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VITAL SIGNS AND SALIVARY CORTISOL AS BIOMARKERS OF STRESS AMONG SENIOR DENTAL TRAINEES AT A DENTISTRY FACULTY HOSPITAL

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Abstract: Senior dental trainees tend to experience increased stress since they have to deal with graduation and career concerns, on top of the challenges of their clinical duties. Increased stress can cause stress-related physiological changes. This study aimed to investigate perceived stress, systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), blood oxygen saturation (OS), and salivary cortisol levels (SCL) among senior dental trainees of Tokat Gaziosmanpaşa University Dental Hospital. This cross-sectional study was conducted on 73 systemically healthy senior dental trainees of Tokat Gaziosmanpaşa University Dental Hospital in June 2023. Perceived stress scores (PSS) were obtained via the Perceived Stress Scale-14. SBP, DBP, HR, and OS measurements were performed. An enzyme-linked immunosorbent assay (ELISA) was used to evaluate SCL. No statistically significant correlation was found between PSS and SBP, DBP, HR, OS, and SCL (P>0.05). In addition, there was no statistically significant difference in terms of all variables among the clinical sections (P>0.05). The stress levels of healthy dentistry senior trainees did not cause a significant change in stress biomarkers such as SBP, DBP, HR, OS, and SCL. Dental trainees performing different clinical tasks did not show a significant difference in terms of PSS, SBP, DBP, HR, OS, and SCL.

Keywords: Dentistry students, Perceived stress, Blood pressure, Heart rate, Oxygen saturation, Salivary cortisol

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1. Introduction

Dentistry is a stressful profession (Collin et al., 2019). Performing dental treatments tends to cause stress regardless of the education or experience of the clinicians. Especially, individuals with poor self-efficacy and the ones who have certain performance obligations under supervisory control are at higher risk of stress (Halboub et al., 2018). Therefore, dental trainees are exposed to significant stress during their clinical training (Alamoush et al., 2024). Clinical proficiency exams, fear of failing from clinical courses, lack of time to complete clinical requirements, and excessive workload are associated with causes of stress (Alhajj et al., 2018; Collin et al., 2020). During the clinical training, they are involved in the treatment processes of patients in different departments such as oral and maxillofacial surgery, prosthodontics, pediatric dentistry, oral and maxillofacial radiology, orthodontics, endodontics, restorative dentistry, and periodontology. Stress levels of dental trainees tend to increase due to limited time to treat patients, a certain number of practical tasks to be performed, and the need to find suitable patients for these tasks (Guthardt et al., 2024). Among senior dental trainees, stress levels may increase even further as career concerns add to the cumulative effects of stress factors (Tangade et al., 2011; Fang et al., 2025).

Increased stress levels can cause stress-related physiological changes, since stress causes the activation of certain systems and the secretion of certain hormones or chemicals in the body (McEwen, 2017; Noushad et al., 2021). One of the systems activated in stress regulation is the autonomic nervous system, which consists of sympathetic and parasympathetic systems whose main neurotransmitters are norepinephrine and epinephrine (Noushad et al., 2021). Exposure to an acute stressful stimulus increases heart rate (HR) and blood pressure (BP) due to activation of the sympathetic system (De Vente et al., 2003). By altering the balance of the sympathetic-parasympathetic system, psychological stress can cause adverse effects on the cardiovascular system both acutely and chronically (Brotman et al., 2007). Due to these effects of stress on the cardiovascular system, BP, HR, and as well as blood oxygen saturation (OS) can be used to investigate the body's response to stress (Gellisch et al., 2024).

The other activated system after exposure to stress in

humans is the neuroendocrine system, mainly the hypothalamic-pituitary-adrenal axis, and its end product is cortisol (Young et al., 2004). Therefore, cortisol is known as one of the diagnostic biomarkers of chronic stress, and it can be determined through hair samples, saliva, blood, and urine (Noushad et al., 2021). Among these methods, salivary cortisol determination is simple, non-invasive, convenient to store, and stress-free in contrast to serum (Elagra et al., 2022; Huang et al., 2023). Salivary cortisol is reported to indicate stress levels in individuals; however, further research is essential, as studies are not conclusive (Nijakowski et al., 2022). Additionally, little is known about the relationship between stress levels and vital signs such as systolic blood pressure (SBP), diastolic blood pressure (DBP), HR, and OS that may change as a result of stress in senior dental trainees. There are also no studies investigating whether these variables vary among the students performing different treatments as tasks in different dentistry departments.

Therefore, the primary aim of this study is to investigate whether stress is associated with SBP, DBP, HR, OS, and salivary cortisol levels (SCL) among senior dental trainees of Tokat Gaziosmanpaşa University Dentistry Faculty Hospital. In addition, whether these markers differ among different clinical departments will also be evaluated.

2. Material and Methods

This cross-sectional study was conducted on senior dental trainees of Tokat Gaziosmanpaşa University Dentistry Faculty Hospital in June 2023. These students were included as they were the most stressed population who could perform dental treatments in the dentistry faculty hospital. The study was conducted in accordance with the Declaration of Helsinki. Before starting the study, ethical approval was obtained from Tokat Gaziosmanpaşa University Clinical Research Ethics Committee (Project number: 23-KAEK-126). Senior dental trainees from eight different clinical sections (Oral and maxillofacial surgery, Prosthodontics, Pediatric dentistry, Oral and maxillofacial radiology, Orthodontics, Endodontics, Restorative dentistry, Periodontology) were invited to participate in the study. Only systemically healthy individuals were included. The presence of chronic systemic illnesses, periodontal disease, hormone abnormalities, psychiatric disorders, or the use of any medications was excluded. In total, 73 participants aged 22-24 from the clinical sections were enrolled. Written informed consent was obtained from all participants.

The study was performed in the last week of their clinical training before the students' clinical proficiency exams were to be held. Participants were warned not to take any food, drink, sugary gum, cosmetics such as lipstick, or any medication within one hour before the test in order to avoid affecting their measurements. The senior dental trainees from each section were called simultaneously. All data and saliva samples were obtained at a certain time of the day (between 09:00 and 10:00 am) to minimize time-of-day effects. First, participants were asked to fill out the Turkish version of the 14-item Perceived Stress Scale (PSS-14) form for perceived stress assessment in the preceding month to determine stress levels (Cohen et al., 1983; Eskin, 2013). In each item, the participants were asked to indicate how often they felt or thought a certain way according to a five-point Likert scale from “zero” meaning never, to “four” meaning very often. The maximum perceived stress score (PSS) in total that can be obtained is 56, and a higher score indicates a greater perceived level of stress. Secondly, blood pressure, pulse, and oxygen saturation measurements were taken by a nurse. Measurements of SBP and DBP were performed by using a sphygmomanometer and a stethoscope. HR measurement was performed via the right wrist radial artery. Blood OS was evaluated by using a fingertip pulse oximeter. Finally, unstimulated saliva samples were collected in a plastic cup for 10 minutes in a sitting position with the head and neck in a comfortable position. These samples were centrifuged, and the supernatant was stored at −20 °C until analysed.

SCL was measured by a commercially available Cortisol Saliva ELISA kit (DiaMetra Co, Milan, Italy) in accordance with the manufacturer's instructions.

2.1. Statistical Analysis

The SPSS 20.0 package program was used to analyze the data, and the significance level was considered as $P<0.05$. Descriptive statistics were performed. The normality tests of the total data were done with the Kolmogorov-Smirnov test. However, intragroup normality assessments were made with the Shapiro-Wilk test. The relationship between PSS and SCL was analyzed using Pearson Correlation Analysis; the other relationships were analyzed using Spearman Correlation Analysis. To compare the clinical section groups, one-way ANOVA was used for PSS, HR, and SCL values; the Kruskal-Wallis test was used for SBP, DBP, and OS values since they did not meet the normal distribution criteria.

3. Results

73 dental students (43 female, 30 male) participated in the study from the Oral and maxillofacial surgery (n=13), Prosthodontics (n=12), Pediatric dentistry (n=8), Oral and maxillofacial radiology (n=8), Orthodontics (n=8), Endodontics (n=8), Restorative dentistry (n=8), and Periodontology (n=8) section.

The mean ± SD score of PSS and SBP, DBP, HR, OS, and SCL for the total sample were 29.9 ± 6.6, 99.7 ± 13.9, 58.5 ± 8.6, 82.8 ± 11.7, 96.7 ± 2, and 28.9 ± 11.9, respectively (Table 1). The median, minimum, and maximum values of variables for the total sample are also shown in Table 1. No statistically significant correlation was found between PSS values and other variables ($P>0.05$) (Table 2).

The mean, standard deviation, median, minimum, and maximum values of the variables according to the clinical sections are shown in Table 3. No statistically significant difference was found in terms of PSS, SBP, DBP, OS, and SCL values among the clinical sections ($P>0.05$).

Table 1. Descriptive statistics of research variables

Variable	N	Mean ± SD	Median (Min-Max)
Perceived Stress Score	73	29.9 ± 6.6	30 (17 - 49)
Systolic blood pressure	73	99.7 ± 13.9	100 (70 - 150)
Diastolic blood pressure	73	58.5 ± 8.6	60 (40 - 90)
Heart rate	73	82.8 ± 11.7	82 (56 - 116)
Oxygen saturation	73	96.7 ± 2	97 (90 - 99)
Salivary cortisol level[a]	73	28.9 ± 11.9	29.3 (6.3 - 55.5)

[a] = ng/ml

Table 2. Correlation between perceived stress score and other variables

	Perceived stress score	
	r	p
Systolic blood pressure	-0.063	0.597*
Diastolic blood pressure	0.035	0.769*
Heart rate	0.122	0.302*
Oxygen saturation	0.181	0.126*
Salivary cortisol level	-0.034	0.774**

*= Spearman correlation test, **= Pearson correlation test.

4. Discussion

The present study investigated the relationship between PSS and SBP, DBP, HR, OS, and SCL among senior dental trainees of Tokat Gaziosmanpaşa University Dentistry Faculty Hospital. The findings showed no significant correlations between perceived stress and researched vital signs or salivary cortisol. Besides, there were no significant differences between the clinical sections in terms of the research variables.

For evaluation of perceived stress, the original 14-item Perceived Stress Scale of Cohen et al. (1983) was used, as it is a convenient questionnaire with adequate psychometric properties (Cohen et al., 1983; Lee, 2012). The total score ranged from zero to 56, and a higher score indicates a greater perceived level of stress (Cohen et al., 1983). The trainees in this study had a score of 29.9 ± 6.6. However, this level of stress was not associated with the researched biomarkers of stress in this study. Although not among dental trainees, there are similar research results in other studies evaluating stress with the same scale. One of them was performed on Latin adolescents and found no significant relationship between PSS and serum cortisol or salivary cortisol awakening response (Sanogo et al., 2025). In another study conducted on university students at exam time, no significant relationship was found between stress measured with PSS-14 and salivary cortisol (Irshad et al., 2020). However, a study using a different stress scale reported that morning salivary cortisol levels were strongly correlated with stress levels in dental students (Nijakowski et al., 2022). Additionally, in a study assessing stress in senior Saudi dentistry trainees using salivary cortisol as a biomarker, the authors reported that the students' cortisol values in the last weeks of their clinical education and one hour before the final exams were significantly higher than the initial values in the first week of the semester (Pani et al., 2011).

Table 3. Comparison of the variables according to the clinical sections

Section (n=73)	1 (n=13)	2 (n=12)	3 (n=8)	4 (n=8)	5 (n=8)	6 (n=8)	7 (n=8)	8 (n=8)	test statistic	P value
PSS	Mean±SD Median Min-Max 29.2±6.4 30 17-49	Mean±SD Median Min-Max 31.8±5.9 31.5 22-41	Mean±SD Median Min-Max 28±2.8 28 23-31	Mean±SD Median Min-Max 29.9±8.7 30 20-47	Mean±SD Median Min-Max 31±9.9 30 20-49	Mean±SD Median Min-Max 31.6±5 32 24-37	Mean±SD Median Min-Max 26.4±6.3 26.5 17 - 34	Mean±SD Median Min-Max 30.9±6.5 33 19-38	0.702	0.67*
SBP	105.4±13.9 110 80-120	103.3±15 110 70-120	98.8±11.3 100 80-110	100±13.1 100 80-120	96.3±13 95 80-110	92.5±7.1 90 80-100	95±9.3 95 80-110	101.3±23 95 80-150	8.587	0.284**
DBP	62.3±10.9 60 50-90	58.3±8.3 60 40-70	60±7.6 60 50-70	60±7.6 60 50-70	55±7.6 60 40-60	56.3±5.2 60 50-60	53.8±7.4 55 40-60	60±10.7 60 50-80	6.216	0.515**
HR	82.6±13.3 80 56-115	84.8±12 84 62-111	79.8±9.1 80 65-95	84±9.1 82 75-104	71.3±9.2 72 57-82	84.4±7 81.5 78-98	84±9.3 83.5 71-100	91.1±15.4 90 70-116	2.052	0.62*
OS	96.2±2.6 97 90-99	96.7±1.5 97 94-99	96.5±2.2 97 92-99	96.9±1.8 97 93-99	96±2 96 93-99	96.9±1.8 97 93-99	97.5±2.1 98.5 93-99	97±2 97.5 94-99	4.185	0.758**
SCL[a]	7.8±4.7 6.7 2.4-15.7	7.4±4 7.4 2.7-17.3	7.2±4.2 6.3 2.6-15	9.8±5.1 8.8 3.2-18.5	8.6±4.2 9.3 3.2-5.2	8.9 ± 5.9 7.2 2.7-21.4	9±1.7 9 6.8-11.8	8.8±3.6 7.8 3.8-14.7	0.367	0.918*

*= One way ANOVA test, **= Kruskal-Wallis test, PSS= perceived stress score. [a]= ng/ml, SBP= systolic blood pressure, DBP= diastolic blood pressure, HR= heart rate, OS= oxygen saturation, SCL= salivary cortisol level, 1= oral and maxillofacial surgery, 2= prosthodontics, 3= pediatric dentistry, 4= oral and maxillofacial radiology, 5= orthodontics, 6= endodontics, 7= restorative dentistry, 8= periodontol.

There are also researchers investigating the effect of stress on other markers of our study besides SCL. For instance, some researchers investigated the effect of high-fidelity simulation, as a stressor, on senior medical students (Bialka et al., 2021). Although they didn't observe any significant difference in salivary cortisol, DBP, and OS, they found that SBP and HR were significantly higher after simulation. In another study conducted on final year physiotherapy students, three different simulation-based training scenario groups generating low, medium, or high stress were created (Cavaleri et al., 2023). According to their results, no significant difference was observed in SCL between groups, but higher heart rates were detected in the high stress group compared to the low and medium stress groups during simulation-based learning. Although the findings of these two studies are also consistent with our SCL, DBP, and OS relationship results, no significant relationship was found between PSS and SBP or HR in our study. On the other hand, there are studies reporting a non-significant relationship between blood pressure measurements and stress due to work or job strain (Nyberg et al., 2013; Magnusson Hanson et al., 2017).

This study also revealed that there are no significant differences among senior dental trainees of Tokat Gaziosmanpaşa University training in different clinical sections in terms of PSS, SBP, DBP, HR, OS, and SCL. There is not much research performed on this subject in the literature. In a study, it has been reported that the highest level of perceived stress among dentistry students transitioning from preclinical to clinical education is in the endodontic clinic. In our study, no significant difference was found among the clinical sections (Roudsari et al., 2022). The country, university, and academic year in which the study was conducted may have caused differences in the study results.

One of the limitations of this study is that it was conducted on senior dental trainees from a single dentistry faculty. Studies with a larger sample size may be required. Secondly, results were based on measurements taken at a single time. Repeated measurements could reflect more accurate results. In addition, serum or daily total cortisol levels could be examined in addition to morning salivary cortisol evaluation.

5. Conclusion

Perceived stress, as measured by PSS-14, was not associated with SBP, DBP, HR, OS, and SCL among senior dental trainees of Tokat Gaziosmanpaşa University Dentistry Faculty Hospital. In addition, these markers did not significantly differ among dental trainees performing different clinical tasks. Within the limitations of this study, it can be said that the stress levels of healthy dental senior trainees did not cause a significant change in vital signs and salivary cortisol. Having different tasks to perform and different skills to develop in different internships did not cause a significant change in the trainees' stress levels or stress biomarkers such as SBP, DBP, HR, OS, and SCL.

Author Contributions

The percentages of the authors' contributions are presented below. All authors reviewed and approved the final version of the manuscript.

	G.I.K.	H.B.Y.	S.A.	T.K.
C	25	25	25	25
D	25	25	25	25
S	25	25	25	25
DCP	25	25	25	25
DAI	25	25	25	25
L	25	25	25	25
W	25	25	25	25
CR	25	25	25	25
SR	25	25	25	25
PM	25	25	25	25
FA	25	25	25	25

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of interest

There is no conflict of interest.

Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki. Before starting the study, ethical approval was obtained from Tokat Gaziosmanpaşa University Clinical Research Ethics Committee (Aproval date: March 15, 2023, prodocol code: 23-KAEK-126).

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