CHANGES IN THE START REACTION TIMES IN THE 200 m RUN AT THE WORLD CHAMPIONSHIPS AFTER THE TIGHTENING OF FALSE START RULE

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Summary: Reaction time is an important component of the structure of sports performance in sprint disciplines. In our observation, we focused on the men's and women's 200 metres discipline at the World Championships (WCH) in two periods. The first in 1999-2009 and the second in 2011-2019. This division was conditioned by the change in the false start rule, which states that any competitor who makes a false start, except in multicontest, will be disqualified (valid since 1st January 2010). This change affected the speed of the sprinter's reaction. The monitored group were finalists of the 200 m runs at the WCH, a total of 11 events. We used basic mathematical-statistical characteristics and assessed changes in reaction times using parametric paired and parametric unpaired t-test and Wilcoxon test. We compared reaction time in the heats and the finals. We found that at some WCH, worse reaction times were achieved in the finals of both categories compared with the heats. By comparing the reaction speed in the heats with the reaction speed in the men's finals, we recorded this statistically significant difference in the first period ($p < 0.01$) and after tightening the rule at the level of $p < 0.10$. In the women's group, this difference was not statistically significant in any period. The percentage of the reaction speed in the final time of the 200 m run was 0.76 – 0.86 % in the men's group and 0.74 – 0.78 % in the women's group. The analysis of the results from the WCH in athletics confirmed the importance of reaction speed in the 200 m run.

Keywords: World Athletics Championships, reaction time, men's and women's 200 m running, heats, finals, IAAF (WA)

Introduction

The structure of sports performance is a complex, versatile and variable system. It is necessary to take into consideration the interconnections and relationships between individual parts instead of studying them as separate factors (Košťál 1984). The author emphasised that there is a specific hierarchy (the genesis of the structure) between the individual factors of the

whole. Short distances are characterised by maximum load intensity in order to cover a given distance in the shortest possible time. As reaction time is a necessary part of these disciplines, Kampmiller & Košťál (1986), Sedláček (1992) have already included the ability to react in the first factor level in the structure of youth sports performance in the 100 m run (14.2 % share in total performance). In addition, among the limiting factors of achieving performance in athletic sprint disciplines belongs the maximum running speed and the ability to maintain it during performance at speed – referred to as endurance in speed (Kampmiller & Košťál, 1986). Unlike these authors, Choutka (1976) classified reaction speed in relation to sports performance into the second-factor level. The speed of response is influenced by several factors: age, gender, physiological and psychological abilities, fatigue, warm-up, athletic age, intelligence, anticipation (Schweitzer 2001; Luchies et al. 2002; Barral & Debu 2004; Van der Berg and Neely 2006; Kohen et al. 2008; Zemková 2011; Hodgkins 2013). The study by Adam et al. (1999) considered the hypothesis that men and women use other information processing strategies to create responses to given tasks. This fact was also confirmed by Brosnan, Hayes & Harrison (2016), who found significant differences in the reaction speed of elite athletes. Based on this, they recommended different limits to determine the violation of the response speed rule. Instead of the current 0.100 s for both categories, they recommend a limit of 0.115 s for men and 0.119 s for women.

The results are in favour of men, who achieved a much faster reaction time than women in a selective, compatible, and incompatible task that required a verbal response. Its significant position can be easily demonstrated with a sprint at 100 m. As the author Ozolin (1986) and Kuchen (1978) state, if we theoretically imagine two athletes with a difference in the start reaction of 20 ms, it would be reflected as a 20 cm distance in the finish, which is at the current differences in performance often the length difference between the first and fifth competitor. Although the share of reaction time in sports performance is getting smaller with increasing running distance, it is important to realise that the result is often decided by hundredths of seconds (Delalija & Babić 2008). Their research was also focused on reaction time as the first factor in the time sequence of the sprint. The sample included 250 women and 360 men from the 2004 Olympic Games in Athens. The research aimed to determine the effect of reaction time on the result of the sprint. The authors statistically proved a significant correlation between the reaction time and the achieved performance in the women's 100 m hurdles and the men's 100 m and 110 m hurdles. At 200 m, a significant linear increase in the mean reaction time was demonstrated at start (Baumann 1980; Babic & Delalija 2009). The authors Locatelli and Arsac (1995) stated that this is mainly due to the fact that the 200 m runners are aware of the small

share of the reaction time in their final performance. We believe that a factor such as reaction speed must be approached as responsibly and with sufficient emphasis as the development of other skills. The speed of the reaction could also be influenced by the rules of athletics about start in short distances (rule no. 162). Changes in the number of false starts and tightening of the criteria for excluding an athlete could have affected the speed of the sprinter's reaction. The 2009 rule (effective from 1 January 2010) stipulated that the reaction rate should not be below 0.100 s. Since then, any competitor who makes a false start (except for multicontest) will be disqualified. After taking the final start position, the competitor must not start moving before the gun is fired. If in the opinion of the starter or a deputy – starter assistant, the athlete begins the movement earlier, it is considered a false start (IAAF Rules of Athletics 2018 - 2019).

This paper aimed to compare the reaction times at the start of men and women finalists of the 200 m World Championships in the years 1999 to 2019. The criterion for comparing the speed of reaction in the monitored groups (1999-2009, resp. 2011-2019) was the rule tightening on the exclusion of an athlete at the start.

Hypotheses

H1 We assume a statistically significant improvement of the start reactions in the final runs at individual WCH in comparison with the heats in the group of men and women in the whole monitored period.

H2 We assume, due to the rule change of a false start, we will find a statistically significant deterioration of the start reactions in the WCH at the period of 2011-2019 in comparison with the period of 1999-2009 at the heats and the finals of men and women.

H3 We assume statistically significantly better values of start reactions of men and women in the finals in comparison with the heats at the WCH in the first and second period, as well.

Tasks

1. Find and evaluate start reaction data from the official website of the IAAF (WA - World Athletics) from the WCH 1999-2019.
2. Analyse, compare, and statistically prove changes in start reactions in individual disciplines.

Methods

Participants

We researched men and women sprinters in the 200 m runs, who took part in the finals at the WCH in Athletics in the years 1999-2019. The group consisted of 348 athletes (176 men and 172 women).

Procedure

We obtained the values of the start reactions of sprinters from the mentioned period from the official website of the IAAF (WA). We calculated their percentage share of performance.

Statistical analysis

In the calculations, we used the basic statistical characteristics (Tab. 1): arithmetic mean ($\bar{x}$), standard deviation (s), minimum value ($x_{\min}$), maximum value ($x_{\max}$) and variation range (v_r). We determined the statistical significance of changes (heats vs finals at individual WCH) using the Wilcoxon t-test. We used parametric paired and parametric unpaired t-test to compare the differences in the reaction speed in the monitored periods. The normality of the distribution was assessed by the Shapiro-Wilk test.

Results

The first hypothesis was the assumption that in each observed period, both men and women achieve faster start reactions in the final runs compared to the heats (Fig. 1, Fig. 2).

Legend: * $p < 0,05$; ** $p < 0,01$; s.i. – statistically insignificant

Figure 1

Comparison of the average values of men's start reactions ($n = 8$) in the 200 m run from 1999 to 2019 at the World Athletics Championships

Figure 1 shows that men achieved, on average, faster start reactions in the finals at almost all WCH. In 2001 ($p < 0.05$) and 2011 ($p < 0.01$) the changes were statistically significant. In contrast, during 2015 and 2019, there was a deterioration in the speed of reaction in the finals (by 12.02 % and 3.57 %, respectively).

Legend: * $p < 0,05$; s.i. – statistically insignificant

Figure 2

Comparison of the average values of women's start reactions ($n = 8$) in the 200 m run from 1999 to 2019 at the World Athletics Championships.

In Fig. 2, it can be seen that the women achieved an improvement in the mean start reactions in 6 WCH. We recorded a deterioration in the average start reactions in the finals at five WCH, in 2003, 2009, 2013, 2017 and 2019. The average value of the improvement of the start reaction was 9.16 %. The average deterioration in the reaction rate was 5.51 %. Based on these results, we can state that we did not confirm H1.

In H2, we assumed that due to the change in the rule of the false start, we would find a statistically significant deterioration of the start reactions in the WCH during the second period (2011-2019) compared to the first (1999-2009) in the heats and finals of men and women. Table 1 shows the basic statistical characteristics of the observed periods, and Table 2 shows their statistical significance of differences.

Table 1

Basic statistical characteristics of men (M) and women (W) in heats and the finals in the 200 m run at the World Championships 1999-2019

Category and period	X	Me	s	$x_{\min}$	$x_{\max}$	v_r
M heats 1999-2009 ($n=48$)	0,162	0,159	0,023	0,124	0,229	0,105
M finals 1999-2009 ($n=48$)	0,151	0,156	0,016	0,124	0,186	0,062
M heats 2011-2019 ($n=40$)	0,175	0,165	0,039	0,128	0,314	0,186
M finals 2011-2019 ($n=40$)	0,160	0,161	0,018	0,119	0,198	0,079
W heats 1999-2009 ($n=46$)	0,178	0,169	0,04	0,133	0,367	0,234
W finals 1999-2009 ($n=46$)	0,174	0,172	0,039	0,124	0,277	0,153
W heats 2011-2019 ($n=40$)	0,167	0,161	0,023	0,136	0,238	0,102
W finals 2011-2019 ($n=40$)	0,168	0,162	0,021	0,138	0,228	0,09

Legend: Me – median, x – arithmetic mean, s – standard deviation, $x_{\min}$ – minimum value, $x_{\max}$ – maximum value, v_r – variation range, M – men, W – women

Table 2

Statistical significance of differences in reaction times in heats and the finals of the 200 m men's and women's run at the World Championships in Athletics

Period	1999-2009	t-test	2011-2019	1999-2009	t-test	2011-2019
M	Heats	s.i.	Heats	Finals	s.i.	Finals
W	Heats	s.i.	Heats	Finals	s.i.	Finals

Legend: s.i. – statistically insignificant, M – men, W – women

In the heats, men's reaction time in the second period was 0.175 s, which was a deterioration of 5.56 % compared to the first period (0.162 s). There was a similar trend in the final runs. In the years 2011-2019, the reaction rate deteriorated to 0.160 s (i.e. by 5.96 %) compared to the years 1999-2009, in which the average reaction rate time was 0.151 s. However, this deterioration was not statistically significant either in the heats or in the finals. In the women's group, we found an improvement in average times by 6.18 % (0.178 s and 0.167 s, respectively). In the final, there was an improvement of 3.45 % (0.174 s and 0.168 s, respectively). However, even these differences were not statistically significant. We state that we did not confirm H2.

In H3, we assumed that in the monitored periods (1999-2009, respectively 2011-2019), both men and women would achieve faster start reactions in the finals than in the heats. Table 3 shows that in the first period, this difference was statistically significant in men at the level of $p < 0.01$ and after tightening the rule at the level of $p < 0.10$. In women, this difference was not statistically significant in any period.

Table 3

Statistical significance of differences in reaction times in heats and in the finals of the World Championships in Athletics

Period	1999-2009				2011-2019		
M (n=48)	Heats	p < 0,01	Finals	M (n=48)	Heats	p < 0,10	Finals
W (n=46)	Heats	s.i.	Finals	W (n=46)	Heats	s.i.	Finals

Legend: s.i. – statistically insignificant, M – men, W – women

The importance of the reaction speed is confirmed by its percentage share in the final time of sprinters in the 200 m run (Table 4).

Table 4

Reaction times and their percentage share of the achieved performance in the 200 m run in the period 1999-2009 and 2011-2019

Period	Men				Women			
	Heats		Finals		Heats		Finals	
	RT [s]	% share	RT [s]	% share	RT [s]	% share	RT [s]	% share
1999-2009	0,162	0,79	0,151	0,76	0,178	0,78	0,174	0,77
2011-2019	0,175	0,86	0,160	0,79	0,167	0,74	0,168	0,75

Legend: RT – reaction time

Discussion

The first hypothesis about the improvement of start reactions in the final runs was not confirmed. Men at two WCH (2015, 2019) and women at five WCH (2003, 2009, 2013, 2017, 2019) achieved worse reaction times in the finals than in the heats.

In the second hypothesis, we assumed statistically significant differences in the reaction speed in the heats and the finals in the first (1999-2009) and the second (2011-2019) period. Our assumption was not confirmed in any of the groups. We did not confirm the third hypothesis about better reaction times in the finals in each period and both categories.

Among men, we showed a statistically significant improvement in the reaction speed in the finals in the first and second periods, but not in women. By tightening the rule of exclusion of the sprinter in the event of a false start, the statistical significance was reduced from $p < 0.01$ to $p < 0.10$. Our results confirmed the conclusions of Pilianidis, Mantzouranis & Kasabalidis (2012), who noted a deterioration in the reaction speed of top sprinters following the introduction of the new rule on a false start. Similar results were presented by Haugen, Shalfawi & Tønnessen (2013). However, women did not confirm this trend. The reaction speed in the second period was higher in the heats (0.178 and 0.167 s, respectively) and the finals (0.174 s and 0.168 s, respectively) than before the rule tightening. These results confirmed the conclusions of Englert & Bertrams (2014), who stated that reaction skills could be improved through regular and systematic training, so it is necessary to monitor and pay attention to the reaction time in the training process. In a sample of 37 runners, the authors showed that the strength of self-control of athletes influences the value of reaction time. The result depends on the level of difficulty of the tasks performed by the athlete before the start. The fact that the reaction speed often decides the overall ranking is also proven by several data from the WCH in the 200 m run (Helsinki, 2005). Bronze runner Arron (FRA) and the second in the order Boone-Smith (USA) had the same final time in the finals (22.31 s). Arron's reaction time was 0.184, which was the second slowest reaction time in the finals. Smith won a silver medal with a reaction time of 0.161 s. At the WCH in Moscow (2013), the silver runner Ahouré (FRA) and the bronze Okagbare (Nigeria) reached the same time in the final run (22.32 s). Thanks to good reaction time, Okagbare (0.154 s) matched the faster runner in 2nd place, Ahouré, who had a reaction time of 0.180 s. A similar situation occurred in the men's running finals in Beijing (2015). Fourth in the final run, Edward (Panama) and third Jobodwana (JAR) reached the same time 19.87 s. The placement was again determined by the reaction time, which Edward had 0.170 s and Jobodwana 0.154 s. Barral & Debu, (2004) and Hodgkins (2013) found that men have faster start reaction compared to women. We confirmed this conclusion in our

investigation in three comparisons. We found the opposite trend - a better reaction time for women - in the period after the rule was tightened. In the heats, women had a faster reaction time (0.167 s) than men (0.175 s). During this period, in the final runs, the reaction speed was in favour of men (0.160 s and 0.168 s, respectively).

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