

Analysis of speed patterns in 100-m sprints

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Abstract

The running speed of men's and women's 100-m sprints, including Tyson Gay (USA), Asafa Powell (JAM) and Veronica Campbell (JAM), at the 11th IAAF Athletics Championships in OSAKA were measured by using laser beam apparatus (LAVEG Sport, JENOPTIK, Germany). The purpose of this brief report was to investigate changes in running speed during the 100-m races and to provide information a sprint training. The highest speed of Gay (USA), who won the men's 100-m, and Powell (JAM) was 11.83 m/s and 11.79 m/s, respectively, and the rate of decrease in speed was 2.2% for Gay and 8.1% for Powell. However, their top speed was slower than that of Carl Lewis at the 3rd IAAF World Championships in Tokyo (12.05m/s, 9.86s of previous WR). In women, the highest speed attained by Campbell (JAM) was 10.56m/s and the rate of decrease in speed was 9.6%. The correlational coefficient between the top speed and goal time was -0.933 for men ($p < 0.0001$) and -0.962 for women ($p < 0.0001$). The rate of decrease in speed ranging from 2% to 13% has a small effect on the goal time. However, it may influence the ranking of the races of both the men's and women's.

1. Introduction

Tyson Gay (USA) won the 100-m world title for men in 9.85 s, followed by Derrick Atkins (BAH) who won the second rank in 9.91s, with world record holder Asafa Powell (JAM) attaining the third position. Powell led the run from the start to a distance of 60 m; however, after 60~70 m, his speed decreased suddenly. Taking the same time of 11.01 s, Veronica Campbell (JAM) defeated the defending champion Lauryn Williams (USA).

In 100-m races, the important factors comprise the acceleration from the start to the top speed, the top speed, and the decrease in speed just before the goal. Analysing 100-m races of the world championship will provide extremely important data for planning the training strategy in a sprint. The speed analyses of 100-m races were conducted by using video cameras or measuring instruments with the laser beam method. This method could measure the running speed from start to finish with a sampling rate of 100 Hz, although we had employed this method for evaluating the speed of the sprinters

during 100-m races.

2. Method

In this study, the apparatus using the laser beam (LAVEG Sport, JENOPTIK, Germany) was employed for measuring the running speed. The error of measurement of this device is 7 cm, and the safety of the laser beam is categorised as class 1 by the safety standard. In this



Figure 1. Setting the 5 lavegs in seat in stand.

Tabel 1. Reaction time, Goal time, top speed, percent of decrease in speed, elapsed time, speed, %max in 100m finals of men and women.

rankname	reaction time s	goal time s	top speed m/s	top distance m	%Decrease in Speed %	Distance(m)	10	20	30	40	50	60	70	80	90	100
1 Tyson Gay USA	0.143	9.85	11.83	65	2.2	elapsed time (s)	1.90	2.94	3.86	4.73	5.59	6.44	7.28	8.13	8.99	9.85
						speed(m/s)	5.25	9.70	10.83	11.42	11.72	11.79	11.83	11.80	11.67	11.57
						% max speed	44.4	82.0	91.6	96.6	99.0	99.7	100.0	99.7	98.7	97.8
2 Derrick Atkins BAH	0.137	9.91	11.74	55	1.8	elapsed time (s)	1.89	2.93	3.87	4.75	5.62	6.47	7.32	8.18	9.04	9.91
						speed(m/s)	5.28	9.65	10.69	11.26	11.57	11.74	11.71	11.70	11.58	11.53
						% max speed	45.0	82.2	91.1	95.9	98.6	100.0	99.7	99.7	98.7	98.2
3 Asafa Powell JAM	0.145	9.96	11.79	55	8.1	elapsed time (s)	1.88	2.91	3.83	4.71	5.57	6.42	7.29	8.16	9.04	9.96
						speed(m/s)	5.31	9.73	10.83	11.38	11.67	11.79	11.51	11.51	11.34	10.84
						% max speed	45.1	82.5	91.8	96.6	99.0	100.0	97.7	97.6	96.2	91.9
5 Churandy Martina AHO	0.180	10.08	11.67	65	2.6	elapsed time (s)	1.98	3.03	3.98	4.88	5.75	6.62	7.47	8.34	9.20	10.08
						speed(m/s)	5.05	9.49	10.62	11.09	11.42	11.58	11.67	11.60	11.56	11.37
						% max speed	43.3	81.3	91.0	95.0	97.8	99.2	100.0	99.4	99.0	97.4
6 Marlon Devonish GBR	0.149	10.14	11.48	65	3.9	elapsed time (s)	1.96	3.00	3.95	4.85	5.73	6.61	7.48	8.36	9.23	10.14
						speed(m/s)	5.11	9.60	10.52	11.09	11.31	11.42	11.48	11.37	11.42	11.03
						% max speed	44.6	83.7	91.7	96.7	98.6	99.5	100.0	99.1	99.5	96.1

Women 100m final (Wind;-0.2m/s), & best time(Wind;-0.1m/s)

rankname	reaction time s	goal time s	top speed m/s	top distance m	%Decrease in Speed %	Distance (m)	10	20	30	40	50	60	70	80	90	100
1 Veronica Campbell JAM	0.167	11.01	10.56	55	9.3	elapsed time (s)	2.01	3.14	4.15	5.11	6.07	7.02	7.97	8.96	9.97	11.01
						speed(m/s)	4.97	8.84	9.96	10.36	10.46	10.56	10.45	10.12	9.94	9.58
						% max speed	47.1	83.7	94.3	98.0	99.0	100.0	98.9	95.8	94.1	90.7
2 Lauryn Williams USA	0.145	11.01	10.40	45	6.1	elapsed time (s)	2.01	3.13	4.13	5.10	6.06	7.03	8.00	8.98	9.99	11.01
						speed(m/s)	4.97	8.97	9.95	10.32	10.40	10.37	10.35	10.14	9.95	9.76
						% max	47.8	86.2	95.7	99.3	100.0	99.7	99.5	97.5	95.7	93.9
4 Torri Edwards USA	0.141	11.05	10.45	45	7.3	elapsed time (s)	2.00	3.12	4.15	5.12	6.08	7.04	8.01	9.00	10.02	11.05
						speed(m/s)	5.01	8.87	9.78	10.25	10.45	10.42	10.34	10.06	9.84	9.68
						% max	47.9	84.9	93.6	98.1	100.0	99.7	98.9	96.2	94.2	92.7
5 Kim Gevaert BEL	0.143	11.05	10.32	55	6.9	elapsed time (s)	1.98	3.10	4.11	5.10	6.08	7.04	8.02	9.01	10.01	11.05
						speed(m/s)	5.06	8.92	9.86	10.08	10.30	10.32	10.28	10.12	9.97	9.61
						% max	49.0	86.4	95.6	97.6	99.8	100.0	99.6	98.0	96.6	93.1
6 Christine Arron FRA	0.164	11.08	10.41	45	7.9	elapsed time (s)	2.03	3.15	4.16	5.13	6.09	7.06	8.03	9.02	10.04	11.08
						speed(m/s)	4.93	8.95	9.84	10.30	10.41	10.41	10.29	10.04	9.86	9.59
						% max	47.3	85.9	94.5	98.9	100.0	98.8	96.4	94.7	92.1	
SF Veronica Campbell JAM	0.144	10.99	10.46	55	9.5	elapsed time (s)	2.00	3.12	4.12	5.10	6.07	7.02	7.98	8.96	9.93	10.99
						speed(m/s)	4.99	8.94	9.98	10.21	10.37	10.46	10.39	10.30	10.22	9.47
						% max	47.7	85.4	95.5	97.6	99.1	100.0	99.4	98.5	97.7	90.5

study, we positioned the five apparatuses at 64~68 m before the start line and 22~24 m above ground level (Figure 1). We measured the running speeds during sprinting for all races of men and women, from the first to the final round. In each race, five sprinters were selected based on their best performance in the daily programme. The measurement tools were positioned at the top of the stand behind the 100-m lanes such that different noises remained in the data, affected by the tilting movement of the device, particularly from the start to a distance of 40 m. These noises were removed by the spine interpolation; other noises were removed by the 1-Hz low pass Butterworth digital filter. Using filtered data, the elapsed time of 10 m from the start to the goal was calculated using the distances-time curves data. From the elapsed time, we calculated the running speed at each interval, the top speed and the rate of the decrease in speed from the top to the last speed, i.e. from 90 m to 100 m. The official results were used in the goal

and reaction times.

3. Results

The measuring objects included 75 examples from the first to the final round; we obtained the data of 63 samples for men, with the goal time ranging from 9.85 s to 10.46 s, and the data of 71 samples for women, with the goal time ranging from 10.99 s to 11.98 s. In our opinion, the data loss occurred when the runner did not begin and qualify and when the laser light beam was unable to follow the runners because the device was positioned high on the stand.

Goal time, top speed, the appeared distance of the top speed, the reaction time at the start, the elapsed time of 10 m, the speed of a 10-m interval, the rate of decrease in speed from the top to the speed of the last interval of every man and woman were recorded in table 1. These data represented the data of the 1st, 2nd, 3rd, 5th, and

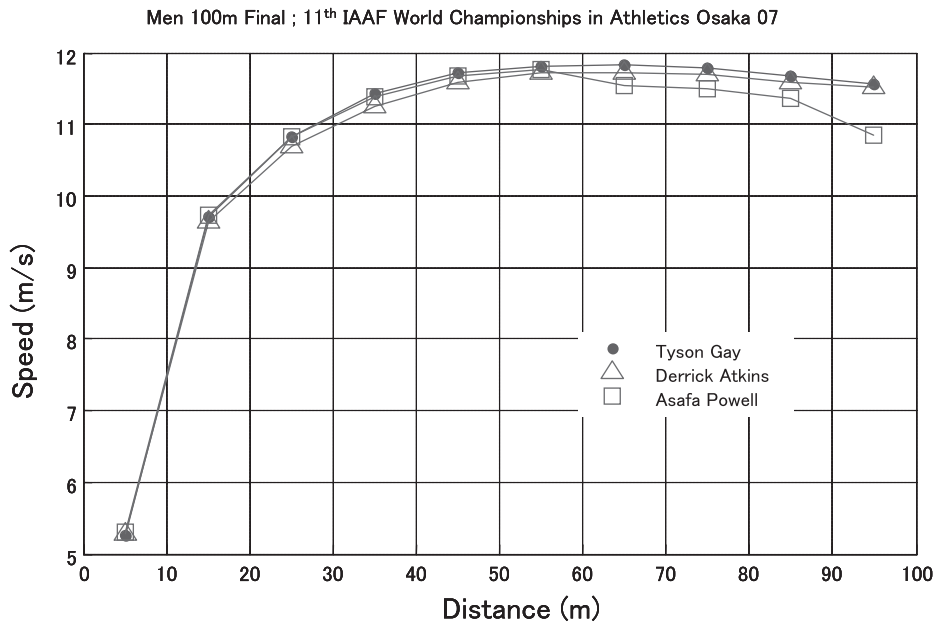


Figure 2. Speed changes in top 3 sprinter at men's 100m final

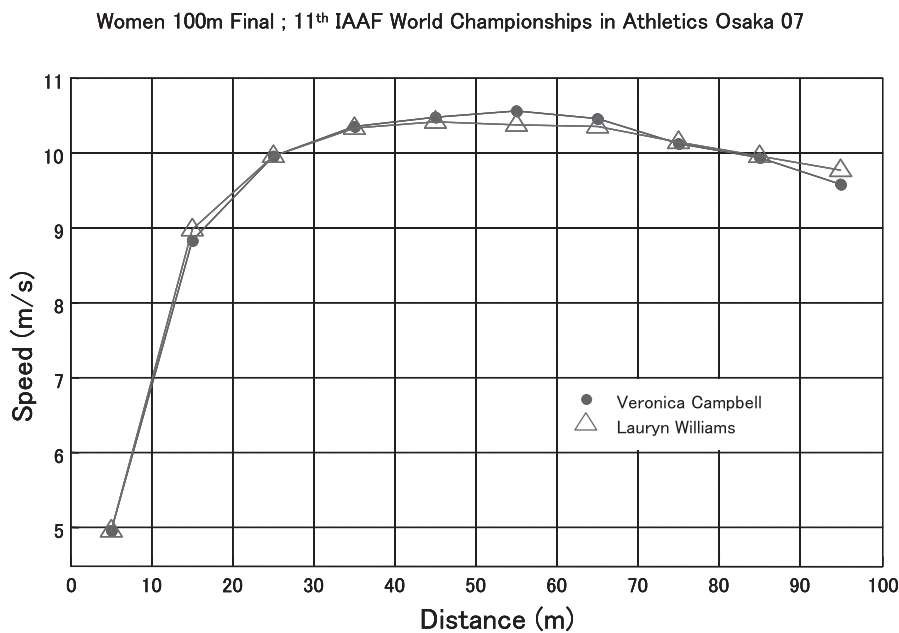


Figure 3. Speed changes in top 3 sprinter at women's 100m final

6th ranked male runners and the 1st, 2nd, 4th, 5th, and 6th ranked female runners and the time of 10.99 s at their semi-final. The maximum top speed attained by Gay (USA) over a distance of 60–70 m is 11.83 m/s; he was followed by Powell who ranked 3rd with a speed of 11.79 m/s. Lewis (USA) whose goal time was 9.86 s recorded a top speed of 12.05 m/s in the men's 100-m final at the third IAAF World Championships in Tokyo in 1991. Thus, Gay's top speed was 0.22 m/s slower than that of Lewis. With regard to the women's championship,

Campbell (JAM) who attained the 1st position in the final was the fastest with a speed of 10.56 m/s, followed by Williams (US) who ranked 2nd with a speed of 10.45 m/s.

The changes in the speed of the top three male sprinters have been recorded in figure 2. From the start to a distance of 60 m, the tendency of changes in speed in Gay and Powell almost exhibited an identical pattern; however, after covering a distance of 60 m, the speed of Powell decreased suddenly. On the other hand, after this

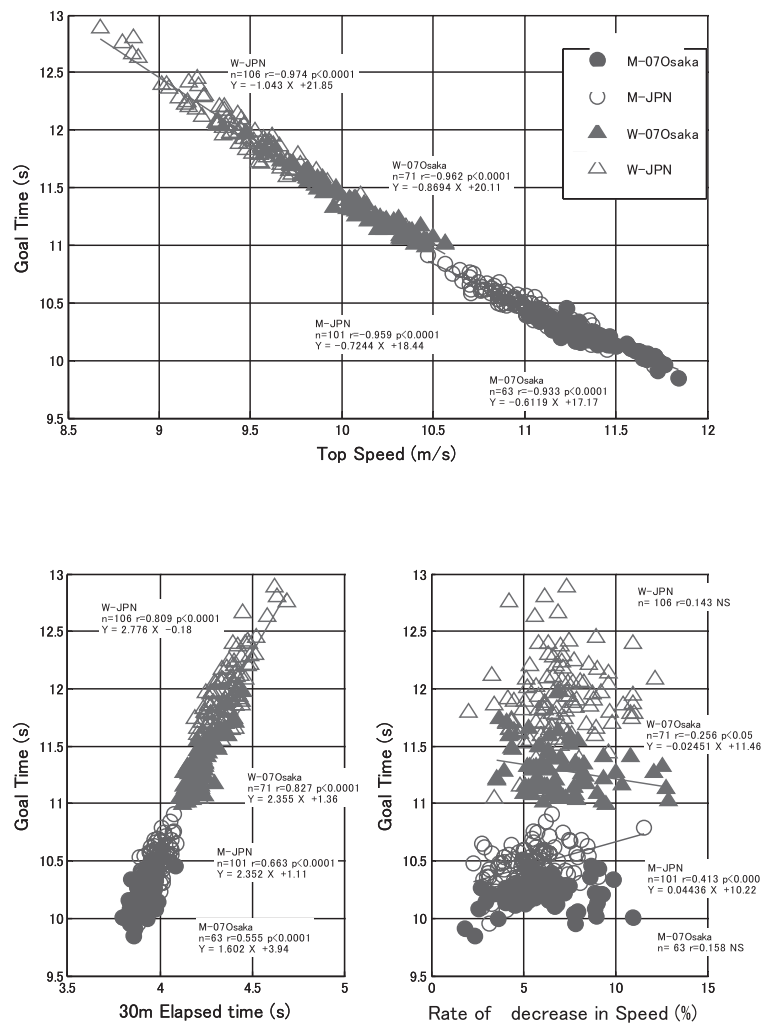


Figure 4. The relationship among top speed, 30m elapsed time, and percent of decrease in speed, and goal time.

point, Gay maintained his speed at the same level, and decreased it slightly just before the goal. The percentage of the decrease in speed was 2.2% in Gay and 8.1% in Powell. Figure 3 presents the changes in the speed of the top two female sprinters. Taking the same time, Campbell defeated the defending champion Williams and attained a top speed of 10.56 m/s in the distance from 50 m to 60 m; however, after this point, her speed decreased. The top speed of Williams who ranked second was lower than that of Campbell by 10.40 m/s. However, William's acceleration at the start and the ability of maintaining her speed was higher than that of Campbell. Thus, during the distance from 70 m to the goal, the speed of Williams was higher than that of Campbell.

Figure 4 presents the relationship among the top speed, the elapsed time of 30 m, the percentage of decrease in speed and the goal time. M represents men, W represents women, JPN is the data collected in Japan which includes the data of the international events held in Japan and 07 Osaka represents the present world championship in

athletics. Among men, the range of the goal time in 101 samples of JPN was from 9.95 s (Gatlin; USA, 2006) to 10.91 s; among women, the range of the goal time in 106 samples was from 11.05 s (Felix; USA, 2005) to 12.89 s. The top speed and the goal time were inversely related, and significant statistical correlations existed for any group (M-07 Osaka = -0.933, M-JPN = -0.959, W-07 Osaka = -0.962, W-JPN = -0.974, $p < 0.0001$). It has been demonstrated that in 100-m races, the higher the top speed, the better is the performance. In any group, the elapsed time at 30 m was also statistically related to the goal time. The correlation coefficients were from 0.555 to 0.809, which were lower than the relationship of the top speed with the goal time.

The rate of decrease in speed had been distributed in the range of 2% to 13% in all groups. When we observe the decrease rate of the speed and goal time in each group, we find that there was a positive relation in M-JPN and a negative relation in W-07 Osaka with statistically significant $p < 0.05$, and that in the other group, they had

no relationship between them. From these results, it was suggested that there was a small effect of maintaining speed to the goal on a 100-m sprint performance. This is the one of the factors that did not result in any relationship between the goal time and the percentage of the decrease in speed.

4. Conclusion

We obtained the extremely important data for 100-m sprinting in men (63 samples) and women (71 samples) in the 11th IAAF World Championships in Osaka.

The highest speed of Gay (USA), who won the men's 100-m finals, was evaluated to be 11.83 m/s and the rate of decrease in speed was evaluated to be 2.2%. In women, the highest speed attained by Campbell (JAM) was 10.56m/s and the rate of decrease in speed was 9.6%. Statistically significant relationships exist between the top speed and goal time in men ($r = 0.933$, $p < 0.0001$) and women ($r = 0.962$, $p < 0.0001$).

The value of the rate of decrease in speed distributed from 2% to 13% has a small effect on the goal time; however, it affects the ranking in each race, for example, in both the men's and women's finals.