

Utilizing technology to develop fundamental motor skills in young athletes specializing in hand-to-hand combat

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Abstract:

The aim of this study is to assess the efficacy of technology in improving the fundamental motor skills of young athletes specializing in hand-to-hand combat. *Materials and Methods.* Twenty-four young athletes from the Arsenal Comprehensive Children's and Youth Sports School in Kyiv, Ukraine participated in this study. The study employed theoretical data analysis, pedagogical experimentation, and mathematical statistics. Expert evaluations were utilized to identify common mistakes made by these athletes with the concordance coefficient used to gauge the experts' consensus. *Results.* We have systematized the most common mistakes, which, according to the consensus opinion of experts (concordance coefficient $0.79 \leq W \leq 0.94$; $p < 0.05$), are assumed by young athletes specializing in hand-to-hand combat when mastering certain punches. The technology of teaching the fundamental combative techniques of hand-to-hand combat in young athletes was based on the following structural components: projective, content, methodical, procedural and control modules. The multimedia project "DOMINI" is a component of the training environment, an electronic tool aimed at forming the basic technique of hand-to-hand combat in young athletes, where the integrity of the didactic cycle of the pedagogical process is ensured by a certain organization of the information structure, and the interaction of the athlete with the multimedia environment is the basis of pedagogical activity. *Conclusions.* The efficacy of technology in improving the fundamental motor skills of young athletes specializing in hand-to-hand combat was successfully proved by the results of formative pedagogical experimentation. Statistical analysis of quantitative indicators confirmed these findings.

Keywords: hand-to-hand combat, young athletes, technique of motor actions, mistake, multimedia project.

Introduction

Modern hand-to-hand combat is one of the most complex types of sports, which includes the technical arsenal of many types of duels and requires attention and objective study from scientists and trainers to find and determine the features and trends of its development (Hakim, 2018; Radchenko, et al., 2020). One of the tendencies in modern hand-to-hand combat is the fast rise in the complexity of combative technique, which leads to the elicitation of new problems and unresolved issues in technical training of young athletes (Kashuba, et al., 2012; Korobeynikov, et al., 2019). The system of hand-to-hand combat involves the proper organization of the training process, during which the motor skills of hand-to-hand combat are developed and the necessary fighting abilities, as well as special tactical skills are improved (Adamovich et al., 2018; Vako, 2019). Coaches recommend a 4-weeks functional training at high intensity based on CrossFit® when preparing of elite combat sambo male athletes for national competitions (Kudryavtsev, et al., 2023). The fundamental technique of hand-to-hand combat consists of stances, movements, throws, as well as punches, kicks and defensive actions with leg and foot. Additional techniques characterize the individual athlete's qualities and include complex techniques that require sustained training (Chernozub et al., 2019; Vako et al., 2021). Although these studies offer some insight into the prevalence of hand-to-hand combat, they are limited in offering lessons learned for improving the fundamental motor skills of young athletes. The bibliographic analysis made it possible to establish that the formation of the fundamental technique of motor skills of young athletes specializing in hand-to-hand combat is descriptive in nature (Chernozub et al., 2020; Radchenko, et al., 2020), therefore, practitioner coaches focus on the acquired experience and personal ideas about combative technique. In this regard, the identification of typical mistakes made by young athletes specializing in hand-to-hand combat allows to obtain necessary data that can be used for the development of technology in improving the fundamental motor skills of young athletes specializing in hand-to-hand combat. The aim of this study is to assess the efficacy of authors' technology in improving the fundamental motor skills of young athletes specializing in hand-to-hand combat.

Materials & Methods

Participants

Twenty-four young athletes from the Arsenal Comprehensive Children's and Youth Sports School in Kyiv, Ukraine participated in this study. The study was conducted in accordance with the principles of the Helsinki Declaration of the World Medical Association «Ethical principles of medical research involving a person as an object of research». All study participants provided informed consent in writing to participate in the study.

Procedure

In order to determine the typical mistakes made by young athletes specializing in hand-to-hand combat, when learning the basic combative technique: direct punch with the left hand from the left stance (jab), direct punch with the right hand from the left stance, side punches with the hands (front stance), punches from below, direct kick with the left leg from the left stance (front leg), direct kick with the right leg from the left stance (back leg), sidekicks (front stance), kick with the left leg from the left stance to the side (front leg), kick with the right leg from the left stance to the side (back leg), the expert evaluation method was used. The expert evaluation was carried out with the participation of 20 experts (coaches with more than 5 years of experience), the degree of their consensus was established by calculating the Kendall concordance coefficient.

To conduct the pedagogical experiment, three groups of athletes were formed by random selection: two experimental groups (EG-1 and EG-2) and one control group (CG), each of which included 8 athletes from the Complex Children's and Youth Sports School "Arsenal" in Kyiv city. The control group (CG) trained according to the hand-to-hand combat training program for children and youth sports schools (Educational program on hand-to-hand combat for children's and youth sports schools, 2019). The first experimental group (EG-1) trained according to the methodological recommendations developed by us for improving the fundamental motor skills, which were integrated into the hand-to-hand combat training program for children's and youth sports schools. The second experimental group (EG-2) trained according to the methodical recommendations developed by us based on the use of the multimedia project "DOMINI" (to demonstrate the fundamental technique of motor skills before the start of the educational and training sessions, 3 times a week for 15 minutes, a multimedia complex was used, which consisted of a computer with the "DOMINI" multimedia project, a video projector and a screen). Methodical recommendations were also integrated into the hand-to-hand combat training program for children's and youth sports schools.

Statistical analysis

The expert evaluation was carried out with the participation of 20 experts (coaches with more than 5 years of experience), whose degree of agreement was established by calculating the concordance coefficient. In the process of research, experts using the superiority method needed to express their opinion about the mistakes made by young athletes specializing in hand-to-hand combat when learning the fundamental combative technique.

The degree of inter-expert reliability was determined by calculating Kendall concordance coefficient according to the formula:

$$W = \frac{12S}{m^2(n^3 - n)},$$

where S – the sum of the squared deviations of all rank estimates of each examination object from the average value; m – number of experts; n – the number of examination objects.

The range of Kendall concordance is from 0 to +1. Values close to zero represent lack of consensus among experts, while values close to 1 represent perfect agreement in the rankings of the objects among experts. The opinion of experts can be considered agreed if the concordance coefficient was statistically significant. Statistical significance of Kendall concordance coefficient was determined by Pearson chi-square test (Antomonov, et al., 2021).

To analyze a statistical significance of difference between the number of mistakes of two groups of athletes, Fisher exact test for crosstabulation was used. The simplest form of crosstabulation is the 2 by 2 table where two variables are "crossed," and each variable has only two distinct values (Table 1):

Table 1. Crosstabulation 2 by 2

	EG	CG	Row Total
Mistaking	<i>a</i>	<i>B</i>	<i>a + b</i>
Non-mistaking	<i>c</i>	<i>D</i>	<i>c + d</i>
Column Total	<i>a + c</i>	<i>b + d</i>	<i>a + b + c + d (=n)</i>

Fisher's exact test is based on the following rationale: Given the marginal frequencies in the table, and assuming that in the population the two factors in the table are not related, how likely is it to obtain cell frequencies as uneven or worse than the ones that were observed? For small n, this probability can be computed exactly by counting all possible tables that can be constructed based on the marginal frequencies. Thus, the

Fisher's exact test computes the exact probability under the null hypothesis of obtaining the current distribution of frequencies across cells, or one that is more uneven. We used two-sided probability. Statistica Version 14.0.1.25 (TIBCO Software) was used for data statistical processing.

Results

As a result of the research, we have systematized the most common mistakes, which, according to the consensus opinion of experts (concordance coefficient $0.79 \leq W \leq 0.94$; $p < 0.05$), are assumed by young athletes specializing in hand-to-hand combat when improving certain punches (Fig. 1).

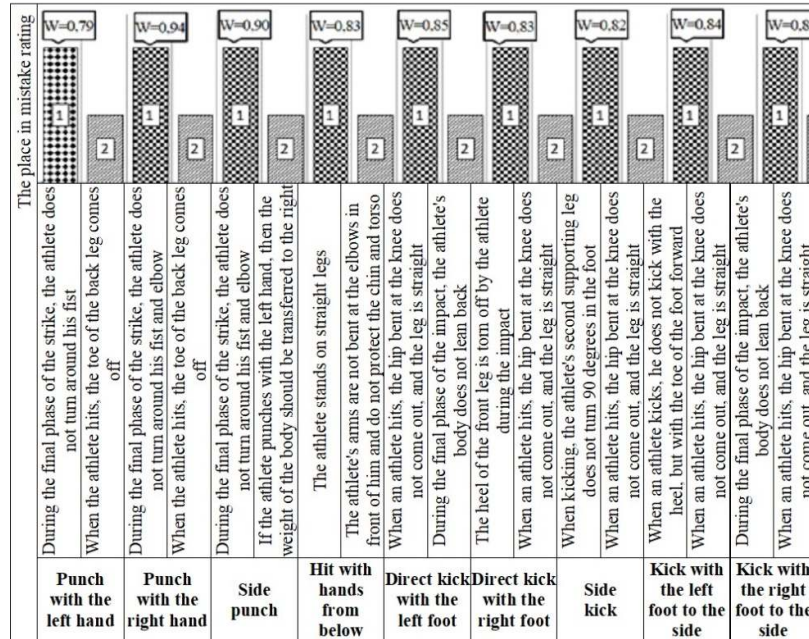


Fig. 1. The most common mistakes in the young athletes' combative technique

Received data were used as the basis of the technology in improving the fundamental motor skills of young athletes specializing in hand-to-hand combat.

The technology of teaching the fundamental combative techniques in young athletes consisted of: projective, content, methodical, procedural and control modules (Fig. 2).

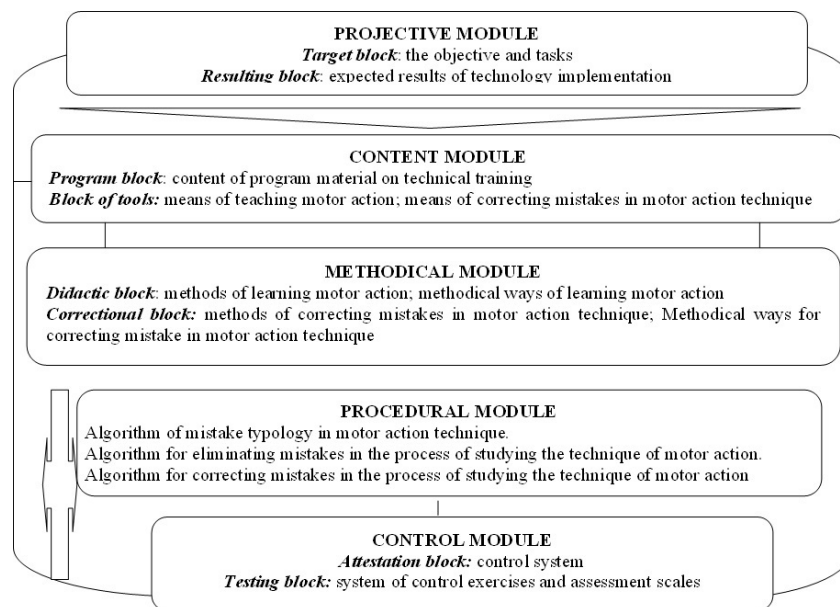


Fig. 2. The structure of the technology in improving the fundamental motor skills of young athletes specializing in hand-to-hand combat

The projective module of the developed technology consists of target and resulting blocks. The components included in the first of them establish the content of target guidelines for the process of improving the fundamental motor skills of young athletes. Here, the main tasks of implementing the developed technology in the training process are revealed, the solution of which should ensure the achievement of the main target and create conditions for improving the quality and reducing the time it takes young athletes to master the basic techniques of hand-to-hand combat.

The components of the resulting block appear to be logically mandatory in this module, as they demonstrate the predicted parameters of the technical readiness of young athletes, which allow to assess the efficacy of technology in improving the fundamental motor skills of young athletes specializing in hand-to-hand combat, but also to determine the resulting pedagogical efficacy of the developed authors' technology.

The content module of the developed technology includes a program block and a block of tools, the composition of which allows implementing the program content of technical training process of young athletes specializing in hand-to-hand combat. The program block of the content module is represented by the program of sports training for young athletes, which reveals the main goal orientation and tasks of the initial training stage, material by types of training, modes and plan of training work, requirements for sports preparedness, volumes of training and competition loads, distribution of educational material by main structural blocks of planning, materials of methodical support and pedagogical control, which ensure in total strict consistency and continuity of the entire process of developing sports skills of young athletes. The block of tools of the content module is represented by sets of exercises to improve the fundamental motor skills of young athletes contained in the sports training program, as well as sets of exercises designed to correct mistakes that arise at the initial stage in improving the basic combative techniques.

The methodical module of the authors' developed technology in improving the fundamental motor skills of young athletes, based on the accounting of mistake typology, is presented by didactic and correctional blocks with the use of the "DOMINI" multimedia project. The didactic block of the methodological module includes and describes traditional methods and innovative methodological recommendations for young athletes to learn the fundamental combative techniques, which allow to provide conditions for the effective formation of motor abilities and skills.

The correctional block of the methodical module presents and describes traditional methods and modern methodical ways for correcting mistakes that occur when young athletes perform technical strokes at the initial stage of training.

The procedural module of the authors' developed technology in improving fundamental motor skills of young athletes contains a set of algorithms for: typology of mistakes in the technique; minimize the composition and number of mistakes that occur when performing a technical stroke at the stage of initial training; to rationalize the sequence of mistake correction in the process of studying the basic technique of hand-to-hand combat.

The control module of the developed authors' technology is represented by attestation and testing blocks. The scheme of improving the fundamental combative technique by young athletes using the multimedia project "DOMINI" as a structural element of the technology is presented in Fig. 3.

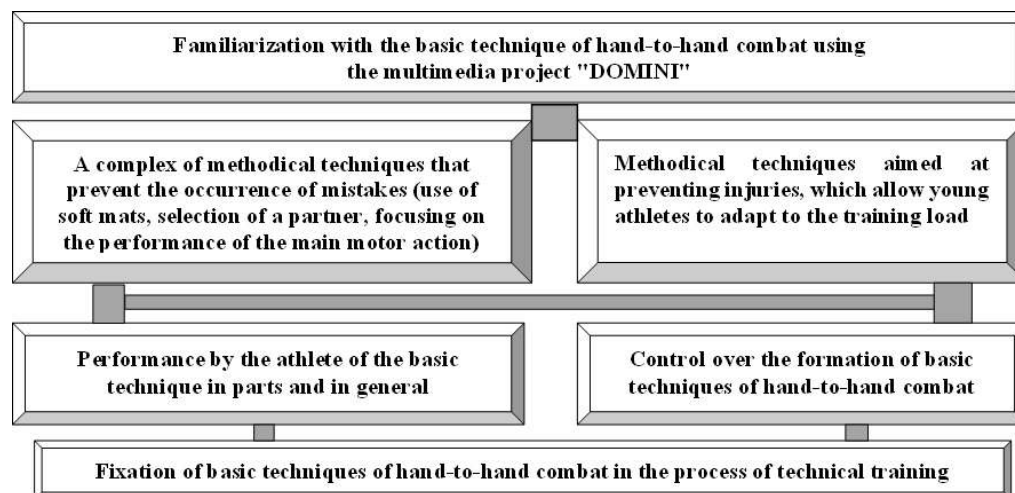


Fig. 3. Scheme of improving the fundamental motor skills by young athletes using the multimedia project "DOMINI"

The efficiency of training process in improving the fundamental motor skills of young athletes who specialize in hand-to-hand combat is expected due to the following actions:

- information is transmitted to the athlete in the most understandable form, due to the combination of demonstration and explanation, which ensures the prevention of distortion of the learning method when mastering the motor action technique;
- the coach fixes the attention of young athletes on the essential elements of action or operations of sports technique with the help of visibility of fact and visibility of laws, which ensures a clear understanding of the purpose of each operation being studied in the semantic structure of the motor action;
- the coach presents the young athletes first with the object of study in general, without highlighting the details, then large fragments of the action (main postures, phases of the exercise), and the algorithm of information delivery is formed by the athlete;
- the athlete, in the course of a rationally organized training process, gets the opportunity to feel the movement faster, which provides a combination of the image of muscle sensation with the knowledge obtained during the explanation to the athletes;
- during training tasks, the athlete performs a conscious search for solutions to the motor task based on the analysis of visual objects selected for the athletes according to the appropriate levels of complexity;
- visualization of didactic information allows to reduce the time for explaining the motor task, which ensures improvement of the motor training process;
- the trainer performs the control and assessment aspect of the learning process based on the comparison of the movement performed by the athlete with a video recording of the etalon movement;
- implementation of the technique of motor action, which standardizes the assessment procedure and allows athletes to understand better the content of technical mistakes;
- the athlete receives a task for self-dependent performance of exercises, and a set of exercises is formed by the coach, thus managing the activity of the athlete in the development of motor abilities and skills.

The criteria for the efficacy of the developed technology in improving the fundamental motor skills of young athletes specializing in hand-to-hand combat served an assessment of the young athletes' mastery of the basic combative technique. 3 experts evaluated the mastery of the basic elements of movement techniques by young athletes who specialize in hand-to-hand combat. The results of the examination of mastering the combative technique by young athletes specializing in hand-to-hand combat are presented in the Table 2 and Table 3.

Table 2. Indicators of punching technique of young athletes who specialize in hand-to-hand combat, n = 24

Stroke number	Punching technique	CG, n=8		EG-1, n=8		EG-2, n=8		Statistical difference (p) between		
		quantity	%	quantity	%	quantity	%	CG & EG-1	CG & EG-2	EG-1 & EG-2
1	Punch with the left hand (righthander's stance) (jab)	8	100	8	100	8	100			
Mistakes	During the final phase of the strike, the athlete does not turn around his fist	2	25	3	37.5	3	37.5	1.0	1.0	1.0
	When hitting, the athlete does not turn his body in the direction of the hit	4	50	0	0	0	0	0.08	0.08	1.0
	After the impact, the athlete's hand does not return to its original position and does not cover the chin	0	0	2	25	0	0	0.47	1.0	0.47
	The kick was made by the athlete without stepping with the front leg	0	0	0	0	0	0	1.0	1.0	1.0
	Total mistakes per stroke: 14	6	75	5	62.5	3	37.5	1.0	0.47	0.71
2	Direct punch with the right hand (righthander's stance)	8	100	8	100	8	100			
Mistakes	When an athlete kicks, the body weight is not transferred from the rear leg to the front leg	0	0	0	0	0	0	1.0	1.0	1.0
	During the final phase of the punch, the athlete does not unfold his fist and elbow	0	0	0	0	0	0	1.0	1.0	1.0
	When the athlete punch, the toe of the back leg takes off	0	0	0	0	0	0	1.0	1.0	1.0
	The athlete, when hitting with the right hand from the left stance, lowers the left hand, which protects the chin	7	87.5	2	25	2	25	0.04	0.04	1.0
	After the impact, the athlete's hand does not return to its original position and does not cover the chin	7	25	2	25	0	0	0.04	0.001	0.47
	Total mistakes per stroke: 13	6	75	5	62.5	2	25	1.0	0.26	0.43
3	Side punches (frontal stance)	8	100	8	100	8	100			

Mistakes	After the impact, the athlete's hand does not return to its original position and does not cover the chin	0	0	0	0	0	0	1.0	1.0	1.0
	During the final phase of the punch, the athlete does not unfold his fist and elbow	0	0	0	0	0	0	1.0	1.0	1.0
	If the athlete punches with the left arm, then the body weight should be transferred to the right foot and vice versa	0	0	0	0	0	0	1.0	1.0	1.0
	During punch the athlete takes off foot, which is the same name as the punching arm	0	0	0	0	0	0	1.0	1.0	1.0
	The athlete lowers the left arm that protects the chin during punch with the right arm from the left stance	1	12.5	2	25	1	12.5	1.0	1.0	1.0
	The athlete does not turn the torso and pelvis to the punch direction (does not make a semicircle by the entire punching biolink) during the punch	0	0	0	0	0	0	1.0	1.0	1.0
	The athlete lowers the arm that protects the chin during punch	2	25	1	12.5	1	12.5	1.0	1.0	1.0
Total mistakes per stroke: 8		3	37.5	3	37.5	2	25	1.0	1.0	1.0
4	Hit with hands from below	8	100	8	100	8	100			
Mistakes	The athlete stands on direct feet	2	25	1	12.5	0	0	1.0	0.47	1.0
	The athlete's arm does not return to its initial position and does not cover the chin and torso after the punch	0	0	0	0	0	0	1.0	1.0	1.0
	The athlete's arms are not bent at the elbows in front of him and do not protect the chin and torso	0	0	0	0	0	0	1.0	1.0	1.0
	Total mistakes per stroke: 3	2	25	1	12.5	0	0	1.0	0.49	1.0
Total mistakes per 4 strokes: 38		17	44.7	14	36.8	7	18.4	0.71	0.06	0.18

Table 3. Indicators of kicking technique of young athletes who specialize in hand-to-hand combat, n = 24

Stroke number	Kicking technique	CG, n=8		EG-1, n=8		EG-2, n=8		Statistical difference (p) between		
		quantity	%	quantity	%	quantity	%	CG & EG-1	CG & EG-2	EG-1 & EG-2
1	Direct kick with the left foot (righthander's stance)	8	100	8	100	8	100			
Mistakes	At the impact, the athlete stands on his entire foot	5	62.5	5	62.5	0	0	1.0	0.03	0.03
	Athlete's body weight is on the punching foot but not on the supporting foot	5	62.5	5	62.5	0	0	1.0	0.03	0.03
	Athlete's body does not lean back during the final phase of the punch	0	0	1	12.5	1	12.5	1.0	1.0	1.0
	An athlete does not put out a hip bent at the knee and there is leg direct	0	0	0	0	0	0	1.0	1.0	1.0
Total mistakes per stroke: 5		3	37.5	1	12.5	1	12.5	0.61	0.61	1.0
2	Direct kick with the right foot (righthander's stance)	8	100	8	100	8	100			
Mistakes	The weight of the athlete's body is on the striking leg, not on the supporting leg	0	0	0	0	0	0	1.0	1.0	1.0
	During the final phase of the punch, the athlete's body does not lean back	5	62.5	0	0	0	0	0.03	0.03	1.0
	The heel of the front leg is torn off by the athlete during the impact	6	75	1	12.5	1	12.5	0.04	0.04	1.0
	An athlete does not take out a hip bent at the knee, and a leg is straight	0	0	0	0	0	0	1.0	1.0	1.0
Total mistakes per stroke: 4		2	25	1	12.5	1	12.5	1.0	1.0	1.0
3	Side kicks	8	100	8	100	8	100			
Mistakes	The athlete's torso does not turn to the punch direction	0	0	0	0	0	0	1.0	1.0	1.0
	The athlete does not transfer his body weight to the supporting foot in the punch final phase	0	0	0	0	0	0	1.0	1.0	1.0
	When kicking, the athlete's second supporting leg does not turn 90 degrees in the foot	4	50	2	25	1	12.5	0.61	0.28	1.0
	An athlete does not take out a hip bent at the knee, and a leg is straight	0	0	0	0	0	0	1.0	1.0	1.0
Total mistakes per stroke: 7		4	50	2	25	1	12.5	0.67	0.35	1.0
4	Kick with the left foot to the side (righthander's stance)	8	100	8	100	8	100			
Mistakes	When kicking, the athlete's second supporting rear leg does not turn 45 degrees in the foot	2	25	1	12.5	1	12.5	1.0	1.0	1.0

5		During the kick final phase, the athlete's body does not lean back	2	25	1	12.5	0	0	1.0	0.47	1.0
		An athlete does not kick by the heel but by the foot's toe forward	0	0	0	0	0	0	1.0	1.0	1.0
		During the kick, an athlete does not put out the hip bent at the knee and there is the leg direct	0	0	0	0	0	0	1.0	1.0	1.0
		Total mistakes per stroke: 7	4	50	2	25	1	12.5	0.67	0.35	1.0
		Kick with the right foot to the side (righthander's stance)	8	100	8	100	8	100			
	Mistakes	When kicking, the athlete's second supporting rear leg does not turn 45 degrees in the foot	2	25	1	12.5	1	12.5	1.0	1.0	1.0
		During the kick final phase, the athlete's body does not lean back	1	12.5	1	12.5	0	0	1.0	1.0	1.0
		An athlete does not kick by the heel but by the foot's toe forward	0	0	0	0	0	0	1.0	1.0	1.0
		During the kick, an athlete does not put out the hip bent at the knee and there is the leg direct	0	0	0	0	0	0	1.0	1.0	1.0
		Total mistakes per stroke: 6	3	37.5	2	25	1	12.5	1.0	1.0	1.0
Total mistakes per 5 strokes: 29			16	55.2	8	27.6	5	17.2	0.14	0.02	0.57

The analysis of the presented indicators of the punching technique of young athletes shows that the largest number of mistakes (14) was made when performing the left-handed punch (right-handed stance) (jab). The experts identified typical mistakes made by athletes: during the punch final phase, the athlete does not open his fist and during the punch, the athlete does not turn his torso to the punch direction. The obtained actual data indicate that athletes of EG-2 made the least number of mistakes (3) when performing this stroke. Athletes of EG-1 made 5 mistakes, and athletes of CG made 6 mistakes, respectively. Analyzing the indicators of the kicking technique of young athletes who specialize in hand-to-hand combat, it should be noted that the largest number of mistakes (7) were made when performing strokes: Sidekicks and kick with the left foot to the side (right-hander's stance). Athletes of EG-2 made the fewest mistakes (1) in sidekicks. Athletes of EG-1 made 2 mistakes when performing this stroke, and athletes of CG made 4 mistakes, respectively.

When performing a kick with the left foot to the side (right-hander's stance), the same pattern was observed, namely: athletes of EG-2 – 1 mistake, athletes of EG-1 – 2 mistakes, and athletes of CG – 4 mistakes, respectively. It should be noted that the athletes made the least number of mistakes when performing punches from below – 3. At the same time, athletes of EG-2 did not make a single error, athletes of EG-1 made 1 mistake, and athletes of CG – 2 ones.

Discussion

During the study of the scientific literature, it was found that the formation of the technique of motor actions is an integral and important component of the sports training system, since the mastering of the correct technique is one of the decisive factors in the realization of the motor potential of a young athlete (Gamaliy, et al., 2008; Kashuba, et al., 2012; Ivchenko, et al., 2023). According to the researchers (Laputin, 1986; Gamalii, et al., 2018; Todorova, et al., 2020), the process of learning the technique of motor actions is built through the coach's perception and his internal idea of the specifics of movement performing. Capable hand-to-hand combatants can use a variety of different styles and disciplines to physically overwhelm an opponent (Isler, 2018). This includes the ability to throw combinations of punches, kicks, knees, grappling throws, and other moves (Dougherty, 2010). Scientific sources and practical experience of leading specialists in hand-to-hand combat (Radchenko, et al., 2018; Vako, 2020; Radchenko, et al., 2021) indisputably testify about the need to develop a comprehensive knowledge system for the formation of basic elements of technique in young athletes. In the specialized literature (Shtefiuk, et al., 2018; Todorova, et al., 2019; Vako, et al., 2021) it is noted that a mistake is the performing of an exercise with a deviation from the technique model, which has a tangible effect on the result of the action. Expert assessment was and remains an important and effective method of research as it allows to use the significant theoretical and practical potential of specialists in one or another field of social activity. During this study, thanks to the experts, it was possible to single out the most important factors that are important for the formation of the basic technique in hand-to-hand combat. In the process of research, the efficacy of the qualimetry usability to determine the typical mistakes made by young athletes when learning the fundamental motor actions was confirmed (Krykun, et al., 2021). During the conduct of this research, thanks to the experts, it was possible to identify typical mistakes made by young athletes when improving the combative techniques.

The transformation of the latest scientific ideas made it possible to develop the "DOMINI" multimedia project. The advantages of using multimedia didactics, in particular, the multimedia project "DOMINI", include:

- possibility of creating own didactic product for the coach;
- availability for trainers to develop and use of basic multimedia project modules;

- simultaneous use of several channels of the athlete's perception in the training process, due to which the integration of information delivered by several different senses was achieved;
- stimulation of cognitive aspects of learning, such as perception and awareness of information (Korobeynikov, et al., 2023);
- use of opportunities for self-dependent work for young athletes;
- individualization of the training process;
- the possibility of using remote communication due to the capabilities of modern social networks and messengers;
- appropriate distribution of educational and training material, presentations, videos, etc.

The work received further development based by Laputin (1999), the concept of "artificial control environment" in the system of sports training.

Conclusions

The scientific interest in quality metrics in sports from the point of view of interaction, interconnection and interpenetration of human PolySystems (as a principle and object of research), humanities and educology is due to the synthesis of the methodological organization of human qualimetry and sport qualimetry, which in turn integrates the qualimetry of a human, the qualimetry of knowledge and qualimetry of activity.

The developed technology includes projective, content, methodical, procedural and control modules.

Expert evaluation of mistakes during mastering of the basic technique of hand-to-hand combat by athletes is a dynamically developing direction characterized by a wide scope of application. The number of mistakes when performing a direct punch with the right arm by athletes of CG differs statistically significantly from the number of mistakes made by athletes of experimental groups EG-1 and EG-2. In 7 athletes of CG, when punching with the right arm from the left stance, the left arm, which protects the chin, was lowered. Only 2 athletes of both experimental groups EG-1 and EG-2 made the same mistake. The difference between the number of mistakes made by athletes of CG and athletes of each of the experimental groups EG-1 and EG-2 was statistically significant at the level of $p=0.04$, which was confirmed using Fisher exact test. Also, in 7 athletes of CG, the hand does not return to its original position after the impact and does not cover the chin. Only 2 athletes of the experimental group EG-1 made the same mistake. Athletes of EG-2 did not make any such mistake. The difference between the number of mistakes between athletes of CG and athletes of EG-1 was statistically significant at the $p=0.04$ level, and between athletes of CG and athletes of EG-2 at the level $p=0.001$.

No statistically significant difference was found between the number of mistakes made by the athletes of the experimental groups EG-1 and EG-2 when performing a direct punch with the right hand.

The technique of a direct kick with the left foot to the side (right-hander's stance) differed in the number of mistakes made by athletes of CG and athletes of both experimental groups EG-1 and EG-2. Thus, 5 athletes of CG and 5 athletes of EG-1 stood on their full foot at the impact, unlike athletes of EG-2, none of whom made this mistake. So, the difference between the number of mistakes made by athletes of CG and athletes of EG-2 was statistically significant at the $p=0.03$ level. At the same time, the difference between the number of mistakes made by athletes of EG-1 and athletes of EG-2 was statistically significant at the $p=0.03$ level. The same pattern was observed when the athlete's body weight was on the striking leg, not on the supporting leg.

Performing of a kick with the right foot to the side (right-hander's stance) differs in the number of mistakes made by athletes of CG and athletes of both experimental groups EG-1 and EG-2. In 5 athletes of CG, during the final phase of the impact, the athlete's body did not bend back. Not a single athlete of both EG-1 and EG-2 made this mistake. 6 athletes of the CG break off the heel of the front leg during the impact, in contrast to the EG-1 and EG-2 groups, in which only one athlete made this mistake.

Conflicts of interest

The authors declare no conflict of interest.

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