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Chinese and foreign men's decathlon performance comparison and structural factor correlation test based on SPSS regression model

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ABSTRACT

By consulting lots of documents, adopt grey correlation analysis and factor analysis to make research on Chinese and foreign decathlon athletes total performances and each single item performance internal relations and athletes' performance internal structure, and do comparative analysis, find out Chinese athletes and world level athletes' performance main gaps, which provides certain theoretical basis for Chinese men's decathlon training plan designing, athletes' scientific selection and athletics development. Rey correlation analysis result shows that Chinese athletes each single item to total performance influences ranked by correlation degree as 110m hurdle>100m>long jump>400m> high jump> pole vault>shot put> javelin throw> discus throw>1500m; and world rank as: 110m hurdle> long jump>100m>400m>pole vault>high jump>javelin throw>shot put>discus throw>1500m. It is clear that domestic athletes still keep larger some paces with foreign excellent athletes by comparing in higher special technique requirement pole vault and javelin throw the two events; factor analysis result shows that during Chinese and foreign excellent athletes performance structures, 100m,400m, 110m hurdle the three single items take largest effects, they can be called as speed, explosive power factor; discus throw, javelin throw and shot put the three items take the secondary effects, which can be called as strength factors; high jump effects are the third ones, which can be called as smart factor. All the four factors are related to speed quality, thereupon it reveals that men's decathlon is core featured with speed. © 2014 Trade Science Inc. - INDIA

INTRODUCTION

With Olympic Games as well as other major sporting events successful hosting in China, Chinese sports have come a long way, but athletics backward level still is the key factor that restricts Chinese sports competitive levels improving, especially for athletics events' decathlon competitive level and world athletics level generate huge differences, and according to data analysis, though Chinese decathlon athletes catch up with and surpass world advanced level in short term is still a long-term objective, only if we can correctly find out Chinese decathlon backward internal causes, make improvement, learn from each other strong points to make up for shortcomings, achieve leading position in Asia during short-term can be completely realized.

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"The one gets athletics gets the world" such words explain athletics important role in sports competitive court, men's decathlon is always named as "the king of athletics", while someone call it as "ironman" competition event. Athletics men's decathlon has been formally set up in the 5th Olympic Games in 1912, until now the event setting hasn't changed, which is composed of 100m, long jump, shot put, high jump, 400m, 110m hurdle, discus throw, pole vault, javelin throw and 1500m.

Usually factor analysis generated factors can finally achieve naming explanatory by all kinds of ways. Factors' naming solution to each single item, it is impossible to arrive at completely balance, system and things are composed of multiple factors, imbalanced development and dynamic changes among factors decide complex in prediction of system and things. Based on that, this paper according to Chinese and foreign 28 excellent all-round athletes' competition performance, adopts SPSS software respectively making factor analysis and establishing every single item performance and total performance multiple linear regression prediction model, in the hope of better exploring decathlon internal elements structures and project rules features.

CHINESE AND FOREIGN MEN'S DECATHLON TOTAL PERFORMANCES AND EACH SINGLE ITEM PERFORMANCES INTERNAL RELATIONS GREY CORRELATION ANALYSIS

By collected the 11th national games data, select Chinese and world top 14 excellent men's decathlon athletes as research objects, their performance total scores and each single item score as following TABLE 1, TABLE 2 show, it basically represents Chinese and foreign men's decathlon top level.

According to grey system theory, it can regard decathlon as a grey system, and make grey correlation analysis of selected research objects performance. By correlation degree analysis, it is clear that every single item performance effects on total performance as well as its position in all-round training.

TABLE 1: Chinese 14 excellent men's decathlon athletes' each single item performance and total performance

By observing TABLE 1, TABLE 2, it is clear that athletes' each single item performance and total performance has the same dimension, it is no need to make dimensionless with data.

Select each athlete total performance $x_0(k)$ as reference sequence:

$$x_0 = \{x_0(k)|k = 1,2,\ldots,n\} = \{x_0(1), x_0(2),\ldots,x_0(n)\}$$

(From which k represents the k athlete)

Select each athlete each single item performance $x_i(k)$ as comparison sequence:

$$x_i = \{x_i(k)|k = 1,2,\ldots,n\} = \{x_i(1), x_i(2),\ldots,x_i(n)\}$$

(From which i represents the i single item)

It can get the k athlete comparison sequence x_i to reference sequence x_0 correlation coefficient:

$$\xi_i(k) = \frac{\min\limits_{s}\min\limits_{t}|x_0(t) - x_s(t)| + \rho\max\limits_{s}\max\limits_{t}|x_0(t) - x_s(t)|}{|x_0(k) - x_i(k)| + \rho\max\limits_{s}\max\limits_{t}|x_0(t) - x_s(t)|} \tag{1}$$

Among them, $\rho \in [0,1]$ is resolution coefficient.

It is called formula (1) $\min\limits_{s}\min\limits_{t}|x_0(t) - x_s(t)|$ as two-level minimum difference, $\max\limits_{s}\max\limits_{t}|x_0(t) - x_s(t)|$ two-level maximum difference. Generally speaking, the bigger resolution coefficient ρ is, the bigger resolution rate would be; the smaller ρ is, the smaller resolution rate would be.

Formula (1) defined correlation coefficients data turn to be excessive dispersive not convenient to compare, therefore it can adopt average correlation degree to make comparison.

$$r_i = \frac{\sum\limits_{k=1}^{n}\xi_i(k)}{n} \quad (r_i \text{ is sequence } x_i \text{ to reference sequence } x_0$$

correlation degree)   (2)

According to Chinese and world excellent men's decathlon athletes' sports performance data table in 2012 (TABLE 1, TABLE 2) data, apply MATLAB software programming calculation, it gets Chinese and world excellent athletes' all-round performances and each single item ones correlation degree as following TABLE 3, TABLE 4 show:

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TABLE 1 : Chinese 14 excellent men's decathlon athletes' each single item performance and total performance

Rank	Athlete	1500m	Javelin throw	Pole vault	110m hurdle	100m	400m	Shot put	High jump	Long jump	Discus throw	Total performance
1	Qi Hai-Feng	643	752	761	872	893	849	699	804	906	769	7946
2	Yu Bing	594	772	674	888	895	813	744	723	942	754	7798
3	Zhu Heng-Jun	601	705	761	944	929	874	711	697	855	636	7712
4	Liu Hai-Bo	640	669	618	832	785	779	673	916	809	713	7433
5	Hao Ming	605	546	820	844	800	747	720	832	772	692	7376
6	Wang Jian-Bo	522	743	731	836	755	709	724	697	835	800	7351
7	Zhao De-Ning	601	680	703	843	835	816	626	645	840	679	7266
8	Lu Huan-Yong	629	658	646	794	800	691	695	887	838	623	7260
9	Guo Wei-Zhao	616	671	703	850	837	823	659	723	795	556	7233
10	Li Ya-Gui	591	585	674	871	806	794	660	723	847	560	7111
11	Lin Qing-Quan	520	799	618	726	811	753	696	697	734	664	7017
12	Yang Wen-Liang	640	702	790	728	768	726	620	645	700	695	7014
13	Tang Jun	561	551	618	934	832	739	539	777	730	485	6766
14	Zhou Bin	590	300	703	807	783	755	484	671	779	456	6327

TABLE 2 : World 14 excellent men's decathlon athletes' each single item performance and total performance data table

Rank	Athlete	Country	1500m	Javelin throw	Pole vault	110m hurdle	100m	400m	Shot put	High jump	Long jump	Discus throw	Total performance
1	Ashton Eaton	America	721	767	972	1032	1011	963	769	850	1068	716	8869
2	Trey Hardee	America	674	838	849	1035	994	904	807	794	942	834	8671
3	Leonel Suarez	Cuba	744	996	819	917	801	859	759	906	940	782	8523
4	Hans van Alphen	Belgium	795	763	849	863	850	853	819	850	970	835	8447
5	Warner	Canada	746	780	819	926	980	899	712	850	945	785	8442
6	Rico Freimuth	Germany	695	698	880	989	940	906	782	714	864	852	8320
7	Oleksiy Kasyanov	Ukraine	721	661	790	963	961	888	756	794	947	802	8283
8	SergeySviridov	Russia	702	865	790	799	910	866	754	794	922	817	8219
9	Kerzen	South Africa	768	810	760	955	841	882	715	850	854	738	8173
10	Pascal Behrenbruch	Germany	696	810	819	932	847	813	831	767	850	761	8126
11	Eelco	Netherlands	737	720	1004	920	894	868	739	740	903	509	8034
12	Newdick	New Zealand	692	735	819	847	838	804	795	767	900	791	7988
13	Barroilhet	Chile	629	697	1035	959	821	766	758	850	767	690	7972
14	Gaztia	Cuba	689	736	790	944	906	873	758	794	755	711	7956

TABLE 3 : Chinese excellent athletes' all-round performance and each single item correlation degree

Item	110m hurdle	100m	Long jump	400m	High jump
Correlation degree	0.9123	0.9106	0.9096	0.9064	0.9037
Rank	1	2	3	4	5
Item	Pole vault	Shot put	Javelin throw	Discus throw	1500m
Correlation degree	0.8998	0.896	0.8951	0.8948	0.8907
Rank	6	7	8	9	10

From TABLE 3, TABLE 4, it is clear that Chinese athletes each single item to total performance in-

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TABLE 4 : World excellent athletes' all-round performance and each single item correlation degree

Item	110m hurdle	Long jump	100m	400m	Pole vault
Correlation degree	0.964	0.9612	0.9611	0.9584	0.9577
Rank	1	2	3	4	5
Item	**High jump**	**Javelin throw**	**Shot put**	**Discus throw**	**1500m**
Correlation degree	0.9536	0.9509	0.9503	0.9495	0.9459
Rank	6	7	8	9	10

fluences rank by correlation degree is: 110m hurdle>100m>long jump>400m> high jump> pole vault>shot put> javelin throw> discus throw>1500m; and world rank is 110m hurdle>long jump>100m>400m>pole vault>high jump>javelin throw>shot put>discus throw>1500m. Compared with foreign athletes' ranking, ten single items'110m hurdle, 400m, discuss throw and 1500 meters ranking are the same, they respectively rank in the first, fourth, ninth and tenth, domestic top three also are long jump, 100m and 110m hurdle but there are differences in the rank, these three items all require horizontal speed takes absolute advantages; foreign pole vault, javelin throw are respectively ranking in the front of high jump, shot put, while it is opposite at home. It is clear that domestic athletes still keep larger some paces with foreign excellent athletes by comparing in higher special technique requirement pole vault and javelin throw the two events, which shows that Chinese athletes have shortcomings in high speed, quick rhythm technical motions completion abilities, it should be taken seriously by Chinese all-round coaches.

CHINESE AND FOREIGN MEN'S DECATHLON PERFORMANCE FACTOR ANALYSIS

To athletes, it is impossible to achieve each item fully balance. Due to connections exist among items, and each item development status decides athletes' total performances, the model according to statistical principle and method, use SPSS19 statistics software making statistics and handling with 28 Chinese and foreign men's decathlon athletes' sports performances and each single item performance, and makes research on each large type item level to total performance effect.

Correlation coefficient matrix test

The model adopts KMO test to make factor analysis

fitness testing, input TABLE 1, TABLE 2 data into SPSS software, running, and then gets as following TABLE 5:

From TABLE 5, it is clear that KMO test result is 0.765 that above 0.5 indicates data with poor partial correlation and it is fit for factor analysis.

Bartlett

Value=173.277, P<0.001, shows that correlation matrix is not a unit matrix; it can carry out factor analysis.

Factor analysis

Extract principal component

First it should convert every variable value into standard value. In principle, the number of factors is the same as that of original variables, but after extracting main factors, if rest variance is quite small, it can abandon other factors so as to achieve the purpose of simplifying data.

The model sets 10 items as variable, in order, 1500m, javelin throw, pole vault, 110m hurdle, 100m,400m, shot put, high jump, long jump, discus throw. Regard athlete total performance as sample observation value, apply SPSS to make factor analysis, it can get as following TABLE 6:

From TABLE 6, it is clear according to professional knowledge judgment, it selects four principal components. The four principal components accumulation contribution rate arrives at 84.359% that above 80%, therefore, it can be thought that the four

TABLE 5 : KMO and bartlett test

Sampling sufficient degrees Kaiser-Meyer-Olkin measurement.		.765
Bartlett sphericity degree test	approximate to chi-square	173.277
	df	45
	Sig.	.000

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TABLE 6 : Each item variance and accumulation contribution rate

	Explanatory total variance					
Component	Initial feature value			Extract squaresum and load in		
	Total	Variance %	Accumulation %	Total	Variance %	Accumulation %
1	5.333	53.332	53.332	5.333	53.332	53.332
2	1.446	14.457	67.789	1.446	14.457	67.789
3	.927	9.274	77.063	.927	9.274	77.063
4	.730	7.297	84.359	.730	7.297	84.359
5	.502	5.025	89.384			
6	.363	3.627	93.011			
7	.301	3.012	96.023			
8	.183	1.826	97.850			
9	.151	1.509	99.359			
10	.064	.641	100.000			

TABLE 7 : Explanatory total variance

Component	Rotational square sum load in		
	Total	Variance %	Accumulation %
1	3.083	30.826	30.826
2	2.582	25.820	56.646
3	1.391	13.913	70.558
4	1.380	13.801	84.359
5			
6			
7			
8			
9			
10			

TABLE 8 : Factor load after rotation

Rotational component matrix[a]				
	Component			
	1	2	3	4
100m	.917	.192	-.028	.139
400m	.882	.268	.106	.217
110m hurdle	.742	.009	.187	.406
Long jump	.706	.417	.279	.026
Discus throw	.186	.880	.107	.064
Javelin throw	.169	.856	.165	.051
Shot put	.250	.784	.179	.403
High jump	.080	.186	.947	.058
1500m	.446	.327	.539	.393
Pole vault	.292	.184	.092	.906

Extract method: Principal component; Rotation method: Kaiser standardized orthogonal rotation method.; a. Rotation convergent after 5 times' iteration

principal components loaded sports single item is decathlon athletes' scoring uppermost item.

Factor rotation

Generally, after extracting initial factors, it cannot make effective explanation on factors. At this time, it tends to require making factor rotation (rotation); it makes factor solution significance more easily to explain by coordinate transformation. The purpose of axis rotation is to change subjects' sizes in each factor load; when rotating axis, it adjusts each factor load sizes according to subjects and factors structural relations close level; after axis rotating, let variable every factor load get bigger (close to 1) or smaller (close to 0), which is different from the status that each factor has almost same load before axis rotating, it lets common factors naming and explanatory variables get more easily. After axis rotating, every common factor feature value will change but every variable commonality will not change.

Extracted each principal component accumulation contribution rate after factor rotation is as following TABLE 7:

From TABLE 7, it is clear that extracted each principal component accumulation rate after factor rotation doesn't change and still is 84.359%, but feature values tend to concentrate and values all above 1.

By orthogonal varimax rotation, after 5 times' rotating, it gets as following TABLE 8:

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TABLE 9 : Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.995[a]	.991	.986	78.31389

a. Predictors: (Constant), discus throw, 110m hurdle, high jump, pole vault, long jump, javelin throw, 1500m, 100m, shot put, 400m; b. Dependent Variable: total performance

From TABLE 8, it is clear the first principal component larger load variables are 100m, 400m, 110m hurdle, and long jump. Second principal component larger load variables are discus throw, javelin throw, and shot put. The third principal component larger load variable is high jump. The fourth principal component larger load variable is pole vault.

Factor analysis result

From factor analysis result, it is clear that during Chinese and foreign excellent athletes performance structures, 100m, 400m, 110m hurdle the three single items take largest effects, they can be called as speed, explosive power factor; discus throw, javelin throw and shot put the three items take the secondary effects, which can be called as strength factors; high jump effects are the third ones, which can be called as smart factor; the minimum effects item is 1500m, it can be called as speed endurance factor. The four factors structure can explain that Chinese and foreign excellent athletes still focus on absolute speed training during training; discus throw, javelin throw and shot put that rank in the second factors not only require athletes have sufficient guarantee in absolute strength, but also they have high correlations with individual speed quality, though they are not remarkable in scoring contribution rate aspect throwing type events by comparing with other types events, under present all-round sport guiding thought of "bal-

TABLE 10 : ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.135E7	10	1134536.674	184.987	.000[a]
	Residual	104262.120	17	6133.066		
	Total	1.145E7	27			

a. Predictors: (Constant), discus throw, 110m hurdle, high jump, pole vault, long jump, javelin throw, 1500m, 100m, shot put, 400m; b. Dependent Variable: total performance

anced development, eliminate weak events", the type factor effects are self-evident; only high jump one item ranks in the third factor, due to high jump's power generated by horizontal speed and vertical speed common functions mutual transformation, meanwhile it also has special requirements on athletes' body shape, specially classifies it as one type; in speed endurance factor, it similarly has requirements on athletes' body shape that are different from the first, second factor requirements, but the four types of factors always correlated to speed quality, therefore, men's decathlon with the core speed conforms to current development trend. To men's decathlon athletes, they should comprehensive develop each item physical quality, especially for speed, strength and technique, and in future training, it should focus on strengthen technical aspect training on the basis of speed, strength consolidation.

MULTIPLE REGRESSION PREDICTION MODEL

Given all-round items 10 single item performances are independent variables, total performance is dependent variables. Adopt enter independent together to make linear regression, apply SPSS software handling

TABLE 11 : Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-298.001	232.235		-1.283	.217
	1500m	1.396	.433	.155	3.225	.005
	Javelin throw	1.134	.200	.216	5.677	.000
	Pole vault	1.074	.211	.180	5.091	.000
	110m hurdle	.837	.339	.102	2.472	.024
	100m	1.962	.482	.214	4.066	.001
	400m	.355	.676	.037	.525	.606
	Shot put	.363	.407	.044	.890	.386
	High jump	1.158	.278	.137	4.160	.001
	Long jump	.948	.282	.125	3.366	.004
	Discus throw	1.170	.230	.196	5.088	.000

a. Dependent Variable: Total performance

with TABLE 1, it can get as following TABLE 9, TABLE 10 and TABLE 11:

TABLE 9 is model's goodness of fit test; from table it is clear that both square coefficient and after adjusting square coefficient arrive at above 0.99 that shows model has high fitting goodness.

TABLE 10 is model variance test, from table, it is clear that $F = 184.987$, significance correlation probability is 0.000^a, which turns significant differences.

TABLE 11 is regression calculation process each equation coefficient table, from table, it is clear that

t Test shows significant level.

According to TABLE 11, it can get relative each item all-round non-standard regression model:

$$Y = -29800 + 1.396X_1 + 1.134X_2 + 1.074X_3 + 0.837X_4 + 1.962X_5 + 0.355X_6 + 0.363X_7 + 1.158X_8 + 0.948X_9 + 1.170X_{10}$$

$X_1 - X_{10}$ are independent variables, which respectively corresponding represents 1500m, javelin throw, pole vault, 110m hurdle, 100m, 400m, shot put, high jump, long jump, discus throw each item performance; Y is dependent variable, it represents decathlon total performance)

TABLE 12 : Compare predicted value with actual value

Name	Predicted total performance	Actual total performance	Prediction accuracy rate
Qi Hai-Feng	7902.37434	7,941.00	0.99513592
Yu Bing	7833.507706	7,791.00	0.994543999
Zhu Heng-Jun	7843.854998	7,708.00	0.982374806
Liu Hai-Bo	7898.012259	7,427.00	0.936581088
Hao Ming	7849.591999	7,370.00	0.934926459
Wang Jian-Bo	7733.213342	7,346.00	0.947289226
Zhao De-Ning	7843.356905	7,261.00	0.919796598
Lu Huan-Yong	7882.3557	7,256.00	0.91367755
Guo Wei-Zhao	7864.222777	7,230.00	0.912279007
Li Ya-Gui	7830.45619	7,106.00	0.898050072
Lin Qing-Quan	7730.492957	7,012.00	0.897533805
Yang Wen-Liang	7898.52487	7,009.00	0.873088191
Tang Jun	7788.761997	6,761.00	0.847986689
Zhou Bin	7829.138226	6,323.00	0.761800059
Ashton Eaton	8011.43	8,869.00	0.903307024
Trey Hardee	7945.818	8,671.00	0.91636697
Leonel Suarez	8043.538	8,523.00	0.943744925
Hans van Alphen	8114.734	8,447.00	0.960664615
Warner	8046.33	8,842.00	0.910012441
Rico Freimuth	7975.134	8,320.00	0.95854976
Oleksiy Kasyanov	8011.43	8,283.00	0.96721357
SergeySviridov	7984.906	8,219.00	0.971517946
Kerzen	8077.042	8,173.00	0.988259146
Pascal Behrenbruch	7976.53	8,126.00	0.981605956
EelcoSintnicolaas	8033.766	8,034.00	0.999970874
Newdick	7970.946	7,988.00	0.997865048
Barroilhet	7882.998	7,972.00	0.988835675
Gaztia	7966.758	7,956.00	0.998647813
Accuracy rate average value			0.939343758

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Input Chinese and foreign excellent all-round athletes each single item performance into prediction model, it gets prediction total performance, and make comparison between predicted value and actual value. It can get as following TABLE 12:

From TABLE 12, it is clear that model prediction accuracy average value is 0.9393; therefore model prediction accuracy is very high. The prediction equation completely can predict Chinese and foreign excellent decathlon athletes' total performance.

CONCLUSIONS

Grey theory correlation analysis method is scientific reasonable, easy, especially in multiple factors, multiple levels comprehensive research analysis, according to "correlation degree" sizes, it can further find out Chinese and foreign gap, meanwhile it can provide reliable and feasible evidence and reference for improving and promoting Chinese decathlon even to other sports levels. Rey correlation analysis result shows that Chinese athletes each single item to total performance influences rank by correlation degree is: 110m hurdle>100m>long jump>400m> high jump> pole vault>shot put> javelin throw> discus throw>1500m; and world rank is 110m hurdle>long jump>100m>400m>pole vault>high jump>javelin throw>shot put>discus throw>1500m. Compared with foreign athletes' ranking, ten single items'110m hurdle, 400m, discuss throw and 1500 meters ranking are the same, they respectively rank in the first, fourth, ninth and tenth, domestic top three also are long jump, 100m and 110m hurdle but there are differences in the rank, these three items all require horizontal speed takes absolute advantages; foreign pole vault, javelin throw are respectively ranking in the front of high jump, shot put, while it is opposite at home. It is clear that domestic athletes still keep larger some paces with foreign excellent athletes by comparing in higher special technique requirement pole vault and javelin throw the two events, which shows that Chinese athletes have shortcomings in high speed, quick rhythm technical motions completion abilities, it should be taken seriously by Chinese all-round coaches. It suggests that Chinese coaches further strengthen athletes' physical training, further improve athletes continuous game abilities, let athletes each

sub item performance get coordinate and balanced development.

From factor analysis result, it is clear that during Chinese and foreign excellent athletes performance structures, 100m, 400m, 110m hurdle the three single items take largest effects, they can be called as speed, explosive power factor; discus throw, javelin throw and shot put the three items take the secondary effects, which can be called as strength factors; high jump effects are the third ones, which can be called as smart factor; the minimum effects item is 1500m, it can be called as speed endurance factor. The four factors structure can explain that Chinese and foreign excellent athletes still focus on absolute speed training during training; discus throw, javelin throw and shot put that rank in the second factors not only require athletes have sufficient guarantee in absolute strength, but also they have high correlations with individual speed quality, though they are not remarkable in scoring contribution rate aspect throwing type events by comparing with other types events, under present all-round sport guiding thought of "balanced development, eliminate weak events", the type factor effects are self-evident; only high jump one item ranks in the third factor, due to high jump's power generated by horizontal speed and vertical speed common functions mutual transformation, meanwhile it also has special requirements on athletes' body shape, specially classifies it as one type; in speed endurance factor, it similarly has requirements on athletes' body shape that are different from the first, second factor requirements, but the four types of factors always correlated to speed quality, therefore, men's decathlon with the core speed conforms to current development trend.

All-round sports training is a long-term and complicated work, it asks high for athletes' physical ability and continuous game ability. Coaches should be good at learning, summarizing experiences, apply advanced training methods and ways into scientific training, strengthen theoretical learning, update ideals, correctly learn themselves status and athletes themselves training features, further improve athletes' continuous game abilities, let athletes each sub item performance get coordinate and balanced development. Strengthen coaches mutual exchanging, go abroad to learn foreign advanced training methods, design reasonable and effective training method by combining with Chinese athletes them-

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selves features, and comprehensive improve Chinese men's decathlon athletes' competitive strengths.

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