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## **THE BIOMEDICAL ASSESSMENT OF THE EFFECTIVENESS OF A DISTANCE COURSE IN PHYSICAL CULTURE FOR STUDENTS OF A SPECIAL MEDICAL GROUP**

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**Keywords:** physical culture, distance learning, special medical group, cardiovascular system, respiratory system, physical performance.

**Annotation.** The article considers the effectiveness of the application of the distance learning program in the discipline «Physical Culture» (PC) on the level of the functional state and reserve capabilities of the body of students of the special medical group (SMG). The functional parameters of the cardiovascular, respiratory systems, the tone of the paravertebral muscles of the back and neck, as well as indicators of strength and endurance were studied in twelve students aged 17-19 years with a diagnosis of idiopathic structural scoliosis of the II-III degree, engaged in PC on the full-time program, and the same students, who studied remotely. It is shown that the remote PC classes do not have the desired corrective effect. Informatization of the educational system of physical education of SMG students should be of a mixed type, where the traditional form of classes remains as the leading one.

**Introduction.** Distance learning (DL) is “maintained when using a combination of educational technologies, with which the purposeful indirect interaction between the student and the lector is made regardless of their location based on pedagogically organized information technologies, using telecommunication means in the first place” [1] and is regulated by the Federal Law of the Russian Federation “On education in the Russian Federation” [2], by the Order of the Ministry of Education and Science of the Russian Federation “On the implementation of additional educational professional programs and using distance educational technologies, electronic learning and in the online form” [3] and by the GOST R 52653-2006 “Information and communication technologies in education. Terms and definitions” [4].

Distant educational technologies (DET) are the “educational technologies, which are implemented using information and telecommunication technologies in case of indirect (on distance) or not fully indirect interaction between the student

and the pedagogical employee” [1]. A material and technical basis for maintaining online learning and DET is a telecommunication network, an educational website and an electronic library system.

As a rule, higher education (HE) establishments administer DL using such platforms as MOODLE and/or Microsoft Teams (MT) [5-7]. Both platforms are functional and user-friendly when used, they allow listening to lectures – online, or a recording, receive and give knowledge, participate in “live” seminars and practical classes. Lecturers and students of the Moscow Aviation Institute (National Research University) (MAI) also interact on two platforms: on the MAI LMS (learning management system), the development and maintenance of which is administered by the MAI’s Office of E-learning, and Microsoft Teams. The MAI LMS platform was developed in 2006. To this moment, it went through six upgrades, acquired a user-friendly navigation, got relevant content, and in this regard became more widespread. Since the 2014-2015 academic years, the “Physical culture” discipline for all education forms, which includes a course of lectures and practical classes, started its partly implementation in the DL form, and since March 17, 2020 it has been fully transferred to a DL format. However, the DET implementation for the “Physical culture” discipline into the educational process not yet has its due development, despite its relevance. Experience of successful DET implementation into lecturing linguistics, economics and law is surely useful. However, in case of physical culture, it cannot be mechanically transferred into the learning process, especially for children, who belong to the SMG, due to the specificity of the subject field.

Thus, there is a contradiction between a necessity to develop new learning models, integrating distance-based and traditional technologies, and an absence of scientifically methodological justification and practical implementation of technologies, which would allow transferring to the new level of employee training, corresponding to requirements of the modern society. Existence of such contradictions serves as an evidence of the relevance of this study’s issue.

The purpose of this study is to examine the effect of physical culture distance learning on the level of the functional state and physical performance of the SMG group students.

**Methods and organization.** Twelve (12) students (6 young men and 6 young women) of the MAI, aged 17-19 years, who belong to the SMG, participated in the study. All students were diagnosed with s-shaped idiopathic structural scoliosis of the II and III degree (I, II type according to King) [8].

The examination included three stages. On the first stage, we studied the effect of PC classes according to the program approved by the curriculum of the Department of Physical Education of the MAI for the full-time department, on

functional indicators of the cardiovascular system and the external respiration function, change in tone of the paravertebral muscles on the back and neck, as well as strength-based indicators, endurance and general physical performance of the SMG students. On the second stage, we studied the effect of PC classes on the same students using the DET program [5]. On the last stage, we compared examined indicators of the first two stages.

Methods of anthropometry (height meter, weights), dynamometry (hand dynamometer DRP-120, manufactured in Russia), spirometry (dry portative spirometer SSP, manufactured in Russia), heart rate monitoring and tonometry (tonometer Omron M2 Basic (HEM 7121-RU), manufactured in Japan), myotonometry (myotonometer NOVOTEST, manufactured in Russia) were used in this study. The physical performance was assessed using the PWC170 modified classic test [9]. General endurance and the maximum oxygen consumption (MOC) was defined using the Cooper test [9]. Changes in vegetative tone were assessed by the Kerdo index [10].

Myotonometric study was carried out in eight symmetrical paravertebral points: point Ex-HN23 (“Xin Shi”), located on the level of the C3 segment; point BL 14 (“Jue Yin Shu”) located on the latissimus dorsi on the back, on the level of the Th4 segment; point BL 24 (“Qi Hai Shu”), located 5 cm more lateral than the spinal process of the III lumbar vertebra; point BL 29 (“Zhong Lu Shu”), located on the level of sacral foramina [11]. The tone was evaluated in compliance to the resistance made by the muscle when the myotonometer probe touches it according to the standard method [12]. The tone rate was registered in common units (c.u.) according to the Shor’s method [12]. In order to measure statistical endurance (SE) of the torso muscle groups (back, press, oblique abdominal muscle etc.), time of pose preservation in lying position with limb fixation was registered [9, 13]. The dynamic strength (DS) was evaluated by the amount of torso lifts in position of lying on the back, stomach and on side position with the legs fixation by a partner [9, 13]. Calculations and graphic presentation of obtained data were carried out using the “STATISTICA 10.0” software package. In order to analyze the obtained data, standard methods of the variation statistics were used: mean values and standard error of the mean were used as measures of central tendency, showing the pronouncement of examined signs. The Shapiro-Wilk test was used to define the normality of data distribution [14]. The Student’s t-test was used to reveal intergroup differences.

**Results and discussion.** Results of the conducted studies show that physical culture classes for SMG students of the full-time program and online program have a number of differences according to most examined functional indicators of an

organism. In order to research changes in dynamics, we are going to examine each stage separately.

The anthropometric data (body mass (BM)), its length and the body mass index (BMI) did not significantly change among students at the first stage. However, the functional indicators of the cardiovascular system (CVS) and the external respiration function (ERF) showed significantly positive changes. It was registered that the online format does not do any substantial effects: BMI and BM increased, the SBP increased by 3,32% ( $p \leq 0,01$ ), the DBP decreased by 8,01% ( $p \leq 0,01$ ). Moreover, the sympathetic effect of the vegetative nervous system (the Kerdo vegetative index – KVI) was registered –  $1,24 \pm 0,05$  c.u.

The fact that before the experiment each student has a sympathetic regulation of the vegetative nervous system – 1,09 c.u., is also notable. At the end of the first stage, the tone of the nervous system shifts by 4,08% ( $p \leq 0,05$ ) to the normotonia for 1,04 c.u. It was shown that systematic physical culture classes decrease the heart rate (HR) significantly by 12,71% ( $p < 0,05$ ), SBP and DBP – by 4,58 and 8,65% ( $p \leq 0,05-0,01$ ) respectively. The respiration rate (RR) decreases insignificantly, the respiratory volume (RV) increases by 4,53% ( $p \leq 0,05$ ), the respiratory minute volume (RMV) and lung ventilation (LV) significantly increase by 21,94% ( $p \leq 0,05$ ) and 13,47% ( $p \leq 0,01$ ) respectively.

It is noteworthy that in the intact state ERF indicators significantly decreased in all examined students in comparison with healthy people. It is known that the presence of the costovertebral hump and thorax deformation in case of idiopathic scoliosis leads to a weakening and asymmetrical disruption of the function of the trunk muscles, decreased volume of the chest cavity and the appearance of respiratory insufficiency [15]. Therefore, physical exercises benefit the ERF and support the increase of physical performance, which is shown through the PWC170 increase by 20,12% ( $p \leq 0,01$ ), the MOC increase by 32,19% ( $p \leq 0,05$ ), and the Cooper's test increase by 35,95% ( $p \leq 0,01$ ).

Comparison of relative changes (%) in indicators of the cardiorespiratory system and physical performance of SMG students, engaging in the full-time and online program, shows that the most significant differences were found in HR, RV, RMV, physical performance and endurance (Fig. 1). The data obtained correspond with an opinion of a number of authors. The set of therapeutic exercises leads to the strengthening of vagotonia, harmonization of reciprocal relationship of the respiratory muscles, economization of the CVS work and the increase in physical performance [10, 13, 15, 16].

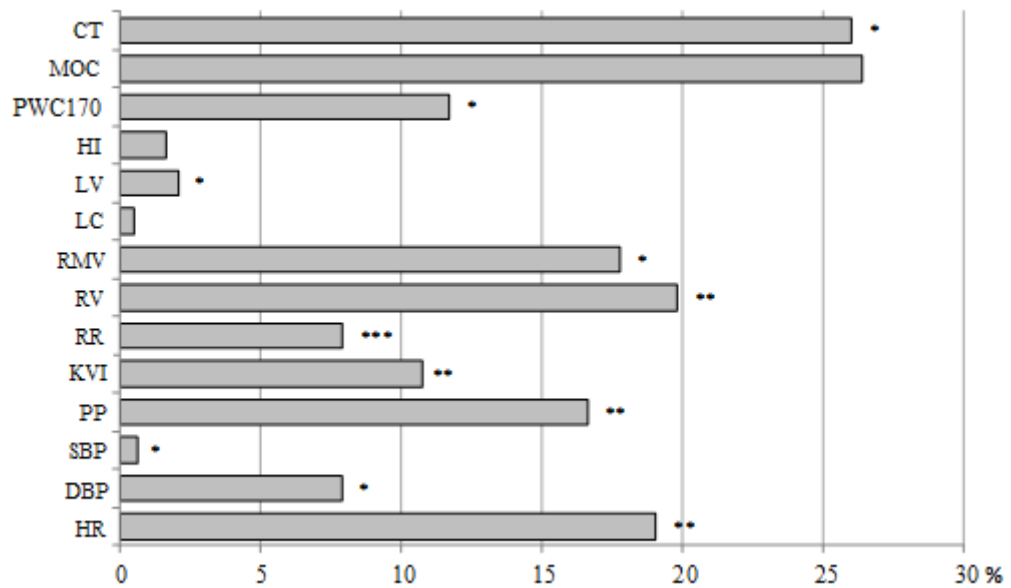


Fig. 1. Comparison of relative changes (%) in indicators of the cardiorespiratory system and physical performance of SMG students, who engage in physical culture classes of the full-time program and online program

Note: CT – Cooper test; MOC – maximum oxygen consumption; PWC170 – physical performance; HI – Hildebrandt index; LV – lung ventilation; LC – lung capacity; RMV – respiratory minute volume; RV – respiratory volume; RR – respiratory rate; KVI – Kerdo vegetative index; PP – pulse pressure; DBP – diastolic blood pressure; SBP – systolic blood pressure; HR – heart rate; \* –  $p \leq 0,05$ ; \*\* –  $p \leq 0,01$ ; \*\*\* –  $p \leq 0,001$ , the significance of differences according to the Student's t-test

It was revealed as a result of the muscle tone study that differences, obtained on the I and II stages in all points, are significant ( $p \leq 0,05-0,001$ ). Physical culture classes in the full-time form (in case if the coach controls everything) significantly decreases muscle tone in the cervical spine from 10,01% to 16,38% ( $p \leq 0,001$ ), in the thoracic spine – from 22,81% to 25,84% ( $p \leq 0,001$ ), in the lumbar spine – symmetrically by 28% ( $p \leq 0,001$ ) and in the sacral spine – from 16,62% ( $p \leq 0,05$ ) to 22,80% ( $p \leq 0,001$ ). The data obtained correspond with our previous studies, when the use of author methods for correction of the muscle-tone asymmetry of the paravertebral area [13] supports to minimizing pathologic motor stereotypes, harmonizing the muscle tone and strengthened contractibility of the thorax muscles. The blood supply of pathologically spasmic muscles improves, their motor units are introduced in reciprocal relationship in a new way, the work of myofibrils and sarcomeres happen in new, close to normal, dynamic and biomechanical conditions, so that even in case of significant disturbances of the spine's state, this way allows implementing a changed corset muscle into the correct work to eliminate disturbances [13].

When analyzing data from the II stage, it was revealed that independent performance of the exercise sets does not decrease the muscle tone, but vice versa, increases it: in the cervical spine – from 63,35% to 100,44% ( $p \leq 0,001$ ), in the thoracic spine from 51,02% to 75,81% ( $p \leq 0,001$ ), in the lumbar spine – almost two times, and in the sacral spine – from 68,14% to 109,49% ( $p \leq 0,001$ ). In our opinion, such tone strengthening is caused by insufficient motor activity, long-term sitting at a computer desk in an uncomfortable position, insufficient level of methodological skills of using the method of therapeutic exercising and theoretical knowledge of students.

Comparison of relative changes (%) in myotone indicators showed that the most sensitive to changes are the muscles of the cervical-thoracic spine and the lumbar spine (Fig. 2).

When analyzing changes in the muscle strength endurance of students, it is noteworthy that at the I stage the muscle strength of both hands increased by 10% ( $p \leq 0,01$ ), the statistical endurance of muscles of the back and press increased by 15,26% ( $p \leq 0,01$ ), but the dynamic endurance of these muscles did not significantly change. Strength endurance of the oblique abdominal muscles on the right (static and dynamic) did not have a substantial increase, but the strength endurance of the muscles on the left increased by 7,86% and 22,55% ( $p \leq 0,01$ ) respectively.

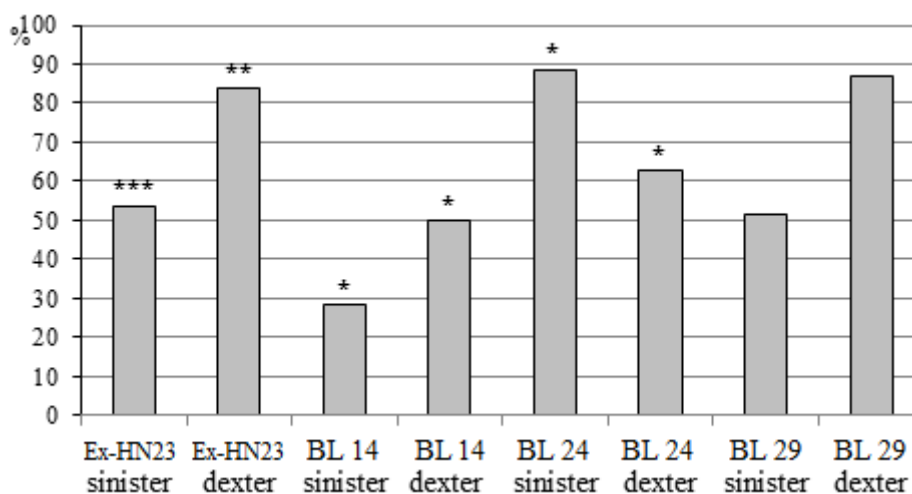


Fig. 2. Comparison of relative changes (%) of muscle tone indicators of the cervical-thoracic spine and the lumbar-sacral spine of SMG students, who engage in physical culture classes of the full-time program and online program

Note: \* –  $p \leq 0,05$ ; \*\* –  $p \leq 0,01$ ; \*\*\* –  $p \leq 0,001$ , the significance of differences according to the Student's t-test

Data obtained on the II stage show the insufficient effectiveness of physical culture classes in the online form, since there is no increase in a number of indicators.

The right hand strength (RHS) and left hand strength (LHS) decreased by 11,7 and 15,79% respectively ( $p \leq 0,01$ ), the statistical endurance of the back and press muscles decreased by 15% ( $p \leq 0,01$ ), the dynamic endurance – by 20% ( $p \leq 0,01$ ). A similar decrease was registered in the endurance of oblique abdominal muscles – the growth rate was 2 to 8% ( $p \leq 0,01$ ).

As it is shown in fig. 3, the comparative analysis of changes in strength endurance (%) shows that the abdominal muscles strength endurance has changed most effectively, the dynamic strength endurance of the oblique abdominal muscles – the least changed the least.

The s-shaped idiopathic spine deformation and compensatory developing hypertones of the paravertebral and torso muscles, forming in zones of destabilization and disruption of motor patterns of the musculoskeletal apparatus, lead to a decrease in aerobic potential of muscles and periarticular tissues, which is significantly decreasing both strength endurance and general performance [8, 10, 13, 15, 16].

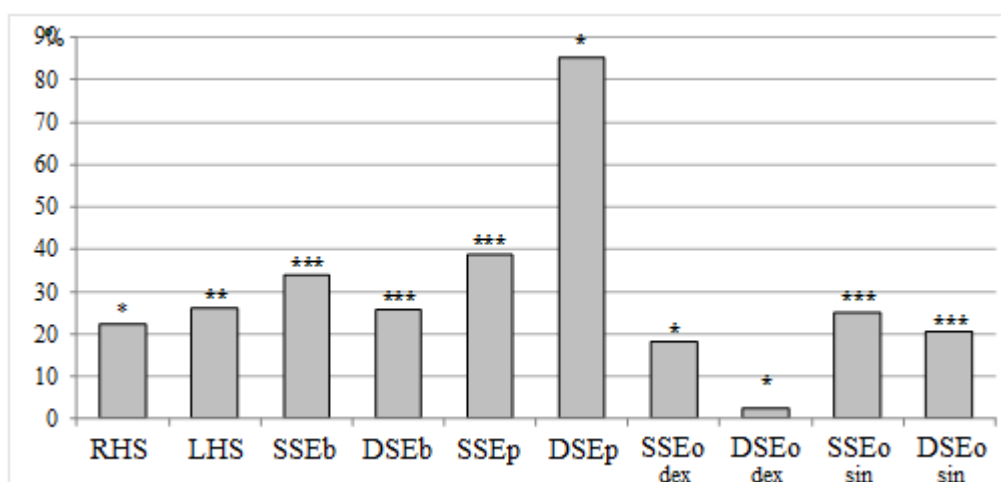


Fig. 3. Comparison of relative changes (%) in indicators of static and dynamic strength endurance of SMG students, who engage in physical culture classes of the full-time program and online program

Note: RHS – right hand strength; LHS – left hand strength; SSEb – static strength endurance of the back muscles; DSEb – dynamic strength endurance of the back muscles; SSEp – static strength endurance of the press muscles; DSEp – dynamic strength endurance of the press muscle; SSEo dex – static strength endurance of the oblique abdominal muscles on the right; DSEo dex – dynamic strength endurance of the oblique abdominal muscles on the right; SSEo sin – static strength endurance of the oblique abdominal muscles on the left; DSEo sin – dynamic strength endurance of the oblique abdominal muscles on the left; \* –  $p \leq 0,05$ ; \*\* –  $p \leq 0,01$ ; \*\*\* –  $p \leq 0,001$ , the significance of differences according to the Student's t-test

**Conclusion.** We suggest that physical culture classes, adaptive physical culture classes in particular, in the professional training of SMG students of different specialties, using any platform including MOODLE and LMS, are not able to give

an equal substitute for full-time classes with a coach in real gym conditions, using specialized training devices and sports inventory. That is why the traditional form remains leading for students with deviations in health. It was shown that students, when engaging independently in distance learning, do not achieve the desired corrective effect: the work of the cardiovascular system and the expiratory respiration function decrease, an increase in muscle tone causes spasms and edema of periarticular tissues on the back and neck, oxygen transfer to the brain is disrupted, venous outflow with underoxidized decay products decreases, muscles oxidize and, as a result, mental and physical performance also decrease. However, it is worthy to note that distance learning for the “Physical culture” discipline is irreplaceable for disabled students and students with limited physical capabilities. The curriculum prescribes the PC course in the online form with an emphasis on theoretical and methodological aspects, which is why we consider it important to develop further and implement programs into distance learning platforms for this category of students.

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