ORIGINAL ARTICLE

The impact of judo training on the morphofunctional state and physical fitness of healthy adolescents

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ABSTRACT

Aim: The aim is to investigate the impact of an experimental judo training program on the morphofunctional state and physical fitness of healthy adolescents.
Materials and Methods: The study involved 54 male adolescents aged 16-17, who were divided into an experimental group (EG, n=27) and a control group (CG, n=27). The morphofunctional state of the students was evaluated based on the indicators of muscular, cardiovascular, and respiratory system activities, while physical fitness was assessed using physical education tests.
Results: It was found that during the experiment, adolescents' morphofunctional state and physical fitness indicators improved in both groups. However, in the EG, the difference between the initial and final data was significant (p 0.05). Moreover, at the end of the experiment, all the studied indicators in the EG were significantly better than in the CG. The most pronounced impact of judo training was observed on the strength index, Ruffier index, Stange index, Genchi index, Robinson index, and the results in the long jump, pull-ups, push-ups, and trunk lifts.
Conclusions: It was proven that extracurricular judo training sessions, provided that adolescents consciously choose the sport and are motivated to participate, as well as the rational planning of training sessions, are more effective compared to traditional physical education lessons in high school for improving the morphofunctional state and physical fitness of healthy adolescents. The high level of the studied indicators in adolescents will enhance their health and improve their future educational and professional activities.

KEY WORDS: judo, adolescents, morphofunctional state, physical fitness, health, physical education

Pol Merkur Lek,2025;53(5):629-634 doi: 10.36740/Merkur202505110

INTRODUCTION

Due to the reform of education in Ukraine and the establishment of the New Ukrainian School, radical changes are occurring in all areas of activity, including physical education and sports. This has led to an active search for new forms, methods, and means of physical education that would contribute to strengthening the health of school youth, improving the morphofunctional state of their main body systems, and enhancing their physical fitness levels [1]. Given that Ukraine has been at war with Russian aggressors for over two years, it is particularly important and relevant to improve the physical education of adolescents, specifically high school students – the future defenders of Ukraine [2].

At the same time, research findings from numerous scientists [3, 4] indicate that the level of somatic health, morphofunctional state, and physical fitness of modern adolescents is insufficient for their further educational and professional activities, military service in the Armed Forces of Ukraine, and overall life activities due to a number of problems. According to scientists [5, 6], a person-centered approach, which involves matching the forms, methods, and means of physical education to the individual psychological characteristics of adolescents and allowing the freedom to choose physical activities or sports that best suit their personal abilities, could be the basis for improving physical education in schools.

Scientists [7, 8] claim that various martial arts (aikido, karate, taekwondo, jiu-jitsu, etc.), combat sports (kickboxing, boxing, MMA, hand-to-hand combat, Muay Thai, etc.), and types of wrestling (judo, sambo, combat sambo, freestyle wrestling, Greco-Roman wrestling) are highly popular among adolescents. These sports can be effective means of physical education for adolescents, enhancing their physical fitness levels, improving their morphofunctional state, strengthening their health, and preparing them for life. One of these sports, which has significant practical importance, contributes to the health improvement of adolescents, enhances their physical fitness levels, and fosters motivation for regular physical exercise, is judo [9]. Judo training helps develop speed-strength abilities, general and strength endurance, flexibility, and coordination, increases physical performance, and fosters the formation of volitional qualities in adolescents. The physical fitness achieved by adolescents through judo

training has broad positive carryover and contributes to high achievements in professional activities, daily life, and other types of physical activity [9].

At the same time, experts [10] note that in the process of planning judo classes, it is important to consider the age and anatomical-physiological characteristics of adolescents. According to scientists [11], the age of 16 to 17 is the most favorable for the development and improvement of most physical qualities and abilities of adolescents, particularly speed-strength, which underlies high achievements in this sport. Given the above, the development and testing of an experimental judo training program regarding the impact of this sport on the morphofunctional state and physical fitness of adolescents (high school students) is relevant.

AIM

The aim is to investigate the impact of an experimental judo training program on the morphofunctional state and physical fitness of healthy adolescents.

MATERIALS AND METHODS

The study was conducted in 2023-2024 at Secondary School No. 20 with enhanced physical training (Zhytomyr, Ukraine) and the Department of Physical Education and Sport Improvement of Zhytomyr Ivan Franko State University. The study involved 54 male adolescents (10th-11th grade students aged 16-17), who were divided into an experimental group (EG, n=27) and a control group (CG, n=27). All 54 adolescents were classified as being in the main medical group for physical education classes (i.e., they were healthy).

The adolescents in the EG participated in a school judo sports section following an author's experimental program during extracurricular hours under the guidance of a judo coach-instructor (they were exempted from physical education classes). The adolescents in the CG attended traditional physical education classes conducted by the school's physical education teacher and did not engage in any additional sports activities. The selection of adolescents into groups was carried out by surveying them to provide them with the right to choose the sport they wished to engage in during extracurricular hours, depending on the available sports sections and, accordingly, the coach-instructors at the school.

The number of sessions per week in each group was the same, with 3 sessions per week, each lasting 45 minutes. The duration of the experiment was 9 months (from September 2023 to May 2024).

The author's experimental program was developed according to the age characteristics of 16-17-year-old adolescents (taking into account the sensitive patterns of physical quality development). The program includes: means, methods, and forms of training; methods of dosing physical loads throughout the academic year and during individual training sessions; and aims at fostering harmonious physical development, strengthening health, enhancing the body's functional capabilities, and forming motivation for physical activity considering the adolescents' interests in self-expression and realizing their potential in training activities.

The main tasks of the experimental program include: improving the general physical fitness level of adolescents; mastering judo techniques and enhancing the technical-tactical mastery of judo moves; improving the functional capabilities of adolescents' bodies; and forming positive motivation for regular physical exercise and the chosen sport.

The author's program includes: the distribution of adolescents by levels of physical fitness (low, average, high); variability of means (general developmental and specific preparatory exercises) depending on the adolescents' physical fitness level; learning judo techniques and combinations of techniques; regulation of the volume and intensity of load during training sessions; application of group training with differentiated and individual approaches; use of various teaching methods; use of special movement games with elements of wrestling; use of pedagogical and operational control over students' health, technical, and physical preparation. The application of special movement games with elements of wrestling helps develop speed-strength abilities; physical exercises with elastic bands and ropes ensure high density of judo training sessions; a wide range of techniques with dummies and partners allows for rational dosing of physical loads; controlled increase in physical load according to individual capabilities of adolescents, which contributes to health improvement, increased performance, and enhancement of the morphofunctional state of adolescents' bodies; participation in regional competitions, allowing adolescents to achieve sports ranks and increase their motivation for judo; and a high level of general physical fitness that provides a solid foundation for developing professionally relevant qualities for future professional activity and life skills, are the features of the 9-month author's experimental judo training program.

Research methods: bibliosemantic, medical-biological, testing, and mathematical-statistical methods. The bibliosemantic method was used to determine the state of the problem through the analysis of literary sources and electronic resources. A total of 20 scientific sources were reviewed, most of which are included in scientific databases such as Scopus, Web of Science Core Collection, PubMed, Index Copernicus, and others. Medical-biological methods were used to assess the morphofunctional state of the muscular, cardiovascular, and respiratory systems of adolescents using indices such as the strength index, life index, Ruffier index, Stange index, Genchi index, and Robinson index [12]. The testing method was applied to evaluate the physical fitness of adolescents using tests such as the 30-meter run, standing long jump, pull-ups on a bar, push-ups from a prone position for 1 minute, trunk lifts in a sitting position for 30 seconds, and shuttle run 4x9 meters. Mathematical-statistical methods were used for quantitative processing of the obtained data, qualitative analysis, and evaluation of reliability using the Student's t-test. The reliability for all studies was established at no lower than $p<0.05$. Results are presented as M±m, where M is the arithmetic mean and m is the standard deviation error. All statistical analyses were conducted using IBM SPSS Statistics 21 software, adapted for medical research.

This study adheres to the Academic Integrity Policy of Zhytomyr Ivan Franko State University and the Helsinki Declaration of the World Medical Association. The research topic was approved by the Academic Council of Zhytomyr Ivan Franko State University (protocol No. 2 dated 18.09.2023). Consent for voluntary participation was obtained from all adolescents involved in the study.

RESULTS

A comparative analysis of the morphofunctional state indicators of adolescents in the EG and CG at the beginning and end of the pedagogical experiment, as well as the dynamics of the investigated indicators in each group during the pedagogical experiment, is presented in Table 1.

There was no significant difference ($p>0.05$) between all the investigated morphofunctional state indicators of adolescents in the EG and CG at the beginning of the experiment. During the experiment, most indicators showed a trend towards improvement in both groups of adolescents; however, in the EG, the difference between the indicators at the beginning and end of the experiment was significant for all investigated indices ($p<0.05$-0.001), while in the CG it was not ($p>0.05$), except for the vital index ($p<0.05$). Moreover, at the end of the experiment, all investigated indicators in the EG adolescents were significantly ($p<0.05$-0.001) better than in the CG.

The most pronounced effect of judo training was observed on the following indices in the EG adolescents: strength index, Ruffier index, Stange index, Genchi index, and Robinson index. Specifically, at the end of the experiment, the EG adolescents had better results than the CG by 8.33% in the strength index ($p<0.05$), by 3.59 units in the Ruffier index ($p<0.001$), by 6.71 seconds in the Stange index ($p<0.05$), by 6.13 seconds in the Genchi index ($p<0.001$), and by 3.78 units in the Robinson index ($p<0.05$). The conducted research indicates that judo training sessions, provided there is a conscious choice of sport and motivation for participation, are more effective compared to traditional physical education classes in senior grades for improving the morphofunctional state of 16-17-year-old adolescents.

The level of physical fitness of adolescents in the EG and CG at the beginning and end of the pedagogical experiment, as well as the dynamics of the development of their motor qualities during the study, are presented in Table 2.

At the beginning of the experiment, the level of physical qualities in adolescents from both the EG and CG was not significantly different across all tests ($p>0.05$). At the end of the experiment, adolescents in the EG demonstrated significantly better physical fitness across all tested measures compared to the CG: 0.07 seconds faster in the 30 m sprint ($p<0.05$), 11 cm longer in the standing long jump ($p<0.01$), 4.64 more pull-ups on the bar ($p<0.001$), 4.29 more push-ups ($p<0.05$), 3.51

Table 1. Dynamics of morphofunctional state indicators of adolescents in the EG (n=27) and CG (n=27) throughout the pedagogical experiment (n=54, M±m)

Investigated indicators/ Significance of difference	Groups	Stages of the experiment		Δ	Significance of difference	
		Beginning	End		t	p
Strength Index, %	EG	64.23±1.78	73.57±1.64	9.34	3.86	<0.01
	CG	63.58±1.82	65.24±1.74	1.66	0.72	>0.05
t; p		0.26; >0.05	3.48; <0.05			
Vital Index, ml/kg	EG	61.12±1.84	66.54±1.92	5.42	2.04	<0.05
	CG	61.86±1.82	63.91±1.89	2.05	0.78	>0.05
t; p		0.29; >0.05	0.98; >0.05			
Ruffier Test, units (y.o.)	EG	13.26±0.45	7.72±0.31	5.54	10.14	<0.001
	CG	12.85±0.40	11.31±0.36	1.54	2.86	<0.05
t; p		0.68; >0.05	7.56; <0.001			
Stange Test, s	EG	46.53±1.86	58.17±1.54	11.64	4.82	<0.001
	CG	45.57±2.35	51.46±1.84	5.89	1.97	>0.05
t; p		0.32; >0.05	2.80; <0.05			
Genchi Test, s	EG	30.73±0.66	37.24±0.53	6.51	7.69	<0.001
	CG	29.83±0.54	31.11±0.55	1.28	1.66	>0.05
t; p		1.06; >0.05	8.03; <0.001			
Robinson Index, units (y.o.)	EG	86.91±1.23	81.12±1.07	5.79	3.55	<0.01
	CG	86.55±1.16	84.90±1.11	1.65	1.03	>0.05
t; p		0.21; >0.05	2.45; <0.05			

Note: Δ – increase in indicators over the experimental period; t – value of the Student's t-test; p – significance of the difference between the investigated indicators

Source: compiled by the authors of this study

Table 2. Dynamics of physical fitness of adolescents in the EG (n=27) and CG (n=27) throughout the pedagogical experiment (n=54, M±m)

Tests/ Significance of difference	Groups	Stages of the experiment		Δ	Significance of difference	
		Beginning	End		t	p
30 m Sprint, s	EG	6.04±0.12	5,470,10	0.57	3,65	<0.01
	CG	6.61±0.13	5,54±0,11	0.37	1,94	>0.05
t; p		0.92; >0.05	2.26; <0.05			
Standing Long Jump, cm	EG	204.1±2.77	219,4±2,71	16.3	3,95	<0.001
	CG	201.7±2.58	208,4±2,49	6.7	1,87	>0.05
t; p		0.63; >0.05	2.99; <0.01			
Pull-ups on Bar, times	EG	8.56±0.59	13,72±0,52	5.16	6,56	<0.001
	CG	7.78±0.62	9,08±0,57	1.30	1,54	>0.05
t; p		0.91; >0.05	6.01; <0.001			
Bending the arms in a lying position (1 min), times	EG	22.65±1.12	29,18±1,14	6.53	4.09	<0.001
	CG	21.96±1.07	24,89±1,04	2.93	1.96	>0.05
t; p		0.45; >0.05	2.78; <0.05			
Raising the torso in the saddle (30 s), times	EG	16.55±1.02	24,16±1,05	6.61	4,52	<0.001
	CG	17.04±0.97	20,65±0,99	2.61	1.88	>0.05
t; p		0,35; >0.05	2.43; <0.05			
Shuttle run 4x9 m, s	EG	10.91±0.13	10,12±0,12	0.79	4,47	<0.001
	CG	10.65±0.12	10,43±0,11	0.20	1,23	>0.05
t; p		1,47; >0.05	2.03; <0.05			

Note: Δ – increase in indicators over the experimental period; t – value of the Student's t-test; p – significance of the difference between the investigated indicators

Source: compiled by the authors of this study

more sit-ups (p<0.05), and 0.31 seconds faster in the shuttle run (p<0.05). The greatest effect of judo training was observed in the development of speed-strength qualities, strength endurance, and agility. Over the experimental period, results improved in all tests for both groups, but the changes in the EG were statistically significant (p<0.05-0.001), whereas those in the CG were not (p>0.05). This demonstrates the positive impact of the experimental judo training program on the physical fitness level of adolescents aged 16-17.

DISCUSSION

Given the current low levels of health and physical fitness among students in general education schools, their insufficient motivation for physical activity, non-adherence to healthy lifestyle principles, and the negative impact of the learning conditions during the state of martial law in Ukraine, as well as the inadequate quality of physical education lessons, numerous scientific studies [13] reflect efforts to renew and improve the existing process of physical education for adolescents. Various approaches are proposed for organizing both curricular and extracurricular forms of physical education for students, including those in senior classes.

Our previous research [14, 15] has established that a promising direction for improving the current process of physical education for adolescents is the introduction of sports-oriented health and sports training technologies. The organization of the physical education process based on students' self-selection of physical activities is considered the most progressive form. This approach stimulates interest in specific sports and the development of physical abilities. By providing freedom in choosing physical activities (or any sport), students can demonstrate self-initiative and, consequently, have full autonomy in learning: having chosen the activity themselves, they are more motivated to acquire knowledge and skills in that area. The ability for students to rely on their own feelings and desires in choosing physical activities is of significant importance [16].

At the same time, the analysis of physical education forms in schools indicates that their effectiveness does not meet modern requirements. In many secondary education institutions, physical education and sports events are organized at a low educational and methodological level. The number of students interested in participating in school sports clubs and physical education extracurricular activities is relatively small [17].

When implementing modern sports-oriented technologies in secondary education institutions, it is crucial to remember that, in addition to developing specific sports skills and abilities in adolescents, it is necessary to cultivate vital motor skills, acquire knowledge about a healthy lifestyle, and foster a conscious need for regular physical exercise.

One of the key incentives for students' interest in systematic training in a particular sport includes: improving health and body shape, socializing and forming friendships with peers, participating in competitions and earning medals and awards, and achieving high sports results [18]. Additionally, extracurricular training sessions or physical education classes organized in an individualized format play important roles: promoting and advertising sports and wellness activities, engaging students in productive and enjoyable leisure activities, improving the social and psychological climate in student groups, and setting personal records [19]. Thus, a promising direction for addressing the above-mentioned issues is the implementation of a person-centered approach to physical education in general secondary education institutions, taking into account students' free choice of sport. This approach should consider the material and technical resources available, students' motivation and preferences, and the availability of qualified sports specialists.

Based on a number of studies and considering the high interest among modern adolescents in martial arts, we have developed and substantiated an experimental judo program for school extracurricular activities and implemented it into the physical education curriculum at one of the schools in Zhytomyr.

As a result of implementing the author's experimental judo program into the training process of the school judo section and evaluating its effectiveness over a period of 9 months, we have confirmed the findings of many researchers that adolescents aged 16-17 experience intensive development of speed-strength qualities, muscular endurance, and agility. This facilitates effective acquisition of motor skills and abilities and serves as a prerequisite for the effective execution of judo techniques during training and competitive activities. Additionally, we have expanded upon the data of researchers [7, 9, 11, 17, 20] regarding the organization of the judo training process, the planning of training preparation, and the methodology for teaching and developing physical qualities and abilities of high school students, as well as improving their morphofunctional state and health through judo practice.

CONCLUSIONS

It was found that the indicators of morphofunctional status showed a tendency to improve in both groups of adolescents over the course of the experiment. However, in the experimental group (EG), the difference between the indicators at the beginning and end of the experiment was significant ($p<0.05$-0.001) for all the studied indices, while in the control group (CG) it was not significant ($p>0.05$). Furthermore, at the end of the experiment, all the indicators in the EG were significantly ($p<0.05$-0.001) better than those in the CG. The most pronounced effect of judo training was observed on the indices such as the strength index, Rufier index, Shange index, Genchi index, and Robinson index. At the end of the experiment, the EG showed improvements over the CG of 8.33% for the strength index ($p<0.05$), 3.59 units for the Rufier index ($p<0.001$), 6.71 seconds for the Shange index ($p<0.05$), 6.13 seconds for the Genchi index ($p<0.001$), and 3.78 units for the Robinson index ($p<0.05$).

It was found that the level of physical fitness in adolescents from the experimental group (EG) was significantly better than that in the control group (CG) at the end of the experiment for all the tested measures: by 0.07 seconds in the 30-meter sprint ($p<0.05$), by 11 cm in the standing long jump ($p<0.01$), by 4.64 repetitions in pull-ups ($p<0.001$), by 4.29 repetitions in push-ups ($p<0.05$), by 3.51 repetitions in sit-ups ($p<0.05$), and by 0.31 seconds in the shuttle run 4x9 meters ($p<0.05$). The greatest effect of judo training was observed on the development of speed-strength qualities, muscular endurance, and agility. During the experiment, results improved in both groups for all tests, but in the EG, these changes were significant ($p<0.05$-0.001), whereas in the CG, they were not significant ($p>0.05$).

The conducted research indicates that extracurricular judo training sessions based on the author's experimental program, provided there is a conscious choice of sport and motivation to participate, are more effective compared to traditional physical education classes for improving the morphofunctional state and physical fitness of healthy adolescents aged 16-17. The high level of the studied indicators in adolescents participating in judo is likely to contribute to their health improvement and enhance their future educational and professional activities.

Prospects for further research involve assessing the effectiveness of the author's judo program in improving the morphofunctional state and physical fitness of girls aged 16-17 during extracurricular training sessions.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

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RECEIVED: 20.02.2025
ACCEPTED: 04.08.2025