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Relationships between the technique index and performance in 60-m hurdle indoor races in elite male heptathletes

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Abstract

A practical assessment of the hurdle clearance technique was carried out applying the technique index (T_{INDEX}), namely the difference between performance in a hurdle race and performance in a respective race without hurdles. The aim of the present study was to examine T_{INDEX} of combined events athletes that competed in all World and European Indoor Athletics Championships. The analysis included the heptathletes who won (n = 84) or did not win (n = 192) a medal, the progress of T_{INDEX} per decade (1990s: n = 75; 2000s: n = 97; 2010s: n = 104) and its correlation with performance (total points won) in heptathlon for a total of 276 cases from the heptathlon 60-m sprint and 60-m hurdle races held from 1993 to 2019. Results revealed that medal winners (median [interquartile range] = 0.99 [0.20] s) had significantly ($p < 0.001$) lower T_{INDEX} compared to non-medal winners (1.10 [0.24] s). No significant ($p > 0.05$) T_{INDEX} differences were observed among the cases in the examined decades. Finally, a significant negative correlation ($\tau_b = -0.27$, $p < 0.001$) was observed for T_{INDEX} and performance in heptathlon. In conclusion, hurdle clearance with the minimum time loss is a precondition for success in indoor combined events.

KEYWORDS: sprint, track and field, performance, time analysis, heptathlon, time differential.

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Introduction

The 60-m hurdle race is a part of indoor track and field combined events for both men (heptathlon) and women (pentathlon). These events were included in major indoor competitions for the first time in the early 1990s. Performance in the combined events is highly related with fast times in the hurdle event in outdoor athletics combined events [21]. Research in the indoor hurdle event has shown that male combined event athletes (heptathletes) display a similar average speed pattern with hurdlers despite being significantly slower [20]. Biomechanical studies [2, 18] have investigated the differences between hurdlers and heptathletes. Those studies revealed that the hurdle clearance distance and height are greater in decathletes and result in longer hurdle clearance time of the decathletes compared to hurdlers. These lead to reduced velocity during hurdle clearance [18], which is suggested to be an essential parameter for better performance [12]. Another disadvantage of the hurdling technique exhibited by combined event athletes is connected with the more upright body position compared to hurdlers at the instant of landing after the hurdle [2]. This body posture is not favourable for the fast transition from hurdle clearance to the sprinting action towards the next hurdle [3, 27].
As mentioned above, the hurdle clearance time depicts the effectiveness of the hurdling technique [12]. Thus, the importance of hurdle clearance is also evident when comparing combined event athletes and hurdlers by means of time analysis. For example, time analysis of the indoor 60-m hurdle race revealed a small event-specific difference of the hurdle clearance time, since

heptathletes were inferior compared to hurdlers, especially when clearing the third hurdle [20]. It can be concluded that an efficient hurdle clearance technique, widely assessed by the hurdle clearance time, is a crucial factor for the optimisation of performance in combined events.

Apart from the biomechanical characteristics and the hurdle clearance time, an alternative measure of the efficiency of hurdle clearance is the percentage ratio of the difference in average velocity of a hurdle race with a sprint of the same distance to average velocity of the hurdle race [15]. Nevertheless, the most common practical quantitative measure for the effectiveness of the hurdling technique among practitioners is the technique index (T_{INDEX}). The latter is calculated as the difference between performance in a hurdle race and performance in a respective race without hurdles [26]. Decrease of the T_{INDEX} indicates a faster hurdle clearance [17] and, consequently, a more effective hurdle clearance technique. It is common practice to use the personal best performance during an official event for the calculation of T_{INDEX} [3], as it is believed that the maximal effort of an athlete is achieved during participation in a competition. As such, T_{INDEX} for elite female athletes ranges from 0.30 s to 0.79 s in the indoor 60-m hurdle race and from 0.47 s to 1.54 s in the outdoor 100-m hurdle race [3, 26]. As presented above, T_{INDEX} is used to evaluate female rather than male athletes. This is due to the fact that, in outdoor competitions, the official racing distances are identical in women (100-m dash/100 m-hurdle race), but not in men (100-m dash/110-m hurdle race). However, the assessment of T_{INDEX} is a useful tool for the evaluation of the hurdling technique in heptathletes, as both the dash and the hurdle races are of equal distance (= 60 m). Another advantage of using T_{INDEX} for the evaluation of the hurdling technique in heptathletes is the fact that both the 60-m dash and the 60-m hurdle races are performed in the same competition. Due to this fact, the calculation of T_{INDEX} is more accurate, as the physical conditioning of the heptathletes when executing these two events is the same. The advantage of calculating T_{INDEX} in heptathletes might provide further insight when studying their overall performance. This is because the hurdle event is considered to be the key event in the combined events [21]. Thus, it is of importance to examine the relationship of T_{INDEX} with performance in the heptathlon.

Aim of Study

The purpose of the present study was to examine the relationship between the T_{INDEX} and performance of elite male combined events athletes, who competed in major indoor athletics events. Specifically, the aims were: a) to compare the T_{INDEX} of elite male heptathletes who won or did not win a medal in major competitions, b) to check the progression of T_{INDEX} per decade, and c) to examine the possible relationship between T_{INDEX} and overall performance in the men's heptathlon.

Material and Methods

Study design

Performance data from elite male heptathletes who competed in major Indoor Championships were collected. For the purposes of the study, major Indoor Championships were the World Athletics Indoor Championships and the European Athletics Indoor Championships, where the men's heptathlon was inaugurated in 1993 and 1992, respectively. The retrieved performance data were classified depending on: a) the connection with overall heptathlon performance (total points won), b) the relation to winning or not winning a medal in the Championship, and c) the decade from which the data were retrieved, i.e. from a Championship held in the 1990s (1992-1999), 2000s (2000-2009) or 2010s (2010-2019). In total, 333 cases were collected from 14 World Athletics Indoor Championships and 14 European Athletics Indoor Championships. From the initial 333 cases, 35 were excluded as the heptathletes did not finish both 60-m and 60-m hurdle races, thus T_{INDEX} could not be calculated. Another 22 cases were also excluded despite the availability of T_{INDEX}, as no overall heptathlon performance was recorded due to disqualification or withdrawal from the competition. In total, 276 cases involving 157 male heptathletes were selected for further analysis, since both inclusion criteria were satisfied. The study was conducted in accordance with the ethical standards of the Institutional Research Committee Guidelines and the recommendations of the Declaration of Helsinki, with the exception that no informed consent needed to be obtained, as the data were based on publicly available resources.

Procedure and data analysis

Performance data of the heptathlon events in the World Athletics Indoor Championships held from 1993 to 2018 were obtained from Wikipedia (https://en.wikipedia.org/wiki/0000_IAAF_World_Indoor_Championships_%E2%80%93_Men%27s_heptathlon; where 0000 is the year of the competition) after checking the validity of the presented information with the official results published in the public databases of

the World Athletics (formerly named the International Association of Athletics Federations IAAF; https://www.worldathletics.org/competitions/world-athletics-indoor-championships/history/). In addition, performance data of the heptathlon events in the European Athletics Indoor Championships held from 1992 to 2019 were also collected from Wikipedia (https://en.wikipedia.org/wiki/0000_European_Athletics_Indoor_Championships_%E2%80%93_Men%27s_heptathlon; where 0000 is the year of the competition) after checking the validity of the presented information with the official results contained in the public databases of the European Athletics (https://www.european-athletics.org/competitions/european-athletics-indoor-championships/history/). Inclusion criteria were: a) the athlete was not banned for doping for the period where his performance was documented, b) both 60-m dash and 60-m hurdle race official times (T60 and T60H, respectively) were provided, and c) the athlete had completed the heptathlon and his overall heptathlon performance (point score) was available.

T_{INDEX} was calculated as T60H minus T60. The percentage contribution of T_{INDEX} to T60mH (T%) was calculated as $T_{INDEX} \times 100 / T60H$. The points earned by the heptathletes in the 60-m dash and 60-m hurdle races (P60 and P60H, respectively) were also documented, as well as their percentage referred to the total points won (P60% for the 60-m dash and P60H% for the 60-m hurdle race).

Statistical analysis

Normality of distribution and the equality of variance were assessed using the Shapiro–Wilk test ($p > 0.05$) and Levene's test ($p > 0.05$), respectively. According to the results of the Shapiro–Wilk test (Table 1), an Independent Samples T-test and a one-way ANOVA with Tukey's HSD post hoc test were run for T60m and P60mH regarding the comparison of medal winners and non-medal winners and the comparison of the 1990s, 2000s and 2010s, respectively. The respective analyses for total points won, T60H, T_{INDEX}, P60, P60%, P60H% and T% were conducted with the Mann–Whitney U test and the Kruskal–Wallis H test. A Kendall's tau-b (τ_b) correlation was run to determine the relationship between T_{INDEX} and overall heptathlon performance. The effect sizes were checked as follows [28]: a) the Hedges' g for the Independent Samples T-test (with values of <0.2, <0.5, <0.8 and ≥0.8 being considered as trivial, small, medium and large, respectively), b) the Wilcoxon–Mann–Whitney r for the Mann–Whitney U test (with values of <0.1, <0.3, <0.5 and ≥0.5 being considered as trivial, small, medium and large, respectively), c) the partial eta squared (η_p^2) for the one-way ANOVA (with values of <0.01, <0.06, <0.14 and ≥0.14 being considered as trivial, small, medium and large, respectively), and d) the epsilon-squared estimate of effect size (ε_R^2) for the Kruskal–Wallis H test (with values of <0.01, <0.08, <0.26 and ≥0.26 being considered as trivial, small, medium and large, respectively). All statistical analyses were conducted with the use of the IBM SPSS Statistics v.25 software (International Business Machines Corp., Armonk, NY), with the level of significance set at $\alpha = 0.05$.

Results

The results of the examined parameters are presented in Table 1. The overall performance of the examined cases was about 97.7% of their personal best.

Medal winners vs non-medal winners

Medal winners comprised 30.4% of the analysed cases. The results of the analyses concerning the comparison between medal winners and non-medal winners are presented in Table 2. All parameters, with the exception of P60% and P60H%, were significantly different between groups.

Medal winners were faster in both disciplines, as they had significantly smaller T60 and T60H compared to non-medal winners. Medal winners performed the 60 m hurdle race with a significantly lower T_{INDEX} and T% than non-medal winners. Both medal winners and non-medal winners scored higher in the 60-m hurdle race than in the 60-m dash. P60% was about 14.6% ± 1.0 of total points won, whereas P60H% contributed to 15.9% ± 1.0 of the overall heptathlon performance.

Performance progression

Table 3 depicts the results of the analyses for the 1990s, 2000s and 2010s. The only significant differences were observed for P60H and P60H%, as significantly higher values in these parameters were scored in the 2010s compared to the 2000s.

Despite being non-significant ($p > 0.05$), a trend to perform the examined events with faster T60 and T60H was shown in the 2010s compared to the previous two decades. This non-significant trend was also evident for T_{INDEX}. Descriptive statistics showed that the lowest average T% was observed in the 2010s compared to the previous two decades.

Relationship between T_{INDEX} and performance in heptathlon

The results of the examination of the relationship between T_{INDEX} and overall heptathlon performance are

Table 1. Descriptive statistics and results of the normality test for the examined parameters (n = 276)

Parameter	min	max	mean	SD	median	interquartile range	95% confidence interval		*skewness*	*kyrtosis*	Shapiro–Wilk	
							lower bound	upper bound			*W*	*p*
T60 (s)	6.61	7.46	7.04	0.14	7.05	0.19	7.02	7.06	–0.161	0.509	0.990	0.068[a]
T60H (s)	7.64	8.91	8.14	0.22	8.13	0.28	8.11	8.17	0.374	0.107	0.990	0.048[b]
T_{INDEX} (s)	0.71	2.02	1.10	0.20	1.07	0.26	1.08	1.12	0.913	1.260	0.953	<0.001[b]
T%	8.8	22.7	13.5	2.1	13.1	2.80	13.2	13.7	0.741	0.765	0.967	0.001[b]
Points	4135	6645	5974.6	295.9	6001.0	319.00	5939.5	6009.7	–1.697	6.817	0.984	<0.001[b]
P60	706	1026	868.1	50.8	865	67.00	862.0	874.0	0.167	0.717	0.988	0.020[b]
P60H	766	1074	948.6	54.1	949	72.00	942.3	955.1	–0.325	0.007	0.992	0.122[a]
P60%	11.8	22.0	14.6	1.0	14.5	1.0	14.4	14.7	2.128	11.867	0.871	<0.001[b]
P60H%	12.6	24.5	15.9	1.0	15.9	1.0	15.8	16.0	2.829	21.402	0.811	<0.001[b]

Note: T60 – official time in the 60 m dash; T60H – official time in the 60 m hurdles race; T_{INDEX} – technique index; T% – percentage contribution of T_{INDEX} to T60H; Points – overall points in heptathlon; P60 – points won in the 60 m dash; P60H – points won in the 60 m hurdles race; P60% – percentage of P60 referred to Points; P60H% – percentage of P60H referred to Points
[a] parametric data; [b] non-parametric data

Table 2. Results for comparisons between medal winners and non-medal winners

Parameter	Medal winners (n = 84)	Non-medal winners (n = 192)	*t*	*U*	*p*	*effect size*	
T60 (s)[a]	6.96 [0.14]	7.08 [0.13]*	6.455	–	<0.001	0.90	large
T60H (s)[b]	7.99 [0.26]	8.19 [0.29]*	–	649.500	<0.001	0.45	medium
T_{INDEX} (s)[b]	0.99 [0.20]	1.10 [0.24]*	–	3486.500	<0.001	0.25	small
T%[b]	12.5 [2.2]	13.5 [2.8]*	–	5958.500	0.001	0.21	small
Points[b]	6215.5 [173.0]	5906.0 [252]*	–	5523.500	<0.001	0.73	large
P60[b]	895.0 [77.0]	858.0 [59.0]*	–	4582.500	<0.001	0.34	medium
P60H[a]	983.3 [47.2]	933.5 [50.0]*	7.781	–	<0.001	1.02	large
P60%[b]	14.3 [1.2]	14.5 [0.9]	–	6868.000	0.050	0.12	small
P60H%[b]	15.8 [0.8]	15.9 [1.0]	–	7475.000	0.334	0.06	trivial

Note: T60 – official time in the 60 m dash; T60H – official time in the 60 m hurdles race; T_{INDEX} – technique index; T% – percentage contribution of T_{INDEX} to T60H; Points – overall points in heptathlon; P60 – points won in the 60 m dash; P60H – points won in the 60 m hurdles race; P60% – percentage of P60m referred to points; P60H% – percentage of P60H referred to points
[a] parametric data (group comparisons with Independent Samples T-test; descriptive statistics: mean [standard deviation]; effect size: Hedges' *g*); [b] non-parametric data (group comparisons with Mann–Whitney's U test; descriptive statistics: median [interquartile range]; effect size: Wilcoxon–Mann–Whitney *r*)
* $p < 0.05$

Table 3. Results for comparisons between cases in different decades

Parameter	1990s (n = 75)	2000s (n = 97)	2010s (n = 104)	*F*	*H*	*p*	*effect size*	
T60 (s)[a]	7.04 [0.16]	7.05 [0.12]	7.03 [0.14]	1.233	–	0.141	0.226	large
T60H (s)[b]	8.08 [0.34]	8.16 [0.31]	8.12 [0.25]	–	5.510	0.064	0.013	small
T_{INDEX} (s)[b]	1.06 [0.29]	1.10 [0.25]	1.05 [0.25]	–	3.854	0.146	0.007	trivial
T%[b]	13.1 [3.1]	13.5 [2.7]	13.0 [2.6]		3.224	0.199	0.004	trivial
Points[b]	6023.0 [304.0]	5984.0 [334.0]	5997.0 [329.0]	–	1.033	0.597	0.004	trivial
P60[b]	868.0 [81.0]	861.0 [56.0]	868.0 [67.0]	–	1.454	0.483	0.002	trivial
P60H[a]	950.0 [60.3]	937.4 [52.3]	958.5 [49.5]*	3.762	–	0.024	0.283	large
P60%[b]	14.4 [1.1]	14.4 [0.8]	14.5 [1.2]	–	1.669	0.434	0.001	trivial
P60H%[b]	15.9 [1.0]	15.7 [0.9]	16.0 [1.0]*	–	7.739	0.021	0.021	small

Note: 1990s – cases recorded from 1992 to 1999; 2000s – cases recorded from 2000 to 2009; 2010s – cases recorded from 2010 to 2019; T60 – official time in the 60 m dash; T60H – official time in the 60 m hurdles race; T_{INDEX} – technique index; T% – percentage contribution of T_{INDEX} to T60H; Points – overall points in heptathlon; P60 – points won in the 60 m dash; P60H – points won in the 60 m hurdles race; P60% – percentage of P60m referred to Points; P60H% – percentage of P60H referred to Points

[a] parametric data (group comparisons with Independent Samples T-test; descriptive statistics: mean [standard deviation]; effect size: partial eta squared [η_p^2]); [b] non-parametric data (group comparisons with Mann–Whitney's U test; descriptive statistics: median [interquartile range]; effect size: epsilon-squared estimate of effect size [ε_R^2]

* $p < 0.05$ compared to 2000s

Table 4. Kendall's τ_b coefficients for the relationship between T_{INDEX} and overall points won in the heptathlon

Examined group	T_{INDEX} (s)	*points*	τ_b	*p*
All heptathletes (n = 276)	1.07 [0.26]	6000.0 [317.0]	–0.27*	<0.001
All medal winners (n = 84)	0.99 [0.20]	6215.5 [173.0]	–0.18*	0.019
All non-medal winners (n = 192)	1.10 [0.24]	5904.0 [252.0]	–0.23*	<0.001
1990s heptathletes (n = 75)	1.06 [0.29]	6023.0 [304.0]	–0.20*	0.013
1990s medal winners (n = 24)	0.99 [0.25]	6219.5 [191.0]	0.06	0.691
1990s non-medal winners (n = 51)	1.09 [0.27]	5939.0 [239.0]	–0.27*	0.006
2000s heptathletes (n = 97)	1.10 [0.25]	5984.0 [334.0]	–0.34*	<0.001
2000s medal winners (n = 30)	0.99 [0.18]	6202.5 [174.0]	–0.27*	0.040
2000s non-medal winners (n = 67)	1.13 [0.29]	5884.0 [266.0]	–0.25*	0.003
2010s heptathletes (n = 104)	1.05 [0.25]	5993.0 [329.0]	–0.24*	<0.001
2010s medal winners (n = 30)	0.99 [0.16]	6232.0 [191.0]	–0.34*	0.008
2010s non-medal winners (n = 74)	1.09 [0.25]	5932.0 [242.0]	–0.16*	0.049

Note: T_{INDEX} – technique index; points – overall points in heptathlon; results are presented as median [interquartile range]

*$p < 0.05$

presented in Table 4. With the exception of the medal winners in the 1990s, a significant negative correlation was found between T_{INDEX} and performance in the heptathlon (τ_b coefficients ranging from –0.16 to –0.34).

Discussion

The study was conducted to examine the relationship of T_{INDEX} with overall performance in the men's indoor heptathlon. In addition, possible differences in T_{INDEX}

between medal winners and non-winners, as well as the T_{INDEX} progression over time were examined. Results revealed that a significant moderate negative correlation was observed between T_{INDEX} and total points won in heptathlon and that medal winning heptathletes had significantly lower T_{INDEX} compared to non-winning athletes. On the other hand, no significant changes of T_{INDEX} were observed for the three examined decades.

Results of time analysis studies revealed a common performance structure of the 60-m hurdle event that is independent of the level of performance and hurdling specificity in high level athletes [20]. However, the examined heptathletes had lower official hurdle race times than hurdlers analysed in previous major Indoor Athletic Championships [20, 24]. It was found that male heptathletes present a reduced capability to maintain high levels of speed as the 60-m hurdle race progresses compared to hurdlers [20]. In addition, previous research showed that combined event athletes clock faster in a separate 110-m hurdle race compared to races within the decathlon [22]. Although race time is not considered as a good representation of hurdle clearance comparable to horizontal clearance velocity [25], T_{INDEX}, as the difference between the athlete's best times for the dash and the hurdle races, is believed to reflect the contribution of good hurdle technique to performance [3]. This can be confirmed in the present study, since T_{INDEX} was significantly correlated with overall performance in the heptathlon. Specifically, the obtained correlation coefficients indicated the existence of a weak to moderate significant negative relationship between those two parameters in a vast majority of the subgroups examined. This finding provides further evidence to previous research findings that the hurdle event is among the key events for success in the combined events [21].

The heptathletes that won a medal had significantly lower T_{INDEX} compared to non-winning competitors. Medal winning heptathletes were also significantly faster both in the 60-m dash and the 60-m hurdle races than the rest of the athletes. This finding implies that apart from sprinting speed, an efficient hurdling technique is essential for success in the combined events. The level of performance has an impact on the temporal factors of different segments of the 60-m hurdle race, as it was found to differentiate the intermediate hurdle unit time [9, 19]. Differences due to the performance level are also observed for the sprint after the last hurdle, as lower level hurdlers were found to be slower compared to elite level athletes [9, 20]. Another significant difference is the hurdle clearance time, as lower level hurdlers [13] or not event-specific athletes [20] perform the clearance with a longer flight time. For the indoor 60-m hurdle race, slower athletes performed the hurdle clearance with a lesser mean horizontal velocity of the body center of mass [25].

Despite the significant difference between medal winners and non-medal winners, there was no difference concerning the contribution of the points won in the 60-m dash and the 60-m hurdle races on the total point score won in the heptathlon. This can be attributed to the fact that, in the hurdle events, the sprinting and hurdling techniques are similarly important for the performance in the hurdle events [3]. In addition, a high level male decathlete gains additional 50 points by an improvement of his performance in the hurdle event two times greater than the improvement of his performance in the sprint event [29]. For the improvement of performance in the hurdle events, the athletes have to perform the hurdle clearance with a forward body lean, a low clearance of the hurdle without an unnecessary loss of horizontal velocity, and an active downward movement of the lead leg for the landing, as these were suggested to be among the key technique elements [27]. Studies have shown that male combined event athletes do not execute these technique elements with the efficiency observed in hurdlers [2, 18]. Thus, adding the fact that the hurdling clearance spatiotemporal parameters are adapted to the specific demands of each hurdle-unit [10], it is of importance to prepare the athletes to optimise their technique accordingly. It has also been suggested that training to acquire an optimal technique and focusing on the movements and postures of the athlete in every hurdle session is essential [3].

Despite observing relatively similar average official times for the 60-m dash through the examined decades, a considerable, non-significant faster average 60-m hurdle time was clocked in the 2010s. This resulted in a slightly lower T_{INDEX} in the past decade. Nevertheless, no significant change of T_{INDEX} through the three decades examined was observed. This might be due to the fact that, as the hurdle race is among the highest score gaining disciplines [21], attention is given to other events. Taking the women's heptathlon as an example, the hurdle event is not considered among the disciplines with the most scope for improvements such as i.e. the jumping events and the javelin throw [4]. However, the contribution of points won in the 60-m hurdle event in the overall performance in heptathlon by competitors in the 2010s was significantly higher compared to the one in the 2000s. In the present study, the points won contributed to approximately 15.9% of the overall heptathlon performance, which is

the highest percentage of point contribution among the other events. This might indicate the emphasis given to the hurdle event because it is among the key events for success in the combined events [21].

It is worth mentioning that 17.1% of the competitors who started the event did not finish the race. The percentage of competitors not finishing the event is higher than that reported for major indoor competitions in the last decade [6]. Of the 57 cases when the athletes did not complete the event, 38.6% stopped at the last two events. It has been observed that there is an even distribution of the occasions, when athletes stop the competition during both days of the competition and that these drop-outs occured prior the disciplines with high technique demands, such as the hurdles and the pole vault [5]. Injuries are more frequent in combined event athletes and comprise one of the main reasons for not completing the event [7]. Injuries in indoor men's heptathlon are more frequent than in the other combined events in athletics [8] and are associated with lower odds of winning a medal [6]. In general, the combined events comprise a demanding discipline in athletics where loss of motivation (i.e. a low chance to achieve the goal set for the competition) and fatigue contribute to drop-outs [7].

As for the limitations of the study, the reaction time at the starting blocks was not extracted from the official results in the 60-m hurdle race and the 60-m dash. This was due to the fact that the reaction time was not provided for each analysed competition. In the Olympic decathlon, reaction time was found to be different for the 110-m hurdle race and the 100-m dash [1]. Nevertheless, studies has shown that there is no correlation of the reaction time and the official hurdle race time in both outdoor [23, 30] and indoor competitions [20]. In addition, sprinting performance and reaction time are suggested to be improved equally in the recent past [23]. Another limitation of the study was connected with the effect of contacting the hurdle during its clearance. This factor was not considered. Hitting the hurdle during its clearance is related with a decrease in velocity during the hurdle clearance phase and with a lower sprinting speed after landing behind the hurdle [16], leading to the loss of the rhythm in the following hurdle unit [11]. Despite the fact that hurdle clearance velocity is a determining factor for performance [12, 19], there are biased results regarding the importance of the average hurdle clearance time on hurdle race performance, as it was found to be related with official 60-m hurdle race times [24] but not with official times in the 110-m hurdle race [30]. Finally, the anthropometric characteristics (i.e. leg length, height of the centre of mass, etc.) affect hurdle clearance time [14], but a possible relationship of these characteristics with the performance data was not examined. Future studies should take under consideration the above factors to establish the magnitude of their effect in the evaluation of the hurdle clearance technique using indicators such as T_{INDEX}. Concerning the output for practitioners and coaches, the findings of the present study suggest that an appropriate emphasis should be given to the hurdle clearance technique and the effective transition to sprint the intra-hurdle distance in combined event athletes.

Conclusions

The technique index, namely the difference between performance in a hurdle race and performance in a respective race without hurdles, seems to be an important indicator of performance in 60-m hurdle indoor races in elite male heptathletes. Lower values in the technique index indicate less time spent for hurdle clearance. As the present results showed that a significant negative correlation exists between the technique index and total points won in the heptathlon and that medal winners had a significantly lower technique index than non-medal winners, hurdle clearance comprises a precondition for success in indoor combined events. Thus, it is suggested that the appropriate hurdle clearance technique that results in minimum time loss should be applied by male heptathletes in order to further improve their overall performance in the event.

Conflict of Interests

The authors declare no conflict of interest.

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