

Virtual technologies in professional training of student-athletes: assessment of functional indicators and competencies

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Abstract

Objective of the study was to study the functional indicators of the cardiovascular system and respiration of students with massive sports categories when passing a VR scenario for assessing competencies with an emotionally intense situation.

Methods and structure of the study. The scientific experiment involved 30 students of the Faculty of Physical Culture and Sports of a pedagogical university with mass sports ranks. The control group consisted of 33 university students who did not regularly engage in sports. The subjects' heart rate, blood pressure, pulse pressure, Kerdo autonomic index, endurance coefficient, index of functional changes, type of self-regulation of blood circulation, respiratory rate, and Hildebrandt index were assessed in the subjects at rest, during instruction, and during the passage of the scenario using VR glasses. The study was carried out using the "Virtual pedagogical simulator Tut360", containing emotionally intense pedagogical scenarios ("Fire at school"). At the same time, the formation of psychological and pedagogical competencies (UC-3, UC-8, GPC-3, GPC-4, GPC-6, PC-1) was automatically assessed.

Results and conclusions. In the group of students systematically involved in sports, lower heart rate, blood pressure, Kerdo index, type of self-regulation of blood circulation and Hildebrandt index were found at all stages of the study compared to the control group. More pronounced changes in indicators of the cardiovascular and respiratory systems (not always significant) were detected in student-athletes at the stage of familiarization with the instructions, and in untrained students - at the stage of passing the scenario. Based on the results of completing the scenario, the development of psychological and pedagogical competencies among students of the two groups was noted to be approximately at the same level. We believe that the use of VR technologies in the process of professional training of students of various specialties will allow them to psychologically prepare for performing real professional tasks and increase the efficiency of the educational process.

Keywords: virtual pedagogical simulator, VR technologies, stress, functional indicators, psychological and pedagogical competencies, student-athletes of the mass ranks.

Introduction. Physical activity is considered by many authors as the most important condition for human adaptation, contributing to the optimization of the functional state in difficult, including extreme situations [5, 7]. Considering that the learning process of students is accompanied by various stressful situations and increased psycho-emotional stress, adaptation to them is accompanied by significant tension in the body's compensatory-adaptive systems. One of the priority tasks of professional training of students is to increase their adaptive potential through the development of effective educational technologies. These

are virtual technologies (VR), which allow simulating controlled stressful situations from real professional activities (including teaching), giving students the experience of solving them without risk, safe repeated practice and adaptation to them [2].

Objective of the study was to assess the functional indicators of the cardiovascular system and respiration during the passage of the "Virtual Pedagogical Simulator Tut360" with an emotionally tense situation by students with massive sports ranks.

It is assumed that student-athletes' cardiovascular and respiratory systems are functionally more resist-



ant to emotional stress than those of untrained students.

Methods and structure of the study. The scientific experiment was attended by 30 students of the Faculty of Physical Culture and Sports of the Pedagogical University with mass sports ranks (group 1), and 33 untrained students of various pedagogical profiles (control - group 2). The average age of students is 20 years. All subjects were previously familiarized with the content of the study and gave consent to it. To create emotional tension, a scenario was used that simulated a fire in a school and the evacuation of students [6]. As its criteria, indicators of the functioning of the cardiovascular (CVS) and respiratory systems (RS), which are highly responsive and play a key role in the adaptive changes of the body, not only to physical stress, but also to emotional stress, were assessed [1, 4, 5]. The subjects were determined to have heart rate (HR), systolic and diastolic blood pressure (SBP and DBP), pulse pressure, Kerdo autonomic index (AIK), endurance coefficient (EC), functional change index (FCI), type of self-regulation of blood circulation (TSC), respiratory rate (RR), Hildebrandt index (HI) [4]. The indicators were measured three times: before the start of the test (rest, relative emotional stability), during instruction using virtual reality glasses, and during the passage of the scenario (emotionally tense situation). The Wilcoxon T-test was chosen as a criterion for assessing the severity of shifts in the studied indicators under different conditions in each group. The significance of differences between the study groups was assessed using the Mann–Whitney U test.

Results of the study and discussion. The results of the study revealed lower resting heart rate and

blood pressure in student-athletes than in the control group, which remained the same throughout the experiment (Table 1).

Changes in heart rate and related hemodynamic parameters are considered the most common reactions to stress from the cardiovascular system [1, 3, 5]. The highest pulse values among students in the control group were achieved as a result of completing the scenario, and among student-athletes during preparation for it - at the stage of familiarization with the instructions, which can be considered as the mobilization of the cardiovascular system to complete the task and the dynamic regulation of the body for the upcoming load.

In our study, the blood pressure indicators of the subjects, although they underwent some changes, remained within normal limits both at the initial stage and during the course of the scenario. A tendency was revealed for a decrease in ABP, DBP and PP from the first measurement to the final one in both groups, which may indicate that it reflects the regulatory mechanisms of the autonomic nervous system.

To assess the influence of the autonomic nervous system on the cardiovascular system in the subjects, they were determined by the Kerdo autonomic index. At rest, the majority of students in the two groups showed a balance between the tone of the sympathetic and parasympathetic systems, with a predominance of parasympathetic influences in the athletes group and sympathetic influences in the control group. During the experiment, sympathicotonia was detected in the groups - with an increase in the vegetative index in the second group and normotonia - in the group of student-athletes. Positive changes in the vegetative

Table 1. Average values of indicators in the studied groups

Indicators \ Stages	Heart rate (bpm)	SBP (mm Hg)	DBP (mm Hg)	PP (mm Hg)	AIK (point)	EC (point)	FCI (point)	TSC (c.units)	RR (units/min)	HI (c.units)
Group 1 – athletes										
At rest	72,4	120,3	78,7	41,6	-10,7	18,3	2,2	110,7	20,3	3,9
Briefing	79,4»*	119,2	78,6	40,6	-0,5»	21,3	2,2	100,5	20,5	3,9
Scenario	77,7»*	117,8»	77,3*	40,5	-0,7	20,4	2,2	101,7	19,8	4,2
Group 2 – control										
At rest	87,8	122,5	82,9	39,6	3,2	24,2	2,5	96,8	20,1	4,6
Briefing	88,5	120,5	82,8	37,8	4,6	26,7	2,5	95,4	21,3»	4,4
Scenario	91,5»	118,6»	82,3	36,3	8,6	27,4	2,5	91,4»	22,2	4,4

Note: significance of the U test between groups: * – $p \leq 0.05$; significance of the T-test compared to rest: “ – $p \leq 0.05$



index indicate the activation of the ergotropic regulatory mechanism and the tension in the functioning of the body.

The tension in the circulatory system and the weakening of the cardiovascular system are also evidenced by the revealed increase in the endurance coefficient, which was more pronounced in the control group. It was quite high among students both before and after the test on the simulator, which may indicate a lack of functional capabilities of the circulatory system. At the initial stage, 40% of student-athletes and only 15% of students in the second group had an endurance coefficient within normal values, and its decrease was found in 53% and 82% in the corresponding groups. An increase in the endurance coefficient may indicate detraining of the CVS of the subjects, which was more pronounced in the control group.

One of the informative indicators reflecting the characteristics of the body's adaptive reactions is the type of self-regulation of blood circulation. On average, among students of the two groups at rest, the cardiovascular type of regulation predominates. However, during the process of passing the scenario on the simulator, an increase in the proportion of students with cardiac regulation type in the control group was revealed (from 36% to 42%). Such shifts may indicate the tension in the functioning of central hemodynamics and the provision of adaptation to sudden, short-term disturbing influences of the external environment [3]. On the contrary, in the group of athletes, the proportion of students with a cardiovascular type of regulation increased: from 50% at rest, to 63% and 70% at the next stages of the experiment, which reflects the optimal functioning and balanced regulation of the circulatory system [3].

To assess the adaptive potential and adaptive capabilities of the subjects, an assessment was made of the index of functional changes, which on average remained within normal values and did not change significantly in the groups during the test with the simulator. Assessing the distribution of this indicator in the control group at rest, satisfactory adaptation

of the cardiovascular system was revealed in 77% of students, its tension in 30%, and unsatisfactory adaptation in 3% of subjects. In virtual reality glasses and during the passage of the scenario, the proportion of students with tension in adaptation mechanisms increased to 40%, respectively, and from unsatisfactory to 6% of students. In the group of student-athletes, no one was identified who had manifestations of unsatisfactory adaptation at all stages of the examination, and passing the instructions and the scenario itself was accompanied by an increase in the proportion of students with adaptation stress from 3% to 12% and 9%, respectively. The data obtained may indicate a greater increase in the tension of regulatory systems and the inclusion of functional reserves when passing the test in untrained students, which is the "price" of adaptation, due to which the main vital signs are maintained within normal limits for a long time [1].

On the part of the respiratory system, there was an increase in the respiratory rate of students in the control group at each subsequent stage of the experiment, and in the group of student-athletes this indicator remained within the normal range with a tendency to decrease as the scenario progressed. A reflection of the cardio-respiratory relationship is the Hildebrandt index, which showed higher values, but within the normal range, at each stage of the study in students of the second group compared to those in student-athletes. In general, the indicator indicates the presence of coordinated changes in the activity of the cardiovascular system and respiratory system in both groups.

Assessment of the development of psychological and pedagogical competencies using VR technologies showed that students of both groups, solving pedagogical situations in a virtual environment, experienced a state of stress to varying degrees, but this did not affect the total score of competencies (student-athletes had an average score for the sum of the competencies studied - 36.3, in the control - 37.1). Student-athletes showed a slightly lower level of com-

Table 2. Indicators of the development of professional and psychological competencies obtained using the "Virtual Pedagogical Simulator Tut360"

Groups	Formation of competencies (points)					
	UC-3 (max. 12)	UC-8 (max. 9)	GPC-1 (max. 3)	GPC-4 (max. 6)	GPC-6 (max. 3)	PC-1 (max. 12)
Athletes	9,87	7,17	2,30	4,90	2,30	9,80
Control	10,5	7,38	2,88	5,38	2,63	10,25

Note: UC - universal competence, GPC- general professional competence, PC – professional competencies



petence development with more stable indicators of the functional state (Table 2.)

Conclusions. It was revealed that among student-athletes, more pronounced changes (not always significant) were noted at the stage of familiarization with the instructions, and, rather, are associated with mobilization before passing the scenario (HR, AIC, EC, TSC, RR), and among untrained students - at stage of passing the scenario (HR, SBP, PP, AIC, IV, TSK, RR), which may indicate a slight increase in the voltage of regulatory systems and the inclusion of functional reserves when performing a task. With a small acting external factor in terms of strength and time, the cardiovascular system can maintain a satisfactory nature of adaptation and an optimal mode of functioning due to the relatively small tension of the regulatory mechanisms [1]. It is likely that systematic sports activities increase the ability for self-regulation, stress resistance and mobilization of athletes when performing an emotionally intense task [7].

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