DOI 10.26773/smj.210914

SportMont

ORIGINAL SCIENTIFIC PAPER

Technology for Improving the Technical Skills of Skilled Long Jumpers

Wang Wei[1], Elena Kozlova[2] and Kirill Kozlov[3]

[1]National University of Ukraine on Physical Education and Sport, Kyiv, Ukraine, [2]National University of Ukraine on Physical Education and Sport, Department of the Olympic Sport History and Theory, Kyiv, Ukraine, [3]National University of Ukraine on Physical Education and Sport, Kyiv, Ukraine

Abstract

The improvement of technical skills is closely associated with a focus on the informative biomechanical indices upon which the achievement of high sports results in the long jump depends: speed of run-up before take-off, kinetic energy at the moment of foot placing on the support for take-off; speed of the body general center of mass "departure" at the moment of leaving the support; total energy at the moment of foot placing on the support for take-off; duration of take-off phase; kinetic energy at the moment of leaving the support; total energy at the moment of leaving the support; maximum height of the body general center of mass during flight; height of the body general center of mass during foot placing on the support for take-off; angle of the body general center of mass departure; length of the third stride before take-off; take-off power. The majority of participating experts (n=30) consider the most rational to be the performance of various athletic exercises, which in their structure and manifestation of motor qualities are as close as possible to long jumps and allow to influence certain informative biomechanical indices: long jumps with different run-up distance: from short (eight running strides) and medium (10–14 running strides) to full and increased (from 16 to 24 running strides) (W=0.741, p<0.01). The efficiency of the process of improving technical skills depends on the dominance of particular sensory system indices. Among athletes (n=33) specialized in long jump, the key sensory system is visual in 42.42%, audio - in 27.27%, kinesthetic – in 18.18%. The same indices of visual and kinesthetic perception of information are observed in 12.12% of athletes.

Keywords: *long jump, technical skills, technique, sensory system, biomechanical index*

Introduction

Improvement of athletes' technical skills represents an important constituent of the athlete preparation system (Bobrovnik & Kozlova, 2010). There are different definitions of the term technical skills. Under technical skills, the improved possession of the most rational biomechanical structures during focusing on a maximum in the conditions of aggravated sports competition is understood (Dyachkov, 1972). Technical skills are considered as the art of performing a system of movements by an athlete, which corresponds to the specific features of a particular sports event and is aimed at the realization of motor capacities ensuring the achievement of high sports results (Platonov, 2015). The process of improving the athletes' technical skills is closely associated with competitive activity specifics. Long jumps are referred to speed-strength, complex coordinated track and field events. Studying the problem of improving the athletes' technical skills, we proceeded from the general provisions concerning the training process management (Wang & Kozlova, 2019), which applies to all components of the subsystem of an integral system, including technical skills. In the scientific and methodological literature dealing with this scientific problem, the issues of determining the technique biomechanical characteristics that affect the achievement of high sports results, especially by highly skilled athletes have been widely highlighted (Brüggemann, Koszewski, & Müller, 1999; Mendoza & Nicoford, 2011). Not

Correspondence:

E. Kozlova,
National University of Ukraine on Physical Education and Sport, Department of the Olympic Sport History and Theory, Kyiv, Ukraine
E-mail: naukasport777@gmail.com

least important is the study of the regularities of movement construction by athletes of I, II categories, and candidates master of sports (CMS) being at the stage of specialized basic training. The process of improving technical skills necessitates the knowledge of both the biomechanical structure and the mechanism of management and regulation, which provides a high and sustainable result of the means of pedagogical influence and psychological aspects of management. Thanks to the introduction into sports practice of up-to-date achievements of science, complex high-frequency equipment capable of recording all the necessary motion parameters, compact measuring systems, the technology of the process for improving technical skills is being changed today, which requires further research.

The objective of the studies: Improving technical skills of skilled long jumpers on the basis of determining the informative biomechanical characteristics of competitive exercise execution technique, substantiation of training means, and approaches to the improvement of movements.

Methods

The following methods were used to achieve the objective of the study: analysis of scientific and methodological literature and the Internet resources; biomechanical video computer analysis; expert evaluation; testing (identification of the key sensory system); methods of mathematical statistics.

The technology of biomechanical video computer analysis included two main stages: video camera shooting (GoPro HERO4 Silver) with a frequency of 120 frames s-1 at the Kyiv Championship, in accordance with metrological requirements (Laputin, 2001); the processing of the received videograms by means of the specialized software "Dartfish" (Switzerland), Motion Analysis Tools and "BioVideo" (Kozlova, Wang, & Kozlov, 2020; Kozlova & Wang, 2020; Khmelnytska, 2001). The error in determining the time characteristics of the long jump did not exceed the duration of the interframe time interval, i.e., when shooting at a frequency of 120 frames s-1 (PAL format), this error constituted 1/120 s = 8 ms (Kozlova & Wang, 2020).

The study involved 15 male athletes, aged 18-21 years, including 4 candidate master of sports CMS, 6 athletes of the I category, and 5 athletes of the II category, who gave consent to serve as the subjects and allowed to use their personal data. The results of 60 competitive long jumps at the Championship of Kyiv were obtained, which permitted identification of the biomechanical indices influencing the achievement of high sports results in the long jump.

The relationship between the registered kinematic and energy indices with sports result in the long jump was determined by means of correlation through calculating the Pearson correlation coefficients and estimating their statistical significance according to Student t-test at the level of significance α=0,05 ($p<0,05$). The decision on the choice of the parametric method of statistics was based on the result of checking the data for compliance with the normal law of distribution according to Pearson's chi-squared test ($\chi 2$) (Kashuba et al., 2020).

To determine the means of improving technical skills the method of expert assessment was used with the participation of 30 well-known experts (China) in the preparation of skilled long jumpers working at Shanghai Minhang District Youth Sports School, East China Normal University Chengdu Sport University Chizhou University and having work experience of 5-20 years.

To improve the quality of the expert group formation, methods of formal assessment of experts' competence degree were used (Derengovsky, 2007). Data from the scientific and methodological literature (Bobrovnik & Kozlova, 2008; Popov, 2006; Hilliard, 2007) and the method of written brainstorming were used in the development of the questionnaire (Chinese) when experts were asked to send their suggestions by e-mail regarding the most efficient exercises for combined improvement of the take-off technique and development of explosive power of long jumpers. The suggestions repeated by several experts were included in the answer options. In the final version, approved by the experts, the questionnaire contained 9 possible answers. Then the method of preference (ranking) was applied, when experts evaluated athletic exercises by rank in descending order of importance (minimum rank - 1, maximum - 9 points; to assign the same ranks or leave the answer without rank were not allowed). The degree of consistency of experts' opinions was checked by calculating Kendall's concordance coefficient W followed by the assessment of its statistical significance according to the Chi-square criterion at the selected significance level α=0.05 ($p<0.05$) (Byshevets, 2018). The conclusion on the quality of expert evaluation was made depending on the degree of consistency of the experts' opinions. The concordance coefficient W was in the range from 0 (complete lack of consistency) to 1 (absolute consistency).

Mathematical processing of findings was performed using IBM SPSS Statistics software.

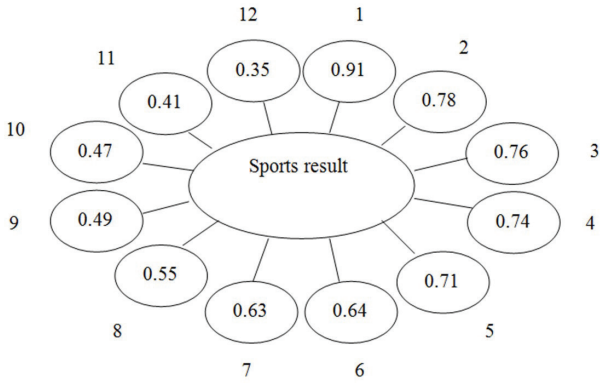
"The key human sensory system" test was used to determine the key sensory system (Karelin, 2007). The study involved 33 skilled long jumpers, among them: 26 athletes of the II category, 2 athletes of the I category, 3 masters of sports, 1 - candidate master of sports (CMS).

In accordance with the international principles of the Helsinki Declaration of the World Medical Association, the UNESCO Universal Declaration on Bioethics and Human Rights (2005), all participants in the study were informed of the content of the measurement procedures and gave their consent to participate in the and to use their personal data with consent forms signed accordingly

Results

The construction of movements is subject to biomechanical regularities, without accounting for which it is impossible to design a purposeful process of improving technical skills (Kozlova et al., 2020).

As a result of the analysis of the long jump technique of 15 skilled athletes (60 competitive trials) on the basis of correlation analysis, the technique informative indices influencing the achievement of high sports results in long jump were determined (Kozlova et al., 2020; Wang et al., 2020). There is a high correlation with the sports result in the long jump of the following parameters: run-up speed ($r = 0.91$, ($p<0.05$), kinetic energy at the moment of foot placing on the support for take-off ($r = 0.78$, ($p<0.05$), speed of the body general center of mass departure at the moment of leaving the support ($r = 0.76$, ($p<0.05$), the duration of take-off phase ($r = -0.71$, ($p<0.05$), the total energy at the moment of foot placing on the support for take-off ($r = -0.74$, ($p<0.05$) at the set criterion of significance ($r = 0.35$), as well as with other biomechanical indices shown in (Figure 1).



Legend: 1 — run-up speed before take-off, m·s⁻¹; 2 — kinetic energy at the moment of foot placing on the support for take-off, J; 3 — the speed of the body general center of mass departure at the moment of leaving the support, m·s⁻¹; 4. — total energy at the moment of foot placing on the support for take-off, J; 5 — duration of take-off phase, s; 6 — kinetic energy at the moment of leaving the support, J; 7 — total energy at the moment of leaving the support, J; 8 — maximum height of the body general center of mass during flight; 9 — the height of the body general center of mass at the moment of foot placing on the support for take-off, m; 10 — the angle of the body general center of mass departure; 11 — length of the third stride before take-off, m; 12 — take-off power, W; average sports result — 6,80 m

FIGURE 1. Correlation of informative indices of long jump technique with sports result (r=0.35)

Regularities of organizing rational biomechanical structure in long jumps in the course of sports results improvement are connected with: increase of run-up speed before take-off, take-off power, angular and amplitude characteristics in joints, angle and speed of departure, kinetic and total energy, and also with a decrease of departure time (Kozlova et al., 2020).

Revealed biomechanical indices and regularities of their change, underlie the organization of a rational biomechanical structure of long jump technique, are objective criteria for designing a training process and control over the improvement of technical skills of qualified athletes (I category, CMS).

The next important step in coaching after revealing the informative characteristics of the long jump technique is the choice of a rational composition of special means that are as close as possible to the competitive exercise in structure and manifestation of kinetic and energy characteristics. To determine such means, an expert assessment was conducted with the participation of 30 Chinese experts in the field of sports (Wang & Kozlova, 2019). Kendall's concordance coefficient constituted W = 0.741, p <0.01, which indicated the consistency of the experts' opinions.

As a result of conducted studies, most experts put in the first place the performance of long jumps from short (eight running strides), medium (10-14 running strides) to full and increased by two to four running strides (16-24 running strides) run-up, with a gradual increase in the length of the run-up to the end of the result increase (252 points) (Wang et al., 2019). The following exercise was considered not least important by experts: from four to six running strides of run-up on a bench (or another stable surface) landing on a take-off leg followed by a leap, jump on a swinging leg, step and landing on foam mats (224 points). Then the answers of experts on the importance are arranged in the following sequence:

• long jump from six to eight running strides of run-up with getting in the highest point of flight of the suspended subject by a hand homonymic to a swinging leg, with focus on performing natural running movements (205 points);

• from four-six running strides of run-up on a bench (or another stable surface) landing on a take-off leg followed by a leap, jump on a swinging leg, step, and landing on foam mats (203 points);

• forward-upward taking-off from four-eight running strides of run-up with jumping over the bar from a direct run with gradual raising the bar height or moving off the take-off place while controlling the direction of action in take-off with landing on the mat or in the sand pit (133 points);

• forward-upward taking-off from four-six running strides of run-up with jumping on a raised support (mats) gradually increasing the distance to the support (97 points);

• take-off with the opposite swing of the hands from four-six running strides of run-up with circular hand motions and touching a suspended object (basketball ring) in a flight (96 points);

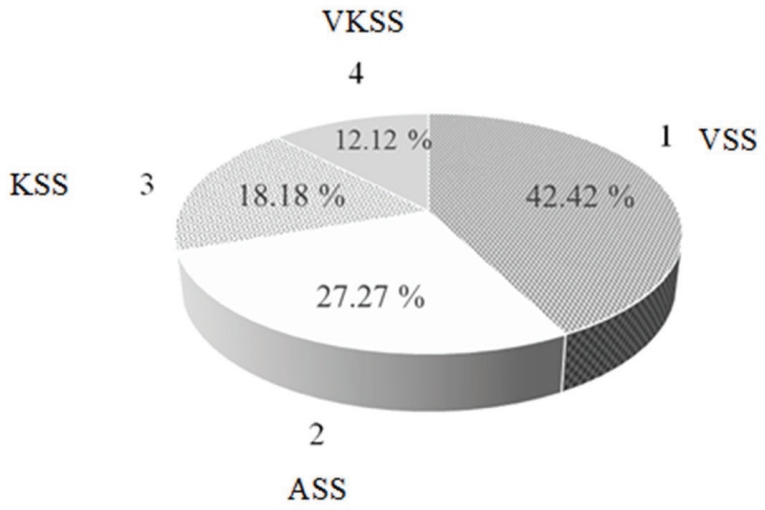
• take-off from two-three running strides of run-up with touching a suspended object in a flight (75 points);

• getting an object by leg bent in the knee joint from three-five strides of run-up with opposite hand swing (69 points) (Wang et al., 2019).

While choosing training means, there are great opportunities for the coach to use a creative approach, but before starting to select exercises, one should clearly define the task.

Guidelines are important in improving technical skills (Kozlova et al., 2020). One of the approaches is their formulation, depending on the way the athlete perceives information (Kozlova et al., 2020). The type of sensory system of athletes influences the peculiarities of perception, and hence the process of learning and improving motor actions. There are different types of real world perception: auditory (focused on the perception of information by ear), visual (predominant vision), kinesthetic (focus on tactile sensations) (Vysochina & Kozlova, 2014; Kozlova et al., 2020). It should be noted that pure types are extremely rare; it is about dominance (Bjorklund, 2010).

In order to manage the process of improving technical skills, the preferred method of perceiving the information provided to the athlete by the coach was determined. It was found that among 33 athletes specialized in the long jump the key sensory system was visual in 14 athletes (42.42%). In 9 jumpers (27.27%) who took part in the research, the indices of the auditory sensory system prevailed, whereas in 6 athletes (18.18%) – those of the kinesthetic sensory system. The same indices of visual and kinesthetic perception of information were noted in 4 athletes (12.12 %) (Figure 2).



Legend: 1 – athletes with dominance of visual sensory system indices (VSS); 2 – athletes with dominance of auditory sensory system indices (ASS); 3 – athletes with dominance of kinesthetic sensory system indices (KSS); 4 – athletes with similar indices of visual and kinesthetic sensory systems of information perception (VKSS).

FIGURE 2. The ratio of skilled long jumpers (n=33) with dominance of different sensory systems of information perception

The findings indicate the dominance of the visual sensory system in qualified athletes; most of them have the qualification of the second sports category (long jump). Of the three athletes (masters of sports), the indices of the kinesthetic sensory system dominated in one of them, whereas in the other two - the same indices of visual and kinesthetic sensory systems of information perception were noted. One may assume that the role of the kinesthetic sensory system of information perception tends to increase along with improving the qualification, however, this assumption needs further verification.

In the process of improving technical skills, athletes with the dominance of the visual sensory system of information perception, should focus mainly on visual landmarks during exercise performance (for instance, during take-off to look at a particular object, place landmarks on the track to improve the tempo-rhythmic structure of the run-up, accuracy of hitting the take-off board, etc.), watch videos, observe the technique of elite athletes, control the technique based on a video recording of the long jumps or other exercises, and after their execution to watch the video, draw diagrams of the long jump, etc. (Kozlova et al., 2020).

In jumpers with the auditory sensory system dominance, the process of improving technical skills will be most effective if the coach uses the verbal method more often, i.e., provides feedback through words, intonation, voice instructions for special exercises, individual elements, and long jump as a whole. Listening to audio recordings with eyes closed, repeating the trainer's instructions in a soft voice, using different sound landmarks to master the tempo-rhythmic structure of the run-up, sound guide (a device that allows the athlete to control the exercise time, focusing on sounds at intervals), the musical accompaniment can also be useful for athletes with a predominant perception of information by ear (Kozlova et al., 2020).

The kinesthetic sensory system dominance in long jumpers allows to focus the process of improving movements on the feeling of one's body, the feeling of interaction with the support during take-off, the sense of time, space (for instance, performing a long jump with different run-ups, on a hard, soft track, executing special exercises with a change of pace, performing exercises with closed eyes, etc.) (Kozlova et al., 2020).

Discussion

The study identified informative biomechanical indices of technique, which are objective criteria for improving the technical skills of skilled long jumpers. These indices can be used to develop prognostic biomechanical models of technique. As in highly skilled athletes, according to the data (Bobrovnik et al., 2010; Brüggemann et al., 1999; Mendoza et al., 2011), there is a high degree of correlation between run-up speed and sports result ($r = 0.91$). A high correlation between the energy characteristics of the technique and sports result has been established. However, it is not correct to compare the scientific achievements of different authors in a particular case, taking into account the application of different conditions for the fixation of necessary motion parameters and measuring systems.

The concepts of using special means in the training process of skilled athletes (Bobrovnik et al., 2008; Shiffer, 2011), which can simultaneously increase the level of speed and strength capacities and influence the improvement of long jump technique have been supplemented. They are as close as possible to long jumps and allow influencing certain informative biomechanical indices.

The visions (Vysochyna et al., 2014) of managing the process of technical skills improvement on the basis of determining the dominant sensory system of information perception have been expanded with relevant recommendations.

Conclusions

The process of improving technical skills is closely associated with a focus on the informative biomechanical indices upon which the achievement of high sports results in the long jump depends: speed of run-up before take-off, kinetic energy at the moment of foot placing on the support for take-off; the speed of the body GCM "departure" at the moment of leaving the support; total energy at the moment of foot placing on the

support for take-off; duration of take-off phase; kinetic energy at the moment of leaving the support; total energy at the moment of leaving the support; maximum height of the body GCM during flight; the height of the body GCM during foot placing on the support for take-off; angle of the body GCM departure; length of the third stride before take-off; take-off power.

2. The process of improving technical skills is aimed at the use of various track and field exercises, which in their structure and the manifestation of motor abilities are as close as possible to long jumps and allow to influence certain informative biomechanical indices. Most experts (n=30) consider it the most rational to perform long jumps from different run-ups: from short (eight running strides) and medium (10-14 running strides) to full and increased (from 16 to 24 running strides) ($W = 0.741$, $p < 0.01$).

3. Among 33 long jumpers the visual, auditory, and kinesthetic systems were the key sensory systems in 42.42%, 27.27%, and 18.18% of athletes, respectively. The same indices of visual and kinesthetic information perception were noted in 12.12% of athletes. The efficiency of the process of technical skills improvement depends on the dominance of indices of a certain sensory system.

4. Athletes with visual sensory system dominance of information perception should focus preferentially on visual landmarks during exercise performance. In long jumpers with auditory sensory system dominance, the most efficient feedback between the coach and the athlete is through words and intonation. Kinesthetic sensory system dominance allows to focus the process of motion improvement on the feeling of one's body, that of interaction with the support during take-off, the sense of time, space.

Acknowledgements

Authors express their gratitude to Irina V. Khmelnitskaya, Associate Professor of the Department of Biomechanics and Sports Metrology of the National University of Physical Education and Sport of Ukraine for the cooperation

Conflict of Interest

The authors declare that there are no conflicts of interest.

Received: 18 October 2020 **| Accepted:** 03 December 2020 **| Published:** 01 September 2021

References

Bjorklund, R. (2010). *The Senses*. Marshall Cavendish Corporation.

Bobrovnik, V. I., & Kozlova, E. K. (2010). Improving training process of elite female long jumpers in the system of annual preparation at the stage of the highest sports mastery maintenance under conditions of track and field professionalization. Technique and methodology of athletics training track and field & science. – Sofia: *National sports academy"Vassil Levski", 1*(10), 9–15.

Bobrovnyk, V. I., & Kozlova, O. K. (2008). Major means of technical skill formation in elite athletes (as illustrated by track and field jumps). In.: Iermakov SS, editor. *Pedagogics, psychology and medico-biological issues of physical education and sport, 3*, 21–24.

Brüggemann, G-P., Koszewski, D., & Müller, H. (1999). *Biomechanical reserch Project Athens 1997*. Final report. Oxford: Meyer & Meyer Sport (UK) ltd, 175.

Byshevets, N. H., Serhiienko, K. M., & Holovanova, N. L. (2018). Preparation of students of higher education institutions of physical culture profile for application of expert assessment method. Theory and Practic*e of Physical Culture and Sport, 1,* 29–35.

Derengovsky, V. V. (2007). Application of expert assessment method in the design and organization of radiation-hazardous works for the transformation of "Shelter" object. *Issues of the safety of nuclear power stations and Chernobyl, 7*, 91-96.

Dyachkov, V. M. (1972). *Improving technical skills of athletes* (Pedagogical management problems). M: Physical culture and sport.

Hilliard, C. (2007). Technical preparation & coaching drills for the long jump. *Modern Athlete and Coach, 45*(3),7-9.

Kashuba, V, Stepanenko, O, Byshevets, N, Kharchuk, O., et al. (2020). The Formation of Human Movement and Sports Skills in Processing Sports-pedagogical and Biomedical Data in Masters of Sports. *International Journal of Human Movement and Sports Sciences, 8*(5), 249-257. doi: 10.13189/saj.2020.080513.

Khmelnytska, *I*. V. (2000). *Biomechanical video computer analysis of sports motions*: Methodical guide. K.: Scientific world.

Karelin A. A. (2007). *Great encyclopedia of psychological tests*. Moscow.

Kozlova, O., & Wang, (2020). Individualization of the process of technical skills improvement in skilled long jumpers. *Science in the Olympic sport, 2*, 77-84.

Laputin, A. M. (2001). *Sports biomechanics*. K.: Olympic literature.

Mendosa, L., & Nikiford, E. (2011). Biomechanical analysis of horizontal jumps at the IAAF 2009 World Athletics Championship. *IAAF Athletics Bulletin, 3-4*, 25-60.

Platonov, V. N. (2015). *System of athletes' preparation in the Olympic sport. General theory and its practical applications: textbook for coaches*. Kiev: Olympic literature.

Popov, V. B. (2006). *System of special exercises in preparation of track and field athletes*. Moscow.

Shiffer, Y. (2011). Horizontal jumps. *IAAF New Studies in Athletics, 3-4*, 7-22.

Vysochina, N. L., & Kozlova, E. K. (2014). Manifestation peculiarities of personality mental features in skilled track and field athletes under stress conditions. Scientific journal. Scientific and pedagogical problems of physical culture. *Physical culture and sport, 9*(50), 33-6.

Wang, W., & Kozlova, E. (2020). Analysis of Factors Affecting Sports Performance of Long Jumpers. *Physical Education Review, 39*(6), 98-100.