CHARACTERISTICS OF THE TECHNIQUES OF SKILLED FEMALE JUNIOR ATHLETES IN 10 KM RACE WALKING

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Original scientific paper

Key words:

race walking, female junior athletes, technique kinematic characteristics

The paper presents the major kinematic characteristics of the techniques of skilled female junior athletes in 10 km race walking (n = 20, number of results – 32). Comparative analysis of athletes with different level of sports mastery has been carried out. It has been revealed that for the level of results of $\bar{x}$ = 50:29 (S = 01:14), the average velocity at distance segments constitutes 3.30 m·s^{-1} (S = 0.09), the average index of stride length is equal to 1.02 m (S = 0.03), whereas the stride frequency and support phase duration – 3.24 stride·s^{-1} (S = 0.10) and – 0.282 s (S = 0.013), respectively. The angle of foot placement was equal to 70.48º (S = 3.22), whereas that of take-off – 58.09º (S = 1.93).

INTRODUCTION

The level of the results of the winners of female world forums in race walking demonstrates constant increase. The requirements to the level of female athletes' fitness tend to increase in connection therewith, necessitating continuous improvement of training methods of not only the elite athletes at the stages of maximal realization of individual capacities and maintenance of high sports mastery but those being at preceding stages of long-term preparation as well (Matveyev, 1999; Korolev, 2005).

In this regard, of tremendous importance is the stage of specialized basic preparation involving female athletes of "junior" age, during which the foundation of technical and special fitness is laid that will further become the basis for athletic perfection of sportswomen. At the same time, one should bear in mind that the end of this stage of long-term preparation in athletes specialized in race walking is related to transition from 10-km to 20-km distance.

In addition to the above, one should keep in mind that the change of the volumes and ratio of training means at the basic stages of long-term preparation may lead to forced training process; in this regard, accentuating technical preparation improvement may create optimum prerequisites for achievement of high results in the future (Matveyev, 1999).

This necessitates the search for the new ways of improvement of technical preparation of athletes specialized in race walking, which can not but force out the detailed analysis of the competitive activity as the fundamental for further improvement of their training process.

In few studies (Tyupa, 2009; Hanley, 2013; 2014; Sovenko, Budkevich, Litvinchuk, 2014, etc.) dealing with analysis of the technique of female athletes specialized in 10 km race walking the foundations for studying this problem have been laid.

Objective of study – to determine the main kinematic characteristics of the techniques of skilled junior female 10 km race walkers.

METHODS AND ORGANIZATION OF STUDIES

The following methods were used to solve the set tasks: analysis of scientific and methodological literature, pedagogical observations, video recording with computer analysis of athletes' motor actions and methods of mathematical statistics.

Biomechanical analysis of the technique of competitive exercise execution by 20 female athletes was made on the bases of data obtained as a result of conducted video recording of Ukrainian championships in race walking held in 2015 and 2016 as well as team championship held in 2016 in Ivano-Frankovsk. Most track and field athletes participated in several competitions, that is

why the total number of sports results constituted 32. Biomechanical characteristics during competitions were determined at three distance segments: 2, 5 and 8 km.

Video image was analyzed by means of “Lumax” hardware and software complex, the main technical characteristics of which are presented in every detail in publications of the developers (Ostrovsky, 2003).

Body positions of female athletes during competitive exercise execution were recorded by “Sony DCR-SR 65” video camera at a rate of 25 frames per second followed by separation into 50 half-frames. At 2016 national championship “Sony HDR-PJ50E” video camera was used for body position recording at a rate of 50 frames per second.

In the course of study, all metrological requirements were taken into account, which made it possible to place the camera correctly and to minimize systematic and random errors. 20-link model of human body was used to digitize the kinematics of athletes’ bio-links. It should be noted that the points were plotted in distinct sequence.

RESULTS OF STUDIES AND THEIR DISCUSSION

Athletic result in race walking depends on average velocity of displacement, which, in its turn, is dependent on stride length and frequency. Therefore, determination of these characteristics and their ratio represents the basis for evaluating the technique of race walking execution (Fruktov, Travin, 1989; Bondarenko, 1993; Korolev, 2005).

In order to achieve the results of high world level in 20 km race walking the indices of female stride length and frequency while covering the competitive distance should be in the range of 1.06 – 1.19 m and 3.34 – 3.60 stride·s^{-1} (Hanley, 2014; Sovenko, 2016), respectively. At 10 km distance these indices in the best juniors constitute 1.08–1.10 m and 3.35–3.40 stride·s^{-1} (Hanley, 2013), respectively. Therefore, at similar velocity of distance covering the junior athletes demonstrate practically the same indices of stride length and frequency as the adult athletes.

It should also be taken into account that these indices and their ratio tend to vary in different athletes and mainly depend on height or rather the foot length and the degree of technical and physical fitness (Sovenko, 2016).

Let us consider the technique characteristics of the best Ukrainian juniors at the recent national championships (Table 1).

Table 1 Kinematic technique characteristics of junior female athletes in 10 km race walking (n=32)

Athlete, group	***Index***																	
	Result	Height, m	Body mass, kg	Average velocity, $m \cdot s^{-1}$	**Stride length, m**	Rear stride length, m	Flight length, m	Front stride length, m	Length of support transition, m	**Stride frequency, stride·s^{-1}**	Duration of one stride, s	Single support duration, s	Duration of absorption in single support phase, s	***Flight duration, s***	Foot placement angle, degrees	Take-off angle, degrees	***Knee joint angle during foot placement on support, degrees***	K_a
S. G.	47:10	1.64	54	3.53	1.07	0.40	0.18	0.24	0.24	3.31	0.30	0.27	0.09	0.04	72.86	55.88	179.93	0.65
D. I.	50:16	1.60	48	3.31	1.02	0.40	0.14	0.24	0.24	3.24	0.31	0.28	0.11	0.03	67.59	55.18	178.87	0.64
B. Y.	50:19	1.64	55	3.31	1.06	0.37	0.18	0.26	0.25	3.13	0.32	0.28	0.12	0.04	70.95	59.11	177.85	0.65
B. K.	50:31	1.75	56	3.30	1.02	0.37	0.14	0.25	0.25	3.24	0.31	0.28	0.11	0.03	71.90	58.87	178.48	0.58
P. K.	50:42	1.63	48	3.29	0.98	0.39	0.13	0.20	0.25	3.37	0.30	0.27	0.11	0.03	74.82	62.09	178.05	0.60
P. K.	50:47	1.63	48	3.28	0.96	0.43	0.13	0.16	0.25	3.41	0.29	0.27	0.10	0.03	75.23	57.35	177.27	0.59
K. D.	51:11	1.52	47	3.26	1.05	0.42	0.07	0.31	0.25	3.11	0.32	0.31	0.13	0.02	66.84	56.95	177.26	0.69
B. A.	51:12	1.65	52	3.26	0.99	0.37	0.14	0.24	0.24	3.30	0.30	0.29	0.12	0.02	69.54	58.68	179.98	0.60
K. D.	51:15	1.52	47	3.25	1.02	0.38	0.15	0.26	0.24	3.17	0.32	0.30	0.12	0.02	66.04	58.49	177.21	0.67
G. O.	51:29	1.66	52	3.24	1.03	0.39	0.16	0.24	0.24	3.16	0.32	0.29	0.11	0.03	69.07	58.33	178.72	0.62
I (n=10)	**50:29**	**1.62**	**50.70**	**3.30**	**1.02**	**0.39**	**0.14**	**0.24**	**0.24**	**3.24**	**0.309**	**0.282**	**0.111**	**0.026**	**70.48**	**58.09**	**178.36**	**0.63**
S	01:14	0.07	3.50	0.09	0.03	0.02	0.03	0.04	0.01	0.10	0.010	0.013	0.011	0.008	3.22	1.93	1.03	0.04
V	2.5	4.1	6.9	2.6	3.4	5.1	21.9	16.2	2.2	3.2	3.2	4.7	10.0	30.8	4.6	3.3	0.6	5.9
K. O.	51:44	1.65	56	3.22	1.01	0.40	0.17	0.19	0.25	3.17	0.32	0.28	0.12	0.03	74.31	60.00	178.33	0.62
P. K.	51:52	1.63	48	3.21	0.99	0.39	0.18	0.16	0.25	3.26	0.31	0.28	0.11	0.03	72.78	58.40	178.87	0.60
K. D.	52:22	1.52	47	3.18	1.02	0.46	0.07	0.25	0.24	3.13	0.32	0.30	0.13	0.02	69.55	55.46	178.85	0.67
B. K.	53:11	1.75	56	3.13	0.98	0.41	0.09	0.23	0.26	3.19	0.31	0.30	0.12	0.01	70.32	63.26	177.27	0.56
C.I	53:14	1.69	56	3.13	1.04	0.44	0.10	0.27	0.24	3.02	0.33	0.31	0.14	0.02	68.10	58.32	178.72	0.61
B. Y.	53:25	1.64	55	3.12	0.98	0.38	0.14	0.21	0.25	3.19	0.31	0.30	0.12	0.02	68.52	56.72	178.11	0.60
P. V.	53:54	1.64	54	3.09	1.04	0.41	0.07	0.29	0.26	2.97	0.34	0.33	0.14	0.00	69.68	57.08	176.89	0.63
Z. O.	54:35	1.62	52	3.05	0.98	0.39	0.16	0.20	0.23	3.13	0.32	0.30	0.12	0.02	72.51	60.85	179.05	0.60
D. D.	54:40	1.70	50	3.05	1.02	0.40	0.08	0.27	0.26	3.00	0.33	0.32	0.13	0.01	68.78	62.00	179.70	0.60
P. K.	55:11	1.70	56	3.02	1.00	0.38	0.16	0.21	0.26	3.03	0.33	0.32	0.13	0.01	72.68	60.29	179.91	0.59
I. V.	55:19	1.65	42	3.01	0.99	0.42	0.06	0.27	0.24	3.03	0.33	0.33	0.13	0.00	68.55	58.84	179.90	0.60
G. N.	55:19	1.61	61	3.01	0.94	0.35	0.13	0.23	0.24	3.19	0.31	0.30	0.12	0.02	67.52	57.88	179.83	0.59
C. I.	55:36	1.69	56	3.00	1.01	0.35	0.13	0.29	0.25	2.96	0.34	0.32	0.13	0.02	66.77	63.25	178.44	0.60
P. V.	55:49	1.64	54	2.99	0.96	0.38	0.08	0.26	0.24	3.11	0.32	0.30	0.13	0.02	69.73	60.00	176.24	0.59
L. E.	56:19	1.72	54	2.96	0.97	0.37	0.11	0.25	0.24	3.06	0.33	0.31	0.12	0.02	73.55	60.20	179.81	0.56
M. K.	56:44	1.68	58	2.94	0.97	0.34	0.14	0.26	0.24	3.02	0.33	0.32	0.14	0.01	74.64	61.75	182.01	0.58
G. N	56:52	1.61	61	2.93	0.93	0.43	0.05	0.21	0.24	3.14	0.32	0.31	0.13	0.01	69.59	58.46	179.58	0.58
N. A.	57:22	1.67	53	2.91	1.00	0.42	0.00	0.32	0.26	2.90	0.35	0.35	0.15	0.00	64.57	60.79	177.87	0.60
N. A	57:26	1.67	53	2.90	0.98	0.41	0.06	0.26	0.25	2.97	0.34	0.33	0.14	0.01	66.44	63.34	176.55	0.59
P. V.	57:45	1.64	51	2.89	0.99	0.48	0.00	0.27	0.24	2.91	0.34	0.34	0.14	0.00	68.00	59.18	177.08	0.60

Athlete, group	***Index***																	
	Result	Height, m	Body mass, kg	Average velocity, $m \cdot s^{-1}$	**Stride length, m**	Rear stride length, m	Flight length, m	Front stride length, m	Length of support transition, m	**Stride frequency, $stride \cdot s^{-1}$**	Duration of one stride, s	Single support duration, s	Duration of absorption in single support phase, s	***Flight duration, s***	Foot placement angle, degrees	Take-off angle, degrees	***Knee joint angle during foot placement on support, degrees***	K_a
G. K.	58:06	1.68	50	2.87	0.93	0.36	0.07	0.25	0.25	3.08	0.33	0.31	0.14	0.01	68.86	62.53	171.68	0.55
D. D.	59:46	1.70	50	2.79	0.93	0.40	0.06	0.22	0.25	2.99	0.34	0.32	0.14	0.02	69.20	62.71	179.99	0.55
II (n=22)	**55:18**	**1.66**	**53.32**	**3.02**	**0.99**	**0.40**	**0.10**	**0.24**	**0.25**	**3.07**	**0.327**	**0.312**	**0.129**	**0.015**	**69.76**	**60.06**	**178.39**	**0.59**
S	02:09	0.05	4.45	0.12	0.03	0.04	0.05	0.04	0.01	0.10	0.011	0.018	0.010	0.009	2.65	2.28	2.04	0.03
V	3.9	2.9	8.4	3.9	3.2	8.8	53.5	15.2	4.2	3.3	3.3	5.6	7.7	59.1	3.8	3.8	1.1	4.5
p*	p<0.01	p>0.05	p>0.05	p<0.01	p<0.05	p>0.05	p<0.05	p>0.05	p>0.05	p<0.01	p<0.01	p<0.01	p<0.01	p<0.01	p>0.05	p<0.05	p>0.05	p<0.05

* – Mann-Whitney criterion was used

In the course of studies the athletes were divided into two groups according to the level of results. Each group was homogeneous in terms of results, anthropometric and the main biomechanical characteristics as evidenced by the value of the coefficient of variation, which did not exceed 10 %.

Let us compare the main biomechanical characteristics of the technique of athletes with higher level of sports results (first group – the results of candidates for national team of Ukraine) and those (second group – the results of the I and the II category according to classification of Ukraine), whose level of achievements was lower at statistically significant differences ($p < 0.01$). Let us consider the factors contributing to the improvement of the level of sports results**.**

The result in race walking is directly proportional to the average velocity of displacement, which, in its turn, depends on stride length and frequency. Therefore, identification of these characteristics as well as their ratio represents the basis for assessment of the technique of race walking.

As seen in Table 1, average indices of stride length in more skilled athletes constituted 1.02 m (S = 0.03) significantly exceeding those of athletes of the second group – 0.99 m (S = 0.03) ($p < 0.05$). The same was peculiar for the values of the coefficient of utilization of anthropometric data (ratio of stride length and height), which were higher in athletes of the first group: $K_a = 0.63$ (S = 0.04). Stride frequency in the first group of athletes was significantly higher than in athletes of the second group and constituted 3.24 $stride \cdot s^{-1}$ (S = 0.10) and 3.07 $stride \cdot s^{-1}$ (S = 0.10), respectively ($p < 0.01$).

Let us consider the main constituents of stride length (Fig.1).

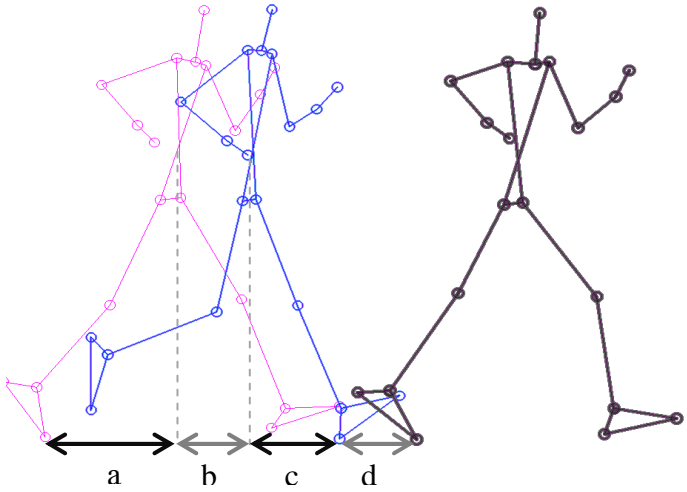

Figure 1 Measurement of stride length constituents: a – rear stride; b – flight distance; c – front stride; d – support transition (foot length)

As the Table 1 shows, stride length increase in athletes of the first group occurred at the expense of flight length $\bar{x}$ = 0.14 m (S = 0.03) at statistically significant differences between indices ($\bar{x}$ = 0.10; S = 0.05) of athletes with lower athletic results ($p < 0.05$). This being said, the flight duration in more skilled athletes constituted 0.026 s (S = 0.008) on the average, as compared to 0.015 s (S = 0.009) in athletes of the second group. Comparison of these indices with those of top-level female athletes allows to conclude that athletes of both groups have the reserves for stride length increase at the expense of flight length.

Flight length increase mainly depends on the efficiency of take-off as well. More efficient technique of take-off execution by athletes of the first group is evidenced by the index of its duration equal to $\bar{x}$ = 0.282 c (S = 0.013), being on the average 0.03 s higher than in athletes of the second group ($p < 0.01$). An important point is that the reduction of the time of take-off in these athletes mainly occurs at the expense of decrease of the time of absorption during single support phase to 0.111 s and 0.129 s in athletes of the first and the second group, respectively ($p < 0.01$). The above is indicative of the higher efficiency of force interaction with the support conditioned by respective manifestation of speed-strength capacities in the face of special endurance.

Value of take-off in athletes of the first group constituted 58.09º (S = 1.93), being lower than in athletes of the second group at statistically significant differences ($p < 0.05$), and thus, confirmed higher efficiency of interaction with the support.

Let us consider individual indices of athletes at different segments of the distance (Table 2).

Table 2 Individual kinematic characteristics of the technique of athletes at different segments of the distance (2015 championship of Ukraine, Ivano-Frankovsk)

Place	Result	Height, m	Body mass, kg	Distance segment, km	Characteristics		
					Average velocity, $m \cdot s^{-1}$	Stride length, m	Stride frequency, $stride \cdot s^{-1}$
1	47:10	1.64	54	1-3	3.58	1.07	3.33
				4-6	3.46	1.06	3.28
				7-10	3.56	1.07	3.33
2	50:16	1.60	48	1-3	3.42	1.06	3.23
				4-6	3.30	1.02	3.23
				7-10	3.26	0.99	3.28
3	50:31	1.75	56	1-3	3.42	1.06	3.23
				4-6	3.28	1.02	3.23
				7-10	3.24	0.99	3.28
4	51:12	1.65	52	1-3	3.44	1.03	3.33
				4-6	3.25	1.01	3.23
				7-10	3.15	0.95	3.33

As seen in the Table 2, the decrease of velocity in less skilled athletes at the distance was mainly due to stride length reduction. At the same time, the winner of the competitions, Anna Suslyk, having demonstrated the result of high world level (for the given age group) managed to maintain the given stride length and frequency at the whole distance. It is noteworthy that she managed to increase the velocity at the last two kilometers of the distance to 3.58 and 3.56 $m \cdot s^{-1}$, respectively.

CONCLUSION

Biomechanical characteristics of the best female junior athletes of Ukraine specialized in 10 km race walking have been analyzed. It has been revealed that for the level of results of $\bar{x}$ =50:29 (S = 01:14), the average velocity at distance segments constituted 3.30 $m \cdot s^{-1}$ (S = 0.09). Average index of stride length and frequency constituted 1.02 m (S = 0.03) and 3.24 $stride \cdot s^{-1}$ (S = 0.10), respectively. Duration of support phase was 0.282 s (S = 0.013). The angle of foot placement was equal to 70.48º (S = 3.22), whereas that of take-off – 58.09º (S = 1.93).

Further studies should be focused on determining the characteristics of force interaction with the support, which along with data presented in the paper, would allow to identify methodical approaches to be used for selection of the most efficient special and auxiliary means in the process of special fitness improvement.

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This article is an original piece and has not been previously published.

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Received: March 24, 2017
Accepted: April 28, 2017