ANALYSIS OF RACE WALKING TECHNIQUE POST-COMPETITIVE PERIOD IN A WORLD ATHLETICS CHAMPIONSHIP.

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The purpose of this study was to analyse the kinematic variables of an elite race walker gait technique during the post-competitive period in a World Athletics Championship. The elite athlete performed three race walking gait technique tests in a laboratory using three competitive race walking paces. Data for the flight time, step length, step frequency, and speed for the tests was collected. The one-way ANOVA of the three tests did not show statistically significant differences in flight time, step length, step frequency, and speed. However, the findings of this study showed that the competitive race walking pace would influence race walking kinematic variables and the elite athlete's gait technique.

KEYWORDS: flight time, high performance, competition.

INTRODUCTION: The 20 km men's race walking is a major event in the World Athletics Championship. The results obtained from the world championship are a benchmark that allow comparisons to be made with other race walkers who participate in the Olympic Games and World Championships. Previous studies indicate that the biomechanical variables of these athletes should focus on understanding the kinematics determinants of race walking performance (Hanley, Athanassios & Drake, 2015). Since the 2012 London Olympic Games and the 2011 World Athletics Championship, 12% of walkers were disqualified for flight phase or loss of contact with the ground, and knee flexion upon contact with the ground. The special characteristics of the race walking gait technique have been the object of study and have led researchers to question some of the decisions of the judges during the competition. (Gironimo, et al., 2016)

Due to the implications of race walking rules, investigators have analysed knee motion during the stance phase rather than the leg swing phase. However, it is the swing phase that can influence step length and other key variables. On the other hand, the influence of competitive race walking speed pace, step length, step frequency and flight time in race walking performance have been analysed in several publications (Hakim, Rumini, & Sulaiman, 2021). The purpose of this study was to analyse the kinematic variables of an elite race walker gait technique during the post-competitive period in a World Athletics Championship using three similar competitive race walking paces. We hypothesized that competitive race walking pace after participating in a World Championship influences the kinematic variables, step length, step frequency, and flight time. Besides, the flight time influence race walking gait technique.

METHODS: A 26 year old elite race walker, with a 1.77 m height, 68 kg weight, and a 21.7 body mass index. The athlete had no injuries, and was in the competitive period 2 days after his participation in the 2015 World Athletics Championship. The Academic Committee of the Sports Sciences Laboratory of Beijing Sport University accepted and approved this study.

Procedure: The test was conducted at the Sports Sciences Laboratory of Beijing Sports University. A 50 m digital running track system was used for testing the gait technique of the elite athlete, using three similar competitive race walking speed paces over 20 km (4 - 4:20 min/km, 4.16 - 3.8 m/s) (Campaña, 2019). The digital running track system is a track and field training information collection and feedback system. The digital running track system uses flexible array sensors to detect the athlete's plantar contact with the track, and it includes four components. The flexible array sensors measure the real-time motion of the athletes on the track. The signal acquisition collects signals of the flexible array sensors, transmitting them to

the monitoring computer through the CAN bus and the USB. The real-time feedback that facilitates obtaining athletes' performance results in real-time. And the software analysis for data processing and calculating the signals collected and the kinematic variables. Two evaluators collected the test results, one operated the computer connected with the digital running track system and recorded the data, and the other controlled the start signal and the rest time of the athlete. The athlete had to perform three times race walking (RW) with the same speed and pace used in a competition, the athlete stood behind the sensors of the digital running track system before the start signal, the first step should commence with the right leg (RL) for all three tests. The following kinematic variables were collected: SL step length (m), SF step frequency (steps/s), FT flight time (s), and S speed (m/s). The athlete performed three tests with a rest time of 5 minutes between each test. The numbers of steps taken from the different test were the following: 1st Test=30, 2nd Test=30, 3rd Test=31. The measurements of the right leg (RL) and left leg (LL) steps variables that have shown 0 values were not considered for data analysis.

Statistical Analysis: Data for the flight time, step length, step frequency, and speed for the RW tests was collected. The researchers calculated descriptive statistics (means ± SDs) for the variables. One-way ANOVA with Tukey post-hoc comparisons were used to analyse the differences between the three tests when using three similar competitive race walking speed paces. Statistical significance was set at $p \leq 0.05$. The effect-size statistics were calculated using Cohen's d, categorized into small (< 0.2), medium (< 0.5), and large (< 0.8), respectively. Statistical significance was set at $p \leq 0.05$. Data analysis was performed using the Statistical Package for Social Sciences version 28.0 (SPSS, Inc., Armonk, NY).

RESULTS: The one-way ANOVA revealed that there were no statistically significant inter-test differences using three similar competitive race walking speed paces in FT ($p = 0.431$), SL ($p = 0.365$), SF ($p = 0.904$) or S ($p = 0.968$) for the tests. Post-hoc comparison for all FT, SL, FT, and S revealed that there was no statistical difference between the tests.

Table 1: Race walking tests and gait technique variables performance

	FT (s)	SL (m)	SF (steps/s)	S (m/s)
1st Test	0.076±0.020	1.24±0.03	3.45±.034	4.29±0.43
2nd Test	0.072±0.020	1.23±0.02	3.46±0.40	4.27±0.51
3rd Test	0.079±0.024	1.23±0.03	3.50±0.51	4.31±0.59
Total Means	0.076±0.021	1.23±0.02	3.47±0.43	4.29±0.51

FT: Flight time (s); SL: Step length (m); SF: Step frequency (steps/s); S: Speed (m/s).
Data collected and presented as mean ± SD.

The SEMs values for the RW tests variables were FT (SEM= 0.002), SL (SEM= 0.003), SF (SEM= 0.044), S (SEM= 0.053). All Cohen's effects sizes for the inter-test differences regarding flight time, step length, step frequency, and speed were small.

DISCUSSION: The purpose of this study was to analyse the kinematic variables of an elite race walker's gait technique during the post-competitive period in a World Athletics Championship using three similar competitive race walking paces. The results showed that the kinematic variables flight time, step length, step frequency and speed can influence the race walking gait technique.

In this study, the one-way ANOVA of the three tests did not show statistically significant differences in flight time, step length, step frequency and speed when using three similar competitive race walking paces. Previous studies have shown that the increase in FT can be related to inertia momentum and the pendulum or swing phase, when the leg swings in the air during toe push-off and initial support (Hakim, Rumini, & Sulaiman, 2021). In this case, if the athlete is presenting FT variations, he might be performing RW gait technique errors, or losing control of the competitive race walking pace. The FT mean obtained in our study was FT=

0.076 ± 0.021 s, it was looking higher than the results in comparison with the FT mean determined by Chinese scientists for elite race walkers FT= 0.042 s to 0.070 s in World Level Competitions. In our research, the FT mean was also higher in comparison with the FT means obtained in another study of international athletes FT= 0.064± 0.001 s. Researchers assert that the control of FT is crucial to avoid being detected by the judges, banned or disqualified from the competition. Through the FT results obtained in this study, It has been identified that there is a competitive race walking pace and gait technique deficiency in comparison with other international athletes. And to overcome such deficiency, it would be necessary to emphasise on FT technique exercises for the control of the swing phase and loss of foot contact until the initial support.

The mean of SL=1.23±0.02 is higher in comparison with step length results of Chinese elite race walkers of a previous study SL= 1.19 ± 0.004 (Wang, 2010), our elite athlete SL is higher in comparison with the results of other study, which analysed the SL during each 5km in an international competition SL= 1.17 ± 0.004 (Wang, 2010), and in comparison, with the data obtained from a survey of 24 elite athletes SL= 1.20 ± 0.003 is higher. (Hao, 2009) The SL mean in our study is higher than the range of the mean results of other athletes who have participated in World Championships or other international competitions. However, using similar competitive race walking paces, the FT and SL were not significant, the FT and SL race walking technique did not show changes. Another aspect to consider is that during a competition the athlete faced changes in pace rhythm, muscle fatigue, and resistance to greater distance in step length.

In our study, the step frequency and speed mean were SF= 3.47± 0.43 and S= 4.29 ± 0.51, this result is higher in comparison with the data obtained of a World Championship at 16.7 km, SF= 3.428 ± 0.030 and S= 4.193 ± 0.130 (Jing, 2010). In another study, the speed mean was S= 4.207 ± 0.001 (Helmar, 2009), this data was obtained from the first 4 positions in a 20 km International Competition. The speed mean data in our results is also higher than the S mean obtained in the mentioned study. The conditions of the three tests performed by the elite athlete in the laboratory would allow him to perform the SF and S race walking technique using a competitive race walking pace, and we compared that with some other elite athletes' results. Although, we collected data using the 50 m digital running track testing conditions, it would be more effective for other researches to analyse the changes of the athlete S and SF in real competitions or in longer distances. However, our study showed that the results of SF and S are higher in comparison with the range of high-level athletes from other countries.

In our study, there were no significant differences between each variable FT, SL, SF and S when using three similar competitive race walking paces. The data obtained showed that the athlete did not present significant variations in the 1st, 2nd and 3rd test, the mean of the FT have not showed significant changes with the SL, SF, and the S, separately. The limitations of this study include the fact that the results were obtained in accordance with the race walking test protocols in a digital running track system, it would be recommended to collect data during official World Championships or international competitions. Another aspect to consider is that the athlete has competed two days before the test in a World Championship. He was exposed to some physiological, environmental, psychological, and other factors that can influence the race walking gait technique performance. Therefore, the FT, SF, SL and S would be affected by muscle fatigue, decreasing the elite athlete race walking performance, the technique control, and influencing changes in the different variables.

CONCLUSION: In conclusion, the differences observed in our study reveal that the competitive race walking pace would influence the kinematic variables flight time, step length, step frequency and speed. The competitive race walking pace also would influence elite athlete's race walking gait technique and results during a real competition. Implementing practical equipment for evaluating elite race walkers gait technique in the different training phases is essential for professional coaches and athletes; the results of this study showed that the digital running track system is an appropriate tool for observing, measuring, and effectively monitoring elite race walking technique.

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