DIFFERENCES BETWEEN QUALIFICATION AND FINAL RESULTS OF JAVELIN THROW FINALISTS OLYMPIC GAMES IN LONDON 2012

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Abstract
Olympics as the most important sports event bring forth new results that often represent new Olympic, World or national records. Olympics in London are exactly an indication of such results. There has been recorded a shot of national record (NR=84,58m) of a javelin thrower, of the athlete of Trinidad and Tobago (K. Walcott), which his result from qualifications in the final performance increased by almost 3m. It is the result of Walcott, that was the reason for this study that treats differences in result success of male and female athletes of javelin throwers in the qualifying and final appearance. The main objective of this study was to determine the differences between individual results male and between individual results of female athletes participants of the Olympic Games in London in 2012. The sample included the top 24 elite athletes (12 female and 12 male), who participated in the qualifications and finals of the Olympic Games. The collected data were analyzed by the program package Statistica 7.0. by applying module's t-test for small dependent samples. The results did not confirm the existence of a statistically significant differences between the qualifying and final performance of competitors. Also, the results showed that only 33% of competitors in both sub causes obtained better shot in the final than in the qualification.

Key words: *differences, Olympic game, javelin throwing*

Introduction

Athletics is one of the oldest sports whose history dates back to ancient times. Since the first competition in certain athletic disciplines, whose rules are standardized, there is a progressive trend of growth of results. It is a logical sequence of events, because in every following competition perfected the technology of performance, technology of training, sports shoes and clothing, as well as competition growing stronger (Milinović, Milanovic and Harasin, 2008). Such a case can be mapped also to javelin throwing in both competition. Following the results of the winners at the Olympic Games, one can notice a progressive upward trend in results over the every next Olympics.

Predicting of sports results, which can be achieved in the future, is the knowledge base, essential for the proper functioning of coaches and teams in the sport. Important (1978) states, that the researches aimed to discover the laws that govern the development of sports results in the corresponding long period of time, processing the data from the past can explain many "unclear" appearance and predict the results that can be achieved in the future. Very often as a problem of researching, defined biomechanical parameters and possible prediction of the result success and very often possible models of javelin throwing. The researches of aerodynamic parameters of javelin throwing explored Hubard, 1984, Bartlett & Best, in 1988. Using computer simulations they estimated the speed of throw out, corner throw out, throw out height, phase contact with the ground. It was a new framework and roadmap for research of this kind in the javelin throwing.

The purpose study (Knuz, & Kaufmann, 1983) was to analyse by correlational methods the biomechanical factors involved in achieving the maximal distance thrown in the javelin event. Twelve Swiss decathletes and two world class javelin specialists were filmed by a high speed (102 fps) 16 mm camera throwing a total of 20 trials. The co-ordinates of the resulting cyclo grams were processed by a computer programme and the results submitted to correlational analysis. The highest correlation was 0.76 between velocity at release and distance thrown. Other negative correlations were found between distance thrown and angle of the javelin with the horizontal (0.52) and distance thrown and throwing hand to contra lateral foot distance during the last strides (0.67). Javelin specialists, who had longer throws than decathletes (mean = 79.03 m versus 54.29 m), had a smaller difference between the angle of attack and angle of release. The results suggest that in order to attain maximal distance thrown the javelin thrower should achieve positive acceleration during the running approach, effective thrusting with th right leg on the penultimate stride and carry the javelin during the last strides at the optimal angle of release (32º-36º). An interesting study on the possibility of application of the javelin throwing explored Maier, Wank, Bartonietz, & Blickhan (2000). Model for predicting the flight has been developed based on neural network perceptor. It was found that the most important parameter is the speed of ejection at angle of attack 1 º -3 º at a speed of 27-28m / s. For higher speeds it is the other way around. Similar research in the elite men's and women's javelin spent Liu, Leigh, & Bing Yu (2010).

The purpose of this study was to determine the general sequence of movements of the upper and lower extremities of 30 elite male and 32 elite female javelin throwers. The sequences of the upper and lower extremity movements are determined by statistical analysis. They came to the conclusion that the movement of the upper extremities was not accompanied by a sequence proximal to distal, as stated in the literature, so it is necessary to study more about this issue**.** According to (Atwater, 1979; Menzel, 1987), the pattern of motion used in the javelin throw is similar to other movements used when striking or throwing an object. These are characterized by the fact that the body segments act sequentially to attain the maximum speed in the most distal segment of the system at the instant when the object is struck or thrown**.** Some researchers were researching the determining the differences between male and female javelin throwers. Bartlett, Muller, Lindinger, et al. 1996 have found differences between the javelin throwers (elite, subelite and beginners), in the ejection speed and in the angle of turn of javelin. As expected, significant differences ($p < .01$) were found between the all three groups in the angle turn and speed of the segments of the shoulder, elbow, fist. The research regarding the differences of results in all disciplines. Results obtained at the Qatar Athletics Championships in Doha (Sheker, 2010) show characteristics of each model of javelin thrower who in practice can be compared with the characteristics of the same throwers in the other competitions. Basically, he came to the conclusion that the Qatari throwers hold javelin longer and they throw shorter compared to other competitors.

Study (Viitasalo, Mononen, & Norvaplo, 2003) was designed to investigate the effects of release speed, release angle and uncorrected angle of attack measured at the foul line on the official javelin throwing result. The data were collected in international competitions for 26 elite male and 15 elite female javelin throwers (total 248 throws). Multiple regression models were constructed to predict the range of throw for a) individual throwers, b) a group of throwers using the mean value for each thrower in the analysis, and c) all individual throws registered for each gender separately. The data collection was carried out using a computerised photocell gate that consists of two invisible infrared walls two metres apart, perpendicular to the throwing direction. Release speed was found to have the highest correlation with the official throwing result. The three release parameters accounted for 56% of the variance in the official result for the male and 51% for the female throwers. For individual male and female throwers, the variance explained by the model was between 46 and 87%. Among the individual male throwers an increase of 1 m.s-1 in the release speed from 29 to 30 m.s-1 was calculated to increase the official result between 2.12 to 6.14 m while among the female throwers the effect of increase from 24 to 25 m.s-1 in the release speed was from 2.25 to 3.68 m.

The study emphasises the importance of investigating javelin throwing biomechanics on an individual thrower basis. However, despite knowledge of the relevant biomechanical parameters and anthropometric characteristics of participants and predictions of their performance in the future, it is often the case in practice, at the major events that same athlete experiences a lower score in the final than in the qualifying competition, although it would be logical that the final performance of the most successful for each individual. The question arises in practice, is it really so, or is the final result of the individual more successful than qualifying performance? There are no studies that have dealt with the differences found in the performance qualification and the final performance of javelin throwers, they are most studies that have examined the different biomechanical performances, the result trend in javelin throw and the differences between the sexes. Alexander was in 1996. conducted research on the finalists of throwing disciplines of the Olympic Games in Barcelona with the aim of comparing the biomechanical performance of male and female athletes. He got the results that there are certain differences and they are a result of muscular strength, flexibility and explosive strength in male and female athletes.

Harasin & Milanovic, 2005 on a sample of top throwers, conducted a research with the aim of determining the differences between the best Olympic and world results in the throwing disciplines from Montreal, in 1976. to Athens, 2004. By statistical procedures they established the trend of growth and differences in each event individually, where for the success of his score, in addition to motor skills, a significant proportion had morphological status of each competitor. Milinović et al. 2008 have analyzed the development of trend of the results of the Olympic women champions in the javelin from 1932. to 2004. It has been found that there is a progressive trend of the results, which in the last seven games has no such a high growth of results as in previous Olympics. The forecast results for the women winner of the Olympic Games in Beijing was performed, which should help coaches and teams of experts to determine which model female thrower that will throw the javelin for the wictory in the finals of the competition. According to these requirements, they will be able to determine the composition of sports preparation, make appropriate selections, plan and program the training process. Given the current trend, it is possible to make an assessment, and that this should be taken only as an attempt of approximation of possible achievements for 2008. For more precise and accurate forecast one should take into account other factors that affect the result, and certainly should consider the degree of development of female athletes that achieve the best results and the availability of resources that can provide the required level of preparedness of the female athletes during the period for which the results forecast is made for.

Milinović et al. 2013 conducted a survey of top female javelin throwers, disc, hammer, ball in order to examine the differences between the world's best and Olympic results. The sample included female results from 1928. and male from 1932. until the 2012. The results that were obtained rejected the hypothesis that there are no statistically significant differences between the achieved the world's best and Olympic results in the throwing disciplines. The results are more relevant and more necessary for practice if it is the case of a sample of top athletes throwers participants of some great competition such as the Olympic Games. The problem of this research is exactly focused on the analysis of the results achieved in the qualifying and finals in the javelin, in order to determine differences in terms of achieved results and eventual differences within the same sex. The assumption is that for the result success, in addition to motor skills, achieved also a significant share of the morphological status of each competitor, as well as their level of motivation, psychological conditions, etc.

Methods

The study included a sample of 24 top athletes in the javelin (12 male and 12 female) who took part in qualifying and finals of the Olympic Games in London 2012. year. Variables that were taken in the analysis are the best results that have male and female throwers achieved in the qualifying and final appearance. The results are taken from the official reports of the Olympic Games in London 2012. issued by the IAAF and the official IAAF website. The data obtained by the survey were analyzed by standard descriptive methods, and differences between groups of respondents were tested using Student's t-test for small dependent samples. Statistical analysis was done using the statistical program Statistica 7.0.

Results

Table 1 Results of male athletes

	Name	Nationality	Qualific.	Final	Result
1.	Keshorn Walcott	TRI	81,75	84,58	Q<F
2.	Oleksandr Pyatnytsya	UKR	82,72	84,51	Q<F
3.	Antti Ruuskanen	FIN	81,74	84,12	Q<F
4.	Vitezslav Vesely	CZE	88,34	83,34	Q>F
5.	Tero Pitkamaki	FIN	83,01	82,80	Q>F
6.	Andreas Thorkildsen	NOR	84,47	82,63	Q>F
7.	Spiridon Lebesis	GRE	82,40	81,91	Q>F
8.	Tino Haber	GER	80,39	81,21	Q<F
9.	Stuart Farquhar	NZL	82,32	80,22	Q>F
10.	Roderick Genki Dean	JPN	82,07	79,95	Q>F
11.	Ari Mannio	FIN	81,99	78,60	Q>F
12.	Julius Yego	KEN	81,81	77,15	Q>F

Table 2 Results of female athletes

	Name	Nationality	Qualific.	Final	Result
1.	Barbora Špotakova	CZE	66,19	69,55	Q<F
2.	Christina Obergfoll	GER	66,14	65,16	Q>F
3.	Linda Stahl	GER	64,78	64,91	Q<F
4.	Sunette Viljoen	RSA	65,92	64,53	Q>F
5.	Huihui Lu	CHN	64,45	63,70	Q>F
6.	Kathrina Molitor	GER	62,05	62,89	Q<F
7.	Martina Ratej	SLO	63,60	61,62	Q>F
8.	Madara Palameika	LAT	60,62	60,73	Q<F
9.	Kathryn Mitchell	AUS	60,11	59,46	Q>F
10.	Maria Abakumova	RUS	63,25	59,34	Q>F
11.	Hjalmsdottir Asdis	ISL	62,77	59,08	Q>F
12.	Elizabeth Gleadle	CAN	60,26	58,78	Q>F

Table 3. Descriptive statistics male and female

	Mean	Min	Max	Range	SD	Skew	Kurt
Qualification (m)	82,75	80,39	88,34	7,95	2,00	2,21	5,96
Final (m)	81,75	77,15	84,58	7,43	2,39	-,61	-,51
Qualification (f)	63,35	60,11	66,19	6,08	2,24	-,19	-1,33
Final (f)	62,48	58,78	69,55	10,77	3,26	,77	,31

Table 4. T-test for dependent samples male and female (p<,050)

	Mean±SD	t-value	p-level
Qualification (m)	82,75±2,00	1,314	,216
Final (m)	81,75±2,38		
Qualification (f)	63,35±2,24	1,536	,153
Final (f)	62,48±3,26		

(Mean (average value), standard deviation (SD), coefficient of t-test value(t-value), significance level (Sig.*p<0,05)

Tables 1 and 2 show the results of male and female athletes in the qualification and final appearance. It can be seen that in both subsamples of four competitors (33.33%) achieved a better result in the final than in the qualifying throwing. Of the male athletes (Walcott, Pyatnytsya, Ruuskanen and Haber) have made a better final result from the qualifying (an average of 1.96 m), unlike the female competitors (Spotakova, Stahl, Molitor, Palameika) who also performed better the final than qualifying result (but an average of 1.11m). Both male and female athletes in the qualification achieved, on average, better result than in the final performance. A minimum score of women amounted to (Min=60,11m), and maximum (Max=66,19m) with a range of 6,08m and were significantly more result homogeneous (Table 3).

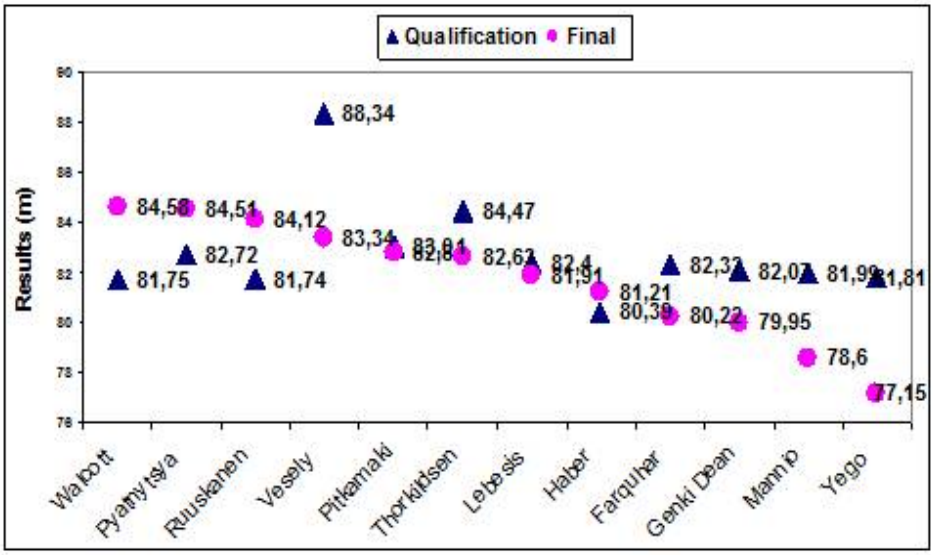

Figure 1. Graphical representation the results of male athletes

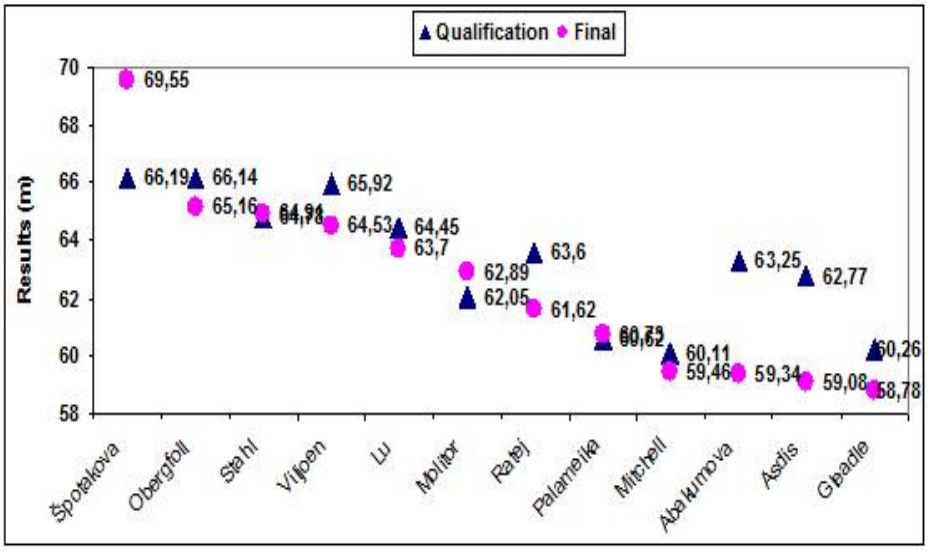

Figure 2. Graphical representation the results of female athletes

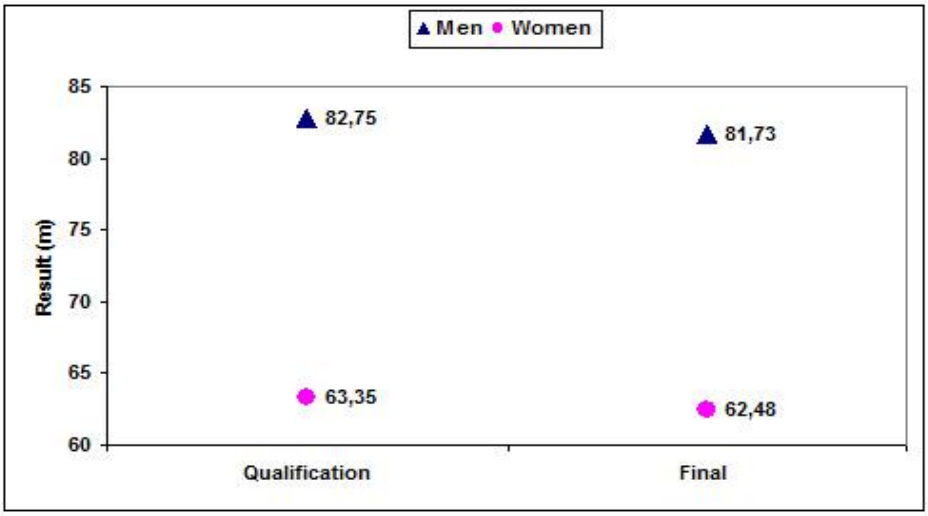

Figure 3. Graphical representation the average results of male and female athletes

In the finals, achieved average score of women (Mean=62.48m) is slightly weaker than the result achieved in qualifying. Also, the range of results is less homogeneous, and there was an amount of nearly 11m. Female athletes have also achieved better results in qualifying than in the finals. That also shows the achieved average values, and the result in the final was recorded, which is less by exactly 1 meter in relation to the qualifications. An interesting fact is that the minimum and maximum score in the final appearance of throwing is weaker than the minimum and maximum results in qualifying, while the range for both performances ranged from 7,43m-7,95m (Table 3).

Generally speaking, it can be concluded that in both subsamples of competitors the results in qualifying performances were better than the final performances. In order to determine a statistically significant difference it was applied the T-test for small dependent samples and in Table 4 are presented the results of t-test. For male sample are confirmed the differences, for value (t=1.314), but they are not statistically significant. The situation is identical with the female sample, wherein the differences of the results were also recorded, for value (t=1.536), which also did not record statistical significance. Graphical display of the distribution of individual results of male and female athletes in the qualification and the final performance is shown in Figures 1 and 2, and their mean values in Figure 3.

Discussion

The results of this study on a sample of top javelin throwers in men's and women's competition in the qualifying and final appearance of the Olympic Games in London clearly showed obvious differences, but which did not achieve statistical significance. The question is why is this so? Is it because of morphological status of competitors, shown motor skills in qualifications and finals, biomechanical parameters or psychological state of athletes or motivation of each competitor. In order to try to give the correct answer to these questions, we should first start with some similarities between the throwing disciplines.

Summing up all the throwing events one can observe similarities in three events (shot put, discus and hammer throw). For contestants in these disciplines can be said to have almost identical morphological status (height, weight, BMI), while for the javelin significantly different (Amour & Elliot, 1989). Javelin is structurally and biomechanically different from other throwing disciplines, particularly in terms of device weight, so the body height, body weight, BMI does not play an important role in achieving results. However, it can not be said for the shot put, discus and hammer throw which in achieving of results limits, first the space for throwing (the diameter of the circular segment) and then the shape and the weight of equipment.

Also, throwing disciplines require a high level of production of power in a very short period of time. Because of these characteristics, the results success is, in addition to technical performance and motor skills, subordinated to the morphological status of athletes throwers. Result in the throwing events in addition to the morphological size and sex (Alexander et al. 1997) is defined also by the biomechanical parameters of ejection (speed, height, angle), by the aerodynamic characteristics of the device, by the influence of the environment (wind, air density), by ground reaction force (Mc Coy et al. 1985, Tončev, 2001; Jovovic, 2006, Idrizović, 2010). Certain dynamometric and kinematic analysis showed a high correlation of the inhibitory action of the left leg of a thrower with sports result. Angle of placing the left leg on the ground in the top throwers is between 160º and 165º, there must be strong support (load reaches 350-400kg), in order to effectively use the rotating moment of leg on which the body holds.

For the entire activity of ejection of javelin and the achievement of optimum acceleration the following parameters are relevant: the length of the way and the time of its execution, the angle and height of ejection. In the top throwers the trajectory length in ejection ranges from 210-250cm, and the time interval from 0.12-0.18sec., ejection angle from 27º-30º and height of ejection from 190-220cm, which allows achieving results from over 90 meters (Bukhatsov 1988 according to Idrizović 2010; Stefanovic, 1992). For the length of javelin throw to be good, the height of ejection must be higher, and the other parameters must at the appropriate level (angle and speed of ejection). Studies have shown that the angle of experienced pitchers, ranges from 29º-36º, the ejection velocity is about 33m/s (Linthorne, 2001). On a length of flight affects aerodynamic force (Fa), which is the product of interaction between the javelin and airflow. The aerodynamic force is decomposed into two forces. One acts contrary to the direction of movement of the javelin and makes the frontal resistance force (Fc), while the other holds the javelin that flies in the air and makes the lift force (Fu). During the flight javelin rotates about the longitudinal axis because of the effect of aerodynamic forces in the center of pressure (CP), and not in the center of gravity of javelin (CTK), so that the air flow acts on its entire surface. If the center of pressure (CP) of airflow does not fall into the center of gravity of javelin (CTK), then comes to creation of the aerodynamic moment, that taking into account the lever (r) and the aerodynamic force (Fa) turns the spear tip down. The closer the center of gravity of javelin is placed (CTK) toward the center of pressure (CP),the lever is lower (r) and normally the so-called pikirajući moment (javelin still flying), which means that the javelin longer retained the angle of attack. The angle of ejection of javelin (α) the angle between the direction of movement of the javelin and the horizontal is 29º-36º. (Pavlovic, 2010).

The speed of run up is very important to achieve the maximum possible initial velocity. In the top throwers the velocity of movement at the end of the first part of run up is about 8m/s. If the thrower during the final stage of run up moved at maximum speed, then the moves of throwing techniques he could not be able to implement in the best way. Therefore, avelin thrower must align optimal running speed with the technique of performing the movement in phase of outrunning taking care to not disturb the rhythm of racing steps. What is very important in the training process and it is important to note is the fact that during training in athletics It is necessary from the very beginning train the contemporary technique, regardless of which discipline is about. Already in the earliest period occurs first automation of movements that are stored in the CNS. An interesting study among students of physical education at Tanta University in Egypt conducted Kaegi El Falah, 2010. He has implemented a special program of individual adoption of technical elements in the javelin throwing. Has come to that using individualized learning by programmed instruction lead to improving the technical stages of Javelin throwing skill and in helping the learner in self -learning. Javelin integrates several motor skills (speed, coordination, flexibility, explosive strength). Each of these skills is manifested in a particular phase of the movement, and techniques of performance. It is the development of certain motor skills that is crucial in training the correct technique of javelin throwing. Strength development of javelin throwers is a delicate matter. Working too fast on it without consideration of the individuals technical abilities may result in undesirable consequences in their further technical improvement. Premature strength development most frequently results in 'throwing from hand' because of the false feeling of the apparatus light weight. Premature strength development combined with low sports performance may have a negative effect on the young javelin thrower's mental condition and motivation. That is the reason why knowledge about the strength training of the best is essential for the preparation of young javelin throwers - preparation with fewer mistakes on the road to high sports performance (Stoikov et al. 2010). In javelin thrower is very important to monitor the development of power as a precondition for achieving good results.In research (Stoikov, Karapetrova, & Stoykov, 2010) is presented a unique opportunity for following up the qualification aspect of javelin throwers' strength development. In order to achieve international level performances (over 80 m) with male javelin throwers their strength abilities should be measured as follows: barbell snatch-over 100 kg, squat-over 160 kg, clean turn-140kg, lying barbell clean–over 130kg. In order to achieve performances of high international level (over 60m) with women with female javelin throwers their strength abilities should be measured as follows: barbell snatch-over 70kg, squat-over 120kg, clean turn–90kg, lying barbell–over 80kg.

A very important place in every competition has a psychological preparation, emotional state and motivation of athlete. These parameters also have significant, if not decisive influence on the outcome. The study of personality as a factor of success in athletics explored Ward et al. in 1979. For each of four subsamples of Olympic-quality athletes 14 Discus, 8 Hammer, 11 Javelin, and 12 Shot put specialists-measures of 19 personality constructs yielded only two statistically significant validity coefficients (out of 76 possible significant indices) in the prediction of average length of throw. The conclusion was reached that the self-report personality measures employed afford little promise as predictors of success in the four Olympic events studied (Ward et al. 1979). Also the success in result success of top javelin throwers, can be found in the possible models of throws, similar to the model Maier et al. 2000th, except that the new model would define, in addition to neural changes, some psychological parameters. Despite modern computer simulation (Bartlett & Best, 1988) it is not possible to neutralize the psychological aspect together with the motivational structure of competitors, which is probably crucial in the result succes, and the like can be concluded in this research. All of the previously mentioned biomechanical performances, performance technique, motor skills, every athlete, regardless of gender, must compose into the technique of performance, at the same time taking care to achieve the longest shot.

It is very difficult to perform all of this, in the psychological conditions of large pressure, on one hand and with a strong motivation on the other hand, under conditions of large events, such as the Olympic Games. Then most of the competitors are expected to have their psychological state at a stable level, the motivation also. At the psychological level, the motivational structure plays an important role. Mainly in the athletic elite sport dominate intrinsic motives, and as such form the motivational structure of each competitor. Very often, athletes are between desires and their abilities, which are caused by different motivational factors, a great desire to succeed. Bearing all this in mind, complex psychological structure, requirements, it does not surprise the results of our sample which had a lower result in the final than in the qualification. It is theoretically possible, and the most ideal situation would be, if every athlete in the decisive throw managed to integrate all the anthropological characteristics, abilities, personality traits and channel them towards achieving the result. However, in practice this is difficult to achieve, and therefore we have a situation where in the main performance (final) contestants fail to integrate that. Some athletes who have high motivation to win, while being in good psychological condition, all components at the highest level, they succeed to achieve that. This is exactly the case with the male winner, for many outsider (K.Walcott) who won perhaps their favorite champions (Pitkamaki, Thorkildsen, Pyatnytsya).

Conclusion

A survey was aimed to determine the differences between individual results of male and between individual results of female athletes in the javelin throwing, the participants of the Olympic Games in London 2012. year. The sample consisted of the top 24 athletes (12 female and 12 male), who took part in the qualifying and in the finals. The results showed differences between the qualifying and final throwing at competitors, but they were not as expressed to be statistically significant. However, what this study has shown, and it is important for practice, is the fact that only 33% of the competitors had a better result (shots) in the final than in the qualifying. Based on these indicators, the research results can serve as a starting point and a realistic basis and framework for further research on this issue in order to determine the parameters that have contributed to this result of contestants. The question is, whether it is about a psychological segment or abilities of the participants. Also the similar research of the differences can be made in other throwing events, in order to determine the condition and the achieved results.

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RAZLIKE IZMEĐU KVALIFIKACIJSKIH I FINALNIH REZULTATA BACANJA KOPLJA FINALISTA OLIMPIJSKIH IGARA U LONDONU 2012

Sažetak

Olimpijske igre su najvažniji sportski događaj s novim rezultatima koji često predstavljaju Olimpijhski, Svjetski i nacionalni rekord. Olimpijske igre u Londonu su upravo pokazatelj takvih rezultata. Tu je zabilježena hrpa nacionalnih rekorda (NR = 84,58m) bacača koplja, od sportaša iz Trinidada i Tobaga (K. Walcott), koji je rezultat od kvalifikacija u završnoj izvedbi povećao za gotovo 3m. To je rezultat Walcotta, koji je razlog ovog istraživanja koje tretira razlike u rezultatima uspješnosti muških i ženskih sportašica koplja bacača u kvalifikacijama i finalnom ogledu. Glavni cilj ovog istraživanja bio je utvrditi razlike između pojedinih rezultata muških i između pojedinih rezultata sportašica sudionika Olimpijskih igara u Londonu 2012. Uzorak je sastavljen od najboljih 24 sportaša (12 ženskih i 12 muških), koji su sudjelovali u kvalifikacijama i finalu Olimpijskih igara. Prikupljeni podaci su analizirani programskog paketa Statistica 7.0. primjenom t-testa modula za male zavisne uzorke. Rezultati nisu potvrdili postojanje statistički značajnih razlika između kvalifikacija i konačne izvedbe natjecatelja. Također, rezultati su pokazali da je samo 33% natjecatelja u oba subuzroka izveli bolja bacanja u finalu nego u kvalifikacijama.

Ključne riječi: *razlike, Olimpijske igre, bacanje koplja*

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