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The impact of virtual sports on the functional performance of college students with disabilities

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ABSTRACT

Background: Modern education actively introduces new technologies that help improve the educational process. The presence of health restrictions leads to a decrease in the physical activity of the student. Students exempt from physical education classes experience a further decline in physical activity. Virtual reality technologies can help to overcome the gap between the need for physical activity of students and the health condition that prevents it.
Objective: To assess the effect of virtual sports on the functional characteristics of health and vitality of college students with health restrictions.
Method: Classical experiment. Subjects: 30 college students (17-18 years old) with disabilities; including 16 girls. They were randomly divided into control and experimental groups (15 students each (8 girls and 7 boys)). Diagnostics: breath holding on inhalation (Stange test), static balancing, mindfulness questionnaire (MAAS), vitality questionnaire, "Subjective assessment of diseases" questionnaire. Impact: 3 virtual sports sessions over 3 weeks using VR simulators (rock climbing - The Climb 2, archery: Archery Kings, racket games: First Person Tennis). Statistics: Wilcoxon test, ANOVA analysis of variance.
Results: The experimental group students significantly increased: static balancing time (by 29.7 sec. ($p<0.01$) and stress resistance. The following increased at the trend level: breath holding time on inhalation (by 6.2 sec. ($p<0.10$) and overall vitality. No changes were found in the control group. Functional health indicators are also affected by the duration of sports sessions.
Conclusion: Virtual sports sessions over 3 weeks, 1 session per week, have proven effective for students with disabilities.
Keywords: disabilities, college students, functional disabilities, virtual sports, virtual reality, static balancing, breath holding, mindfulness, vitality

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INTRODUCTION

Functional health limitations do not affect academic performance but reduce students' physical activity, interfere with their participation in physical education, and may negatively impact psychological comfort in educational settings. The 21st century is characterized by rapid technological and scientific advancements. Modern education strives to actively introduce new developments that contribute to the improvement of the educational process, including virtual reality technologies (Skorobogatova and Margolin, 2024). Virtual sports are one of the new and actively developing types of human activity. Thus, the international games of the future - Games of the Future were held in 2024. Researchers demonstrated new technologies in the field of eSports, robotics, augmented and virtual reality, information technology and artificial intelligence (Games of the Future, 2024). Virtual sports include such activities as running, swimming, fitness, archery, etc. Its advantage is that it is a more accessible and safe sport for all age groups and also for people with certain disabilities (Singh and Awasthi, 2026).

Disabilities are physical or mental developmental disorders of the body that affect the social life of the student (Hanakova et al., 2022). The presence of health limitations, even minor ones, leads to a decrease in the physical activity of the student, in particular. he is exempted from physical education classes at the educational institution. Students with health deviations belong to preparatory and special groups in physical education in most countries. Such students are not allowed to fulfill educational standards in physical education; a comparative analysis of physical fitness and health indicators shows lower values in such students compared to their peers (Svietlova et al., 2016).

Modern technologies can help bridge the gap between the need for physical activity for students and the health condition that prevents full-fledged physical education classes. Researchers include virtual reality, augmented reality and mixed reality among new technologies. These tools can improve the educational process, including in the field of physical education. Sports educators use these technologies for educational purposes, fitness and health promotion (Singh and Awasthi, 2024). Educators are the most active users of virtual reality technologies (Jamaludin et all., 2024).

Virtual reality technologies for physical education and sports are technologies that include a whole range of software (physical activity sensors, selection of scenarios for the development of events, various applications paired with a phone). Experts have already invented smart gadgets that monitor physical activity, nutrition, heart rate, and daily routine

of a person. Virtual reality offers additional benefits, allowing users to simulate various sporting scenarios and practice athletic skills in diverse conditions. Doctors can analyze and monitor the physiological reactions of the human body, which is in virtual reality (Lu et al., 2024). The combination of virtual reality technology and physical education teaching is of great importance for increasing students' interest in learning and passion for sports (Feng et al., 2022). Researchers have proven the effectiveness of using sports VR simulators in physical education classes for students and high school students. Many studies are devoted to studying the impact of virtual games on the cognitive abilities of secondary specialized students. In one study, students attended three 20-minute lab sessions where they played active and passive virtual games. During the final session, the researchers observed the participants' actions and recorded their physical activity using hip accelerometers and a heart rate monitor. After each session, the researchers tested the participants' memory, motion sickness, and gaming experience. The authors found that full immersion in the virtual space increased the heart rate of the students, and that sensory and imaginary immersion had a beneficial effect on cognitive performance because it involved less activity (Bauer and Andringa, 2020).

S. Pérez-Muñoz et al. analyzed the WOS, Scopus, PubMed and Google Scholar databases. The aim of the analysis was to study the use and impact of AR, VR and MR technologies in physical education at the compulsory level. The results showed that there has been a noticeable increase in research activity in this area in recent years. The analysis identified four main areas to focus on, namely: the use of pedagogical methods, the development of motor skills and health-related competencies, and the promotion of optimal integration of students into the physical education process. New technologies represent a suitable tool to improve the learning efficiency of students in physical education programs. The authors concluded that in the field of physical education, the importance of virtual, augmented and mixed reality technologies is manifested in the fact that they can be used both for educational purposes and for maintaining physical fitness and health (Pérez-Muñoz et al., 2024). Q. Yang proved the effect of using a VR table tennis simulator in his empirical study. The interest in physical education in the experimental group will increase significantly with the supportive learning using VR technology. The results of the t-test in each measurement before and after the experiment confirmed the conclusion (Yang, 2024).

Teachers are beginning to conduct physical education classes in a virtual environment and use virtual sports for people with disabilities. Numerous examples of the development and use of virtual environments for inclusive education of students are given in the scientific literature. Virtual learning is used for students with disabilities and problematic conditions

(autism, Asperger syndrome, dyslexia, etc.). S. Panzavolta noted in his review that most experiments on the use of VR technologies in teaching people at risk have yielded important positive results. In particular, he highlighted the main technological characteristics of virtual reality that are effective in inclusive education. He included immersion, presence, interaction, transduction and conceptual changes among them. Teachers use virtual environments and virtual worlds to reduce the dropout rate and academic failure in schools. They use VR to diversify the curriculum in classrooms for students in a situation of educational isolation or academic failure (Panzavolta, 2018). Virtual reality training can be used to improve the somatic characteristics of people with disabilities (Berezina et al., 2023). VR programs for teaching physical education to schoolchildren with health problems are being developed in many countries (in Russia, in China, in Iran). Users also use virtual reality technologies to prevent future possible health problems in schoolchildren. In Iran, researchers used virtual sports games for gamification to improve physical activity in elementary school and prevent obesity in older age (Roshanpour and Nikroo 2020). However, despite the large number of studies in this area, some issues remain insufficiently studied. The impact of physical education classes in virtual reality on the health of students with functional limitations has not been sufficiently studied.

METHOD AND METERIALS

The aim of the study

to evaluate the impact of virtual sports (sports classes using VR simulators) on health characteristics, vitality, and mindfulness in college students with disabilities.

Hypothesis: Physical education classes using VR sports simulators (boxing, tennis, shooting, etc.) will improve health indicators in students with functional impairments.

Subjects: students of 1 college aged 17-18, including 16 girls. We randomly selected one college from all colleges in Moscow (Russian Federation). We randomly selected 30 students with disabilities limitations from all students. All of them were part of a special physical education group and were exempted from main classes. We divided the selected students into 2 groups by randomization: experimental and control, each group included 15 people (8 girls and 7 boys).

The study was approved by the Ethics Committee of the Russian Science Foundation on December 28, 2024 and the Ethics Committee of the Faculty of Extreme Psychology of MSUPE (from 01/28/25). All students gave voluntary and informed consent to participate in the study.

Research Methods.

1. Questionnaire "Subjective assessment of diseases", it is part of the battery of tests for determining biological age according to P.V. Voitenko,. The questionnaire includes questions about the presence of certain health problems (Voitenko and Tokar, 1983).

2. Static balancing. This indicator characterized the work of the balance system. We measured the duration of standing on the left leg with closed eyes (in seconds).

3. Duration of holding the breath on inhalation (Stange test). This indicator characterized the work of the respiratory system. We measured the duration of breath holding after entering (in seconds).

4. Mindfulness questionnaire (MAAS). Authors: K. Brown, R. Ryan in Russian adaptation. The questionnaire includes 15 questions. The result is presented in the form of one scale - mindfulness.

5. Vitality questionnaire: Author G.V. Rezapkina (Rezapkina, 2017). The concept of vitality underlies this questionnaire. Vitality is an indicator of general energy associated with health (Smith and Lloyd, 2006).

The questionnaire includes 5 scales:

1) Vital tone characterizes energy, an active life position, interest in people, events and business.

2) Purposefulness is the willingness to take initiative and responsibility, self-confidence, perseverance in achieving goals. 3) Stress resistance is low sensitivity to stressful situations (conflicts, uncertainty, exams).

4) Independence is an indicator of self-sufficiency, criticality. When making a decision, such a person is guided by his own opinion, and not by the opinion of others.

5) General Vitality. Total indicator. General vitality speaks of vitality, energy, positive attitude, determination and firmness in combination with emotional stability and health.

Experimental intervention methods. The experimental intervention was conducted during physical education classes. For three weeks, we conducted physical education classes with the students of the experimental group using virtual reality technologies, one lesson per week. The students of the control group listened to lectures on physical education or did their own things at this time, since they were exempted from the main physical education classes due to health restrictions.

We conducted three classes with the experimental group. The training took place over three weeks, once a week. The classes lasted 1.5 hours. Each class was accompanied by a

mini-lecture, conversation, physical activity, work with VR simulators, reflection and had musical accompaniment. On the first day of the training, we used the VR rock climbing simulator - The Climb 2. On the second day, we used the VR archery simulator: Archery Kings. On the third day, we used the VR racket games simulator: First Person Tennis.

Methods of mathematical statistics:

1) Wilcoxon T-test for related samples; 2) ANOVA analysis of variance to assess the impact of duration of participation in classes on functional health indicators. Independent variable: duration of participation in virtual sports (from 1 to 3 classes). Dependent variables: functional health indicators: duration of static balancing, duration of breath holding on inhalation, vitality and mindfulness indicators.

RESULTS

We divided the sample of students with disabilities into experimental and control groups using randomization. We then compared the health of students in the experimental and control groups. We found no significant differences. The next stage was devoted to the experiment. The results are shown in Tables 1 and 2.

Table 1. The impact of virtual sports on health indicators in college students of the experimental group

Indicator	Average values of the indicator BEFORE training	Average values of the indicator AFTER training	Wilcoxon t-test	p<	Effect
Mindfulness (MAAS)	3,9	4,1	-0,29	0,389	Doesn't affect
Subjective assessment of diseases	10,3	9,49	0,65	0,738	Doesn't affect
Static balancing (seconds)	64,4	94,1	-1,34	0,01	Increase
Duration of holding the breath on inhalation (seconds)	52,9	59,1	-1,07	0,10	Uptrend
General Vitality	13,9	15,1	-1,10	0,1	Uptrend
Purposefulness	3,9	4,1	-0,26	0,39	Doesn't affect
Independence	3,6	3,9	-0,59	0,281	Doesn't affect
Stress resistance	2,9	3,5	-1,75	0,045	Increase
Vital tone	3,4	3,7	-0,49	0,32	Doesn't affect

As can be seen from the table, we found the following changes in health indicators after the VR training. The Stress resistance indicator (scale from the Vitality questionnaire) increased reliably as a result of the classes conducted by the students of the experimental group. We also found several stable trends towards an increase. The duration of static balancing, the duration of holding the breath on inhalation, the General Vitality indicator increased at the trend level. The other indicators remained unchanged.

Table 2. Dynamics of health indicators in college students of the control group

Indicator	**Average values of the indicator, 1 measurement**	**Average values of the indicator, 2 measurement**	**Wilcoxon t-test**	**p<**	**Effect**
Mindfulness (MAAS))	3,6	3,7	-0,30	0,38	Doesn't change
Duration of holding the breath on inhalation (seconds)	39,4	42,6	-0,55	0,29	Doesn't change
Subjective assessment of diseases	11,2	11,9	-0,40	0,35	Doesn't change
Static balancing (seconds)	92,4	70,1	0,69	0,75	Doesn't change
General Vitality	12,3	13,3	-0,56	0,29	Doesn't change
Purposefulness	2,9	3,1	-0,31	0,38	Doesn't change
Vital tone	3,3	3,5	-0,23	0,41	Doesn't change
Independence	3,1	3,4	-0,76	0,23	Doesn't change
Stress resistance	3,1	3,4	-0,59	0,28	Doesn't change

As can be seen from the table, we did not find any significant changes in the indicators in the subjects of the control group.

Table 3. The influence of the duration of virtual sports training on the biopsychological characteristics of the student's personality (only reliable data).

Indicator	**Effect**	**F**	**p**
Stress resistance	Uptrend	3,108	,063
Independence	Uptrend	2,544	,10
General Vitality	Uptrend	2,796	,10
Duration of holding the breath on inhalation	Increase	3,339	,035*

As can be seen from the table, the duration of training significantly affects the duration of breath holding on inhalation (Stange test). We also found three trends. General Vitality, Independence, Stress resistance tend to increase. We can conclude that virtual sports can affect functional health indicators, namely, improving static balancing, breath holding on inhalation, stress resistance and vitality.

DISCUSSION

Virtual sport is either a team or individual competition in virtual reality. It is carried out using a special device - a VR helmet, a laptop.

In this study, we found an increase in objective health characteristics in students who completed a three-week cycle of classes. We are inclined to explain this by the effect of the classes. To assess health, we used such characteristics as breath holding on inhalation and static balancing. These indicators are used both to assess age-related changes in health (Voitenko and Tokar, 1983) and to assess the functional development of the body. We chose these indicators because they can be trained at student age and teachers often use them to assess the physical development of a teenager and to evaluate the effectiveness of his sports activities (Sikora et al., 2024).

We can draw several conclusions from the results of our classes. Even moderate sports activities conducted in facilitated virtual reality conditions lead to the development of the functional capabilities of the body. Researchers can recommend such classes for use by students with disabilities. Teachers can conduct such classes in special physical education groups. We also found a reliable increase in Stress resistance and a tendency to increase overall vitality during the training. Vitality is a subjective experience of life, a person's feeling that he is able to move, act, a sense of his own strength, as well as the presence of energy, enthusiasm, endurance (Yoon et al., 2024). In a narrow sense, vitality is the level of life energy, a personal indicator of productivity leading to success in all areas of life. Our training is able to increase overall vitality in terms of increasing the student's stress resistance, his ability to overcome stress. Perhaps, the increase in Stress resistance is associated with an improvement in the functional capabilities of the body or with an increase in the self-esteem of a student who has mastered sports simulators, even if they were in virtual reality.

Limitation of the study: Our study is pilot, the results are preliminary. The effect of virtual sports on functional indicators is reliable, but we need to clarify the nature of the effect of sports activities in virtual reality on other health indicators.

CONCULSION AND RECOMMODATIONS

Sports training in virtual reality for 3 weeks on VR simulators leads to an increase in objective health indicators of students with disabilities. The time of static balancing significantly increases in students after completing the training. The duration of breath holding on inhalation increases in them at the trend level. We also found an increase in psychological health indicators. The Stress resistance indicator increased significantly after training, and the General Vitality indicator increased at the trend level. Students in the control group had functional health disorders, but they did not undergo our training. The students in the control group did not experience any changes in health indicators.

The duration of virtual sports classes also affects functional health indicators. Classes for three weeks (one class per week) have proven their effectiveness for students with disabilities. If a student attended more classes, then the "breath holding on inhalation" indicator increased more.

Research prospects: The use of sports VR simulators to organize physical education classes for students attending special groups is one of the areas of work on improving the health of young people. Researchers can conduct additional studies, clarify the parameters for organizing such classes and evaluate the effect of their implementation in any educational institution where such classes could be held during the school year.

Research Statement

Conflicts of Interest: The authors declare no conflict of interest.

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