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SPRINTERS' TRAINING WORKLOAD AND REST PATTERNS

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ABSTRACT--*Athlete's training level and high athletic performance are achieved by multiple repetitions of training loads that are differing in volume and intensity. Therefore, to build a sports training program correctly and rationally is to find the optimal intervals between repeated workouts in the training process, in other words, to find the criterion of optimal readiness for the subsequent exercise performance, training session or participation in the competition. The available data on the problem under study are unsystematized and fragmented in the scientific and methodological literature. This issue was the relevant line of our research.However, the issue of the rational alternation of physical exercises in various types of athletics, as applied to short distance running, has not yet received a sufficiently complete scientific justification. This factor served as the basis for the purpose of our study: to determine the optimal combination of patterns of alternating run segments with rest, which contributes to the development of running speed and speed endurance in sprinters.Studying this issue will contribute to the further study of sprint training techniques. Therefore, to answer the research goal, the following tasks were formulated: to generalize the data of the scientific and methodological literature on the influence of various patterns of training and rest on the change in special working capacity and functional state in sprint; to determine the influence of optimal load and rest regimens on the improvement of speed and speed endurance in short distance running.The practical significance of the study lies in determining the optimal load and rest alternation patterns, which affect the change in the functional capabilities of the sprinter during the development of the required physical qualities. The theoretical significance is concerned with updating and adding the latest data to theoretical provisions regarding the problem of training regimens and the workload intensity on the improvement of speed and speed endurance in short distance running.*

Keywords*-- Sprint, means for improving speed and speed endurance.*

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I. INTRODUCTION

The issue of the rational alternation of physical exercises and rest in a separate training session, as well as in the weekly cycle, finds, in theoretical terms, a certain reflection in domestic and foreign literature; it is an important condition for improving the methodology of sports training (Gladilina et al., 2018). In sports practice, the main means for developing motor qualities is to perform appropriate physical exercises. Performance of exercises of varying intensity and volume is accompanied by the expenditure of energy potential, changes in the cardiovascular, respiratory, neuromuscular and other body systems, which entails recovery periods of various durations (Bodrov 2009; Nikiforov 2014; Proskurina 2012; Makarova 2003; Fox et al. 1989; Jacobs et al. 1987; Fry et al. 1991; Kuipers and Keizer 1988; Bonen and Belcastro 1977; Gauron 1984; Cinque 1989; Yessis 1990; Bergeron 1982; Fahey 1992; Clark 1985; Maslennikov et al. 2019). The restoration of the body's performance after tiring activities goes through a series of qualitatively different states – the stages of rest (Alberts B. et al.2003; Bergeron 1982; Menshikov V.Z. and Volkov N.I. 1986; Berezov T.T., Korovkin B.F. 2002; Cinque 1989; Elliott W.H., and Elliott D.C. 2009; Makarova 2003; Gaffar et al., 2019). Not only the response of various systems of the body and the level of performance in general, but also the development of motor capabilities depends on the background at which stage of rest each repeated exercise is performed. Different options for alternating workload and rest in training, as well as alternating training sessions with rest in weekly cycles, result in an unequal change in the athletes' motor capabilities and special performance.

Therefore, the study of the influence of various conditions for workload and rest alternation as one of the factors constantly acting on the athlete's body during sports training is of theoretical and practical interest.

The following hypothesis is suggested: it is expected that the study of the optimal pattens of workload and rest alternation during sprinters' training will further improve the training methodology.

To solve the goal of the experiment, the following tasks were set forth:- to summarize the data of the scientific and methodological literature devoted to the influence of various workload and rest patterns on the change in special working capacity and functional state in short distance running;- to determine the effect of optimal load and rest patterns on the improvement of speed and speed endurance in short distance running.

II. LITERATURE REVIEW

The analysis of the available specialized literature on the runners' training methods gives reason to state the presence of two points of view on the duration of rest between repeated exercise performance in a training session

Some believe that rest should be short, not providing recovery, and assume that in this case, subsequent training loads, despite a decrease in their intensity because of fatigue, occur under increasingly harder conditions for the body, and therefore, its adaptation to the load is improved (Ozolin 1995; Platonov 2024). Other experts believe that rest should be long enough to allow subsequent training work without reducing its intensity, or with a very small decrease (Volkov et al. 2000; Mat Fitzgerald 2014; Bonen and Belcastro 1977).

N.G. Ozolin (1995) points out the feasibility of alternating various loads with rest in the training session, in weekly, monthly and annual planning, and underlines that the effectiveness of the training process depends on the correct alternation of training workload and rest.

I.T. Elfimov (1972), while studying the effectiveness of various rest intervals for the development of special endurance of middle-distance runners, notes that in the group of testees who performed repeated work in the state of under-recovery, the increase in speed endurance was greater than in the group that performed repeated exercises in the state of increased working capacity.

The publications where the authors established the required duration of rest intervals to restore working capacity are of great interest in this regard (Myakinchenko 2003; Kuramshin 2004; Bompa, T., Buzzichelli C.A. 2015; Maslennikov et al. 2019).

A number of works demonstrate the dependence of the recovery period dynamics on the nature, amount and intensity of the work performed (Jacobs, et al. 1987; Fry et al. 1991; Yessis, 1990, Clark 1985). These publications also show that the recovery processes after training loads aimed at improving endurance differ from recovery processes after high-speed loads, because in the first case, recovery is much faster.

The problem of alternating workload and rest patterns in the context of sports practice was also studied by V. Petrovsky (1993), Yu.V. Yermolov, V.A. Zavarzin, and A.G Ushakov. (2008), A. Bonen, and A. Belcastro (1977), R.W. Fry, R. Morton, and D. Keast, (1991). The authors indicate that a certain regimen of workload and rest alternation affects not only a change in the qualitative indicators of muscle performance in a training session, but also a specific result in the development of the functional capabilities of the body.

The cited publications show that the selection of a particular workload and rest pattern provides an opportunity to purposefully influence the development of the athlete's necessary physical qualities.

III. MATERIALS AND METHODS

Nowadays the issue of the most effective workload alternation patterns in various training cycles that cause optimal response of the body, in other words, concerning the methods for the improvement of running speed and speed endurance in sprinters, remains not entirely clear. To clarify the problem, a pedagogical experiment was conducted for determining the influence of various means on sprinters' running speed and speed endurance development.

In the course of the study, the following research methods were applied: a theoretical review of scientific and methodological literature, a questionnaire survey, load characteristics record using a Polar M400 sports watch, a pedagogical experiment, and methods of mathematical statistics.

The experiment lasted for four months and included a preparatory period (September-December of 2019). The experiment involved two homogeneous groups of students of the Department of Theory and Methodology of Athletics (Lesgaft National State University of Physical Education, Sport and Health, Saint-Petersburg, Russia), majoring in short-distance running and having qualifications from the first-class runners to submaster. Each group consisted of nine persons. Both groups trained according to the general plan for training sprinters, and performed the same amount of training loads. However, the first group trained according to "A" pattern, where it was planned to rerun sections of 30, 60, 100 m from the start, and the second group trained according to "B"

pattern. “A” pattern implies that each subsequent exercise is performed in the first stage of rest, and leads to a decrease in all performance indicators from exercise to exercise. In “B” pattern each subsequent exercise is performed in the second stage of rest, which leads to an increase in muscle strength, swiftness and motor coordination, but decreases endurance. Such a training regimen can be maintained only for 3-4 repetitions of exercises (Petrovsky 1993), therefore, when it is necessary to maintain such a regimen throughout the lesson, the serial method should be applied for repeating exercises. Series of 3 to 4 repetitions should be alternated with longer rest intervals. In the preparatory period, the testees performed two workouts per week with repeated running of the above segments.

Control competitions in 100-meter and 400-meter race were held before the start and at the end of the experiment. A 100 m distance, which is widely used in sprinters’ training practice, was taken as a reference segment for evaluating speed development, and a 400 m distance was used to develop speed endurance. After a standard warm-up the testees re-ran the 100-m distance for three times at a maximum speed in “A” and “B” patterns to determine the effect of workload and rest alternation patterns on special working capacity and its qualitative indicators in a training session.

Using a 100 m distance in training provided an opportunity to determine the effect exerted by different duration intervals of rest and a different number of repetitions of the short distance running on the change in the special working capacity of runners. For “A” pattern, repeated runs of the 100 m distance were performed at the end of the phase of rapid decrease in heart rate, which coincided with the stage of working capacity restoration. A small decrease in heart rate by the time the subsequent repetition began was characteristic of this pattern. Intervals of rest between repetitions ranged within 3-4 minutes. For “B” pattern, repeated runs of the 100 m distance were performed in the phase of delayed decrease in heart rate, which coincided with a stage when working capacity exceeds the initial indicators.

The time for running the control segments was recorded using an electronic stopwatch with an accuracy of 0.01 sec. The obtained heart rate indicators were presented in various pulse zones., A Polar M400 sports watch was used for measurements (Figure 1). The watch model is equipped with a heart rate monitor and a GPS sensor.

Figure 1: Polar M400 GPS Smart Sports Watch

In the course of the pedagogical experiment, the testees performed a usual standard warm-up. After warming up, they had a rest for 5 minutes and proceeded to the main part of the training. During the training load planned by the trainer, the athletes’ heart rate was measured prior to and after repeated running of the segments, the special working capacity was determined by the time of repeated running of the segments, and controlled by the duration of the rest intervals.

The Polar Flow computer program was used for data analysis. The results obtained were processed using methods of mathematical statistics and STATGRAPHICS Plus 5.0 software product.

IV. RESULTS

As a result of the experiment, it was found that the first group of students who specialized in short-distance running, and repeatedly ran 30, 60, 100 m from the start in training sessions, improved their results on average by 0.2 sec. in 100-m races, and by 1.4 sec in the 400-m races ("A" pattern). The second group of runners, who repeatedly ran the indicated segments in their training, improved their results on average by 0.4 sec. in 100-m races and by 0.6 sec. in 400-m races ("B" pattern**)**. Changes in the studied indicator had a significant shift (P< 0.05) (table 1).

Table 1: The influence of training sessions in "A" and "B" patterns on the improvement of running speed and speed endurance

Group	Training pattern	Result in 100-m races (sec.)		Difference	P	Result in 400-m races (sec.)		Difference	P
		Before the experiment M±m	After the experiment M±m			Before the experiment M±m	After the experiment M±m		
1	"A"	11.6±0.02	11.4±0.03	+0.2	0.996	52.6±0.06	51.2±0.10	+1.4	0.999
2	"B"	11.6±0.02	11.2±0.05	+0.4	0.999	52.4±0.07	51.8±0.09	+0.6	0.999

Thus, the pedagogical experiment showed that there was a significant increase in speed endurance and a smaller increase in running speed in the group of runners who trained according to "A" pattern during repeated runs of 30, 60, 100 m sections. The group of runners, who trained according to "B" pattern in similar training sessions, demonstrated a significant increase in running speed and a smaller increase in speed endurance.

To determine the effect of the regimens alternating exercise and rest intervals on special working capacity and its qualitative indicators (HR) in a training session, the testees repeatedly ran a 100-m distance for four times at a maximum speed after a standard warm-up in "A" and "B" patterns.

"A" pattern was characterized by a small decrease in heart rate by the beginning of the next repetition of a 100-meter run. The lower limit of heart rate was 127-133 beats/min. before repeated segments, and the upper heart rate limits was 170-178 beats/min. after running. Intervals of rest between the repeated segments ranged within 3-4 minutes. With this regimen of alternating the races with rest intervals in the training session, a decrease in the qualitative indicators of working capacity was observed after the end of the rest interval (table 2) with (P< 0.05).

Table 2: The heart rate values and indicators of special working capacity in a training session ("A" pattern)

The order of 100-m races	Heart rate (beats/min.)				Running time (sec.) M±m
	Before the warm-up M±m	After the warm-up M±m	Before the experiment M±m	After the experiment M±m	
	63±2.07	158±2.07			
1			112±1.55	170±3.10	11.7±0.05
2			130±1.55	169±2.02	11.8±0.06
3			127±1.55	177±2.02	12.1±0.07
4			133±1.03	178±1.03	12.4±0.06

Changes in heart rate parameters caused by the training load did not differ from the changes described in the literature after the use of tedious training, leading to a decrease in working capacity (Clark 1985; Myakinchenko 2003)

As a result of these changes, special working capacity, which is a summarizing indicator of the functional state of the athlete's body, decreased with each subsequent performance when sprinters repeatedly run 4 x 100-m races. The average running speed of the 100-m race decreased in the testees by 0.1 sec. at the second race, by 0.3 sec. at the third race and by 0.3 sec. at the fourth race (Table 2).

For "B" pattern, the 4 x 100-m race was repeatedly run in the phase of a slow decrease in heart rate, which coincided with the stage of initial working capacity (Table 3).

Table 3: The heart rate values and indicators of special working capacity in a training session ("B" pattern)

The order of 100-m races	Heart rate (beats/min.)				Running time (sec.) M±m
	Before the warm-up M±m	After the warm-up M±m	Before the experiment M±m	After the experiment M±m	
	59±1.40	154±1.93			
1			109±1.36	175±1.94	11.8±0.09
2			105±1.94	171±1.29	11.7±0.10
3			108±1.94	170±1.94	11.8±0.08
4			110±1.36	173±2.58	11.8±0.07

Such conditions of alternating workload with rest intervals determined the nature of the pulse curve with a larger amplitude than between the highest and lowest points of its frequency than in the previous mode ("A").

The lower limit of heart rate before repeated races was kept within 105-110 beats per minute, the upper limit was 170-178 beats per minute after running. Intervals of rest between the segments of the running distances lasted 8-9 minutes.

V. DISCUSSION

Studying the influence of regimens alternating intervals of repeated 100-m races and rest on the dynamics of special working capacity, it can be noted that in training sessions according to "A" pattern with an optimal load (repeated 4 x100-m races at a maximum speed), each subsequent workload corresponded to the end of the rapid heart rate drop phase, coinciding with the stage of working capacity recovery. These results comply with the recommendations of V.V. Petrovsky (Petrovsky 1993; Yessis 1990). Moreover, the lower limit of heart rate before repeated runs was kept within 125-135 beats per minute, rest intervals took 3-4 minutes.

The specific features of "A" pattern included the repeatedly performed exercises at the stage of working capacity recovery. The studied parameters had a significant shift ($P< 0.05$). These changes resulted in the decrease in the summarizing indicator of the functional state of the athlete's body – special working capacity, which was expressed in the increased time of each subsequent run of a 100-meter distance. Based on the data of N.N. Yakovlev (1974, 1983), R.W. Fry, R. Morton and D. Keast (1991), N.I. Volkov (2001), R.K. Murray, D.K. Granner, P.A. Mayes, and V.W. Rodwell (2006), the decrease in special working capacity during training is explained by the fact that each subsequent workload was carried out in the training session after a shortened rest interval, when the athlete's working capacity has not yet returned to the initial level.

With short rest intervals between the repeated exercises, the physicochemical shifts caused by the previous workload were unable to get eliminated (Bodrov 2009). The residual effects of fatigue accumulated in the athletes' bodies and inhibited the activity of the central nervous system, which entailed a rapid decrease in special working capacity (Jacobs et al. 1987; Kuipers and Keizer 1988). Similar conditions of workload and rest alternation were not the best for the running speed improvement. A decrease in running speed with each subsequent run of the distance was the immediate result of this regimen (Fitzgerald 2014). But, at the same time, there was an adaptation of all functional systems of the body to perform speed workload in conditions of developing fatigue, and an increase in the potential of anaerobic reactions, that is, the body's ability to perform high-speed work for a long time increased.

The different dynamics of the studied indicators is observed when reducing the same workload duration, amount and intensity and alternating the same exercises with rest intervals in "B" pattern. This regimen was characterized by the repeated execution of exercises in the phase of delayed decrease in heart rate and the stage of excess working capacity coinciding with it (Jacobs et al. 1987; Gauron 1984). The lower limit of heart rate was kept within 105-110 beats per minute before the repeated runs of the distance. Intervals of rest ranged within 8-9 minutes. Such conditions of alternating workload with rest determined the nature of the pulse curve, with a greater amplitude than in the previous patterns between the highest and lowest points of its frequency. Insignificant differences were observed in changes in the heart rate parameters at the end of the training session compared to the changes after training according to ities of the body in the best possible way, which improves running speed to a greater extent and develops speed endurance to a lesser extent.

VI. CONCLUSIONS

Knowing the specifics of the influence exerted by different patterns for alternation of physical exercises with rest on the athlete's body opens up the possibility of building training schemes for coaches and athletes, and, therefore, contributes to a more focused implementation of the pedagogical process of training athletes engaged in short distance running.

The alternation of 100-meter race and rest intervals in "A" pattern in a training session leads to a decrease in special working capacity, an optimal load being 4 x 100-m races at maximum speed.

The alternation of 100-meter race and rest intervals in "B" pattern in a training session leads to an increase in special working capacity or keeps it at a certain level without decreasing by the end of the workload, an optimal load being also 4 x 100-m races at maximum speed.

Thus, the pedagogical experiment showed that there was a significant increase in speed endurance and a smaller increase in running speed demonstrated by the group of runners who applied "A" pattern during repeated 30, 60, 100-m races. The group of runners who applied "B" pattern in the similar training sessions demonstrated a significant increase in running speed and a smaller increase in speed endurance.

REFERENCES

1. Alberts B., Bray D., Lewis J., Raff M., Roberts K., Watson J.D. (2003) Molecular biology of the cell. In 3 volumes. 5th edition. Cold Spring Harbor Laboratory Press.
2. Berezov T.T., and Korovkin B.F. (2002) Biological chemistry. Moscow: Medicine.
3. Bergeron, G. (1982) Therapeutic massage. Canadian Athletic Therapist Association Journal. Summer, 15-17.
4. Bodrov V.A. (2009) Professional fatigue: Fundamental and applied problems. Moscow: Institute of Psychology RAS
5. Bompa, T., and Buzzichelli C.A. (2015) Periodization training for sports. Human Kinetics, Inc.
6. Bonen, A., and Belcastro, A.A (1977) Physiological rationale for active recovery exercise. Canadian Journal of Applied Sports Sciences, 2, 63-64.
7. Cinque, C. (1989) Massage for cyclists: The winning touch? The Physician and Sportsmedicine 17 (10), 167-70, doi: 10.1080/00913847.1989.11709899.
8. Clark, N. (1985) Recovering from exhaustive workouts. National Strength and Conditioning Association Journal, 6(6), 36-37.
9. Elfimov I.T. (Ed.) (1972) Collection of scientific and methodological papers on physical education of students. Department of Physical Education and Sports. Moscow: M.V. Lomonosov se Moscow State University Press.
10. Elliott W.H., and Elliott D.C. (2009) Biochemistry and Molecular Biology. 2nd edition. Oxford University Press
11. Ermolov Yu.V., Zavarzin V.A., Ushakov A.G. (2009) Features of training loads in the preparation of athletes. Omsk Scientific Bulletin, 2, 45-56.
12. Fahey, T.D. (1992) How to cope with muscle soreness. Powerlifting, 15(7), 10-11.

13. Fitzgerald, M. (2014) 80/20 Running. Run Stronger and Race Faster by Training Slower. Berkley.
14. Fox, E.L., Bowes, R.W., and Foss, M.L. (1989) The physiological basis of physical education and athletics. Dubuque, IA: Brown.
15. Fry, R.W., Morton, R., and Keast, D. (1991) Overtraining in athletics. Sports Medicine, 2(1), 32-65.
16. Gaffar, V., Yuniawati, Y., Ridwanudin, O. (2019) A Study of Outdoor Recreation Motivation and Activity Preferences. Journal of Southwest Jiaotong University, 54(3). http://jsju.org/index.php/journal/article/view/297
17. Gauron, E.F. (1984) Mental training for peak performance. New York: Sports Science Associates.
18. Gladilina, I., Yumashev, A. V., Avdeeva, T. I., Fatkullina, A. A., & Gafiyatullina, E. A. (2018). Psychological and pedagogical aspects of increasing the educational process efficiency in a university for specialists in the field of physical education and sport. Espacios, 39(21), 11.
19. Jacobs, I., Esbornsson, M., Sylven, C., Holm, I., and Jansson, E. (1987) Sprint training effects on muscle myoglobin, enzymes, fibre types, and blood lactate. Medicine and Science in Sports and Exercise, 19 (4), 368-374.
20. Kuipers, H., and Keizer, H.A. (1988) Overtraining in elite athletes: Review and directions for the future. Sports Medicine 6, 79-92.
21. Kuramshin Yu.F. (2004) Theory and methods of physical education: A textbook, 2nd ed. Moscow: Soviet Sport.
22. Makarova G.A. (2003) Sports Medicine: A textbook. Moscow: Soviet Sport.
23. Maslennikov A., Zaiko D., Soloviev M., Vakalova L., Dmitriev I. (2019) Improvement of physical condition of football referees by athletics. Journal of Physical Education and Sports 19(1), 8-15.
24. Menshikov V.Z. and Volkov N.I. (Eds.) (1986) Biochemistry: Textbook for the institutes of physical education. Moscow: Physical Education and Sports.
25. Murray, R., Granner, D., Mayes, P., & Rodwell, V., (2006). Harper's Illustrated Biochemistry, 27 edn., New York: McGraw-Hill Medical.
26. Myakinchenko E.B. (2003) The concept of educating local endurance in cyclic sports: Author's abstract of PhD Thesis in Education: 13.00.04. Moscow: Russian State Library.
27. Nikiforov G.S. (2014) Human energy potential. Bulletin of St. Petersburg State University,16(3), 49-56.
28. Ozolin N.G. (1995) The contemporary system of sports training: a monograph. Moscow: SAAM.
29. Petrovsky V.V. (1993) Peculiarities of the development of motor rapidity in athletes-sprinters during training. Modern Olympic Sports: Abstracts of International Scientific Congress, May 10-15, 1993. Kiev: Kiev Institute of Physical Culture., pp. 173-175.
30. Platonov V.N. (2004) The system of training athletes in Olympic sports. General theory and its practical applications. Moscow: Olympic literature.
31. Proskurina I.K. (2012) Biochemistry: a textbook for students of higher educational institutions majoring in "Pedagogical Education". Moscow: Academy.
32. Volkov N.I. (2001) Biochemistry of muscle activity. Moscow: Olympic sport.
33. Volkov N.I., Nessen E.I., Osipenko A.A. (2000) Biochemistry of muscle activity. Kiev: Olympic literature.
34. Yakovlev N.N. (1974) Biochemistry of sports. Moscow: Physical Education and Sports.
35. Yakovlev N.N. (1983) Chemistry of motion. Leningrad: Nauka.
36. Yessis, M. (1990) Soviet training methods, pp. 47-56. New York: Barnes & Noble.