START REACTION TIME AND PERFORMANCE AT THE SPRINT EVENTS IN THE OLYMPIC GAMES

Theophilos Pilianidis, Athanasios Kasabalis, Nikolaos Mantzouranis and Alexandros Mavvidis

Democritus University of Thrace, Department of Physical Education & Sport Science, Komotini, Greece

Original scientific paper
UDC: 794.422.12:796.032.2

Abstract:

The aim of this study was to assess the relationship between the start reaction time and sprinting performance in athletes who took part in the athletics final events in the Sydney 2000, Athens 2004 and Beijing 2008 Olympic Games. The evaluated data originated from 67 male athletes (N=67) and 68 female athletes (N=68) who participated in the events of 100-m and 200-m sprints and 110/100-m hurdles. The evaluation of start reaction time (ms) and the sprinters' performance (s) was based on the published official reports of the International Association of Athletics Federation. The ANOVA results showed a significant difference between genders in start reaction time only in the 100-m ($F_{(1.44)}$=11.82, p<.01) event. The Bonferroni comparisons regarding the Olympic Games revealed that both in male and female athletes the 100-m start reaction times were significantly better in Beijing 2008 in relation to those in Sydney 2000. Similarly, the start reaction times in 110/100-m hurdles were significantly better in Athens 2004 in relation to the Sydney 2000 Olympic Games. Finally, in the men's 100-m final race in Beijing 2008, both the start reaction time and the performance were better than those of the athletes who participated in Athens 2004 and in Sydney 2000 (r=.490, df=38, p<.01). Conclusively, this study's finding confirms that in modern athletics the start reaction time and the outstanding sprinting performance improved equally.

Key words: *sprint race, speed reaction, starting blocks*

Introduction

Since Koroibos of Elis won the 192-m stadium sprint run in the first Olympic Games in Olympia (776 BC), sport has received considerable scientific attention. The superior performance of modern sprinters is the result of a complex blend of many factors, such as genetic endowment, training and an athlete's health status. From an anthropological point of view, the reaction time is the ability to respond rapidly to a stimulus. The higher speed reaction gives a better reaction time, which is reported as the elapsed time between the presentation of a stimulus and the initiation of an athlete's response. In a variety of individual and team sports the coaching science was focused on the improvement of motor control and coordination in order for the athlete to perform the best reaction times according to the notion of competitive activity (Stein, 1999).

Reaction time is only one of several factors which affect success in modern athletics (Dick, 1987; Bruggemann & Glad, 1990). In sprint events the start reaction time is the time-interval (ms) between the starter's gun signal and the initial moment the athlete is able to exert a certain amount of pressure on the starting blocks. Steinbach and Tholl (1969) originally reported that the elite athletes appear to perform better and have more stabile in reaction times in relation to novice athletes. In addition, the speed reaction shows a decline when the athlete is overtrained, but the improvement is significantly reversible when the athlete has recovered (Doherty, 1985).

The evaluation of start reaction time and 100-m sprinting performance showed that they are not considerably affected. Therefore, the start reaction time in the previously mentioned event contributes approximately 1 to 2% to the overall sprinter's performance (Baumann, 1980; Helmick, 2003). Contrary to the aforesaid, the reaction time in the sprint start cannot predict the finish time in 200m. The reasons for this are that the athletes in 200-m run with a slower speed ($m{\bullet}s^{-1}$) and the duration of the aforementioned event is longer than that of the 100-m sprint or 110/100-m hurdles, resulting in greater differences at the finish line (Collet, 2000; Komi, Ishikawa, & Jukka, 2009). Assessing the impact of start reaction time upon the overall sprinting performance, it should be denoted that the reaction time of 200 ms represents only 2% of a 100-m sprint lasting 10.00s, or 0.4% of a 400-m sprint lasting 45 s (Martin, & Buoncristiani, 1995). However, the athletes with better reaction time in the sprint start had a psychological advantage over their opponents which in many races may be important at the finish line (Stevenson, 1997; Michel, & Jarver, 2002; Henson, Cooper, & Perry, 2002).

Currently, sport scientists must determine the relative contribution of start reaction time in the overall sprinting performance of international-level athletes. Considering that the new false start rule was applied for the first time in the Athens 2004 Olympic Games, the aim of this study was to identify the relationship between the start reaction time and the overall performance in the final sprint events of the athletes who participated in the Olympic Games in Sydney (2000), Athens (2004) and Beijing (2008).

Methods

Subjects

This study's subjects were 67 male (N=67) and 68 female (N=68) athletes who took part in the final races of 100-m and 200-m sprints and 110/100-m hurdles in the athletics events during the Olympic Games in Sydney 2000, in Athens 2004 and in Beijing 2008. Five finalists in the men's (N=5) and four (N=4) in the women's finals races who made a fair start but did not pass the finish line or were disqualified were excluded from this study.

Data collection

The start reaction times (ms) as well as the athletes' sprinting performance (s) were analysed for the final races of 100 metres, 200 metres and 110/100-m hurdles according to the Official Reports published by the International Association of Athletics Federation (IAAF).

Statistical analyses

Descriptive statistics with exploration and cross-tabulation were firstly applied for all the categorical variables. The differences in start reaction times among the 100-m, 200-m and 110/100-m hurdles sprint events sprint events were assessed by using the paired samples *t*-test. Comparisons between continuous (*start reaction time and performance*) and categorical variables [*gender* (men-women) and the *Olympic Games* (Sydney 2000-Athens 2004-Beijing 2008)] were performed by using one-way analysis of variance (ANOVA) (*post hoc* Bonferroni comparisons). The partial correlation analysis was applied in order to assess the unadjusted association between the measured variables *reaction time* and *sprint performance* in relation to gender and the Olympic Games. The statistical significance level was set at $p<.05$. All statistical analyses were carried out employing the SPSS-PC software, version 18.0 for Windows (SPSS, Inc., Chicago, IL).

Results

The descriptive statistics (mean ± SD, 95%CI) of the final races data in 100-m and 200-m races, and in 110/100-m hurdles in the Sydney 2000, Athens 2004 and Beijing 2008 Olympic Games as well as the statistical multiple comparisons are illustrated in Tables 1 and 2. The *t*-test revealed statistically significant differences in the mean start reaction times between 100-m and 200-m races (t=–2.2, df=42, 2-tailed p=.03) as well as between 110/100-m hurdles and 200-m final races (t=–2 .4, df=41, 2-tailed p=.02), while no differences were recorded between 100-m and 110/100-m hurdles, (t=–0.28, df=41, 2-tailed p=.79).

The ANOVA results indicated that the women presented significantly slower start reaction times in 100-m sprint than the male sprinters ($F_{(1.44)}$=11.82, p<.001). On the contrary, no statistical differences related to gender were observed in either 110/100-m hurdles ($F_{(1.45)}$=1.25, p=.27) or in 200-m sprint ($F_{(1.43)}$=0.51, p=.48). Regarding the Olympic Games, the Bonferroni multiple comparisons revealed that the start reaction times in men and women in the 100-m sprint were significantly better in Beijing 2008 in relation only to the start reaction times of the same sprint event in Sydney 2000 (p<.05). Similarly, the reaction times of the athletes in sprint start in 110/100-m hurdles were significantly better in Athens 2004 compared to the same event in the Sydney 2000 Olympic Games (p<.05).

The partial correlation analysis for the start reaction time and performance adjusted for gender did not reveal significant correlations between the aforementioned variables. Similarly, the correlation coefficients of these variables in the Olympic Games gave significant r values only for the 100-m race (Table 3). More specifically, in 100-m race in Beijing 2008 in both the male and female participants a better start reaction time and running performance were observed than in the athletes who had participated in 100m in the Athens 2004 and Sydney 2000 Olympic Games (r=.490, df=38, p<.001). However, no significant differences were reported in the start reaction time in 200-m races, either in male or in female sprinters during the three Olympic Games (r=–.073, df=38, p=.656). Similarly, in 110/100-m hurdles no significant differences were observed during the Sydney 2000, Athens 2004 and Beijing 2008 Olympic Games (r=–.117, df=38, p=.471).

Table 1. Start reaction times (ms) in the Olympic Games final races of 100-m and 200-m races and 110/100-m hurdles (mean ± SD, 95%CI) and the Bonferroni multiple comparisons (p<.05)

	100m		200m		110/100-m hurdles	
	Reaction Time (ms)		Reaction Time (ms)		Reaction Time (ms)	
Men (N=67)						
	Mean (±SD)	95%CI	Mean (±SD)	95%CI	Mean (±SD)	95%CI
Sydney 2000	180* (30)	(152-208)	184 (24)	(167-199)	181 (30)	(155-208)
Athens 2004	166** (12)	(156-177)	210 (48)	(165-255)	158# (21)	(144-171)
Beijing 2008	146***† (14)	(129-164)	184 (24)	(158-209)	169 (11)	(160-178)
Women (N=68)						
	Mean (±SD)	95%CI	Mean (±SD)	95%CI	Mean (±SD)	95%CI
Sydney 2000	207 (32)	(178-237)	191 (25)	(167-215)	209 (42)	(165-250)
Athens 2004	185 (20)	(162-212)	199 (30)	(170-215)	160 (18)	(141-180)#
Beijing 2008	183† (33)	(155-211)	186 (15)	(173-198)	176 (30)	(150-202)

* between genders in the Sydney 2000 Olympic Games
** between genders in the Athens 2004 Olympic Games
*** between genders in the Beijing 2008 Olympic Games
† between the Beijing 2008 and Sydney 2000 Olympic Games
# between the Athens 2004 and Sydney 2000 Olympic Games

Table 2. Finish times (s) in the Olympic Games final races of 100-m and 200-m races and 110/100-m hurdles (mean ± SD, 95%CI)

	100m		200m		110/100-m hurdles	
	Time (s)		Time (s)		Time (s)	
Men (N=67)						
	Mean (±SD)	95%CI	Mean (±SD)	95%CI	Mean (±SD)	95%CI
Sydney 2000	10.05 (0.09)	(9.96-10.14)	20.24 (0.12)	(20.13-20.29)	13.30 (0.19)	(13.10-13.40)
Athens 2004	9.93 (0.09)	(9.84-10.01)	20.14 (0.26)	(19.89-20.38)	13.30 (0.25)	(13.05-13.42)
Beijing 2008	9.89 (0.10)	(9.78-9.99)	20.07 (0.45)	(19.60-20.54)	13.32 0.24)	(13.03-13.41)
Women (N=68)						
	Mean (±SD)	95%CI	Mean (±SD)	95%CI	Mean (±SD)	95%CI
Sydney 2000	11.20 (0.50)	(11.15-11.24)	22.41 (0.14)	(22.28-22.54)	12.90 (0.27)	(12.67-12.96)
Athens 2004	11.04 (0.92)	(10.93-11.05)	22.51 (0.32)	(22.09-22.69)	12.60 (0.17)	(12.42-12.78)
Beijing 2008	11.04 (0.13)	(10.93-11.16)	22.20 (0.34)	(21.92-22.49)	12.68 (0.11)	(12.58-12.77)

Table 3. Inter-correlation table for start reaction time and sprinting performance adjusted by gender and the Olympic Games (p<.05)

Variables	r	p values	Significance
Gender			
Sprint 100m vs Sprint 100m RT	.228	p=.156	ns.
Sprint 200m vs Sprint 200m RT	–.068	p=.677	ns.
Sprint 110/100m vs Sprint 110/100m RT	.212	p=.190	ns.
The Olympic Games			
Sprint 100m vs Sprint 100m RT	.490	p<.01	sig.
Sprint 200m vs Sprint 200m RT	–.073	p=.656	ns.
Sprint 110/100m vs Sprint 110/100m RT	–.0117	p=.471	ns.

Discussion and conclusions

The results showed that in the Olympic Games by lengthening the distance of the event, the mean start reaction times linearly increased. The aforementioned is similar to previous studies' findings, in which it was reported that the increase of race length caused a significant linear increase in average start reaction time in world-class athletes (Baumann, 1980; Babic & Delalija, 2009[a]). An apparent explanation for this evidence is that the athletes in 200-m race realize that the reaction time represents a small contribution to their total performance at the finish phase (Locatelli & Arsac, 1995).

Similarly to the recent published reports, this study's finding confirms that the start reaction time of men in sprint events is better than that of female athletes (Babic & Delalija, 2009[b]). However, these findings are in contrast with another study's results which denoted that in the world's best athletes no significant differences were observed in start reaction time between men and women in sprint events (Martin & Buoncristiani, 1995).

The evaluation of the inter-relationships of start reaction times in 100-m and 200-m races, as well as in 110/100-m hurdles among the last three Olympic Games showed that the best reaction time of all was recorded in the 100-m final race in Beijing 2008. Such findings contrast the new IAAF sprint false start regulations which were applied for the first time in the Athens 2004 Olympic Games. However, this may be interpreted by the fact that the athletes' overall sprinting performance development from 2000 to 2008 improved their reaction time in sprint start as well.

Concerning the assessment of start reaction time as a component of sprint performance, this study confirms that the reaction time in the sprint start does not directly correlate with the finish time in either male or female sprinters (Moravec, et al., 1988). Specifically, the significant correlation, which was recorded in this study between the start reaction time and the sprinting performance in 100-m sprint race finalists, is in agreement with a similar design study which evaluated top-level sprinters and found that the start reaction time is strongly correlated with the sprinting performance (Paradisis, Zacharogiannis, Smirniotou, Tziortzis, & Kritharakis, 2006).

However, it is of great importance to denote that in the 100-m final race in Beijing 2008 the male sprinters had outstanding mean start reaction times (146 ms). In addition, the average final race times in 100-m sprint (9.89 s) were much better in Beijing 2008 in relation to the final races times in the Athens 2004 and Sydney 2000 Olympic Games. Possibly the presence of the Jamaican sprinter Usain Bolt with a start reaction time of 165 ms and time 9.69 s (World Record) had a strong influence in both start reaction times and running performance among the finalists of this historical race in the Beijing 2008 Olympic Games.

In summary, this study showed that if the start reaction time is better, the sprinting performance is presumed to be higher. This leads us to the assumption that the start reaction time seems to improve equally with the superior performance of the modern sprinters. Therefore, just before the London 2012 Olympic Games coaches will have to work with their athletes both on the development of the muscular-skeletal system by applying complex sequential skills and on the improvement of the sprinter's concentration in order to achieve faster start reaction times which will lead to an outstanding sprinting performance.

References

Babic, V., & Delalija, A. (2009). Reaction time trends in the women's sprint and hurdle events at the 2004 Olympic Games. *New Studies in Athletics*, *24*(1), 49-57.

Babic, V., & Delalija, A. (2009). Reaction time trends in the sprint and hurdle events at the 2004 Olympic Games: Differences between male and female athletes. *New Studies in Athletics*, *24*(1), 59-68.

Baumann, W. (1980). Kinematic and dynamic characteristics of the sprint start. In P.V. Komi (Ed.), *Biomechanics V-B. International Series on Biomechanics, Volume 1B* (pp. 34-47). Baltimore, MD: University Park Press.

Bruggemann, G.P., & Glad, W. (1990). Biomechanical analyses of the jumping events; time analysis of the sprint and hurdle events: *IAAF Scientific Research Project at the Games of XXXIV^th^ Olympiad-Seoul 1988*: Final Report. Monaco: IAAF.

Collet, C. (2000). Strategic aspects of reaction time in world class sprinters. *Track Coach*, *152*, 486.

Dick, W.F. (1987). Developing sprinting speed. *Athletics Coach*, *21*(4), 4-5.

Doherty, K. (1985). *Track and Field Omnibook*, 4th Ed. Tafnews Press: Los Altos.

Helmick, K. (2003). Biomechanical analysis of sprint start positioning. *Track Coach*, *163*, 5209-5214.

Henson, P., Cooper, J., & Perry, T. (2002). A wider look at the sprint start. *Track and Field Coaches Review*, *75*(4), 19-21.

Komi, V.P., Ishikawa, M., & Jukka, S. (2009). IAAF Sprint Start Research Project: Is the 100ms limit still valid? *New Studies in Athletics*, *24*(1), 37-47.

Locatelli, E., & Arsac, L. (1995). The mechanics and energetic of the 100m sprint. *New Studies in Athletics*, *10*(1), 81-87.

Martin, D., & Buoncristiani, J. (1995). Influence of reaction time on athletic performance. *New Studies in Athletics*, *10*(1), 67-79.

Michel, S., & Jarver, J. (2002). The start is (almost) everything in sprint performance. *Track Coach*, *160*, 5121.

Moravec, P., Ruzicka, J., Susanka, P., Dostal, E., Kodejs, M., & Nozek, M. (1988). The 1987 International Athletic Foundation/IAAF Scientific Project Report: Time analysis of the 100 metres events at the II World Championships in Athletics. *New Studies in Athletics*, *3*, 61-96.

Paradisis, G., Zacharogiannis, E., Smirniotou, A., Tziortzis, S., & Kritharakis, A. (2006). Correlation of reaction time and performance in 100m sprint running. *Medicine and Science in Sports and Exercise*, *38*(5), S518.

Steinbach, M., & Tholl, R. (1969). Uber die Reaktionszeit. [About the reaction time. In German.] *Die Lehre der Leichtathletik*, *20*, 33.

Stevenson, M. (1997). The sprint start: save as many split-seconds as you can on the start and you‘ll be in pretty good shape at the finish. *Coach and Athletic Director*, *66*(8), 18-20.

Stein, N. (1999). Speed training in sport. In B. Elliot (Ed.), *Training in sport: applying sport science*. Chichester: Wiley.

Submitted: March 11, 2011
Accepted: January 25, 2012

Correspondence to:
Assoc. Prof. Pilianidis Theophilos, Ph.D.
Democritus University of Thrace
Department of Physical Education & Sport Science
University Campus, 69100 Komotini, Greece
Phone: ++30531039683
Mobile: ++30932472967
E-mail: Thpilian@phyed.duth.gr

VRIJEME STARTNE REAKCIJE I REZULTAT TRČANJA U SPRINTERSKIM DISCIPLINAMA NA OLIMPIJSKIM IGRAMA

Cilj je ovog istraživanja bio utvrditi povezanost između vremena startne reakcije i rezultata u sprintu atletičara koji su nastupili u finalima Olimpijskih igara u Sydneyu 2000. godine, Ateni 2004. godine i Pekingu 2008. godine u sprinterskim disciplinama. Analizirani su rezultati 67 natjecatelja i 68 natjecateljica koji su nastupili u disciplinama trčanja na 100m, 200m i 110/100m s preponama. Evaluacija vremena startne reakcije (ms) i rezultata u sprintu (s) bazirala se na izvješćima koje je službeno objavila Međunarodna atletska federacija (IAAF). Rezultati analize varijance su pokazali značajnu razliku između spolova u vremenu startne reakcije samo u disciplini trčanje na 100 m ($F_{(1.44)}$=11,82, p<.01). Usporedba rezultata među Olimpijskim igrama, provedena Bonferronijevom metodom, otkrila je da su i muškarci i žene bili značajno bolji u disciplini trčanje na 100 m u Pekingu 2008. godine no u Sydneyu 2000. godine. Isto tako, vremena startne reakcije u disciplinama trčanje na 110/100 m s preponama bila su statistički značajno bolja u Ateni 2004. godine nego u Sydneyu 2000. godine. I naposljetku, u muškoj finalnoj utrci na 100 m u Pekingu 2008. godine i vrijeme startne reakcije i ukupan rezultat trčanja bili su bolji nego rezultati onih koji su se natjecali u Ateni 2004. i Sydneyu 2000. godine (r=.490, df=38, p<.01). Zaključno, rezultati ovog istraživanja pokazuju da su se u modernoj atletici, vrijeme startne reakcije i ukupno vrijeme trčanja jednako poboljšali.

Ključne riječi: *sprinterska utrka, brzina reakcije, startni blokovi*