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ORIGINAL ARTICLE

Sprint race distance affects reaction time in male and female sprinters at the 2022 World Indoor Athletics Championships

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Abstract

In sprint disciplines, the start reaction (SR) time affects the final result in the sprint. This research aimed to analyze and examine whether there are significant differences in the SR in the semi-final and final groups in the 60 m and 400 m disciplines at the World Indoor Championships in Athletics, held in Belgrade in 2022 in men's and women's competition. The aim was also to determine if there were statistical differences between men and women in the 400 m event. T-test for independent samples showed statistical differences between the SR in the 60 m and 400 m athletics events in men (t=-4.434, p=0.000) and women (t=-3.210, p=0.004). For the 400 m running events, an independent samples t-test was used to examine differences between men and women in SR. No significant differences were obtained between men and women in the 400 m event (t=0.401, p=0.691). SR is part of all running disciplines and affects the time achieved in the race (result). Although it has been known for a long time that training can influence SR, a few studies still examine training's effects on SR. The question can be about how much it is possible to reduce SR with specific training exercises or to apply certain neurophysiological methods.

Keywords: 60 m sprint · 400 m sprint

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Introduction

Start reaction time (SR) and starting acceleration are essential for achieving maximum speeds and results in sprint races (Tønnessen et al., 2013; Paradisis, 2013; Pavlović, 2021). Hundredths, and in certain situations even thousandths of a second, are essential for winning or setting sprint records.

The SR is widely used to assess neuromuscular-physiological responses in medicine (Müller, Benz, Bornke & Przuntek, 2004), sports (Guissard & Duchateau, 1990), and other scientific disciplines. The SR depends on several factors: the arrival of the stimulus in the sensory organ, the conversion of the stimulus into a neural signal, neural transmission and processing, muscle activation, soft tissue compliance and the selection of the external measurement parameter, and the factors mentioned above have an associated processing time that contributes to the overall SR (Pain & Hibs, 2007). SR is the time between a sensory stimulus's appearance and subsequent behavioral response (Spierer et al., 2010).

Start reaction time is usually influenced by various factors, such as the athlete's experience level, technique, prediction skills, and muscle activation. In addition to all the above factors, the length of the sprint race can affect the muscle activation patterns and the strategies used by the athletes during the start. Shorter sprints, such as 60 and 100 meters, require an explosive and instantaneous start, where athletes aim to achieve maximum acceleration. In longer sprints, such as 200 and 400 meters, the start can be approached with a slightly different strategy, balancing the need for acceleration with conserving energy for the entire race distance, which is in agreement with Moravec et al. (1988) who state that initial reaction time and initial acceleration are more critical in shorter versus more extended sprint events.

Juhas, Matić, and Janković (2016) analyzed the results of SR finalists from the world championships in 2013 and 2015 in 100 m, 200 m, and 400 m and found no statistically significant differences between men and women in SR. Babić and Delalija (2009) found that men have a shorter SR than women. Similar results were obtained in the study by Der and Deary (2006), in which it was found that men have shorter SR than women. Authors such as Tønnessen, Haugen, and Shalfavi (2013) believe that athletes with high maximum strength and speed of force development in the leg extensors will be able to develop force faster than athletes with weaker abilities. These differences can be used to explain the difference in SR between men and women (Tønnessen et al., 2013). The mentioned studies contrast the results of Martin and Buoncristiani (1995), who found no significant differences in SR between the world's best male and female sprinters. In the results of Matić and Mrdaković (2023), it is stated that there is no statistically significant difference between men and women in the discipline of 60 m hurdles for sprinters, nor between male and female all-rounders. The results obtained in the study by Matić, Juhas, Janković, and Ristov (2023) show that there is a statistically significant difference ($p = 0.01$) between SR when comparing all male and female competitors in the 60 m event from the World Indoor Championships held in Belgrade 2022. When comparing men and women in qualifying races, there is also a significant difference ($p = 0.02$), but in the semi-final and final groups between men and women, there is no significant difference.

This research aimed to analyze and examine whether there are significant differences in SR in the 60 m and 400 m disciplines at the World Indoor Championships in Athletics, held in Belgrade in 2022, in men's and women's competitions. The aim was also to determine if there were statistical differences between men and women in the 400 m event. We hypothesize that the SR of 60 m sprinters will be shorter than sprinters competing in the 400 m event and that men will have shorter SR than female sprinters.

Method

Participants

The SR of the participants, achieved in the semi-final and final races in the 60 m and 400 m disciplines at the World Indoor Athletics Championships, held in Belgrade in 2022, were used to realize the research. The research included 93 results from the semi-final and final groups of male and female competitors (19 men from the semi-final groups and eight from the final group in the 60 m discipline, 23 women from the semi-final and eight from the final group at 60 m, 11 men from the semi-final groups and six from the final from the 400 m discipline, 12 women from the semi-finals and six from the final group from the 400 m discipline). The results and SR are taken from the official IAAF website (https://worldathletics.org/competitions/world-athletics-indoor-championships/world-athletics-indoor-championships-7138985/timetable/bydiscipline).

Statistical procedures

The results were processed using standard descriptive and comparative statistical procedures. Central and dispersion parameters were calculated from the space of descriptive statistics for each variable: arithmetic mean (M), standard deviation (SD), minimum (Min), and maximum values (Max). A t-test for independent samples was used to compare the SR of men and women. Data distribution was performed using the Kolmogorov-Smirn test and homogeneity of variances using the Levene test. T-test for independent samples examined whether there are statistical differences between the SR in the 60 m and 400 m athletics events and whether there are statistical differences between the SR between men and women in the 400 m events. When a statistically significant difference was obtained, the size of the difference was expressed using the eta square indicator of the influence size (eng. Eta-Square − pη2). Statistical data processing was performed in the program (SPSS 21.0; Chicago, IL).

Results

Table 1 shows the number of results (N), mean (M), standard deviation (SD), Minimum (Min), and maximum (Max) of the result expressed in seconds.

Table 1. Descriptive statistics of the result expressed in seconds in the 60 m and 400 m disciplines in men and women

Variable	Men					Women				
	N	M	SD	Min	Max	N	M	SD	Min	Max
60 m sfin_fin	27	6.59	0.09	6.41	6.79	31	7.13	0.09	6.96	7.31
400 m sfin_fin	17	46.27	0.67	45	47.21	18	51.69	0.71	50.31	52.95

Note. sfin_fin: competitors from the semi-final and final groups

Table 2. Descriptive statistics of the SR in the 60 m and 400 m disciplines in men and women

Variable	Men					Women				
	N	M	SD	Min	Max	N	M	SD	Min	Max
60 m sfin_fin	27	0.139	0.016	0.12	0.18	31	0.143	0.015	0.12	0.18
400 m sfin_fin	17	0.162	0.017	0.14	0.2	18	0.165	0.027	0.13	0.22

T-test for independent samples investigated whether there are statistical differences between the SR in the athletic disciplines 60 m and 400 m in men and women. It can be seen from Table 3 that a statistically significant difference was obtained in the SR in the examined disciplines. The results of the Eta square test in men (0.319) and women (0.180) indicate that the influence of the discipline in which one competes is significant on SR.

Table 3. Differences between the time of SR in the athletic disciplines 60 m and 400 m

Variable	Men				Women			
	T	p	Df	ETA	T	p	Df	ETA
60 m vs. 400 m	-4.434	0.000	42	0.319	-3.210	0.004	22.882	0.180

Note. t: the value of independent t-test; p: if the value of $p<0.05$, there is a statistically significant difference in the SR; df: degree of freedom; ETA: effect size (0.01 small impact; 0.06 medium impact; 0.14 large impact).

In the 400 m running events, an independent samples t-test was used to examine differences between men and women in SR. In the 400 m event, no significant differences were obtained between men and women (Table 4).

Table 4. Differences in SR between men and women

Variable	t	p	df
400 m	0.401	0.691	33

Discussion

This study obtained statistically significant differences in SR in the 60 m and 400 m disciplines at the World Indoor Championships in Athletics. The first hypothesis, in which it was assumed that the SR of 60 m sprinters would be shorter compared to sprinters competing in 400 m, has been confirmed (Men t=-4.434, p=0.000; Women t=-3.210, p=0.004). In the study, Pavlović, Raković, Idrizović, and Mihajlović (2013), a statistically significant difference was obtained between SR in 100 m and 400 m in women (t=-3.227, p=0.006), while in men, no statistically significant difference was obtained between SR in the disciplines 100 m and 400 m (t=-1.833, p=0.088). In the study, Juhas, Matić, and Janković (2016), one-factor analysis of the variance of different groups investigated whether there are statistically significant differences in the SR in the disciplines 100 m, 200 m, 400 m at the 2013 and 2015 world championships. Although no statistically significant differences were obtained, the results indicate SR differences between disciplines in men (F=3.04, p=0.07) and in women (F=3.29, p=0.06). One study found that SR makes up about 1-2% of the total duration of a sprint race (Helmick, 2003). The influence of SR on the result decreases with the lengthening of the running distance, so the impact of SR in the 200 m race is smaller than in the 100 m race or the 110 m hurdles (Bezodis, Salo & Trewartha, 2015). In this study, the average SR for men at 60 m is 0.139 s, and for women, 0.143 s. In the 400 m event, the average SR for men is 0.162 s, and for women, 0.165 s. Given that the athletic rules define that SR must not be less than 100 ms, it can be concluded that competitors from the semi-final and final groups in the 60 m discipline can improve their SR time by about 40 ms without being disqualified, and in the 400 m in about 60 ms. In the final and semi-final race at 60 m, the average result was 6.59 s, meaning that if the athlete started 0.1 s after the shot, his overall result could be improved by about 0.61%, and for women by about 0.62%. If the potential time improvement in the 400 m discipline is calculated similarly, it amounts to about 0.14% for men and about 0.13% for women. Although the possibility of a percentage improvement of the results in the analyzed results is less than one percent, it should be remembered that in the final race at 60 m of the World Championship held in Belgrade in 2022, the first-placed competitor beat the second-placed by only 3 ms. Research by Michel and Jarvere (2002) found that competitors with a shorter SR have a psychological advantage, which affects the final result and placement to a certain extent. Following the above, the authors Pain and Hibbs (2007) state that shorter SR enables a better result and is one factor that influences success.

There were no statistically significant differences in SR between men and women in the 400 m event. The second hypothesis was not confirmed, in which it was assumed that the SR of male sprinters would be significantly different compared to female sprinters. It can be said that the results of this study follow the results of the study Pavlović, Raković, Idrizović, and Mihajlović (2013) in which there was no statistically significant difference between SR in men and women in the 400 m discipline (t=-0.640, p=0.532). In the 400 m discipline, in the studies of Juhas, Matić, and Janković (2016), no significant differences were obtained between men and women in the SR. The average SR for men was 0.207 s at the world championship for the group of finalists in 2013 and 0.290 s at the world championship for the group of finalists in 2015. In the same study, the average SR of women in the final group in the 400 m discipline was measured to be 0.225 s in 2013 and 0.194 s in 2015. The shorter SR in women compared to men contradicts the results of the studies of Der and Deary (2006), Babić and Delalija (2009), and Tønnessen, Haugen, and Shalfavi (2013), who obtained the results that men have a shorter SR than women.

Interestingly, women's SR in 2015 was shorter than men's by as much as 0.096, and it should be checked whether all participants in the finals had a slow SR. In our study, the average SR in men is 0.162 s, and in women, 0.165 s in the 400 m event. Our study's average times of SR are shorter than those of 2013 and 2015 at the world championship. It should be investigated whether there is any difference in how SR is measured in the 2022 competition compared to how it was measured in 2013 and 2015.

It was established fifty years ago that elite athletes have a shorter and less variable SR than novice athletes (Steinbach & Tholl, 1969). It should be determined what the differences are in SR among competitors at the world championships in the junior and senior categories on a larger sample of respondents. Such an analysis will show how much it is possible to influence the shortening of SR through training. It should also be determined whether, in the junior category, there is a significant difference between SR in men and women in sprint disciplines. SR has also been found to increase when the athlete is not training (Doherty, 1985). The question can be raised about how much it is possible to reduce SR with specific training exercises or by

applying certain neurophysiological methods. The effect of transcranial magnetic stimulation on SR should be investigated in cross-sectional and longitudinal studies. How to most effectively influence motor learning, which is a set of processes related to physical exercise or experience and leads to a relatively permanent change in the ability to perform some motor activities (Schmidt & Lee, 2005).

Conclusion

A review of the available literature found many more studies of outdoor competitions than indoor ones, which should encourage researchers to analyze the results of indoor competitions.

The results of the studies that examine the differences in SR in the 60 m or 100 m discipline compared to the 400 m need to be more consistent. Also, consistency was not found when examining the difference in SR between men and women in the 400 m discipline. The reasons for this are probably: the groups (qualifying, semi-final, final) of respondents that are taken into account when analyzing the results of SR, type of equipment (sensitivity of starting block to the magnitude of the force at the moment of starting to push off from the supports), level of competition from which the results were analyzed (national championship, European championship, world championship).

Although it has been known for a long time that SR can be influenced by training, there are still a small number of studies examining training effects on SR, and it is not known which means are the most effective for shortening SR.

Conflict of interest

The authors declare no conflict of interest related to this manuscript.

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