

## THE VARIABILITY OF RESULTS IN WOMEN'S AND MEN'S HURDLES RACES ON THE EXAMPLE OF OLYMPIC FINALS OVER THE PERIOD FROM 1968 TO 2016

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### Keywords:

- hurdles races
- Olympic Games
- prediction

### Abstract:

**Background:** The aim of this study was to analyze the results in women's and men's hurdles achieved in the Olympic finals from 1968 (Mexico) to 2016 (Rio de Janeiro). **Results:** The results of Olympic female champions and other medalists as well as those of athletes finishing outside of the medals were taken into account. Percentage disparities between the above mentioned groups and trends occurring in this area throughout the whole researched period of time were determined. The average results of all tight finals participants in individual events were also analyzed. **Conclusions:** The final result of the analysis is an attempt to define the results development indicators in the individual groups of athletes.

### INTRODUCTION

The development of results in the world's track and field events is varied. In some events, after dynamic period of development, there is a clear tendency to stagnation; in other events, however, after a period of relative stability, the pace of development increases with regard not only to the record results, but also to the overall global or local sports performance level of the given event. The reasons for this development can be mainly seen in the continuous improvement of the recruitment process and selection of athletes for competitive sports, as well as in the optimization of the applied training load, biological renewal, improvement of equipment or change of regulations [Maszyk 2013].

Athletics, as a measurable sport, allows for a quite accurate prediction of future results that can guarantee success in major worldwide track and field events. In contemporary sports, the problem of recruitment and selection of young athletes is of particular importance. Athletes representing the highest sports performance level are characterized by excellent health, specific body build according to the given event, and a high level of psychophysical features [Sozański 1999, Dulceanu and Mihailescu 2001, Korzewa et al. 2012]. They determine success in the given discipline.

In the course of many years of preparation for the event that is most important for the athlete, i.e. Olympic Games, the trends of the given discipline development should be taken into account. The purpose of this paper is an attempt to determine the trends of results development in women's and men's hurdles based on the example of the final Olympic competitions over the period from 1968 to 2016.

### MATERIAL AND METHOD

The material for this paper includes the results of Olympic finals in hurdles achieved by hurdles at distances of 100 and 400 m (women) and 110 and 400 m (men) within the period from 1972/1968 to 2016. [Iskra 2012]. All collected material both in the category of women and men takes into account the division into 4 groups. The first group involves results

achieved by Olympic champions, the second one - average medalists' results, the third one - average results of male and female hurdlers from positions 4-8, and the final group includes results of all final races participants. In each of the analyzed events, the percentage disparities between the medalists and athletes taking positions outside the medal zone were calculated.

Based on those data, approximated regression lines and regression coefficients were estimated, which illustrates the tendency to shape the disparities in sports performance level between the aforementioned groups. At the final stage of analysis, the percentage growth rates of results between the successive Olympic finals were calculated for each of the 4 groups, and, on this basis, the average rate of results development throughout the entire analyzed period was determined using the formula [Cieszkowski 2014]:

$$GRR = \frac{results_i - results_{i-1}}{results_{i-1}} * 100\%,$$

where: *GRR* - growth rates of results, *results<sub>i</sub>* – results of Olympic finals, *results<sub>i-1</sub>* – results of previous Olympic finals.

## DISCUSSION OF RESULTS

### 100 and 400 m hurdles (women)

The 100 m hurdle race was introduced in 1970 in place of the previously held 80 m race. It is a speed-technical-endurance event, and its final result is determined by the body height and weight, horizontal speed of the center of gravity, height of the center of gravity in each phase of the race, speed of reaction, dynamic force and the angle of take-off from the ground, the length and frequency of steps, appropriate proportions of the lower limbs and torso, optimal rhythm of the run and hurdles clearance. [Spiegel and Mureikab 2003, Coh 2003]. The limit value determined by Nowak [2007] is at the level of 11,23 sec. and according to him the dynamics of result variability will increase by over 10%.

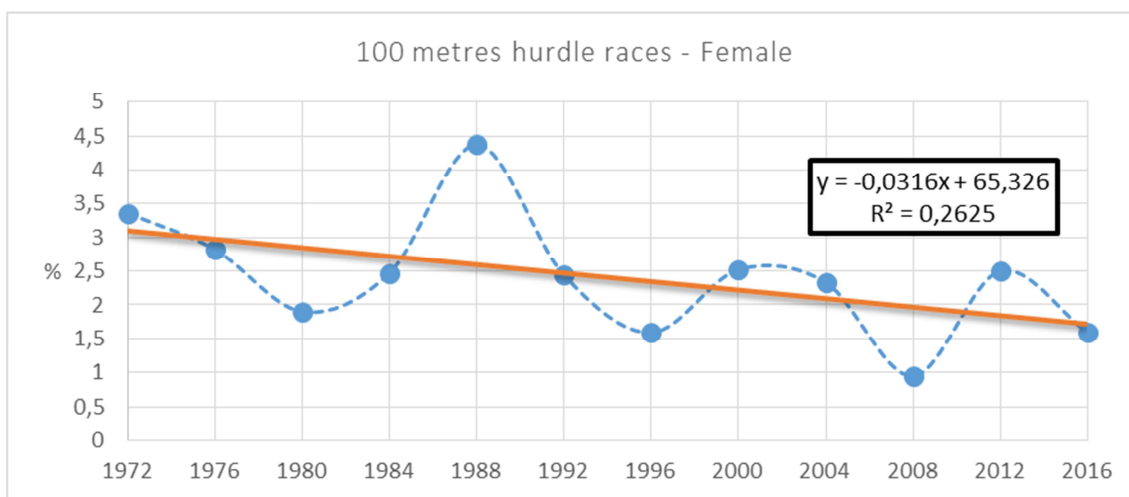
In this event, the Polish female athletes were from the very beginning, i.e. since 1970, among the world's best hurdlers. In the years 1976-1980, the best Polish hurdler was Grażyna Rabsztyn (12,36 sec.). The current world record in this discipline belongs since 1988 to Bulgarian athlete Donkova and is 12.21 seconds. In the first Olympic finale that was held in Munich, the result of 12.59 seconds was achieved by Ehrhardt (GDR). On the other hand, the best result within the entire analyzed period was achieved by the female Olympic champion from London (12.35). The final race held at those Olympics is characterized by the highest average level of results. The medalists achieved the average result of 12.40 seconds and the athletes outside the medal zone that of 12.71 seconds. The average result of all female finalists is one of the best results achieved throughout the whole history of Olympic finals and is 12.60 (Table 1). The greatest variation in sports performance level (almost 4.5%) between the medalists and athletes from positions 4-8 was recorded at the Olympic Games in Seoul (1988) and the smallest one (less than 1%) in Beijing. On the basis of the magnitude of regression coefficient and the course of the balanced regression lines, it follows that the variance of the athletes' sports performance level between the medalists and athletes outside the medal zone is of a highly decreasing nature (Fig. 1), and the confirmation of this situation is the highest value of the growth rate of results in this group (Table 1).

The 400 m hurdle run is a speed-endurance distance event where four factors, i.e. speed, strength, and technique, combined with the hurdle rhythm, which is characteristic for this discipline, decide on the results [Grimshaw 1997, Salo et al. 1997, Iskra 2012]. In the 70s, the Polish female athletes belonged to the world's top hurdlers running this distance. The current world record belongs to the Russian athlete Pechonkina and is 52.34 sec. The limit value of

the results defined by Nowak is at the level of 49.57 seconds, and in the future the dynamics of variability among women will increase by almost 7% [Nowak 2007].

**Table 1.** Results Olympic finals in the years 1968-2016

Competition	Group	1972	1976	1980	1984	1988	1992	1996	2000	2004	2008	2012	2016	WD RW
100 m hurdles	I	12,59	12,77	12,56	12,84	12,38	12,64	12,58	12,65	12,37	12,54	12,35	12,48	0,7
	I-III	12,78	12,78	12,61	12,93	12,58	12,68	12,61	12,7	12,46	12,61	12,4	12,56	1,68
	IV-VIII	13,21	13,14	12,85	13,25	13,13	12,99	12,81	13,02	12,75	12,73	12,71	12,76	3,36
	I-VIII	13,05	13	12,76	13,13	12,92	12,87	12,72	12,9	12,61	12,68	12,6	12,68	2,76
	%	3,36	2,82	1,9	2,47	4,37	2,44	1,59	2,52	2,33	0,95	2,5	1,59	---
400 m hurdles	I	---	---	---	54,61	53,17	53,23	52,82	53,02	52,82	52,67	52,7	53,13	2,70
	I-III	---	---	---	55,07	53,33	53,74	53,04	53,35	53,21	53,39	52,95	53,40	3,00
	IV-VIII	---	---	---	56,15	54,28	54,88	54,27	54,33	54,54	55,15	54,64	54,34	3,13
	I-VIII	---	---	---	55,75	53,92	54,4	53,81	53,96	54,04	54,49	54,01	53,99	3,18
	%	---	---	---	1,96	1,78	2,12	2,32	1,84	2,31	3,3	3,19	1,76	---



**Figure 1.** 100 meters hurdle races – female

In the first final women's 400 meters hurdle run in 1984, El Moutawakel, the Olympic champion from Morocco, achieved the result of 54.61 seconds and the best result of all the previous finals was recorded in Beijing - 52,64 (Walker from Jamaica). The London medalists achieved the best average result in the history of this event held at the Olympic Games. On the other hand, at the Atlanta Olympics, athletes outside the medal zone as well as all final race participants featured the highest athletic skills (54.27 seconds and 53.81 seconds, respectively). The highest difference in sports performance level between the medalists and athletes from positions 4-8 was recorded at the Beijing Olympics and the lowest one in Rio de Janeiro. The analysis of the extent of results development rate shows that it is the lowest among the Olympic champions and the highest one relates to athletes from positions outside the medal zone (Fig. 3). The course of the balanced regression line and the regression coefficient value is an evidence for the constant variation of sports performance level between the medalists and other final run participants (Fig. 2).

110 m and 400 m hurdles (men)

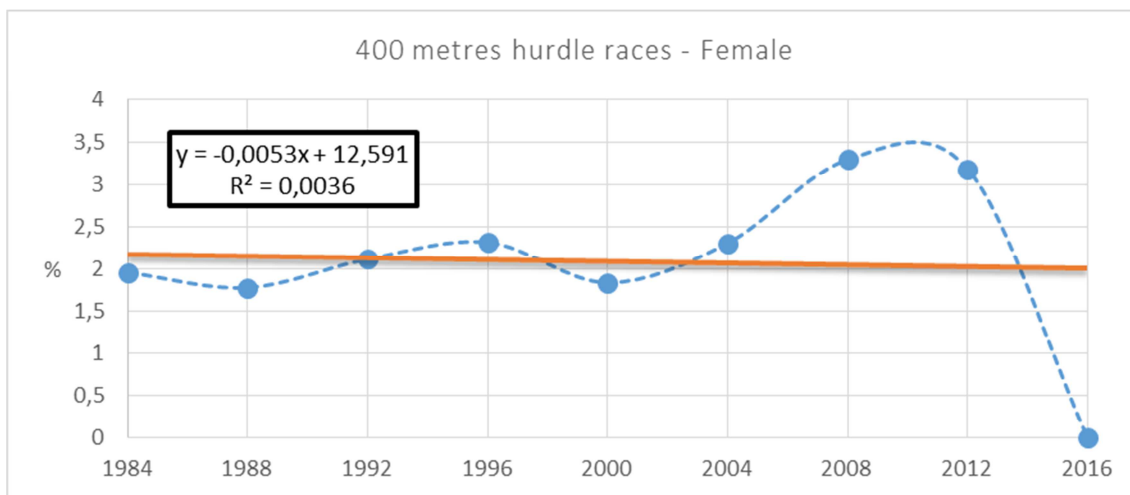


Figure 2. 400 meters hurdle races – female

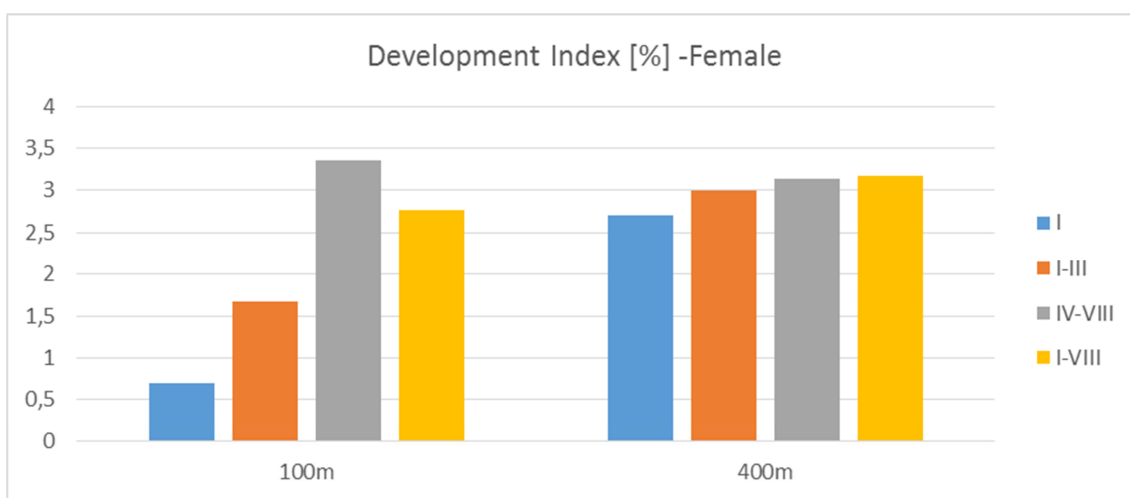


Figure 3. Development index (growth rates of results)

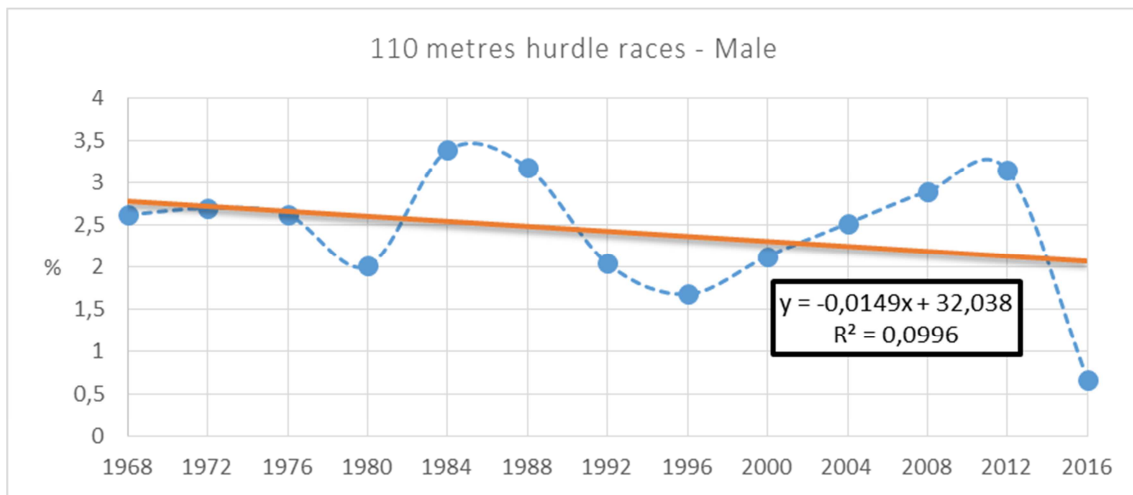
The 110m hurdle race is an event of speed and technical nature and the results are strongly influenced by the dynamic force and motor coordination [Maszczyk 2013]. The speed of the race is determined by the speed of reaction, dynamic force and the angle of take-off from the ground, the length and frequency of steps, ratio of lower limbs and torso, as well as the optimal rhythm of the run and the hurdles clearance [Coh 2002,2003, Luis et al. 2011]. The limit value of results is at the level of 11.23 seconds and on this basis it can be assumed that in the future the dynamics of result variability will increase by 13.1% [Nowak 2007].

In the period up to 1955, the United States athletes were the world's top hurdles. The 13-second barrier was broken in 1981 by Ronaldo Nehemiah, and the current world record (12.80) belongs to the American Aries Meritta. In thirteen 110 m hurdle races that were held at the Olympic Games, the Olympic champion achieved five times the result of less than 13 seconds with the best result in Athens in 2004 (12.91 sec., Chinese Liu Xiang). The average best results of medalists were recorded at the Olympics in Athens. On the other hand, at the Atlanta Games (1996), the athletes outside the medal zone presented the highest level of results. At the same contest, the highest average level of all final race participants was also recorded (Tab. 2).

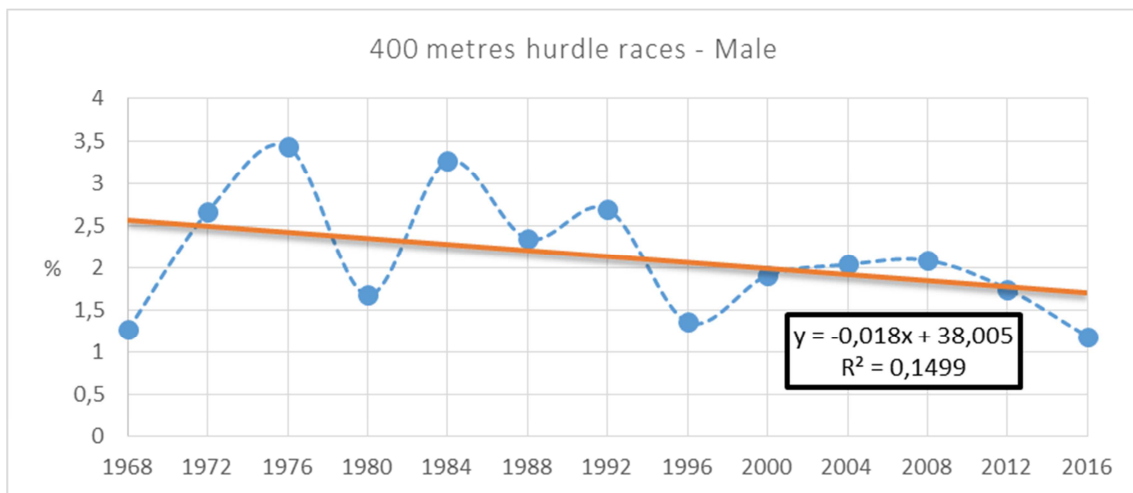
**Table 2.** Results Olympic finals in the years 1968-2016

Competition	Group	1968	1972	1976	1980	1984	1988	1992	1996	2000	2004	2008	2012	2016	WD RW
110 m hurdles	I	13,30	13,24	13,30	13,39	13,20	12,98	13,12	12,95	13,00	12,91	12,93	12,92	13,05	1,85
	I-III	13,37	13,35	13,34	13,41	13,28	13,21	13,21	13,07	13,13	13,10	13,09	13,03	13,15	1,80
	IV-VIII	13,72	13,71	13,69	13,68	13,73	13,63	13,48	13,29	13,41	13,43	13,47	13,44	13,35	2,71
	I-VIII	13,59	13,58	13,56	13,56	13,56	13,47	13,38	13,21	13,30	13,30	13,33	13,26	13,27	3,12
	%	2,62	2,70	2,62	2,01	3,39	3,18	2,04	1,68	2,13	2,52	2,90	3,15	0,67	---
400 m hurdles	I	48,10	47,82	47,63	48,70	47,75	47,19	46,78	47,54	47,50	47,63	47,25	47,63	47,73	0,50
	I-III	48,70	48,28	48,59	48,89	48,02	47,33	47,42	47,76	47,61	48,00	47,76	47,88	47,81	1,62
	IV-VIII	49,32	49,57	50,26	49,71	49,59	48,44	48,70	48,41	48,52	48,98	48,76	48,72	48,38	1,90
	I-VIII	49,09	49,09	49,64	49,36	48,92	48,02	48,22	48,17	48,18	48,61	48,37	48,41	48,14	1,91
	%	1,27	2,67	3,44	1,68	3,27	2,35	2,70	1,36	1,91	2,04	2,09	1,75	1,19	---

The greatest distance between the medalists and the athletes from positions 4-8 was recorded in 1984 in Los Angeles and the most balanced level was presented by the hurdlers at the final race in Rio de Janeiro. Over the whole analyzed period of time, there is a constant blurring of differences dividing the two groups (Fig. 4). By analyzing the extent of the dynamics of results development, it can be stated that the group of all finalists and the group of athletes from positions 4-8 feature the highest progression, and the progression among the medalists is the lowest (Fig. 6).



**Figure 4.** 110 meters hurdle races – male



**Figure 5.** 400 meters hurdle races – male

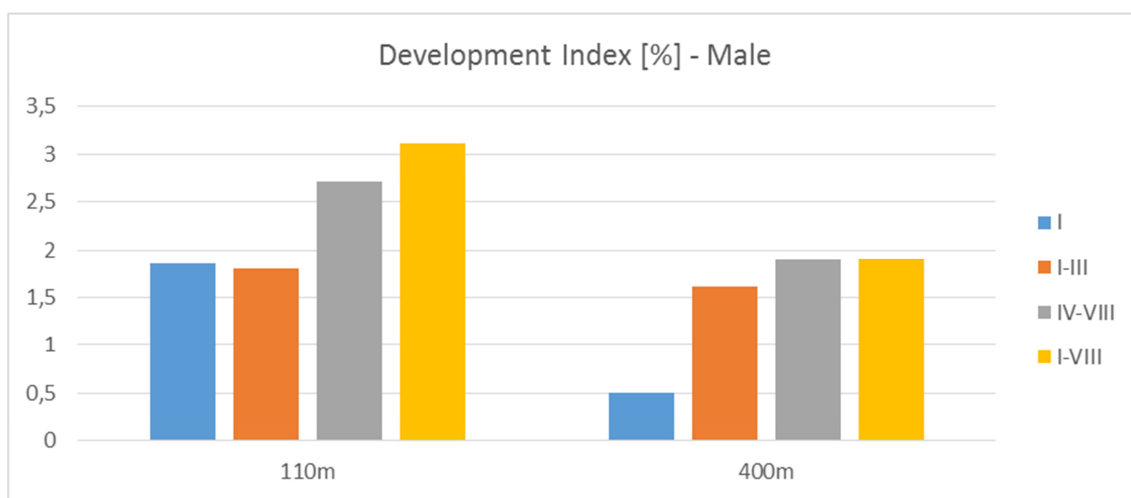


Figure 6. Development index (growth rates of results)

The 400 m hurdle run is an event of speed and technical nature with a very significant portion of dynamic force, motor-spatial coordination and strength. According to many authors, both somatic features (height and weight) and horizontal velocity of the center of gravity, the height of the center of gravity during the individual phases of the run, the speed of reaction, the angle of take-off from the ground, the length and frequency of steps decide on the run velocity [Grimshaw 1994,1998, Salo et al. 1997, Iskra 2012]. Nowak [2007] defined the limit value of results at the level of 42.79 seconds. It can be assumed that in the future the dynamics of the variation of results will increase by almost 10%. In 1956, the American Glenn Devis was the first hurdler to break the barrier of 50 seconds (49.5 seconds). 12 years later, the British David Hemery covered this distance within less than 49 seconds (48.12), and in 1972, John Akii-Bua from Uganda broke the barrier of 48 seconds with the result of 47.82 seconds. The current world record belongs to the American Kevin Young and is 46.78 seconds. That result was achieved at the Olympics in Barcelona and it is the best result in the history of Olympic finals in this event. On the other hand, the best average level of medalists and all final run participants were recorded at the Seoul Olympic Games (1988). Athletes outside the medal zone presented the highest level in Rio de Janeiro. The greatest disparities between the medalists and athletes from positions 4-8 were recorded in Montreal, the lowest ones in Rio (Table 2). By analyzing the magnitude of the regression coefficient and the course of the regression line, it can be concluded that this distance is of a constantly decreasing nature (Fig. 5). The fastest pace of results development is characterized by the group of all final run participants (almost 2%) and the slowest one by the group of Olympic champions (Fig. 6)

The linear regression model shows that in 2020 the distance between medalists and players from places 4-8 will be further reduced by the following values: 100 hurdles F-1,49%, 400 hurdles F-1,88%, 110 hurdles M- 1,94%, 400 hurdles M- 1,64%

## CONCLUSIONS

The analysis of results allows for the following conclusions:

1. Except for the 400m women's hurdle run, there is a noticeable tendency to reduce the distance between the medalists and athletes outside the medal zone, which is a proof of the steady narrowing of the gap between the sports performance level of Olympic finalists in these events; it is also reflected in the growth rate of the dynamics of results development in the group of all final runs participants over the analyzed period of time.



2. In the group of women, the lowest dynamics of results development feature the Olympic champions in 100m hurdles and among men - gold medalists in the 400m hurdle run.
3. The women's 400 m hurdle run is characterized by the highest average dynamics of results development over the analyzed period of time.

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