jdhs Journal of Dental Hygiene Science

J Dent Hyg Sci Vol. 21, No. 3, 2021, pp.150-157
https://doi.org/10.17135/jdhs.2021.21.3.150

RESEARCH ARTICLE

Relationship between Saliva Factors Measured Using the SILL-Ha® Saliva Test System and Blood Cell Counts according to Perceived Stress Scale Scores in Female College Students

Sun-Mi Lee[1], Eun-Ha Jung[2], and Mi-Kyoung Jun[3,†]

[1]Department of Dental Hygiene, Dongnam Health University, Suwon 16328, [2]Department of Dental Hygiene, Yonsei University, Wonju 26493, [3]Sae • e Dental Clinic, Suwon 16294, Korea

Background: Stress as a cause of mental health problems is known to be more prevalent in women than in men and has a negative effect on several aspects of physical health, such as the composition of blood and saliva. This study investigated the relationship of perceived stress with blood cell counts, saliva flow rate, and saliva factors.

Methods: We recruited women in their 20s with a high prevalence of stress. Stress was evaluated using the Korean version of the perceived stress scale. Blood tests included white blood cell, hemoglobin, and platelet. We then examined the saliva flow rate and cariogenic bacteria level, acidity, occult blood, buffer capacity, leukocyte level, protein level, and ammonia level using rinse water with the SILL-Ha® saliva test system.

Results: In a total of 70 participants, the average age was 21.64 years old, the average perceived stress score was 16.96±4.32, and high levels of stress were reported by 80% of the participants (n=56). The high-stress group had lower hemoglobin levels. In addition, the high-stress group showed a lower saliva flow rate than the low-stress group, and there was a difference in the salivary acidity and buffer capacity. The total perceived stress score showed a positive correlation with acidity and negative correlation with buffer capacity and the hemoglobin level.

Conclusion: This study found that stress in female college students might affect the composition of blood and saliva. High levels of stress were positively correlated with the hemoglobin level, saliva flow rate, and acidity and negatively correlated with the buffer capacity.

Key Words: Blood cell count, Oral health, Perceived stress scale, Saliva

Introduction

Stress itself is an unavoidable part of life among people in the modern age, and the concept of stress has gained importance as it has been linked as a contributing factor to many diseases[1]. Perceptions of stress vary from person to person and depend on interpersonal, academic, and environmental factors. In a previous study targeting college students, it was reported that junior freshmen had higher stress levels than students in other grades, and stress levels of female students were more than twice as high as that of male students[2]. Individuals in their early 20s are generally known to have a physically healthy life cycle with low risk of mortality or disease morbidity. However, they are exposed to high stress levels due to poor health habits, uncertainty about the future, and excessive competition among their peers. Exposure to such stress can affect not only their current health status but also their health levels when they become as they become older[3]. In Korea, efforts related to health promotion are still mainly focused on middle-aged and elderly people. Therefore, there is a demand for health management programs for young

Received: June 14, 2021, **Revised:** August 23, 2021, **Accepted:** August 26, 2021

eISSN 2233-7679

†Correspondence to: Mi-Kyoung Jun, *https://orcid.org/0000-0003-1813-9193*
Sae • e Dental Clinic, 109-8, Songwon-ro, Jangan-gu, Suwon 16294, Korea
Tel: +82-31-255-9010, Fax: +82-0504-390-2116, E-mail: mijjomg@naver.com

people because they are not usually the target population for health promotion[4].

The effect of stress on the salivary gland occurs through the autonomic nervous system. The parasympathetic nerves cause vasodilation and increased salivation. In contrast, the sympathetic nervous system causes a complex series of reactions that do not significantly affect the salivary glands, causing the secretion of protein-rich saliva[5]. The general view about the effect of stress on saliva flow rate is that both acute and chronic stress cause a decrease in the saliva flow rate[6,7]. In addition, research on the effect of stress on changes in saliva components includes studies on the relationship between high stress and salivary cortisol concentration[8] and between salivary cortisol levels and self-reported stress scale scores[9].

Saliva consists of 99.5% water, 0.5% organic components, and inorganic components that maintain the oral environment. Its functions include buffer capacity, antibacterial action, antiviral action, antifungal action, tissue coding, lubrication, remineralization, and aiding in digestion[10]. However, when salivary problems occur, the risk of oral issues increases, which adversely affects overall oral health.

In addition, in a previous study on the relationship between stress and blood characteristics, the blood glucose level and stress level showed a positive correlation, and among the blood characteristics, the uric acid level showed a positive correlation with stress levels[11]. Consequently, it was confirmed that stress also affected blood components.

Although previous studies have shown that perceived stress has a negative effect on the composition of blood and saliva, only a few studies have confirmed the relationships among stress, blood, and saliva[12,13]. Thus, there is insufficient evidence regarding the mutual influence among stress, blood, and saliva.

Therefore, the aims of this study were to identify the relationship of perceived stress scale (PSS) scores with blood cell counts and salivary factors using the SILL-Ha® saliva test system among female college students with high stress levels and to establish the necessary underlying data for stress management.

Materials and Methods

1. Participants

The purpose and procedures of this study were described to all participants before commencing the study, and written consent was obtained from all subjects prior to inclusion. This study was conducted from September to November 2020. The study participants were determined through a screening procedure that excluded female college students who smoked, took drugs such as antibiotics, and had systemic diseases. The sample size was calculated using G*Power 3.1.9.2, with a significance level of 0.05, median effect size of 0.30, power of 0.95, and dropout rate of 20.0%, which was reflected in the results obtained from 70 participants. Of the total 85 participants in the study, 70 were finally selected; 15 participants were excluded as they did not respond to the questionnaire or did not undergo the blood and saliva tests.

2. Research tools

1) Perceived stress scales

The Korean version of the PSS, which was developed to measure the level of stress experienced by an individual subjectively, has six positive factors (items 1, 2, 3, 6, 9, and 10) and four negative factors (items 4, 5, 7, and 8)[14]. The participants indicated their responses to the PSS using a 5-point Likert-type scale ranging from 0 (never) to 4 (very often), and negative verbal items were recorded during the analysis. The total score ranged from 0 to 40, with higher scores indicating higher levels of stress. According to the criteria of a previous study[15], high stress levels and low stress levels were distinguished based on the total PSS score of ≥ 13 and < 13, respectively.

2) Blood cell counts

Using a disposable vacuum blood collection set (Becton Dickinson, Franklin Lakes, NJ, USA), a 3 ml blood sample was collected by a trained clinical pathologist once in a vacuum collection vessel (ethylenediaminetetraacetic acid) containing an anticoagulant. The items of the blood count test, which were white blood cell (WBC), hemoglobin (Hb), and platelet (PLT), were analyzed using

LABGEO HC10 (Samsung Medison Co., Suwon, Korea).

3) Saliva flow rate and saliva factor analysis using the SILL-Ha® saliva test system

Saliva tests were performed using the saliva flow rate and SILL-Ha® saliva test system (SILL-Ha® ST-4910; ARK-RAY, Kyoto, Japan). The participants were instructed to refrain from eating, chewing gum, brushing their teeth, and using a mouthwash for up to 2 hours prior to the test. All assessments were conducted between 9:00 AM and 12:00 PM to minimize life-cycle-related changes in salivation and were performed by a trained examiner[16]. First, saliva components were evaluated using the SILL-Ha® saliva test system. As per the manufacturer's instructions, each participant was instructed to rinse their mouth with 3 ml of distilled water for 10 seconds. A sample of 10 μl was dropped on each of the seven pads of the test strip and analyzed for carious bacteria, pH, buffer capacity, occult blood, leukocytes, protein, and ammonia. Subsequently, the stimulation rate of saliva was measured and evaluated after collection for 5 minutes using a plastic measuring cup with paraffin wax masturbation in an upright sitting position. The saliva flow rate was calculated by dividing the collected volume (1 g of saliva=1 ml) by the collection time (min); the values are presented in ml/min[17].

3. Statistical analysis

Statistical analysis of the collected data was performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA), and a significance level of 0.05 was set. All the continuous variables are expressed as means±standard deviations. The relationship between the blood counts and saliva tests according to the perceived stress levels was analyzed using the Mann−Whitney test because normality was not satisfied, which was investigated using the Kolmogorov−Smirnov test for normality. Pearson's correlation analysis was used to examine the associations among the total perceived stress score, blood count, saliva flow rate, and saliva test results.

Results

1. Measurement data of the participants

The average age of the participants was 21.64 years and average perceived stress score was 16.96±4.32. The proportion of participants with high stress levels was 80.0% (56 participants), which was the highest (Table 1).

Table 1. Measurement Data of the Subjects

Characteristic	Division	Value
Age (y)		21.64±2.20
Blood test	WBC (10^3/ml)	6.38±1.43
	PLT (10^3/ml)	280.83±46.15
	Hb (g/dl)	12.53±0.70
Saliva flow rate		1.54±0.56
Saliva test	Cariogenic bacteria level	23.37±19.83
	Acidity	64.07±19.43
	Buffer capacity	19.66±13.84
	Occult blood	10.51±13.16
	Leukocyte level	26.43±22.18
	Protein level	25.63±12.87
	Ammonia level	26.93±20.24
Perceived stress scale	Sum of total	16.96±4.32
	Low	14 (20.0)
	High	56 (80.0)
Total		70 (100.0)

Values are presented as mean±standard deviation or number (%).
WBC: white blood cell, PLT: platelet, Hb: hemoglobin.

2. Differences in the blood cell count test results according to perceived stress levels

Table 2 shows the results of the analysis of the differences in the blood cell count tests according to the perceived stress levels. Among the blood cell count test items, the Hb level was statistically significantly lower in

Table 2. Differences in Blood Cell Count Test according to PSS Level

Variable	PSS		p-value[a]
	Low (n=14) (PSS score # 0∼13)	High (n=56) (PSS score # ≥14)	
WBC (10^3/ml)	5.95±1.83	6.48±1.31	0.215
PLT (10^3/ml)	273.43±39.03	282.68±47.90	0.506
Hb (g/dl)	13.01±0.63	12.41±0.67	0.003

Values are presented as mean±standard deviation.
PSS: perceived stress scale, WBC: white blood cell, PLT: platelet, Hb: hemoglobin.
[a]p-value obtained from Mann−Whitney U-test.

the high-stress group than in the low-stress group, with the average values being 12.41±0.67 g/dl and 13.01±0.63 g/dl, respectively ($p=0.003$, Table 2).

3. Differences between saliva flow rate and saliva test results according to perceived stress levels

The high-stress group (1.34 ml/min) had a significantly lower rate of stimulatory saliva than the low-stress group (2.31 ml/min) ($p<0.001$, Table 3). Among the seven factors of the saliva test, the high-stress group had an acidity of 66.70±18.13 and a buffer capacity of 17.48±9.04, which were significantly different from those of the low-stress group ($p<0.05$, Table 3). The other factors did not demonstrate statistically significant differences.

4. Correlation of average perceived stress score with blood count, saliva flow rate, and saliva test results

Table 4 shows the correlations of the average perceived stress score with the blood cell counts, saliva flow rate, and saliva test results. Among the seven saliva test factors, the average perceived stress scores showed a positive correlation with acidity ($r=0.320$) and negative correlation with buffer capacity ($r=-0.381$) ($p<0.01$).

Discussion

According to the results of the Korean National Health and Nutrition Examination Survey, the stress perception rate among those in their twenties in the past three years (2017～2019) was about 35.1% to 37.9%, and this age group ranked first or second among those surveyed[18]. An approximately 2.4% higher stress recognition rate has been reported in women than in men[19], which might be attributed to social values and differences in hormones between men and women[20]. Although it has been reported that stress affects different physiological factors that could contribute to various diseases[21,22], there are only a few studies on the changes in the blood and saliva due to individual perceived stress. Therefore, this study attempted

Table 4. Correlation between Sum of Perceived Stress Score and Blood Cell Count, Saliva Flow Rate and Saliva Test

Variable	r	p-value[a]
Blood cell count		
WBC	0.071	0.561
PLT	−0.037	0.763
Hb	−0.287	0.016
Saliva flow rate	0.041	0.736
Saliva test		
Cariogenic bacteria level	0.045	0.712
Acidity	0.320	0.007
Buffer capacity	−0.381	0.001
Occult blood	−0.026	0.833
Leukocyte level	0.180	0.135
Protein level	−0.005	0.969
Ammonia level	0.109	0.369

WBC: white blood cell, PLT: platelet, Hb: hemoglobin.
[a]p-value by pearson's correlation analysis.

Table 3. Difference between Saliva Flow Rate and Saliva Test according to PSS Level

Variable	PSS		p-value[a]
	Low (n=14) (PSS # 0～13)	High (n=56) (PSS # ≥14)	
Saliva flow rate	2.31±0.30	1.34±0.42	<0.001
Saliva test			
Cariogenic bacteria level	18.00±14.90	24.71±20.78	0.260
Acidity	53.57±21.53	66.70±18.13	0.026
Buffer capacity	28.36±23.84	17.48±9.04	0.008
Occult blood	15.50±19.31	9.27±11.01	0.114
Leukocyte level	24.64±20.33	26.88±22.77	0.739
Protein level	28.07±14.01	25.02±12.63	0.431
Ammonia level	21.93±20.85	28.18±20.08	0.305

Values are presented as mean±standard deviation.
PSS: perceived stress scale.
[a]p-value obtained from Mann-Whitney U-test.

to identify the effects of stress on blood and saliva in adult women and to determine whether they can be used as clinical evaluation indicators to manage stress.

To identify the effect of stress on blood cells, the differences in WBC, PLT, and Hb levels according to the PPS scores were confirmed (Table 2). Previous studies have shown that the human body responds to stressful situations through the nervous system and hormones[23,24]. Cortisol is a representative hormone that can be affected by stress, which suppresses or damages cells of the immune system (T cells and B cells), thereby reducing resistance to inflammatory disease[24,25]. The blood cell count, which is used as a major indicator to evaluate the immune system, is known to increase due to rises in WBC and PLT levels in the blood during an infection or inflammatory response in the body[26]. Therefore, we expected to find low WBC and PLT levels in the high-stress group. However, in the study results, there were no differences in the WBC and PLT levels between the groups. This is because the PSS, the stress scale used in this study, evaluated both positive and negative stress experienced by the participant during the last month and stress that the participant felt at that moment. This might not have been sufficient to affect the immune system of the body. According to previous studies, even when exposed to the same stressful environment, experiencing positive stress for a short period of time can lead to the secretion of a small amount of adrenocorticotropic hormone from the pituitary gland and activation of the parasympathetic nerve within 10 minutes, which then returns to its original state[27,28]. In addition, it has recently been shown that chronic stress suppresses or dysregulates immune function, and acute stress often has immuno-enhancing effects[29]. Thus, to clearly interpret the results between individual perceived stress and blood test results, further studies that consider the type and duration of stress are required. On the other hand, regarding the Hb levels, the average values in the high- and low-stress groups were 12.41±0.67 g/dl and 13.01±0.63 g/dl, respectively, and the high-stress group had a Hb level that was lower by approximately 0.6 g/dl. Although there was a statistically significant difference in the Hb levels between the groups according to the PPS scores, this result might have little clinical significance. The normal Hb range in adult women is 12 to 15 g/dl. Nevertheless, these differences between the stress groups might have been attributed to physiological stress responses. When exposed to a stressful environment, the sympathetic and parasympathetic nervous systems are stimulated and activated. As a result, the pulse rate and blood pressure increase, which stimulates the movement of the heart. In addition, the secretion of the hormone adrenaline also increases, which constricts the blood vessels, raises blood pressure, and increases the number and intensity of heartbeats, in turn greatly increasing blood output from the heart[24,30]. The significant difference in the Hb levels between the stress groups might have been due to the effect of the exposure of such stress on blood vessels and blood flow.

In this study, we also analyzed the saliva flow rate and cariogenic bacteria, acidity, buffer capacity, occult blood, leukocytes, protein, and ammonia in the saliva using the saliva multi-test system to confirm the effect of perceived stress on saliva (Table 3). Participants with high stress levels (1.34 ml/min) had a statistically significantly lower saliva flow rate than those with low stress levels (2.31 ml/min). According to a previous study, salivation is regulated by the activity of parasympathetic nerves and sympathetic nerves such as the glossopharyngeal nerve and facial nerve that are distributed in the salivary glands. As this decrease in salivation can affect the development of oral diseases, such as dry mouth, burning mouth syndrome, and bad breath, careful attention is required[13]. On the other hand, regarding the effect of stress on saliva components using the saliva multi-test system, there were differences in the acidity and buffer capacity levels between the stress groups. These results were consistent with those of previous studies that reported that stress affects the salivary glands through the autonomic nervous system, which increases salivary turbidity and protein content and decreases pH[31,32]. Regarding the saliva flow rate, there is skepticism about evaluating salivary component changes as a measure of stress because a change in the composition of saliva may be caused by a decrease in the saliva flow rate[33]. However, our study results found that high stress levels can affect the saliva flow rate; hence, considering the saliva flow rate and saliva composition changes separately might be clinically limiting. Therefore, if the saliva flow rate and saliva components are considered in the process of examining the saliva multi-test system, it might be possible to predict the psychological and oral health status of participants more comprehensively.

Finally, we tried to confirm whether the blood and saliva can be utilized to objectify an individual's perceived stress by confirming the correlations of the PPS scores with the blood cell test and saliva test results (Table 4). The perceived stress level showed a small correlation with the Hb level in the blood (r=−0.287) and the salivary factors acidity (r=0.320) and buffer capacity (r=−0.381), which were significantly different between the stress groups. As stress has complex actions on blood and saliva, there are limitations to suggesting a high correlation. Nevertheless, this study is meaningful because it demonstrates the possibility of predicting an individual's stress level and obtaining health information easily in a dental institution through indicators such as blood and saliva compositions. In previous studies on stress, many stress-related hormones were analyzed in blood, urine, and saliva samples because stress is closely related to endocrine changes[31)]. In particular, saliva samples can be obtained easily, and researchers will be able to replace them without worrying about problems related to blood or urine measurement, which are subject to physical restraints or ethical issues. Saliva is already highly utilized as a biomarker of not only oral health but also systemic health[34,35)]. Therefore, if personal health information can be easily determined through the analysis of saliva flow rate and saliva composition while visiting a dental institution, it can be advantageously utilized for personal health management.

Notes

Conflict of interest

No potential conflict of interest relevant to this article was reported.

Ethical approval

This study was approved by the Institutional Review Board of Yonsei Wonju Christian Hospital (IRB No. CR320088).

Author contributions

Conceptualization: Mi-Kyoung Jun. Data acquisition: Sun-Mi Lee and Mi-Kyoung Jun. Formal analysis: Mi-Kyoung Jun and Eun-Ha Jung. Writing—original draft: Sun-Mi Lee and Eun-Ha Jung. Writing—review & editing: Mi-Kyoung Jun.

ORCID

Sun-Mi Lee, *https://orcid.org/0000-0003-3133-8912*
Eun-Ha Jung, *https://orcid.org/0000-0002-3737-5899*
Mi-Kyoung Jun, *https://orcid.org/0000-0003-1813-9193*

References

1. Block J, Block JH: Venturing a 30-year longitudinal study. Am Psychol 61: 315-327, 2006. https://doi.org/10.1037/0003-066X.61.4.315
2. Jia YF, Loo YT: Prevalence and determinants of perceived stress among undergraduate students in a Malaysian University. J Health Transl Med 21: 1-5, 2018.
3. Han KS: Self efficacy, health promoting behaviors, and symptoms of stress among university students. J Korean Acad Nurs 35: 585-592, 2005. https://doi.org/10.4040/jkan.2005.35.3.585
4. Kim YB: An Analysis on the change of health status, health behavior, and influencing factors among American college and university students. Korean J Health Educ Promot 27: 153-163, 2010.
5. Oh JK, Kim YJ, Kho HS: A study on the clinical characteristics of patients with dry mouth. J Oral Med Pain 26: 331-343, 2001.
6. Bates JF, Adams D: The influence of mental stress on the flow of saliva in man. Arch Oral Biol 13: 593-596, 1968. https://doi.org/10.1016/0003-9969(68)90121-0
7. Hafner RJ: Physiological changes with stress in depression and obsessional neurosis. J Psychosom Res 18: 175-179, 1974. https://doi.org/10.1016/0022-3999(74)90018-x
8. Lee JH, Kim CY: The effects of stress on salivary cortisol level of some of the dental hygienists. J Dent Hyg Sci 12: 63-70, 2012.
9. Kim DS, Chung YS, Park SK: The relationship between the

stress hormone, salivary cortisol level and stress score by self-report measurement. Korean J Psychol Gen 9: 633-645, 2004.
10. Mandel ID: The functions of saliva. J Dent Res 66 Spec No: 623-627, 1987. https://doi.org/10.1177/00220345870660S203
11. Kim DS, Sung HH, Song CS, Park CE: The correlation between the stress and blood component of female employees with age. J Korea Entertain Ind Assoc 8: 101-108, 2014. https://doi.org/10.21184/jkeia.2014.12.8.4.101
12. Baek D, Park Y: Association between erythrocyte n-3 polyunsaturated fatty acids and biomarkers of inflammation and oxidative stress in patients with and without depression. Prostaglandins Leukot Essent Fatty Acids 89: 291-296, 2013. https://doi.org/10.1016/j.plefa.2013.09.008
13. Ryu JW, Yoon CL, Ahn JM: Application of stress hormones in saliva in research of orofacial pain related with stress. J Oral Med Pain 32: 201-210, 2007.
14. Park JH, Seo YS: Validation of the perceived stress scale (PSS) on samples of Korean university students. Korean J Psychol Gen 29: 611-629, 2010.
15. Bulthuis MS, Jan Jager DH, Brand HS: Relationship among perceived stress, xerostomia, and salivary flow rate in patients visiting a saliva clinic. Clin Oral Investig 22: 3121-3127, 2018. https://doi.org/10.1007/s00784-018-2393-2
16. Dawes C: Circadian rhythms in human salivary flow rate and composition. J Physiol 220: 529-545, 1972. https://doi.org/10.1113/jphysiol.1972.sp009721
17. Navazesh M, Kumar SK: Measuring salivary flow: challenges and opportunities. J Am Dent Assoc 139 Suppl: 5S-40S, 2008. https://doi.org/10.14219/jada.archive.2008.0353
18. Korean statistical information service: Perceived stress rate. Retrieved June 1, 2021, from https://kosis.kr/index/index.do (2020, Feb 11)
19. Korean Statistical Information Services: 2020 Korea social indicators. Retrieved Jun 1, 2021, from https://www.kostat.go.kr/portal/korea/kor_nw/1/1/index.board?bmode=read&aSeq=388792 (2021, Mar 25)
20. Cheon SH: Relationships among daily hassles, social support, entrapment and mental health status by gender in university students. Korean J Women Health Nurs 18: 223-235, 2018. https://doi.org/10.4069/kjwhn.2012.18.3.223
21. Schneiderman N, Ironson G, Siegel SD: Stress and health: psychological, behavioral, and biological determinants. Annu Rev Clin Psychol 1: 607-628, 2005. https://doi.org/10.1146/annurev.clinpsy.1.102803.144141
22. Vinkers CH, Penning R, Hellhammer J, et al.: The effect of stress on core and peripheral body temperature in humans. Stress 16: 520-530, 2013. https://doi.org/10.3109/10253890.2013.807243
23. Camara EG, Danao TC: The brain and the immune system: a psychosomatic network. Psychosomatics 30: 140-146, 1989. https://doi.org/10.1016/S0033-3182(89)72294-5
24. Ranabir S, Reetu K: Stress and hormones. Indian J Endocrinol Metab 15: 18-22, 2011. https://doi.org/10.4103/2230-8210.77573
25. Koh KB: Stress and immune function. Korean J Psychosom Med 4: 146-154, 1996.
26. Park SK: An interpretation on abnormal finding of CBC. Korean J Med 78: 531-539, 2010.
27. Dhabhar FS: Enhancing versus suppressive effects of stress on immune function: implications for immunoprotection versus immunopathology. Allergy Asthma Clin Immunol 4: 2-11, 2008. https://doi.org/10.1186/1710-1492-4-1-2
28. Morey JN, Boggero IA, Scott AB, Segerstrom SC: Current directions in stress and human immune function. Curr Opin Psychol 5: 13-17, 2015. https://doi.org/10.1016/j.copsyc.2015.03.007
29. Dhabhar FS, McEWEN BS: Bi-directional effects of stress on immune function: possible explanations for salubrious as well as harmful effects. In: Ader R, ed. Psychoneuro-immunology. 4th ed. Elsevier, St. Louis, pp.723-760, 2007.
30. Burrage E, Marshall KL, Santanam N, Chantler PD: Cerebrovascular dysfunction with stress and depression. Brain Circ 4: 43-53, 2018. https://doi.org/10.4103/bc.bc_6_18
31. Koo HM, Au Q, Chun YH, Hong JP: Change of the amylase secretion on the rat submandibular gland in the restraint stress condition. J Oral Med Pain 32: 57-67, 2007.
32. Morse DR, Schacterle GR, Esposito JV, Furst ML, Bose K: Stress, relaxation and saliva: a follow-up study involving clinical endodontic patients. J Human Stress 7: 19-26, 1981.

https://doi.org/10.1080/0097840X.1981.9936829
33. Go HS: Stress and salivary gland disease. J Korean Dent Assoc 36: 755-759, 1998.
34. Dawes C, Wong DTW: Role of saliva and salivary diagnostics in the advancement of oral health. J Dent Res 98: 133-141, 2019. https://doi.org/10.1177/0022034518816961
35. Zhang CZ, Cheng XQ, Li JY, et al.: Saliva in the diagnosis of diseases. Int J Oral Sci 8: 133-137, 2016. https://doi.org/10.1038/ijos.2016.38