THE VARIABILITY OF RESULTS IN WOMEN'S TRACK AND FIELD THROWING EVENTS ON THE EXAMPLE OF OLYMPIC GAMES FINALS IN THE YEARS 1968-2012

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Abstract:
The aim of this study was to analyze the results in women's track and field throwing events achieved in the Olympic finals from 1968 (Mexico) to 2012 (London). 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. The final result of the analysis is an attempt to define the results development indicators in the individual groups of athletes.

The development of results in global athletics occurs in a differentiated manner. In some events, after the dynamic period of development, a clear trend towards stagnation is noted, whereas in other events a period of relative stability is followed by an increased rate of results development involving not only record results but also the general sports level of the given event at a global or local scale. The reasons for this should be seen primarily in the continuous improvement of the process of recruitment and selection of athletes for competitive sports, as well as in optimization of applied training loads, biological regeneration, better equipment or change of regulations [Maszczyk 2013].

The track and field throwing events are part of speed & strength events and the throwers are characterized by meso-endomorphic body type [Bartlett 1992, Veccchio et al. 2012]. The increased anti-doping control contributed to the clear trend towards stagnation of the best achievements of top athletes in relation to the record-breaking results [Clasing 2004, Bowers et al., 2010]. Other factors limiting the dynamics of results development included also revision of regulations and improvement of equipment quality (e.g. throwing area limitation or a new type of javelin) [Maszczyk 2013].

Athletics, as a measurable event, allows for a fairly accurate prediction of future results that can guarantee success in the world's most important athletic contests. In the long-term preparations for the most important contest in every athlete's career, i.e. the Olympic Games, the trends in the development of the given event should be taken into account. The aim of this study was an attempt to determine the trends in the development of results in women's track and field throwing events on the example of the Olympic final competitions in the years 1968-2012.

MATERIALS AND METHOD

The material for this study includes the results of the final contests in women's track and field throwing events achieved at the Olympic Games from 1968 to 2012 [Iskra 2012]. The whole collected material takes into account the division into results achieved by the

Olympic champions, the average results of medalists, the average results of athletes finishing in places from 4 to 8 and the average results of all tight final participants. In each of the four events, differences between the medalists and athletes finishing outside the medals were also calculated. On this basis, the regression coefficients were calculated and approximated regression lines illustrating the trends occurring in this area were determined. At the final stage of the analysis, the percentage growth of results achieved at the consecutive Olympic finals for all separated groups of athletes was calculated. Based on these values, the average rate of results development in all groups throughout the whole examined period of time was determined. For this purpose, the following formula was used [2015 Cieszkowski]:

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

where: GRR - growth rates of results, $results_i$ – results of Olympic finals, $reselts_{i-1}$ – results of previous Olympic finals.

DISCUSSION OF THE RESULTS

Shot put

Shot put is a strength & speed event. The throwers feature considerable height and body weight. In this event, the leading factors are strength and the initial velocity, which the female athlete gives to the ball. The initial speed of the equipment is most important, and it affects in direct proportion the distance thrown [Vecchio et al., 2012]. The application of rotational technique made it possible to extend the route and the duration of interaction with the ball and allowed for a better use of the morphologic and functional features of throwers featuring a great body height and long lower extremities [Trowbridge and Paish 1981, Towned 1984, Young and Li 2005]. Nowak [2007], determined the limit values of results for this event at 23.58 m; therefore, it can be assumed that in the future the dynamics of variability of results will tend to increase at the rate of 10.5%. These values coincide with the reports obtained by Mleczko [Mleczko 2008].
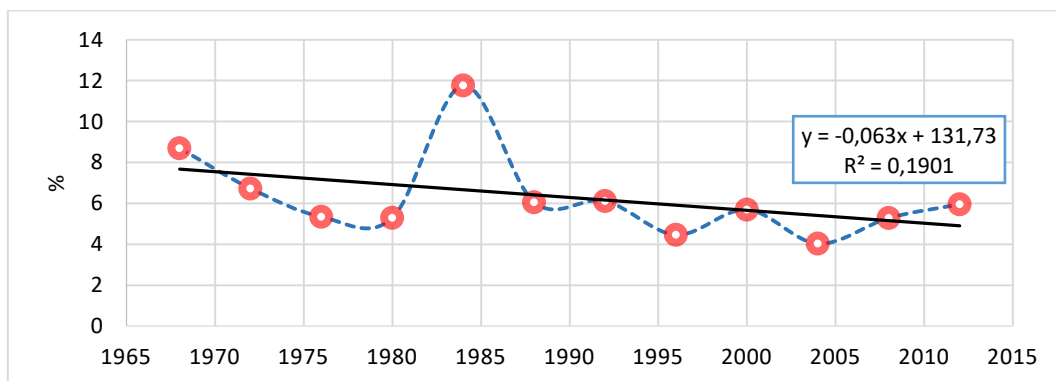

Figure 1. Shot put

With exception of the Olympic final contests in Mexico (1968) and Athens (2004), Olympic champions achieved in this event the results of over 20 m. The analysis of Olympic Games results has shown that the best result was achieved by the gold medalist from Moscow (1980), Ilona Słupianek (22.41m). At the same Olympics, the highest average performance level of the medalists and all tight finals participants (21.68 and 20.82 m, respectively) was recorded. From the analysis of the value of the results development indicator it follows that the greatest progress was recorded among the athletes from places outside the medals, and the

least progress was noted in the group of gold medalists. The Olympic final competition in Athens (2004) proved to be the most balanced contest, in which the difference between the medal winners and athletes from places 4-8 was at the level of slightly more than 4% (Table. 1). By analyzing the size of the regression coefficient and the course of the regression line, it can be said that this event is characterized by a steady decline in the blurring of differences between the medal winners and athletes from places 4-8 (Table 1, Fig.1).

Discus throw

Discus throw is a speed & strength event and the leading somatic traits of the female discus throwers include considerable speed and body weight. Numerous studies show that the most important elements impacting the results in this event include the optimum angle of ejected discus which is 36-38º, as well as the speed of the ejected disc, the height and angle of its release, and biomechanical parameters of athletes [Bartlett 1992, Dapena 1993, Gregor et al. 1994, Bartonietz and Borgstream 1995]. Leigh and Yu determined that women feature a wide variety of technique adaptation to individual somatic parameters [Leigh and Yu, 2007]. The limit value of results in this event developed by Nowak is at the level of nearly 80 m, and the variability of results tends to grow by 10.8% [Nowak, 2007]. The best result in the Olympic final discus throw contest was recorded in 1988 in Seoul, where the gold medal was won by the female athlete of the then GDR, M. Hellman (72.30m). In that contest, the best average result of both the medalists and all tight final participants was also recorded. On the other hand, the most balanced level of results features the final contest held at the Olympics in Beijing, where the difference between the results of medal winners and other contestants was at the level of less than 4%. The definitely greatest disparities were noted in 1984 in Los Angeles. From the analysis of the results development dynamics indicator it follows that the greatest progression is observed in the group of athletes from places outside the medals and the smallest progression is noted among the gold medalists. Based on the regression coefficient it can be stated that there is a constant blurring of differences in the results level between the medal winners and other final contest participants (Table 1, Fig. 2).
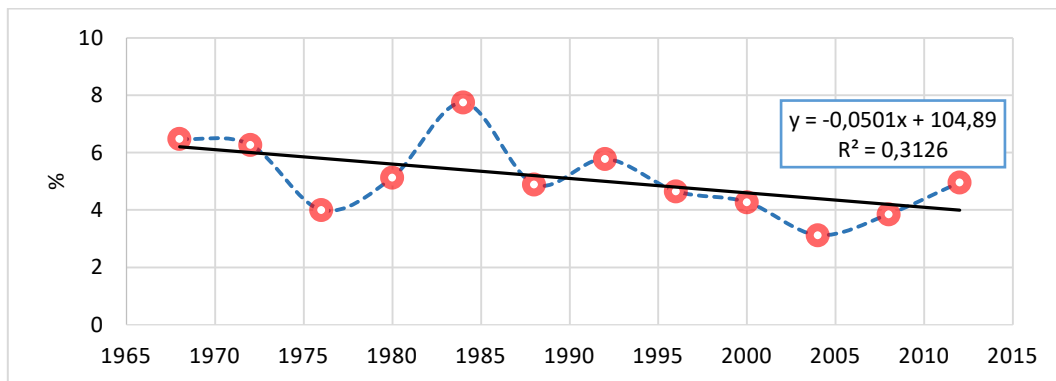

Figure 2. Discus throw

Javelin throw

Javelin throw belongs to the events of technical nature, where the speed and strength abilities play the decisive role. The results in this event depend primarily on speed, the run-up technique and the angle of javelin ejection with the maximum initial velocity. The research results show that the most important factor influencing the results in this event is the initial velocity at the time of javelin ejection given by body weight in correlation with the speed obtained during the run-up and the appropriate setting of ejection angle [Bartlett and Best, 1988, Maier et al. 2000, Murakami and et al., 2006]. The value of limit results in women's

javelin throw is at the level of over 87 m, and the dynamics of results variation tends to increase by 23% [Nowak, 2007].
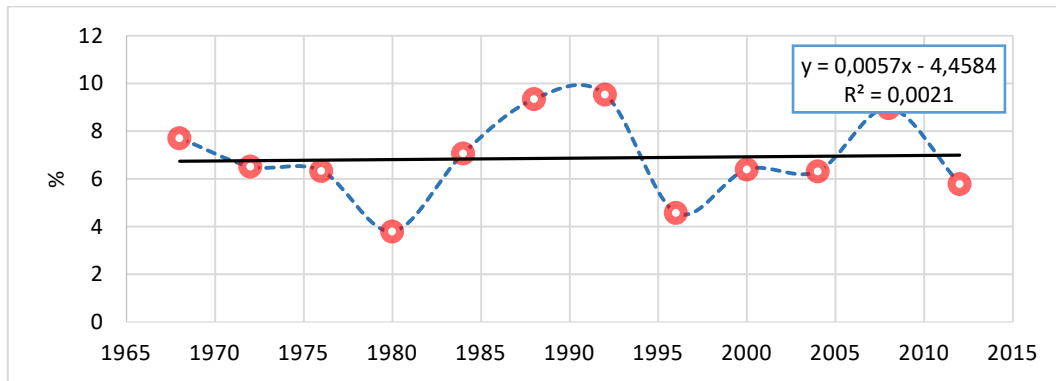

Figure 3. Jevelin throw

In the history of Olympic competitions in women's javelin throw two periods can be distinguished. The first includes the years until 1984 (old type javelin), and the second period involves the years after 1984 (new type of javelin). In the first period, the best result was achieved by the Olympic champion from Los Angeles (1984), Tessa Sanderson from Great Britain (69,56m). At the same Olympics, the highest average level of medalists' results (68.57 m) was also recorded. On the other hand, at the Olympic Games in Moscow (1980), the highest average level of all tight final participants' result was noted. In 1988, the final contest in this event was held using a new type of equipment. The winner was Petra Felke from the former GDR who achieved the result of 74.68 m. The 70 m limit was also exceeded by gold medalists from Athens and Beijing. The 1988 competition is also characterized by the highest average performance level both in the group of medalists and athletes from places 4-8. The most balanced level of performance features the competitions in Moscow (old type javelin) and Atlanta (1996) (new type). Based on the course of the regression line it can be stated that the average distance between the athletes from places 4-8 remained basically constant and was at the level of about 6%. The analysis of the results development index shows that the highest progression is observed among Olympic champions and the lowest one among the medalists (Table 1, Figure 3.).

Hammer throw

High weight and a considerable body height are the basic somatic parameters that determine the result in this event. The essence of motor activity is rotational movement during which there is an interaction between two factors, i.e. body weight and equipment, and the main goal is to achieve maximum linear speed in the final phase of the throw [Dapena et al. 2003, Judge 2004, Mercadante et al. 2004, Tidow 1995]. According to Nowak, the dynamics of the variability of hammer throw results will tend to increase at the level of more than 13% and the limit value fluctuates around the range of 90 m [Nowak, 2007]. The hammer throw contest was first held at the Olympic Games in Sydney (2000). The winner in this competition was the Polish athlete Kamila Skolimowska who achieved the result of 71.16m. In each successive final, a systematic increase in average results is noted. This applies to all researched groups of athletes. The most balanced competition proved to be the Olympic final contest in Athens (2004), in which the distance between the athletes outside the medals was at the level of about 2.5%. This distance remains basically unchanged throughout the whole period considered (Table 1, Fig. 4). The highest rate of performance growth features the group of athletes from the direct background of medalists.
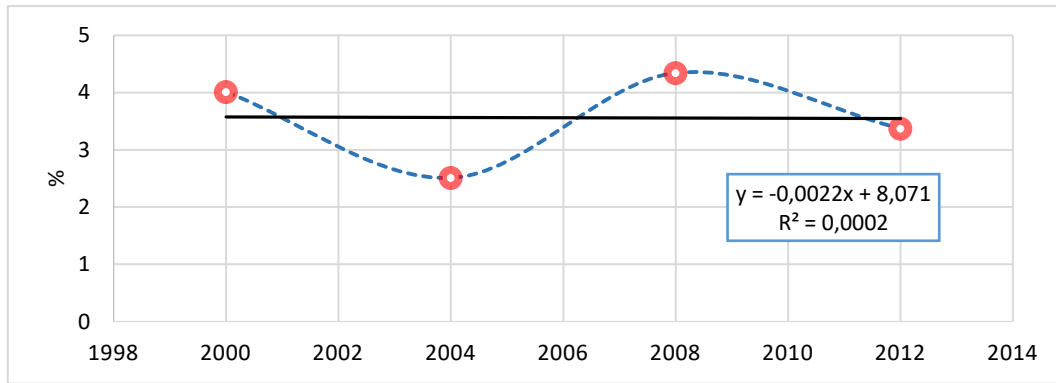
Figure 4. Hammer throw

Table1. Results Olympic finals in the years 1968-2012

Sport	Place	1968	1972	1976	1980	1984	1988	1992	1996	2000	2004	2008	2012	GRR
Shot put	I	19,61	21,03	21,16	22,41	20,48	22,24	21,06	20,56	20,56	19,59	20,56	20,70	0,35
	I-III	18,86	20,20	20,93	21,68	20,05	21,46	20,44	19,93	20,03	19,54	20,23	20,47	0,64
	IV-VIII	17,22	18,84	19,81	20,30	17,69	20,16	19,19	19,04	18,86	18,75	19,16	19,25	0,79
	I-VIII	17,83	19,35	20,23	20,82	18,58	20,64	19,66	19,37	19,30	19,05	19,56	19,71	0,75
	%*	8,70	6,73	5,35	5,30	11,77	6,06	6,12	4,47	5,70	4,04	5,29	5,96	-
Discus throw	I	58,28	66,62	69,00	69,96	65,36	72,30	70,06	69,66	68,40	67,02	64,78	69,11	1,37
	I-III	56,98	65,34	67,71	68,42	64,62	71,31	68,03	67,26	66,44	66,59	63,67	67,96	1,42
	IV-VIII	53,29	61,24	65,60	64,91	59,61	67,82	64,10	64,13	63,60	64,51	61,22	64,59	1,50
	I-VIII	54,67	62,78	66,02	66,23	61,49	69,13	65,57	65,31	64,66	65,29	62,14	65,85	1,46
	%*	6,48	6,27	4,00	5,13	7,75	4,89	5,78	4,65	4,27	3,12	3,85	4,96	-
Jevelin throw	I	60,36	63,88	65,94	68,40	69,56	74,68	68,34	67,94	68,91	71,53	71,42	69,55	1,19
	I-III	59,44	62,12	64,87	67,57	68,57	70,77	67,82	66,15	67,53	67,21	69,44	66,54	0,97
	IV-VIII	54,86	58,07	60,76	65,00	63,72	64,15	61,35	63,12	63,21	62,96	63,21	62,69	1,09
	I-VIII	56,58	59,59	62,30	65,97	65,54	66,63	63,77	64,26	64,83	64,56	65,55	64,16	1,15
	%*	7,71	6,52	6,34	3,80	7,07	9,35	9,54	4,58	6,40	6,32	8,97	5,79	-
Hammer throw	I									71,16	75,02	76,34	78,18	3,08
	I-III									70,07	73,85	75,29	77,63	3,35
	IV-VIII									67,26	72,00	72,02	75,01	3,53
	I-VIII									68,31	72,69	73,24	76,04	3,49
	%*									4,01	2,51	4,34	3,37	-

To sum up, it should be noted that hammer throw, as the latest Olympic event, is one of competitions featuring the most dynamic development of results in the researched period of time. Taking into account the separate groups, the largest progression of results was recorded among athletes from places 4-8, constituting the direct background of the medal zone. On the other hand, shot put is one of the events characterized by the lowest range of results development, and in the group of gold medalists the progress in the results development is the lowest of all events and analyzed groups (Fig. 5).
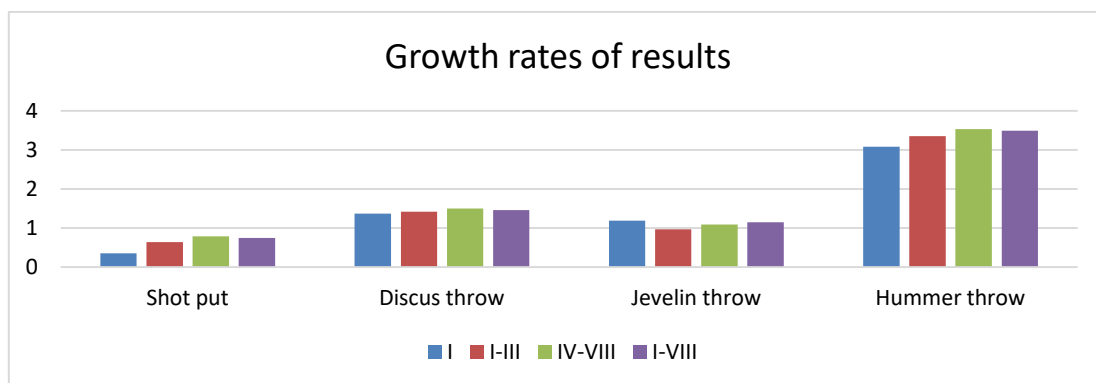

Figure 5. Development index (growth rates of results)

CONCLUSIONS

The conducted analysis allows for the following conclusions:

1. The greatest dynamics of results development in women's track and field throwing events features the hammer throw as the latest Olympic event;
2. Of all the analyzed groups of female athletes, Olympic shot put champions record the lowest rate of results development throughout the whole period of time;
3. From the analysis of the regression index and the course of the regression line it follows that both in shot put and discus throw the distance between the athletes outside the medals shows a clear decreasing trend, what can be the evidence of a significant sports level equalization of female final contests participants; in other events, that distance is in principle at a constant level.

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