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**Original Article**

# Method for improvement of athletic performance in speed skating

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**Abstract**.
Speed skating is characterized by a continuous increase in maximum speeds, which makes it necessary to search for the most effective training methods for both beginners and trained athletes This study is focused on effective enhancement of physical fitness in athletes. The solution of this problem is associated with new means and methods for body adaptation to intensive exercise corresponding to the competitive regime systemic literature review made it possible to conclude that trained skaters differed greatly in terms of physical fitness and skating technique while maintaining the structure of the sliding step.  This means that there is no single optimal technique because each skater has his/her own specific technique, which is essential for understanding speed skating performance. The research was carried out at Sports School of the Olympic Reserve Orlyonok (Perm, Russia). The study involved beginners in speed skating. The control group (CG) (10 people) performed traditional tasks according to the program approved by the school. The experimental group (EG) (10 people) performed our experimental exercises based on the principle of artificial control environment. The results of the study made it possible to conclude that there was a need to study the features of speed skating performance using artificial control environment, which contributed to the formation of optimal athletic skills, reduced the number of skating steps, increased their length, and improved the overall athletic performance among speed skaters.
**Keywords: artificial control environment, speed skating, speed skating performance**.

**Introduction.**

There are various techniques for acquiring athletic skills. These techniques are based on the fundamental provisions of modern theory and methodology of training (Buckley, John P., Roger Eston. et. al, 2022; Noordhof, D.A. et al, 2014; Cherepov, E. A. et al, 2016).

The main component of theory and methodology of acquiring athletic skills is a theoretical concept of "artificial control environment" developed by I. Ratov, which includes motion-related contradictions that impede performance enhancement: the presence of the so-called weak links, the conflict between biomechanical efficacy and physiological effects of exercise, the conflict between skill acquisition and athletic performance, etc. (Ratov I.P. et. al, 1998).

The analysis of these contradictions was also performed in other studies (Bakhareva A.S., Cherenkov V.S., Bykov E.V., Budanov G.V. et. al, 2020; Dopsaj, M., Zuoziene, I. J., Milić R., Masiulis, N., Vodičar, J. et. al, 2020, Cherepov, E., Erlikh, V., Bykov E. V., Stoliarova N. V., Stovba I. R. et. al, 2019). The results of these studies convincingly showed that training practice could only neutralize these contradictions through the use of training means. The fundamental nature of these contradictions and the difficulties associated with the existing training conditions raise the question of creating new conditions for athletes, which may entail a radical renewal of the entire system ( Morishita, S., Tsubaki, A., Takabayashi, T. et. al, 2018; Sylta, O., Tonnessen, E. , Seiler, S. et. al, 2014). Such a renewed system of methodological approaches is presented as artificial control environment.

The main idea of speed skating is to overcome a given distance in the minimum time by using muscle efforts during sliding motions. At the same time, movement speed depends on both physical fitness and the interaction between ice and a ski blade (Abramova, T. F. et. al, 2013; Aikin, V.A. et. Al, 2014; Sylta, O., Tonnessen, E., Seiler, S. 2014). Motion structure in speed skating includes the parameters that show a significant relationship between movement speed and physical fitness (Stovba I. R., Stoliarova N. V., Petrozhak O. L. et. al, 2016; Schmidt, R.F., Lang, F., Hekmann, M. et. al, 2019; Yanchik E.M, Schelgacheva K.B., Potop V., Koroleva A.A. et. al, 2020).

This study is focused on effective enhancement of physical fitness in athletes. The solution of this problem is associated with new means and methods for body adaptation to intensive exercise corresponding to the competitive regime (Isaev, A.P., Erlikh, V.V., Bakhareva, A.S., Saraykin, D.A., Pavlova, V.I., Maleev, D.O. et al, 2018; Williams, N. et al, 2021; Petrozak O. L., Stovba I. R., Stolyarova N. V., Savinykh H. Y et al, (2019).
**Aim.** The paper aims to improve training techniques associated with speed skating performance.


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**Materials and methods.**

The study involved several stages:

1. The first stage included the development of athletic schedule and a review of literature in the area. Therefore, our experimental methodology for the enhancement of speed skating performance was developed, and the control tests and parameters were selected for measuring the level of physical fitness of young athletes.

2. The second stage (December 2018 - March 2018) included control tests and a pedagogical experiment in training conditions. Our experiment was repeated to evaluate the dynamics of control parameters.

3. At the third stage (April - September 2019), the data obtained were processed and analyzed, conclusions were made about the effectiveness of the methodology proposed.

Our experiment lasted two months (from January 13, 2019 to March 01, 2019). Training sessions were held 3 times a week for 90 minutes. A total of 24 training sessions were held. The control and experimental groups consisted of beginners in speed skating. The use of our exercises in the experimental group at the beginning of experimental training sessions was associated with certain difficulties.

Exercise 1 (balancing on the heel zone of the foot) demonstrated the inability of athletes to maintain balance. All athletes of the experimental group finally balanced on toes and then lost their balance.

Exercise 2 (turns around the axis in the heel zone) was easier for athletes from the first week. At the end of the experiment, 8 athletes performed the exercise on the left leg, and 9 – on the right leg. These data can be used for studying the effect of asymmetry on speed skating performance (Kubatkin V.P. et al, 2016; Moseeva, L.I. et al, 2019)

The central principle of artificial control environment is acquiring athletic skills without significant changes in the training process due to the widespread use of various devices from the very first attempts to perform exercises. At the same time, it is extremely important both to protect and support the natural movement patterns of athletes (Gusakov, I.V., Nurmukhanbetova, D.K., Kydyrbaeva, D.B. et al, 2020).

Thus, the athlete and the so-called artificial control environment should represent two connected elements of a single control circuit, which adjusts the entire system of natural movement patterns and the corresponding external influences to ensure the best development of athletic performance. Therefore, the use of artificial control environment in the main part of the training session was associated with artificial discomfort in the metatarsal zone and the zone of the toes (Anokhin, N.V. et al, 2013; Bakhareva, A.S., Aminov A.S., Latypova E.F., Savinykh E.Y., Cherepanov V.S. et al, 2021).

With respect to the specifics of competitive activity in speed skating, 100 m speed skating performance was chosen as a control test. The control parameters of the test are the time (t) and the number of steps (n). The effectiveness criterion was the push-off force coefficient (Gushchina E.Yu., Dikikh K.V. et. al, 2018), which is calculated by the following formula (1):

$$PFC = s : ( t \bullet n) \quad (1)$$

where s is the length of the distance (m), t is the task completion time (s), n is the number of steps within the distance.

The CSR value of 1.666 was taken for the assessment of athletic skills.

A control test and data recording were carried out before and after the pedagogical experiment.

An additional parameter for evaluating speed skating performance was $S_{mean}$ - the average length of a speed skating step, which is calculated by formula (2):

$$S_{mean} = s : t \quad (2)$$

where s is the length of the distance (m), n is the number of steps within the distance.

In this study, timing and movement data recording are used.

The data obtained were processed using MS Excel 2016.

**Results and discussion.**

The experimental model included 2 additional exercises based on the artificial control environment principle. This principle was implemented through the creation of uncomfortable feelings in the areas of the foot by attaching coffee beans to the sole of the athletes' socks to improve foot placement (Bennett, H., Slattery, F. et al, 2019; losnegard T. et al, 2019).

Exercise 1: Starting position – single leg stance on a gymnastic bench; lower the knee to the heel similar to the position of the skater during single-leg sliding; maintain balance for 2-3 seconds and return to the starting position. The exercise was performed for 30 seconds. 4 sets were performed on each leg.

Exercise 2: Starting position - single-leg sliding stance; turn by 450 in the direction of the medial side of the foot (inner part of the foot), the axis of rotation is the heel zone of the foot; maintain balance for 2-3 seconds; repeat the rotation; maintain balance for 2-3 seconds, etc.

The exercise was performed for 30 seconds. 4 sets were performed on each leg.

The assessment of athletic skills was performed based on the data of the control test (task completion time and number of steps) and calculated values (average step length and push-off force coefficient).

During the first attempt, the following data were recorded: task completion time values ranged from 18.60 s to 12.50 s and from 18.40 s to 13 s in the control and experimental groups respectively. The maximum and minimum values differed insignificantly between the groups (within 0.5 s). The number of steps ranged from 42 to 28 in both groups. The average step length ($S_{mean}$) ranged from 3.57 m to 2.38 m in both groups. The push-off force coefficient ranged from 0.286 to 0.128 and from 0.271 to 0.142 in the control and experimental groups respectively. In the control group, the maximum value of the coefficient is greater, while the minimum value is less compared to those of the experimental group.

After the second measurement, the following data were recorded. Task completion time values ranged from 16.60 to 12.50 s (baseline data: 18.60-12.00) and from 14.50 to 11.20 (baseline data: 18.40-13.00) in the control and experimental groups respectively. The maximum and minimum values in the groups differ within 2.1 s in favor of the experimental group. The number of steps ranged from 34 to 26 (baseline data: 42-28) and from 32 to 22 (baseline data: 42-28) in the control and experimental groups respectively. The maximum and minimum values of the number of steps in the experimental group are from 2 to 4 less than in the control group. The average step length ($S_{mean}$) ranged from 3.85 to 2.94 (baseline data: 3.57-2.38) and from 4.55 to 3.13 (baseline data: 3.57-2.38). The maximum and minimum values of the average step length in the experimental group increased by 0.98-0.75, while in the control group the same parameter increased by 0.28-0.56. The push-off force coefficient ranged from 0.321 to 0.177 (baseline data: 0.286-0.128) and from 0.399 to 0.216 (baseline data: 0.271-0.142) in the control and experimental groups respectively. The maximum and minimum values of the push-off force coefficient in the control group increased by 0.035-0.049, and in the experimental group the same parameter increased by 0.128-0.074. Task completion time values before the experiment were 14.53±0.47 and 15.04±0.41 in the control and experimental groups respectively ($p > 0.05$). The average baseline value of the control group was 0.49 seconds less than in the experimental group.

Task completion time values after the experiment were 13.77 ± 0.35 and 13.07 ± 0.25 in the control and experimental groups respectively ($p > 0.05$). The average value of the experimental group was 0.7 s less than in the control group (Fig. 1).

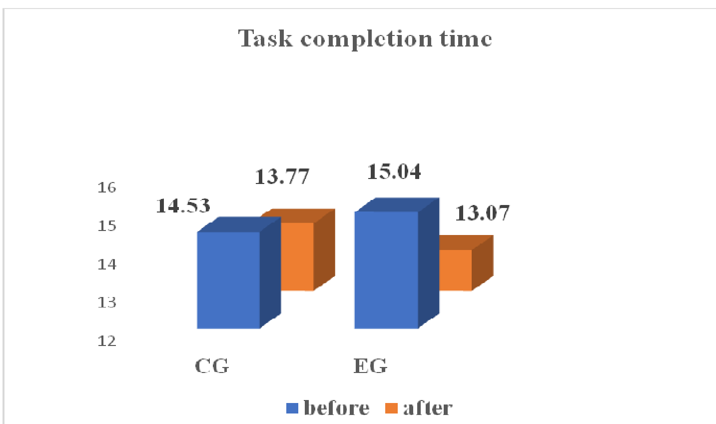


Fig. 1. Task completion time values in the control (CG) and experimental (EG) groups

The number of steps before the experiment were 28.73 ± 0.62 and 26.80 ± 0.77 in the control and experimental groups respectively ($p < 0.05$). The average number of steps in the experimental group was 2.93 less than in the control group (Fig. 2).

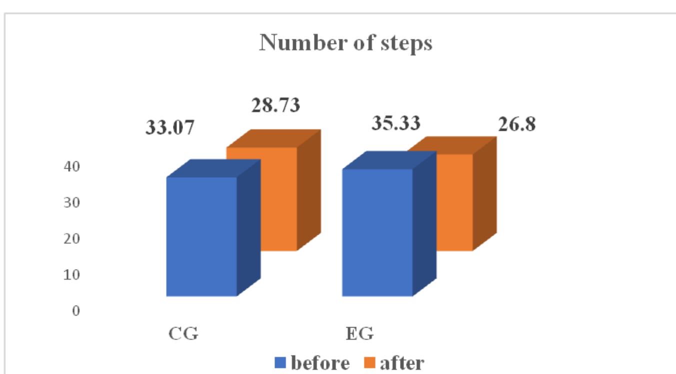


Fig. 2. The number of steps data in the control (CG) and experimental (EG) groups

The number of steps after the experiment were 33.07 ± 1.08 and 35.33 ± 1.08 in the control and experimental groups respectively ($p > 0.05$). The average number of steps in the control group was 2.26 less than in the experimental group.

The average step length before the experiment was 3.06 ± 0.09 and 2.87 ± 0.09 in the control and experimental groups respectively ($p > 0.05$). Step length in the control group was 0.19 more than in the experimental group (Fig. 3).

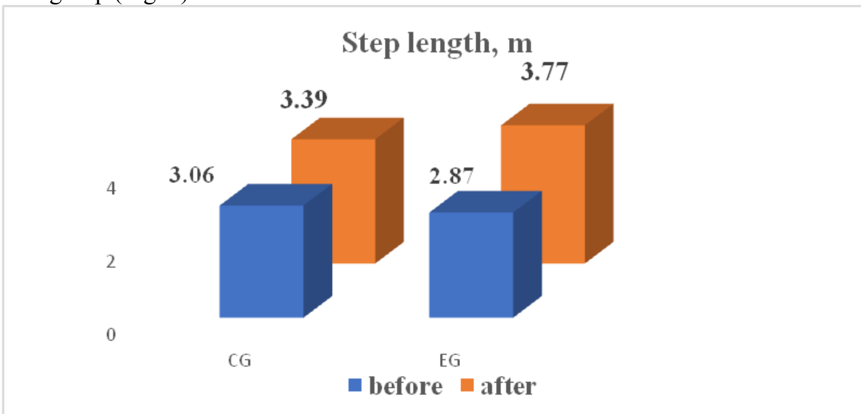


Fig. 3. Average step length values in the control (CG) and experimental (EG) groups

After the experiment, the average step length was 3.39±0.07 and 3.77±0.11 ($p < 0.05$) in the control and experimental groups respectively. The average step length in the experimental group was 0.38 more than in the control group (Fig. 3).

The push-off force coefficient was 0.249 ± 0.011 and 0.291 ± 0.014 in the control and experimental groups respectively ($p < 0.05$) (Fig. 4).

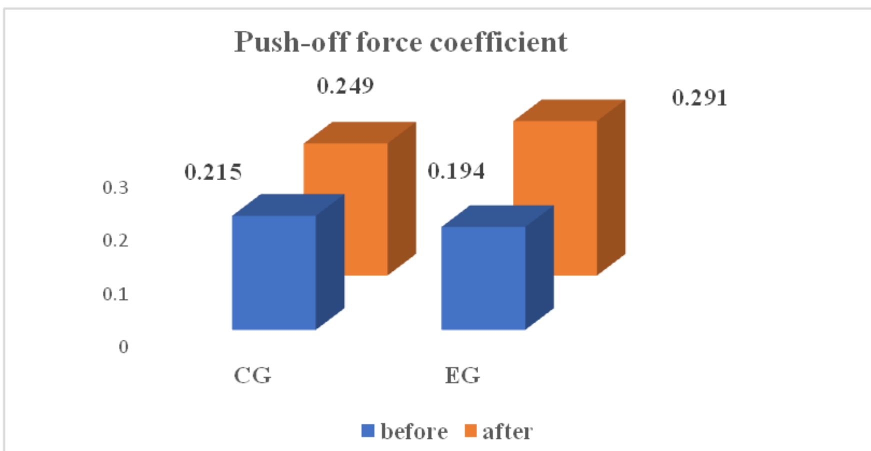


Fig. 4. Push-off force coefficient values in the control (CG) and experimental (EG) groups

The push-off force coefficient in the experimental group was 0.042 higher than in the control group (Fig. 4). The push-off force coefficient was 0.215 ± 0.012 and 0.194 ± 0.010 in the control and experimental groups respectively ($p > 0.05$). The push-off force coefficient in the control group was 0.021 higher than in the experimental group. Thus, task completion time and the number of steps were less in the experimental group, while the average step length and push-off force coefficient were greater in the same group. There were no significant differences between the groups. Nevertheless, there was a tendency towards result improvement.

Task performance time improved by 5.02% and 12.78% in the control and experimental groups respectively. Regardless of the difference of 7.76%, there were no significant differences between the groups.

The number of steps improved by 9.70% and 23.86% in the control and experimental groups respectively (intergroup difference of 14.16%).

The averaged step length improved by 11.13% and 31.81% in the control and experimental groups respectively (intergroup difference of 20.68%).

The push-off force coefficient improved by 17.15% and 51.61% in the control and experimental groups respectively (intergroup difference of 34.46%).

**Discussion.**

The method of acquiring speed skating skills was considered, which contributed to the effective development of physical fitness in this athletic area. Systematic literature review in the area showed that speed skating technique consisted of three phases: free sliding, single-leg push-off, two-leg push-off (Williams, N. et al, 2017). The effectiveness of athletic performance in various athletic disciplines is estimated by the data of these motions (Stolyarova, N.V., Stovba, I.R., Petrozhak, O.L, Savinykh, E.Y. et al, 2021). In speed skating, there are currently no technical possibilities to reliably assess the performance of a competitive exercise. The search for methods for athletic performance assessment in speed skating remains relevant. However, the ideas of artificial control environment can be effectively integrated into the training process as soon as there were significant differences in the number of steps, the average step length and the push-off force coefficient between the groups ($p < 0.05$).

**Conclusion.**

The use of artificial control environment contributes to the development of speed skating skills by focusing athlete's attention on the point of force application. The use of movement speed data for the assessment of speed skating performance is not appropriate. The use of our experimental method contributes to a decrease in the number of steps and an increase in their length.

Thus, it can be recommended to implement the proposed methodology paying special attention to the optimal use of physical fitness, which can be assessed by the number of steps necessary to overcome a given distance.

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