ISSN : 0974 - 7435 Volume 10 Issue 7

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(7), 2014 [2175-2183]

Chinese and foreign men's decathlon top athletes performance features comparative analysis

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ABSTRACT

The paper applies grey relational analysis to analyze the 12th National Games and the 30th Olympic Games men's decathlon competitions top ten athletes' competition performances. It solves Chinese and world top athletes' men's decathlon total performance and each single item performance grey correlation degrees and grey weights, and solves each event weight and rank the sizes. Analysis result shows that Chinese athletes compare with world top athletes, their grey weights in each single event have bigger differences, each event grey weight gap is bigger, but overall rank is the same. It suggests that China to focus on high jump, pole vault, 1500m and javelin throw these single items training, strengthen throwing kinds and endurance kinds of events training, improve physical quality, pay attention to stronger skilled jumping kinds of events technical training, and improve Chinese men's decathlon athletes scientific selection in future athlete training.

KEYWORDS

Decathlon; Grey relational analysis method; The 30th Olympic Games; The 12th National Games.

INTRODUCTION

Men's decathlon has features of many events, difficult skills and big consumption, it needs that athletes possess sufficient physical ability, all-round techniques and strong will, is comprehensive testing on athletes and called "ironman" event. Due to Chinese men's decathlon athletes own physical quality and technique aspect reasons, Chinese men's decathlon still keeps considerable paces with world men's decathlon,it is in the state of relative backward.

In order to look for breakthrough for Chinese decathlon future development orientation and promote Chinese men's decathlon athletes levels, domestics' lots of scholars have researched on it, and got certain attainments. Among them, Zhao Bo (2013) applied documents literature, mathematical statistics, experts' consultation method and others to make analytic investigation on recent sessions' international main competitions men's decathlon performances, and put forward suggestions for Chinese men's decathlon athletes as shortening speed, endurance kinds of events score gap and improving strength kinds scores[1]; Su Tao and others (2010) applied factor analysis method and grey correlation analysis method, made analytic investigation on Chinese and foreign men's decathlon athletes competition performances gaps, and put forward corresponding suggestions, which provided references for Chinese men's decathlon training planning[2]; Wang Guo-Xiang and others (2011)applied documents literature, comparative analysis, mathematical statistics and others, on the basis of the 11th National Games and the 29th Olympic Games, studied on Chinese and foreign men's decathlon athletes differences, put forward the point as Chinese decathlon athletes pole vault event improvement was the key to improve men's decathlon performance[3]; Li Ji-Wei and others (2003)applied documents literature, comparative analysis method, mathematical statistics method and others to make comparative analysis of Chinese men's decathlon athletes performances and world top men's decathlon athletes performances differences causes, pointed out that Chinese decathlon athletes each single event performance, technique grade development was imbalanced, throwing events level was too low as well as others, and put forward countermeasures and suggestions[4]; Wang Xin-Peng and others (2013)applied comparative analysis, grey coordination analysis and other methods to make analytic investigation on Chinese and foreign men's decathlon total performance and each single event grade level, and put forward opinions that domestic decathlon athletes performance was gradually changing from uncoordinated to coordinated[5].

On the basis of formers research, the paper makes statistics and analyzes the 12th National Games and the 30th Olympic Games men's decathlon top ten athletes performances, makes grey relational analysis of them, studies on Chinese men's decathlon athletes and world top athletes gaps, and makes suggestions on Chinese athletes training, in the hope of providing references for Chinese decathlon development.

MEN'S DECATHLON PERFORMANCE GREY RELATIONAL ANALYSIS

In order to analyze Chinese and foreign men's decathlon gap, the paper makes statistics Chinese the 12th National Games Men's decathlon top ten athletes performances and the 30th Olympic Games decathlon top ten athletes performances, and makes grey relational analysis of them, and studies on Chinese and foreign men's decathlon athletes performances differences.

The National Games is Chinese highest domestic level and largest scale comprehensive sports meeting. The paper takes the 12th National Games men's decathlon competition performances as evidence, makes statistics of the 12th National Games men's decathlon competitions top ten athletes performances, every athlete total performance and his each single event performance statistical data is as TABLE 1 shows.

In men's decathlon performance, its total performance and each single event dimensions are different, in order to apply grey relational analysis of the 12th men's decathlon performance, it needs to carry out initialize processing with men's decathlon performance that is to do normalization processing on it. In the 12th men's decathlon performance statistics, for total points, long jump, shot put, high jump,

discus, pole vault and javelin throw such seven single events performances, their performance value gets bigger, and then performance gets higher, while100m、400m、110m hurdle and 1500m as well as other four items single events are just on the contrary. In order to be convenient for handling with total points and each single event performance, the paper set total points, 100m, long jump, shot put, high jump, 400m, 110m hurdle, discus, pole vault, javelin throw and 1500m respectively as $x_0, x_1, \cdots, x_{10}$,from which x_0 is main sequence, $x_1, x_2, \cdots, x_{10}$ is sub sequence. Then data initialization formula is:

$$x_i = (1, \frac{x_i(2)}{x_i(1)}, \cdots, \frac{x_i(10)}{x_i(10)}) \ , \ i = 0,2,3,4,7,8,9$$

$$x_i = (1, \frac{x_i(1)}{x_i(2)}, \cdots, \frac{x_i(1)}{x_i(9)}) \ , \ i = 1,5,6,10$$

By above, it solves total points and each single event initial value as TABLE 2 show.

TABLE 1 : National Games men's decathlon athletes' top ten athletes' performances

Rank	1	2	3	4	5	6	7	8	9	10
Total points	7662	7575	7520	7415	7313	7302	7147	7126	6986	6947
100m	10.85	11.32	11.22	11.25	11.23	11.39	11.35	11.21	10.95	11.22
Long jump	6.99	6.94	7.01	6.87	6.70	6.78	6.90	7.07	7.10	7.10
Shot put	13.16	13.91	13.53	12.79	13.27	11.97	11.64	12.67	11.61	11.64
High jump	1.94	2.03	1.94	2.03	1.97	1.88	2.00	1.94	1.85	1.91
400m	49.59	50.39	50.48	49.71	50.60	48.94	50.04	50.21	49.20	51.26
110m hurdle	14.32	14.78	14.66	14.59	14.64	14.97	14.66	15.35	15.29	14.94
Discus	42.14	45.38	47.16	40.96	41.66	38.88	37.18	38.16	37.57	38.46
Pole vault	4.80	4.40	4.40	4.90	4.70	4.40	4.40	4.20	4.10	4.20
Javelin throw	57.76	58.54	60.40	45.22	39.85	56.14	42.54	46.61	41.63	50.86
1500m	310.3	304.1	310.3	305.0	282.9	277.9	282.6	287.5	288.1	316.6

TABLE 2 : The 12th National Games Men's decathlon performance normalization result

Rank	1	2	3	4	5	6	7	8	9	10
Total points	1.000	0.989	0.982	0.968	0.955	0.953	0.933	0.930	0.912	0.907
100m	1.000	0.959	0.967	0.964	0.966	0.952	0.956	0.968	0.991	0.967
Long jump	1.000	0.993	1.003	0.983	0.959	0.970	0.988	1.011	1.016	1.016
Shot put	1.000	1.057	1.028	0.972	1.008	0.910	0.885	0.963	0.882	0.885
High jump	1.000	1.046	1.000	1.046	1.016	0.969	1.031	1.000	0.954	0.985
400m	1.000	0.984	0.982	0.998	0.980	1.013	0.991	0.987	1.008	0.967
110m hurdle	1.000	0.969	0.977	0.981	0.979	0.957	0.977	0.933	0.936	0.959
Discus	1.000	1.077	1.120	0.972	0.989	0.923	0.882	0.906	0.892	0.913
Pole vault	1.000	0.917	0.917	1.021	0.979	0.917	0.917	0.875	0.854	0.875
Javelin throw	1.000	1.014	1.046	0.783	0.690	0.972	0.737	0.807	0.721	0.881
1500m	1.000	1.020	1.000	1.017	1.097	1.116	1.098	1.079	1.088	0.980

Grey relational degree calculation

Handling with initialized data, input data into formula:

$$\Delta_i(k) = \left| x_0(k) - x_i(k) \right|$$

It can solve main sequence and each sub sequence difference value sequence $\Delta_1, \Delta_2 \cdots, \Delta_{10}$. And screen maximum value and minimum value in each item sub sequence and main sequence difference absolute value; it can solve maximum value and minimum value:

$$\max_i \max_k \Delta_i(k) = 0.2650$$

$$\min_i \min_k \Delta_i(k) = 0$$

Men's decathlon total points and each single event performance correlation coefficient that main sequence x_0 and sub sequence x_i each item correlation coefficient $\xi_i(k)$,it can be solved through formula:

$$\xi_i(k) = \frac{\min_s \min_k \Delta_i(k) + \rho \max_s \max_k \Delta_i(k)}{\Delta_i(k) + \rho \max_s \max_k \Delta_i(k)}$$

Here takes $\rho = 0.8$. Input TABLE 2 data into above formula, it can solve correlation coefficient $\xi_i(k)$ as TABLE 3 shows.

TABLE 3 : The 12th National Games men's decathlon performance correlation coefficient table

Rank	1	2	3	4	5	6	7	8	9	10
Total points	1.000	0.876	0.934	0.982	0.951	0.995	0.902	0.848	0.729	1.000
100m	1.000	0.982	0.910	0.934	0.982	0.926	0.794	0.724	0.671	0.812
Long jump	1.000	0.757	0.822	0.982	0.800	0.831	0.815	0.865	0.876	0.721
Shot put	1.000	0.788	0.922	0.731	0.777	0.930	0.684	0.752	0.835	0.922
High jump	1.000	0.977	1.000	0.876	0.895	0.779	0.785	0.788	0.688	1.000
400m	1.000	0.914	0.977	0.942	0.898	0.982	0.828	0.986	0.898	0.964
Discus	1.000	0.707	0.606	0.982	0.862	0.876	0.806	0.898	0.914	0.797
Pole vault	1.000	0.747	0.765	0.800	0.898	0.855	0.930	0.794	0.785	0.697
Javelin throw	1.000	0.895	0.768	0.534	0.444	0.918	0.520	0.633	0.527	0.711
1500m	1.000	0.872	0.922	0.812	0.599	0.565	0.562	0.687	0.546	0.942

Then each item sub sequence and main sequence correlation degree r_i can be solved by formula:

$$r_i = \frac{1}{n} \sum_{k=1}^{n} \xi_i(k)$$

That is the 12th National Games men's decathlon competition performance total points and each single event performance correlation degree as TABLE 4 shows.

TABLE 4 : Men's decathlon competition total points and each single event performance correlation degree value

	r_1	r_2	r_3	r_4	r_5	r_6	r_7	r_8	r_9	r_{10}
Correlation degree	0.922	0.873	0.847	0.834	0.879	0.939	0.845	0.827	0.695	0.741

The 30th Olympic Games men's decathlon performance statistical analysis

Olympic Games is highest level competition in the world, in order to analyze Chinese men's decathlon athletes competitiveness level and world athletes gap, the paper mainly makes statistics of the

30th London Olympic Games men's decathlon performance top ten athletes competition performance, its statistical data is as TABLE 5 shows.

TABLE 5 : Olympic Games men's decathlon athletes top ten athletes performances

Rank	1	2	3	4	5	6	7	8	9	10
Total points	8869	8671	8523	8447	8442	8320	8283	8219	8173	8126
100m	1011	994	801	850	980	940	961	910	841	847
Long jump	1068	942	940	970	945	864	947	922	854	850
Shot put	769	807	759	819	712	782	756	754	715	831
High jump	850	794	906	850	850	714	794	794	850	767
400m	963	904	859	853	899	906	888	866	882	813
Discus	1032	1035	917	863	926	989	963	799	955	932
Pole vault	716	834	782	835	785	852	802	817	738	761
Javelin throw	972	849	819	849	819	880	790	790	760	819
Rank	767	838	996	763	780	698	661	865	810	810
1500m	721	674	744	795	746	695	721	702	768	696

Similarly, in order to calculate grey correlation degree, it needs to do initialization processing with TABLE 5 statistic Olympic Games men's decathlon athletes performance total points and other ten items single events performances, due to statistic Olympic Games men's decathlon performance data single event are fractions, then by data initialization formal, it is:

$$x_i = (1, \frac{x_i(2)}{x_i(1)}, \cdots, \frac{x_i(10)}{x_i(10)}) \ , \ i = 0,1,2,3,4,5,6,7,8,9,10$$

Its obtained result by initialization is as TABLE 6 shows.

TABLE 6 : The 30th Olympic Games men's decathlon performance normalization result

Rank	1	2	3	4	5	6	7	8	9	10
Total points	1.000	0.977	0.961	0.952	0.952	0.938	0.934	0.927	0.922	0.916
100m	1.000	0.983	0.792	0.841	0.969	0.930	0.951	0.900	0.832	0.838
Long jump	1.000	0.882	0.880	0.908	0.885	0.809	0.887	0.863	0.800	0.796
Shot put	1.000	1.049	0.987	1.065	0.926	1.017	0.983	0.981	0.930	1.081
High jump	1.000	0.934	1.066	1.000	1.000	0.840	0.934	0.934	1.000	0.902
400m	1.000	0.939	0.892	0.886	0.934	0.941	0.922	0.899	0.916	0.844
Discus	1.000	1.003	0.889	0.836	0.897	0.958	0.933	0.774	0.925	0.903
Pole vault	1.000	1.165	1.092	1.166	1.096	1.190	1.120	1.141	1.031	1.068
Javelin throw	1.000	0.874	0.843	0.874	0.843	0.905	0.813	0.813	0.792	0.843
Rank	1.000	1.093	1.299	0.995	1.017	0.910	0.862	1.128	1.056	1.056
1500m	1.000	0.935	1.032	1.103	1.035	0.964	1.000	0.974	1.065	0.965

For the 30th Olympic Games men's decathlon grey relational analysis, similarly take resolution ratio $\rho = 0.8$,its steps are similar to above, it can solve the 30th Olympic Games Men's decathlon top ten athletes total points and each single event performances grey correlation coefficient table as TABLE 7 shows.

Finally by correlation degree formula, it solves grey correlation degree as TABLE 8 shows.

TABLE 7 : The 30th Olympic Games Men's decathlon performance correlation coefficient table

Rank	1	2	3	4	5	6	7	8	9	10
Total points	1.000	0.980	0.616	0.708	0.940	0.970	0.942	0.910	0.751	0.775
100m	1.000	0.738	0.770	0.859	0.801	0.677	0.851	0.810	0.689	0.692
Long jump	1.000	0.790	0.912	0.706	0.912	0.774	0.846	0.834	0.970	0.622
Shot put	1.000	0.861	0.720	0.850	0.849	0.734	0.999	0.973	0.775	0.951
High jump	1.000	0.874	0.797	0.802	0.936	0.990	0.958	0.908	0.980	0.790
400m	1.000	0.914	0.789	0.699	0.831	0.930	0.997	0.639	0.986	0.954
Discus	1.000	0.591	0.673	0.558	0.652	0.518	0.592	0.558	0.712	0.648
Pole vault	1.000	0.722	0.695	0.774	0.712	0.892	0.690	0.703	0.659	0.786
Javelin throw	1.000	0.702	0.444	0.863	0.806	0.906	0.789	0.573	0.667	0.659
1500m	1.000	0.863	0.792	0.643	0.765	0.913	0.803	0.852	0.653	0.846

TABLE 8 : Men's decathlon competition total points and each single event performance correlation degree value

	r_1	r_2	r_3	r_4	r_5	r_6	r_7	r_8	r_9	r_{10}
Correlation degree	0.859	0.789	0.837	0.871	0.903	0.874	0.650	0.763	0.741	0.813

RESULT AND ANALYSIS

The 12th National Games men's decathlon performance grey relational analysis

The paper does further processing with the 12th National Games decathlon grey relational degree, through formula:

$$R_i = r_i / \sum_{k=1}^{10} r_k$$

It can solve men's decathlon total points and each single event performance correlation degree weight, and rank their sizes; obtained result is as TABLE 9 shows.

TABLE 9 : Men's decathlon each single event grey weights

	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}
Weight	0.110	0.104	0.102	0.099	0.105	0.112	0.101	0.098	0.083	0.088
Rank	2	4	5	7	3	1	6	8	10	9

In order to analyze each single event performance and total points correlations, the paper takes each single event performance and total points grey weight value as 0.1 as limit. By TABLE 9, it is clear that the 12th National Games decathlon ten single event performance, single events that their grey correlation weights together with total points surpass 0.1 are six that are respectively 110m hurdle, 100m, 400m, long jump, shot put and discus, their grey weights are respectively 0.112, 0.110, 0.105, 0.104, 0.102 and 0.101, corresponding grey correlation degrees are 0.939, 0.922, 0.879, 0.873, 0.847 and 0.845. Single events that grey correlation weights less than 0.1 are four that are respectively high jump, pole vault, 1500m and javelin throw, their grey weights are respectively 0.099, 0.098, 0.088 and 0.083, their corresponding grey correlation degrees are respectively 0.834, 0.827, 0.741 and 0.695.

For men's decathlon ten single events, it can divide them into four kinds according to their sports features that are speed kind, jumping kind, throwing kind and endurance kind, Chinese men's decathlon each kind of event grey weight is as Figure 1 shows. Among them, 100m、110m hurdle、400m the three single events can be classified into one kind that is speed sports, its weight is the three weights sum that is 0.327, and meanwhile, by above data, it is clear that Chinese men's decathlon athletes performances

three single events that have highest correlation degrees with total points are all speed sports. Long jump, high jump and pole vault can be classified into one kind that is jumping event, weight is 0.301. Discus, javelin throw and shot put can be regarded as one kind event that is throwing sports, its weight is 0.286.1500m is endurance sport, weight is 0.088. Therefore, it is clear that to Chinese athletes, their each kind of sports and total performance correlation weights size rank is speed kind, jumping kind, throwing kind and endurance kind.

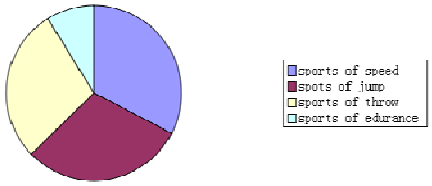

Figure 1 : Chinese men's decathlon each kind of event grey weight

By above analysis, it is clear that Chinese athletes each kind of sport grey weight analysis has certain differences, from which endurance kind is obviously weak, only is 0.088, and throwing kind grey weight is also relative small. It mainly because of Chinese decathlon athletes' selection and coaches. Chinese athletes that engage in decathlon are mostly from jumping kind or speed kind athletics event transformation, Chinese coaches put more emphasis on jumping kind and speed kind athletics events in training[6]. It also illustrates that Chinese men's decathlon athletes' selection is not scientific to a certain degree, which also surely leads to Chinese athletes competitive levels being lower. And meanwhile, due to high jump, pole vault, 1500m and javelin four events compare to other events, their correlation degrees are smaller to total points, and contributions rate is lower to competition result, and such are caused by human reasons, there are considerable space to promote. Strengthen Chinese athletes throwing kind and endurance kind sports training, scientific and reasonable carry on athletes selection and coaches training and learning, improve their throwing kind and endurance kind sports performance, is a general direction for improving Chinese athletes competition levels.

The 30th Olympic Games Men's decathlon analysis

For above solved the 30th men's decathlon performance top ten athlete performance grey correlation degree,it makes further processing, solves their grey weights and ranks them, processing result is as TABLE 10 shows.

TABLE 10 : Men's decathlon each single event grey weights

	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}
Weight	0.106	0.097	0.103	0.107	0.112	0.108	0.080	0.094	0.092	0.101
Rank	4	7	5	3	1	2	10	8	9	6

By TABLE 10, it is clear that the 30th Olympic Games men's decathlon performance top ten each single event and total points grey correlation weight ranks from big to small are in order as 400m, 110m hurdle, high jump, 100m, shot put, 1500m, long jump, pole vault, javelin, throw. Among them, single events that grey weights surpass 0.1 are six that are 400m, 110m hurdle, high jump,100m, shot put, 1500m, their grey weights are respectively 0.112, 0.108, 0.107, 0.106, 0.103, 0.101, their corresponding grey correlation degrees are respectively 0.904, 0.874, 0.872, 0.859, 0.837, 0.813,single events that grey correlation weights less than 0.1 are four that are respectively long jump, pole vault, javelin throw, discus; their grey weights are respectively 0.097, 0.094, 0.092, 0.080, their corresponding grey correlation degrees are respectively 0.789, 0.766, 0.741, 0.6495.

Olympic Games men's decathlon performance each kind of sports grey weight is as Figure 2 show, its speed kind, jumping kind, throwing kind and endurance kind grey weights are respectively 0.316, 0.298, 0.275and0.101, from its sports kinds of event performance grey weights rank, it has no

bigger differences with Chinese athletes, but each event grey weight difference is smaller than that of Chinese athletes. World men's decathlon athletes throwing kind of events and endurance kind of events grey weights are smaller, ranks are lower, their competitive potential further mining space is larger, it can strength such fields training in future training. And meanwhile, to improve performance, it also needs to mine potentials in smaller grey weights events, especially in throwing kind and endurance kind of events; it can take key training surrounding them.

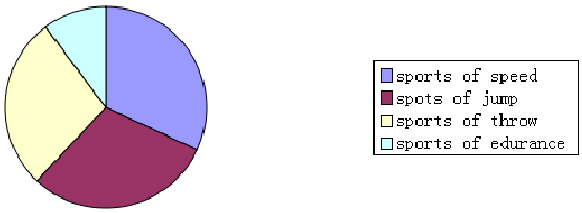

Figure 2 : World men's decathlon athletes each event grey weight

Chinese and foreign men's decathlon difference analysis

Olympic Games athlete competition performance represents world top athletes competitive level, National Games athlete competition performance represents Chinese top athlete competitive level. By above analysis, it is clear that though the 30th Olympic Games and the 12th National Games men's decathlon competition performance each single event performance grey weight rank difference is bigger, sports events grey weight rank is the same. Compare to Chinese men's decathlon athlete, world top athlete each single event and each kind of event competition ability development is relative coordinated. The reason for world top athlete presents such status mainly because decathlon each event has significant difference in requests of athlete competitive ability, every athlete cannot develop these sports required each kind of ability in all-round, Chinese athlete is mainly due to physical quality and special quality being lower. As world and Chinese top athletes speed kind of sports grey correlation degrees are bigger, China mainly because men's decathlon athletes are mostly changed from speed kind of athletics events, coaches also focus on speed events during training, and world athletes is due to their stronger lower limbs explosive powers.

From above analysis, it is clear that China and world men's decathlon athletes javelin throw, pole vault and 1500m such three items single event sports performance correlation degrees with total points are lower, the three events are the ones that world and Chinese athletes can be focused on in training. And in 1500m sports event, Chinese athlete and world top athlete gap is bigger, it can put emphasis on strengthening Chinese athletes endurance training, improve their performance so as to shorten Chinese athlete and world top athlete performance gap. Chinese athlete keeps bigger paces with world top athlete in strength and jumping events, due to it is in the throwing events, its performance improvements can greatly shorten performance gap.

CONCLUSION

Comparing with world top athlete, Chinese men's decathlon athlete physical quality and special quality are lower, each single event sports performance and total points grey weight difference is bigger, each single event development is not coordinated, and athlete selection is also relatively not scientific. World top athlete development is all-round development-based, and Chinese athlete special quality in throwing kind and endurance kind event are rather poor, comparing to world top athlete, technique attribute is rather poor, training strength is not enough, throwing kind and endurance kind events are key developing objects of Chinese athlete.

Chinese athlete on the basis of consolidating speed kind of sports, he also should focus on developing jumping kind and throwing kind events. Chinese coaches go deeper on strengthening athletes physical quality training, Chinese athlete strengthen physical quality, and meanwhile it also should focus on improving his special item technical ability, let each item quality to be all-round and balanced

developed. Especially in higher special and technological jumping kind of sports events should be put higher emphasis. To some Chinese athlete poor ability single sports events as high jump, pole vault, 1500m and javelin throw, it should focus on mining them when training. Chinese men's decathlon athletes' selection should also be scientific, and pay attention to athletes with specialty when selecting.

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