

Changes in women's 400 m hurdle run from 1978 to 2014

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A - Study Design
B - Data Collection
C - Statistical Analysis
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Abstract

Introduction: 400m hurdle run (400m H) is held on a track consisting of nine 35-meter sections separated by ten 91 cm high hurdles. Numerous analyses of the run structure carried out at major events (Olympic Games, World and European Championships) indicate that the tactics of the run consists of two parts: "stride pattern" and "split times". **Material and methods:** The exploration of spacio-temporal structure of the 400m H run included in this study is a meta-analysis, involving all major competitions that were held within the period of 36 years (from 1978 to 2014). The analysis included 260 runs from two periods of time: 1978 -1999 (Group A; n = 128) and 2000-2014 (Group B; n = 132). Detailed data included in the analysis involved temporal parameters (times of particular sections and fragments of the run) and spatial parameters (number of strides). To evaluate the differences between the groups, the analysis of variance (ANOVA) was used. **Results:** The sports performance level was similar in both groups ($53.65 \pm 0.72s$ vs. $0.83s \pm 53.60.60$). The body build was differentiated only by body mass – the female hurdlers competing after 2000 were heavier ($p \leq 0.05$). The analysis of time structure proves that modern female hurdlers cover the distance of 400 m faster in the first part ($p \leq 0.01$), and significantly decrease the running speed in the final part of the run. The number of strides in Group B is significantly lower at the beginning of the run ($p \leq 0.01$), but increases significantly in its following part. **Conclusion:** The tactics of women's 400m H run has changed after 2000. It affects indirectly changes in the training process.

Keywords: 400m hurdle run, race strategies, stride pattern, split times.

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INTRODUCTION

The 400m hurdle run is a track and field event, combining motor preparation with the difficult art of hurdle clearance [1,2,3]. The training of a 400 m hurdle runner includes all elements of athlete's preparation for the competitions - speed, strength, endurance exercises, all kinds of technical training, as well as flexibility exercises supporting the training process [4].

According to most coaches and scientists, essential for the 400 m hurdle run (400m H), is the so called "hurdle rhythm" i.e. running with the minimum loss of speed, regardless of the fatigue and clearing the subsequent hurdles [2,5,6,7]. The method of hurdle run over this distance requires use of the right and left lead leg, which is called by Polish physical culture researchers "tactics of 400m hurdle run" [8,9,10].

The sports tactics is a purposeful, rational, economical and planned way of competing, which takes into account the sports performance level, skills and capabilities, both own and those of the competitors, the track and contest's conditions, as well as provisions and regulations.

The final result in the 400m hurdle run is determined mainly by athlete's running capabilities associated with anaerobic and lactic acid effort [11,12], as well as the ability to clear hurdles, positioned every 35 m from each other around the track.

The analysis of the course of this event is based in general on the measurement of time involving nine distances between the hurdles („split time”) and assessment of the number of strides performed within the above mentioned distance sections („stride pattern”). These two English terms make up the holistic approach to sports competition in 400m hurdle run.

According to Iskra (1999, 2010, 2012, 2012b), this tactics depends on many elements - such as among others body build, motor preparation (in terms of speed, strength and endurance), and the level of coordination capacities (in this case, the hurdle clearance technique).

The hurdle run over the distance of 400m s is one of the most recently introduced women's track and field events. The first attempts to run over this distance took place during the athletic meeting in Bonn in 1971 [15], while the first attempts of (spatio-temporal) analysis of the run were performed during the contest in Edinburgh (06.16.1973), at which the Austrian hurdler Maria Sykora achieved the record-breaking result of 58.5 sec. (Matthews 2012). The systematic documentation of lap times of the run and the number of strides performed within consecutive distances between the hurdles has been carried out since 1978, when this event was included into contests held on the championship level.

The aim of the study was to evaluate the changes in women's 400m hurdle run tactics during two periods of time: from 1978 to 1999 and after 2000.

MATERIAL

The detailed parameters were obtained based on biomechanical examinations performed during the major sports events (Olympic Games, World Championships, European Championships) within two periods of time: from 1978 to 1999 and from 2000 to 2014. In total, 260 final runs (128 during the period from 2000 to 2014 and 132 within the period from 1978 to 1999) were analyzed. Subject of the research were only results achieved in final runs, with electronic timing. The details of events from which the collected data were obtained are included in Table 1. The necessary statistical data were obtained from various sources [7,17,18].

The analysis included 114 female athletes competing from 1978 on, when the first women's hurdle race over the distance of 400m was held at the European Championships in Rome, up to the European Championships held in 2014 in Zurich.

The female athletes competed 132 times during the period from 1978 to 1999, and 128 times after 2000, which makes the total number of 260 runs. The collected material is fully representative for the entire women's 400m hurdles development period.

The female hurdlers achieved results at the highest, world level, i.e. from 52.42 to 59.39 s. The details are included in Table 2.

Table 1. List of sports events at which the strategy of the women's 400 m hurdle race was evaluated.

GROUP A (1978-1999)				GROUP B (2000-2014)			
Year	OG	WC	EC	Year	OG	WC	EC
1978			X	2000	X		
1979				2001		X	
1980				2002			X
1981				2003		X	
1982			X	2004	X		
1983		X		2005		X	
1984	X			2006			X
1985				2007		X	
1986			X	2008	X		
1987		X		2009		X	
1988	X			2010			X
1989				2011		X	
1990			X	2012	X		X
1991		X		2013		X	
1992	X			2014			X
1993		X					
1994			X				
1995		X					
1996	X						
1997		X					
1998			X				
1999		X					

OG - Olympic Games, WC - World Championships, EC - European Championships

Table 2. Characteristics of the researched group of hurdlers

Parameter	Group A (n=132)	Group B (n=128)	F	p
Stature (cm)	172.38±5.44	173.25±5.60	1.32	-
Body mass (kg)	58.95±4.10	60.27±4.60	4.89	0.05
Result of 400 m hurdles (s)	53.65±0.72	53.60±0.83	0.28	-

METHOD

In order to achieve the purpose of this study, the parameters contained in Table 3 were used. In the tables, basic statistical parameters (\bar{x} ±SD) were presented. Differences between the groups were estimated based on the analysis of variance (ANOVA).

Table 3. Spacio-temporal parameters and body build components taken into account for the purpose of this study

A. Temporal parameters	
t_1	- time of covering the distance to the first hurdle,
t_2	- time of covering the distance to the second hurdle,
- t_3, \dots, t_{10}	- times covering distances to the following hurdles,
- t_{400H}	- time of the 400 m hurdle run,
- $t_4 - t_1, t_7 - t_4, t_{10} - t_7$	- times of three consecutive sections of the run
B. Spatial parameters	
- n_1	- number of strides performed during the run,
- $n_2 - n_1$	- number of strides between the first and second hurdle,
- $n_3 - n_2$	- number of strides between the third and second hurdle,
- $n_4 - n_3 \dots$	- number of strides performed at the following distances between the hurdles,
- $n_4 - n_1, n_7 - n_4, n_{10} - n_7$	- number of strides in three consecutive sections of the run
C. Body build parameters	
- stature (cm)	
- body mass (kg)	

RESULTS

The analysis of sports performance level and body build of female hurdlers specializing in running over the distance of 400 m showed that within the last period of time, the sports performance level and stature of athletes did not (statistically significantly) change (54.57 ± 1.00 and 54.58 ± 1.19 s and 172.38 ± 5.44 and 173.25 ± 5.60 cm, respectively), while at the same time their body weight changed ($p \leq 0.05$) - Table 2.

The analysis of the course of competition (running tactics) shows that the consecutive sections of the distance were covered in different ways (Table 4). The hurdlers from Group A ran the first part of the distance more slowly and were definitely faster in the final straight (hurdles 8-10). The statistically significant difference in mid-distance results (hurdle 5, $p \leq 0.05$) was compensated by athletes from Group B in the final section of the run (the difference at the finish line was not statistically significant).

Table 4. Temporal parameters in women's 400 m hurdle run

Parameter	Group A (s)	Group B (s)	F	p
t_1	6,50±0,16	6,43±0,15	6,47	0,05
t_2	10,65±0,18	10,60±0,24	2,66	-
t_3	14,84±0,22	14,86±0,32	0,63	-
t_4	19,14±0,26	19,13±0,39		-
t_5	23,74±0,39	23,50±1,08	3,93	0,05
t_6	28,02±0,31	28,17±0,54	2,59	-
t_7	32,70±0,32	32,91±0,64	3,56	-
t_8	37,55±0,40	37,88±0,77	5,58	0,05
t_9	42,54±0,44	42,96±0,88	7,07	0,01
t_{10}	47,93±0,54	48,24±1,00	11,70	0,01
T_{finish}	6,64±0,49	6,34±0,36	10,19	0,01
400H	54,57±1,00	54,58±1,19		-

Table 5. Spatial parameters (= number of strides) in women's 400 m hurdle run

Parameter	Group A	Group B	F	p
n ₁	22,88±0,68	22,38±0,76	12,03	0,01
n ₂₋₁	15,17±0,52	14,98±0,49	6,49	0,05
n ₃₋₂	15,15±0,49	14,95±0,50	7,99	0,01
n ₄₋₃	15,18±0,51	14,99±0,49	6,87	0,01
n ₅₋₄	15,19±0,52	15,03±0,51	4,88	0,05
n ₆₋₅	15,22±0,58	15,36±0,60	2,42	-
n ₇₋₆	15,37±0,63	15,67±0,66	10,09	0,01
n ₈₋₇	15,78±0,71	16,04±0,81	4,85	0,05
n ₉₋₈	16,13±0,77	16,39±0,69	5,39	0,05
n ₁₀₋₉	16,58±0,79	16,64±0,71	0,20	-
n _{finish - n₁₀}	18,80±1,77	20,03±0,81	15,62	0,01

Table 6. Spacio-temporal parameters in three consecutive sections of the women's 400 m hurdle run

Parameter	Group A	Group B	F	p
Temporal parameters (s)				
t ₄ - t ₁	12,65±0,21	12,73±0,31	1,78	-
t ₇ - t ₄	13,56±0,21	13,79±0,36	13,10	0,01
t ₁₀ - t ₇	14,95±0,41	15,31±0,48	14,74	0,01
Spatial parameters (number of strides)				
n ₄₋₁	45,50±1,48	44,91±1,43	7,86	0,01
n ₇₋₄	45,73±1,60	46,06±1,55	1,92	-
n ₁₀₋₇	48,30±2,21	48,74±3,91	0,47	-

The average values of the number of strides performed in the consecutive distances between hurdles clearly differentiate the two examined groups of female hurdlers. Compared to their predecessors, the contemporary female hurdle runners perform fewer steps in the first part of the distance (n₁, n₃₋₂, n₄₋₃ p ≤ 0,01, n₂₋₁, n₅₋₄ p ≤ 0,05) (table 5). The athletes competing up to 1999 reduced the number of strides performed in successive distances between the 6th and 8th hurdle and from the last hurdle on, before the finishing line (n₇₋₆, n_{finish - n₁₀}, p ≤ 0,01, n₈₋₇, n₉₋₈ p ≤ 0,05). In other parts of the distance, no statistically significant differences were observed (table 5).

The data in Table 6 show significant changes in the time of the run in the second and third sections of the distance (t₇ - t₄, t₁₀ - t₇, p ≤ 0,01), as well as significant change in the number of strides in the first portion of the distance from the 1st to 4th hurdle (n₄₋₁, p ≤ 0,01).

DISCUSSION

Lack of significant differences regarding the results achieved within the two periods of the women's 400 m hurdle run development is not equivalent to stagnation. In the years 1978-1999, the best results were achieved at this distance during major events (Olympic Games, World Championships and European Championships), which impacted the results of the analysis [15].

After 2000, the final runs winners presented a higher performance level, and athletes from more distant places achieved poorer results [19]. The analysis of body build shows changes of somatic nature of the runners. Increased body mass is certainly related to the changes in training methods, taking into account a greater emphasis on the strength preparation. Such trends feature now many coaches [6,20].

The time structure of the run is in opinion of many authors the basic component of 400 m hurdle run tactics [1,2,20]. Changes in this area are significant from statistical point of view (Table 3). Faster start of the run is the evidence of strength and speed preparation [20], which confirms the earlier considerations on body weight. The strength and speed type female hurdlers cover the first part of the distance faster, which is also confirmed by the analysis of Group B (parameter t_5 ; Table 4). Greater endurance opportunities of athletes from Group A are probably related to body build and the tendency in the 70s and 80s to treat the distance of 400 m hurdles as strictly related to 800 m run [21].

The spatial structure, i.e. the number of strides performed in the following distances between the hurdles is closely associated with increasing fatigue and reduced stride length [1,18,22,23].

The data contained in Table 4 indicate these connections. The hurdlers competing in the 21st century begin the run faster by performing fewer strides. Later in the distance, they become weaker and significantly increase the number of strides.

The analysis of two groups of female hurdlers, whose level of results is not differentiated, indicates two ways of training the runners at the highest sports performance level. According to the first method, during selection of future female hurdlers, the coaching staff pays special attention to slimmer runners with endurance capacities. In the second training concept, which is more popular nowadays, the decisive factor is speed and strength preparation of runners with a strong body build.

Both training concepts pursue the same aim with regard to endurance and speed abilities - development of anaerobic capacities that make it possible to effectively continue the run over the entire distance provided that the runners feature a high lactate level [11].

The current trends in training both male and female 400 m hurdle runners pursue that aim with regard to speed exercises [6,24].

CONCLUSIONS

1. While the sports performance level does not change, in the last period of time the 400 m runners have a stronger body build
2. The evaluation of the spacio-temporal structure in women's 400 m hurdle run aims at a faster covering the first part of the distance, with decreasing stride length and running speed after the fifth hurdle.
3. The observed changes are closely related to changes in the concept of training - from strength to the speed and endurance concept.

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