Technique and Tactics of Elite Female Race Walkers

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ABSTRACT

The performance level and overall competitiveness in the women's 20km race walk have both increased at a particularly fast rate since the event was included in the programme of the IAAF World Championships in Athletics in 1999 and the Olympic Games in 2000. This situation means that the demands on athletes aspiring to top-level success are also increasing, necessitating in-depth analysis of the event as the basis for further improvement. The paper presents data on the variants of tactics used by the world's elite in recent years and the biomechanical characteristics of the best athletes at 2014-2016 Ukrainian national championships. Based on his analysis, the author concludes that the following methodical approaches be developed: a) optimum expansion of the volume of race walking at competitive and higher velocity with accentuation of stride length increase, 2) use of race walking at varying velocities aimed at developing the ability for gradual and sharp increases in velocity in the last segments of the race, 3) searching for and using the most efficient special and auxiliary means (of strength, speed-strength, coordination direction, etc.) aimed at a more effective take-off and enhanced hip joint mobility.

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Introduction

The performance level and overall competitiveness in the women's 20km race walk have both increased at a particularly fast rate since the event was included in the programme of the IAAF World Championships in Athletics in 1999 and the Olympic Games in 2000. The world record of 1:24:38 by Liu Hong (CHN), set in 2015, represents the sixth time the standard was lowered since 2000 and at the time this article was written the best performance from before the turn of the century sat at =136 on the world all-time list. These days, the fight for the highest places at world-level competitions often persists until the last metres of the race. For instance, at the 2016 Olympics in Rio de Janeiro Liu was only two seconds ahead of the runner-up Maria Guadalupe Gonzalez (MEX). It is also noteworthy that in that race the five athletes in the leading group came to the 18km mark (2 km before the finish line) within three seconds of each other.

This situation means that the demands on athletes aspiring to top-level success are also increasing, necessitating in-depth analysis as the basis for further improvement[1,2]. Taking into account the fact that the competition exercise of race walking[3,4,5] performed within different intensity zones is the major means used in the training process, the consideration of various other preparation aspects – technical, tactical and, above all, physical – is of tremendous importance. Methodical approaches to the improvement of technico-tactical skills and physical fitness should be substantiated on the basis of analysis of the practice of highly skilled athletes. This will permit coaches to make informed and rational selection of the most effective training means and decide on their distribution within the annual preparation structure.

There are few studies [6,7,8,9,10] aimed at preferential analysis of the technique and tactics of elite female 20km race walkers that give us a basis for addressing this challenge. This is at least partially due to the fact that the attention of the researchers has been mostly focused on the identification and establishment of specific regularities and their determining characteristics, and only to a lesser extent on finding ways to put them into practice in the training process. This indicates the need for further study.

This paper identifies and discusses two areas of concentration for athletes and their coaches wishing to improve performance in the women's 20km race walk: a) pacing and tactics and b) stride length and frequency. It is based on analysis of competition data on the world's top performers and the top Ukrainian athletes.

Methods

The following methods were used to address the set tasks: analysis of scientific and methodological literature and score-sheets, pedagogical observations, video recording with computer analysis of athletes' motor actions and statistical analysis.

Biomechanical analysis of the technique of 15 Ukrainian female 20km race walkers was made on the basis of data obtained from video recordings of Ukrainian championships held in Alushta in 2014, Sumy in 2015 and Ivano-Frankovsk in 2016. Most of the athletes participated in more than one of the competitions, which gave us total of 31 performances to analyse.

The body positions of the athletes during the 2014 and 2015 competitions were recorded by "Sony DCR-SR 65" video camera at a rate of 25 frames per second and then separated into 50 half-frames. In 2016 a "Sony HDR-PJ50E" camera recording at a rate of 50 frames per second was used. The biomechanical characteristics of the studied athletes during the competitions in 2014 were determined at three distance points: 2, 10 and 18km and during competitions held in 2015 and 2016 they were determined at four points: 5, 10, 14 and 18km. This study took into account all the metrological requirements, which made it possible to place the camera correctly and to minimise systematic and random errors.

The video images were analysed using "Lumax" hardware and software complex, the main technical characteristics of which are presented in detail in the publications of the developers[11]. A 20-link model of the human body was used to digitise the kinematics of the athletes' bio-links. It should be noted that the points were plotted in a distinct sequence.

Results and Discussion

Pacing and tactics

Performance in race walking depends on the degree of special endurance manifestation, which is determined by the ability to maintain balance between oxygen demand and uptake for a long period. This has a direct impact on the quality of the athlete's technique at any given moment.

It is known that in endurance events, the achievement of maximum possible performance depends on the maintenance of the highest average velocity for the whole distance. However, as practice shows, this tactical variant is rarely used by women race walkers at the major international competitions.

As seen in Figure 1, the variant of a relatively slow pace at the beginning of the race and an increase through to the end is common for the world's top female race walkers.

The victory of Yelena Lashmanova (RUS) may be illustrative of the above. Although 36 seconds behind Olga Kaniskina (RUS) after 14km, she managed a higher velocity in the last third of the race to win by seven seconds (Note: Kaniskina was later disqualified for a doping offense and her result was annulled). It should be stressed that Lashmanova managed to cover the final two kilometres at an average velocity of 4.12 m·s^{-1}, i.e. at a pace of 4:03 per kilometre. A similar scenario of pace increase at the end of the distance, although

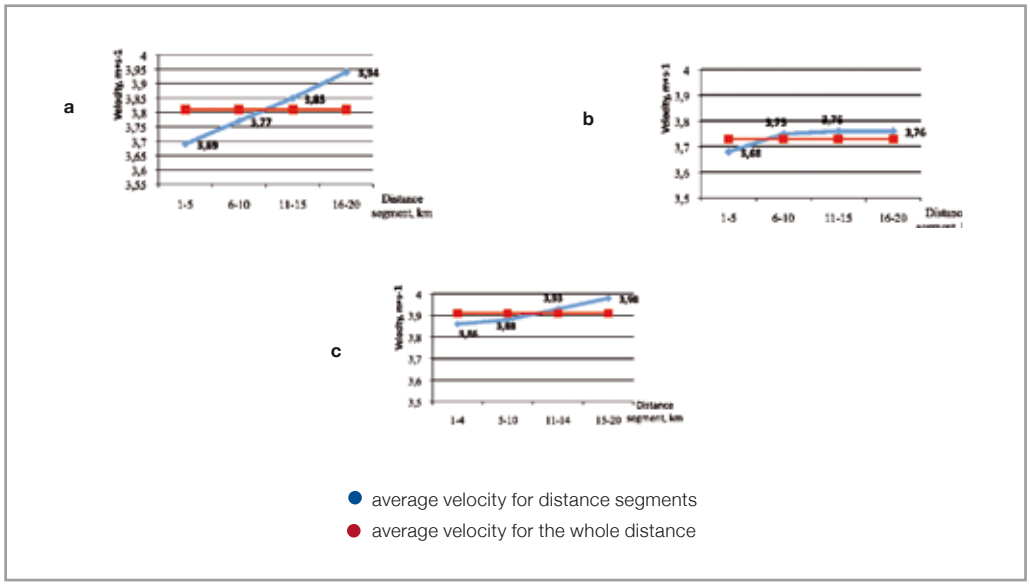

Figure 1: Dynamics of the velocity in the women's 20km race walk (n=53) (a – medallists at the 2013, 2015, 2016 World Championships in Athletics and the 2012 and 2014 IAAF World Race Walking Cups (average performance 1:27:25); b – athletes placing 4–10th at the 2013, 2015, 2016 World Championships in Athletics and the 2012 and 2014 IAAF World Race Walking Cups (average performance 1:29:19); c – medallists in 2012 Olympic Games (average performance 1:25:09

The ability to cover the second half of the distance at a velocity close to 3.9–4 m·s^{-1} is the most distinctive feature of the medallists at the IAAF World Championships in Athletics and the IAAF World Race Walking Cup (Figure 1 a) and it distinguishes them from the athletes placing fourth though 10th in the same races (Figure 1 b). Similiar tactical dynamics can be observed in medallists at the 2012 Olympic Games (Figure 1 c).

with lower initial velocities, was repeated by the winner Liu at 2016 Olympic Games in Rio de Janeiro.

We see that the tactical variant of a consistent pace from the 6th to the 20th kilometres is characteristic for athletes placing from 4th to the 10th in major international competitions (Figure 1 b) but it is obvious that in order to win or achieve medal-quality results, athletes should be ready for any tactical variant.

Another often used tactic is to draw away in the first kilometres of the race and then maintain or vary (increase or decrease) the velocity in subsequent distance segments. The Chinese athletes Liu Hong and Lu Xiuzhi did this successfully at 2015 World Championships in Athletics in Beijing to take the gold and silver medals. A similar approach is common in Ukrainian championships as well, although at lower formance level of the second group is lower, with a statistically significant difference ($p < 0.01$). Both of the groups were homogeneous in terms of results, anthropometric characteristics and the main biomechanical characteristics as evidenced by the value of the coefficient of variation, which did not exceed 10%.

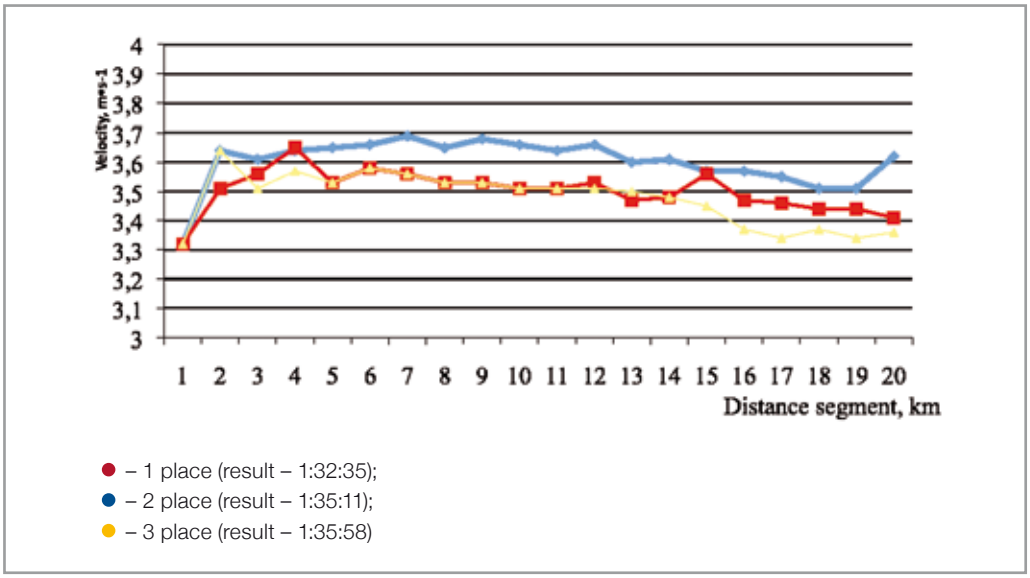

Figure 2: Velocity dynamics of the medallists in the 2015 Ukrainian Women's 20km Race Walk Championship in Ivano-Frankovsk

velocities. As seen in Figure 2, the 2015 champion had a lead of about one minute after the first half of the race and managed to increase this advantage more than twice despite a pace reduction, which was probably due to the lack of competition. At the same time, the fight for the second place began at the 14km point.

Stride length and frequency

Let us now consider the technique characteristics of the best women Ukrainian race walkers at recent national competitions. As seen in Table 1, we divided the athletes into two groups based on their level of performance (Group I (n=6) – International Masters of Sport - and Group II (n=25) - National Masters of Sport). As you would expect, the per-

Performance in race walking is directly proportional to the average velocity, which, in turn, depends on stride length and stride frequency. Therefore, identification of these characteristics as well as their ratio represents the basis for evaluation of the technique of race walking. In order to achieve world level results in the women's 20km, the indices of stride length and stride frequency should be in the range of 1.06 to 1.19m and 3.34 to 3.60 strides·s^{-1}, respectively[8.12]. These indices and their ratios will vary in the athletes depending on body height and foot length as well as the degree of technical and physical fitness. In this regard, it should be noted that athletes of both groups did not differ significantly in the main anthropometric indices – body height and mass.

As Table 1 shows, the average stride length in the more skilled athletes of Group I was 1.09m (S = 0.02), significantly exceeding that of Group II – 1.03m (S = 0.02) ($p < 0.01$). Stride frequency in Group I was slightly higher than in Group II – 3.36 strides·s^{-1} (S = 0.06) and 3.32 strides·s^{-1} (S = 0.06), respectively ($p > 0.05$). Therefore, we can say that improvement in performance mainly occurs because of stride length increase. This is confirmed by significant differences in the indices of the coefficient of utilisation of anthropometric data (ratio of stride length and height), the values of which in athletes of Group I corresponded to those of the world's best: $K_a = 0.66$ (S = 0.01)[12,13].

Turning to Figure 3 and the main constituents of stride length, Table 1 shows that the increase of stride length in the athletes of Group I occurs because of increases of rear stride length ($\bar{x}$ = 0.40m; S = 0.01) and flight ($\bar{x}$ = 0.23m; S = 0.01) with statistically significant differences to the same indices of athletes of Group II. The increase in these indices depends, to a great extent, on the efficiency of the take-off. More efficient take-off execution by the athletes of Group I is confirmed by the index of its duration $\bar{x}$ = 0.26 sec (S = 0.008), being on the average 0.011 sec greater than the athletes of Group II. An important point is that the decrease of take-off time in the Group I athletes mainly occurs because they reduce the time of absorption during single support phase to 0.096 sec as compared to 0.102 sec ($p < 0.05$) in Group II. This is indicative of a higher efficiency of force interaction, with the support conditioned by respective manifestation of speed-strength capacities and special endurance. Characteristics of Inna Kashina's technique (see Table 1 - next page; marked with light blue) during achievement of the results of different levels may serve as a confirming example.

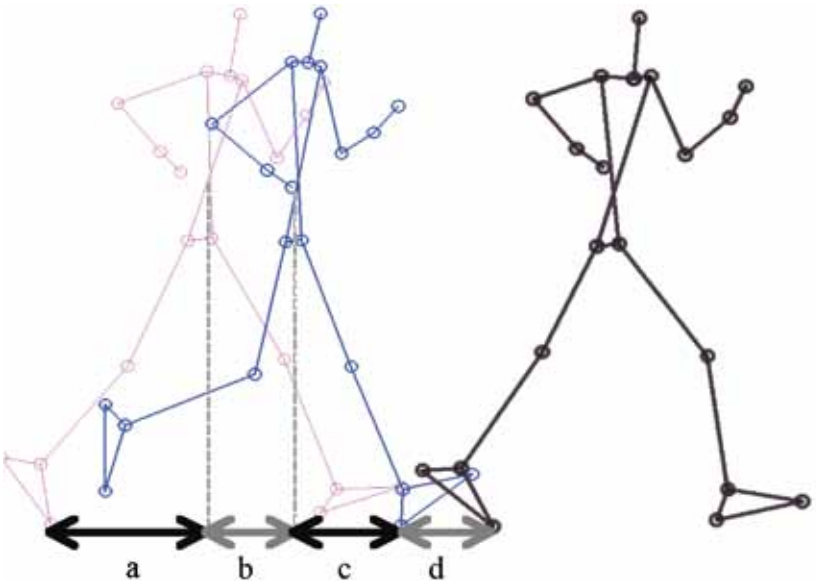

Figure 3: Measurement of stride length constituents: a – rear stride; b – flight distance; c – front stride; d – support transition (foot length);

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 ($stides \cdot s^{-1}$)**
K. I.	1:30:17	1,63	49	3.69	1.10	0.40	0.23	0.22	0.25	3.36
S. O.	1:30:41	1.60	48	3.68	1.08	0.39	0.24	0.22	0.24	3.39
B. N.	1:31:34	1.63	50	3.64	1.09	0.40	0.22	0.22	0.24	3.35
K. N.	1:32:07	1.63	49	3.62	1.06	0.40	0.24	0.17	0.25	3.42
B. N.	1:32:35	1.63	50	3.60	1.07	0.40	0.23	0.20	0.24	3.36
Y. G.	1:32:46	1.67	53	3.59	1.10	0.42	0.20	0.23	0.25	3.25
I (n=6)	1:31:40	1.63	**49.83**	**3.64**	**1.09**	**0.40**	**0.23**	**0.21**	**0.25**	**3.36**
S	*0:01:01*	*0.02*	*1.72*	*0.04*	*002*	*001*	*001*	*002*	*0.01*	*0.06*
V	*1.1*	*1.4*	*3.5*	*1.1*	*1.6*	*2.8*	*6.5*	*10.7*	*2.6*	*1.7*
Y. O.	1:34:36	1.58	45	3.52	1.04	0.39	0.21	0.21	0.24	3.39
K. I.	1:34:51	1.63	49	3.51	1.05	0.36	0.22	0.22	0.25	3.33
S. O.	1:35:11	1.60	48	3.50	1.04	0.37	0.20	0.22	0.24	3.38
V. V.	1:35:24	1.68	53	3.49	1.05	0.38	0.19	0.23	0.25	3.33
S. O.	1:35:33	1.60	48	3.49	1.06	0.39	0.22	0.21	0.24	3.29
K. I.	1:35:58	1.63	49	3.47	1.04	0.36	0.24	0.19	0.25	3.33
M. V.	1:36:17	1.65	53	3.46	1.06	0.36	0.25	0.19	0.26	3.28
M. V.	1:36:45	1.65	53	3.45	1.03	0.43	0.14	0.21	0.26	3.33
T. A.	1:37:01	1.55	43	3.44	1.00	0.36	0.22	0.18	0.24	3.43
K. N.	1:37:02	1.68	48	3.44	1.06	0.35	0.23	0.23	0.25	3.25
T. O.	1:37:28	1.70	55	3.42	1.04	0.38	0.21	0.20	0.25	3.28
Y. O.	1:37:59	1.63	49	3.40	1.02	0.38	0.21	0.20	0.24	3.33
Y. G.	1:38:01	1.67	50	3.40	1.04	0.38	0.22	0.19	0.25	3.27
Y. G.	1:38:04	1.67	50	3.40	1.05	0.40	0.14	0.26	0.25	3.25
P. M.	1:38:05	1.65	53	3.40	1.04	0.33	0.22	0.22	0.26	3.28
K. N.	1:38:15	1.68	48	3.39	1.05	0.36	0.22	0.23	0.25	3.23
M. V.	1:38:29	1.65	53	3.38	1.01	0.38	0.19	0.19	0.25	3.35
T. A.	1:38:48	1.55	43	3.37	0.96	0.34	0.22	0.16	0.24	3.51
P. R.	1:39:03	1.71	53	3.37	1.02	0.35	0.21	0.21	0.25	3.29
M. V.	1:39:34	1.65	53	3.35	1.00	0.37	0.19	0.20	0.25	3.33
K. O.	1:39:42	1.58	48	3.34	1.00	0.37	0.20	0.18	0.25	3.33
K. O.	1:40:13	1.58	48	3.33	1.00	0.36	0.20	0.19	0.25	3.33
R. K.	1:40:43	1.62	50	3.31	1.03	0.35	0.21	0.23	0.25	3.23
Y. O.	1:40:52	1.58	45	3.30	1.00	0.33	0.20	0.23	0.24	3.29
O. O.	1:40:58	1.68	59	3.30	1.00	0.39	0.14	0.21	0.26	3.31
II (n=25)	1:37:48	1.63	49.84	3.41	1.03	0.37	0.20	0.21	0.25	3.32
S	*0:01:55*	*0.05*	*3.78*	*0.07*	*0.02*	*0.02*	*0.03*	*0.02*	*0.01*	*0.06*
V	*2.0*	*2.8*	*7.6*	*2.0*	*2.4*	*5.8*	*14.0*	*10.6*	*2.3*	*1.9*
p*	p<0.01	p>0.05	p>0.05	p<0.01	p<0.01	p<0.01	p<0.05	p>0.05	p>0.05	p>0.05

Athlete, group	Index							
	Duration of one stride (sec)	Single support duration (sec)	Duration of absorption in single support phase (sec)	***Flight duration (sec)***	Foot placement angle (degrees)	Take-off angle (degrees)	***Knee joint angle during foot placement on support (degrees***	K_a
K. I.	0.30	0.26	0.09	0.04	71.20	56.79	179.05	0.67
S. O.	0.30	0.25	0.09	0.05	70.81	57.53	178.31	0.68
B. N.	0.30	0.27	0.10	0.03	70.69	57.97	179.32	0.67
K. N.	0.29	0.26	0.10	0.04	72.12	58.78	179.49	0.65
B. N.	0.30	0.27	0.09	0.03	68.45	58.17	179.98	0.66
Y. G.	0.31	0.27	0.10	0.04	70.29	56.77	178.46	0.66
I (n=6)	**0.298**	**0.260**	**0.096**	**0.039**	**70.59**	**57.67**	**179.10**	**0.66**
S	*0.005*	*0.008*	*0.004*	*0.007*	*1.22*	*0.80*	*0.63*	*0.01*
V	*1.7*	*3.2*	*3.9*	*18.4*	*1.7*	*1.4*	*0.4*	*1.6*
Y. O.	0.30	0.26	0.10	0.04	73.42	57.20	178.94	0.66
K. I.	0.30	0.27	0.08	0.03	71.16	57.09	179.39	0.65
S. O.	0.30	0.26	0.10	0.03	71.43	62.68	178.99	0.65
V. V.	0.30	0.28	0.09	0.03	70.86	58.81	178.42	0.62
S. O.	0.30	0.27	0.11	0.04	73.87	61.64	178.40	0.66
K. I.	0.30	0.27	0.10	0.03	74.71	58.09	179.43	0.64
M. V.	0.31	0.27	0.11	0.04	70.67	61.36	178.06	0.64
M. V.	0.30	0.28	0.11	0.02	72.23	59.50	178.16	0.63
T. A.	0.29	0.26	0.10	0.03	73.51	60.32	179.47	0.65
K. N.	0.31	0.27	0.10	0.04	70.71	57.95	178.60	0.63
T. O.	0.31	0.28	0.10	0.03	72.35	58.21	178.14	0.61
Y. O.	0.30	0.27	0.10	0.03	74.61	58.71	179.63	0.63
Y. G.	0.31	0.28	0.11	0.03	70.83	59.37	178.30	0.62
Y. G.	0.31	0.29	0.11	0.02	69.81	58.90	178.09	0.63
P. M.	0.31	0.28	0.11	0.03	71.40	58.78	177.32	0.63
K. N.	0.31	0.28	0.10	0.03	73.39	58.13	178.24	0.63
M. V.	0.30	0.28	0.11	0.02	75.03	61.17	178.50	0.61
T. A.	0.29	0.26	0.09	0.03	73.34	59.50	179.15	0.62
P. R.	0.30	0.28	0.11	0.02	70.75	58.34	179.69	0.60
M. V.	0.30	0.27	0.10	0.04	72.39	58.60	178.08	0.61
K. O.	0.30	0.26	0.10	0.04	72.92	59.66	178.01	0.63
K. O.	0.30	0.26	0.10	0.04	72.10	58.32	178.62	0.63
R. K.	0.31	0.28	0.11	0.03	72.36	58.50	178.74	0.63
Y. O.	0.30	0.27	0.11	0.04	69.73	60.20	179.87	0.64
O. O.	0.30	0.28	0.11	0.03	69.81	58.08	179.72	0.59
II (n=25)	**0.301**	**0.271**	**0.102**	**0.031**	**72.14**	**59.16**	**178.72**	**0.63**
S	*0.006*	*0.009*	*0.008*	*0.006*	*1.57*	*1.40*	*0.68*	*0.02*
V	*1.9*	*3.2*	*7.6*	*20.5*	*2.2*	*2.4*	*0.4*	*2.6*
p*	p>0.05	p<0.05	p<0.05	p<0.05	p<0.05	p<0.05	p>0.05	p<0.01

Table 1: Physical and technique characteristics of highly skilled Ukrainian women 20km walkers (n=31)

* – Mann-Whitney criterion was used

Table 2: Kinematic characteristics of the technique of highly skilled Ukrainian women 20km walkers in different distance segments during the 2016 Ukrainian Championships in Ivano-Frankovsk

Place	Performance	Height. (m)	Body mass. (kg)	Distance segment (km)	Characteristics		
					Average Velocity ($m \cdot s^{-1}$)	Stride length (m)	Stride frequency. ($strides \cdot s^{-1}$)
1	1:31:34	1.63	50	1-5	3.64	1.09	3.33
				6-10	3.66	1.10	3.33
				11-15	3.66	1.08	3.39
				16-20	3.61	1.08	3.33
2	1:32:07	1.63	49	1-5	3.64	1.06	3.45
				6-10	3.66	1.06	3.45
				11-15	3.65	1.06	3.45
				16-20	3.52	1.06	3.33
3	1:35:33	1.60	48	1-5	3.57	1.07	3.33
				6-10	3.57	1.07	3.33
				11-15	3.48	1.04	3.33
				16-20	3.33	1.05	3.17
4	1:36:17	1.65	53	1-5	3.57	1.07	3.33
				6-10	3.50	1.07	3.28
				11-15	3.37	1.06	3.17
				16-20	3.42	1.03	3.33
5	1:37:01	1.55	43	1-5	3.40	1.00	3.39
				6-10	3.45	1.04	3.33
				11-15	3.46	0.97	3.57
				16-20	3.42	0.99	3.45
6	1:38:01	1,6	50	1-5	3.57	1.09	3.28
				6-10	3.48	1.06	3.28
				11-15	3.33	1.03	3.23
				16-20	3.24	0.99	3.28

Stride length is also influenced by flight duration. The rules of race walking forbid a "visible (to the human eye) loss of contact" with the ground, but for most walkers there is a very brief moment in each stride where contact is lost that can only be seen using video recordings. In the more skilled athletes of Group I this flight phase of each stride is 0.008 sec longer than we see in Group II, which provides an advantage of about 3.5cm in stride length at the average competition velocity. This tendency, however, has no potential for development, as any further increase of the flight phase will result in visual detection by the judges and thus disqualification. Therefore, future studies should consider the hip joint mobility characteristics that also influence the stride length[12].

Looking at the individual indices of Ukrainian athletes in different distance segments we can see that the decrease of velocity in lesser skilled athletes is mainly due to reductions in stride length as the race progresses (Table 2).

Conclusions

Employment of the tactical variant of a relatively slow pace at the beginning of the race and gradually increasing velocity by the end is a characteristic of the world's elite women 20km race walkers. The ability to cover the second half of the distance with velocity close to 3.9–4 $m \cdot s^{-1}$ is a distinctive feature of the medallists at the IAAF World Championships in Athletics, the IAAF World Race Walking Cup and the Olympic Games. Athletes aspiring to world-class must be prepared for this approach to racing.

Increase in the performance of women's 20km race walkers to the world level (from 1:37:48 {S = 0:01:55} to 1:31:40 {S = 0:1:01}) occurs with a stride length increase to 1.09m (S = 0.02), a statistically significant difference in this indicator between the more skilled Group I athletes and those athletes (Group II) with lesser performances ($p<0.01$). Stride length increase occurs because of increases in rear stride length – $\bar{x}$ = 0.40m; S = 0.01 ($p <0.01$) and flight length – $\bar{x}$ = 0.23m; S = 0.01 ($p <0.05$). These are conditioned by a more efficient take-off, which is characterised in Group I athletes by a reduced duration of the single support phase ($\bar{x}$ = 0.26 c; S = 0.008), mainly because of a 0.096 sec shorter absorption time.

The results of the above analysis afford ground for giving high priority to the development of the following methodical approaches to the process of special fitness improvement for the women's 20km race walk:

- Optimum expansion of the volume of race walking at competitive and higher velocity with accentuation of stride length increase;
- Use of race walking at varying velocities aimed at developing the ability for gradual and sharp increases in velocity in the last segments of the race;
- Searching for and using the most efficient special and auxiliary means (of strength, speed-strength, coordination direction, etc.) aimed at a more effective take-off, enhanced hip joint mobility, etc.

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