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DIFFERENCES BETWEEN THE BEST OLYMPIC RESULTS AND THE WORLD'S BEST RESULTS ACHIEVED IN THE OLYMPIC YEARS IN THROWING EVENTS IN ATHLETICS

RAZLIKE MED NAJBOLJŠIMI OLIMPIJSKIMI IN SVETOVNIMI REZULTATI V ATLETSKIH METALNIH DISCIPLINAH V OLIMPIJSKIH LETIH

Abstract

The aim of this study was to identify differences between arithmetic means of the best results in throwing events in athletics that were achieved in the finals of the Olympic Games on the one hand, and the world's best eight results achieved in the Olympic years in other competitions in the 1976-2004 period, on the other hand. Participants were top-level athletes in throwing events who participated in the finals of the Olympic Games between the years 1976 and 2004 and ranked in the top eight in the world. The *t*-test for dependent samples was used to analyse the differences between arithmetic means of the best results achieved in the Olympic Games' finals and the world's best results achieved in the same years in which the Olympic Games were held. The obtained *t*-values of differences between arithmetic means point to the statistically significant differences between the samples of results, namely, it was confirmed with a high level of certainty that the samples had been derived from two very different populations in terms of the analysed feature. The hypothesis that significant differences would be established between the results achieved in the Olympic Games' finals and the world's best results achieved in other competitions in the Olympic years was confirmed.

Key words: throwing events, Olympic Games, best results, trends of development

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Izvleček

Namen te študije je ugotoviti razlike med aritmetičnimi sredinami najboljših rezultatov v metalnih disciplinah v atletiki, ki so bili doseženi v finalu olimpijskih iger, ter aritmetičnimi sredinami najboljših svetovnih rezultatov, ki so bili doseženi v drugih tekmovanjih v olimpijskih letih med 1976 in 2004. Vzorec je zajemal športnike iz različnih držav, in sicer vrhunске metalce krogle, diska, kopja in kladiva, ki so tekmovali v finalu olimpijskih iger med letoma 1976 in 2004 in se uvrstili med prvih osem na svetovni lestvici atletov, ki tekmujejo v metalnih disciplinah. S *t*-testom za odvisne vzorce smo ugotavljali značilnost razlik med aritmetičnimi sredinami najboljših rezultatov iz finala olimpijskih iger in najboljših svetovnih rezultatov, ki so bili doseženi v letih, ko so potekale olimpijske igre. Dobljene *t*-vrednosti razlik med aritmetičnimi sredinami kažejo na statistično značilne razlike med vzorci rezultatov, saj smo z veliko verjetnostjo potrdili, da so bili vzorci pridobljeni iz dveh zelo različnih populacij glede na analizirano značilnost. Hipoteza, da obstajajo statistično značilne razlike med rezultati iz finala olimpijskih iger in najboljšimi svetovnimi rezultati, ki so bili doseženi na drugih tekmovanjih v olimpijskih letih, je bila potrjena.

Cljučne besede: metalne discipline, olimpijske igre, najboljši rezultati, razvojni trendi

Introduction

Since ancient times various types of throwing different implements were a way people showed their strength in contests. It was for fun that they threw a stone, a blacksmith's hammer, a cannonball, a javelin or the like. These types of throws later developed into athletic throwing events. Shot put and discus throw were part of the Olympic programmes already at the first Olympic Games, hammer throw was introduced during the second Olympic Games in 1900, and javelin throw may be found for the first time in the programme of the Jubilee Games in 1906. World records have been recorded since 1909 for the shot putting event, since 1912 for discus and javelin throw, and since 1913 for hammer throw. The furthest distances ever in the throwing events were achieved by the American Randy Barnes (shot put in 1990 in Los Angeles – 23.12 m), the German Jürgen Schult in discus throw (1986 in Neubrandenburg – 74.08 m), the Russian Juri Sedyh in hammer throw (1986 in Stuttgart – 86.74 m) and the Czech Jan Zelezny in javelin throw (1996 in Jena – 98.48 m).

The modern Olympic Games were restored in 1896 and have been held ever since (except during the periods of two World Wars) following the example of the ancient Olympic Games in which the best athletes from the whole world participated. During the Olympic Games athletes from all countries in the world gather, without any racial, religious or other discrimination. The goal of the Olympic movement is the physical and spiritual strengthening of the young and the improvement of their moral qualities on the basis of the quality participation in sports. The last Olympic Games were held in the year 2004 in Athens. The Olympic Games were not held between 1912 and 1920, and between 1936 and 1948 because of the two World Wars, while in 1906 half-Olympics were held in Athens.

The analysis of the trends in the development of results made it possible to identify certain cyclic oscillations (Bartonietz & Borgstom, 1995; Wazni, 1978). These were reflected in the more expressed improvement of results in the Olympic years and in a slow-down in development in the period between the Games. The oscillations were connected with the Olympic Games and the role they have in sport. Since the Olympic Games have become a contest that affects the tendencies in the development of results, it would be important to know whether the athletes achieve better results in the most important competitions in the Olympic years.

Accordingly the aim of this study was to identify differences between the arithmetic means of the best results achieved in the finals of the Olympic Games and the world's best eight results achieved in the Olympic years in the 1976-2004 period. Establishing these differences would actually help us determine the correlation between sporting achievements and the methods used as well as the sociological factors that affect the development of results. Further, this would significantly broaden our knowledge about what may be expected in the future in top-level results in throwing events in athletics. The basic hypothesis that was tested in this study was that significant differences existed between the best Olympic results and the world's best results achieved in other competitions in the four throwing events in the Olympic years.

Method

Participants

Participants were athletes – top-level shot putters, discus throwers, javelin throwers and hammer throwers – from different world countries. The sample was divided into two sub-samples. The first sub-sample consisted of athletes participating in the Olympic Games' finals between 1976 in Montreal and 2004 in Athens. This means that the sample of subjects for each of the Olympics was defined by the sets, each consisting of 8 athletes for each throwing event. The second sub-sample of subjects comprised of sets of 8 best throwers for each throwing event ranking among the top eight in the world classification of throwers in athletics in the Olympic years between 1976 in Montreal and 2004 in Athens. Many of these athletes were included in both sub-samples.

Instruments

The variables used in this study were the results achieved in the throwing events in athletics – shot put, discus throw, javelin throw and hammer throw. The data were collected from *The Complete Book of the Olympics* (Wallechinsky, 2004) and on this basis the series of results were defined. The results of the list of the International Association of Athletics Federations [IAAF] (2005), namely, the best eight results in the Olympic years between 1976 and 2004, were also used and on this basis the series of the world's best results achieved in the Olympic years were defined.

Procedure

The collected data were processed by the *Statistica* program package. The arithmetic means (AM), standard deviations (SD), the best (MAX) and the poorest (MIN) results, as well as the ranges (R) between the best and the poorest results were calculated. The analysis included the data on the statistical significance of differences between arithmetic means of the best results achieved in the Olympic Games' finals and the world's best results achieved in the Olympic years. For this purpose the method and the program for the analysis of differences between arithmetic means were used with the help of the module 't-test for dependent samples'. Dependent t-test is a test of the significance of differences between means of two sets of scores that are related, such as when the same participants are measured on two occasions (Thomas & Nelson, 2001). In our investigation one or more athletes were to be found in both sub-samples – in the sub-sample of the Olympic Games' finalists and in the sub-sample of the best ranked athletes in the world classifications. This, naturally, presented no limitation for the testing of differences between the sub-samples defined in such a way.

Results

Shot put

Prior to identifying differences defined by the aim of this study, the following was determined: descriptive statistical parameters of the original results in shot put achieved in the Olympic Games' finals between 1976 and 2004 and descriptive statistical parameters of the world's best results in shot put in the 1976-2004 period. These parameters are presented in Table 1 and Figure 1.

Table 1: Descriptive statistical parameters of the best results in shot put achieved in the Olympic Games' finals and the world's best results in the Olympic years between 1976 and 2004

Year	The best Olympic results					The world's best results				
	M	SD	MIN	MAX	R	M	SD	MIN	MAX	R
1976	20.61	0.36	20.17	21.05	0.88	21.57	0.32	21.12	22.00	0.88
1980	20.81	0.54	20.07	21.50	1.43	21.54	0.27	21.23	21.98	0.75
1984	20.50	0.64	19.65	21.26	1.61	21.85	0.19	21.64	22.19	0.55
1988	21.24	0.94	20.36	22.47	2.11	22.09	0.62	21.39	23.06	1.67
1992	20.75	0.48	20.23	21.70	1.47	21.43	0.42	20.99	21.98	0.99
1996	20.67	0.45	20.07	21.62	1.55	21.33	0.45	20.90	22.40	1.50
2000	20.81	0.42	20.18	21.29	1.11	21.64	0.27	21.34	22.12	0.78
2004	20.71	0.39	20.26	21.16	0.9	21.58	0.44	21.16	22.54	1.38

Legend (for Tables 1, 3, 5 & 7)

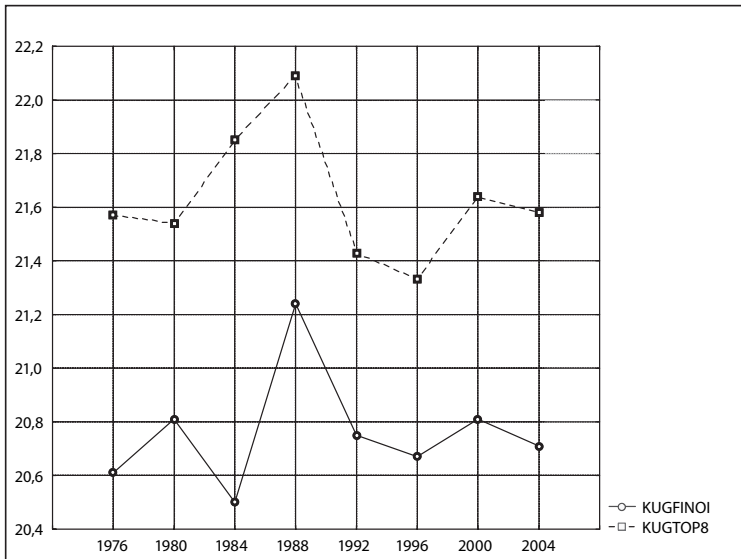
M - arithmetic mean

SD - standard deviation

MIN - the poorest result

MAX - the best result

R - range between the best and the poorest result



Legend:

KUGTOP8 - the average of the world's best results

KUGFINOI - the average of the best Olympic results

Figure 1: Graphical presentation of the average of the best Olympic results and the world's best results in shot put achieved in the Olympic years

The Olympic results in shot put are poorer than those achieved in the Olympic years in other competitions. This difference in results is particularly evident in the year 1984 at the Olympic Games in Los Angeles when some of the world's best shot putters boycotted the Olympics. After determining the descriptive parameters, the statistical procedures were applied to identify differences between arithmetic means of the best results in shot put achieved in the Olympic Games' finals and the world's best results achieved in the same years. This analysis will provide the answer to the main hypothesis in this study about the differences between the two series of results in throwing events in athletics. The results of this part of the analysis are presented in Table 2.

Table 2: Differences between arithmetic means of results in shot put realized in the Olympic Games' finals and the average of the world's eight best results achieved in throwing events in athletics in the Olympic years between 1976 and 2004

	M	SD	N	t	df	p
KUGFINOI	20.76	0.21				
KUGTOP8	21.62	0.24	8	-11.11	7	0.00

Legend:

KUGFINOI – the average of results of the Olympic Games' finalists

KUGTOP8 – the average of the world's best results achieved in the Olympic years

M – arithmetic mean

SD – standard deviation

N – number of results

t – t-test

df – degrees of freedom

p – significance of differences

Discus throw

The descriptive statistical parameters of the original results in discus throw achieved in the Olympic Games' finals between 1976 and 2004 and the descriptive statistical parameters of the best results in discus throw between 1976 and 2004 are presented in Table 3 (see also Figure 2).

Table 3: Descriptive statistical parameters of the best results in discus throw achieved in the Olympic Games' finals and the world's best results achieved in the Olympic years between 1976 and 2004

Year	The best Olympic results					The world's best results				
	M	SD	MIN	MAX	R	M	SD	MIN	MAX	R
1976	64.52	1.85	61.98	67.50	5.52	67.47	1.64	66.04	70.86	4.82
1980	65.10	1.47	63.04	66.64	3.60	68.84	1.01	68.04	70.98	2.94
1984	65.01	1.20	63.22	66.60	3.38	70.31	0.86	68.82	71.26	2.44
1988	66.25	1.70	63.28	68.82	5.54	69.19	0.94	68.22	70.46	2.24
1992	63.29	1.28	61.78	65.12	3.34	68.29	1.24	67.16	70.84	3.68
1996	65.46	1.99	62.78	69.40	6.62	68.33	1.75	66.92	71.14	4.22
2000	66.87	1.76	64.41	69.30	4.89	69.44	1.94	67.59	73.88	6.29
2004	65.34	2.43	65.34	69.89	4.55	68.92	1.27	67.66	70.97	3.31

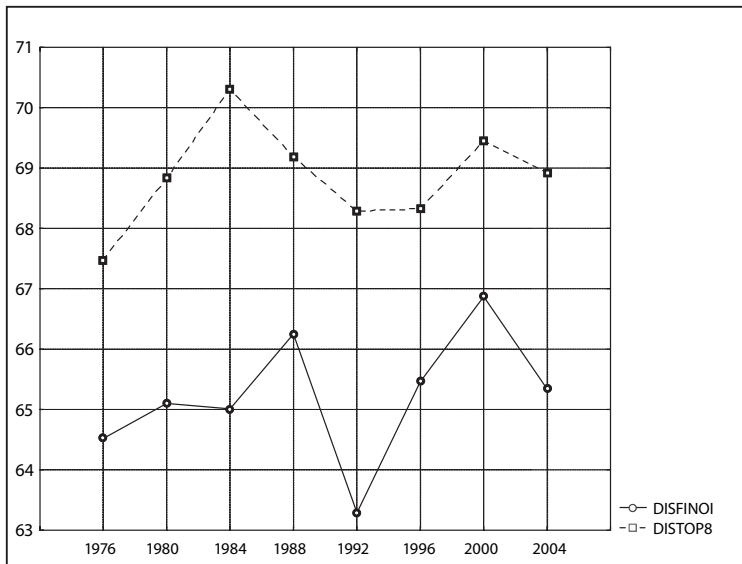


Figure 2: Graphical presentation of the average of the best Olympic results and the world's best results achieved in discus throw in the Olympic years

Big differences between the results are particularly evident in the year 1984 when some of the best discus throwers boycotted the Los Angeles Olympic Games. After determining the descriptive parameters, the statistical procedures were applied to identify differences between arithmetic means of the best results in discus throw achieved in the Olympic Games' finals and the world's best results achieved in the Olympic years between 1976 and 2004. This analysis will provide the answer to the main hypothesis of this study about the differences between the two series of results in throwing events in athletics. The results of this part of the analysis are presented in Table 4.

Table 4: Differences between arithmetic means of results in discus throw achieved in the Olympic Games' finals and the average of the world's eight best results achieved in the Olympic years between 1976 and 2004

	M	SD	N	t	df	p
DISFINOI	65.23	1.07				
DISTOP8	68.84	0.85	8	-10.01	7	0.00

Legend:

DISKFINOI – the average of results of the Olympic Games' finalists

DISKTOP8 – the average of the world's best results in the Olympic years

M – arithmetic mean

SD - standard deviation

N - number of results

t - t-test

df – degrees of freedom

p – significance of differences

Hammer throw

The descriptive statistical parameters of the original results in hammer throw achieved in the Olympic Games' finals between 1976 and 2004 and the descriptive statistical parameters of the world's best results in hammer throw between 1976 and 2004 are presented in Table 5 (see also Figure 3).

Table 5: Descriptive statistical parameters of the best results in hammer throw achieved in the Olympic Games' finals and the world's best results achieved in the Olympic years between 1976 and 2004

Year	The best Olympic results					The world's best results				
	M	SD	MIN	MAX	R	M	SD	MIN	MAX	R
1976	74.76	1.88	71.34	77.52	6.18	77.75	0.89	76.40	78.86	2.46
1980	76.90	3.28	73.74	81.80	8.06	80.38	1.14	78.58	81.80	3.22
1984	75.71	1.95	72.62	78.08	5.46	82.92	2.12	80.68	86.34	5.66
1988	80.10	3.07	76.08	84.80	8.72	83.68	1.03	82.16	85.14	2.98
1992	78.89	2.61	76.16	82.54	6.38	82.39	1.20	81.02	84.62	3.60
1996	79.55	1.36	77.38	81.24	3.86	81.22	0.82	80.02	82.52	2.50
2000	78.72	0.95	77.32	80.02	2.70	81.85	0.43	81.42	82.58	1.16
2004	79.02	1.92	76.30	82.91	6.61	82.83	1.04	81.33	84.46	3.13

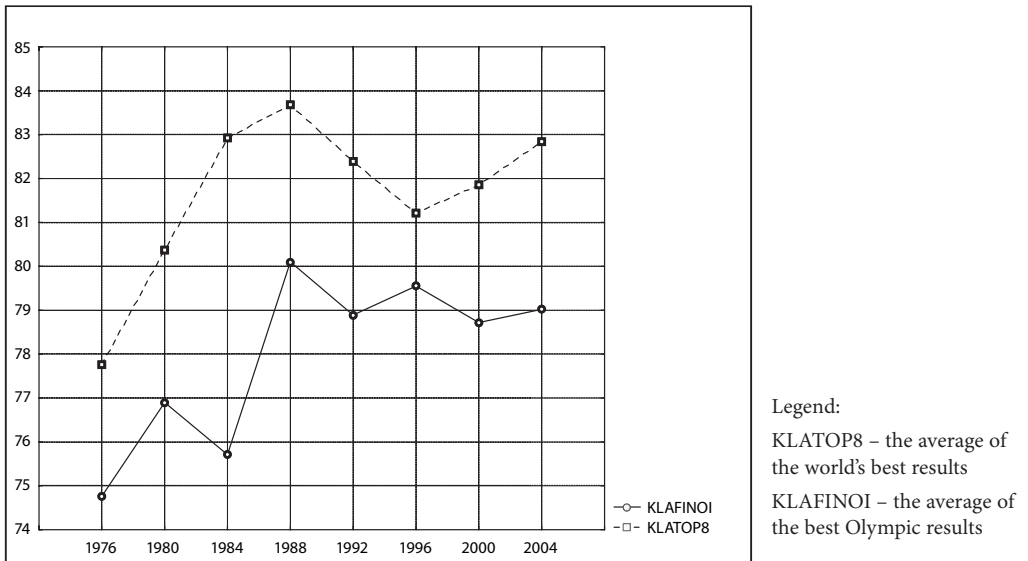


Figure 3: Graphical presentation of the average of the best Olympic results and the world's best results achieved in hammer throw in the Olympic years between 1976 and 2004

The results achieved in hammer throw in the Olympic Games' finals are poorer than the results achieved in other competitions in the Olympic years. An expressed difference may be seen in the year 1984 again when the world's three best hammer throwers (Sedyh, Tamm and Litvinov) did not participate at the Los Angeles Olympic Games due to the boycott of the Games by the erstwhile Eastern block. Having identified the descriptive parameters, the statistical procedures for determination of differences between arithmetic means of the world's best results achieved in the analysed Olympic years were applied. This analysis will give the answer to the main hypothesis of this study about the differences between the two series of results in throwing events in athletics. The results of this part of the analysis are presented in Table 6.

Table 6: Differences between arithmetic means of results in hammer throw achieved in the Olympic Games' finals and the average of the world's eight best results achieved in the Olympic years between 1976 and 2004

	M	SD	N	t	df	p
KLAFINOI	77.95	1.93				
KLATOP8	81.62	1.87	8	-6.59	7	0.00

Legend:

KLAOI – the average of results of the Olympic Games' finalists

KLATOP8 – the average of the world's best results in the Olympic years

M – arithmetic mean

SD - standard deviation

N - number of results

t - t-test

df – degrees of freedom

p – significance of differences

Javelin throw

The descriptive statistical parameters of original results in javelin throw achieved in the Olympic Games' finals in the years between 1976 and 2004, as well as the descriptive statistical parameters of the world's best results in javelin throw achieved between 1976 and 2004 are presented in Table 7 and Figure 4.

Table 7: Descriptive statistical parameters of the best results in javelin throw achieved in the Olympic Games' finals and the world's best results achieved in the Olympic years between 1976 and 2004

Year	The best Olympic results					The world's best results				
	M	SD	MIN	MAX	R	M	SD	MIN	MAX	R
1976	86.51	4.02	80.26	94.58	14.32	90.39	2.53	87.98	94.58	6.60
1980	86.13	3.01	82.40	91.20	8.80	91.60	2.32	89.64	96.72	7.08
1984	85.27	6.33	80.68	100.00	19.32	94.14	4.39	91.12	104.80	13.68
1988	81.93	2.21	78.30	84.28	5.98	84.85	1.42	83.26	86.88	3.62
1992	82.27	4.17	77.74	89.66	11.92	89.06	2.96	86.16	94.74	8.58
1996	86.01	1.64	83.58	88.16	4.58	89.85	3.82	87.44	98.48	11.04
2000	87.34	2.27	83.33	90.17	6.84	89.38	1.79	87.12	91.69	4.57
2004	84.14	1.22	83.01	86.50		87.04	0.58	86.19	87.73	1.54

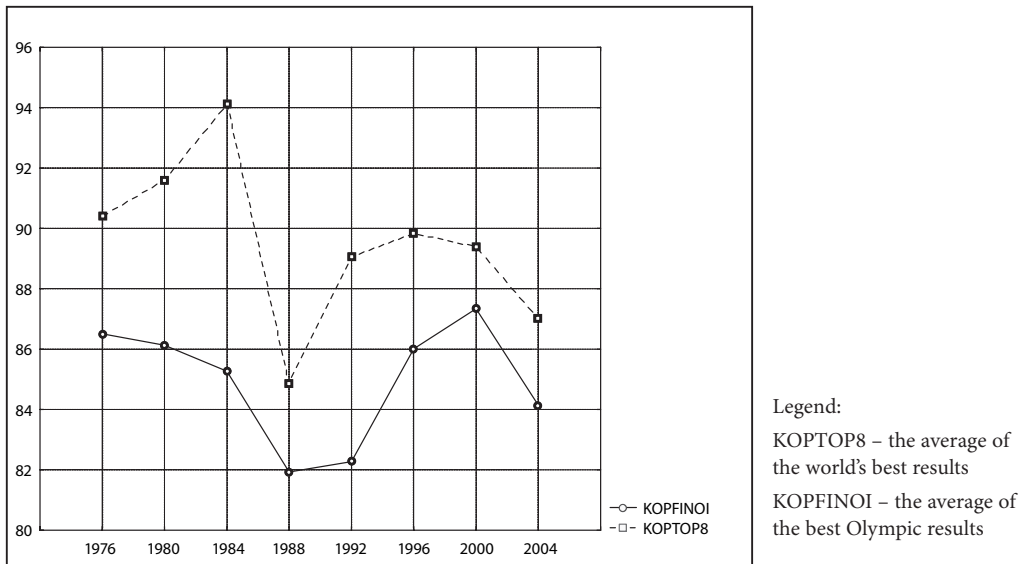


Figure 4: Graphical presentation of the average of the best Olympic results and the world's best results in javelin throw in the Olympic years between 1976 and 2004

The results in hammer throw achieved at the Olympic Games are poorer than the results achieved in other competitions in the Olympic years. This difference is particularly large in the year 1984, due to the boycott of the Los Angeles Olympic Games by the countries of the erstwhile Eastern block, and in the year 1992, due to the increased climate stress (high humidity and high temperatures) (Verdaguer-Codina, Martin, Pujol-AMat, Ruiz, & Prat, 1993). After identifying the descriptive parameters, the statistical procedures were applied to determine differences between arithmetic means of the best results in javelin throw achieved in the Olympic Games' finals and the world's best results achieved in the analysed Olympic years. This analysis will provide the answer to the main hypothesis of this study about the differences between the two series of results in throwing events in athletics. The results of this part of the analysis are presented in Table 8.

Table 8: Differences between arithmetic means of the average of results in javelin throw achieved in the Olympic Games' finals and the average of the world's eight best results achieved in the Olympic years between 1976 and 2004

	AM	SD	N	t	df	p
KOPFINOI	84.95	1.99				
KOPTOP8	89.53	2.79	8	-5.63	7	0.00

Legend:

KOPFINOI – the average of the results of the Olympic Games' finalists

KOPTOP8 – the average of the world's best results achieved in the Olympic years between 1976 and 2004

M – arithmetic mean

SD - standard deviation

N - number of results

t - t-test

df – degrees of freedom

p – significance of differences

Discussion

The tables as well as the graphical presentations and the descriptive parameters make it possible to conclude that the results achieved at the Olympic Games are poorer than the results achieved in the same Olympic years at other competitions. This is particularly evident in the case of two Olympic Games which were boycotted, first by the athletes from the Western countries who boycotted the Olympic Games in Moscow in 1980, and then by the athletes from the Eastern countries who boycotted the Olympic Games in Los Angeles in 1984, as the results were poorer – in some events even substantially poorer.

The samples i.e. the series of results were analysed at 7 time points. The samples were of a limited size and were determined by the possibilities of the methodological procedure. On the basis of the obtained differences between arithmetic means of the samples the *t*-value was calculated and, in fact, it is different for each throwing event. The biggest differences between the results achieved at the Olympic Games and the world's results achieved in other competitions were established in shot put (-11.11), followed by discus throw (-10.01), hammer throw (-6.59), and javelin throw (-5.63). All of these values are statistically significant at the level of 99%. The obtained *t*-values of differences between arithmetic means with six degrees of freedom point to the statistically significant differences between the results of samples, that is, it was confirmed with great certainty that the samples had been derived from two very different populations in terms of the analysed feature. The hypothesis that significant differences will be established between the results achieved in the Olympic Games' finals and the world's best results achieved in the Olympic years in other competitions may be accepted with a 99% certainty. If the difference is not accidental the differentiation between the populations of throwers who did not achieve results at large competitions was influenced by certain factors. The main question is which factors contributed to the fact that the throwers failed to achieve their best results in the most important competition, namely, at the Olympic Games. The reasons may be found in the social, method-related, psychological and pharmacological factors (Dyer, 1989; Milanović, 1989; Mizera & Horvath, 2002; Wazni, 1978; Zatsiorsky, 1973; Zatsiorsky, Lanka, & Shalmanov, 1981). Among the social factors it is the professionalisation in sport that has to be emphasized as well as the increasingly better conditions in which the process of sports conditioning is carried out (Muller, 1991). These factors affected the constant improvement or elevation of the level of results in throwing events. What affected the differences between the Olympic results and the results achieved in the world in other competitions may be the fact that the prizes for top-level results at the non-Olympic competitions are significantly higher, which is why the competitors took part in too many of such competitions, which could have influenced negatively the timing of achieving top-level results at the Olympic Games (Egger, 1994). Outside the methods-related factors is the issue of timing the sports fitness that should be emphasized as well as the impossibility of maintaining the high level of results at competitions throughout a longer time period (Ueya, 1992). Outside the factors belonging to the mental training it should be emphasized that strong stress, i.e. the psychological strain when competing at the Olympic Games could have negatively influenced the achievement level in some athletes. Indeed, it happened often that athletes achieved their best results in the year immediately after the Olympic Games at some athletic meeting in the world series (Scheibe & Dickwach, 1993). It is not easy to list the substantiated facts about the pharmacological factors that could have affected significantly the differences between the results. Due to the stricter doping control at the Olympic Games, it could be assumed that the level of results was somewhat lower. The findings of the doping control have

confirmed the presence of stimulants at some lower-level competitions in which athletes achieved the top-level athletic results (Dolle, 1995). It is precisely because of the high complexity of the trends in development of the sports result in throwing events in athletics that it would be very complicated to determine the size of the influence of any of the factors listed.

Statistically significant differences between the results achieved in the Olympic Games' finals and world's best results achieved in other competitions prove that the throwers in athletics did not achieve their best results at the most important competition, namely, at the Olympic Games. Taking into account numerous factors that affect the result one cannot be sure whether it was the social or the methods-related factors that affected such dynamics of the sports result. The considerations about such a tendency raise a question: Are the medals and the awards for the achieved results not enough anymore? It was the professionalisation of the sport that attributes the overriding importance to the competitions which generate large profits to athletes, while this is not possible at the Olympic Games. Maybe that is why the athletes try to get to peak fitness for the competitions at which good money can be earned? In view of the above it would be interesting to launch a new study to investigate into the issue of what is the worth of a sports result in throwing events. Although for the Olympic winners sport is no longer a secondary occupation that brings them almost no material benefit and although it is impossible to qualify for the finals of the Olympic Games without making a significant investment, we hope that the main principles of the Olympic Games are not forgotten. Thus, the results of this study have set new hypotheses and raised new questions to be answered in the future, which is why they are a good foundation for further research.

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