A KINEMATIC STUDY OF THE SPRINT EVENTS AT THE 1999 WORLD CHAMPIONSHIPS IN ATHLETICS IN SEVILLA

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The purpose of this study was to analyse the performance of the best athletes of the 100m, 200m and 400m sprint events at the World Athletics Championships Seville'99. Selected biomechanical variables were measured and the data obtained were provided to coaches and athletes so that they could be used in their training programming. The subjects of this study were eight men and eight women on each final. Athletes were filmed passing markers placed each 10 and 50m in the track by using two dimensional photogrammetry techniques. The results allow us to analyse in detail the several sections of each race and carry out an exhaustive comparative analysis of the athlete's performance at his race.

KEY WORDS: biomechanics, track and field, sprint events, kinematics, running.

INTRODUCTION: The men's and women's 100m, 200m and 400m sprint events at the World Championships in Athletics Seville 1999, were analysed as part of the objectives of the project "*Biomechanical analysis of throwing and running events at the 1999 IAAF World Athletics Championships*". This project was approved by the International Amateur Athletic Federation" (IAAF) and financially supported by the Interministerial Comission of Science and Technology (CICYT) and the Higher Sports Council (CSD) of Spain. This kind of analysis has been carried out in competition for more than a decade, as it provides coaches and athletes with very useful information as an aid to the programming of training sessions. The analysis of the races of the top athletes in the world in each speciality, works as a reference for assessing technique and finding an explanation to the results. The results of the World Championships in Rome 1987 (Landry, 1987;Moravec *et al.*, 1988), Athens 1997 (Brüggemann *et al.*, 1997) and those of the Seoul Olympic Games (1988) (Susanka *et al.*, 1989a, 1989b, 1989c; Brüggemann et al., 1990), have been a reference for designing the experimental procedure for different events. The aims of this study were:

1. To carry out an analysis of the performance of the men's and women's 100m, 200m and 400m finalists at the World Athletics Championships Seville 99, based on split times and other variables arised from those times.
2. To transmit the results of the study to coaches and athletes all over the world, so they can be used as a reference for the design of training strategies according to the world trends.

In order to carry out the study it was required:

3. To obtain a methodology based on two dimensional video photogrammetric procedures ready for the kinematic analysis of the competition.

METHODS: The subjects of the study were eight men and eight women of each 100m, 200m and 400m sprint races final. The material used for the filming was eight SVHS video cameras and four digital high-speed video cameras (Kodak Motion Corder Analyzer SR 500C). System for data analysis: two SVHS video recorders, a computer with a Video Capture Board and video editing software. For data processing, customised software with calculus routines were developed by our Laboratory. Video cameras, operating at 50 Hz, were placed perpendicular to the running direction for filming the runners when passing through markers which were placed every 10 metres (100m sprint races) and every 50 metres (200 and 400m sprint races). High-speed video cameras, operating at 100 Hz, filmed the runners passing through the distances: 0-15m and 50-65m in 100m sprint races, 100-115m and 150-165m in 200m sprint races, 300-315m and 350-365 in 400m sprint races. Sequences were digitized in order to register at the very moment when each athlete passed the markers which had been filmed before. The anatomical reference point to digitize was the hip. These data were

entered into a calculus routine to obtain the following information related to the athletes, which were released as preliminary reports shortly after the competition:

1. Interval times in 10m sections for 100m sprint races (Table 1).
2. Interval times in 50m sections for 200m (Table 2) and 400m (Table 3) sprint races.
3. Times at the end of each section throughout the race.
4. Comparison of the time intervals between athletes in 10 or 50m sections.
5. Differences from the winner's time.
6. Relative time of each section.
7. Speed curve.
8. Maximum mean speed and sections in which it was achieved.
9. Time intervals from 30 to 50m (100m race).
10. Time intervals from 80 to 100m (100m race).
11. Time intervals every 100 metres (200 and 400m races).
12. Time intervals every 200 metres (400m races).
13. Stride rate in 10/50m sections.

RESULTS: Tables 1, 2 and 3 show the interval times for the first three subjects classified in the 100m, 200m and 400m finals; the interval times for the rest of the finalists are also available. These tables presenting individual data permit the comparison of the results among the athletes.

100m: Maurice Green achieved a maximum average speed of 11.90m/s in the 50-60m section. Average speeds of the race between 9.77 and 10.20m/s were reached in the 100m male races, and those average speeds which were lower than 11.36m/s were not recorded in any 10 metres section. Greene was not able to achieve a good time in the 10-20m section; it can be said that he lost the world record in that part of the race. The winner of the 100m women's race, Marion Jones, achieved an average maximum speed of 10.87m/s in her fastest section (50-60m). The accumulated times for the 30 to 50m and from 50 to 80m respectively indicate how each athlete accelerated and decelerated. It is worth pointing out that the first three athletes (men and women) obtained better times over those distances.

200m: In the male race, the second and third classified athletes had better times during the 50 to 100 m section than the winner, Maurice Green, but he kept the first position from that point until the end of the race and achieved a better average speed between 150m and 200m, clocking differences of 0.05 and 0.13s. Da Silva achieved the fastest average speed per section (50-100m) with 11.26 m/s. In the female race, Inger Miller's partial times over the whole race were better than those of any of her rivals (except for the start). Maximum speeds were produced in the 50 to 100m section with the average maximum speed of 10.12 m/s by Miller.

400m: At the 200m mark Michael Johnson was in the third place with an accumulated time of 21.22s, 0.09 s more than the silver medallist, who at this stage was placed first in the race. In the 200m to 250m section Johnson clocked 0.12 s less than the athlete with the best time at this stage of the race, whose maximum average speed was 10.08 m/s. Johnson kept a speed plateau over the 200m - 300m section avoiding a rapid loss of speed, which was more accentuated in his rivals. At the female race, Cathy Freeman, the winner, beat the second classified, Rücker by 0.07s. The best average speed of the race was 8.05 m/s, which was achieved by Freeman. The maximum average speeds in each section were obtained at the 50m to 100m (8.90 m/s by the third classified).

DISCUSSION:

1. The analysis of sprint races has made possible the study of the performance of the best sprinters who participated in the 1999 World Championships in Athletics in Seville.
2. The data presented shows individual and group results to help the coach to assess the performance of each athlete and to be able to select the most suitable competition strategy.
3. A methodology has been designed in order to carry out the kinematic analysis of sprint races, which will permit the release of the results just a few hours after the competition.

Table 1. Time intervals each 10m in the 100m finals.

The values for interval 0-10m do not include the official reaction time.											
100m FINAL MEN											
NAME	**0-10m**	**10-20m**	**20-30m**	**30-40m**	**40-50m**	**50-60m**	**60-70m**	**70-80m**	**80-90m**	**90-100m**	**OFFICIAL TIME**
GREENE, Maurice (USA)	1.73	1.03	0.92	0.88	0.86	0.84	0.85	0.85	0.85	0.86	**9.80**
SURIN, Bruny (CAN)	1.75	1.00	0.91	0.89	0.85	0.85	0.86	0.86	0.86	0.88	**9.84**
CHAMBERS, Dwain (USA)	1.73	1.02	0.92	0.90	0.86	0.85	0.87	0.89	0.89	0.90	**9.97**
100m FINAL WOMEN											
JONES, Marion (USA)	1.83	1.10	0.99	0.95	0.94	0.92	0.94	0.96	0.97	0.98	**10.70**
MILLER, Inger (USA)	1.83	1.11	1.03	0.96	0.94	0.94	0.95	0.96	0.97	0.97	**10.79**
THANOU, Ekaterini (GRE)	1.89	1.11	1.01	0.95	0.93	0.95	0.95	0.95	0.98	1.00	**10.84**

Table 2. Time intervals each 50m in the 200m finals.

The values for the interval 0-50m include the official reaction time.					
200m FINAL MEN					
NAME	**0-50m**	**50-100m**	**100-150m**	**150-200m**	**OFFICIAL TIME**
GREENE, Maurice (USA)	5.74	4.51	4.69	4.96	**19.90**
DA SILVA, Claudinei Quirino (BRA)	5.88	4.44	4.67	5.01	**20.00**
OBIKWELU, Francis (NGR)	5.83	4.45	4.74	5.09	**20.11**
200m FINAL WOMEN					
MILLER, Inger (USA)	6.16	4.94	5.13	5.54	**21.77**
MCDONALD, Beverly (JAM)	6.31	4.97	5.29	5.65	**22.22**
FRAZER, Merlene (JAM)	6.29	4.97	5.28	5.72	**22.26**

Table 3. Time intervals each 50m in the 400m finals.

The values for the interval 0-50m include the official reaction time.									
400m FINAL MEN									
NAME	**0-50m**	**50-100m**	**100-150m**	**150-200m.**	**200-250m**	**250-300m**	**300-350m**	**350-400m**	**OFFICIAL TIME**
JOHNSON, Michael (USA)	6.14	4.96	5.00	5.12	5.20	5.24	5.52	6.00	**43.18**
PARRELA, Sanderlei (BRA)	6.22	4.90	4.91	5.10	5.41	5.56	5.83	6.36	**44.29**
CÁRDENAS, Alejandro (MEX)	6.00	4.99	5.02	5.18	5.39	5.53	5.86	6.34	**44.31**
400m. FINAL WOMEN									
FREEMAN, Cathy (AUS)	6.56	5.63	5.68	5.92	6.08	6.10	6.53	7.17	**49.67**
RÜCKER, Anja (GER)	6.80	5.61	5.69	5.93	6.06	6.12	6.45	7.08	**49.74**
GRAHAM, Lorraine (JAM)	6.61	5.50	5.62	5.86	6.19	6.34	6.60	7.20	**49.92**

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