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The influence of ultimate frisbee exercises on the level of physical fitness of 15-16-year-old pupils

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Abstract

Background and Study Aim. The presented research determined the influence of an innovative type of motor activity ultimate frisbee on the level of physical fitness of pupils.

Material and methods. The study was conducted based on the general secondary education institution in Kharkiv (Ukraine). 105 pupils 15-16 years old took part in it. The following methods were used during the research: theoretical analysis and generalization of scientific and methodical literature, pedagogical testing, pedagogical experiment, and methods of mathematical statistics. The level of physical fitness of pupils was determined by the indicators of development of coordination abilities, quickness, flexibility, endurance, and power qualities.

Results. The comparative analysis of the results of the level of development of physical qualities in age and gender aspects, with the corresponding norms, before and after the application of experimental exercises was carried out. Considering the results of the level of development of physical qualities of 15-16-year-old persons in the age aspect, it should be noted that there is a tendency to improve the results with age. In most cases, the results differ unreliably ($p>0.05$). The analysis of the results of the level of development of physical qualities in the gender aspect revealed that boys demonstrate higher results in control exercises than girls ($p<0.05$-0.001). The exception is the indicators of the development of flexibility. A comparison of the initial data on the level of physical fitness of 15-16-year-old pupils with generally accepted norms showed that the results correspond to the assessment as "satisfactory". After the introduction of ultimate frisbee exercises into the educational process, there was an increase in the level of development of physical qualities of pupils of the studied groups ($p<0.05$-0.01). A comparison of the results obtained after the experiment with the norms showed an increase in the level of physical fitness of representatives of both age groups to the assessment "good".

Conclusions. The conducted research testifies to the positive influence of ultimate frisbee exercises on the level of physical fitness of 15-16-year-old pupils, which makes it possible to use widely the proposed by us means in the process of school physical education.

Key words: physical qualities, motor activity, high school pupils, physical culture.

Анотація

Вплив занять фризбі на рівень фізичної підготовленості школярів 15-16 років

Ірина Кузьменко, Ірина Масляк, Маргарита Мамешина, Тетяна Бала, Наталя Бихун

Передумови та мета дослідження. У представленому дослідженні визначено вплив інноваційного виду рухової активності фризбі на рівень фізичної підготовленості школярів.

Матеріал і методи. Дослідження проводилося на базі закладу загальної середньої освіти м. Харкова (Україна). У ньому взяли участь 105 учнів 15-16 років. Під час дослідження використовувалися наступні методи: теоретичний аналіз та узагальнення науково-методичної літератури, педагогічне тестування, педагогічний експеримент, методи математичної статистики. Рівень фізичної підготовленості школярів визначався за показниками розвитку координаційних здібностей, швидкісних здібностей, гнучкості, витривалості та силових якостей.

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Результати. Проведено порівняльний аналіз результатів рівня розвитку фізичних якостей у віковому та гендерному аспектах, з відповідними нормативами, до та після застосування експериментальних вправ. Розглядаючи результати рівня розвитку фізичних якостей 15-16-річних осіб у віковому аспекті, слід зазначити, що спостерігається тенденція до покращення результатів з віком. У більшості випадків результати відрізняються недостовірно (p>0,05). Аналіз результатів рівня розвитку фізичних якостей у гендерному аспекті виявив, що хлопці демонструють вищі результати у контрольних вправах, ніж дівчата (p<0,05-0,001). Виняток становлять показники розвитку гнучкості. Порівняння вихідних даних про рівень фізичної підготовленості 15-16-річних школярів із загальноприйнятими нормами показало, що результати відповідають оцінці "задовільно". Після впровадження в навчальний процес вправ з алтимат фризбі відбулося підвищення рівня розвитку фізичних якостей учнів досліджуваних груп (p<0,05-0,01). Порівняння результатів, отриманих після експерименту з нормативами, показало підвищення рівня фізичної підготовленості представників обох вікових груп до оцінки "добре".

Висновки. Проведене дослідження свідчить про позитивний вплив вправ з фризбі на рівень фізичної підготовленості школярів 15-16 років, що дає можливість широко використовувати запропоновані нами засоби в процесі шкільного фізичного виховання.

Ключові слова: фізичні якості, рухова активність, старшокласники, фізична культура.

Introduction

There is a decrease in the motor activity of youth in the last years in the world [1, 2]. Such a negative tendency is the reason for expressed changes in the functioning of vegetative systems of an organism [3], low level of physical fitness, a decrease in physical and mental health [4, 5, 6], well-being, and quality of life [7, 8]. One of the reasons for the low physical activity of pupils is the lack of motivation to exercise [9], and not enough interesting physical education lessons, which in most cases is associated with the use of standard exercises, sports, and equipment [10, 11].

Today Ukraine is reforming its educational system. The key changes concern the organization of the educational process, approaches to learning, and the content of education. In particular, in the process of physical education of pupils, innovative types of motor activities are introduced aimed at increasing the motivation of children to exercise, increasing physical activity, and the formation of socially important competencies [12, 13].

Some authors were engaged in improving the process of physical education through the introduction of innovative exercises in the educational process of general secondary education institutions. Thus, Bala et al. [14] used such a modern and spectacular type of motor activity as cheerleading in the educational process. The authors established the positive influence of cheerleading exercises on the level of physical health and motor fitness of middle and high school pupils.

The positive influence of CrossFit exercises on the level of physical fitness of high school pupils is noted by Petrova [15], Shesterova et al. [16] investigated the influence of special exercises on the improvement of the functional state of sensory systems and, as a consequence, on the change of physical qualities of school-age children. The increase of indicators of coordination abilities of 14-15-year-old girls under the influence of fitball aerobics is noted by Kuzmenko et al. [12].

The authors Mameshina et al. [13] note the increase in the level of physical health and motor fitness of 13-15-year-old pupils after the introduction of differentiation of the content of physical education classes taking into account the indicators of physical health and physical fitness of pupils.

One of the non-standard, interesting means of physical education and sports training for pupils is ultimate frisbee - a team sport, where a flying disc is used as sports equipment. This game has many variants, which are characterized as technically simple and generally accessible, so it can be successfully used in physical culture lessons [17, 18].

Ultimate Frisbee opens up new opportunities for the implementation of a variety of physical education tasks: health promotion, promotion of harmonious physical development, and formation of important motor skills. The game is exciting, dynamic, and spectacular, promotes the development of physical, moral, volitional, and mental abilities. The accessibility of this game allows conducting a lesson on physical culture not only in the hall but also outdoors with the use of the healing powers of nature [19, 20].

It should be noted that publications devoted to the influence of ultimate frisbee exercises on the level of physical fitness of 15-16-year-old pupils aren't covered in the literature, which determined the relevance of the research.

The purpose of the research is to evaluate changes in the development level of physical qualities of 15-16-year-old pupils under the influence of ultimate frisbee exercises.

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Material and methods

Participants

In the research 105 pupils, 15-16 years old took part, from which two experimental and two control groups were formed. The first experimental group - of 15-year-old pupils: 18 boys, 15 girls; the second experimental group - of 16-year-old pupils: 19 boys, 13 girls. The control groups were distributed accordingly – of 15-year-old pupils: 10 boys, 12 girls; of 16-year-old pupils: 8 boys, 10 girls. Pupils gave their consent to participate in the research.

Methods

The following methods were used during the research: theoretical analysis and generalization of scientific and methodological literature; pedagogical testing; pedagogical experiment and methods of mathematical statistics.

Theoretical analysis and generalization of scientific and methodological literature were used to study the relevance of the research problem.

Pedagogical testing was conducted to determine the state and dynamics of the development level of physical qualities of 15-16-year-old pupils. The control exercises proposed by Krutsevich et al. [21], Romanenko [22], Serhiienko [23] were used.

The development level of coordination abilities, flexibility, speed and power abilities, and endurance was estimated in the course of the research.

The exercises "shuttle run 4x9 m" and static balance by Bondarevsky's method were used to determine the development level of coordination abilities

The control exercise "Shuttle run 4×9 m" provided that the test participant ran a distance of 9 m, took one of two wooden cubes, returned by running back, and put it in the starting circle. Then he ran for the second cube and, having taken it, returned and put the second cube in the starting circle. The result of the test was the time from the start to the moment when the participant put the second cube in the starting circle. The result of the participant was determined by the best of the two tests. According to the evaluation scale of Krutsevich et al. [21].

In the exercise "Static balance by Bondarevsky's method" the test participant acquired a stable position on one leg, hands on the belt. It was necessary to hold this position as long as possible. Time registration on the stopwatch began after acquiring a stable position and ended at the moment of loss of balance. The exercise was performed with eyes closed. Holding a static posture was carried out on the right and left legs. The best result was fixed. According to the norms of Serhiienko [23].

For determination of speed abilities, 60 m run and running on a place for 5 seconds were used.

In the control exercise "Running for 60 m" the test participant had to overcome the distance of 60 m as quickly as possible from a high start position. Only one attempt was allowed. According to Romanenko's evaluation scale [22].

The control exercise "Running on place for 5 seconds" involved running on the spot for 5 seconds with raising the hip to a rubber harness stretched at the waist level. The number of touches with one leg was counted, and then the result was doubled. The test participant was given two attempts, the best result was counted. According to Romanenko's evaluation criteria [22].

The level of flexibility development was assessed by performing the cross splits and tilting the trunk forward from a sitting position.

During the control exercise "Cross split" the test participant stood with his back to the gymnastic wall, hands held at shoulder level. Behind him, a vertical bar was fixed on the wall, on which centimeter divisions were applied (from bottom to top). At the command, the participant carried the cross-split slide. The shortest distance from the groin area to the floor in centimeters was recorded on the measuring bar. The result of mobility in the hip joints according to Serhiienko [23].

The control exercise "Torso bending forward from a sitting position" provided that the test participant sat on the floor barefoot, the distance between the heels – 20-30 cm, the feet should be placed vertically on the floor, and the hands should be placed on the floor between the knees with palms down. The partner had to keep the legs at knee level to avoid bending them. On command, the test participant smoothly leaned forward without bending his legs, trying to reach his hands as far as possible. The position of maximum tilt should be held for 2 seconds, fixing the fingers on the markings. The test was repeated twice. The result was counted by the fingertips that reached the highest digital mark. According to the evaluation scale of Krutsevich et al. [21].

The following exercises were used for the determination of power abilities: raising the torso sitting for 1 minute, bending and extending the arms in a lying position, wrist dynamometry, and a long jump from a place.

During the control exercise "Flexion and extension of the arms in the supine position", the test participant had to take a supine position, arms straightened and spread shoulder-width apart with hands forward, torso and legs had to form a straight line, toes resting on the floor. On command, the participant had to start rhythmically bending and extending his arms with full amplitude. When bending the arms, it was neces-

sary to touch the support with the chest. It wasn't allowed to touch the support with the hips, to change the straight position of the body and legs, to be in the starting position of the body with bent arms for more than 3 seconds, to lie on the floor, to bend the arms alternately, to bend and flex the arms with not full amplitude. One attempt was given. According to the normative indicators of Krutsevich et al. [21].

The control exercise "Raising the torso in sitting position for 1 minute" provided that the test participant sat on the mat, bending the knees at 90°. The feet had to rest completely on the surface of the mat, the distance between them was about 30 cm. Hands were joined at the back of the head, fingers intertwined, elbows rested on the knees. After the command "Go!" the pupil lay on his back, touched the mat with his shoulders, and then rose and returned to the starting position. For 1 min the test participant tried to make the maximum number of repetitions. According to the norms of Krutsevich et al. [21].

In the exercise "Hand dynamometry" the test participant occupied the following initial position: hand dynamometer in the hand (the strongest), the arm is lowered and moved away from the body, legs slightly apart. On the command "Go!" the test participant had to vigorously, without jerking, evenly squeeze the dynamometer and fix it for two seconds. There were 2 attempts, the best result was recorded. According to Romanenko's rating scale [22].

The control exercise "Long jump from the place" consisted in the fact that the examinee stood toes to the line, swung his hands back, then sharply brought them forward, pushing off with his legs, and jumped as far as possible. The result of the test was the jump distance in centimeters in the best of two attempts. According to the normative indicators of Krutsevich et al. [21].

The development of endurance was assessed by the indicators of shuttle run 4x30 m and running for 6 minutes.

The exercise "Shuttle run 4x30 m" provided that the participant of the test on the command "On start!" stood in a high start position behind the starting line. On the command "Run!" he ran 30 m to the second line, ran back, and repeated the exercise. The participant was given one attempt. According to the norms of Romanenko [22].

The control exercise "Running for 6 minutes" consisted of the fact that the test participants had to cover the greatest possible distance within 6 minutes. Only one attempt was allowed. According to Romanenko's evaluation scale [22].

For carrying out of the pedagogical experiment which was carried out in several stages, the investigated were divided into experimental and control groups.

At the first stage of the experiment, preliminary testing was conducted to establish the identity of the experimental and control groups, which didn't reveal significant differences between them. At the same stage, the initial development level of physical qualities of 15-16-year-old pupils was determined.

The second stage of the experiment consisted of the introduction of ultimate frisbee exercises in the process of physical education of pupils in experimental groups.

The content of the experimental component included: theoretical, general physical, special physical, technical, tactical training and educational game. The content of theoretical training included such topics as: "History of the development of ultimate frisbee in the world and Ukraine", "Rules of the game, resolution of controversial issues", "Safety precautions during the game of ultimate frisbee", "Terminology of the game", "Fundamentals of technical and tactical training" and others.

General physical training included general developmental exercises without objects, with objects: balls for tennis, table tennis, Frisbee disc, stuffed balls, jump ropes, exercises for the formation of correct posture, walking, running and their varieties, etc.

The content of special physical training included: running with acceleration for 5-10 m from various starting positions, running at maximum pace for 30-40 m, moving with a change of direction and speed, running on a signal, backward, alternating walking and running, various jumps, running at medium distances of 200-500 m, shuttle run 3x10 m, uniform 6-minute run, outdoor games, relay races with a Frisbee disc, etc.

The content of technical training was based on the study of the technique of disc throws (backhand, forehand, hammer, blade), catching (on the spot, in a jump, while running), passes, and deceptive movements. The content of tactical training included the study of individual, group and team interactions in attack and defense. At the end of the main part of the lesson, relay races with a disc or an educational game were conducted.

Exercises with elements of frisbee were also included in the content of other variable modules of the lesson.

The experiment was built based on generally accepted principles and methods of training.

At the third stage of the experiment, repeated testing was carried out to study the degree of change in the development level of motor abilities of 15-16-year-old persons after the use of ultimate frisbee exercises.

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Procedure

The research was conducted in stages during the academic year. In the first stage, the analysis and generalization of scientific and methodical literature were carried out. This made it possible to study the state of the research problem, determine the contingent, develop a research model and select appropriate methods. In the second stage, preliminary testing of the development level of physical qualities of 15-16-year-old pupils and the pedagogical experiment was conducted. During the academic year (October-April), the content of physical education lessons of pupils of experimental groups was supplemented with ultimate frisbee exercises, and pupils of control groups were engaged in the generally accepted physical education program, mastering such sections as badminton and handball. In the third stage, repeated testing was carried out to determine the degree of influence of ultimate frisbee exercises on the indicators of the development of physical qualities of the studied contingent. Statistical processing and comparative analysis of the obtained results were carried out, and conclusions of the research were made.

Statistics processing

For statistical processing, the average and standard error of each measurement were calculated using the SPSS (version 25.0) statistical program. Normality of data distribution was verified using the Kolmogorov-Smirnov test. ANOVA statistical test was conducted to examine the differences between groups. The significance level was $p<0.05$.

Results

Data from initial research of physical fitness at the development level revealed the absence of significant differences in indicators of experimental and control groups ($p>0.05$).

The analysis of indicators of pupils' 15-16 years old physical qualities development level in gender aspect showed that boys' results are higher than girls' one. Exceptions are indicators of static balance and flexibility, where the results are better for girls. It should be noted that the differences, in most cases, are reliable ($p<0.05$-0.001).

Considering the results of the development of motor qualities of 15-16-year-old persons in the age aspect, it should be noted that with age there is a tendency to the improvement of results, except for indicators of flexibility development which deteriorate with age. At the same time, the results differ mainly insignificantly ($p>0.05$).

Considering data on the development of coordination abilities of 15-16-year-old pupils of experimental and control groups after the introduction of ultimate frisbee exercises (table 1), it was determined that the indicators of shuttle run 4x9 m and static balance by Bondarevsky's method of pupils of experimental groups significantly increased ($p<0.05$-0.01) in comparison with the data of persons of control groups, however, the differences are unreliable ($p>0.05$) in indicators of a shuttle run 4x9 m of 15-16-year-old girls.

Analyzing indicators of pupils' 15-16 years old quickness development of experimental and control groups after the experiment (table 1), it should be noted that data of 60 m run and running on place for 5 s of young people of experimental groups are significantly higher than results of pupils of control groups ($p<0.05$-0.01).

Analyzing the results of flexibility development of 15-16-year-olds of experimental and control groups after the experiment (table 1), it should be noted that the data of trunk forward tilt from sitting position of pupils of experimental groups are significantly better than the indicators of young people of control groups ($p<0.05$-0.01). The results of cross splits of pupils of experimental groups are also higher than the indicators of pupils of control groups, however, the reliable character of differences is observed only at girls of 16 years old ($p<0.05$).

The analysis of results of the development of pupils' power qualities of experimental and control groups after implementation of experimental exercises (table 1), showed that indicators of raising the torso in a sitting position for 1 minute of persons of experimental groups are higher than data of youth of control groups, however, there is the unreliability of differences ($p>0.05$). In the results of hand dynamometry, flexion and extension of the arms in the supine position, and long jump from the place there are significantly higher results of persons of experimental groups ($p<0.05$-0.01) in comparison with pupils of control groups. Except for indicators of flexion and extension of the arms in the supine position boys and hand dynamometry girls of 16 years old, in which data there are insignificant differences ($p>0.05$).

Considering the results of endurance development of 15-16-year-old youth of experimental and control groups after the experiment (table 1), it should be noted that the data of pupils of experimental groups are higher than those of control groups. Thus, reliability of differences is observed only in indicators of shuttle run 4x30 m of girls ($p<0.05$).

Analysis of results of pupils' physical qualities' development of experimental and control groups in gender aspect after experiment revealed the same tendency as at the beginning of the academic year: boys demonstrate higher results in control exercises than girls. The exception is the data on static balance and flexibility development,

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Table 1. Indicators of physical qualities development of 15-16-years-old pupils of experimental and control groups after the experiment

Test	Age	Gender	Experimental groups	Control groups	ANOVA	
			X+SE	X+SE	F	p
Coordination abilities						
Shuttle run 4×9 m, s	15	Boy	10.09±0.25	11.29±0.12	11.76	<0.01
		Girls	10.89±0.23	11.48±0.14	4.18	>0.05
	16	Boy	9.25±0.17	9.96±0.19	6.03	<0.05
		Girls	10.68±0.31	11.34±0.16	3.03	>0.05
Static balance by Bondarevsky's method, s	15	Boy	16.11±1.18	11.80±0.92	6.17	<0.05
		Girls	20.67±1.60	15.50±1.04	6.56	<0.01
	16	Boy	18.16±1.43	12.88±1.72	4.53	<0.05
		Girls	23.92±2.23	15.80±2.11	6.63	<0.05
Speed						
Running for 60 m, s	15	Boy	8.89±0.09	10.09±0.41	13.65	<0.01
		Girls	10.21±0.23	11.02±0.15	7.99	<0.01
	16	Boy	8.29±0.16	9.58±0.38	13.61	<0.01
		Girls	9.72±0.36	10.85±0.16	6.67	<0.05
Running on place for 5 seconds, number of steps	15	Boy	42.44±1.50	37.00±1.32	5.83	<0.05
		Girls	35.47±1.84	30.25±1.01	5.35	<0.05
	16	Boy	46.42±1.48	38.38±3.09	7.09	<0.05
		Girls	37.15±2.28	29.40±2.40	5.38	<0.05
Flexibility						
Torso bending forward from a sitting position, cm	15	Boy	13.06±1.50	7.80±1.22	5.60	<0.05
		Girls	15.40±1.48	10.00±0.76	9.11	<0.01
	16	Boy	11.42±1.32	6.88±1.09	4.40	<0.05
		Girls	14.54±1.33	10.20±1.02	6.02	<0.05
Cross split, cm	15	Boy	37.11±2.18	43.70±1.81	4.16	>0.05
		Girls	22.23±2.06	29.42±3.01	4.00	>0.05
	16	Boy	38.58±2.16	42.75±2.53	1.25	>0.05
		Girls	23.00±2.55	31.00±1.69	5.98	<0.05
Power qualities						
Raising the torso in sitting position for 1 minute, number of times	15	Boy	41.44±2.04	36.70±2.58	2.00	>0.05
		Girls	38.80±2.92	34.17±2.60	1.33	>0.05
	16	Boy	43.11±1.71	39.13±2.78	1.55	>0.05
		Girls	41.69±2.11	36.80±2.61	2.18	>0.05
Hand dynamometry, kg	15	Boy	40.61±1.44	36.10±0.57	5.14	<0.05
		Girls	28.87±1.26	24.33±1.32	6.07	<0.05
	16	Boy	45.16±1.43	39.88±1.95	4.29	<0.05
		Girls	31.62±1.97	26.10±2.04	3.68	>0.05
Flexion and extension of the arms in the supine position, number of times	15	Boy	27.44±1.32	21.30±2.33	6.17	<0.05
		Girls	12.93±1.55	8.25±0.63	6.56	<0.05
	16	Boy	29.32±1.97	24.38±3.28	1.78	>0.05
		Girls	15.15±1.82	10.30±1.00	4.62	<0.05
Long jump from the place, cm	15	Boy	210.56±7.26	178.20±9.26	7.33	<0.05
		Girls	168.33±4.97	148.92±6.50	5.84	<0.05
	16	Boy	230.00±4.19	212.50±7.32	4.79	<0.05
		Girls	175.23±5.27	154.50±8.04	5.02	<0.05
Endurance						
Shuttle run 4x30 m, s	15	Boy	25.91±0.67	27.77±1.04	2.46	>0.05
		Girls	27.33±0.83	30.34±1.03	5.33	<0.05
	16	Boy	24.83±0.68	26.14±0.69	1.29	>0.05
		Girls	26.82±0.68	28.93±0.92	3.56	>0.05
Running for 6 minutes, m	15	Boy	1311.11±26.06	1250.00±27.89	2.25	>0.05
		Girls	1006.67±53.20	891.67±43.45	2.61	>0.05
	16	Boy	1365.79±34.00	1287.50±47.01	1.66	>0.05
		Girls	1092.31±53.66	975.00±60.67	2.09	>0.05

**X - arithmetic averages; SE - standard error of the mean; F – criterion was used to determine the degree of reliability of the difference in indicators; p - statistical significance*

where the results for girls are higher. At the same time, the differences in most cases are reliable ($p<0.05$-0.001).

Considering the results of the development level of motor qualities of 15-16-year-old persons of experimental and control groups in the age aspect after the experiment, it should be noted that with age there is a tendency to the improvement of results. Thus, in most cases, the results have the unreliable character of differences ($p>0.05$).

Discussion

The development of physical qualities is one of the most important issues in physical education, sports, pedagogy, psychology, and physiology. In the process of physical education, considerable attention should be paid to the development of physical qualities, the level of which largely determines the state of health of pupils [24, 25]. The research on the development level of physical qualities of pupils of different ages is devoted to the work Shesterova et al. [16], Ingegerd [26], Bukvić et al. [27], Alnedral et al. [28], Marchenko Svitlana et al. [29]. The results of our research supplemented the knowledge about the current state of development of physical qualities of high school pupils confirming the authors' data about the insufficient level of their development and the need to find ways to improve them. A comparison of the initial data of the level of motor fitness of the studied contingent with the corresponding norms, revealed that the results, on average, corresponding to the assessment "satisfactory".

Specialists in the field of physical culture and sport offer various ways of physical qualities development in pupils [13, 30, 31, 32]. Our research confirmed the effectiveness of the use in the educational process of such an innovative means as Ultimate Frisbee, and the positive impact of these exercises on improving the physical fitness of pupils.

A comparison of indicators of shuttle run 4x9 m of pupils of experimental groups with the standards proposed by Krutsevich et al. [21] showed that the score increased by an average of 2 points: pupils of 15 years old and girls of 16 years old began to correspond to "4 points", and boys of 16 years old – "5 points". A comparison of the data of static balance with the norms presented by Serhiienko [23] revealed that the results of pupils aged 15-16 years improved and became higher than average.

A comparison of the results of the development of coordination qualities with the presented evaluation scale in pupils of the control groups didn't reveal any changes in the assessment at the end of the school year.

Comparing indicators of running for 60 m of pupils of experimental groups with the estimation scale proposed by Romanenko [22], it should be noted that the estimation increased on average by 2 points: boys and girls of 15-16 years old began to perform the exercise for the assessment "4". A comparison of indicators of running on a place for 5 s with norms according to Romanenko [22], showed the increase of estimation by 1 point: it became "4 points" at boys and girls – "3 points".

A comparison of data of run for 60 m and running on the place for 5 s of pupils of control groups with corresponding norms revealed absence of any changes: as at the beginning of the academic year, results of boys and girls of 15-16 years old corresponded to the assessment "2".

Comparing the results of torso bending forward from a sitting position in the studied contingent with the norms proposed by Krutsevich et al. [21] it should be noted that the score of 15-year-old pupils increased by 1 point, in pupils of 16 years old by 2 points and began to correspond in both age groups to "3 points". A comparison of the results of cross split with the evaluation scale according to Serhiienko [23], showed that in boys of 15-16 years old the results increased by 1.6 points and began to correspond to 2.8 points, in girls of 15 years old – by 1,6 points and began to correspond to 5.6 points, in girls of 16 years old – by 2.7 points and began to correspond to 5.2 points.

Comparing the results of pupils' flexibility development in control groups with the presented norms, it should be noted that the estimation of indicators of torso bending forward from a sitting position and cross split remained unchanged in comparison with the initial data.

A comparison of data of raising the torso in sitting position for 1 minute of 15-16-year-old pupils of experimental groups with the normative scale offered by Krutsevich et al. [21] revealed that the estimation concerning initial data didn't change in boys, and as well as before the experiment is equal to "3 points". The score increased by 1 point in 15-year-old girls, in girls of 16 years old – by 2 points, in both age groups the results began to correspond to the score "4 points". Comparison of hand dynamometry indicators in the studied contingent with the norms presented by Romanenko [22] showed an increase in the score by 1 point: pupils of 15 years old began to perform the exercise for "5 points", and pupils of 16 years old – for "4 points". Comparing the data of flexion and extension of the arms in the supine position with the norms according to Krutsevich et al. [21] a comparison of long jump data showed that pupils aged 15 didn't change their score, while pupils aged 16 increased it by 1 point. At the same time, the results of pupils aged 15-16 after the experiment corresponds to assessment "4".

A comparison of indicators of power abilities

development of the studied control groups, it is worth noting that the assessment remained the same as at the beginning of the academic year.

A comparison of results of shuttle run 4x30 m and running for 6 min. with norms presented by Romanenko [22] revealed that 15-16-year-old pupils of experimental groups increased their score by 1 point and became equal to "3 points".

A comparison of pupils' endurance development indicators of control groups with the presented norms revealed that there were no changes in the assessment, as well as at the beginning of the year, the results corresponded to the assessment as "unsatisfactory".

Thus, a comparison of results of experimental groups' physical qualities' development level with presented norms revealed that physical fitness level after the experiment increased on average by 1,4 points and began to correspond to assessment "4". The level of physical fitness at the end of the academic year also changed among pupils of control groups, but these changes are less significant than among pupils of experimental groups (the average mark remained 3 points).

Babich et al. [17, 33], note that ultimate is a popular and exciting team game, which uses such non-standard equipment as a flying disc. Ultimate is great for the all-around development of children. Players actively use various throwing techniques over a wide range of distances, catching the disc with one or two hands, jumping, lunging, running at a variable speed at different distances, changing direction, stopping and jerking, turning, and falling. At the same time, the game takes place at a high pace in the fight with the opponent, which is effective for the development of coordination, speed, endurance, and strength of arms, legs, and torso. In addition to the development of physical qualities, this game promotes the development of thinking, willpower, and social competencies. The results of our study complement the authors' data on the positive impact of ultimate frisbee exercises on physical qualities. Thus, in the course of the study, a significant increase in the results of the development of coordination and speed qualities, flexibility, strength, and endurance of 15-16-year-old pupils was found. At the same time, the indicators of pupils of experimental groups after the experiment in most cases had a reliable character of differences ($p<0.05$-0.001).

Fomenko et al. [34], investigated the influence of Ultimate Frisbee exercises on the level of development of physical qualities of 17-18-year-old students of higher education institutions in extracurricular classes. The results of the research conducted by the authors indicate an increase in the physical abilities of pupils in the experimental groups. Thus, the indicators of strength increased by 11%; agility - by 36%; speed - by 22%; endurance - by 9%; flexibility - by 10%. Based on the research, the authors recommend the introduction of Ultimate Frisbee in the extracurricular activities of pupils. The results of our research provide an opportunity to expand the contingent of those who can engage in this sport and confirms its positive impact on the development level of physical qualities of 15-16-year-old pupils, which makes it possible to recommend the use of the proposed exercises in physical culture classes at school.

In our opinion, the accessibility, emotionality, and innovative component of the game is a good option for increasing the motor activity of pupils, involving them in systematic physical exercises and improving their health.

Our research is consistent with the data of specialists in the field of physical culture and sports about the positive impact of innovative exercises on increasing motivation, and changes in the development level of physical qualities and confirms the feasibility of introducing Ultimate Frisbee exercises in the process of physical education of pupils around the world.

Conclusions

The analysis of indicators of physical fitness of 15-16-year-old pupils after the introduction of ultimate frisbee exercises into the educational process showed that the results of pupils of experimental groups significantly increased in comparison with pupils of control groups. At the same time, the differences are in most cases reliable ($p<0.05$-0.01). The conducted research testifies to the positive influence of ultimate frisbee exercises on the level of physical fitness of 15-16-year-old pupils, which makes it possible to recommend physical culture teachers to include the means proposed by us in the educational process.

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