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SHOOTING: ANALYSIS OF NEW FOREIGN SPORTS TRAINING TECHNOLOGIES

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Annotation. The article is devoted to the analysis of modern aspects and technologies of training athletes in shooting abroad. One of the most significant areas in the focus of researchers' attention is the improvement of technical and tactical readiness, determination of the factors of shooting performance, which most often include postural stability, the time the aiming point was held on the target and the accuracy of aiming the weapon at the target. To organize training in improving the technique of shooting, specialists develop various specialized hardware and software systems and optoelectronic training devices. Despite this, there is little research devoted to analyzing the differences between biomechanics and techniques of virtual and real shooting.

Introduction. Shooting is one of the most popular summer sports, which is related to availability regardless of sex, age and physical abilities. Shooting, as a type of sports, is a great way of teaching many physical and morally psychological qualities of an individual. Foreign scientists and experts work intensively on improving methodology of shooters' training, searching and developing new technologies of increasing performance, improving technical and informational support of the training process.

The purpose of this study is to analyze new achievements of foreign scientists and experts in the field of sports training technologies in shooting.

Methods and organization. We conducted an analysis of modern foreign studies on relevant issues of the sports training in shooting. 23 studies were analyzed, 11 most relevant studies were selected and presented in this article.

Results and discussion. Results of the conducted analysis of foreign studies showed that the relevant direction in studying sports training technologies in shooting is examining the specificity of training shooting at the optoelectronic target. Experts of the Kazimierz Pułaski University of Technology and Humanities in Radom (Poland) carried out a study in this area [1]. Authors note that the postural control and stability of the weapon are the distinctive features in shooting. That is why such optoelectronic training devices as Noptel, RIKA and SCATT are quite popular nowadays. Specific features of shooting while using the optoelectronic training device in comparison with real shooting with a weapon are still not identified. Therefore, it is needed to compare digitally targets of the SCATT virtual system and real targets. The Steyr LP-10 pneumatic pistol and 4,49 mm bullets were used in the experiment. As a result, authors concluded that predictions based on the SCATT system are not accurate, because it does not consider basic changes in movements of the weapon due to its activation.

Same researchers, continuing their study on using the SCATT system in shooters' training, developed a methodology of evaluating parameters of shooting's effectiveness, according to the analysis of the trajectory of the aiming point's movement [2]. The aim of their second study was to develop a scientific methodology for maintaining the evaluation of the target's stability of shooters, who use the pneumatic pistol, based on analyzing following questions: justification of parameters of the aiming stability, defining a quantitative method for evaluating the use of optoelectronic targets, evaluation of reliability to determine the target's stability and development of the methodology to create individual and group parameters, which define the target's stability.

Researchers calculated a trajectory of aiming, made by 95 shooters with the pneumatic pistol, each of them shot 60 times. Coordinates of the aiming trajectory were recalculated in the given coordinates' system. Then, the mean value of each trajectory was calculated. Horizontal (x) and vertical (y) coordinates of the average aiming point were transferred to an electronic table file, showing all data of shots. Parameters of the target's stability in shooting from the pneumatic pistol were developed using the modified method of cluster analysis.

It was revealed that the average trajectory point (on the SCATT optoelectronic target) appears one second before the shot and is considered as a parameter of the weapon holding process (Fig. 1). This parameter of technical readiness does not depend on ballistic features of the pistol and bullets. Use of the suggested method allows revealing weak points in the structure and organizing of shooters' training and regulating the learning process [2].

Scientists of the faculty of information technologies in the University of Moratuwa (Sri Lanka) suggest a new training system for shooting with the

pneumatic rifle and the pistol [3]. Authors present a new training hardware and software system. Hardware components help to manage sports activity and insert shooters' data. The software module is used to perform analysis of results, where performance and psychological input signals from the hardware module are analyzed, and the result is shown on the screen. As an addition, the support system of making decisions is integrated into the software in order to support the coach's decisions. Inputs, obtained through the infrared port, as well as methods of video processing were used for processing the optimal position of hands' movement.



Fig. 1. Example of the target, showing parameters of the aim: $t=-1$ s is a beginning of the aiming trajectory, 1 s before pulling the trigger; $t=0$ – moment of the shot; O_K – trajectory of one shot's center; O – total average point of all aim's trajectories (60 shots)

Experts of the Iraq Technological University presented an article, which is devoted to the creation and development of a cheap, high-precision and high-speed system of evaluating aims, based on image processing. The suggested structure of aim's evaluation does not require additional equipment and relies on existing image preparation, such as edge finding, image improving and object recognition. The study was conducted in two stages: the first stage was conducted using a standard image from the database for testing the suggested system of aim's evaluation; the second stage was conducted using video in real time, recorded using an HD digital camera. Results of testing the system demonstrated great results [4].

A great number of studies is dedicated to revealing predictors or factors of shooting's performance. Scientists of the Scientific and Research Center of Sports and Sports Sciences (UK) and the Department of Health Sciences of the University of Sydney (Australia) studied characteristics of visual search, movements of the rifle and their meaning for successful performance of elite shooters [5]. According

to data of their studies, key characteristics, which differ elite shooters from less qualified ones, are the prolonged search for the target and earlier beginning of searching the target visually, with lesser shift of the weapons' barrel and a more effective strategy of time distribution. Feedback and teaching how to move with your sight can be used for increasing performance and skills of both elite and less qualified shooters.

Scientists of the Loughborough College (UK) and the Scientific and Research Laboratory of Neuromechanics of the Department of Kinesiology of the Auburn University (USA) studied the effect of the position's width on the performance and postural stability of shooters of the national level, who use the pistol [6]. Authors note, that currently the appropriate range of a position's angle when shooting with the pistol is 0-45°. However, there is almost no information, which confirms these recommendations. The aim of their study was to determine whether the change in the position's width would influence on upcoming changes in postural stability or the pistol's stability. According to results, changing the position's angle did not reveal significant changes in terms of the issue of consequences of the postural stability. Improvements in performance and indicators of the shooting process were recorded in a position with the 15° angle. Results of the study also showed what is recommended to use in order to increase the shooting performance.

Scientists of the Human Research Laboratory of the Hong Kong University of Science and Technologies (China) study accuracy of shooting with the pistol as a dependent of following variables: experience, eyes' openness and exposition time [7]. Results showed that the most significant influence on the mean value and the mean square root error of shooting at the target was given by the experience. Results also revealed that in order to achieve better performance, the exposition time should not exceed 2 s for an experienced shooter, who uses the pistol, and 3 s for a beginner shooter. Differences, which were observed in athletes with different experience, are due to the postural balance, not aiming of cognitive component of the task.

Scientists of the Department of Medicine and Gerontology of the Faculty of Human Movement Sciences of the D'Annunzio University in Chieti (Italy) and the Scientific and Research Institute of Olympic Sports (Finland) developed the model of multiplane actions and used it on the Italian shooting team during training for 2012 London Olympics [8] to help athletes to improve, stabilize and optimize their performance during training and competitions. The model consisted of following actions of shooters: description of ordinary sequence of actions to perform one shot from the beginning till the end; defining a small number of the most significant main components (three or four), which are considered as a base for appropriate

performance; performing several shooting sessions in conditions of increased discomfort and modelled competitions. By using the logistic ordinal regression analysis, they obtained levels of possibility of appropriate/lowered performance, related to the evaluation of main components. The conclusion notes advantages of using the model of multuplane actions in training elite shooters.

Richard Hawkins from the Warnborough College (UK), when studying mechanics of shooting with the pneumatic pistol [9], defined three substantial factors: way of holding the aiming point on the target; time of holding the aiming point on the target; accuracy of aiming the pistol at the target. These indicators indicate important information, which should be used by athletes during the training.

Researchers of the Department of Armament of University of Defense in Brno (Czech Republic) are engaged in determining main points of shooter and rifle's movement in the process of sports shooting. This method allows evaluating position of the shooter or the rifle when making the shot in order to compare calculated and measured movements of the shooter [10].

Researchers of the Faculty of Physics of the University of Natural Sciences and the Faculty of Applied Physics of the Lublin University of Technology (Lublin, Poland) presented data on changes in the temperature of the rifle's body when shooting in the rhythm, typical for athletes of Olympics [11], which do not exceed 0,3 °C in one shot. Total increase of temperature after 40 shots with a speed of 2 shots per minute does not exceed 5 °C. There were no correlations between hits and temperature changes. Regardless of the barrel's temperature, all shots showed the angular range that is less than the maximal support of the 100% hit's effectiveness.

Conclusions were made on the fact that the external temperature of the rifle's barrel was increasing mainly in its near area (up to 5 °C). Alongside with the increase of distance from blocking, the temperature increase decreases and amounts to 1,5 °C at the end of the barrel. The observed increase of the maximal temperature in the barrel does not influence the aiming point. Despite common views, the purpose of first shots, made during competitions (test shots), is not heating up the barrel, but cleaning it from the remaining particles.

Conclusion. The conducted study of new developments of foreign scientists on the issue of training in shooting allowed defining main directions, in which foreign scientists are engaged, and note the most significant facts, tendencies and regularities:

- a quantitative evaluation of training with the SCATT optoelectronic training device compared with shooting from the pneumatic pistol was conducted;

- a methodology for evaluating parameters of the shooter's performance according to the aiming point's trajectory was suggested;
- data on the influence of the shooting position's angle on the postural stability and performance of shots with the pneumatic pistol were presented;
- a new training system for shooting with the pneumatic rifle or the pistol was suggested;
- a model of multiplane actions in shooting was developed;
- parameters of shooting, which best predict its performance, were defined;
- comparison of modelled and real movements of the shooter was conducted;
- data on temperature changing in the rifle's body during shooting were presented.

The presented data can be useful for experts, who are engaged in issues of training shooters, as well as for weapons training of service personnel and employees of the Ministry of Internal Affairs of Russia.

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