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ASSESSMENT OF CHANGES IN THE BIOCHEMICAL STORE OF STUDENTS' SALIVA DURING PHYSICAL ACTIVITIES OF VARIOUS INTENSITY

V. V. BEVZO

Bukovinian State Medical University,
Ukraine, 58002, Chernivtsi, Theater Square, 2
bevzo.valentyna@bsmu.edu.ua

The aim of the work was to study changes in saliva pH, lactate content, mineral composition and α-amylase activity during high and moderate intensity physical activity on the body of students with different levels of physical fitness.
The study involved 2 groups of students: Group 1 – 13 people who attended only physical education classes 2 times a week and performed moderate intensity physical exercises; Group 2 – 12 students who, in addition to academic classes, attended a daily athletics section and performed intense physical activity. Saliva was collected at rest and immediately after completing physical activity of varying intensity. The total calcium, inorganic phosphorus, lactate, α-amylase activity and pH levels were determined in the saliva of students using conventional biochemical methods and standard reagent kits. It was found that high-intensity physical activity leads to a significant increase in pH, lactate concentration, total calcium, inorganic phosphorus and α-amylase activity in the saliva of highly trained students, which reflects the body's response to training stress and indicates the adaptive capacity of the body and metabolic needs caused by physical activity.The results obtained can be used to monitor parameters such as pH, lactate concentration, calcium/phosphorus content and α-amylase activity in saliva, which can provide valuable information on the physiological adaptation of the body during physical activity of varying intensity.

Key words: pH, lactate, calcium, phosphorus, α-amylase, saliva, physical activity.

Introduction. Saliva is a complex fluid containing many substances such as enzymes, electrolytes, and proteins that can reflect changes in the body caused by various stimuli, including physical exercise. Changes in saliva composition during and after physical exercise can provide valuable information about training stress, adaptation, exercise performance, its potential risks, and the ability of saliva to serve as an indicator of health (Franco-Martínez et al., 2019). However, there are currently conflicting data on how the biochemical composition and properties of oral fluid as an environment immediately surrounding the teeth change during long-term exposure to moderate and intense physical activity (Hermann et al., 2019).

The aim of the work was to study changes in saliva pH, lactate content, mineral composition, and α-amylase activity during high- and moderate-intensity physical activity in students with different levels of physical fitness.

Materials and methods. The students were divided into 2 groups: Group 1 – 13 students who attended only physical education classes twice a week and performed moderate-intensity physical exercises; Group 2 – 12 students who, in addition to academic classes, attended a track and field sports section 4–5 times a week and performed intense physical exercise. Saliva was collected at rest and immediately after completing physical exercise of varying intensity.

Pre-selected saliva samples in the amount of 2–3 *ml* were diluted with saline solution by 2 times and centrifuged at 3000 *rpm* for 15 *min*. The supernatant was used for further studies.

The content of total calcium, inorganic phosphorus, lactate, α-amylase activity and pH of oral fluid were determined in the saliva of students using generally accepted biochemical methods and standard reagent kits.

Statistical processing of the results was performed using Student's *t*-test. The difference between the control and experimental parameters was considered probable at $p \leq 0.05$. The data are presented as the arithmetic mean (M) and standard error (m): $M \pm m$.

Results and discussion. It was found that the pH values of oral fluid, mineral composition, namely the content of total calcium and inorganic phosphorus, lactate level and α-amylase activity of saliva of students at rest in both experimental groups did not differ significantly and did not depend on their level of physical fitness (Table 1).

One of the key parameters affected by physical activity is the pH level of saliva. During physical exercises, especially high-intensity ones, the frequency of breathing and metabolic needs increase, which leads to the production of by-

products, such as lactic acid. This can lead to a decrease in the pH level of saliva immediately after training. Thus, in students of group 2, the pH of saliva after intense physical activity decreased by 50%, while in students of group 1, after moderate physical activity, this indicator decreased by 21% compared to the initial level. There is an opinion (Belskaya et al., 2020) that saliva, having a lower buffer capacity than blood, better reflects the violation of the acid-alkaline balance in the athlete's body.

Table 1.

Biochemical composition of students' saliva during moderate and high intensity physical activity

Indicators	1 group, *n*=14		2 group, *n*=14	
	At rest (control)	After exercise	At rest (control)	After exercise
pH	7,31 ± 0,381	5,77 ± 0,320*	7,20 ± 0,452	3,60 ± 0,323*,
Lactate, mmol/l	0,28 ± 0,021	0,33 ± 0,018*	0,32 ± 0,029	0,47 ± 0,029*
Calcium, mmol/l	1,96 ± 0,098	2,21 ± 0,181	2,35 ± 0,128	2,82 ± 0,155*
Phosphorus, mmol/l	4,21 ± 0,218	4,63 ± 0,182	4,66 ± 0,240	5,50 ± 0,225*
α-amylase, U/l	2156 ± 150,9	2608 ± 234,7*	2180 ± 196,8	3924 ± 372,8*

*Note: * – statistically significant difference compared to control, $P \leq 0.05$*

It is known (Ntovas et al., 2022) that the content of lactate in saliva increases due to the increase in the blood level during physical exercise. Determination of lactate content in saliva gives information about the intensity of glycolysis in muscle tissue and the ability to perform anaerobic work (Ferradans et al., 2020). Under the influence of intense physical exertion in the saliva of students of 2 groups, a probable increase in lactate content was observed by 45% compared to the resting state. An 18% increase in lactate content was observed in the saliva of students of group 1 after moderate physical exertion compared to the initial level. A significant increase in the level of lactate during intense physical activity reflects the metabolic demands placed on the body during physical activity.

Calcium-phosphate homeostasis is important for the functioning of all types of body cells, as well as for neuronal and neuro-muscular activity (Lombardi et al., 2022). Homeostatic control of these two parts is important for physical activity and performance of strength exercises. Against the background of a weakly acidic oral fluid environment, there was a probable increase in the content of total calcium and inorganic phosphorus in the saliva of students of the 2nd experimental group after intensive physical exertion by 20% and 18%, respectively, compared to the resting state. In untrained students (group 1), the level of total calcium and phosphorus in saliva decreased and amounted to 13 and 10% compared to the resting state and did not reach statistically significant values.

The activity of salivary α-amylase, an enzyme responsible for the degradation of starch and glycogen and used as a biomarker of activation of the sympathetic nervous system, was determined in the saliva of students after moderate and intense physical exertion. Both cortisol and α-amylase of saliva are markers of response to stress during exercise. However, α-amylase is a sensitive marker of stress caused by physical exertion, as it is produced locally in the salivary glands and is controlled by the autonomic nervous system (Wunsch et al., 2019). A significant increase in salivary α-amylase activity was shown by 1,8 times after intense physical activity in students of group 2, while in students of group 1, after moderate physical activity, this indicator increased by 21% compared to the initial level.

In addition, increased salivary α-amylase activity after exercise may improve the protective effect of saliva, since it is known (Jespersgaard C. et al., 2002) that this enzyme belongs to the non-immunoglobulin factor of human saliva, which inhibits the glucosyltransferase of *Streptococcus mutans* and inhibits the attachment of bacteria to the surfaces of the oral cavity.

In conclusion, it should be noted that physical activity has a significant effect on the biochemical composition of saliva, reflecting the body's reaction to stress caused by physical exertion and metabolic needs. Monitoring of such parameters as pH level, lactate concentration, calcium/phosphorus content and α-amylase activity in saliva can provide valuable information about the physiological adaptation of the body that occurs during physical activity.

Conclusions. The established changes in the biochemical parameters of students' saliva during physical activity of different intensity completely depend on the level of students' physical fitness and tolerance to physical activity.

High-intensity physical activity leads to a significant increase in the pH level and lactate content in the saliva of highly trained students, which reflects the body's response to the training stress caused by physical activity, as well as metabolic needs.

It is shown that the activity of α-amylase in the saliva of student-athletes during physical activity and its dependence on the intensity of physical exercise.

It has been established that regular physical activity and high-intensity exercise are associated with higher levels of calcium and phosphorus in the saliva of students, which may have a positive effect on bone mineralization processes, and also reflects the adaptive capabilities of the body to stress caused by physical exertion.

Interests disclosure. *The authors declare no conflict of interest.*

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ОЦІНКА ЗМІН БІОХІМІЧНОГО СКЛАДУ СЛИНИ СТУДЕНТІВ ПРИ ФІЗИЧНИХ НАВАНТАЖЕННЯХ РІЗНОЇ ІНТЕНСИВНОСТІ

В.В. Бевзо

Буковинський державний медичний університет,
Україна, 58002, м. Чернівці, Театральна площа, 2
bevzo.valentyna@bsmu.edu.ua

Метою роботи було дослідження змін pH слини, вмісту лактату, мінерального складу та активності α-амілази при фізичних навантаженнях високої та помірної інтенсивності на організм студентів з різною фізичною підготовкою. В дослідженні брали участь 2 групи студентів: 1 група – 13 чоловік, що відвідували 2 рази на тиждень лише заняття з фізичної культури та виконували фізичні вправи помірної інтенсивності; 2 група – 12 студентів, які окрім академічних занять відвідували щодня спортивну секцію з легкої атлетики та виконували інтенсивні фізичні навантаження. Слину брали в стані спокою і відразу після завершення фізичних навантажень різної інтенсивності. У слині студентів визначали вміст загального кальцію, неорганічного фосфору, лактату, активності α-амілази та рівень pH за загальноприйнятими біохімічними методами з використанням стандартних наборів реактивів.

Встановлено, що фізичні навантаження високої інтенсивності призводять до значного підвищення рівня pH, концентрації лактату, вмісту загального кальцію, неорганічного фосфору та активності α-амілази у слині студентів з високим рівнем тренованості, що відображає реакцію організму на тренувальний стрес, а також свідчить про адаптаційні можливості організму та метаболічні потреби, викликані фізичним

навантаженням.Отримані результати можуть бути використані для моніторингу таких параметрів, як рівень pH, концентрація лактату, вміст кальцію/фосфору та активність α-амілази у слині, що може дати цінну інформацію про фізіологічну адаптацію організму під час фізичної активності різної інтенсивності.

Ключові слова: pH, лактат, кальцій, фосфор, α-амілаза, слина, фізичні навантаження

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ORCID ID
Valentyna Bevzo: https://orcid.org/0000-0001-5742-008X