



BIOMECHANICAL ANALYSIS OF THE MEN’S 400 M HURDLES AT THE IAAF WORLD ATHLETICS CHAMPIONSHIPS DOHA 2019: RHYTHMIC STRUCTURE AND EFFORT DISTRIBUTION.

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INTRODUCTION

The 400 m hurdles race is a rhythmic sprinting event. Speed and speed endurance are basic requirements, but the ability to express these in a rhythmic pattern is more important. Then, race distribution and rhythmic structure are for a successful in this event (1). There have been numerous studies of the 400 m hurdles over the last few years. However, the 400 m hurdles race is an athletic discipline rarely subjected to official individual biomechanical study at World Championships or Olympic Games (2,3,4).

RESULTS

Related to the stride patterns or rhythmic structures, uniformity is non-existent and most patterns are individual (one-person). Most of the athletes do not repeat stride patterns from one round to the next. And no finalist repeated the number of strides between hurdles throughout the 3 races. This may be due to the use of different strategies according to the necessities of each race, or because the stride pattern is not yet assumed.

92.75 % of athletes execute at least one change of stride pattern during the race. As usual in men races of 400 m hurdles, the first change is mostly carried out at the 7th hurdle. Although among the finalist, the first change is preferably delayed to the last two hurdles or no change take place.

Although it is preferable to lead with the left leg at hurdles on a curve (hurdles 1, 2, 6, 7 and 8), only 3 athletes from the final attack those 5 five hurdles with their left leg, and 2 attack all with their right. In the total sample, 64.28 % attack hurdles on a curve with their left leg.

22 different rhythmic structures have been found in heats, 13 in the semi-finals (including 5 new ones) and 6 in the final (including 1 new one). None of the finalists repeats rhythmic structure in the disputed races. Moreover, the athletes who ran the fewest steps in the total race achieved better results (Rxy .577, p<.001).

Related to the distribution of the effort, the best athletes are the ones with the lowest speed losses after the fifth hurdle, have the smallest time difference between fastest and slowest interval, and less time wasted before the change of rhythmic structure in each section. A correlation curve between the time between hurdles and the final time has been found in the total of the sample, being the highest in the fifth rhythmic unit, between hurdles 5 and 6 (Rxy .823,p<.001).

METHODS

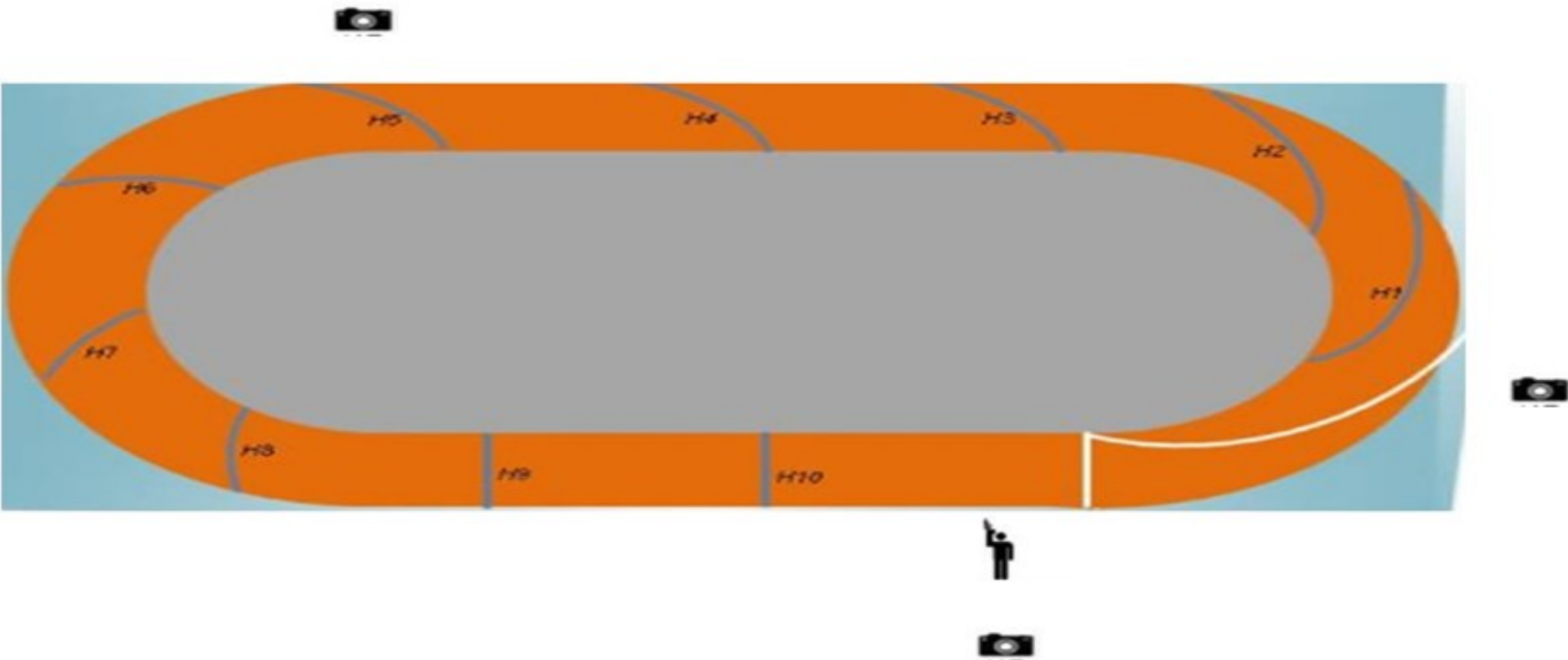


Figure 1: Location of the 3 cameras in the stadium stands. All of them took the reference from the start of the race (gun) and, from the first hurdle, they kept all participants in the framing throughout the race.

The rhythmic structure and effort distribution of the nine men's 400m hurdles races of the IAAF World Athletics Championships Doha 2019 have been analysed: 5 heats (37 athletes), 3 semi-finals (24 athletes) and 1 final (8 athletes). Thus, 69 individual performances have been analysed. 87 variables of each athlete by race were analysed, 19 qualitative and 68 quantitative (including spatial, temporal and spatio-temporal parameters), related to the rhythmic structure and effort distribution. All races were recorded by 3 cameras (2 Casio Ex-F1 and 1 Sony A9) placed in different positions of the stand of the Khalifa Stadium, permanently recording all the participants in each race and also recording the output trigger signal. The images were analysed using Kinovea (v.0.8.15) software.

Table 1: Rhythmic structures found in heats, semi-finals and final and number of athletes who carried them out.

Rhythmic structure	Heats	Semi-finals	Final	Total
13 to 8th, 15 to 10th	1	1		2
13 to 6th, 14 to 9th, 15 to 10th	1			1
15 to 9th, 16 to 10th	1			1
13 to 8th, 14 to 10th	2		2	4
15 to 10th	2	1		3
13 to 7th, 14 to 10th	2	4		6
13 to 7th, 14 to 9th, 15 to 10th	1		2	3
13 to 3th, 12 to 5th, 13 to 9th, 14 to 10th	1			1
13 to 6th, 14 to 8th, 15 to 10th	4	4		8
13 to 5th, 14 to 7th, 15 to 10th	4	2	1	7
14 to 6th, 15 to 10th	2	1		3
15 to 2th, 14 to 6th, 15 to 10th	1			1
15 to 7th, 16 to 9th, 17 to 10th	1			1
13 to 9th, 14 to 10th	1		1	2
13 to 5th, 14 to 10th	3			3
13 to 8th, 15 to 9th, 14 to 10th	1			1
14 to 9th, 15 to 10th	1			1
13 to 6th, 14 to 10th	3	5		8
14 to 7th, 15 to 10th	2	1		3
13 to 5th, 14 to 8th, 15 to 10th	1			1
14 to 3th, 13 to 4th, 14 to 6th, 15 to 10th	1			1
14 to 2th, 15 to 3th, 14 to 5th, 15 to 10th	1			1
13 to 3th, 12 to 5th, 13 to 8th, 14 to 10th		1		1
14 to 3th, 13 to 4th, 14 to 8th, 15 to 10th		1		1
13 to 10th		1	1	2
15 to 8th, 16 to 10th		1		1
13 to 5th, 14 to 9th, 16 to 10th		1		1
13 to 9th, 15 to 10th			1	1



Figure 2: Karsten Warholm, of Norway (lane 4), in the passage of the last hurdle in the final, where he won with a time of 47"42.

CONCLUSION

A correct distribution of effort and a more stable rhythmic structure are determining factors to obtain the best results in the men's 400m hurdles event.

Numerous and clearly differentiated stride patterns appear in this World Championship. Uniformity is non-existent and more rhythmic structures are individual (one-person)

REFERENCES

1) Schiffer, J. (2012) The 400m Hurdles, *New Studies in Athletics*, 1-2 (9-24)
 2) López, JL. et al. (2012) Analysis of the Choice of the Predominant Lead Leg in the 400m Hurdles at the 13th World Athletics Championships Daegu 2011. *Apunts. Educación Física y Deportes*, 110, 4 (70-77)
 3) Guex, K. (2012) Kinematic Analysis of the Women’s 400m Hurdles, *New Studies in Athletics*, 1-2 (41-51)
 4) Behm, J.J. (2007) 400 haies: 1900-2006. *Histoire de quatrache* (44-47).

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