Correction of movement patterns of skaters through feedback on the distribution of plant pressure in speed running

UDC 796.91:796.012.36

Dr. Hab., Professor **V.P. Sushchenko**[1]
PhD, Associate Professor **V.E. Vasyuk**[2]
Master **D.Yu. Bykov**[2]
[1]Peter the Great St. Petersburg Polytechnic University, St. Petersburg
[2]Belarusian State University of Physical Culture, Minsk

Corresponding author: docent-07@mail.ru

Received by the editorial office on 30.12.2023

Abstract

Objective of the study was to identify the possibilities of correcting movement patterns of speed skaters using feedback on the distribution of plantar pressure in speed running.

Methods and structure of the study. The pilot experiment involved an athlete with many years of experience in international speed skating competitions. To record the distribution of plantar pressure during push-off in skating locomotion, the F-scan system (Tekscan, USA) was used. Based on the results of the first testing, the athlete focused on improving his technical readiness for six weeks. During repeated testing, changes were observed in the characteristics of the implementation of efforts during take-off in high-speed running on ice.

Results and conclusions. The use of feedback techniques in the training process of qualified speed skaters based on plantar pressure distribution indicators helps to improve the individual model of take-off technique in high-speed running on ice, both in a straight line and along a turn.

Keywords: *repulsion, technical readiness, dynamic characteristics.*

Introduction. To cover a competitive distance in the shortest possible period of time, speed skaters must be able to optimally distribute their energy. This applies to sprint races, and middle and long distance races. For sprinters, however, the explosive features of the functioning of the muscular system, as well as the ability to show maximum effort throughout the entire competitive distance, are extremely important [3, 7].

Speed skating is a complex and very complex phenomenon from various points of view, forcing coaches to be in a constant search for methods and means that can expand their theoretical and practical knowledge [4, 8]. The latter relate to both the search for optimal movement techniques and improving the effectiveness of the training system for athletes as a whole [6].

From the standpoint of cybernetics and systems analysis, sports training represents a certain qualitative transition between the initial and final states through a number of intermediate ones [2]. Thus, during training, it is necessary to change the parameters of the athlete's physical, technical and other types of preparedness so that the increase in sports results, which is an integral characteristic of skill, is greatest. In turn, in order to make appropriate adjustments to the educational and training process that can lead to the necessary changes, it is important for the trainer to make adequate management decisions in a timely manner [5].

As stated in a number of works devoted to speed skating, one of such foundations when making decisions regarding the technical readiness of athletes may be information about the peculiarities of the implementation of dynamic parameters during take-off [1, 9].

Objective of the study was to identify the possibilities of correcting movement patterns of speed skaters using feedback on the distribution of plantar pressure in speed running.

Methods and structure of the study. The experiment consisted of two stages, conducted six weeks apart. A qualified athlete aged 23 years, specializing in all-around/long-distance speed skating, took part in the study.

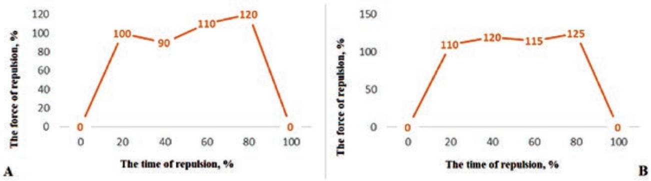
Both control sections were carried out according to the general plan. After a 15-minute ice warm-up, the athlete was alternately asked to perform a test task in speed skating 400 meters on the move in the sprint style, and then in the stayer style (Fig. 1). Rest between runs varied between 5-9 minutes.

Figure 1. Fragment of the study

The distribution of plantar pressure during the races was recorded at a frequency of 100 Hz using sensor insoles of the F-Scan system (Tekscan, USA). In the course of processing the obtained data separately for each foot and its regions, motor cycles were identified separately for each race, as well as when overcoming straight sections of the distance and turns. Transitional steps before the change of each segment were excluded from the analysis.

Features of the pressure distribution in the area of the sole of a skating boot are presented in the form of the dependence of the horizontal component of the ground reaction force averaged between the left and right foot on the time between placing the skate on the ice and the moment of its removal (the cycle time is reduced to 0 100%). The values are averaged, since there is currently no evidence that bilateral asymmetries have an exclusively negative effect on either competitive performance or a possible increase in the risk of injury on this basis [10].

Results of the study and discussion. The force of repulsion within the framework of a sliding step is not constant in its magnitude and at the end of the phase of single-support repulsion with the metatarsal part of the foot (before placing the skate of the swing leg on the ice) can reach maximum values of 120-150% of the athlete's body weight. In Fig. In general, according to known data, Figure 2 shows the dependence of the change in repulsion force on time when running in a straight line and turning [4].



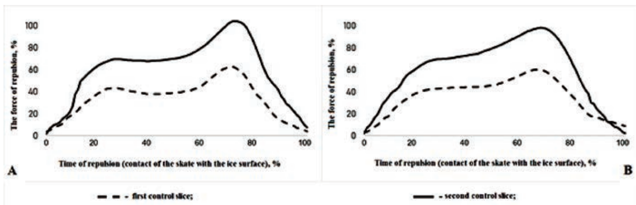
A – straight; B – turn

Figure 2. Dependence of repulsion force on time at different sections of the competitive distance

The model presented above served as a starting point for improving the athlete's movement technique during the six-week period between control sections. Figure 3 shows the results of this work.

When running in a straight line, as a rule, two pronounced maxima are observed on the repulsion force curve. The first is a consequence of loading the swing leg with body weight when placing it on the ice. The push-off force reaches its second peak as a result of active work by the metatarsal part of the foot.

When running around a turn, the magnitude of the repulsion force is on average higher than along a straight section of the distance. In addition, on a straight line, upon reaching the first peak, there is usually a slight decrease in the magnitude of the force, due to the nature of the movements in the free sliding phase, during which the athlete is only preparing for the subsequent push-off with the metatarsal part of the foot. Since this phase is absent when running around a turn, the graph between the peaks has a more straightforward form [7].



A – straight; B – turn

Figure 3. Dependence of the athlete's repulsion force on the time of skating at various distance segments

A similar pattern of effort implementation can be observed in our subject both during the first and second control sections. The changes that occurred during the training work were reflected in the almost parallel transfer of the graph of the repulsion force function in the positive direction along the vertical axis. In such a case, it would be fair to assume that the noted transformation resulted from an increase in strength indicators themselves, and not due to the fact that the athlete began to better realize the level of strength fitness available to him by reorganizing his movement pattern. However, the second assumption is supported by the increased magnitude of the force at the moment the swing leg is fully loaded with body weight when placing it on the ice (the first peak, observed after approximately 20-25% of the take-off time). It is at this moment that, due to the specifics of the movements, the athlete does not need to generate forces exceeding his body weight.

However, it is important to note that despite the positive changes, the horizontal component of the ground reaction force at the moment of loading the swing leg is still less than body weight. The nature of this phenomenon is not clear and may be associated with features: the inclination of the skate to the plane of the ice surface, maintaining balance, etc.

Conclusions. The use of feedback techniques in correcting the distribution of plantar pressure during push-off in locomotion on ice makes it possible to achieve certain shifts in movement organization patterns in skilled speed skaters. However, research in this direction should be continued to clarify the nature of the influence of such shifts on sports results.

References

1. Bakaev V.V., Bolotin A.E., Vasilyeva V.S., Tikhonov Yu.V. Struktura i soderzhaniye modeli trenirovki marafontsev s uchetom osobennostey mekhanizma energoobespecheniya myshechnoy deyatelnosti. Teoriya i praktika fizicheskoy kultury. 2023. No. 8. pp. 92-94.
2. Bolotin A.E., Bakaev V.V., Van Zwieten K.Ya. et al. Differentsirovannaya podgotovka plovtsov-marafontsev k sorevnovaniyam na otkrytoy vode s uchetom tipov energeticheskogo metabolizma. Teoriya i praktika fizicheskoy kultury. 2020. No. 10. pp. 37-39.
3. Kolesnikov N.V., Poniasov O.E., Fursov V.V. et al. Faktornaya struktura predsorevnovatelnoy podgotovki skorokhodov vysokoy kvalifikatsii. Teoriya i praktika fizicheskoy kultury. 2023. No. 7. pp. 90-92.
4. Mikhailov K.K., Poniasov O.E., Titarenko Yu.A. Proyavleniye dykhatelnykh funktsiy khokkeistov pri trenirovochnykh vozdeystviyakh razlichnoy napravlennosti. Teoriya i praktika fizicheskoy kultury. 2023. No. 3. pp. 9-11.
5. Poniasov O.E., Pugachev I.Yu., Paramzin V.B. et al. Kinematicheskiy analiz tekhniki plavaniya na osnove sinkhronnoy videozapisi lineynogo dvizheniya. Teoriya i praktika fizicheskoy kultury. 2023. No. 1. pp. 14-16.
6. Poniasov O.E., Romanenko N.V., Barchenko S.A. et al. Sensomotornaya integratsiya v sovershenstvovanii slozhnykh igrovykh koordinatsiy khokkeistov. Teoriya i praktika fizicheskoy kultury. 2022. No. 2. pp. 97-99.
7. Bakayev V., Bolotin A. (2020). Differentiated Training Model for Marathon Runners on Building Tempo and Speed Endurance Based On the Types of Energy Metabolism. Sport Mont, 18(3), pp. 31-34. doi: 10.26773/smj.201011
8. Bolotin A., Bakayev V. (2017). Method for Training of Long Distance Runners Taking into Account Bioenergetic Types of Energy Provision for Muscular Activity. In Proceedings of the 5th International Congress on Sport Sciences Research and Technology Support. pp. 126-131.
9. Park K.B., Lee J.S. (2007). An Analysis of 500m Inline Skate Starting Motions. Korean Journal of Sport Biomechanics. 17(2). pp. 23-29.