SPRINTING SPEED OF ELITE SPRINTERS AT THE WORLD CHAMPIONSHIPS

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The purpose of this study was to analyze the sprinting speed of the sprinters during the men's 100 m events at the IAAF World Championships (WC) in order to provide important information to track and field coaches and athletes. Sprinting speed of the sprinters was collected by using laser guns (Laveg Sport, Jenoptik, Germany) during the World Championships in Daegu 2011. Then, data from Osaka 2007 WC and Berline 2009 WC were included in the analysis. The findings indicated that a reduction of a sprinter's maximum speed is correlated with their performance time (p<0.05). Three top sprinters showed less than 2% reduction of thier maximum speed. Therefore, how the sprinters maintain their maximum speed until the end of the race is important for best performance.

KEY WORDS: sprinting speed, Laveg system, maximum speed, speed reduction.

INTRODUCTION: The measurement of reliable running speed is important for the analysis of sprinting events but some biomechanical applications such as the method of video digitization are costly and time consuming. Currently, laser systems developed for measuring vehicle speed has been used for meauring running speed in track and field evnets (Harrison et al., 2004). A previous study suggested that sprinting should be divided into three phases: acceleration, maximum speed, and deceleration (Murase et al., 1976). However, in world class elite sprinting events, sprinters complete the race within ten seconds and almost without a deceleration phase. Therefore, the purpose of this study was to investigate sprinting speeds of world class sprinters in recent WCs, especially focused on how performance time is related to characteristics of sprinting speed.

METHODS: Three laser speed guns (LAVEG Sport, Jenoptik, Germany) were used to measure sprinting speed. The calibration process of the LAVEG system was done by two individuals in the 100 meter lane (Figure 1). The system measured an instant performance time at a given distance. Therefore, an instant speed of the sprinter was calculated by dividing the distance by time. Data was sampled with a frequency of 100 frames per second and filtered with a low pass filter (cutoff frequency: 0.5). Four top sprinters at the WC in Daegu 2011 were selected for the measurement of sprinting speed. Then, speed date for the six sprinters in the recent WCs (2007 Osaka WC and 2009 Berlin WC) were included in the analysis. Pearson's correlation coefficients were calculated to investigate the relationship between performance time and speed characteristics at an alpha level of 0.05 using SPSS version 17.0 program.

RESULTS: Table 1 shows speed data for the top sprinters in the men's 100 meter at the recent WCs between 2007 and 2011. Their average performance time is 10.01 seconds (SD: 0.197) with a reaction time of 0.155 seconds (SD: 0.014). Also, the average maximum speed between the races is 11.69 seconds (SD: 0.25) with a range from 11.31 to 12.27 seconds. In addition, the reduction of speed between 80 meters and 100 meters with respect to the maximum speed was 4.73 % (SD: 3.34) with a range from 1.69 % to 9.54 %. The three top sprinters among the eleven selected sprinters show less than a two percent reduction of their maximum speed between 80 meters and 100 meters.

Figure 1: Measurements of sprinting speed (Left: Laveg system, Middle: Calibration process, Right: Sprinting speed of Yohan Blake's 100 meter final at 2011 WC in Daegu). Figure is adapted from Ryu et al. (2011).

Table 1: Speed data of the top sprinters in the men's 100 meter at the World Championships.

Name	WC	Rank/ Rd.	React Time (sec)	Final Time (sec)	Max. S. (m/s)	Avg. S. (m/s) 80m-100m	S 80m-100m /Max S(%)	Reduc. (%)of S btw 80m-100m
T. Gay (USA)	07	1/F	0.143	9.85	11.83	11.63	98.31	1.69
D.ATKINS (BAH)	07	2/F	0.137	9.91	11.74	11.56	98.47	1.53
A.POWELL (JAM)	07	3/F	0.145	9.96	11.79	11.11	94.23	5.77
C.MARTINA (AHO)	07	5/F	0.180	10.08	11.67	11.49	98.46	1.54
M.DEVONISH (GBR)	07	6/F	0.149	10.14	11.48	11.24	97.91	2.09
U. BOLT (JAM)	11	1/1R	0.153	10.10	11.64	10.53	90.46	9.54
U. BOLT (JAM)	11	1/SF	0.164	10.05	11.74	10.65	90.72	9.28
M.FRATER (JAM)	11	1/1R	0.149	10.26	11.42	10.53	92.21	7.79
N.CARTER (JAM)	11	1/1R	0.164	10.26	11.31	10.42	92.13	7.87
Y.BLAKE (JAM)	11	1/F	0.174	9.92	11.75	11.39	96.94	3.06
U. BOLT (JAM)	09	1/F	0.146	9.58*	12.27	12.04	98.13	1.87
Mean			0.155	10.01	11.69	11.14	95.27	4.73
SD			0.014	0.197	0.25	0.54	3.34	3.34

* World record of men's 100 meter, 07: Osaka, 09: Berlin, 11: Daegu, S: speed, 2007 Osaka WC data is adapted from JAAF (2007) report

Table 2 shows the pearson correlation coefficients between performance time and variables. The results indicated that the performance time of the sprinters is negaively correlated with maximum speed and an average speed between 80 meters and 100 meters (p<0.01). Furthermore, the performance time of the sprinters is positively correlated with speed reduction between 80 meters to 100 meters with respect to their maximum speed (R=0.567, p<0.05). However, there was no significant correlation between performance time and reaction time of the sprinters.

Table 2: Pearson's correlations coefficients (R) between performance time and variables.

N=11	Reaction time (sec)	Maximum Speed (m/sec)	Avgage Speed btw 80m-100m	Speed Reduction btw Max Speed & 80m-100m
Performane Time (sec)	0.307	-0.967**	-0.843**	0.567*

One tail test, **p<0.01, * p<0.05

Figure 2 shows the linear relationship between performance time and speed characteristics. There was a tendency to show a significant correlation between the sprinters' performance time and a maximum speed as well as reduction of maximum speed.

Figure 2: Correlation coefficients between the performance time and Maximum speed (left), and Speed reduction (right).

DISCUSSION: It is critical for the sprinters to perform a maximum speed during the race to show the best performance. How sprinters can reach a high sprinting speed and maintain a maximum speed have been the interestof much bimoechanics research. Ito et al. (2007) suggested that knee flex in the swing leg has a positive impact on maximum speed. Also, their correlation analysis indicated that greater hip extension velocity and smaller knee flexion velocity of the support leg are positively related to maximum speed. In addition, maintaining maxium speed throughout the race to the finish line is as important as reaching a high level of sprinting speed. The sprinters somehow experience a deceleration phase after their maximum speed. When Usain Bolt set the world record for the men's 100 meter race, 9.58 seconds, his maximum speed was 12.27 m/sec at a distance of 65 meters. Then, he continued to maintain that speed throughout the race as there was only a 1.87% reduction of maximum speed between 80 meters and 100 meters. Also, Tyson Gay, who won in 2007 Osaka WC and Derrick Atkins, who second place showed a reduction of 1.69 % and 1.53 %, respectively. Therefore, how the sprinters maintain their maximum speed throughout the race is an important topic to understand the sprinting mechanics of today's top male sprinters.

CONCLUSION: The findings indicated that increasing the maximum speed with a minimum reduction of maximum speed over time are important factors that affect sprinters' performance time. Therefore, how sprinters achieve and maintain their maximum speed until the end of the race is requried for further biomechanical investigation.

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