Influence of increasing weights on the motor characteristics of running in track and out sprinter athletes

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Abstract

Objective of the study was to evaluate the influence of increasing load on the kinematic and ergometric characteristics of sprinters when performing a specific exercise, to identify the relationship of these characteristics with the results of competitive activity.

Methods and structure of the study. 16 male sprinters were examined, qualifications: I sports category - master of sports. The Optogait optical-electronic system, Witty electronic timing and Sprint 1080 traction device are used to record the ergometric and kinematic characteristics of running.

Results and conclusions. Biomechanical indicators of sprinters were identified that influence the efficiency of performing a competitive exercise (tempo 5 m, 30 m, V 30 m, Acc 30 m, tk 30 m). In subjects of various sports levels, the biomechanical characteristics of running are determined to a greater extent by speed abilities (tk5m; pace 5 m) rather than by strength abilities (Acc 30 m; W/kg). Qualitative differences in fatigue make it possible to increase the objectivity of assessing the state of athletes sports form.

Keywords: *control over special preparedness, kinematic, ergometric characteristics, fatigue*

Introduction. Intensification and individualization of the sports training of a highly qualified athlete cannot be realized in the absence of an objective assessment. The inclusion of control testing in the training process makes it possible to evaluate the various effects of long-term adaptation, including those that arise during delayed recovery of the athletes body [3]. Important advantages of the proposed experimental methodology are: specificity of testing, the possibility of using a testing protocol and the necessary equipment for recording and analyzing data in laboratory or field conditions [1, 2, 4].

Objective of the study was to evaluate the influence of increasing load on the kinematic and ergometric characteristics of sprinters when performing a specific exercise, to identify the relationship of these characteristics with the results of competitive activity.

Methods and structure of the study. The study was carried out on the basis of the State Institution "TsSTiSK" Moskomsport from May to September 2023, on a voluntary basis. 16 sprinters of different sports levels were examined (1st sports category - master of sports): age 20,4±1,8 years; height 178±5,82 cm; body weight 72±6,88 kg. The heterogeneity of the sample is manifested in the division into two conditional groups - athletes specializing in short and long smooth sprints. Statistical processing: Statistica Basic Academic 13,0, MS Excel 2021. Distribution estimates – Shapiro–Wilk test; correlations – Spearman rank coefficient; intergroup differences – Mann–Whitney test; statistical significance $p \leq 0.05$.

The testing protocol involved 7 runs of maximum intensity from a low start in blocks on a 30 m long rubberized track in the hall. The work-rest time cycle is 5 minutes from the moment of finishing. Registration of kinematic parameters was carried out by an Optogait electron beam measuring system and a Witty electronic timing system (Microgate). Values were record-

ed at distances of 0-5 m from the start inclusive; 5-30 m inclusive and 0–30 m.

Registration of energy characteristics (average relative power, W/kg) of running was carried out with a traction device - Sprint 1080. Each run was performed with constant resistance throughout the entire distance and increased as follows: run № 1–1 kg (zero load), № 2–2 kg, № 3–4 kg, № 4–6 kg, № 5–8 kg, № 6–10 kg, № 7–12 kg.

The information content of specific running testing was determined by identifying correlation relationships between the integral average speed indicator over the entire distance of 30 m, the average speed indicator in the first 5 m of the distance and the results of competitive activity at 100 and 200 m. The information content of running testing was determined by the correlation between the average running speed indicator 30 m and the results of the 100 and 200 m competitions.

When considering the kinematic and energy indicators characterizing the level of special preparedness of the subjects, phases (segments) and the corresponding parameters were identified: speed of running a distance of 0–5 m (exit from the starting blocks), distances of 0–30 m (starting run), distances of 5- 30 m.

The following were studied: vertical oscillation indicator (h_{5m}, cm), flight and contact indicators (tp_{5m}, tp_{30m} and tk_{5m}, tk_{30m}, s), running frequency ($tempo_{5m}$, $pace_{30m}$, sh/s), lactate concentration in capillary blood (La, mmol/l), power (25m, W/kg), running time (t_{30m}, s), running speed (V_{5m}, V_{30m}, m/s), acceleration (Acc_{30m}, m/ s^2), running stride length (L5m, L30m, cm) .

The division of the total sample was made according to the median value of the average running speed identified during testing.

Results of the study and discussion. Correlation analysis revealed low information content of the indicators of the flight phase of running with the results of competitive activity (Tables 1, 2).

It turned out that it was impossible to determine the average indicators of the running stride length, flight time and vertical oscillation height in the «distance running» and «finishing» phases for a short footage of the testing protocol. The «leaving the starting blocks» and «starting run» phases involve intense and fast pushing, which is necessary to quickly reach the maximum possible running speed. The identified differences between the correlations of CA (competitive activity) 100 and 200 meters may indicate the presence of heterogeneity in the sample.

The lack of differences between the samples in terms of the level of special preparedness (flight phase of running) is the result of athletes being included in the sample not according to the typological profile, but according to the average speed for all runs (Tables 3, 4). Moreover, each group included athletes who showed both high and low running characteristics, which were often compensated by pace and pushing force.

The use of a traction device also made it possible to evaluate changes in various running charac-

Table 1. Ergometric and kinematic testing indicators

№	Parameters	Total sample			High level athletes			Reduced level athletes		
		UQ	*Me*	*LQ*	*UQ*	*Me*	*LQ*	*UQ*	*Me*	*LQ*
1	t_{30m}, s	4,53	4,64	4,85	4,47	4,56	4,63	4,71	4,88	5,17
2	V_{5m}, m/s	4,77	4,92	5,04	4,97	5,00	5,10	4,58	4,75	4,84
3	tp_{5m}, s	0,06	0,06	0,07	0,06	0,06	0,07	0,06	0,06	0,07
4	tk_{5m}, s	0,17	0,18	0,20	0,17	0,17	0,18	0,18	0,20	0,20
5	$temp_{5m}$, w/s	3,84	4,10	4,32	4,09	4,31	4,41	3,65	3,83	4,10
6	L_{5m}, cm	102	106	108	104	107	108	102	105	107
7	h_{5m}, cm	0,50	0,55	0,67	0,51	0,55	0,61	0,49	0,58	0,69
8	25 m, W/kg	7,78	8,27	8,83	8,28	8,65	8,83	6,77	7,72	8,36
9	V_{30m}, m/s	6,53	6,81	6,95	6,91	6,97	7,16	6,23	6,52	6,66
10	Acc_{30m}, m/s^2	0,44	0,49	0,43	0,51	0,54	0,51	0,38	0,43	0,46
11	L_{30m}, cm	148	151	154	151	153	156	147	150	151
12	tp_{30m}, s	0,09	0,09	0,10	0,09	0,09	0,10	0,09	0,09	0,10
13	tk_{30m}, s	0,14	0,14	0,14	0,13	0,14	0,14	0,14	0,15	0,16
14	$temp_{30m}$, w/s	4,15	4,32	4,13	4,36	4,39	4,36	3,86	4,13	4,22
15	La, mmol/l	6,19	7,31	8,92	7,29	8,41	10,16	5,34	6,42	7,41

Legend: UQ – 1st, LQ – 3rd quartile, Me – median.

Table 2. Correlation analysis of the results of competitive activity (CA) and indicators in the experiment

№	Parameters	CA at 100 m	CA at 200 m	V_{5m}, m/s	V_{30m}, m/s
1	t_{30m}, s	0,54	0,63	0,94	- 0,97
2	V_{5m}, m/s	- 0,51	- 0,55	-	0,93
3	tp_{5m}, s	0,23*	0,29*	- 0,64	- 0,67
4	tk_{5m}, s	0,56	0,64	- 0,70	- 0,62
5	$temp_{5m}$, w/s	- 0,59	- 0,67	0,80	0,76
6	L_{5m}, cm	- 0,08*	- 0,12*	0,49*	0,51
7	h_{5m}, cm	0,22*	0,29*	- 0,56	- 0,57
8	25m, W/kg	- 0,58	- 0,62	0,61	0,62
9	V_{30m}, m/s	- 0,60	- 0,70	0,93	-
10	Acc_{30m}, m/s^2	-0,68	- 0,72	0,80	0,92
11	L_{30m}, cm	- 0,19*	- 0,25*	0,53	0,63
12	tp_{30}m, s	0,20*	0,28*	- 0,43*	- 0,44*
13	tk_{30m}, s	0,63	0,71	- 0,75	- 0,76
14	$temp_{30m}$, w/s	- 0,63	- 0,73	0,80	0,80
15	La, mmol/l	-0,37*	-0,37*	0,46*	0,55

*Legend: * – values below rcrit = 0,50.*

Table 3. Difference in indicators of athletes with high and reduced levels of special preparedness in running testing

№	Parameters	Difference of indicators (Uamp)	Difference in %
1	t_{30m}, s	8,5	7
2	V_{5m}, m/s	8,5	5
3	tp_{5m}, s	27,5**	1
4	tk_{5m}, s	10	19
5	$temp_{5m}$, w/s	10	11
6	L_{5m}, cm	28,5**	2
7	h_{5m}, cm	31,5**	4
8	25m, W/kg	15	11
9	V_{30m}, m/s	0	6
10	Acc_{30m}, m/s^2	3	20
11	L_{30m}, cm	20**	2
12	tp_{30m}, s	32**	1
13	tk_{30m}, s	6	14
14	$temp_{30m}$, w/s	8,5	5
15	La, mmol/l	15	22

*Legend: ** – no statistically significant differences*

teristics and the increase in physiological fatigue. High-level athletes demonstrated a smoother decline in ergometric and kinematic running indicators after the 7th run and over all attempts in general. At the same time, running testing was more difficult for high-level subjects: the La concentration for all testing was 8,41 mmol/liter (initial – 3,47, after the 7th run – 11,07) than for subjects with lower results: all testing – 6,42 (initial – 3,47, after the 7th run – 7,56). It is obvious that athletes of lower qualifications are not capable of achieving maximum values in physiological processes due to the level of physical fitness.

Conclusions. Biomechanical indicators of sprinters have been identified that influence the efficiency of performing a competitive exercise.

Table 4. Changes in running characteristics during testing

№	Parameters	Dynamics of characteristics between attempts 1, 3, 4, 7 (%)			
		High level athletes		Reduced level athletes	
		№ 4 (6 kg)	№ 7 (12 kg)	№ 3 (4 kg)	№ 7 (12 kg)
1	t_{30m}, s	9	21	11	27
2	V_{5m}, m/s	7	12	6	16
3	tp_{5m}, s	8	8	14	14
4	tk_{5m}, s	0	6	3	8
5	$pace_{5m}$	0	2	4	3
6	L_{5m}, cm	5	8	6	14
7	h_{5m}, cm	24↑	6↓	2↑	32↓
8	W/kg	145↑	271↑	89↑	252↑
9	V_{30m}, m/s	9	18	7	20
10	ACC_{30m}	20	41	17	56
11	L_{30m}, cm	6	14	5	18
12	tp_{30m}, s	4	9	2	12
13	tk_{30m}, s	4	10	1	17
14	$temp_{30m}$, w/s	1	3	1	5
15	La, mmol/l	68	116	43	91

Legend: ↑ – increase, ↓ – decrease in indicator by more than 5% compared to the first run.

In subjects of different athletic levels, the dependence of the biomechanical characteristics of running is determined to a greater extent by speed abilities (tk5m; tempo5m) rather than by strength abilities (Acc30m; W/kg). Qualitative differences in kinematic and physiological indicators of fatigue make it possible to increase the objectivity of assessing the state of athletes sports form.

Using this method, identification and subsequent correction of missing qualities of special preparedness allows one to increase the level of sprinters and improve competitive results.

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