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THE TECHNIQUE OF ELITE ATHLETES SPECIALIZED IN 50 KM RACE WALK

Purpose: to reveal trends of changing the technique of highly skilled 50 km race walkers along with the increase of sports results based on biomechanical characteristics analysis. Material and methods. Technique biomechanical analysis data of the best world and Ukrainian athletes, obtained in the course of studies at 2015–2018 national race walk championships in 50 km and 35 km distances are presented. Biomechanical characteristics of 22 highly skilled athletes (14 males and 8 females) specialized in 50 km race walk (total number of sports results 30) have been determined and analyzed. Results. Improvement of sports result in the men's 50 km race walk to the world best level occurs mainly at the expense of stride length increase 1.10 m ($p < 0.05$). Result improvement to the world level from 4:10:00 (S = 0:07:50) to 3:56:27 (S = 0:02:08) mainly occurs at the expense of stride frequency increase to 3.32 stride·s–1 (S = 0.10) at statistically significant differences with indices of the national level athletes ($p < 0.01$). It has been revealed that in females of the high national level specialized in 50 km race walk (results close to 4:31:37), the indices of stride length and frequency constitute 0.95 m (S = 0.02) and 3.22 stride·s–1 (S = 0.12), respectively. Conclusions. Comparative analysis of race walk technique kinematic characteristics of athletes of different skill levels specialized in 50 km race walk has been conducted. Prospects and directions for improving sports results of potential national team members have been revealed on the basis of comparison with the indices of national team members and elite athletes. A sharp improvement of sports results of female athletes in 50 km race walk during the last few years is noteworthy. It was due to this discipline inclusion in the program of Track

and Field World Championships.

Key words: *race walk, athletes, technique kinematic characteristics.*

Совенко Сергій. Техніка елітних спортсменів, які спеціалізуються у спортивній ходьбі на дистанції 50 км. *На основі аналізу біомеханічних характеристик виявити тенденції зміни техніки спортивної ходьби висококваліфікованих спортсменів на дистанції 50 км із підвищенням спортивних результатів. Матеріал і методи. Наведено дані біомеханічного аналізу техніки кращих спортсменів світу та України, отримані на основі вивчення виступів на національних чемпіонатах зі спортивної ходьби 2015–2018 рр. на дистанціях 50 км та 35 км. Визначено та проаналізовано біомеханічні характеристики 22 спортсменів вищої кваліфікації (14 чоловіків і 8 жінок), які спеціалізуються у спортивній ходьбі на дистанції 50 км (загальна кількість спортивних результатів 30). Результати. Поліпшення спортивного результату у спортивній ходьбі на дистанції 50 км серед чоловіків до кращого світового рівня відбувається переважно за рахунок збільшення довжини кроку до 1,10 м ($p < 0,05$). Покращення результату до світового рівня з 4:10:00 ($S = 0:07:50$) до 3:56:27 ($S = 0:02:08$) відбувається переважно за рахунок збільшення частоти кроків до 3,32 крок·с–1 ($S = 0,10$) при статистично значущий різниці з показниками спортсменів національного рівня ($p < 0,01$). Виявлено, що у жінок високого національного рівня, які спеціалізуються у спортивній ходьбі на дистанції 50 км (результати, близькі до 4:31:37), показники довжини та частоти кроку становлять 0,95 м ($S = 0,02$) та 3,22 крок·с–1 ($S = 0,12$) відповідно. Висновки. Проведено порівняльний аналіз кінематичних характеристик техніки спортивної ходьби спортсменів різного рівня кваліфікації, які спеціалізуються у спортивній ходьбі на дистанції 50 км. Виявлено перспективи та напрямки покращення спортивних результатів потенційних членів національної збірної на основі порівняння з показниками членів національної збірної та спортсменів вищого рівня. Заслуговує на увагу різке покращення спортивних результатів спортсменок у спортивній ходьбі на 50 км за останні роки. Це пов'язано із включенням цієї дисципліни до програми Чемпіонатів світу з легкої атлетики.*

Ключові слова*: спортивна ходьба, спортсмени, кінематичні характеристики техніки.*

Introduction.Race walk on the whole and at 50 km distance, in particular, is one of the most distinctive track and field events. Its main uniqueness lies in the fact that athletes are covering the distance under conditions of prolonged severe fatigue and exhaustion, manifesting will, character, concentration, mutual support, and other human qualities. Therefore, race walk competitions are often full of emotionality, dramatism, heroism, and unpredictability. The above was confirmed at the 2016 Rio de Janeiro Olympic Games with the Slovak athlete, Matej Tóth winning with the result of 3:40:58, and the first three athletes finishing within 26 seconds [17]. At the Tokyo Olympics 2021, Dawid Tomala from Poland became the winner, and the gap between him and the silver and bronze medalists was insignificant and constituted 36 and 51 seconds, respectively. At the same time, there was a stiff struggle for second and third place as five athletes came to the 45 km mark within one second.

Today, we observe the unceasing growth of contest and the level of sports results in men's competitions [13, 15], including race walk [8, 12, 16], along with intensive development of the women's 50 km race walk. In 2017, it was first included in the program of the London World Championship, and we got the first winner, Inês Henriques from Portugal, who finished with the world record of 4:05:56. Evidence of rapid growth of the results at 50 km distance is the victory of Chinese Rui Liang at the 2018 Team World Championship in Taiwan with a new world record of 4:04:36. It should be noted that this result corresponded to the men's 34th place at the competition with 59 participants. However, unlike the 2017 World Championship that numbered 7 female athletes representing 4 National Federations, the 2018 Team Championship welcomed already 32 female athletes from 15 countries, of which 29 race walkers covered the distance. It should be stressed that the general level of sports results has increased significantly, as evidenced by numerous continental, national and personal records.

In 2019, Liu Hong, the most prominent 20 km racewalker in the world from China, became the first woman ever to cover a 50-km race walk in less than four hours, finishing in 3:59:15. It should be noted that the male athletes, the prize-winners of the Olympic Games in this distance took 40 years to pass this milestone at the most prestigious competitions of our time. Bernd Kannenberg from West Germany succeeded to do this in 1972 at the Munich XX Olympic Games.

Today, more and more often at the major world and national forums for men and women, instead of 50 km, the distance of 35 km is practiced. Thus, sets of awards at this distance are contested at all official major international competitions in 2022 - the World Championships, the European Championships, and the World Team Championships.

Such a state can not but force the generalization of theoretical knowledge and data of advanced practical experience, the search for methodological approaches to improve the process of preparation of world-class athletes, who specialize in 35 and 50 km race walk.

In this regard, one of the top priorities should be the improvement of the training process of female athletes with due account for sports event specifics, female body peculiarities, and the priorities of female sport development on the whole [4, 15].

Taking into account the fact that in the training process of athletes specialized in race walk, the major means is the competitive exercise [5, 6], performed within different intensity zones, the complex consideration of various fitness aspects, tactical, technical, and physical, in particular, is of great importance. This cannot but force the detailed analysis of competitive activity tactics and technique as the basis for further improvement of their training process [1, 18, 19, 20].

In a few recent advanced studies [2, 7, 8, 9, 12] and some other researches mainly dealing with the analysis of the tactics and technique of elite race walkers, only the foundations for solving this problem have been laid.

The hypothesis of the study: analysis of the competitive activity techniques of race walkers with different levels of sports results, will further permit to substantiate the methodological approaches to improving technical skills and make a rational choice of the most efficient training means.

The objective of the study: to reveal trends of changing the technique of highly skilled 50 km race walkers along with the

increase of sports results on the basis of biomechanical characteristics analysis.

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

Participants. Biomechanical analysis of the competitive exercise techniques was made in 22 athletes of high international and national levels, specialized in 50 km race walk, including 14 men and 8 women.

Research Design. Biomechanical analysis of the technique of competitive exercise execution was made on the basis of data obtained as a result of conducted video recording of Ukrainian Championships in race walk held in 2015, 2016 (men's 50 km) and 2017, 2018 (men's 35 km, women's 50 km) in Ivano-Frankovsk and 2018 in Lutsk (women's 35 km). Some athletes participated in both disciplines, that is why the total number of sports results constituted 30 (22 and 8 in males and females, respectively). Biomechanical characteristics were determined at five distance segments: 10, 15, 25, 35 and 45 km (50 km race) and 10, 15, 25, 30 and 34 km (35 km race).

Video image was analyzed by means of "Lumax" (Ukraine) hardware and software complex, the main technical characteristics and capacities of which are presented in every detail in publications of the developers [14]. Body positions of athletes during competitive exercise execution at the championships of Ukraine in 50 km race walk were recorded by "Sony DCR-SR 65" video camera at a rate of 25 frames per second followed by separation into 50 half-frames, whereas those in 35 km race – by "Sony HDR-PJ50E" video camera at a rate of 50 frames per second. In the course of the study, all metrological requirements were taken into account, which allowed to place the camera correctly and to minimize systematic and random errors. A human body model consisting of 20 points was used to digitize the kinematics of athletes' bio-link displacements. It should be noted that the points were plotted in distinct sequences.

Data on the age and anthropometric characteristics of athletes (height and body mass) were obtained from the official website of the Athletics Federation of Ukraine, as well as during the survey at the competitions.

Statistical analysis. MS Excel licensed software was used for the analysis of findings. Indices of descriptive statistics were determined: arithmetic mean ($\bar{x}$), standard deviation (S), and coefficient of variation (V). The significance of differences in the groups was evaluated by means of the Statistica-10 program (StatSoft, USA) using the nonparametric Mann-Whitney criterion for independent samples (U), at a significance level of $p = 0.05$.

Results. Sports result in race walk depends on the degree of special endurance manifestation that directly influences tactics and technique of competitive exercise performance. It is known that in endurance events of track and field the achievement of the highest possible result depends on the maintenance of the highest average speed at the whole distance [6, 11].

Males.In the course of our studies, the athletes were divided into three groups according to the level of results. Each group was homogeneous in terms of results, anthropometric, and the main biomechanical characteristics (stride length and frequency, above all) 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 high world level of sports results (first group – the results at 35 km distance, the average speed of its covering allows to place high at the major competitions in 50 km race walk), world-class athletes (second group – the results of the international master of sports) and athletes (the third group – the results of national master of sports); the level of achievements showed statistically significant differences between groups ($p < 0.01$). It should be noted that the best athletes of Ukraine who occupy high places in international competitions at 50 km distance, mainly take part in the winter national championship (35 km race walk), which is the main qualifying competition for the World Team Championships, the World Championships, and the Olympic Games. Therefore, in determining the biomechanical characteristics of the technique, their results were used as a benchmark for other athletes. Let us consider what does contribute to the improvement of the level of sports results (Table 1; Figure 1)

Table 1

Kinematic characteristics of technique of highly skilled 50 km race walkers (males, n=22)

Athlete, group	Index																	
	Result	Height, m	Body mass, kg	Average speed		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	Ka
				m·s–1	*km·h–1*														
H. I.	*2:31:40*	*1.68*	*61*	*3.85*	*13.85*	*1.11*	*0.44*	*0.16*	*0.25*	*0.26*	*3.46*	*0.29*	*0.26*	*0.12*	*0.03*	*71.11*	*55.44*	*179.31*	*0.66*
B. I.	*2:32:23*	*1.80*	*70*	*3.83*	*13.78*	*1.12*	*0.39*	*0.25*	*0.22*	*0.27*	*3.42*	*0.29*	*0.25*	*0.12*	*0.04*	*73.51*	*57.22*	*179.09*	*0.62*
Z. M.	*2:34:56*	*1.80*	*65*	*3.77*	*13.55*	*1.09*	*0.42*	*0.15*	*0.22*	*0.30*	*3.45*	*0.29*	*0.27*	*0.12*	*0.02*	*72.50*	*57.34*	*178.68*	*0.61*
L. V.	*2:35:35*	*1.75*	*75*	*3.75*	*13.50*	*1.09*	*0.39*	*0.16*	*0.25*	*0.28*	*3.45*	*0.29*	*0.27*	*0.12*	*0.02*	*69.87*	*56.63*	*177.39*	*0.62*
*I * (n=4)*	*2:33:38*	*1.76*	*67.75*	*3.80*	*13.67*	*1.10*	*0.41*	*0.18*	*0.23*	*0.28*	*3.45*	*0.290*	*0.261*	*0.119*	*0.029*	*71.75*	*56.65*	*178.62*	*0.63*
S	*0:01:54*	*0.06*	*6.08*	*0.05*	*0.17*	*0.01*	*0.03*	*0.04*	*0.02*	*0.02*	*0.01*	*0.001*	*0.007*	*0.002*	*0.008*	*1.59*	*0.87*	*0.86*	*0.02*
V	*1.2*	*3.2*	*9.0*	*1.2*		*1.3*	*6.4*	*24.1*	*8.7*	*7.1*	*0.4*	*0.4*	*2.8*	*1.6*	*27.9*	*2.2*	*1.5*	*0.5*	*3.8*
H. A.	*3:53:04*	*1.74*	*54*	*3.58*	*12.87*	*1.03*	*0.41*	*0.16*	*0.18*	*0.28*	*3.47*	*0.29*	*0.25*	*0.10*	*0.04*	*70.71*	*63.08*	*178.39*	*0.59*
H. A.	*3:53:53*	*1.74*	*54*	*3.56*	*12.83*	*1.03*	*0.40*	*0.15*	*0.19*	*0.28*	*3.45*	*0.29*	*0.26*	*0.11*	*0.03*	*74.25*	*63.47*	*179.80*	*0.59*
S. I.	*3:55:34*	*1.79*	*63*	*3.54*	*12.74*	*1.11*	*0.43*	*0.17*	*0.24*	*0.28*	*3.17*	*0.32*	*0.30*	*0.14*	*0.02*	*73.98*	*57.36*	*179.36*	*0.62*

Athlete, group	Index																		
	Result	Height, m	Body mass, kg	Average speed		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	Ka
				m·s–1	km·h–1														
Z. M.	3:56:30	1.80	65	3.52	12.68	1.07	0.40	0.13	0.24	0.31	3.28	0.31	0.28	0.11	0.03	74.34	57.70	178.90	0.60
Z. M.	3:57:18	1.80	65	3.51	12.64	1.07	0.41	0.14	0.22	0.30	3.29	0.30	0.28	0.13	0.02	72.57	59.99	179.22	0.59
H. V.	3:57:56	1.83	67	3.50	12.61	1.07	0.40	0.14	0.26	0.27	3.28	0.31	0.28	0.13	0.02	74.64	56.68	179.96	0.58
L. V.	3:58:33	1.75	75	3.49	12.58	1.07	0.44	0.15	0.19	0.29	3.26	0.31	0.29	0.12	0.02	70.12	61.23	177.76	0.61
S. D.	3:58:49	1.79	64	3.49	12.56	1.05	0.41	0.14	0.20	0.30	3.32	0.30	0.28	0.11	0.02	74.65	54.63	178.34	0.59
II (n=8)	3:56:27	1.78	63.38	3.52	12.69	1.06	0.41	0.15	0.21	0.29	3.32	0.302	0.277	0.118	0.025	73.16	59.27	178.96	0.60
S	0:02:08	0.03	6.86	0.03	0.11	0.03	0.01	0.01	0.03	0.01	0.10	0.009	0.014	0.011	0.006	1.82	3.18	0.77	0.01
V	0.9	1.9	10.8	0.9		2.5	3.6	8.0	12.1	4.6	3.0	3.0	5.2	9.4	24.5	2.5	5.4	0.4	2.2
U	0	14.5	10.5	0		3.0	14.0	5.0	10.0	8.0	6.0	6.0	6.0	16.0	8.0	7.0	6.0	12.0	4.0
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>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p<0.05
V. O.	4:00:47	1.84	70	3.46	12.46	1.09	0.40	0.14	0.26	0.28	3.18	0.31	0.29	0.13	0.02	73.72	56.46	178.53	0.59
S. O.	4:02:33	1.74	65	3.44	12.37	1.09	0.42	0.14	0.26	0.28	3.14	0.32	0.29	0.13	0.03	72.93	54.41	179.82	0.63
S. I.	4:03:39	1.79	63	3.42	12.31	1.08	0.43	0.13	0.25	0.27	3.16	0.32	0.29	0.13	0.02	69.35	58.74	178.41	0.60
B. O.	4:04:45	1.92	80	3.40	12.26	1.06	0.37	0.15	0.25	0.29	3.23	0.31	0.29	0.14	0.02	72.49	62.86	178.44	0.55
H. V.	4:04:48	1.83	67	3.40	12.25	1.02	0.36	0.18	0.20	0.27	3.34	0.30	0.28	0.12	0.02	75.33	63.00	178.04	0.56
S. O.	4:11:15	1.74	65	3.32	11.94	1.06	0.42	0.14	0.22	0.28	3.13	0.32	0.29	0.12	0.03	71.60	55.00	180.00	0.61
R. O.	4:12:37	1.73	68	3.30	11.88	1.04	0.39	0.14	0.23	0.28	3.16	0.32	0.29	0.13	0.03	69.56	60.34	179.16	0.60
R. A.	4:17:35	1.75	60	3.24	11.65	0.99	0.38	0.12	0.21	0.27	3.27	0.31	0.29	0.12	0.02	75.35	63.62	179.41	0.57
K. S.	4:18:58	1.79	63	3.22	11.58	1.02	0.44	0.07	0.24	0.27	3.15	0.32	0.31	0.14	0.00	72.64	56.23	179.37	0.57
S. D.	4:23:04	1.79	64	3.17	11.40	1.00	0.37	0.12	0.22	0.29	3.17	0.32	0.30	0.14	0.02	70.44	60.46	177.50	0.56
III (n=10)	4:10:00	1.79	66.5	3.34	12.01	1.04	0.40	0.13	0.23	0.28	3.20	0.313	0.292	0.131	0.021	72.34	59.11	178.87	0.58
S	0:07:50	0.06	5.52	0.10	0.37	0.04	0.03	0.03	0.02	0.01	0.07	0.006	0.010	0.008	0.008	2.14	3.45	0.81	0.03
V	3.1	3.3	8.3	3.1		3.5	6.8	20.5	8.9	3.0	2.1	2.0	3.3	5.9	36.6	3.0	5.8	0.5	4.6
U	0	40.0	31.0	0		29.0	26.0	23.0	20.0	21.0	11.0	11.0	13.5	16.0	33.5	30.0	37.0	39.0	28.0
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<0.05	p<0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05
II-III (n=18)	4:03:59	1.79	65.11	3.42	12.31	1.05	0.40	0.14	0.23	0.28	3.25	0.308	0.285	0.125	0.023	72.71	59.18	178.91	0.59
S	0:09:05	0.05	6.17	0.12	0.45	0.03	0.02	0.02	0.02	0.01	0.10	0.009	0.014	0.011	0.007	1.99	3.24	0.77	0.02
V	3.7	2.7	9.5	3.6	3.6	3.2	5.7	16.2	11.1	4.1	3.1	3.0	4.9	8.9	31.3	2.7	5.5	0.4	3.8
U	0	32.0	27.0	0		5.0	31.0	8.0	30.0	24.0	6.0	6.0	6.0	17.0	17.0	24.0	20.0	28.0	8.0
p	p<0.01	p>0.05	p>0.05	p<0.01		p<0.01	p>0.05	p<0.05	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	p>0.05	p<0.05

* – the results of the first group athletes are presented in terms of 35 km distance;

** – Mann-Whitney criterion was used

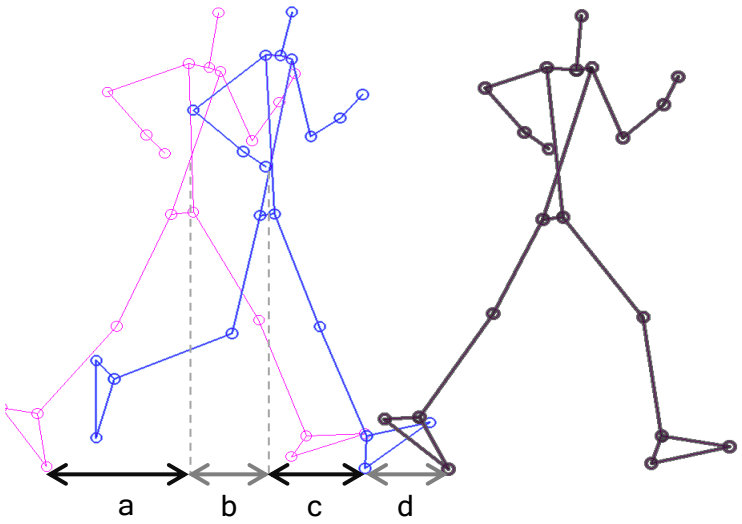

Figure 1. Measurement of stride length constituents: a – rear stride; b – flight distance; c – front stride; d – support transition (foot lengt).

The result in race walking depends on the average speed of distance covering, which, in its turn is dependent on stride length and frequency. Therefore, determining these characteristics as well as their ratio enables to assess the technique of race walking [3]. In order to achieve high results in men's 50 km race walk, the indices of stride length and frequency during distance covering should be within the range of 1.13–1.20 m and 3.30–3.34 stride·s–1, respectively [8]. These indices and their ratios tend to vary in different athletes depending, first of all, on the height or more precisely foot length as well as the degree of technical and physical fitness [17]. It should be noted in this regard that athletes of all groups did not differ in the main anthropometric indices – body length and mass ($p > 0.05$) (see Table 1).

As seen in Table 1, average indices of stride length in elite athletes constituted 1.10 m (S = 0.01) significantly exceeding those of athletes of the second group – 1.06 m (S = 0.03) ($p < 0.05$). Stride length increase occurred at the expense of flight and front stride length, although significant differences were not observed.

The values of the coefficient of anthropometric data usage (ratio of stride length to the height of athlete) were higher in athletes of the first group at statistically significant differences ($p < 0.05$) and corresponded to those peculiar for the world best race walkers Ka = 0.63 (S = 0.02). An increase of the level of sports results occurred at the expense of stride frequency, which constituted 3.45 stride·s–1 (S = 0.01) and 3.32 stride·s–1 (S = 0.10) in athletes of the first and the second group, respectively. Significant differences in indices between groups were not observed.

The difference in indices of stride length between athletes of the second and the third group constituted about 2 cm; statistical differences were not observed ($p > 0.05$). The result mainly increased at the expense of stride frequency, which was higher in athletes of the second group and constituted 3.32 stride·s–1 (S = 0.10) vs. 3.20 stride·s–1 (S = 0.07) in athletes of the third group ($p < 0.01$). Stride length increase was mainly due to decreased single support duration at the expense of reduction of the time of absorption ($p < 0.05$). The above is indicative of higher efficiency of strength interaction with the support conditioned by respective manifestation of speed and strength capacities in the face of special endurance.

There were no statistically significant differences in the indices of the take-off angle and that of foot placement on the support between the athletes of all groups, their values varied within the range of 56.65–59.27 and 71.75–73.16 °, respectively.

Comparison of technique indices of the first group athletes with total indices of the second and the third group athletes demonstrated a significant difference in almost all major kinematic characteristics.

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

Table 2

Individual kinematic characteristics of technique of race walkers at different segments of the distance (2016 and 2017 Championships of Ukraine, 35 km and 50 km distance, Ivano-Frankovsk)

Place	*Result*	*Height, m*	*Body mass, kg*	*Distance segment, km*	*Average speed, m·s–1*	*Stride length, m*	*Stride frequency, stride·s–1*
1	*2:31:40*	*1,68*	*61*	*1–10*	*3.79*	*1.10*	*3.45*
				11–15	*3.83*	*1.11*	*3.45*
				16–25	*3.89*	*1.13*	*3.45*
				26–30	*3.88*	*1.12*	*3.45*
				31–35	*3.88*	*1.10*	*3.51*
2	*2:32:23*	*1.80*	*70*	*1–10*	*3.79*	*1.06*	*3.57*
				11–15	*3.83*	*1.15*	*3.33*
				16–25	*3.89*	*1.13*	*3.45*

				26–30	*3.89*	*1.13*	*3.45*
				31–35	*3.75*	*1.12*	*3.33*
3	*2:34:56*	*1.80*	*65*	*1–10*	*3.73*	*1.04*	*3.57*
				11–15	*3.77*	*1.09*	*3.45*
				16–25	*3.76*	*1.09*	*3.45*
				26–30	*3.77*	*1.13*	*3.33*
				31–35	*3.83*	*1.11*	*3.45*
1	*3:53:04*	*1.74*	*54*	*1–10*	*3.46*	*0.99*	*3.51*
				11–15	*3.60*	*1.01*	*3.57*
				16–25	*3.61*	*1.01*	*3.57*
				26–35	*3.58*	*1.07*	*3.33*
				36–50	*3.63*	*1.07*	*3.39*
2	*3:56:30*	*1.80*	*65*	*1–10*	*3.46*	*1.04*	*3.33*
				11–15	*3.60*	*1.08*	*3.33*
				16–25	*3.61*	*1.10*	*3.28*
				26–35	*3.55*	*1.07*	*3.33*
				36–50	*3.45*	*1.10*	*3.13*
3	*3:58:33*	*1.75*	*75*	*1–10*	*3.38*	*1.06*	*3.17*
				11–15	*3.46*	*1.04*	*3.33*
				16–25	*3.51*	*1.09*	*3.23*
				26–35	*3.50*	*1.08*	*3.23*
				36–50	*3.58*	*1.08*	*3.33*

As seen in Table 2, speed gain after covering 10 km of the distance occurred mainly at the expense of stride length increase with maximum values observed until 25–30 km.

Females

Let us consider the kinematic characteristics of the technique of female 50 km race walkers of high international and national levels (Table 3).

Table 3

Kinematic characteristics of technique of highly skilled female 50 km race walkers (n=8)

Athlete*, group	Index																		
	Result	Height, m	Body mass, kg	Average speed		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 angl during foot placement on support	Ka
				m ·s–1	k m·h–1														
. A.	:04:19	.55	5	.16	1.39	.93	.36	.13	.19	.25	.42	.29	.28	.12	.02	1.03	4.12	79.69	.60
. L.	:09:03	.66	6	.09	1.11	.95	.34	.11	.24	.26	.24	.31	.30	.14	.01	4.25	6.73	78.02	.57
. M.	:12:46	.62	7	.03	0.89	.96	.36	.11	.24	.24	.15	.32	.31	.14	.01	8.58	0.11	78.83	.59
. M.	:17:23	.64	9	.96	0.64	.94	.36	.14	.18	.26	.13	.32	.31	.14	.01	4.19	0.45	79.21	.57
. V.	:18:50	.65	3	.22	1.59	.96	.40	.15	.17	.25	.34	.30	.27	.12	.03	3.51	1.49	79.41	.58

Athlete*, group	Index																	
	Result	Height, m	Body mass, kg	Average speed		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 angl during foot placement on support,	Ka
				m·s–1	k m·h–1														
. K.	:32:14	.67	8	.06	1.02	.93	.33	.13	.22	.25	.28	.31	.29	.13	.01	1.44	8.64	79.73	.56
. K.	:34:49	.62	9	.03	0.92	.97	.39	.14	.20	.25	.12	.32	.31	.14	.02	3.28	6.57	79.86	.60
. V.	:37:55	.66	4	.00	0.79	.97	.41	.12	.19	.26	.08	.33	.31	.13	.01	2.94	6.55	78.83	.59
	:31:37**	.63	1.38	.07	1.04	.95	.37	.13	.20	.25	.22	.311	.296	.131	.015	2.40	8.08	79.20	.58
		.04	.57	.09	.31	.02	.03	.01	.03	.01	.12	.011	.015	.008	.005	.94	.50	.62	.01
		.4	.9	2.8		.9	.4	1.0	3.9	.4	.7	.7	.9	.3	4.3	.7	.3	.3	.4

* – the results of the first four athletes at 35 km distance;

** – mean result of all athletes determined on the basis of their average speed of covering the distance

As Table 3 shows, the average index of stride length in highly skilled female athletes was 0.95 m (S = 0.02). The average indices of the length of rear stride, flight, front stride and support transition constituted 0.37 m (38.9 %), 0.13 m (13.7 %), 0.20 m (21.1 %) and 0.25 m (26.3 %), respectively. Judging by the level of women's results, it is not a surprise that these indices corresponded in percentage terms to those of male athletes of the national level – 38.5; 12.5; 22.1 and 26.9 %. The values of the coefficient of anthropometric data usage in female athletes were also similar to those of the above male race walkers Ka = 0.58. The same was peculiar for stride frequency – 3.22 stride·s–1. It is noteworthy that among temporal characteristics the greatest difference was observed in flight duration – 0.015 s and 0.021 s in females and males, respectively, despite its equal length (0.13 m). These high indices in females are probably achieved at the expense of less take-off angle $\bar{x}$ = 58.08 ° (59.11 ° in males) as well as greater hip mobility and lower body mass. Therefore, the results of these female athletes may be improved, first of all, through the increase of stride length at the expense of enhanced indices of both duration and length of the flight.

In general, the improvement of female results at 50 km distance should be related to the regularities revealed in men.

Let us consider individual indices of female athletes at different segments of the distance (Table 4).

As seen in Table 4, after 10 km of the distance almost all athletes decreased the speed of covering the distance segments due to reduction of stride frequency and length. The average reduction of these indices at the last segment of the distance constituted about 2.5 % of the mean value at the 30 km segment (35 km distance) and the 35 km segment (50 km distance). It is noteworthy that at 35 km distance the speed mainly declined due to a decrease of stride length (5.5 %), whereas at 50 km distance – as a result of stride frequency reduction (4.7 %).

Table 4

Individual kinematic characteristics of female race walkers technique at different segments of the distance (2017 and 2018 Championships of Ukraine, 35 km and 50 km distance, Ivano-Frankovsk, Lutsk)

Place	Result	Height, m	Body mass, kg	Distance segment, km	Average speed, m·s–1	Stride length, m	Stride frequency, stride·s–1
1	3:04:19	1,55	45	1–10	3.27	0.95	3.45
				11–15	3.27	0.90	3.64
				16–25	3.21	0.96	3.33
				26–30	3.05	0.92	3.33
				31–35	2.99	0.89	3.36
2	3:09:03	1.66	56	1–10	3.18	0.95	3.33
				11–15	3.13	0.97	3.23
				16–25	3.10	0.99	3.13
				26–30	3.04	0.93	3.28
				31–35	2.98	0.92	3.23

3	3:12:46	1.62	47	1–10	3.27	1.03	3.17
				11–15	3.15	0.98	3.23
				16–25	3.00	0.96	3.13
				26–30	2.86	0.93	3.08
				31–35	2.86	0.90	3.17
1	4:32:14	1.67	58	1–10	3.03	0.94	3.23
				11–15	3.13	0.94	3.33
				16–25	3.11	0.93	3.33
				26–35	3.12	0.92	3.39
				36–50	2.96	0.95	3.13
2	4:34:49	1.62	49	1–10	3.16	1.01	3.13
				11–15	3.11	1.00	3.13
				16–25	3.13	1.00	3.13
				26–35	2.98	0.91	3.28
				36–50	2.86	0.97	2.94
3	4:37:55	1.66	54	1–10	3.16	1.01	3.13
				11–15	3.11	1.00	3.13
				16–25	3.07	0.97	3.17
				26–35	2.94	0.97	3.03
				36–50	2.83	0.96	2.94
1	4:18:50	1.65	53	1–10	3.15	0.95	3.33
				11–15	3.17	0.95	3.33
				16–25	3.19	0.96	3.33
				26–35	3.24	0.96	3.39
				36–50	3.31	0.99	3.33

Discussion. Our findings confirm the data [8, 12] according to which to achieve the results of high world level in men's 50 km race walk, the stride length and frequency at the competitive distance should be in the range of 1.13-1.20 m and 3.30–3.34 stride·s–1, respectively. The flight duration should be within permissible levels up to 0.04 s [10].

As noted at the beginning of the article, in women this sports discipline has been developing at a rapid rate both in the world and Ukraine during the last several years, however, the studies in this area are hardly available. Therefore, in this article, the author for the first time presents the kinematic characteristics of the technique of female athletes specialized in 50 km race walk. However, this is only a small portion of factual material that will provide the basis for future studies.

In the course of studies, the kinematic characteristics of men's and women's techniques at the distance of 35 km, which is rather popular in many countries, including Ukraine, and is also used as a qualifying distance to the major world forums for track and field athletes specialized in 50 km race walk have been revealed and presented. Given that this distance was practically neglected by the researchers, these data also create new guidelines for technique, which can be used by coaches in the process of technical preparation.

The results of studies confirm the theoretical provisions [13, 15] about the tendency to the competitive activity intensification, which is characteristic of the

current development of the elite sport.The obtained data, in our opinion, have enhanced our insight [2, 8, 11, 12] into the competitive activity tactics and techniques of high international and national level athletes who specialize in race walking and created the prerequisites for further improvement of their training methods.

Conclusions. Sports result improvement in men's 50 km race walk to the highest world level occurs mainly at the expense of stride length increase at statistically significant differences from indices of athletes with lower sports results. It occurs at the expense of the increase in length and flight time at permissible levels.

In general, the improvement of female results at 50 km distance should be related to the regularities revealed in men. However, further studies are necessary to reveal the technique peculiarities of top-level female 50 km race walkers.

The primary task for further improvement of technical skills of race walkers is to determine the characteristics of strength interaction with support taking into account the individual characteristics of athletes. This will allow identifying the most effective means to increase the stride length while maintaining or increasing their frequency, especially in the last quarter of the distance.

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МОНІТОРИНГ СФОРМОВАНОСТІ КОГНІТИВНОГО КОМПОНЕНТУ ЗДОРОВ'ЯФОРМУВАЛЬНОЇ КОМПЕТЕНТНОСТІ МАЙБУТНІХ УЧИТЕЛІВ ФІЗИЧНОЇ КУЛЬТУРИ

У статті на основі аналізу та узагальнення літературних джерел визначено необхідність формування здоров'яформувальної компетентності майбутніх учителів фізичної культури. Проаналізовано різні підходи до формування ціннісного ставлення до власного здоров'я і здоров'я підростаючого покоління в умовах освітнього процесу. Мета наукової статті полягає у проведенні моніторингу сформованості когнітивного компоненту здоров'яформувальної компетентності майбутніх учителів фізичної культури. Відповідно до мети визначено такі завдання: проаналізувати дані наукової та методичної літератури щодо проблеми формування когнітивного компоненту здоров'яформувальної компетентності майбутніх учителів фізичної культури; дослідити результати сформованості когнітивного компоненту здоров'яформувальної компетентності майбутніх учителів фізичної культури. Для проведення моніторингу сформованості когнітивного компоненту здоров'яформувальної компетентності майбутніх учителів фізичної культури до впровадження здоров'яформувальних технологій у освітній процес закладів загальної середньої освіти ми використовували параметричний статистичний критерій Стьюдента.

Результати статистичної обробки даних наукового дослідження свідчать, що всі рівні сформованості когнітивного компоненту здоров'яформувальної компетентності майбутніх учителів фізичної культури на кінець