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## Developmental Tendencies of Results in Female Heptathlon in the Olympic Games during the Years 1984–2008

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## Developmental Tendencies of Results in Female Heptathlon in the Olympic Games during the Years 1984–2008

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A – Study Design  
B – Data Collection  
C – Statistical Analysis  
D – Data Interpretation  
E – Manuscript Preparation  
F – Literature Search  
G – Funds Collection

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**Key words:** *Olympic Games, track and field, heptathlon, women.*

### Abstract

**Background:** *The aim of this study is to assess a change tendency of the results in heptathlon and in particular events of this discipline.*

**Material/Methods:** *In the research the authors used results achieved in heptathlon in the Olympic Games during the years 1984–2008. Top 20 female athletes of general standing were taken into consideration. MS Excel 2007 spreadsheet program and a method of document analysis were used to analyse and assess a change tendency.*

**Results:** *Mean values achieved in particular events showed that the highest results, which were above the average in each Olympic Games, occurred in 1992 and 2008. The levels of all mean values and final results in heptathlon were higher than average values described in the above mentioned years. Mean values did not show developing tendencies in the Olympic Games.*

*A correlation analysis showed that 100 m hurdles, 200 m run and long jump had the biggest influence on the final result in heptathlon.*

**Conclusions:** *The best results achieved in different events show a high sport level of these results which are close to results in individual competitions.*

*Throwing events demonstrated the highest increasing tendency of results: javelin throw (10.84%) and shot put (8.02%); the smallest changes in the sport level were noticed in sprint events: 200m run (2.94%) and 100m hurdles (3.14%) and in high jump (3.89%).*

*Big events such as the Olympic Games on the whole create favourable conditions for setting the world records, as is confirmed by the example of Jackie Joyner-Kersey with her result 7 291 points in Seoul Olympic Games.*

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## **Introduction**

Multi-sport athletics is a very interesting scientific issue because of its complexity with reference to fitness and coordination areas.

An increase in interest in multi-sport athletics occurred in the 1960s and the 1970s. In this period works of Finnish scientists [1] became an inspiration to undertake analyses of male athletics based on wider and more sophisticated sport level material [2,3,4,5,6,7,8]. Female heptathlon, which was introduced in 1981, made methods of research on male athletics implemented in women's combined events.

The final result of heptathlon includes a very wide range of information. Seven events could be treated as specific tests, which measure comprehensive abilities from fitness and technical areas. The analysis of information included in sport results in female heptathlon as well as gathered points are the source of knowledge regarding many phenomena which appear in this complex discipline [9]. The structure of achievements in different heptathlon events is undergoing changes. First years of a sport career are dominated by speed and speed-strength predispositions. Also the time to receive top results is the shortest then. However, at the next stage of sport preparation strength predispositions play the main role [9,10,11]. The authors also proved that longer time is required to reach top results in difficult technical events such as hurdles.

The aim of this study is to assess a change tendency of the results in heptathlon and in particular events of this discipline.

## **Material and Methods**

In the research the authors used results achieved in heptathlon in the Olympic Games during the years 1984–2008. Top 20 female athletes of general standing were taken into consideration. MS Excel 2007 spreadsheet program and a method of document analysis were used to analyse and assess a change tendency. The arithmetical mean ( $\bar{x}$ ) and range of results were marked out. To define the changeability of results a variability coefficient ( $V$ ) and range ( $R$ ) were used. The relationship between changeability of the final result in heptathlon and diversity of the results achieved in particular events were determined by a correlation analysis (Pearson's Correlation Coefficient). Values from -1 (negative correlation) to +1 (positive correlation) were accepted. The relationship between the studied variables is higher when the correlation value is closer to -1 or +1.

## **Results**

Female athletes' results in heptathlon achieved in the Olympic Games during the years 1984–2008 were analysed. Sport results of the considered athletes in particular events are shown in Tables 1 and 2. Mean points achieved in all the Olympic Games amounted to 6 217 and fell within the range from 4 913 (in 1984 OG) to 7 291 points in the 1988 Seoul Olympic Games.

Mean values achieved in particular events showed that the highest results, which were above the average in each Olympic Games (Table 2), occurred in 1992 and 2008. The levels of all mean values and final results in heptathlon were higher than the mean values described in the above mentioned years (Tables 1 and 2). The lowest mean values were achieved in Los Angeles (1984) and in Sydney (2000). In LA none of the heptathlon events scored higher than the average of all the analysed games. However, in Sydney only in throwing events mean values were higher (shot put and javelin throw). Out of all the events results in 800m and 200m runs, 100 m hurdles and high jump rarely exceeded mean values. Both in Barcelona and Beijing all means were above the average of all the analysed Olympic Games. Mean values did not show developing tendencies in the Olympic Games.

Tab. 1. Mean values and the range of the results in particular heptathlon events during the analyzed Olympic Games

| Events                       |         | Los Angeles<br>1984 | Seoul<br>1988   | Barcelona<br>1992 | Atlanta<br>1996 | Sydney<br>2000  | Athens<br>2004  | Beijing<br>2008 |
|------------------------------|---------|---------------------|-----------------|-------------------|-----------------|-----------------|-----------------|-----------------|
| 100 m hurdles                | X       | 13.95               | <b>13.58</b>    | <b>13.59</b>      | 13.72           | 13.76           | <b>13.55</b>    | <b>13.53</b>    |
|                              | min-max | 13.02 - 15.43       | 12.69 - 14.39   | 12.85 - 14.10     | 13.22 - 14.90   | 13.23 - 14.71   | 13.13 - 14.03   | 12.78 - 13.90   |
| High jump                    | X       | 177                 | <b>181</b>      | <b>179</b>        | <b>179</b>      | 175             | 178             | <b>181</b>      |
|                              | min-max | 153-189             | 171-186         | 158-194           | 171-186         | 160-184         | 167-191         | 171-189         |
| Shot put                     | X       | 12.64               | 13.49           | <b>13.99</b>      | <b>13.73</b>    | <b>13.76</b>    | <b>13.56</b>    | <b>13.70</b>    |
|                              | min-max | 10.63-14.39         | 11.58-16.23     | 12.83-15.33       | 12.29-15.95     | 11.53-15.55     | 11.28-16.40     | 11.59-17.29     |
| 200 m run                    | X       | 25.03               | <b>24.35</b>    | <b>24.40</b>      | 24.60           | 24.70           | <b>24.40</b>    | <b>24.38</b>    |
|                              | min-max | 24.05-26.89         | 22.56-25.61     | 23.12-25.44       | 23.72-25.70     | 23.53-26.39     | 22.91-25.46     | 23.21-25.50     |
| Long jump                    | X       | 6.00                | <b>6.33</b>     | <b>6.22</b>       | <b>6.28</b>     | 6.06            | <b>6.21</b>     | <b>6.24</b>     |
|                              | min-max | 5.05-6.71           | 5.99-7.27       | 5.90-7.10         | 5.71-6.70       | 5.47-6.59       | 5.84-6.78       | 5.96-6.63       |
| Javelin                      | X       | 38.89               | 41.58           | <b>45.10</b>      | <b>45.94</b>    | <b>44.70</b>    | <b>44.07</b>    | <b>43.48</b>    |
|                              | min-max | 32.62-46.60         | 35.68-47.50     | 37.58-52.12       | 40.08-55.70     | 37.00-50.19     | 36.70-53.32     | 35.41-52.05     |
| 800 m run                    | X       | 02:17.45            | <b>02:14.36</b> | <b>02:14.47</b>   | 02:18.21        | 02:15.96        | 02:15.96        | <b>02:13.59</b> |
|                              | min-max | 2:09.05-2:33.17     | 2:04.20-2:26.67 | 2:05.08-2:31.84   | 2:11.67-2:30.89 | 2:09.08-2:21.82 | 2:10.77-2:25.10 | 2:06.50-2:21.97 |
| Overall result of heptathlon | X       | 5942                | <b>6292</b>     | <b>6326</b>       | <b>6254</b>     | 6135            | <b>6242</b>     | <b>6325</b>     |
|                              | min-max | 4913-6390           | 5734-7291       | 5993-7044         | 5897-6780       | 5762-6584       | 6066-6952       | 6041-6733       |

Tab. 2. Selected values in particular heptathlon events in the Olympic Games 1984-2008

| Olympic Games 1984-2008      | Mean value | Standard deviation | Correlation coefficient | Variability coefficient |
|------------------------------|------------|--------------------|-------------------------|-------------------------|
| 100m hurdles                 | 13.67      | 0.43               | -0.726                  | 3.14                    |
| High jump                    | 178        | 6.94               | 0.577                   | 3.89                    |
| Shot put                     | 13.55      | 1.09               | 0.579                   | 8.02                    |
| 200 m run                    | 24.55      | 0.72               | -0.693                  | 2.94                    |
| Long jump                    | 6.19       | 0.31               | 0.754                   | 4.97                    |
| Javelin                      | 43.39      | 4.70               | 0.281                   | 10.84                   |
| 800 m run                    | 02:15.71   | 6.44               | -0.606                  | 4.10                    |
| Overall result of heptathlon | 6 217      | 309.89             | x                       | 4.98                    |

Dispersion of the results was evaluated by the dispersion coefficient (V). The highest values were achieved in throwing events: javelin throw (10.84%) and shot put (8.02%). The smallest changes in the sport level were in running events: 200 m run (2.94%), 100m hurdles (3.14%) and in high jump (3.89%). A similar situation was observed in each Olympic Games (Table 3). In all years the highest values of the results were noticed in throwing events. The exception was during 1984, when long jump (7.33%) took the second place after javelin (11.80%). The smallest changes in the sport level, similarly to overall OG classification, were found in particular years. During OG in 1984, 1992, 2000 and 2004 the smallest changes were noticed in sprint events. In 1988 and 2008 a profile of the events slightly changed and 200m run was substituted by high jump. In 1996 the highest dispersion coefficient was determined in 200 m run (1.99%) and high jump (2.31%)(Table 3).

From the point of view of individual achievements of female athletes a lot of information is provided by the range of results (Table 4). Average improvement in the results in javelin throw was above 14.22 m and in shot put above 4.20 m. Also in sprint events there were huge disproportions in the achieved results. Greater changes referred to comparisons between individual results of the

athletes. The final scores of some athletes differed over 2 sec. in 100m hurdles, 36cm in high jump and over one and a half meter in long jump. It was observed that the 1996 and 2008 Olympic Games had the most equal level in the majority of events.

Tab. 3. Level of the variability coefficient in particular heptathlon events during the analyzed Olympic Games

| Events                       | Los Angeles 1984 | Seoul 1988 | Barcelona 1992 | Atlanta 1996 | Sydney 2000 | Athens 2004 | Beijing 2008 |
|------------------------------|------------------|------------|----------------|--------------|-------------|-------------|--------------|
| 100 m hurdles                | 4.37             | 3.02       | 2.72           | 2.99         | 2.87        | 2.32        | 2.23         |
| High jump                    | 5.86             | 2.22       | 4.89           | 2.31         | 3.46        | 3.94        | 2.56         |
| Shot put                     | 6.65             | 9.71       | 5.00           | 6.63         | 6.27        | 9.02        | 8.68         |
| 200 m run                    | 3.20             | 3.37       | 2.99           | 1.99         | 2.69        | 2.73        | 2.69         |
| Long jump                    | 7.33             | 4.58       | 4.66           | 4.14         | 4.75        | 3.59        | 3.08         |
| Javelin                      | 11.80            | 9.16       | 8.03           | 9.51         | 6.82        | 10.39       | 11.82        |
| 800 m run                    | 4.82             | 4.67       | 5.10           | 3.98         | 2.84        | 2.32        | 3.44         |
| Overall result in heptathlon | 6.84             | 6.06       | 4.48           | 3.51         | 3.92        | 3.20        | 3.29         |

Tab. 4. The value of the differences between minimal and maximal values (range – R) achieved in particular heptathlon events of the analyzed Olympic Games competitions

| Events            | Los Angeles 1984 | Seoul 1988 | Barcelona 1992 | Atlanta 1996 | Sydney 2000 | Athens 2004 | Beijing 2008 | Olympic Games 1984-2008 |
|-------------------|------------------|------------|----------------|--------------|-------------|-------------|--------------|-------------------------|
| 100 m hurdles (s) | 2.41             | 1.70       | 1.25           | 1.68         | 1.48        | 0.90        | 1.12         | 1.51                    |
| High jump (cm)    | 36               | 15         | 36             | 15           | 24          | 24          | 18           | 24                      |
| Shot put (m)      | 3.76             | 4.65       | 2.50           | 3.66         | 4.02        | 5.12        | 5.70         | 4.20                    |
| 200 m run (s)     | 2.84             | 3.05       | 2.34           | 1.98         | 2.86        | 2.55        | 2.29         | 2.56                    |
| Long jump (m)     | 1.66             | 1.28       | 1.20           | 0.89         | 1.12        | 0.94        | 0.67         | 1.11                    |
| Javelin (m)       | 13.98            | 11.82      | 14.54          | 15.62        | 13.19       | 17.72       | 12.64        | 14.22                   |
| 800 m run (s)     | 23.22            | 22.47      | 26.76          | 19.15        | 21.90       | 14.33       | 15.47        | 20.47                   |

Tab. 5. Correlation analysis results between the achieved points and results from particular heptathlon events during the analyzed Olympic Games

| Events        | Los Angeles 1984 | Seoul 1988 | Barcelona 1992 | Atlanta 1996 | Sydney 2000 | Athens 2004 | Beijing 2008 |
|---------------|------------------|------------|----------------|--------------|-------------|-------------|--------------|
| 100 m hurdles | -0.914           | -0.844     | -0.731         | -0.526       | -0.618      | -0.092      | -0.533       |
| High jump     | 0.782            | 0.313      | 0.674          | 0.314        | 0.600       | 0.519       | 0.506        |
| Shot put      | 0.653            | 0.781      | 0.256          | 0.514        | 0.536       | 0.378       | 0.527        |
| 200 m run     | -0.798           | -0.826     | -0.727         | 0.731        | -0.596      | -0.012      | -0.590       |
| Long jump     | 0.851            | 0.876      | 0.744          | 0.383        | 0.682       | 0.701       | 0.551        |
| Javelin       | -0.062           | 0.500      | -0.211         | 0.601        | 0.309       | 0.393       | 0.055        |
| 800 m run     | -0.931           | -0.687     | -0.545         | -0.397       | -0.262      | -0.362      | -0.570       |

A correlation analysis (Table 5) confirmed that changes in the level of heptathlon are the results of changes in the level of strength, which is seen in correlation results in throwing events, and in the level of strength-speed features presented in jump events (high jump, long jump). Also in sprint events time changed, reaching statistically significant values. The lowest level of significance among the analysed heptathlon components was noticed during the Olympic Games

in Athens and Atlanta. In sprint events (100 m hurdles, 200 m run) and in long jump the highest number of significant correlations was observed in each of the Olympics.

Huge disproportions in the number of achieved points in the final classification were also revealed. 6 435 and 6 424 points achieved in 2004 in Athens allowed winning silver and bronze. In Atlanta (1996) and Sydney (2000) these total points gave the fifth place. In Seoul (1988) and Barcelona (1992) it was only the sixth and in Beijing just the eighth position.

An analysis of the results during the research period shows constant improvement. The overall classification revealed a huge change in the sport level of female athletes. In 1984 eighteen female heptathlon athletes collected enough points to get the Master International Class (MM) – 11 and the Master National Class – 7. In the next Olympic Games all athletes got International or National Master Class and in 2004 and 2008 the number of points achieved by female heptathletes gave them all 20 the International Master Class. Only twice during the Olympic Games history (1988 and 1992) Jackie Joyner – Kersee from the United States crossed a barrier of 7000 points. Gold medallist from Seoul (1988) was the only one, during the analysed period, to set the world record with 7 291 points [12].

## **Discussion**

Sport results in heptathlon include a lot of information which can become a great source of knowledge used in practice. Beside the final result in heptathlon we have information regarding achievements in each event. No other athletic discipline gives this kind of opportunity [13].

An analysis of the results achieved in particular heptathlon events showed that female athletes gained very good results which enabled them to compete in individual events. Very interesting are results in long jump: 7.27 m achieved by Joyner-Kersee from the USA in Seoul (1988) and 7.10 m in Barcelona (1992) gave her silver and bronze medals individually. Similarly, 12.69 s achieved by her in OG in Seoul (1988) in 100 m hurdles guaranteed the bronze medal.

The highest increase in mean values in particular heptathlon components was observed in Seoul (1988). But in throwing events and in overall result the highest mean values were noted in 1992 in Barcelona (in shot put – 13.99 m and in javelin throw – 45.10 m). The research confirms that the slowest process of development of the results was in throwing events [9,13,14]. A correlation analysis confirms that 100 m hurdles, 200 m run and long jump have the most significant influence on the final result in heptathlon. These events are determined by the same area of function [15, 16, and 17].

## **Conclusions**

1. Research results are a very valuable source of information regarding increasing tendencies of results in heptathlon in overall and in seven different events.
2. The best results achieved in different events show a high sport level of these results which are close to results in individual competitions.
3. Throwing events demonstrated the highest increasing tendency of results: javelin throw (10.84%) and shot put (8.02%); the smallest changes in the sport level were noticed in sprint events: 200m run (2.94%) and 100m hurdles (3.14%) and in high jump (3.89%).
4. Big events such as the Olympic Games on the whole create favourable conditions for setting the world records, as is confirmed by the example of Jackie Joyner-Kersee with her result 7 291 points in Seoul Olympic Games.
5. A correlation analysis showed that 100 m hurdles, 200 m run and long jump had the biggest influence on the final result in heptathlon.

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