Individualization of Short Distance Runners Training based on Analysis of Specific Preparedness

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Keywords: Individualization of Training, Specific Training, Track and Field, Short Distance Runners, Testing and Training, Wingate Test, Tapping Test, Athlete's Specific Preparedness Profile.

Abstract: High-intensity training load in the training of short distance runners require consideration of individual features of components of their specific preparedness. The assessment of different aspects in advances sprint performers (males, age 19.9±2.1 years; the level of sports results: 60 m running – 6.8-7.1 s; 200 m running–21.0–23.0 s) through tests is under consideration. Methods: Wingate test, Tapping test, simple sensomotor reaction, 30 m running with out of blocks start, 30 m running on the move, maximum and repeated jump test. Results: Peak power, explosive power, strength endurance, speed performance and psycho physiological factors important in sprint: latent time of reaction, taps frequency, nervous system type, leg muscles composition were defined in the research. Obtained individual athlete characteristics highlight the significant differences in the structure of athletes' specific preparedness. Individual post-test recommendations were suggested.

1 INTRODUCTION

The main principles of advanced athletes' training theory are to focus on the highest possible levels of performance, in-depth specificity and individualization. For the success in sport performance it is important to identify the athlete' individual structure of preparedness, which will allow to find reserves in order to ensure the growth of sports results.

However, in sports practice during training plan development coaches often rely on the experience of elite athletes preparation, own practice and intuition in many cases without considering the individual characteristics of the athlete. This leads to inadequate training impacts that do not achieve planned results. For improving such situation it is necessary to have objective indicators and informative criteria that reflect the functional and morphological properties of the athlete and factors associated with talent identification which will allow giving an adequate assessment of the athlete. The individualization of specific training is extremely important as it is associated with sport performance demands.

The structure of the specific physical preparedness of the sprinter includes the following components: latent time of reaction, the rate and velocity of movement, peak power, speed and strength endurance, etc. For the development of each of the above listed components high intensity loadings are used (Verkhoshansky, 1985; DeWeese et al., 2015, part 2). Since the development of specific physical preparedness components of the athletes may vary considerably, inappropriate use of high-intensity loads (same for all) can provoke the exhaustion of adaptive resources (Shephard and Astrand, 2008; Myakinchenko and Seluyanov, 2009; Kenney et al., 2015; Kuznetsova et al., 2015). Therefore, it is important to plan the advanced sprint performers training taking into account the individual characteristics of their physical preparedness.

As sprint running is extremely fast it is hard to evaluate the structural components of performance without use of modern information technologies. This situation actualizes the search of informative criteria to assess the individual specific preparedness of short distance runners with the use of athletes' testing support technologies in order to provide individualization of training.

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2 ORGANIZATION AND METHODS

Research Organization. The research was conducted in Ural Federal University in 2016. Nine advanced short distance runners (males, age 19.9±2.1 years; the level of sports results: 60 m running – 6.8–7.1 s; 200 m running – 21.0–22.5 s) took part in the research. The participants of the study had more than 7 years of sport experience in track-and-field. All subjects were free of cardiovascular or any other chronic disease. The investigation conforms to the principles of the Declaration of Helsinki of the World Medical Association. Athletes had been provided with comprehensive information on the procedures, methods, benefits and possible risks involved in the study before their written consent was obtained. The study was approved by the Ural Federal University Ethics Committee.

Methods. Tests were chosen under the principle of objective assessment of essential athletes' demands of short-distance runners (Table 1).

For the assessment of psychophysiological features of athletes the hardware and software complex "Neurosoft" (Ivanovo, Russia) was used. Two tests were conducted with "Neurosoft" in the research: ***simple sensomotor reaction*** (SSMR) and Tapping test. Following indicators were defined in SSMR: average time of 30 attempts of reaction, number of signal omissions (SO) and premature reaction (PM) and functionality level (FL).

Tapping test (rapid tapping with electronic stick on electronic plate during 30 seconds) was conducted for finding of nervous processes strength by monitoring of tapping rate dynamics in every five seconds interval. Total amount of taps (TA), taps frequency, workability graph character with taps distribution in 5 seconds intervals were under consideration.

Cycling Wingate test was conducted with the use of the ergometer BIKE MED (TechnoGym, Italy) and Cardio Memory software V 1.0 SP3. The athlete has 30 seconds to perform the leg cycling at maximum speed with load, which is set automatically in accordance with the athlete body weight. Anaerobic power measures were obtained using leg cycling Wingate anaerobic test, and included peak power (PP, W), relative PP (W/kg), power at 15 (P_{15}, W) and 30 sec (P_{30}, W), average power (AP_{30}) and their relative values (P_{15}, W/kg, P_{30}, W/kg, AP_{30}, W/kg) and fatigue (F, %).

Maximum jump test involves the execution of a standing countermovement vertical jump with hands on hip with fixing its height. Subjects were asked to perform three attempts with a recovery interval sufficient for the realization of the maximum potential of athletes in each attempt.

Table 1: Short distance runners tests.

Specific physical preparedness components	Test	Athletes' indicators
Latent time of reaction	Simple sensomotor reaction (SSMR)	Average time of 30 attempts of reaction, number of signal omissions (SO) and premature reaction (PM), functionality level (FL)
Movement rate	Tapping test	Total amount of taps (TA), amount of taps per 5 second interval, frequency of taps in every 5 second interval, Hz, nervous processes strength
Explosive power	Maximum jump test	Vertical jump height, cm
Peak power	Cycling Wingate-тест	Peak power, W, Relative Peak power, W/kg
Speed performance	30 m running with out of blocks start, 30 m running on the move	Running time, sec
Strength endurance	Cycling Wingate-тест	Power reduction (peak power, power at 15th and 30th seconds), level of fatigue
Leg muscle composition	Repeated jump test	Vertical jump height changing

The determination of maximal jump height testing was done with video recorder camera. Between the camera and athlete transparent ruler – a sheet of plexiglass with nontransparent transverse graduations was installed (Shishkina, 2008). It allows to fix the maximum height of an athlete waist belt control marker movement. Once jump testing is complete, the video was viewed frame-by-frame on the monitor. Thus the determination of the jump height and time of peak height reaching of the waist marker were proceeded.

The repeated jump test was also used in the proposed set of short-distance runner tests to define biodynamic evaluation of muscle composition

(Shishkina, 2008). The athlete performed 40-50 maximal (all-out) standing countermovement vertical jumps from the half squat. Measuring the vertical jumps height during the test was carried out through video as in maximum jump test in our research.

The percentage indicator of slow twitch muscles content K was calculated according to a formula:

$$K = H_{30} \div H_{max} \times 100\%, \qquad (1)$$

where H_{30} – average height of the thirty first, thirty second and thirty third jumps, H_{max} – average height of the first three vertical jumps (Shishkina, 2008).

Statistical analysis was performed with the use of statistic software package Microsoft Excel. Mean value (M) and standard deviation (SD) of the used parameters were calculated.

For each studied parameter three levels were set:

- the average level with indicators being in range M± 0.5 SD;
- above the average with indicators more than M+0.5 SD;
- below the average with indicators less than M-0.5 SD (Zaciorskij, 1982).

For a holistic understanding of the level of athletes specific physical preparedness graphical representation of the data was used. To build the ***individual athlete's specific preparedness profile*** in accordance with established levels each athlete's result was rated with following points: below the average - 1, the average - 2 and above the average - 3.

3 RESULTS AND DISCUSSIONS

Speed abilities in elementary forms of their manifestation depend upon two factors: operational efficiency of neuro-motor apparatus and motor mobilization (Platonov, 2004). So to be elite sprint performer in track-and-field one must have several innate prerequisites such as excellent latent time of reaction, great amount of taps in Tapping test and muscle composition with prevalence of fast-twitch fibers, preferentially recruited while sprinting.

The testing of advanced sprint performers revealed that they had excellent (average latent time of sensomotor reaction (149.9±16.9 ms) and a large number of taps during 30 seconds (207.1±25.3 ms). When performing Tapping test the sprinters demonstrated three types of nervous system determined by E. Ilyin (1981): strong nervous system with even workability graph character (A1, A3, A8), weak when the workability graph is descending (A4, A5, A7) and intermediate (A2, A6, A9). In our research the type of athlete' nervous system (figure 1) considered as a clue to load distribution in a training session. So, strong type of nervous system is characterized by a uniform distribution of movement rate in Tapping test. Such workability is like personal "handwriting" when performing any work.

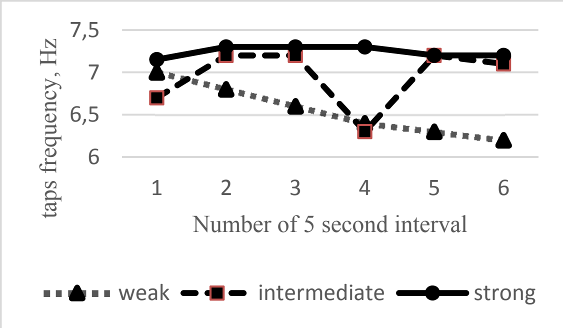


Figure 1: Tapping test workability graph of sprinters with different types of nervous system.

For athletes with strong type of nervous system the physical load can be distributed evenly in the main part of training session. An intermediate type is characterized by reduced performance in the middle of work and its restoration to baseline levels after short period of "rest" (frequency fall-off) in tapping test. So, for effective training session the physical load, especially in high-intensity programs, should be divided in two or three parts to det the most out of the workouts. In case of downward type of workability intensive work should be carried out in the first half of the training sessions.

Following important factors of achieving success in sprint is the muscle composition. Olympic Champions in sprint are characterized by a predominance of type II motor units (or fast twitch fibers), the content of which is up to 60 %. Results of repetition maximal test revealed the relatively low content of slow twitch motor units indicating the high level of potential development of power only in one athlete (A1). On the contrary athlete 9 (A9) has a high percentage of slow twitch motor units, that is a low potential in sprinting. The rest of the athletes are within the average, that means that they need corrections in the training process in favor of increasing the volume of exercises aimed at developing power or extend the competition distance length (Platonov, 2004; Seluyanov, 2007; DeWeese et al., 2015, part 1).

Wingate test results enable to work out power and speed endurance norms for advanced short-distance runners (table 2).

Table 2: The results of advanced sprint performers testing and levels norms.

Parameters	Athletes' indicators	M ± SD	Levels (points)		
			Above the average (3)	The average (2)	Below the average (1)
Latent time of reaction	Average time of 30 attempts of reaction, ms	143.6±12.8	<137.2	137.2–150.0	>150.0
Movement rate	Total amount of taps, times	207.1±25.2	>219.7	194.5–219.7	<194.5
Explosive power	Vertical jump height, cm	52.2±3.7	>54.05	50.3–54.1	<50.3
Peak power	Peak power, W	861.0±84.0	>903.0	819.0–903.0	<819.0
	Relative Peak power, W/kg	11.9±1.3	>12.55	11.25–12.55	<11.25
Speed performance	30 m running with out of blocks start, s	3.7±0.1	<3.65	3.65–3.75	>3.75
Strength endurance	Level of fatigue in Wingate test, c.u.	36.7±5.9	<33.75	33.75–39.65	>39.65

Table 3: Short-distance runners levels of specific physical preparedness components on completion of testing.

Specific physical preparedness components	Athletes, points								
	A1	A2	A3	A4	A5	A6	A7	A8	A9
Latent time of reaction	2	3	3	2	1	3	1	1	3
Movement rate	2	2	2	2	3	2	3	3	2
Explosive power	3	3	3	2	2	3	1	1	1
Peak power	1	2	2	2	1	3	1	3	2
Speed performance	1	3	3	3	1	2	1	2	1
Strength endurance	2	3	1	3	2	2	1	1	3

Comparison of individual results with norms allowed to evaluate the peak power (relative PP parameters were under consideration for final research execution, that is of athletes specific preparedness athletes specific preparedness structure design) and strength endurance by degree of fatigue, calculated by Cardio Memory software of the ergometer BIKE MED by TechnoGym.

Analyzing the obtained results, it can be noted that two athletes have above the average level of absolute peak power (A2, A3) and two athletes are the leaders in relative power (A6, A8). For athletes with below average level of PP (A1, A5, A7) at first it is recommended to provide hypertrophy through a higher volume of exercise with an intensity of 60-80% of the 1 RM (DeWeese et al., 2015, part 2).

The level of strength endurance above the average observed in three athletes (A2, A4, A9) and three athletes (A3, A7, A8) are below the average. The last sprinters are recommended to increase the share of maximal intensity short sprint with duration not more than 3-5 seconds (Seluyanov, 2007).

Assessment of explosive power showed a high level of four athletes (A1, A2, A3, A6) and the relatively low level of explosive power in athletes (A7, A8, A9). The latter athletes group should emphasize on heavy load (90-100%) in strength training.

Summary table with individual athlete characteristics (table 3) of advanced short-distance runners highlight the significant differences in the structure of athletes specific preparedness, their strengths and weaknesses. So, athletes show close sports results due to their advantages in various components. At the same time athletes have lagging components. It is obviously that low level of some components development is compensated by other components excellence. All this confirms the sharp necessity of training process individualization of the athletes.

The athletes profiles (figure 2) contain innate aspects which is hardly improving through training (time of reaction and rate of movement in tapping test) and two physiologically different and developing in training components: strength and power related and endurance. Speed performance serves a detector of optimal carryover of strength and power to running performance: if a sprinter have higher level in strength and power development and below the average level of speed performance (for example, A6), then the possible reason of this discordance is poor running technique of the athlete.

Table 4 presents examples of athlete specific preparedness profiles and recommendations in accordance with individual athlete characteristics.

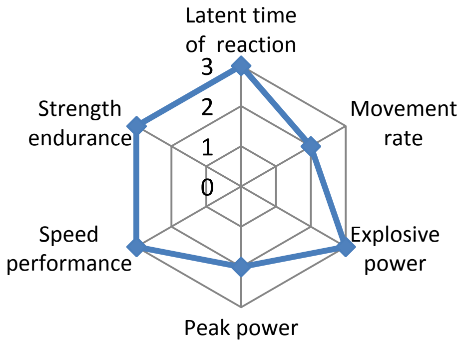
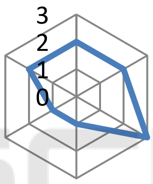
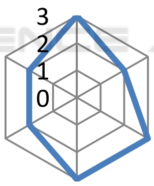
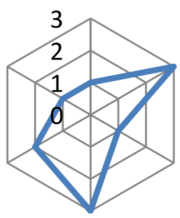
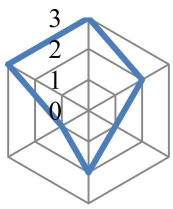


Figure 2: The individual athlete's specific preparedness profile (A2).

Table 4: Recommendations for individualization of sprinter training.

Athlete	Athlete's specific preparedness profile	Recommendations for individualization of sprinter training		
		Power and strength development	Strength endurance improvement	Comments and suggestions
A1		For peak power twice per week hypertrophy training with 60 -80 % of 1 RM. Then specific track-and-field power training with exercises for quick production of high levels of force.	Short "all-out" sprint (30-50 m). 20-30 reps may be divided in 3 sets.	High intensity load may be distributed evenly in core of training session (strong nervous system). Take a shot at length or high jumping. Pay attention to running technique.
A6		No need of power or strength development.	Short "all-out" sprint (30-50 m). 20-30 reps may be divided in 3 sets. Strength training (bodybuilding, weightlifting, resistance training): low intensity (25 RM)-high volume.	High-intensity training session should be divided in two or three parts because of intermediate type of athlete 6 nervous system. Select effective specfic running exercises for running technique improvement.
A8		For explosive power development high intensity (90-100%) or 1-3 RM weightlifting exercises, plyometric training, power training.	Short "all-out" sprint (30-50 m). 20-30 reps may be divided in 3 sets. Strength training (bodybuilding, weightlifting, resistance training): low intensity (25 RM)-high volume.	High intensity load may be distributed evenly in core of training session (strong nervous system). Above the average movement rate and peak power permit central nervous system to keep up the pace in sprint competition but muscle strength endurance is A8 weakness.
A9		For explosive power development high intensity (90-100%) or 1-3 RM weightlifting exercises, plyometric training, power training. Provide leg muscles hypertrophy with 60 -80 % of 1 RM.		High-intensity training session should be divided in two or three parts because of intermediate type of athlete 9 nervous system. Low percentage of fast twitch motor units causes the lack of power, strength and speed. A9 may consider running distance extension.

Recommendations are separated into two differently directed blocks‒strength and endurance development (table 4). This separation allows the coach to emphasize on the various types of fitness development using block periodization, that is effective in advanced and elite athletes (Verkoshansky, 1985; Issurin, 2010; DeWeese et al., 2015, part 2).

In case of identifying below the average components of the specific preparedness (for example, poor explosive power, peak power and strength endurance, etc) it is necessary to increase the volume of exercise focused on stressed development of appropriate qualities in the training process (in micro- and mesocycles).

4 CONCLUSIONS

1. For individualization of short distance runners specific physical training one should take into account athlete's innate features and power, speed and strength endurance development levels.

2. Testing of advanced short distance runners with the help of sport science technologies revealed that similar level of short distance running results is achieved through different athletes' phycho-physiological features and physical fitness level. Thus, individual profile of specific preparedness varies greatly.

3. The short distance runners tests under consideration in the research allowed to identify the weaknesses of the athletes and suggest adequate corrections to the content of the training process.

4. The type of sprinter's nervous system obtained from Tapping test may be used to determine the load distribution structure especially in high intensity training session.

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