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The Relationship Between Reaction Time and 60 m Performance in Elite Athletes

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Abstract

The aim of this study was to investigate the relationship between 60m sprint results and reaction times in athletes who took part in the World Indoor Athletics Championships. The reaction times and 60m sprint results were compiled for 483 sprinters (253 male, 230 female) who performed 60m sprint event. Corresponding data were obtained from archives of the official website of the International Association of Athletics Federation (IAAF). The relationship between reaction time and 60m sprint results were calculated using Pearson correlation coefficient. Additionally, the Independent Samples T-Test was used to compare athletes' reaction times and 60m sprint results. Positive moderate correlation was found between mean values of all 60m sprint results and reaction times, which were analyzed together in all categories ($r=.436$, $p<0.01$). Moreover, significant differences were also found between male and female finalists based on the 60m sprint times and reaction times respectively ($t=-27.98$, $p<0.01$; $t=-3.26$, $p<0.01$). As a result, it can be concluded that reaction time has great importance on 60 m performance. The best reaction time is related to the higher performance of 60m sprint in both male and female athletes. Moreover, this is also similar for round 1, semifinal and final categories. Coaches and athletes may consider improving reaction time to achieve better 60m performance.

Keywords: athletics, IAAF, sprinter, 60m performance, reaction time, sprint

1. Introduction

Reaction time is a term described as the time between the impulse and movement (Badau et al., 2018) and in athletics, it is defined as the signal of a start coordinator and the pressure that athletes apply on the starting block. Theoretically, if an athlete starts to move any time after the signal, the start is deemed valid. However, if an athlete starts to move before the starting signal, it is deemed a false start according to the rules set by the International Association of Athletics Federation (IAAF) (Moravec et al., 1988). In athletics events, a reaction time less than 0.100 seconds is considered a false start (IAAF, 2017). In sprint racing, disqualification occurs after the first instance of a false start so focusing on starting mechanics and reacting to the sound of the gun are very important. Since 60 m dash is the shortest discipline in athletics events, the starting reaction time of athletes are utmost importance (Freeman W., 2015). Performance during short distance races depends on athlete's start, acceleration, reaching and keeping maximal speed. Reaching maximal speed is especially important for sprint distances and dependent upon an athlete's acceleration (Moravec et al., 1988). Especially acceleration is the most complicated part of a sprint performance. Many sprinters reach maximum speed between 30 and 60 meters. In order to reach this maximal speed, athletes should present a quality starting performance. Insufficient acceleration and inability to reach maximal speed due to weak start reaction make it impossible for athletes to optimize their stride length (Smajlovic and Kozic, 2006). This poses great importance for 60 m races, the shortest race in athletics. A fair reaction time negatively affects athlete to obtain good performance. When pondering world-class sprinters, the lack of observational data still prevents us from completely understanding the factors affecting sprint performance (Morin et al., 2012).

In elite athletes, reaction time is of great importance during world championships, particularly where the differences among these sprinters are minimal (Gutiérrez-Dávila et al., 2006). Weak reaction time at the start of the race negatively affects the rest of the race and impairs an athlete's ability to maximize performance. However, there is evidence that athletes can compensate their mistakes on the starting block during the 100m, 200m and 400m races. For instance, Usain Bolt had the fifth best reaction time (0.160s) during 100m race, and the sixth best reaction time (0.180s) during the 200m race in London Olympics. In both races, he was the first athlete to cross the finish line (Pavlovic et al. 2014). Another example is Ramil Guliyev, European and World Champion. Guliyev came in the first place after having the sixth best reaction time (0.165) during the London World Athletics Championship. Martin and Buonchristiani (1995) stated that performance during 100 and 200 m races is related to acceleration phase, distance to reach maximal speed and speed continuity. Çolakoglu et al. (1987) suggested that reaction time can be developed with training and maturation. The study found that older athletes presented better reaction time than younger athletes did. Moreover, reaction time among teenagers differs significantly (Baydil 2006). Because reaction time is crucial for a better race performance, the aim of this study was to determine whether 60 m performance is affected by start reaction time. As previously stated, the 60 m dash is the shortest athletics event and the better reaction time is crucial for the better 60 m performance. Therefore, we hypothesized that there is a positive correlation between the reaction time and 60 m performance. We also hypothesized that reaction times decreasing from round 1 to the final round. The aim of this study was to assess the relationship between the start reaction time and 60 m performance among elite athletes who took part in World Indoor Championships.

2. Method

Subjects

Samples composed of 518 athletes (272 male, 246 female) who performed 60 m sprint event in Doha 2010, İstanbul 2012, Sopot 2014, Portland 2016, Birmingham 2018 IAAF World Indoor Championships. The competitions performed before 2010 were not included into this study because of the new false start rule set by the IAAF. A total of 35 disqualified athletes (19 male, 16 female) were excluded from this study. Therefore, 483 athletes (272 male, 246 female) who made a successful start and pass the finish line were included into this study.

Data Processing

This study is a comparative and a correlational study. Previous research has found that reaction times increase from short to long distances (Collet C., 1999). Therefore, only 60 m sprint event was included in order to focus on short reaction times. All data were obtained from archives of the official website of the IAAF. Athlete’s reaction times (s) and 60 m sprint times (s) were taken for round 1, semifinal, final and all rounds according to the rules set by the IAAF. Athletes were assumed to be familiar with competitions and performed their best performances due to the IAAF entry standards to qualify world championship. The results of the competitions in which athletes participated during the whole tournament were considered as dependent variable in this regard. A total of 776 reaction times and 60 m sprint results, compiled from 483 athletes, were evaluated as a sample size. In order to standardize reaction times and 60 m sprint results all championships organizer used the same official brand of the stopwatch set by the IAAF. The distribution of data was analyzed according to the championships, genders and rounds. The relations were assessed between the reaction times and the 60 m sprint times. The differences were examined between male and female athletes’ reaction times and 60 m sprint times.

Statistics

All statistical analysis of the data was carried out with SPSS 22. The reaction time was defined as a dependent variable, whereas 60 m performance results, gender and rounds were defined as independent variables in this study. Firstly, descriptive statistics (mean, standard deviation) were calculated for all variables. The Pearson’s Correlation Coefficient was used to determine the relationship between reaction time and 60 m sprint results. Correlation coefficients were classified according to Hopkins [Hopkins, 2018]. Independent Sample T-test was used to determine the difference in reaction time and 60 m performances between male and female athletes for round 1, semifinal and final. The significance level was set at $P<0.05$.

3. Results

Table 1. The statistical parameters of 776 reaction times that performed in all categories

World Indoor Championship	Gender	Reaction Time (s)					
		Round 1		Semifinal		Final	
		n	*Mean (±SD)*	*n*	*Mean (±SD)*	*n*	*Mean (±SD)*
Doha 2010	Male	51	0.187 ±0.046	15	0.161 ±0.037	7	0.150 ±0.131
	Women	34	0.232 ±0.704	16	0.168 ±0.027	8	0.160 ±0.010
Istanbul 2012	Male	57	0.268 ±0.085	23	0.185 ±0.053	8	0.148 ±0.011
	Women	62	0.221 ±0.066	22	0.173 ±0.034	8	0.169 ±0.018
Sopot 2014	Male	43	0.165 ±0.031	24	0.149 ±0.015	8	0.141 ±0.013
	Women	43	0.181 ±0.040	24	0.164 ±0.021	8	0.157 ±0.013
Portland 2016	Male	53	0.161 ±0.036	23	0.142 ±0.016	8	0.138 ±0.012
	Women	44	0.168 ±0.052	23	0.148 ±0.017	7	0.167 ±0.065
Birmingham 2018	Male	49	0.163 ±0.023	22	0.158 ±0.016	8	0.155 ±0.009
	Women	47	0.170 ±0.031	23	0.159 ±0.027	8	0.162 ±0.011

SD: standard deviation; s: second

The descriptive statistics of the round 1, semifinal and final results (mean ± SD) as to reaction times were represented in Table 1.

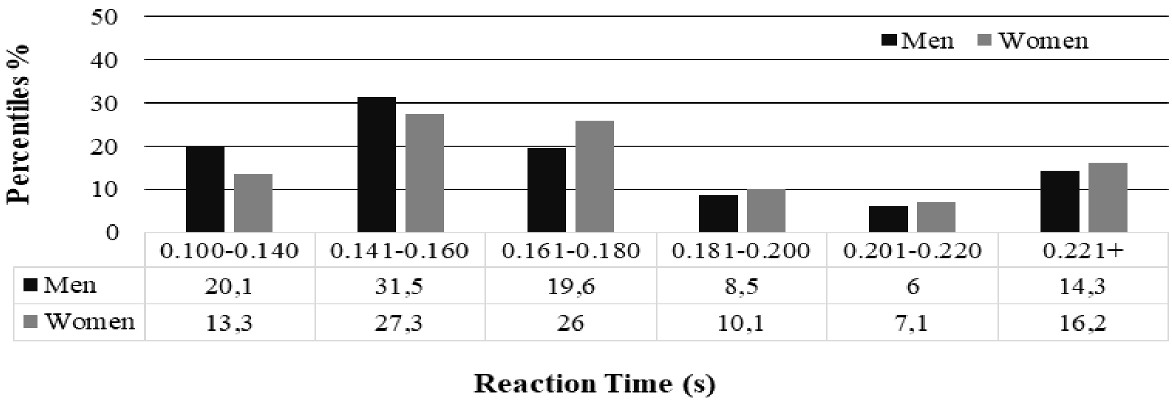

Figure 1. Reaction time for men and women in percentiles

Figure 1 illustrated that the distribution percentile of the reaction time of athletes. According to these findings the majority of the athletes' reaction times were ranged from 0.141 to 0.160 by 31.5% and 27.3% for men and women, respectively.

Table 2. Reaction times and 60 m performances of both genders

World Indoor Championships (2010-2018)	n	Reaction Time (s) Mean (±SD)	60 m Time (s) Mean (±SD)	r	p
Round 1	483	0.193 ±0.063	7.20 ±0.48	.410**	0.000
Semi Final	215	0.160 ±0.031	6.94 ±0.32	.162*	0.018
Final	78	0.155 ±0.024	6.84 ±0.30	.423**	0.000
Round1, Semifinal, Final	776	0.180 ±0.056	7.09 ±0.45	**.436****	**0.000**

*p<0.05, **p<0.01, SD: Standard Deviation, n: The number of evaluated 60m sprint times and reaction times

Table 2 shows that when all rounds were analyzed together positive moderate correlation was found between the mean values of all 60m sprint results and reaction times (r=.436, p<0.01). When round categories analyzed separately for round 1, semifinal and final, there was also moderate significant correlation in round 1 and finals respectively (r=.410, p<0.01; r=.423, p<0.01). Although the reaction time and 60 m performance had a moderate correlation in round 1, final and all rounds together, there was a significant but poor correlation (r=.162, p<0.05) in semifinals.

Table 3. Relationship between reaction times and 60 m performances of athletes

	World Indoor Championships (2010-2018)	n	Reaction Time (s) Mean (±SD)	60 m Time (s) Mean (±SD)	r	p
Male	**Round 1**	253	0.192 ±0.066	6.90 ±0.30	.487**	0.000
	Semi Finals	107	0.159 ±0.034	6.64 ±0.10	.408**	0.000
	Finals	39	0.147 ±0.013	6.55 ±0.74	.346*	0.031
Female	**Round 1**	230	0.195 ±0.060	7.53 ±0.43	.570**	0.000
	Semi Finals	108	0.162 ±0.026	7.24 ±0.12	.270**	0.005
	Finals	39	0.163 ±0.028	7.12 ±0.10	.316*	0.041

*p<0.05, **p<0.01, SD: standard deviation, s: second, n: the number of evaluated 60m sprint times and reaction times

As shown in Table 3, when male and female athletes' reaction times and 60m sprint times analyzed separately, a positive moderate correlation was found both for male and female athletes in round 1, semifinal and final categories, except for female athletes in final. We observed that both reaction times and 60 m sprint times tend to decrease from round 1 to final categories both for male and female athletes. The shortest mean reaction times were observed in the finals for male and in the semifinals for female athletes (Table 3). On the other hand, the fastest 60m sprint results were performed in the final for both female and male athletes.

Table 4. The differences in 60 m time and reaction time between male and female athletes

World Indoor Championships (2010-2018)		Gender	n	Mean (±SD)	t	p
60 m Time (s)	**Round 1**	Male Female	253 230	6.90 ±0.30 7.53 ±0.43	-18.81	0.000*
	Semi-Final	Male Female	107 108	6.64 ±0.10 7.24 ±0.12	-40.39	0.000*
	Final	Male Female	39 39	6.55 ±0.74 7.12 ±0.10	**-27.98**	**0.000***
Reaction Time (s)	**Round 1**	Male Female	253 230	0.192 ±0.066 0.195 ±0.060	-0.56	0.576
	Semi-Final	Male Female	107 108	0.159 ±0.034 0.162 ±0.026	-7.62	0.447
	Final	Male Female	39 39	0.147 ±0.013 0.163 ±0.028	**-3.26**	**0.002***

*p<0.01, SD: Standard deviation, s: second, n: the number of evaluated 60m sprint and reaction times

Table 4 presents the differences in reaction times and 60m sprint times for male and female athletes. A statistically significant differences were found in 60m sprint times between male and female athletes in round 1, semifinal and final categories (p<0.01). On the other hand, there was only statistically significant differences between male and female finalists (t=-3.26, p=0.002).

4. Discussion and Conclusion

The main finding of this study was that there was a significant correlation between reaction time and 60 m performance results. Significant correlation was found between the reaction times and 60 m sprint times in round 1, semifinals and finals of the world indoor championships between 2010 and 2018. Coaches and sprinters know that better reaction time means better sprint performance. Little is known about relationship between reaction time and 60 m performance. Doherty (1985) indicated that short reaction time positively affects short distance sprint performance. In this context, it has been suggested that good reaction time demonstrated at the beginning of the race affects athletes' performance by 1-2% (Baumann, 1980; Helmick, 2003).

Pilianidis et al. (2012a) investigated the relationship between reaction time and 60 m, 200m and 60 m hurdles performances of 159 male athletes who participated in World Championships between 1997 and 2009. They found significant correlation between reaction time and 60 m performance (r=0.32, p<0.05). Tonnessen et al. (2013) also found significant correlation between reaction time and 100m performance in male (r=.292) and female (r=.328) athletes (p<0.01). This shows that shorter reaction time means better sprint performance.

Pilianidis et al. (2012b) also investigated the relationship between reaction time and 100m, 200m and 100m/110m hurdles of 67 male and 68 female athletes in the Olympic Games (2000 Sydney, 2004 Athens and 2008 Beijing). Their study suggested that mean reaction time increases when the distance covered increases. Our findings are consistent with their results. Babic and Delalija (2009) indicated in their review study that male athletes have better reaction time than female athletes. However, with regard to mean reaction times we have only found significant differences between male and female finalists ($t=-3.26$, $p=0.002$). Other studies show no significant differences between male and female athletes, including those of Martin and Buoncristiani (1995), Collet (1999) and Pavlovic et al. (2013). Their results are consistent with our study's findings for round 1 and semifinal, respectively ($t=-0.56$, $p= .576$; $t=-7.62$, $p= .447$).

In another study, Collet (1999) compared reaction time of 60 m and 400m among elite sprinters. The author found no significant difference in terms of reaction time between 100m and 110m hurdles, 400m and 400m hurdles. Reaction time according to increasing distance covered by the athletes was also investigated by Collet. Significant differences were found between 60 m and 200m, 60 m and 400m, 100m and 200m, 200m and 400m. Longer reaction time was observed with longer race distance.

Pavlovic et al. (2014) investigated the differences in reaction time between 100m, 200m and 400m performances of 72 male and 72 female finalists at the Olympics (2004 Athens, 2008 Beijing and 2012 London). They found no difference in reaction time between male and female 100 m sprinters in Beijing ($t=-2.926$, $p<0.05$) and male and female 400m runners in London ($t=-2.782$, $p<0.05$). However, significant differences were found in reaction time among 100m finalists between Athens and Beijing, Beijing and London, respectively. Moreover, significant difference in reaction time was found among finalists between Athens and London, Beijing and London. No significant difference was stated among 200m male finalists. Also, researchers observed that reaction time significantly shortened from qualifications to finals. While significant difference was observed between qualifications and semifinals, qualifications and finals, no significant difference was observed between qualification and quarterfinal, quarterfinal and semifinal, quarterfinal and final, semifinal and final.

Moravec et al. (1988) stated that female athletes presented longer mean reaction time compared to male athletes during 100m, 200m and 400m races at European and World Championships and Olympics. Pavlovic et al. (2013) compared reaction time of 24 male and 24 female 100m, 200m and 400m finalists at World Athletics Championships in Moscow. They found significant difference in reaction time of female athletes between 100m and 400m ($t=-3,227$, $p<0.01$), 200m and 400m ($t=-3,794$, $p<0.01$) but no difference was stated for male athletes. When male and female athletes were compared, significant difference was found between 100m, 200m and 400m performances but no difference was observed in reaction time. When male and female athletes were compared, significant difference was found between 100m, 200m and 400m performances but no difference was observed in reaction time. As a result of these studies, it can be concluded that longer distance means longer reaction time.

In this study, positive moderate correlation was found between mean reaction time and 60m performance of male and female athletes. Moreover, no significant difference was found between male and female athletes. Additionally, we observed that the mean values of 60m sprint time and reaction time decreased gradually from round 1 to finals. Therefore, it can be concluded that reaction time of the athletes decreased from qualifications to finals, and thus 60m performances were better in finals. Tonessen et al.'s (2013) study also supports our research findings. Their research found that the reaction time of elite athletes decreased from round 1 to finals. They also found that 100m performance times of the athletes also improved during the finals category of the competition. Moreover, multiple studies found that short reaction time may affect performance at such short races as 60m (Ploncon and Alexandrescu, 1981; Martin and Buoncristiani, 1995). However, when the distance covered by the athletes increased, reaction time may not be of great importance. Theoretically, this is because better reaction time positively affects acceleration and speed continuity. It also positively affects 60m performance. Reaction time, therefore, positively affects 60m performance. This was demonstrated by the findings stated above that reaction time increases when the distance increases. In other words, reaction time is not a criterion for longer distance races such as 400m (Collet, 1999).

According to the findings of this study, the importance of reaction time may change according to the race category; reaction times of the athletes are prone to decrease from qualifications to finals. One consistent explanation for this finding is that athletes do not want to risk a false start disqualification during the round 1 races. However, since athletes want to be the first to reach the finish line at the finals level, their reaction times are faster compared to round 1 and semifinals as this risk-reward factor is greater.

In conclusion, to win in the final round, the best eight athletes' strategies differ from the round 1. This study demonstrates that when the reaction times of the athletes are faster, so is their 60m performance. This is supported by the literature conducting similar studies as described in the discussion section. It can be concluded that coaches may include specific training focused on improving reaction time for competitive racing to improve overall athletic performance. It can be suggested that further studies investigating the relationship between reaction time, performance and different distances (60m-100m, 100m-400m, 110 hurdles-400m hurdles) be conducted in order to shed light on literature and scientific evidence supporting the competitive athletics industry.

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