

Priority directions of speed endurance development in higher sports skill athletes in short track

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Abstract:

This study presents data that reveal the need for speed endurance development, taking into account the psycho-physiological indicator dynamics of highly qualified athletes specializing in short track. This work emphasizes the special role of regulating and maintaining short trackers' optimal mental state before participating in the qualifying and main competitions of the sports season. It was determined that the volume of training load associated with speed endurance development at the stage of early starts for short trackers reaches 53.5%, which does not lead to significant difference in their physical fitness results ($p > 0.05$). It is established that athletes show high sports results in competitions if their mental state parameters (i.e., the level of anxiety, motivation, biopotential, sense of time, and sense of pace) are stabilized at optimal values 3–5 weeks before the competition. Therefore, it is advisable to control the abovementioned parameters during the training process during the preparatory and competitive periods of the annual training cycle. The implementation of the developed methodology for short trackers' speed endurance development based on the dynamics of psycho-physiological indicators contributes to achieving high sports results in competitive activities. Significant differences in speed skating at a distance of 500 m were established among the athletes of the experimental group 1 (EG-1). In ice skating at distances of 1000 m and 1500 m, significant differences were also recorded among athletes of EG-1 and experimental group 2 (EG-2) ($p < 0.05$). In EG-2, there were no significant differences in technical results in skating at a distance of 500 m ($p > 0.05$) and in the athletes of the control group (CG) at all three distances ($p > 0.05$). At the end of the experiment, statistically significant differences were revealed between the control and experimental groups of short trackers in four physical tests out of five, i.e., «Tenfold standing long jump», «Track and field running 100 m», «Shuttle running 3 times 10 m», «Ice skating 1000 m» ($p < 0.05$). There were no significant differences between the CG and EG of men and women in the «Track and field running 1500 m» test ($p > 0.05$). The obtained results indicate effectiveness of the developed methodology.

Key Words: highly qualified athletes, short track, higher sport skill stage, physical training, competition

Introduction

Short track is a sport that places high demand on athletes competing at the level of the highest sports skill training. Competitive activity is associated with the conditions of performing a specialized load in the sub-maximal power zone (Voronov, 1999). Thus, one of the leading physical qualities in running on a short track is speed endurance; the performance of high-intensity training loads is inherently associated with athletes' optimal mental state formation (Voskresensky, 2003; Krylova, 2014; Khotsko and Dikikh, 2016; Shevchenko and Martinenko, 2020).

An integral part of these processes is the dynamics of the psycho-physiological parameters of the functional state, on which the competitive activity result largely depends (Leontieva, 2013; Bahareva et al., 2021). Of note, the long-term use of the same training means leads to the adaptation of the functional state physiological component, and the positive effect of training loads decreases, which causes a slowdown in the development of athletes' physical abilities (Guba and Marinich, 2016; Krylova, 2014; Bolotin, and Bakayev, 2017).

After many years, short track has acquired its own characteristic features that distinguish it from classical speed skating; therefore, there is a need to identify new approaches and directions for monitoring and controlling parameters that limit speed endurance development in short track (Marius, 2017).

A considerable contribution to the field of scientific research on short track belongs to T. I. Krylova (2007–2014). In her work, integral sports training in short track is considered (i.e., periodization, physical qualities, sports training, and psychological readiness for competitions), innovative models of general and special physical training facilities management are developed, and model characteristics of qualified athletes in short track are given (Krylova 2013,2014; Krylova et al., 2011).

A small number of studies on short track are associated with the study of such technical and tactical actions of athletes, the performance of which is directly related to special endurance development (Krylova and Chernysheva, 2015; Voskresensky et al., 2018; Martynenko and Oreshkina, 2020).

The analysis of previous studies has shown that a small number of works are devoted to the study of qualified short trackers' psychological training (Zimina et al., 2013; Oreshkina and Panasyuk, 2016; Leontieva et al., 2013; Sopov and Leontieva, 2015).

Materials and methods

This research was conducted in 2011–2020 in four stages. During the first stage (April 2011–October 2011), an information search was conducted on the selected research problem, the research methodology was determined, and types of work were planned. During the second stage (May, September, and October 2011), an ascertaining experiment was conducted, and the athletes' personality traits were measured (the athletes' competitive success was determined by converting achieved places into points). During the third stage (December 2011–October 2012), the results of the ascertaining phase of the pedagogical experiment were processed, on the basis of which training tools were developed to increase the physical fitness level of highly qualified athletes' in short track in the annual training cycle. Later, those results were applied in the formative phase of the pedagogical experiment. During the fourth stage (November 2012–April 2020), the obtained results were processed, the information was analyzed and summarized, and materials were prepared for publication. The pedagogical experiment included ascertaining and forming phases.

The aim of the *ascertaining experiment* was to calculate the training load volume in weekly microcycles and to determine the intensity zones and training means dynamics during the main periods of the annual training cycle. During the ascertaining phase of the experiment, the physical fitness levels were determined, and the correlation between the effect of training load on the highly qualified short trackers' functional states dynamics with characteristic personality traits were established. The obtained data generalization contributed to the development of a methodology for highly qualified short trackers' speed endurance development, based on the dynamics of psycho-physiological parameters in the annual training cycle.

A total of 16 highly qualified short-trackers (18–26 years old) participated in the ascertaining experiment. Athletes' qualification was Masters of Sports in short track. During the first stage, the evaluation of highly qualified short trackers at the stage of higher sports skills training program description was performed by the method of the best practical experience and documentary data generalization. Pedagogical observations were aimed at determining the actual volumes and specifics of the training load performed at various stages of the highly qualified short trackers' annual training cycle. During the second stage, the determination of aerobic capabilities was performed using bicycle ergometry and gas analysis. The significance of differences in the functional fitness level was revealed using a nonparametric statistical criterion (i.e., the Mann–Whitney *U*-test). The obtained informative data on the short trackers' functional capabilities allowed to identify the main aerobic parameter values and determine the degree of training load impact on the athletes' body.

The highly qualified short trackers' physical fitness level during the transition and preparatory periods of the annual training cycle was revealed using the control and pedagogical tests. The significance of differences in the physical fitness level was revealed using the Student's *t*-test; to characterize the obtained data, the arithmetic mean (*X*) and the error of the average value (*m*) were calculated. The determination of speed abilities was performed using the «Track and field running 100 m» test; speed and strength abilities were determined using the results of the «Tenfold standing long jump» test; the general endurance level was evaluated using the «Track and field running 1500 m» test; other tests included «Shuttle running 3 times 10 m» (speed and strength abilities) and «Competitive distance 1000 m» (special speed endurance).

When identifying the personality's characteristic properties, the psycho-diagnostic method of R. Kettel was used. During the third stage, the functional state parameters dynamics were revealed depending on the highly qualified short trackers' competitive success level. The relationship between the functional state parameter indicators, personality factors, and the performance success in competitions was calculated using the Spearman correlation coefficient (*r*) in the STATISTICA 8 program.

The mental component of the functional state psycho-diagnostics methods included the measurement of the mental, energy, and motor state of highly qualified athletes in short track. These methods were used during the ascertaining phase of the pedagogical experiment in 16 highly qualified short-trackers and during the formative phase of the pedagogical experiment in CG (n = 15) and EG (n = 15) during the main periods of the annual training cycle. The measurements were performed 2 times in each microcycle on the day before rest and on the first day after rest.

Methods of measuring the athletes mental state

The personal and situational anxiety measurement was performed using the Spielberger–Hanin scale (Hanin, 2012). The motivation level was measured using the scale of V. F. Sopov's motivational state (Sopov, 2010). The method of measuring the athletes' body energy state included bio-potentiometry according to V. H. Kirlian.

Methods of the motor state measuring included a metered tapping test (tap test) and measuring the sense of time. The formative phase of the pedagogical experiment included the development of training tool complexes contributing to the development and experimental validation of various endurance components in short trackers at the stage of higher sports skills during the annual training cycle. The duration of the experiment was 6 months. During the experiment, in the preparatory period and at the stage of early starts, the parameters of the athletes' functional mental states were monitored (2 times in each microcycle). If there was a deviation from the norm, a set of measures for their correction was performed (1–3 times in the microcycle).

During the formative phase of the pedagogical experiment, two groups of 15 people (CG and EG) were formed to substantiate the developed training methodology for increasing their speed endurance level. The formed groups included highly qualified athletes in short track (18–24 years old).

The experimental group was divided into two subgroups, i.e., EG-1 (athletes who needed to reduce anxiety level to the optimal level) and EG-2 (whose participants first needed to optimize the motivation level and then the anxiety level).

The volumes of individual types of training of the CG athletes' training program corresponded to the minimum volumes of the Federal Standard for the sport «Speed Skating» (Order No. 28 of 19.01.2018), hereinafter referred to as the Standard (Federal Standard for Sports Training for the sport «Speed Skating», 2018). In EG, the workload volumes associated with tactical, theoretical, and psychological training were increased to 14% (233 hours) with a primary emphasis on the latter type of training in accordance with the Standard, and the special physical training volumes were also increased to 60% (998 hours). Functional state correction was performed by taking into account the recommendations of A.V. Alekseev (Alekseev, 2006). The effectiveness of the developed training methodology was evaluated by conducting and analyzing control tests to determine the highly qualified short trackers' general and special physical fitness according to the results of competitions (the final competitions of the sports season and those held at the stage of early starts). The functional state level was assessed using physiological and psycho-diagnostic tests.

Results

The training load dynamics determination aimed at speed endurance development during the annual training cycle showed that its volume reached 53.4% (673 min per week) of the total load; however, despite such significant percentage, there were no significant differences in physical fitness tests and physiological indicators in the ascertaining experiment. As a result of the comparative analysis of the training type approximate ratio for highly qualified short trackers in the annual macrocycle and the Federal Standard for the sport «Speed Skating», it was determined that in specialized schools of the Olympic reserve, 50% of the possible 60% is allocated to special physical training, and 10% of the possible 10–14% is allocated to tactical, theoretical, and psychological training (Federal Standard for Sports training for the sport «Speed Skating», 2018).

Thus, the volume of training in the experimental group was increased to the maximum values in accordance with the provided data. During the ascertaining experiment, it was also revealed that athletes with a high level of competitive success had optimal values of the mental state parameters 3–5 weeks before the competition. Based on the obtained results, a method of sports training was developed that promotes speed endurance development (by increasing the capacity of alactic anaerobic and glycolytic components) and optimizes the functional mental state parameters. The indicator of the developed methodology implementation effectiveness was the significant differences ($p < 0.05$) obtained during the test on the bicycle ergometer between CG and EG after the experiment. The shifts in physiological parameters in EG were significantly higher than those in CG. When identifying differences in physical fitness indicators between CG and EG after the experiment, statistically significant changes were revealed in four out of five tests. Significant differences between CG and EG were not observed only in the «Track and field running 1500 m» test ($p > 0.05$).

When identifying differences in the development of speed endurance indicators, the «Ice skating 1000 m» test was conducted. Athletes in CG and EG skated 9 laps from the start with a maximum speed.

It was revealed that tactically the distances were covered evenly; during the final testing, the speed was higher for women, and the sports result was improved in EG by 6.42% (6.51 s), and in CG – by 2.71% (2.76 s); in turn, in men in EG – by 7.1% (6.86 s), and in CG – by 2.91% (2.83 s).

When establishing the significance of differences between the groups' results at the beginning of the experiment, no difference was detected ($p > 0.05$); after the experiment, significant differences were revealed ($p < 0.05$). According to the competitive activity results before the experiment, no significant differences were identified ($p > 0.05$) in skating at distances of 500, 1000, and 1500 m between the groups of women. After the experiment, significant research results were identified ($p < 0.05$); no differences were found in CG ($p > 0.05$). Figure 1 shows an increase in the results at various distances among women.

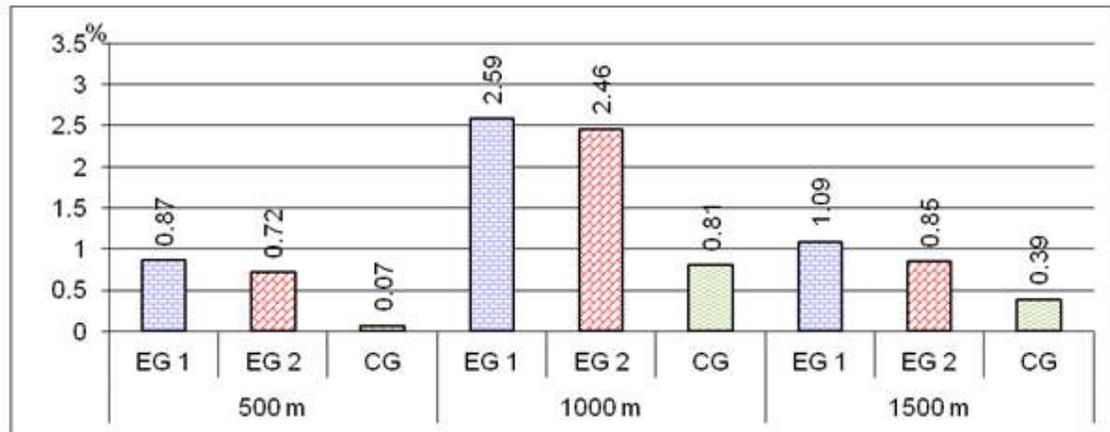


Fig. 1. Increase in the competition results before and after the experiment in highly qualified women in short track ($p < 0.05$)

It is observed that the greatest improvement in the results of the competition occurred at a distance of 1000 m in EG-1 and EG-2 by 2.59% and 2.46%, respectively. The same trend in the difference in results is observed in men (see Fig. 2).

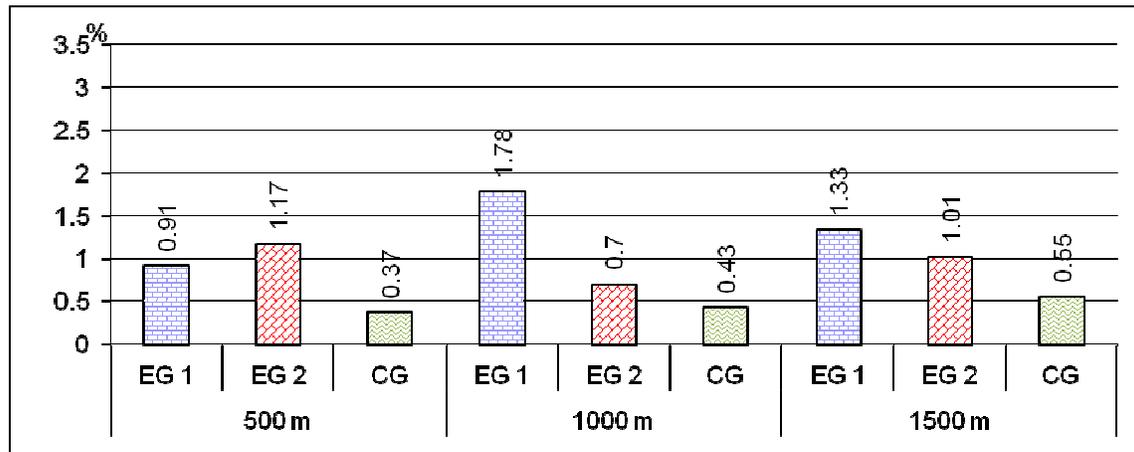


Fig. 2. Increase in the competition results before and after the experiment in highly qualified men in short track ($p < 0.05$)

Among men, the greatest increase in the result was recorded in EG-1 for a distance of 1000 m (1.78%), in EG-2 – for a distance of 500 m (1.17%).

The use of a set of exercises in the first subgroup in the 5th mesocycle, aimed at optimizing the psychological component parameters, allowed to reduce the anxiety level and perform in the main finals of the competitions (in the finals during the first competitions and in the finals A and B during the second competitions). The training load correction in such athletes consisted of warming-up modeling, as on the day of the competition at the beginning of three training sessions in each week of the mesocycle. The main task was to switch the athletes' attention to the clear implementation of methodological instructions in each exercise.

After the first competitions, there was a further optimization of the functional state parameters; by the second competitions, 5 weeks before the start, the athletes had an optimal level of all five indicators.

The athletes of the second subgroup during the special preparatory stage had an increased level of motivation (10.5 levels) and biopotential (12 levels); in the 5th mesocycle, they had an increased level of anxiety. To correct these states, a set of exercises for speed endurance development was first applied, where the role of a leader in a training race was assigned to athletes with an increased motivation and biopotential levels. Optimization of these parameters occurred because these athletes were overtaken by their teammates at the finish line. All of this led to a decrease in motivation and biopotential to the optimal level directly for the first competitions. To optimize the anxiety of EG-2 athletes, a set of standard competitive warm-ups was used three times a week for one microcycle. Before the second competition, all five functional state parameters were optimal. This allowed the EG-2 athletes to also show high sports results in competitions.

The high level of anxiety, motivation, and biopotential in CG in the 5th mesocycle affected the athletes' ranking lower than those of the first and second subgroups performance in competitions.

Discussion

Thus, the developed and implemented methodology for speed endurance development gave positive, statistically significant results, which were obtained both by increasing the athletes' physical fitness and by timely functional state correction. Short track competitions are characterized by fighting dynamics, the unpredictability of the situation, and ragged nature of running. When conducting tactical overtaking at high speeds, race participants need to keep the maximum running time for 3–4 laps (the time range for overtaking and holding the lead in the race is up to 30 s); this fact explains the lack of significant differences in the «Track and field running 1500 m» test ($p > 0.05$).

The experimental data obtained during the formative phase of the experiment also prove the effectiveness of the developed training method of highly qualified athletes in short track. After the experiment, the EG athletes attained higher places in the final competition table ranking than the short trackers from CG. The author's method allowed to increase the sports fitness level and the competitive activity results, as confirmed by the obtained statistically significant results. In addition, the obtained results allowed us to identify special skating exercises that contribute not only to speed endurance development but also to professionally important mental state optimization, such as highly qualified short trackers' anxiety and motivation.

Conclusions

The priority direction in highly qualified short trackers' training process is the purposeful development of speed endurance in combination with control, aerobic capabilities, and mental state parameter optimization, such as anxiety, motivation, sense of pace, sense of time, and biopotential during the annual training cycle. To effectively overcome any competitive distance, athletes in short track should pay considerable attention to anaerobic energy source development.

It is determined that highly qualified athletes in short track show high sports results in competitions, provided that their mental state parameters (i.e., level of anxiety, motivation, biopotential, sense of time, and sense of pace) are stabilized at optimal values 3–5 weeks before the competition. Therefore, it is advisable to control the abovementioned parameters during the training process during the preparatory and competitive periods of the annual training cycle.

Significant differences in speed skating at a distance of 500 m were established among highly qualified EG-1 athletes. In ice skating at distances of 1000 and 1500 m, significant differences were also observed among EG-1 and EG-2 athletes ($p < 0.05$). In EG-2, there were no significant differences in technical results in ice skating at a distance of 500 m ($p > 0.05$), and in CG athletes – at all three distances ($p > 0.05$).

At the end of the experiment, statistically significant differences between CG and EG of highly qualified short trackers were revealed in four out of five tests, i.e., «Tenfold standing long jump», «Track and field running 100 m», «Shuttle running 3 times 10 m», «Ice skating 1000 m» ($p < 0.05$). There were no significant differences between CG and EG, both in men and women, in the «Track and field running 1500 m» test ($p > 0.05$).

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