue	8 (30)	10 (30)	20 (38)	NS
Gingival recessions	8 (30)	6 (18)	8 (15)	NS
Mean tone of right masseter, μV	65.4 ± 6	66.5 ± 11.4	67.5 ± 8.3	$P = 0.048$
Mean tone of left masseter, μV	65.9 ± 5	66.3 ± 7.7	68.9 ± 12.8	NS

Data presented as mean ± SD, or *n* (%) prevalence.
Low PSS-10, 0–13 points; medium PSS-10, 14–19 points; high PSS-10, 20–40 points.
NS, no statistically significant between-group difference ($P \geq 0.1$).

There were no statistically significant differences between the studied parameters and the level of perceived stress in most cases, but there was a non-significant increasing trend in the proportion of students with tooth wear and tongue crenations with increasing stress level according to PSS-10 category (Table 3). Students with a high level of perceived stress had the youngest mean age ($P = 0.002$), and the mean right masseter muscle tone was statistically higher in students presenting a high level of perceived stress (67.5 μV in those with high levels of perceived stress versus 65.4 μV in those with low levels of stress; $P = 0.048$; Table 3). Analysis using Pearson's correlation coefficient (Table 4) showed that older age was associated with a lower level of perceived stress ($r = –0.30$; $P < 0.001$), and there was a statistically significant positive relationship between level of perceived stress and the mean tension of both the right and left masseter muscles ($P < 0.05$).

Table 5 presents the distribution of analysed parameters according to normal, borderline or abnormal HADS-A scores.

Table 4. Correlation between the perceived level of stress, according to Perceived Stress Scale (PSS)-10, and student age and masseter muscle tone in 113 dental students.

Variable pair	Pearson's correlation coefficient	
	r	Statistical significance
PSS-10 and age	–0.30	$P < 0.001$
PSS-10 and right masseter	0.17	$P = 0.026$
PSS-10 and left masseter	0.23	$P = 0.002$

For all studied variables, no statistically significant differences were observed in relation to the level of perceived anxiety. However, among students with abnormal/high levels of anxiety, there was a numerically higher proportion of students with linea alba on the buccal mucosa versus students with normal and borderline anxiety levels, which had a tendency toward statistical significance ($P = 0.057$). Similar to the PSS-10 scores, correlation analyses using Pearson's correlation coefficient (Table 6) showed that the higher the mean age of

Table 5. Distribution of study parameters in 113 dentistry students categorized according to Hospital Anxiety and Depression Scale (HADS)-Anxiety (A) scores.

Parameter	Study group: Normal HADS-A $n = 44$	Borderline HADS-A $n = 36$	Abnormal HADS-A $n = 33$	Statistical significance
Age, years	21.7 ± 2	21.2 ± 2	21.0 ± 1.7	NS
Perceived temporomandibular joint pain	12 (27)	9 (25)	7 (21)	NS
Self-observed bruxism	11 (25)	7 (19)	6 (18)	NS
Tooth wear symptoms	25 (57)	15 (42)	16 (48)	NS
Linea alba	24 (55)	14 (39)	21 (64)	$P = 0.057$*
Crenated tongue	15 (34)	13 (36)	10 (30)	NS
Gingival recessions	9 (20)	5 (14)	7 (21)	NS
Mean tone of right masseter, μV	64.9 ± 5.7	65.1 ± 6.3	67.7 ± 9.6	NS
Mean tone of left masseter, μV	65.7 ± 6.4	66.3 ± 6.9	67.3 ± 12.8	NS

Data presented as mean $\pm$ SD, or *n* (%) prevalence.
Normal HADS-A, 0–7 points; borderline HADS-A, 8–10 points; abnormal HADS-A, 11–21 points.
*Possible tendency towards statistical significance.
NS, no statistically significant between-group difference ($P \geq 0.1$).

Table 6. Correlation between level of experienced anxiety, according to Hospital Anxiety and Depression Scale (HADS)-Anxiety (A) scores, and student age and masseter muscle tone in 113 dental students.

Variable pair	Pearson's correlation coefficient: *r*	Statistical significance
HADS-A and age	–0.19	$P = 0.002$
HADS-A and right masseter	0.15	$P = 0.047$
HADS-A and left masseter	0.13	$P = 0.089$*

*Possible tendency towards statistical significance.

the respondents, the lower the level of perceived anxiety ($P = 0.002$). In addition, there was a positive correlation between the level of perceived anxiety and mean tone of the right masseter muscle ($P = 0.047$), and a tendency toward a positive correlation between the left masseter tone and anxiety level ($P = 0.089$).

Discussion

The present study investigated the psychoemotional state of a population of undergraduate dentistry students, using the PSS-10 and HADS psychological tools, which allowed the observation of increased exposure to stress and increased measured values of anxiety. Of the whole study population, 47% of subjects had high, abnormal perceived stress levels and 29% showed abnormal levels of experienced anxiety. The present results concur with those of a published meta-analysis on the subject of perceived stress among dentistry students,[14] which showed that 34% of dental students had high perceived stress

levels and 54% had medium stress levels. A similar prevalence (30.5%) of abnormal anxiety levels was observed in a study of Portuguese students,[32] while other studies reported even higher prevalences of anxiety disorders among medical students (45% and 60%, respectively).[33,34]

Among first-grade dental students in the present study, the mean value of masseter muscle tone in the resting position of the mandible was 64.8 μV for both masseters. Among senior (fifth-grade) students, mean tone of the right masseter was 66.3 μV, and of the left was 66.8 μV, with statistically significant differences between the first and fifth grade students. The lack of significant differences between the right and left masseter muscle tone in either group indicated the symmetry of muscle work and the absence of one-sided disturbances. Lower resting values for the masseter muscles have been described previously.[35–37] The higher values in the present results may be explained by the fact that, in the present study group, up to 76% of participants showed medium or high pathological levels of perceived stress, and it is known that stress overload can increase the resting activity of the masseter muscle.[38,39] Moreover, a high percentage of the present study population reported bruxism (23%) and other complaints within the temporomandibular joint (25%), which may also influence the values obtained for mean tone measurements, because people with bruxism are characterized by higher masseter muscle tension in the resting position.[40–42] The present results may be limited by the high stress levels and high proportion of participants reporting bruxism and other temporomandibular joint disturbances.

The entire study group ($n = 113$) was categorised according to psychological stress test results to assess the relationships between factors, and revealed that as PSS-10 scores increased, the tone of both the right and left masseter muscles increased, and the age of the subjects decreased. Low, medium and high levels of stress corresponded to mean values for right masseter muscle tone of 65.4 μV, 66.5 μV and 67.5 μV, respectively, and for the left masseter muscle tone: 65.9 μV, 66.3 μV, and 68.9 μV, respectively. However, statistically significant differences were only seen between changes in tone of the right muscle. Pearson's correlation coefficient analyses showed that tone of the right and left masseter muscles increased along with increasing perceived stress. Similar observations have been published in a study that used the same psychological tools and surface EMG measurements,[43] and the research also showed significantly lower values of masseter muscle tone in groups with lower psychoemotional load in a population of healthy students. Another study also confirmed the positive correlation between the increase of masseter muscle tone and perceived stress level.[44]

In the present study population categorised according to anxiety levels (HADS-A), it was observed that numerically increased tension in both masseters coincided with increased level of experienced anxiety. Differences between mean tone values were not statistically significant, however, Pearson's correlation coefficient analysis showed a statistically significant positive correlation between an increase in right masseter muscle tone and increased anxiety scores ($P = 0.047$), and a tendency toward a statistically significant relationship in the left masseter ($P = 0.089$). An inverse correlation was confirmed between age of the respondents and anxiety level ($P = 0.002$). Additionally, in the present study population, there was a possible tendency toward a statistically significant increased frequency of linea alba as anxiety levels increased ($P = 0.057$). The comorbidity of elevated anxiety level and masticatory muscles and

temporomandibular joint complaints has also been shown in previous studies.[25,45,46]

Stress, anxiety, and psychoemotional burden together with occlusal parafunctional activities play an important role in the aetiology of TMD. Moreover, the experience of stress is emphasised to result in increased masticatory muscle tone, with research showing that patients with TMD declare greater stress than the rest of the healthy population.[25,27,47–49]

Results from numerous studies show that students more often experience oral parafunctions and temporomandibular disorder than the rest of society, due to more stressful conditions of life and the age of this population,[28,46,49] and people aged between 20 and 40 years are emphasized to be more vulnerable to developing TMD. In a fifth-year outcomes study, dental students were found to develop emotional exhaustion and psychological distress throughout the five years of academic training.[12] The present findings did not reveal a linear relationship between increasing emotional distress and academic learning progress, as first-grade students had higher psychological tool scores than those who had nearly graduated (fifth-grade). However, if other stress-related variables are considered, such as self-observed bruxism and temporomandibular joint concerns, higher masseter tone, and presence of tooth wear, it may be concluded that the present study population also showed a rise in psychoemotional distress over the educational period. Masseter muscle tension has been shown to increase significantly during experimental stressful conditions (caused by solving a mathematical test and a computer game) compared with the situation of emotional silence.[7,50] Therefore, stress is one of the main sources of excessive tension and muscle activity, that can be transmitted directly to the dental arches through parafunctional muscle activity (through the limbic system and gamma loop) during, for example, involuntary bruxing or teeth clenching, that exceeds physiological forces.

High neuromuscular tension in the stomatognathic system is the result of stress, but it should be emphasized that the body's response to stress is largely dependent on personality.[9,51–55] Recent research has shown that so-called civilization stress, resulting from increased life pace and high expectations related to individuals in developed countries, plays one of the main roles among the aetiopathological factors of TMD development.[8,11] In addition, stress is associated with increased muscle tone, and more frequent muscle activity, of the jaws. All of these factors concur with the results of the present study.

In conclusion, the present study showed that increased psychoemotional burden and increased rates of experienced anxiety result in increased tone of the masseter muscle in a population of dentistry students. Moreover, to the best of the authors' knowledge, the present study is the first to focus on associations between psychoemotional state and oral cavity symptoms. The study revealed a possible tendency toward more frequent observation of linea alba on the buccal mucosa among subjects with an elevated sense of anxiety, which gives an incentive to study more deeply the relationship between psychoemotional state and the state of the oral cavity. Furthermore, the high percentage of parafunctional symptoms within the stomatognathic system, combined with the recognized above-average psychoemotional stress among the present study participants, may indicate the presence of an undiagnosed TMD. In light of the obtained results, it may be hypothesized that the examined student group are an 'at risk group' for the development of psychosomatic disorders, in particular temporomandibular disorders, which are included in this type of disease. Thus, it is justified to conduct further, broader research covering a larger number of

student study populations of different faculties, and to introduce changes into the dental education system to reduce the impact of stress and anxiety.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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