DIFFERENCES IN TIME OF START REACTION IN THE SPRINT DISCIPLINES IN THE FINALS OF THE OLYMPIC GAMES (ATHENS, 2004 - LONDON, 2012)

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Abstract
In the sprint events a very important place take the start and start acceleration which is largely generated by the final score. Depending on the appropriate individual morphological dimension, especially motor and functional abilities of competitors, good possibility to implement these parameters is certain. However, despite the excellent results they achieve, differences in these two parameters are evident, which in terms of the final result has a certain effect. The aim of this study was to determine the differences in the starting reaction of the finalists at the Olympic Games in Athena, 2004., Beijing, 2008., and London, 2012. The results from the finalists 144 (72 male and 72 women) participants were analysed that participated in the final races in the 100m, 200m and 400m. The evaluation of starting reaction time (ms) and results in a sprint (s) based on the reports that were officially published by the International Association of Athletics Federations (IAAF). In accordance with the results it can be concluded that no statistically significant differences in the time of start of the reaction between male and female finalists at the Beijing Olympics in the discipline of running 100m (t= -2.926) in the discipline of running 400m at the Olympic Games in London (t= -2.728*). Between male finalists at the Olympics were also identified differences in the 100m and 400m events (p<0.01 and p<0.05), while the 200 is not. In the women's finalists were statistically significant differences in any discipline at the Olympics, at the level (p<0.01 and p<0.05).*

Key words: *the Olympic Games, sprint, reaction time, the differences, male and female athletics*

Introduction

Starting acceleration is relevant in all sprint athletic disciplines, as in many other branches of sports which require developing the speed in relatively short distance (tennis, volleyball, handball, basketball, soccer, etc.). However, in the sprint events start and starting acceleration, as the two major components largely generate the final result of running the 60m, 100m, 200m and 400m (Čoh & Tomažin, 2008). It is said that the starting acceleration is of one of the most complex segments of the sprint, in which can be rationalized sprint capacity that will be manifested only in the segment of maximal running speed. The most common length in start accelerating is from 25-30m, at which the top sprinters in the first 10m develop 50 to 55% of their maximum speed, and in other 10 (up to 20m) 70-80% in the third 10 (up to 30m) 85-95% (Čoh, 2001). Between 50 and 80m they achieve maximum speed, and after 80-90 meters the speed decreases. It is therefore no coincidence that many of the authors entered the biomechanical analysis of these two phases in order to explain the phenomenon of sprint speed and start acceleration based on the time of the start reaction (Mero, Luhtanen, & Komi, 1983; Moravec, Ruzicka, Susanka, & Nosek, 1988; Coppenolle & Delecluse, 1989; Coppenolle, Delecluse, Goris, Diels , & Kraayenhof, 1990; Brüggemann & Hunger, 1990; Mero & Komi, 1990; Guissard, Duchateau, & Hainaut, 1992; Delecluse, Coppenolle, Diels, & Goris, 1992; Schot & Knutzen, 1992; Mc Clements, Sanders, & Gander, 1996, Harland & Steele, 1997, Coh, Peharec & Bacic, 2007; Bračić, Peharec Bacic & Coh, 2010).

The start of the sprint and start acceleration are the first two factors of sprint speed with which athlete tries to achieve maximum speed. Earlier Tom Tellez study, of the legendary coach of Carl Lewis showed that these two phases are as much as 64% of participation in the sprint result at 100 m (Téllez & Doolittle, 1984). Studies by some other authors (Coppenolle & Delecluse, 1990;. Schot & Knutzen 1992, Korchemny, 1992; Guissard, Duchateau, & Hainaut, 1992; Harland & Steele, 1997; Wang, 2006; Pain & Hibbs, 2007; Babic, 2008; Babic & Coh, 2010) have agreed that the result in the sprint depends from the position in the start block that. from the center of gravity of the body, start reaction time and from start accelerating. Optimal coherence between the start of the sprint start and start acceleration represent specific motor problems that athletes must integrate in terms of time and spatial parameters in the unipolar movement of cyclic character. Start acceleration is a complex cyclic motion defined mainly by progression of frequency and step length, duration of the contact phase and the phase of flight and the position of the center of gravity of the body at the moment of contact with the ground, the propulsion in phase of the flight and the forces that are handled in the first step (Hunter, Marshall, & McNair, 2005; Bračić, Peharec Bacic & Coh, 2010). All these parameters are conditioned by the operation of CNS, motor skills, energy processes, morphological characteristics and structure of muscle (Cavagna, Komárek, and Mazzoleni, 1971; Mann & Sprague, 1980; Mero, Kuitunen, Harland, Kyrolainen, & Komi, 2006; Moravec et al, 1988; Mero & Komi, 1990; Mero, Komi, & Gregor 1992, Locatelli & Arsac, 1995; Young, McLean, Ardagna, 1995; Muller & Hommel, 1997; Coh, et al. 1998; Coh, Tomažin , and Štuhec, 2006). In modern athletics, the time of the start reaction becomes more and more important in the result success. It is about the top sprinters with outstanding results in both categories, that their path to success is based on good implementation of this factor. By the good realization they tend to in the first meters of shooting acquire certain advantage that they want to keep until the end of the race. Often at the major events (Olympic Games, World and European Championships, Diamond League) are observed some differences in the time of the start reaction between disciplines and depending on gender.

However, sometimes these differences are not large, so for example, often, the 100m sprinters achieve almost the identical reaction time to reaction time at 400m or between the reaction time in the 100m, 200m or 400m there is no significant difference, although it is about some differences in the length of the track. These findings are in contrast to the fact that the importance of start acceleration and reaction time is more important at shorter (Moravec, 1988) than in the longer sprint events. This suggests that these are elite athletes who engage most of their mental and physical capacity, regardless of the length of the track. Also, some studies have shown that certain characteristics of a sprinter and the response time were extremely good predictors of results in the sprint (Brueggemann & Hunger, 1990; Buonchristiani & Martin, 1995; Ozolin, 1996; Susanaka et al. 1998). Also (Martin & Buonchristiani, 1995), believe that for the final result in the sprint (100m and 200m) are more important, the length of acceleration, maximum speed achieved and speed-endurance. Moravec, Ruzicka, Susanka, et al. (1988) analyzed the sprint events at the II World Championships in Rome and confirmed the results of the research in 1982 (Dostal) and gave reaction times at larger competitions for men and women.

They also confirmed that the results of the reaction time at the World Championship in 1987. were significantly different from the results obtained on large competitions held from 1978. to 1986. Duffy 2004 according to Smajlović and Kozic, 2006, in his study of reaction time at 16 top sprinters sample of top sprinters participants of the meeting of the Golden League Rome 2003, indicate that the average response time was 153ms (± 28ms) and that the average response time in the semi-final and final races of discipline the men's 100m at the World Championships from 1997 to 2003 range from 120ms to 160ms, while the correlation of reaction and results in the race is .05. Some authors (Smajlović and Kozic 2006) tried to determine the effects of change in athletic rules on time of start reaction in sprint events. In a sample of top athletes participants in the World Championships in Edmonton in 2001 and Paris in 2003, results were obtained that confirmed the differences in the starting reaction time between the two World Championships in events, 100m, 200m, 110m and 100m hurdles for men and women, while differences). The research the difference of time starting reaction and achieved results of the World Championships in Moscow were conducted (Pavlovic, Rakovic, Idrizović & Mihajlovic 2013). Analyzed the results of male and female finalists in the races at 100m, 200m and 400m. Results of the analysis of T-test showed statistically significant differences in reaction time among female athletes in running events of 100m and 400m (**) as well as the 200m and 400m events (**), unlike male finalists which have not been reported statistically significant differences. Also, in the same disciplines between genders were no statistically significant differences, as evident in the results achieved in the 100m, 200m and 400m (**). Authors (Colet 2000; Babic, 2008; Babic & Coh, 2010; Theophilos Pilianidis, Kasabalis, Mantzouranis, & al. 2012) have studied this parameter in terms of sprint discipline trying to analyze the response time of start reaction and running result in sprint disciplines at major events, such as the European Championships and Olympic Games.

This study is based on reasons precisely because of the importance of starting acceleration in athletic sprint events, based on the starting time of the start reaction. The main objective of this study was to identify and analyze the differences in the time of starting reaction of the finalist of Olympic Games of Athena, 2004. to London 2012. in the sprint events. In addition to its primary objective, partial objectives are contained in: - determining the difference in time between the start of the reaction of male and female finalists in the 100m, 200m and 400m at the Olympic Games (Athens, 2004 - London, 2012); - determining the differences in the time of starting reaction male athletes in the 100m, 200m and 400m at the Olympic Games (Athens, 2004 - London, 2012); - determining the differences in the time of starting reaction female athletes in the 100m, 200m and 400m at the Olympic Games (Athens, 2004 - London, 2012)

Methods

The population defined in the research has included top male and female athletes in the sprint events Olympic Games (Athena, 2004; Beijing, 2008; London, 2012). The sample included a total of 144 finalists (77 male and 77 female competitors), who participated in the final races of sprint events (100m, 200m, 400m). Starting reaction time (ms) are taken from the official report of the Olympic Games of 2004, 2008 and 2012, issued by the IAAF. Data obtained in the survey were analyzed by standard descriptive methods, and the differences between groups of respondents-finalists were tested using Student's t-test for independent samples. Statistical analysis was done using the statistical program Statistica 6.0.

Table 1 Basic statistical parameters finalists Olympics Game

			Mean	Min.	Max.	Range	SD	Skew.	Kurt.
Athena 2004	100	m	,168	,151	,188	,037	,012	,396	,050
		w	,185	,154	,212	,058	,020	-,184	-1,006
	200	m	,210	,153	,294	,141	,049	,761	-,121
		w	,199	,162	,259	,097	,031	,886	1,044
	400	m	,260	,178	,352	,174	,050	,276	1,839
		w	,245	,205	,276	,071	,024	-,419	-,579
Beijing 2008	100	m	,146	,133	,169	,036	,014	,874	-,654
		w	,183	,149	,234	,085	,033	,858	-,832
	200	m	,177	,144	,212	,068	,025	,279	-1,133
		w	,186	,167	,206	,039	,015	,075	-2,098
	400	m	,230	,164	,318	,154	,051	,855	,051
		w	,242	,181	,378	,197	,066	1,449	1,712
London 2012	100	m	,162	,139	,179	,040	,015	-,338	-1,343
		w	,156	,128	,176	,048	,015	-,525	,148
	200	m	,174	,153	,216	,063	,020	1,396	2,177
		w	,166	,150	,176	,026	,009	-,707	-,448
	400	m	,162	,143	,185	,042	,013	,487	,081
		w	,193	,167	,258	,091	,029	2,042	4,829

Table 2 The differences in the time of the starting reaction between male and female finalists

Olympic Game	Disciplines	Reaction Time (s) Men (N=72) : Women (N=72)			
		Gender	Mean ± SD	T-test	p-level
Athena 2004	100	Men	0,168± 0,012	-2,064	0,058
		Women	0,185± 0,020		
	200	Men	0,210±0,049	,525	0,608
		Women	0,199±0,031		
	400	Men	0,260±0,050	,731	0,477
		Women	0,245±0,024		
Beijing 2008	100	Men	0,146±0,014	-2,926	0,011*
		Women	0,183±0,033		
	200	Men	0,177±0,025	-,869	0,399
		Women	0,186±0,015		
	400	Men	0,230±0,051	-,398	0,697
		Women	0,242±0,066		
London 2012	100	Men	0,162±0,015	,847	0,411
		Women	0,156±0,015		
	200	Men	0,174 ±0,020	1,037	0,317
		Women	0,166±0,009		
	400	Men	0,162±0,013	-2,782	0,015*
		Women	0,193±0,029		

Mean (average value), standard deviation (SD), coefficient of t-test value(T-value), significance level (Sig.* p<0,05)

Table 3 Differences in the time of start of the reaction between male finalists

Disciplines	Reaction Time (s) Men (N=72)			
	Olympic Ganme	Mean ± SD	T-test	p-level
100m	Athena	0,168± 0,012	3,456	0,004**
	Beijing	0,146±0,014		
	Athena	0,168± 0,012	,907	0,380
	London	0,162±0,015		
	Beijing	0,146±0,014	-2,199	0,045*
	London	0,162±0,015		
200m	Athena	0,210±0,049	1,694	0,114
	Beijing	0,177±0,025		
	Athena	0,210±0,049	1,940	0,074
	London	0,174 ±0,020		
	Beijing	0,177±0,025	,285	0,780
	London	0,174 ±0,020		
400m	Athena	0,260±0,050	1,170	0,262
	Beijing	0,230±0,051		
	Athena	0,260±0,050	5,384	0,000**
	London	0,162±0,013		
	Beijing	0,230±0,051	3,704	0,002**
	London	0,162±0,013		

Mean (average value), standard deviation (SD), coefficient of t-test value(T-value), significance level (Sig.**p<0,01; * p<0,05)

Table 4 Differences in the time of start of the reaction between female finalists

Disciplines	Reaction Time (s) Women (N=72)			
	Olympic Game	Mean ± SD	T-test	p-level
100m	Athena	0,185± 0,020	,145	0,887
	Beijing	0,183±0,033		
	Athena	0,185± 0,020	3,283	0,005**
	London	0,156±0,015		
	Beijing	0,183±0,033	2,139	0,050*
	London	0,156±0,015		
200m	Athena	0,199±0,031	1,105	0,288
	Beijing	0,186±0,015		
	Athena	0,199±0,031	2,983	0,010*
	London	0,166±0,009		
	Beijing	0,186±0,015	3,287	0,005**
	London	0,166±0,009		
400m	Athena	0,245±0,024	0,135	0,894
	Beijing	0,242±0,066		
	Athena	0,245±0,024	4,008	0,001**
	London	0,193±0,029		
	Beijing	0,242±0,066	1,930	0,074
	London	0,193±0,029		

Mean (average value), standard deviation (SD), coefficient of t-test value(T-value), significance level (Sig.**p<0,01; * p<0,05)

In Table 1 are presented the basic statistical parameters of the starting reaction time (RT) of male and female finalists of the Olympic Games (Athens, 2004.-London, 2012.). Looking at Table 1 it is mainly observed normality of distribution, with a few exceptions in terms of symmetry and dispersion of results. Less homogeneity manifests itself in the discipline 400m for women, with higher values of kurtosis, and it can be concluded that it is about a greater range of actual response time in this event, which was recorded by the female finalists at the Olympics. Also, the increased value of skewness is the proof that it is about large value of the reaction time in the same event. In running 200m for men were observed increased measures of variability in both parameters, but slightly less than in the previous case. By inspection of Table 1 it can be concluded that the medium (numerically the least) the reaction time in the 100m discipline in men (Beijing-0,146sec.) with the lowest (fastest) response time of 0.133sec. from all disciplines in both competitions. As the lowest average and individually starting reaction time was also achieved in male finalist in the 400m discipline (Athena, mean= 0.260 sec., or Max.=0.352sec). The range of the best start reaction time to the lowest time in both categories is 0.250 sec. which is not a big difference if you take into account the diversity of track length (100mW:400mW). In order to identify any differences in the starting reaction time by events for male and female finalists and reaction time differences between the sexes, there has been applied t-test for independent samples. In Table 2 are presented differences in the starting reaction time of male and female finalists in events 100m, 200m and 400m at the Olympic Games (Athens 2004, Beijing 2008, London, 2012). By inspection of Table 2, differences between the disciplines were realized but the differences were not statistically significant. The results of t-test showed statistically significant differences between male and female finalists determined at the Olympic Games in Peking 2008 in the discipline of 100m (t =-2.926*) and discipline 400m at the Olympic Games in London 2012. (t=-2.728*) in favor of males finalists, which had quicker start reaction time. At the Olympic Games in Athens, 2004th male finalists had a faster reaction in the discipline of 100m, and the women in the 200m and 400m. Also, women were better than men's sprinters in London in the disciplines of 100m and 200m, while the male finalists achieved faster reaction in the 200m and 400m in Peking 2008., but without statistical significance. Compared with male finalists, it can be concluded that the women in the Olympic Games in Beijing were the weakest in the reaction time in all disciplines, while in Athens and London, those differences were minimal. Overall, in the three Olympic cycles women achieved the best start reaction in London 100m (RT=156ms), 200 (RT=166ms), 400m (RT=193ms). Unlike women men at the Beijing Olympics had the best reaction in the discipline 100m (RT-146ms), while in London they were the best in events 200m (RT=174ms) and 400 (RT=162ms). London Olympics are an indication of better training process in the sprint events, which is manifested in better coordinating-speed characteristics and development of the neuro-motor reactions of sprinters.

In Table 3 are presented the differences in the starting reaction time of male finalists in sprint events at the Olympics. By inspection of Table 3, the differences were recorded in the 100m and 400m events. The results of t-test showed statistically significant differences of male finalists in running the 100m were determined between Athens Olympic Games in Beijing (t=3.456**) and Beijing-London (t=-2.199*). The fastest time of starting reaction in the discipline 100m have achieved finalists of the Olympic Games in Beijing (RT=0.146 ± 0.014 sec.) and the lowest in Athens (RT=0.168 ± 0.012 sec). Average reaction time in running 100m in three Olympics is 0.159 sec. In the 200m event the differences between the finalists were determined, but did not reach statistical significance.

The best (fastest) reaction time was recorded in the finals of the Olympic Games in London (RT=0.174 sec) and the lowest in Athens (RT= 0.210 sec). Statistically significant differences were recorded in the final races at 400m from the Olympic Games in Athens and London (t=5.384**) and between the Beijing Olympic Games and London (t=3.707**). The fastest start reaction achieved finalists in London (RT=0.162±0.013 sec), and the lowest in Athens (RT=0.260 ± 0.050 sec.) which is almost 100ms difference.

The mean reaction time in all three competitions amounted to 0, 217sec. Looking at Table 4 it can be concluded that in the Olympics in women's finalists were recorded five statistical differences in sprint disciplines. In the discipline of 100m statistically significant differences were achieved between the Olympic Games Athens-London (t=3.283**) and between the Beijing-London (t=2.139*). The fastest time of starting reaction in the discipline 100m achieved women finalists of the Olympic Games in London (RT=0.156 ± 0.015 sec.) and the lowest in Athens (RT=0.185 ± 0.020 sec), while the average start reaction time in running 100m in three Olympics amounted approximately 0,175 sec in a range from 0,029 sec. At the same Olympics were evidented differences in the 200m event. Significant statistical difference in the results was achieved between games in Beijing and London (t=3.287**), where the fastest reaction time was achieved (RT=0.166±0.009sec). The differences were recorded between Athens and London (t=2.983*) with the slowest reaction (RT=0.199±0.031sec).

The average reaction time for all three Olympics was about 0.183 sec. with a range of 0.033 sec. High statistical difference was observed in the final 400m race between games in Athens and London (t=4.008**). The fastest reaction in the final race was achieved at the Olympic Games in London (RT=0.193±0.029 sec.), the slowest in Athens (RT=0.245±0.024 sec). The average time in this event was about 0.227 sec. with a range of from 0.052 sec.

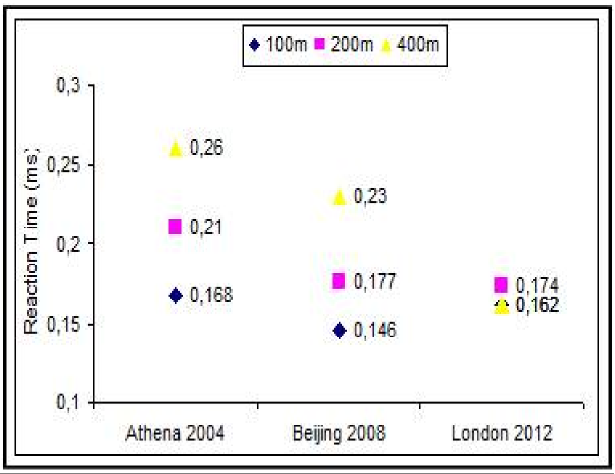

Figure 1 Mean the reaction time of male finalists

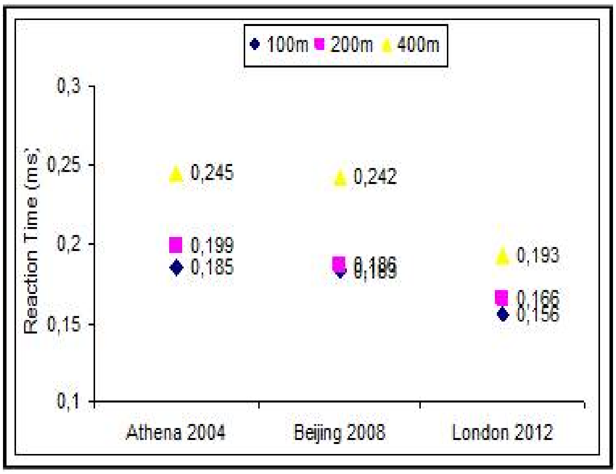

Figure 2. Mean the reaction time of female finalist

Discussion

Starting acceleration is one of the most complex segments of the sprint, in which can be rationalized sprint capacity that will be manifested only in the segment of maximal running speed. The time lost due to poor start reaction, poor start and, ineffective start progression and late reaching speed, it is difficult or impossible to make it up in the rest of the race (Smajlović and Kozić, 2006). However, in recent times it also happens that a poor start, starting with a lower reaction does not necessarily mean the failure of the race, and weaker result. This conclusion is supported by the planet's fastest man, Usain Bolt, who in the finals of the Olympic Games in London achieved the fifth time of starting reaction (160ms) in the 100m and sixth in the 200m (180ms) and still took first places. These remarks confirm earlier studies which claim that for the final score in the sprints (100m and 200m) are more important length of acceleration, reached maximum speed and speed-endurance (Buonchristiani & Martin, 1995).

It is believed that the execution of the contact phase after the start and during the race one of the most important generators of success in the implementation of sprint speed (Lehmann & Voss, 1997). Contact phase should be as short as possible with an optimal phase of reflection and phase of flight, while step frequency depends on the functioning of the CNS and is genetically determined, increased step frequency, shorter step and vice versa (Mero, Komi, and Gregor, 1992). The high performance of sprinters are the result of a complex mixture of many factors such as genetic potential, training and health of athlete. From the anthropological point of view, the reaction time is the ability to quickly respond to stimulation. Higher reaction rate gives better response time, which is only one of several factors that influence the success of modern athletics (Dick, 1987; Brüggemann & Hunger, 1990; Pain & Hibbs, 2007). In the sprint events start reaction time is the time interval (ms) of pistols signal and movement of athlete when he will put pressure on the starting blocks.

Steinbach and Tholl (1969) were once published a study stating that elite athletes have a faster and more stable response from novice athletes. In addition, the reaction speed shows decreased result when athlete did not train (Doherty, 1985), so the initial reaction time affects about 1 to 2% of the total score of sprinter (Baumann, 1980; Helmick, 2003). Contrary to the above, the reaction time in the sprint can not predict the final time in the 200m, compared to the 100 and 110m hurdles, because of the long run at finish line (Collet, 2000, Komi, Ishikawa, & Jukka, 2009). Time of 200ms represents only 2% of the 100m sprint in 10.00 s duration, or 0.4% of the 400m sprint, which takes about 45 seconds (Buonchristiani & Martin, 1995). However, research (Stevenson, 1997, Michel and Järvere, 2002 Henson, Cooper, and Perry, 2002) have shown that athletes with better response time to the beginning of the sprint had the psychological edge over their opponents, which in many races may be important on the target plane. Comparing the results of this study with previous (Moravec et al. 1987, Colet 2000; Duffy, 2004 Smajlović and Kozić 2006; Babic, 2008) it can be concluded that these are the results achieved almost of the same level in all disciplines. The study Theopilos Pilianidis, et al. (2012) found that both men and women were significantly better in the discipline of running on 100m in Beijing in 2008. than in Sydney in 2000. Similarly, the times of starting reaction in the disciplines of running 100/110m hurdles were significantly better in Athens in 2004. then in Sydney in 2000. Finally, in the men's 100m final race at the Beijing in 2008. Both the time of start reaction and overall score of running's were better than the results of competitors that participated in Athens in 2004. and in Sydney in 2000.

Also the results of this research in the discipline of 100m are slightly weaker from the results of the Rome Golden League meeting in 2003. Comparing the results of this study with previous (Moravec et al. 1987, Colet 2000; Duffy, 2004 Smajlović and Kozić 2006; Babic, 2008) it can be concluded that these are the results achieved almost of the same level in all disciplines. The study Theopilos Pilianidis, et al. (2012) found that both men and women were significantly better in the discipline of running on 100m in Beijing in 2008. than in Sydney in 2000. Similarly, the times of starting reaction in the disciplines of running 100/110m hurdles were significantly better in Athens in 2004. than in Sydney in 2000.

Finally, in the men's 100m final race at the Beijing in 2008. Both the time of start reaction and overall score of running's were better than the results of competitors that participated in Athens in 2004. and in Sydney in 2000. Also the results of this research in the discipline of 100m are slightly weaker from the results of the Rome Golden League meeting in 2003. Previous results have shown that the Olympics with extending tracks , increases linearly also the time of the starting reaction in world-class sprinters (Baumann, 1980; Babic & Delalija, 2009).

Also, in some studies it was confirmed that the time reaction of male sprinters is better than women.
However, the results of this study are in contrast to studies that have confirmed that there is no difference in the time of the starting reaction between male and female sprinters (Buonchristiani & Martin, 1995). When it comes to reaction time differences by gender, the results of this study partly confirmed (Table 2). Almost identical results were obtained by Smajlović and Kozic in 2006 in their study of world championships in Edmonton in 2001 and in Paris in 2003.

The results indicate that it is about superb athletes, with good performances and the differences are almost impossible or minimal. The differences are evident not only in the reaction time, but also in some mental and physical abilities only in cases if it is about selected, and non-selected categories. Also with this goes that only a good selection, the technology of the training process, with of course naturally predisposed there could be success (Meckel, Atterborm, Grodjinovsky, Ben-Sira, & Rotstein, 1995). Significant impact on the response time in sprint and the implementation of starting acceleration is in dependence of the force manifestation of isometric and isotonic muscle contraction on the starting blocks, the position and angle of the knee joint, the horizontal and vertical impulses (Young, McLean, & Ardagna 1995; Hunter, Marshall, & McNair, 2005). In their study (Coh, Tomažin, and Štuhec, 2006) analyze and identify the main kinematic parameters in the phase of the sprint and starting acceleration that affect the overall result.

The research has shown that the optimum distance of blocks, the speed of leaving the starting blocks, the length of the first step, height of center of gravity of the body in the first three meters of acceleration, the optimal ratio between length and step frequency key success factors in the two-stage sprint. Researches (Dostal, 1982 by Smajlović and Kozić 2006; Moravec et al. 1988) have confirmed that the starting time of the reaction in the sprint is not directly correlated to the final result neither in male nor in female sprinters. Similar research in ten leading sprinters conducted Paradisis et al. 2006 and obtained conflicting results. They found that the time of starting reaction is closely related to the results in the sprint.

This is particularly important, given that in the final race in London in 2012. men achieved a mean time of starting reaction 162ms and a total score of 10.09 sec. Also, in the final of the Beijing Olympic Games in 2008, male sprinters had an average response time of starting reaction (146ms) and achieved a total score of 9.89 sec. and they were better than in the final race of the OG in Athens in 2004 and in Sydney in 2000. At the World Championship in Berlin 2009.there has been, so to speak, an explosion of the results. In 2009. The average reaction time of male finalists was better than in Beijing (138 ms with the achieved result 9.91 sec.).

Perhaps the presence of Jamaican Usain Bolt in all the finals, with the reaction times of 165ms and a world record time of 9.69 sec. in Beijing, then 146ms and 9.58 sec. in Berlin, and finally 165ms and 9.63 sec. in London in 2012. had a strong influence in all three starting reactions and performances of these final races.

Also, the same formula can be given for women's finalists, where the first-placed SA Fraser-Pryce made the response time of 153ms and the result of 10.75 sec. and second-placed C. Jeter 153ms and 10.78 sec. Also, the observation that the response time is linearly increasing with the lengthening of the section (Baumann, 1980; Babic 2008; Babic & Delalija, 2009) can not be fully accepted. As an argument against this conclusion are less average values of response time achieved in the final 400m in London for men (161ms) compared to 100m (162ms) and 200 (174ms). The results of this study indicate that in the modern track and field, the time of starting reaction and total running time are equally improved, that there is no difference by gender and there are not evident statistically significant differences by the disciplines.

The results are in contrast to research of some authors who state that the time of reaction in female sprinters response is slower than in male sprinters, and that it increases with the length of the section. Also research findings are inconsistent with the results of Babic (2008) who analyzed the participants of qualification groups, the semi-final and final at the Athens Olympics in 2004. in sprint events and hurdles for women, where she received the results that in almost all disciplines were achieved statistically significant differences.

In general, these results partially confirm the results of previous researches in the sprint events related to the World Championships in Rome, 1987 (Susanaka et al.1988), Stuttgart, 1993 (Martin & Buonchristiani, 1995), in Edmonton, 2,001. and Paris, 2003 (Smajlović & Kozic, 2006) and the Olympic Games in Seoul in 1988 (Brueggemann, & Hunger, 1988) and Athens 2004 (Smajlović and Kozic 2006; Theophilos Pilianidis et al. 2012, Pavlović et al.2013).

Conclusion

The study included a sample of 144 (72 male and 72 female) athletes who have performed in the finals of the Olympic Games (Athens 2004.- London 2012) in the sprint events: 100m, 200m, 400m. The study was aimed to determine any statistically significant difference in the start time of the reaction and results in the sprint discipline at the Olympic Games (Athens, Beijing, London). Results of reaction time and 'score works that have achieved the finalists are the same and the higher level of previous studies of the top athletes . Probability distributions slightly better results of this study lies in the fact that it is a final competition where they performed only the best in both competitions. In accordance with the results it can be concluded that no statistically significant differences in the time of start of the reaction between male and female finalists at the Beijing Olympics in the discipline of running 100m ($t= -2.926$ *) in the discipline of running 400m at the Olympic Games in London ($t= -2.728$ *). By analyzing the results of reaction time male finalists can be concluded: 1) Significant differences between the 100m finalists Olympics in Athens and Beijing ($t= 3.456$, $p<0.004$) and among the finalists of the Beijing Olympics and London ($t= -2.199$, $p<0.045$); 2) Significant differences in the discipline between 400m finalist Olympic Games in Athens and London ($t=5.384$, $p<0.000$) and between the finalists of the Olympic Games in Beijing and London ($t= 3.704$, $p< 0.002$); 3) The Olympics were no statistically significant differences among the finalists in the 200m event. By analyzing the results of reaction time female finalists can conclude the following: 1) -Significant differences between the 100m finalists Olympics in Athens and London ($t= 3.283$, $p<0.005$) and between the finalists of the Olympic Games in Beijing and London ($t= -2.139$, $p<0.050$) ; 2) -Significant differences in the discipline between 200m finalist Olympic Games in Athens and London ($t=2.983$, $p< 0.010$) and between the finalists of the Olympic Games in Beijing and London ($t= 3.287$, $p< 0.005$); 3) Significant differences in the discipline between 400m finalist Olympic Games in Athens and London ($t= 4.008$, $p< 0.001$).

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RAZLIKE U VREMENU STARTNE REAKCIJE U SPRINTERSKIM DISCIPLINAMA U FINALIMA OLIMPIJSKIH IGARA (ATENA 2004 – LONDON 2012)

Sažetak
U sprinterskim natjecanjima iznimno važno mjesto zauzimaju start i startno ubrzanje koje većinom generira konačni rezultat. Ovisno o odgovarajućim individualnim morfološkim dimenzijama, kao i osobito o motoričkim i funkcionalnim sposobnostima natjecatelja, postoji velika mogućnost ugradnje ovih parametara. Međutim, usprkos sjajnim rezultatima koje postižu, razlike u ova dva parametra su očite, što u terminima konačnog rezultata ima jasan učinak. Cilj ovog rada je utvrđivanje razlika u startnoj reakciji finalist Olimpijskih Igara u Ateni 2004, Beijingu 2008 i Londonu 2012. Analizirani su rezultati 144 sudionika finalista (72 muškarca i 72 žene) koji su sudjelovali u finalnim utrkama na 100m, 200m i 400m. Evaluacija vremena startne reakcije (ms) i rezultati u sprintu (s) temeljeni su na izvješću koje je službeno objavila International Association of Athletics Federations (IAAF). Sukladno rezultatima može se zaključiti da nema značajnih statističkih razlika u vremenu startne reakcije između muških i ženskih finalist u Beijingu na 100m, i u Londonu na 400m. Kod muškaraca uočene su razlike na 100 i 400 m (p<0.01 i p<0.05), ali ne in a 200m. Kod žena finalistkinja značajne statističke razlike su uočene u svim disciplinama (p<0.01 i p<0.05).

Ključne riječi: *Olimpijske Igre, sprint, vrijeme reakcije, razlike, atletičari i atletičarke*

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