



# The Effect of Body Weight and Psychological Characteristics on Periodontal Disease Development

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## Abstract

**Aim:** The aim of the study was to examine the association between periodontal health in young patients with various body mass indexes and psychological traits such as temperament, level of anxiety, and autonomic nervous system tone.

**Materials and methods:** The study included 132 male and female subjects aged 18–22 years with different body mass indexes (BMI). They were allocated into four groups by their BMIs: normal weight, overweight, and first- and second-degree obesity. We completed periodontal charts for all patients and evaluated basic oral hygiene and periodontal indexes, such as the Green-Vermillion index (OHI), the approximal plaque index by Lange (API), and papilla bleeding index by Saxer & Mühlemann (PBI). Eysenck personality questionnaire, the state-trait anxiety inventory of Spielberger-Khanin, and Wayne questionnaire were used to determine the psychological characteristics.

**Results:** Patients with the first and second degrees of obesity were found to have the highest prevalence and severity of generalized gingivitis (up to 90%). Patients with normal BMI had significantly lower levels of extraversion and higher levels of neuroticism than the obese individuals, while subjects with extra weight and normal BMI were more emotionally stable. We found no evidence that choleric or melancholic temperament had an impact on BMI or periodontal health. However, phlegmatic temperament was found to be linked to a normal BMI, good oral hygiene, and an intact periodontium, while sanguine temperament was linked to obesity and gingivitis in young adults. A significantly higher level of state and trait anxiety was observed in obese individuals. Fifty percent of the obese subjects had disturbances of the functional state of the cardiovascular system and the tone of the autonomic nervous system.

**Conclusions:** Because obesity and periodontal pathology are multifactorial diseases linked to lifestyle, stress tolerance, and habits, personality temperament may play a causal role in their development.

## Keywords

gingivitis, personality type, obesity, temperament, stress

## INTRODUCTION

The prevalence of periodontal diseases is among the highest in the world; in some populations, it can reach 96%.<sup>[1,2]</sup> Despite enormous advances in preventive dentistry, the number of patients with periodontal diseases continues to rise. Systemic factors modify the body's response to the local pathogen (parodontopathogenic microflora). Periodontal diseases are associated with numerous systemic conditions such as diabetes mellitus, chronic viral diseases, cardiovascular pathology, obesity, etc.<sup>[3-6]</sup> Stress is one of the most underestimated factors in the onset of periodontal disease, and a person's response to stress is determined by their temperament, behavior, psychological and physiological peculiarities. Stress disrupts the balance between the central nervous system and the immune system via a complex network of bidirectional signals linking the nervous, endocrine, and immune systems. Chronic stress leads to hyperactivation of the hypothalamus-pituitary-adrenal axis, which has an immunosuppressive effect, and down-regulation of the inflammation, which leads to severe damage of periodontal structures.<sup>[7]</sup> A study has found that chronic stress can modulate immune response via the autonomic nervous system pathways, release of neuropeptides, and hypothalamic and pituitary hormones.<sup>[8]</sup>

Stress can cause periodontal damage indirectly by altering salivary flow and quality, changing pH, or by changing the chemical composition of saliva, such as IgA secretion, enzymatic activity, and so on.<sup>[9]</sup> Children who experience high levels of anxiety typically develop oral habits like thumb sucking, tongue thrusting, infantile swallowing, and biting of the tongue, lip, cheek, or fingernails. Adults, however, as a result of stress and anxiety, develop bad habits like neurotic clenching, bruxism, tooth doodling, and smoking, which change the periodontal structures. Emotions can affect the smooth muscle tonus of gingival blood vessels by

regulating the autonomic nervous system. Furthermore, the constant constriction of blood vessels during long-lasting or continuous emotions may impair the supply of oxygen and nutrients to tissues.<sup>[10]</sup>

Body weight reflects the personality traits and lifestyle choices of people and contributes to the way they perceive themselves.<sup>[11]</sup> People who have high neuroticism or extraversion but low conscientiousness were found to have higher BMI, more body fat, and a larger waist and hip circumference.<sup>[12]</sup> Chronic stress can also induce obesity by activating stress-induced emotional eating.<sup>[3,13]</sup>

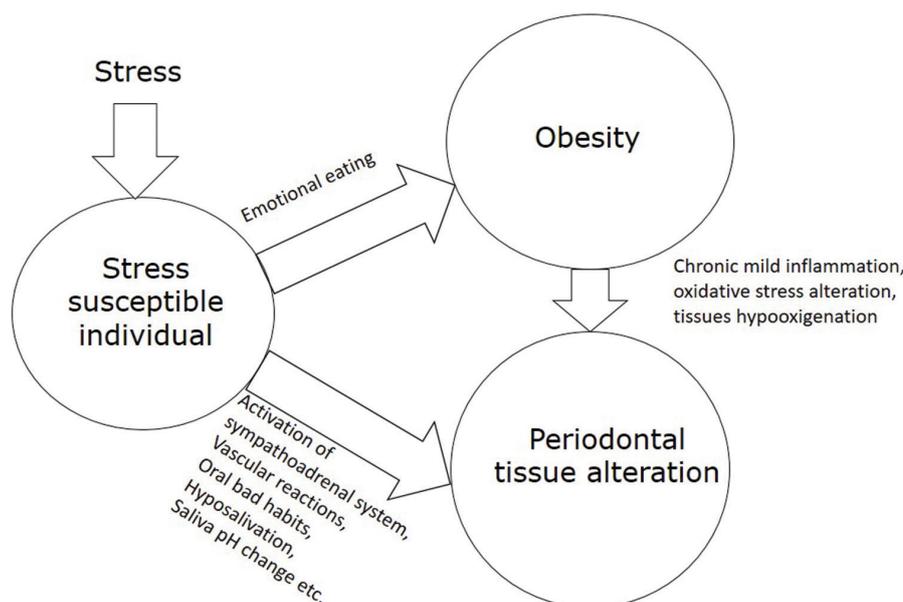
Thus, the individual's temperament, which determines the body's response to stress, the level of neuroticism, and the sympathetic nervous system's response to stress, regulates the inflammatory process in patients with periodontal diseases. Stress triggers the emotional component of eating behavior, which leads to obesity development and additionally exacerbate periodontist via adipocytokines secretion by adipocytes.<sup>[14]</sup> This hypothesis is illustrated in **Fig. 1**.

## AIM

The research aims to discover the relationship between psychological peculiarities (temperament, anxiety level, and autonomic nervous system tone) and periodontal health in young patients with different BMI.

## MATERIALS AND METHODS

The study included 132 male and female participants ages 18 to 22. The Bioethics Commission of Poltava State Medical University approved the research design (decision No. 197). All participants provided written informed consent.



**Figure 1.** Possible mechanism of temperament and obesity influence on periodontal health.

To achieve the objectives of the study, the sample consisted of a group of 132 individuals of both sexes, aged 18–22 years. According to the sample size calculation, with a 95% confidence interval. Sample size calculation was performed in accordance with the recommendations for cross-sectional studies using the Sample Size Calculator program.<sup>[15]</sup> The minimal size of each group should be 28, type I error rate ( $\alpha$ )=5%, (estimated prevalence of 26.9%; 95% CI 22.4 to 27.3), the margin of error considered as 85%. The inclusion criteria were age 18–22 years, different body mass index (BMI), and a signed informed consent for participation in the research. The exclusion criteria were pregnancy, breastfeeding, drug use, alcoholism, a history of a mental disorder, participation in another study at least 2 months before inclusion in the following study, history of active tuberculosis and viral hepatitis, and presence of non-removable orthodontic appliance in the oral cavity.

BMI was determined for all patients. According to the BMI, patients were allocated into four groups: group 1 consisted of 33 people with normal BMI (18.5–24.9 kg/m<sup>2</sup>), group 2 had 36 people with extra weight (BMI, 25–29.9 kg/m<sup>2</sup>), group 3 was of 31 persons with the first degree of obesity (BMI, 30–34.9 kg/m<sup>2</sup>), and group 4 – 32 persons with the second degree of obesity (BMI, 35–39.9 kg/m<sup>2</sup>). The initial periodontal status was evaluated using the oral hygiene index which includes determination of the Green-Vermillion index (OHI), the approximal plaque-index by Lange (API), and the papilla bleeding index by Saxer and Mühlemann (PBI). Periodontal charts were completed for all patients. Periodontal diagnosis was made according to the 2017 Classification of Periodontal and Peri-Implant Diseases and Conditions (November 9–11, 2017 Chicago).<sup>[16]</sup>

### Analysis of psychological characteristics of individuals

The temperament is a component of a personality that characterizes the ways of behavior and expression rather than their content. Temperament is determined biologically – by the quotient of genetic and environmental factors affecting the intrauterine fetal development, and, indirectly, the physiological properties of the brain. The temperament type is an important predictor of the occurrence of certain somatic diseases.<sup>[17]</sup> We used the Eysenck personality questionnaire to measure two dimensions of personality, Extroversion-Introversion and the level of neuroticism.<sup>[18]</sup> The questionnaire consists of 57 closed questions with Yes or No answers. Twenty-four questions are used to assess extroversion, 24 questions to determine neuroticism, and 9 questions to control the reliability of answers.

Neuroticism is one of the most well established and empirically validated personality trait domains, with a substantial body of research to support its heritability, childhood antecedents, temporal stability across the life span, and universal presence. Neuroticism is the trait disposition to experience negative effects, including anger, anxiety,

self-consciousness, irritability, emotional instability, and depression. The level of neuroticism determines the response of the personality to the environmental stress, assessment of the ordinary situations, and the type of behavioral reaction to a certain type of situation.<sup>[19]</sup> According to LA Ulyanova, a score of 1 to 13 points in the extra-introversion scale indicates introversion, and 14–24 points – extroversion. The level of neuroticism up to 12 points is characterized as low – such individuals are emotionally stable; a level of neuroticism exceeding 12 points characterizes emotionally unstable individuals. According to the Eysenck's hypothesis, Pavlov's strong and weak types are very close to extroverted and introverted personality types. By the introversion, extroversion, and neuroticism, the personality temperament type was determined according to Pavlov's classification: sanguine, choleric, phlegmatic, and melancholic temperaments.

The study of the state and trait anxiety was determined using the state-trait anxiety inventory (STAI) of CD Spielberger, later adapted by Khanin YL. The Spielberger-Khanin scale consists of 40 questions, 20 of them aiming to determine state anxiety, and the other 20 – the trait anxiety. For each of the proposed questions, there are 4 answer options according to the degree of intensity. The results were interpreted as follows: a score of up to 30 points indicated a low level of anxiety, a score of 31 to 44 points indicated a moderate level, and a score of over 45 points indicated a high level of anxiety.<sup>[20]</sup>

### Determination of the autonomic nervous system tone.

To determine the initial state of the central nervous system and to identify signs of changes in its function, a questionnaire designed by Wayne was used.<sup>[18]</sup> This questionnaire consists of 17 questions with the answer options of 'yes' or 'no' and is filled in by the patient. Each question has a value of 3–8 points. The result is calculated as a total sum of questions. In healthy individuals, the sum of the second part should not exceed 25 points, and if it is higher, a syndrome of autonomic dysfunction is diagnosed.<sup>[21,22]</sup>

### Statistical analysis

GRAPHPAD PRISM 8.0.1 by Dotmatics was used for data statistical analysis. All results were described as mean and standard deviation. For data analysis, we used a one-factor analysis of variance (one-way ANOVA) for unrelated samples and corrections Bonferroni for multiple comparisons was done. The difference between groups was considered statistically significant at  $p < 0.05$ . Correlation relationships were determined using the Spearman's rank correlation test. Statistical analysis of the data in percentages was performed using the method of variation statistics according to IA Oyvin.

## RESULTS

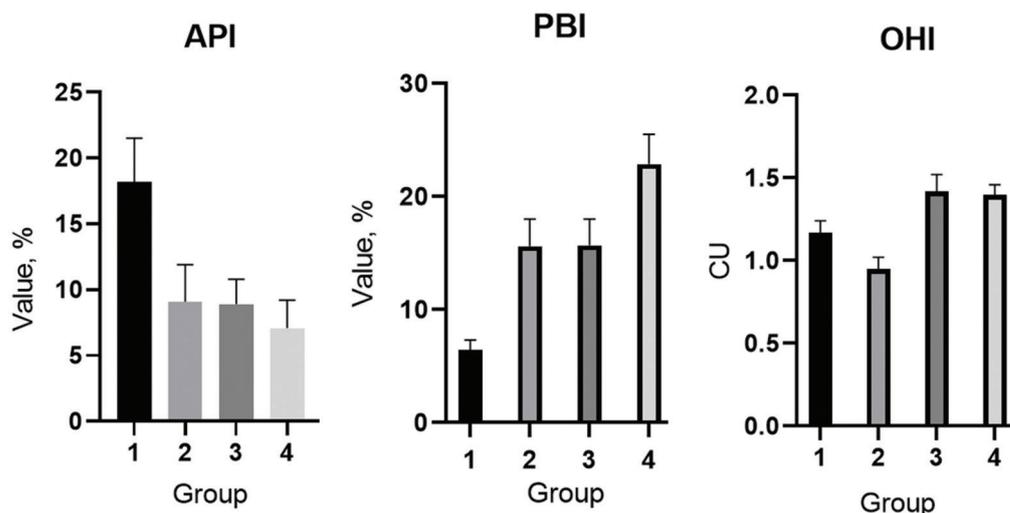
The average mean  $\pm$  standard deviation of BMI in group 1 was  $22.69 \pm 0.29$  kg/m<sup>2</sup>, in group 2 –  $27.84 \pm 0.21$  kg/m<sup>2</sup>, in group 3 –  $32 \pm 0.28$  kg/m<sup>2</sup>, and in group 4 –  $38.18 \pm 0.68$  kg/m<sup>2</sup>. Intact periodontium was diagnosed in 45.5% of the individuals in group 1, in 25% of group 2, in 19.4% of group 3, and in 9.4% of group 4. Biofilm-associated gingivitis was diagnosed in 54.5% of group 1, and in 75% of group 2. Den-

tal plaque-induced gingivitis modified by systemic factor (obesity) was detected in 80.6% of group 3 individuals and in 90.6% of group 4.

The values of OHI, PBI and API are shown in **Fig. 2**.

Analysis of the temperament and neuroticism level in patients with diverse BMI, based on the Eysenck personality questionnaire, is presented in **Table 1**.

The results of state-trait anxiety assessment of CD Spielberger are presented in **Table 2**.



**Figure 2.** Values of hygienic indices in patients with diverse BMI.

**Table 1.** Analysis of temperament and neuroticism level in patients with diverse BMI

Group	1	2	3	4
Extraversion-Introversion	10.63 $\pm$ 0.43	13.03 $\pm$ 0.51	12.3 $\pm$ 0.5	12.94 $\pm$ 0.6
	$p_{(1-2)} < 0.05, p_{(1-3)} < 0.05, p_{(1-4)} < 0.05, p_{(2-3)} > 0.05, p_{(2-4)} > 0.05, p_{(3-4)} > 0.05$			
Neuroticism	11.53 $\pm$ 0.64	11.16 $\pm$ 0.65	12.13 $\pm$ 0.66	12.63 $\pm$ 0.73
	$p_{(1-2)} > 0.05, p_{(1-3)} > 0.05, p_{(1-4)} > 0.05, p_{(2-3)} < 0.05, p_{(2-4)} < 0.05, p_{(3-4)} > 0.05$			
Melancholic	18.2% $\pm$ 6.7	11.1% $\pm$ 5.3	16.1% $\pm$ 6.6	9.4% $\pm$ 5.2
Choleric	24.2% $\pm$ 7.5	25% $\pm$ 7.2	32.3% $\pm$ 8.4	25% $\pm$ 7.6
Sanguine	12.1% $\pm$ 5.7	38.9% $\pm$ 8.1	22.6% $\pm$ 7.5	46.9% $\pm$ 8.8
Phlegmatic	45.5% $\pm$ 8.7	25% $\pm$ 7.2	29% $\pm$ 8.1	18.7% $\pm$ 6.9

**Table 2.** Spielberger's state-trait anxiety assessment

Group	1	2	3	4
Trait anxiety	40.93 $\pm$ 1.25	43.25 $\pm$ 0.65	49.16 $\pm$ 1.32	49.75 $\pm$ 0.89
	$p_{(1-2)} > 0.05, p_{(1-3)} < 0.01, p_{(1-4)} < 0.01, p_{(2-3)} < 0.05, p_{(2-4)} < 0.05, p_{(3-4)} > 0.05$			
Low level	9.1% $\pm$ 5.0	-	6.45% $\pm$ 4.1	-
Moderate level	66.6% $\pm$ 8.2	77.7% $\pm$ 6.9	6.45% $\pm$ 4.1	9.38% $\pm$ 4.9
High level	24.3% $\pm$ 7.5	22.3% $\pm$ 6.9	87.1% $\pm$ 5.6	91.62% $\pm$ 4.9
State anxiety	41.63 $\pm$ 1.5	41.13 $\pm$ 1.06	47.06 $\pm$ 1.1	46.15 $\pm$ 1.48
Low level	9.1% $\pm$ 6.9	2.7% $\pm$ 2.7	9.7% $\pm$ 5.3	6.25% $\pm$ 4.3
Moderate level	63.6% $\pm$ 8.4	66.6% $\pm$ 7.9	29% $\pm$ 8.2	43.75% $\pm$ 8.8
High level	27.3% $\pm$ 7.8	30.7% $\pm$ 7.7	61.3% $\pm$ 8.8	50% $\pm$ 8.8

The results of the functional state of the cardiovascular system and a tone of the autonomic nervous system assessment in patients with diverse BMI are presented in **Table 3**.

### Correlation analysis

A high level of correlation was found in group 1 between the functional state and tone of the autonomic nervous system index (Wayne index) and the API ( $r=-0.51$ ), the level of neuroticism and personal anxiety ( $r=0.67$ ). In group 2, a high level of correlation was found between the trait anxiety and Wayne index ( $r=0.6$ ) and the Wayne index and the level of neuroticism ( $r=0.58$ ). In group 3, the level of correlation between the state anxiety and BMI was  $r=-0.51$ , the level of neuroticism and BMI  $r=-0.53$ , the level of neuroticism and personal anxiety  $r=0.62$ . In group 4, a high correlation was found between the Wayne index and the level of personal anxiety ( $r=0.63$ ). The correlation coefficient between the level of neuroticism and personal anxiety was  $r=0.55$  and between neuroticism and the Wayne index  $r=-0.51$ .

## DISCUSSION

Periodontal diseases were found to have the highest prevalence (up to 90%) in patients with the first and second degree of obesity. The biofilm-associated gingivitis predominated in patients with normal BMI and excess weight, whereas the dental plaque-induced gingivitis modified by some systemic factors predominated in obese patients. Patients with excess weight and obesity had disease severity as measured by PBI (**Fig. 2**) that was significantly higher than that of subjects with normal BMI, with patients with second-degree obesity having the highest PBI. The oral cavity hygiene (measured by API and OHI) (**Fig. 2**) was significantly worse in patients with obesity compared with the individuals with normal BMI. This testifies to the neglect of basic individual hygiene of the oral cavity, such as regular tooth brushing, flossing, and tongue cleaning. The data we obtained that indicated that obesity affects periodontal health is consistent with other studies looking at the prevalence of periodontal diseases in obese patients.<sup>[23-26]</sup> However, in most of them the age range they study is quite wide (from 18 to 60 years) which makes it impossible to find the time when gingivitis first appears and when it transforms into periodontitis in obese people. Our findings show that in young individuals with obesity, gingivitis has a more severe course compared with normal

BMI subjects. We can explain it by the strong adaptive potential of young patients, which prevents the destruction of junctional epithelium and restrains the development of clinical attachment loss.

Based on our findings, patients with normal BMI had a significantly lower level of extraversion-introversion compared with obese and extra weight individuals ( $p<0.05$ ), while obese subjects had significantly poorer oral hygiene ( $p<0.05$ ). Our findings contradict a similar study conducted in 1977 by Vogel, who discovered that introversion is associated with periodontal disease severity and poor oral hygiene.<sup>[27]</sup> However, because the study was conducted 50 years ago and included subjects aged 21 and older (a rather broad age range), we believe that over the last 50 years, people have become more aware of the importance of oral hygiene, and the shift in their behavior occurred as a result of the rapid development of technology, the environment, and dental education development. Another study on older adult population reported that the periodontal diseases were significantly less prevalent in extroverts.<sup>[28]</sup>

Young obese subjects had significantly higher level of neuroticism, while extra weight and normal BMI subjects were more stable. Since body weight reflects the behavioral and lifestyle patterns of every individual, individuals with higher neuroticism have higher BMIs.<sup>[12]</sup> We suggest that higher neuroticism is linked to poor oral hygiene in obese people because they avoid regular oral cavity care, such as brushing teeth and flossing, due to the constant feeling of fatigue reported by 87.5% of obese patients. High neuroticism is associated with activation of the sympathetic nervous and sympathoadrenal systems, which leads to severe vascular and behavioral responses such as emotional eating.<sup>[3,29]</sup>

We found no differences in the prevalence of melancholic or choleric temperaments in patients with different BMIs in our study. However, the number of subjects with sanguine temperament was significantly higher in patients with obesity and gingivitis. The prevalence of phlegmatic temperament was highest, up to 50%, in patients with normal BMI and was associated with healthy periodontal tissues and good oral hygiene, whereas the number of subjects with phlegmatic temperament was two times lower in obese and extra-weight individuals. Our results are consistent with a study on college students, which has found that extraverts have better oral hygiene and that the best oral cavity hygiene is detected in melancholic and phlegmatic subjects, while bad mouth odor, intensive tongue coating, and a high level of stress are detected in choleric and sanguine students.<sup>[30]</sup>

**Table 3.** Assessment of the functional state and tone of the autonomic nervous system

Group	1	2	3	4
The first questionnaire	23.02±1.42	24.52±2.6	25.94±2.3	29.93±2.37
	$P_{(1-2)}>0.05, P_{(1-3)}>0.05, P_{(1-4)}<0.05, P_{(2-3)}>0.05, P_{(2-4)}<0.05, P_{(3-4)}<0.05$			
Normal, %	72.7%	62.8%	51.6%	50%
Disturbance, %	27.3%	37.2%	48.4%	50%

State anxiety reflects the degree of an individual's concern and emotional tension in response to a specific stressful situation. Trait anxiety is a more constant and stable individual characteristic that reflects the personality's complex of emotional and behavioral response to stress. Furthermore, anxiety influences blood pressure control and the severity of inflammatory reactions.<sup>[31]</sup> Obese people were found to have the highest levels of trait and state anxiety, and their levels were significantly higher than those of the subjects with a normal BMI ( $p < 0.01$ ). According to the qualitative analysis of state-trait anxiety, subjects with a BMI of 29.99 kg/m<sup>2</sup> or less exhibited a moderate level of state and trait anxiety, whereas obese people with a BMI of 30 kg/m<sup>2</sup> or higher exhibited a high level of this anxiety. The systematic review showed that a high level of anxiety was associated with chronic periodontitis in adult patients and exacerbation of the disease.<sup>[32]</sup> Our results showed that a high level of state and trait anxiety was associated with a high BMI, obesity, and development of gingivitis in young individuals. High level of trait and state anxiety contributes to gingivitis developments through modification of the stress response (vascular reaction and sympathoadrenal system activation), and indirectly, by triggering emotional eating that leads to obesity<sup>[3,7,13,27]</sup> (Fig. 1).

Almost 50% of the obese subjects experienced a functional state disturbance of the cardiovascular system and the tone of the autonomic nervous system. It is significantly two times more common for obese people to have problems with the tone of their autonomic nervous system and their cardiovascular system's functionality than it is for people with a normal body mass index. Disturbance of the autonomic regulation of the body occurs against the background of obesity. An impaired autonomic nervous system function creates conditions for cardiovascular pathology, while the deviations in autonomic tone and changes in the autonomic nervous system reactivity lead to changes in periodontal tissue blood supply.<sup>[6,32]</sup>

According to the research findings, an individual's temperament and trait anxiety levels – which are the more stable individual characteristics that do not change over time and determine the personality's habits, behavior, lifestyle, response to stress, etc. – are the determining factors of gingivitis and obesity development. In some cases, a person's temperament can be the initial factor that causes obesity and periodontal pathology because these two are multifactorial diseases that are associated with lifestyle, stress resistance, and habits.

## CONCLUSIONS

When compared to people of normal weight, young obese people had a significantly higher prevalence of generalized gingivitis and a significantly higher level of neuroticism. The majority of young obese subjects had a sanguine temperament, while phlegmatic temperament predominated in people with normal weight. In all groups, melancholic

and choleric temperaments were equally prevalent. Obese individuals had a significantly higher state and trait anxiety level compared with normal-weight individuals. Almost 50% of the obese subjects had a functional state disturbance of the cardiovascular system and the autonomic nervous system tone. Sanguine or phlegmatic temperaments can be associated with high or low risk of obesity development and more severe course of periodontal diseases as a secondary event.

## Author contributions

Research concept and design: M.S., T.P., K.N., I.S., M.S., and N.V.; Collection and/or assembly of data: M.S. and K.N.; Data analysis and interpretation: M.S., T.P., and K.N.; Manuscript drafting: M.S.; Critical revision of the article: I.S., M.S., and N.V.; Final approval of the article: I.S., M.S., and N.V.

## Conflict of Interest

Authors declared no conflicts of interests

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# Влияние массы тела и психологических особенностей на развитие заболеваний пародонта

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## Резюме

**Цель:** Целью исследования было изучить связь между здоровьем пародонта у молодых пациентов с различными индексами массы тела и психологическими особенностями, такими как темперамент, уровень тревожности и тонус вегетативной нервной системы.

**Материалы и методы:** В исследование были включены 132 испытуемых мужского и женского пола в возрасте 18–22 лет с различным индексом массы тела (ИМТ). Их разделили на четыре группы по ИМТ: нормальный вес, избыточный вес и ожирение первой и второй степени. Мы заполнили пародонтологические карты для всех пациентов и оценили основные показатели гигиены полости рта и пародонтальные индексы, такие как индекс Green-Vermillion (ОИ), индекс аппроксимального зубного налёта Lange (API) и индекс кровоточивости сосочков Saxer & Mühlemann (PBI). Для определения психологических характеристик использовали личностный опросник Eysenck, опросник состояния тревожности Spielberger-Khanin и опросник Wayne.

**Результаты:** Установлена наибольшая распространённость и тяжесть генерализованного гингивита (до 90 %) у пациентов с ожирением первой и второй степени. У пациентов с нормальным ИМТ наблюдался значительно более низкий уровень экстраверсии и более высокий уровень невротизма, чем у лиц с ожирением, тогда как субъекты с лишним весом и нормальным ИМТ были более эмоционально стабильными. Мы не нашли доказательств того, что холерический или меланхолический темперамент влияет на ИМТ или состояние пародонта. Однако было обнаружено, что флегматический темперамент связан с нормальным ИМТ, хорошей гигиеной полости рта и неповреждённым пародонтом, тогда как сангвинический темперамент связан с ожирением и гингивитом у молодых людей. Значительно более высокий уровень тревожности как состояние или черта личности наблюдался у лиц с ожирением. У 50 % больных с ожирением наблюдались нарушения функционального состояния сердечно-сосудистой системы и тонуса вегетативной нервной системы.

**Заключение:** Поскольку ожирение и патология пародонта являются многофакторными заболеваниями, связанными с образом жизни, стрессоустойчивостью и привычками, темперамент личности может играть причинную роль в их развитии.

## Ключевые слова

гингивит, тип личности, ожирение, темперамент, стресс