

## Running preparation and the final decathlon score in terms of sports career development

### Authors' Contribution:

A - Study Design  
B - Data Collection  
C - Statistical Analysis  
D - Manuscript Preparation  
E - Funds Collection

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### Abstract

**Introduction:** Success in decathlon contests is achieved by athletes of all ages - from 18 to almost 40 years. The development and importance of individual competitions in the final point score have changed during many years of sports ontogenesis. The aim of the study was to evaluate the changes taking place in sports performance level within the decathlon running competitions and their impact on the final result during the long-term sports championship (sports career) development. **Materials and methods:** In the analysis, data concerning the "sports ontogenesis" of the world's best decathletes (N= 25, mean score 8198 points) were used. The final point score and results in three running competitions, i.e. 100, 400 and 1500m runs were taken into account. In the evaluation of sports championship development, four stages were singled out: junior (up to 19 years), youth (to 23 years), the age in which the best results are achieved (up to 30 years), and the final stage of sports championship (decrease of the performance level - 31 years and more). The changes in performance level were evaluated based on analysis of variance (ANOVA), the relationship between the partial results (runs) and the final score (decathlon) was evaluated based on the Pearson correlation analysis. **Results:** The calculated values of correlation coefficient showed that there is a relationship between the results achieved in the running events and the total score at the individual stages of athletes' sports development. The highest Pearson correlation values in all researched periods were determined for the 400m run ( $|r_{xy}| > 0.59$ ;  $p < 0.05$ ). Additionally, at the third stage of sports career development (stage, at which athletes achieve the best results), the final score is also impacted by the level of results achieved at the distance of 100m. The correlation values for distances of 100 and 400m, are at this stage comparable and are approx.  $|r_{xy}| = 0.6$ . **Conclusions:** The greatest impact on the final score achieved by decathletes at all stages of their sports career is running preparation over the distance of 400m.

**Keywords:** decathlon, sports career, athletics

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## INTRODUCTION

Decathlon is a complex athletic contest taking place at the stadium during two days of competition. Since 1911, athletes compete in 10 events, which include flat races (over the distances of 100, 400 and 1500m), hurdles (110m), jumps (long jump, high jump and pole vault), and throws (shot put, discus throw, javelin throw) [1]. The best results from all partial competitions are calculated based on the combined events scoring tables and converted into points that, summed up, result in the final score and indicate the place of the particular athlete in the contest classification.

Decathlon requires from the contestants both great motor skills (speed, strength and endurance), and technical skills, which are used to a varying extent in particular decathlon events [2,3,4].

Running is an important attribute of athletics, and running preparation is the basis for the athletic decathlon training. The "running" type determines the basic type of a decathlete, who owes his achievements in combined events first of all to his results in running competitions [5].

The speed preparation is also an important component of training in three jumping events included in the decathlon. There is no need to discuss the importance of speed in the 110m hurdle race [6].

In the history of men's combined field and track events (at first "allaround", then pentha- and decathlon), the best results were very often achieved by runners. Starting from the original forms of combined athletic events competition in the nineteenth century (Malcolm Ford, Alexander Jordan), through the subsequent record holders (including the representative of Taiwan, Yang Chuan-kwang and Englishman Francis "Daley" Thompson), ending with the best 21<sup>st</sup> century decathletes (Trey Hardee and Bryan Clay) [7,8,9].

In 1968, during the Olympic Games in Mexico, the American Bill Toomey, ran during the decathlon the distance of 100 meters in 10.41 seconds and 400m in 45.68 s. [10] Ashton Eaton, the current world record holder, is even faster. During the World Championships in Beijing in 2015 (9045 pts.), he achieved his record results by covering the distance of 100 meters in 10.23 s, 400m in 45.00 s and 110m hurdles, a little earlier, in 13.35 s [11].

A slightly different situation applies to the distance of 1500m; that competition is of a completely different nature than other events (aerobic endurance versus strength and speed preparation) [12]. Despite this fact, that competition, as the last one, can decide on the final classification. Such situation occurred, among others, during the Olympic Games in Munich in 1972, when Russian Leonid Litvinenko, moved from the eighth to the second, medal place, in the final classification by winning the final running competition in a record time (4:05.9 s) [10]. However, the contradiction of training effort (speed and strength in opposition to endurance training) does not allow the decathletes to accentuate exercises of the aerobic nature.

The aim of the study was to evaluate the impact of sports performance level in flat races (100, 400, 1500m) on the final score in men's decathlon at four stages of sports championship.

## MATERIALS AND METHODS

The analyzed research material includes sports careers of 25 world's best athletes (mean score at the level of 8198 points), competing in the track and field decathlon over the period from 1985 to 2015. Following their sports career, results achieved by them during 286 decathlon performances were analyzed. As the beginning of the period, the year of the last update of the combine events scoring tables (1985) was adopted. The data, which include the best results achieved by athletes in individual years of their career, were obtained mainly from the databases of the International Association Athletic Federation (IAAF) [11]. Other data and missing ones were gathered from publications of athletics statisticians [13,14] and on the

website, whose founder is Janek Salmistu [15]. Another source of information was the available periodicals and magazines on athletics („Legkaja Atletyka”, „Atletika”, „Lekkoatleta” and many others).

In this study, we analyzed the data in terms of the impact of running preparation on the final score achieved in the athletic decathlon during particular athlete’s sports career. For that reason, the athletes’ sports careers were divided into the following four stages:

- 1<sup>st</sup> stage (junior) starting period up to 19 years of age
- 2<sup>nd</sup> stage (youth) starting period from 20 to 23 years of age
- 3<sup>rd</sup> stage (sports championship) from 24 to 30 years of age
- 4<sup>th</sup> stage (period of decreasing results) from 31 years to the end of the career.

In order to evaluate the impact of changes in sports performance level in running events (100, 400 and 1500m) on the final score, by taking into account the above described stages of “sports ontogenesis”, Pearson coefficient values ( $r_{xy}$ ) along with scatter charts as well as basic numerical characteristics were determined.

The correlation coefficient defines relations between two examined variables and its values are within the range  $<-1, 1>$ . The calculated coefficient value specifies the strength (rate) of the correlation, where the correlation of  $-1$  is the evidence of the perfect negative correlation, the value of  $1$  defines the perfect positive correlation, whereas the value of  $0$  expresses lack of any variable relations. Furthermore, it is important to define the statistical significance of obtained  $r_{xy}$  coefficients, in order to check their credibility. Data analysis was conducted using the STATISTICA 10 PL software package [16].

## RESULTS

In order to examine the influence of running preparation on the final score at different stages of athletes’ career, within the group of the world’s top decathletes the numerical characteristics of individual running competitions in terms of the given athletes’ career stages was determined (Table 1).

Table 1. Basic statistics at four stages of sports championship development in running events.

Group	100m [s] (p=0.0001*)	400m [s] (p=0.0001*)	1500m [s] (p=0.0001*)
	$\bar{x} \mp sd$	$\bar{x} \mp sd$	$\bar{x} \mp sd$
I (N=33)	11.22±0.30	50.65±1.41	282.07±9.09
II (N=83)	10.85±0.25	49.02±1.43	276.80±10.32
III (N=132)	10.75±0.26	48.50±1.10	280.00±11.90
IV (N=38)	11.00±0.22	49.39±1.19	286.94±13.47

\*- statistical significance at the level of  $\alpha=0.05$

Table 2. Pearson correlation between the total decathlon score and the results of individual running competitions at four stages of sports championship

Stage career		100m	400m	1500m
I stage	$r_{xy}$	-0.45	-0.78	-0.36
	p	0.01*	0.00*	0.04*
II stage	$r_{xy}$	-0.49	-0.70	-0.45
	p	0.00*	0.00*	0.00*
III stage	$r_{xy}$	-0.57	-0.62	-0.10
	p	0.00*	0.00*	0.25
IV stage	$r_{xy}$	-0.30	-0.59	-0.42
	p	0.07	0.00*	0.01*

\*- statistical significance at the level of  $\alpha=0.05$

From the conducted analysis it follows that the best results in 100 and 400m races are achieved at the third stage of athlete's sports career, i.e. at the age from 24 to 30 years. With regard to the distance of 1500m it was found out, that the shortest times were achieved by the decathletes at the second stage of their career (up to the age of 23 years). In addition to that, it is worth noting that results achieved in all analyzed running events are significantly differentiated ( $p < 0.05$ ) by the given stage of athlete's career.

The next stage of the research was to analyze the value of Pearson correlation coefficient (Table 2) that determine the linear relationship between the final score and sports performance level in individual running events at different stages of championship development. Most of the determined correlation coefficients showed statistical significance. By examining the strength of the designated correlation it was found out that at the first stage of sports championship development, among the running events, the greatest effect on the final score in track and field decathlon have the times achieved in the 400m run, where the value of the determined  $r_{xy}$  coefficient is  $-0.78$ .

At the youth and junior stages, the final decathlon score is affected by changes in sports performance level concerning the 400m running competition. The determined Pearson correlation coefficient was defined at the level of  $r_{xy} = -0.70$ . At the third stage of sports career, where athletes achieve their personal bests, the calculated correlation values revealed that there is a moderate strength relationship between the final score and the sports development level in 100m race ( $r_{xy} = -0.57$ ) and 400m run ( $r_{xy} = -0.62$ ). At the final stage of athletes' career, statistically significant relationship between the 400m run and the total decathlon score ( $r_{xy} = -0.59$ ) was also determined.

It is significant that at all stages of athletes' career, the relationship between the final score and the sports development level in 400m run was the largest and statistically significant, while the examined relationship for 100 and 1500m runs was weak or average, and sometimes irrelevant.

The above calculations and interpretation are confirmed by the designated scatter charts. In all considered cases, negative correlation between the achieved total result and the running preparation was observed.

The analysis of relationship between times achieved in three running events (100, 400, and 1500m) contested in decathlon (Table 3), allowed for a conclusion that there are two reliable linear correlations. The first of them, determined at the level of  $r_{xy} = 0.60$ , defines the correlation between 100 and 400m races and the other one, significantly weaker ( $r_{xy} = 0.31$ ), describes the relationship between times achieved in runs over the distance of 400 and 1500m. The relationship between results achieved in 100 and 1500m runs remains without any influence.

Table 3. Pearson correlation values between times achieved in decathlon races over distances of 100, 400, 1500m.

Distance		100m	400m	1500m
100 m	$r_{xy}$	1.00	0.60	-0.04
	p	---	0.00*	0.47
400 m	$r_{xy}$	0.60	1.00	0.31
	p	0.00*	---	0.00*
1500 m	$r_{xy}$	-0.04	0.31	1.00
	p	0.47	0.00*	---

\*- statistical significance at the level of  $\alpha=0,05$

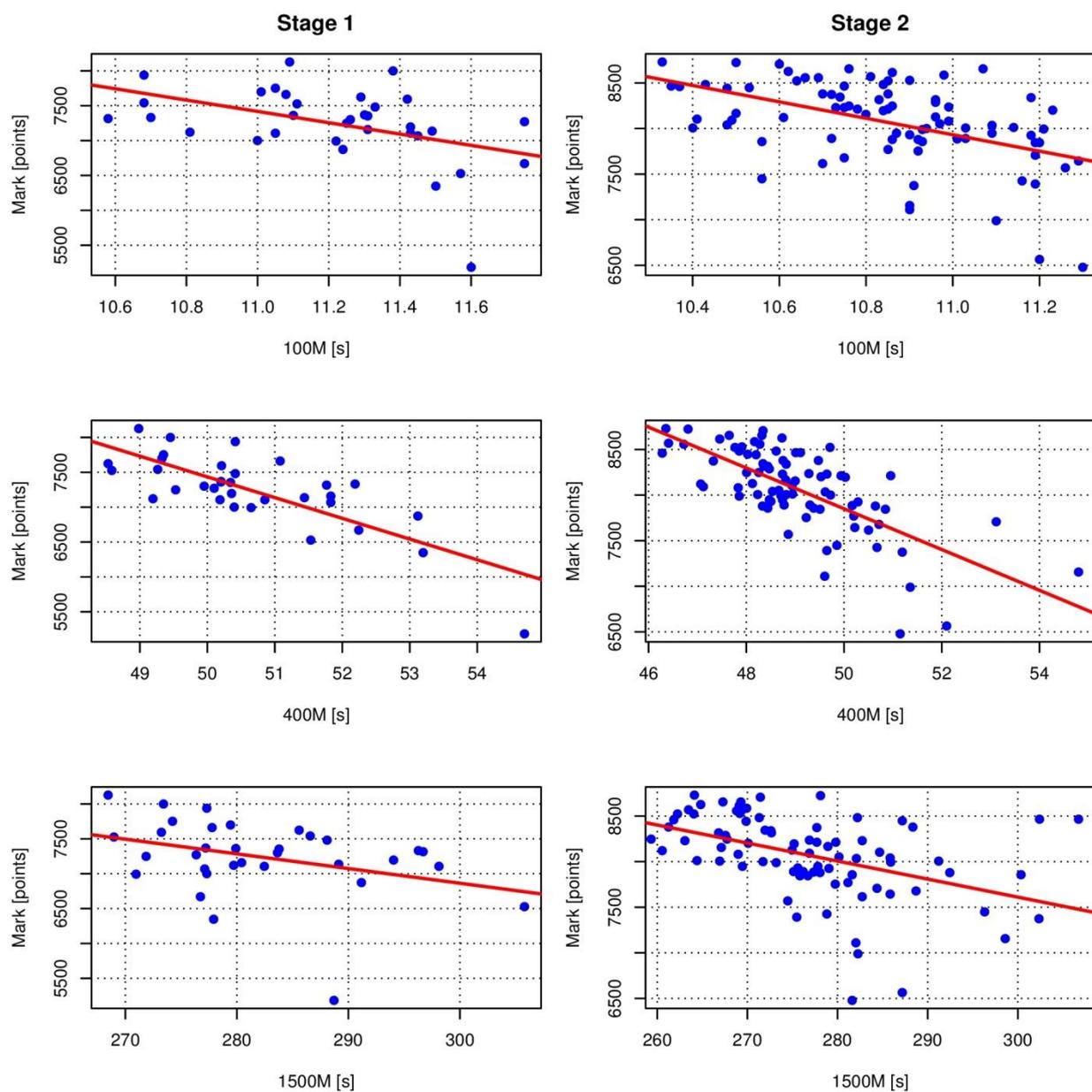


Fig. 1. Scatter charts for individual running events; stage 1 - junior; stage 2 - youth.

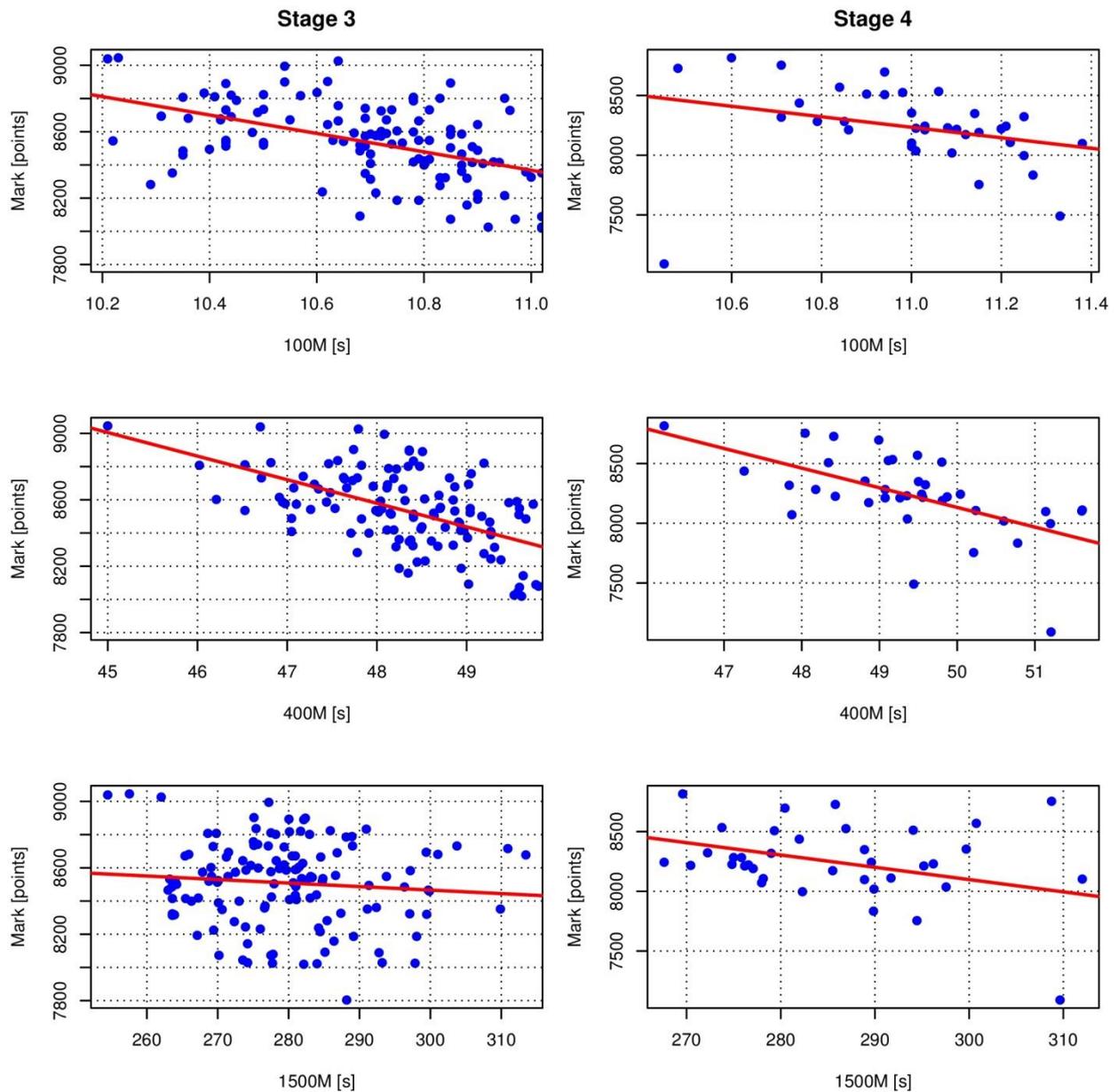


Fig. 2. Scatter charts for individual running events; stage 3 – sports championship; stage 4 – result decrease period.

The study also included the Pearson correlation between the three above-described running events in terms of individual athletes' age groups. Based on the obtained results (Table 4), it was noted, that at the first stage of sports career the relationship between runs over distances of 400 and 1500m is statistically significant ( $r_{xy} = 0.41$ ); on the other hand, when the athletes achieve the age from 20 to 23 years, the relationship between distances of 100 and 400m, as well as 400 and 1500m is significant and comparable ( $r_{xy} = \text{ca. } 0.46$ ). Taking into account the sports championship and result decrease periods, the greatest relationship between the achieved times was observed in 100 and 400m runs.

Table 4. Pearson linear correlation between the decathlon runs over distances of 100, 400 and 1500m at various stages of athlete's career, in competition.

Group	Distance		100m	400m	1500m
I stage	100m	$r_{xy}$	1.00	0.31	-0.01
		p	---	0.08	0.95
	400m	$r_{xy}$	0.31	1.00	0.41
		p	0.08	---	0.02*
	1500m	$r_{xy}$	-0.01	0.41	1.00
		p	0.95	0.02*	---
II stage	100 m	$r_{xy}$	1.00	0.46	-0.07
		p	---	0.00*	0.54
	400 m	$r_{xy}$	0.46	1.00	0.47
		p	0.00*	---	0.00*
	1500 m	$r_{xy}$	-0.07	0.47	1.00
		p	0.54	0.00*	---
III stage	100 m	$r_{xy}$	1.00	0.54	-0.23
		p	---	0.00*	0.01*
	400 m	$r_{xy}$	0.54	1.00	0.19
		p	0.00*	---	0.03*
	1500 m	$r_{xy}$	-0.23	0.19	1.00
		p	0.01*	0.03*	---
IV stage	100 m	$r_{xy}$	1.00	0.52	-0.01
		p	---	0.00*	0.96
	400 m	$r_{xy}$	0.52	1.00	0.32
		p	0.00*	---	0.05
	1500 m	$r_{xy}$	-0.01	0.32	1.00
		p	0.96	0.05	---

\*- statistical significance at the level of  $\alpha=0,05$

## DISCUSSION

The results of decathlon running preparation analysis at separate time intervals indicate an increase in the level of results achieved up to the age of 30 years (100, 400m) and their relative stabilization during the entire sports career in the 1500m run (Table 1). For short distances, the best results were achieved in record starts in decathlon (stage 3), and in the 1500m run in the youth age category. These data suggest that specific training of a decathlete aged over 24 years leads to decrease of results in the last event. This observation also applies to the analysis of the starts of the best athletes in events at the championship level [1, 7]. This also confirms the generally accepted assumption of the sports training theory, that the excessive strength training lowers the endurance capacity [17].

The analysis of correlation between the final decathlon score and results achieved in running competitions at the initial stage of sports championship (age of 17-19 years) indicates the importance of the 400m distance in the search for future track and field pentathlon champions. Referring to the fact that 400 meters run is one of the most difficult athletic events [6], the problem of anaerobic endurance training within the pentathlon at the junior stage requires a specific methodology [18].

In decathlon sports training optimization it is important to specify the type of the athlete with respect to his running abilities - is he the high-speed or endurance type? The analysis of the relationship between results achieved in runs over three distances, at all stages of training, showed that the relationship between results in 100 and 400 meters runs is significant for the

youth, sports championship stages and at the final stage of sports career, while the distance of 1500m showed statistically significant associations with the distance of 400m at the three initial stages of athletes' sports championship development, where the highest correlation coefficient values, were calculated at the first and second stage ( $r_{xy} \geq 0.41$ ). No significant relationship between the results of 100 and 1500m runs at almost all stages of sports ontogenesis were demonstrated. An exception is the negative weak correlation ( $r_{xy} = -0.23$ ), determined at the third stage of training, based on which it can be stated, that the increase of achieved results over the distance of 100m implicates a decrease of times in the 1500m run and vice versa.

The problem of diversification of the endurance efforts in decathlon races has been discussed for several times [19]. A combination of speed efforts (100 m) with the remaining speed and strength events (jumps, in part also throws) seems to be not only simple but also necessary [12]. A more difficult issue for coaches is the incorporation of preparation for the final competition (1500 m). Given the difference of efforts in terms of energy (anaerobic metabolism during the 100-400m and the aerobic metabolism during the 1500m races), the coaches must consider the balance of "profit and loss" (mainly in terms of points).

## CONCLUSIONS

The conducted research allowed for the following conclusions:

1. The greatest impact on the final score achieved by decathletes at all stages of their sports career has the running preparation for the race over the distance of 400m.
2. The endurance and speed preparation (the efforts of the glycolytic nature) is an important, but difficult to solve component of decathletes' condition preparation.
3. The problem of decathletes' preparation for the final competition (1500m) requires an individual approach, an analysis of the athlete's type and the scoring evaluation of the competition.

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