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## Grey correlation method-based China “three big balls” development influence factors research

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### ABSTRACT

China has already been a major sports country, but if it wants to transform from a major sports country to sports power, it must balance and upgrade Chinese sports event. In current stage China's sports circles focus is “Layout 2016 Rio de Janeiro”, no doubt, “three big balls” development has already become a crucial part in current Chinese sports focus. The paper started from China “three big balls” development influential numerous factors, combines with correlation research and investigation result, selects economic factors, reserve talents factors and field construction factors as relative important factors, establishes China “three big balls” development-based grey correlation degree model, by comparing the three correlation degrees, it gets China “three big balls” development main influence factors. The conclusion is: reserve talents factor correlation degree is the largest, is a main influence factor, and secondly is economic factor, field construction factor. On this basis, it makes comprehensive evaluation on numerous factors, and then makes comprehensive analysis of China's “three big balls” development status, finally provides feasible suggestions, and points out that improve China “three big balls” development should focus on cultivating reserve talents, strengthen “three big balls” investment and field construction, so that promote “three big balls” development.

### KEYWORDS

Three big balls; Grey correlation degree; Comprehensive evaluation; Mathematical model.



## INTRODUCTION

As a major sports country, China "three big balls" development is one of key factors that restrict Chinese sports impacting on world sports power. In addition, affected by "Olympic gold medal strategy", collective sports events of big investment, little medal quantity that similar to football, basketball, volleyballs are more easily to suffer impacts. Only observe 2008 Beijing Olympic Games and 2012 London Olympic Games, it can easily find China "three big balls" reflects collectivity falling tendency.

Though China "three big balls" development tendency is not going well, Chinese scholars always constantly go in for researching. In the article " Chinese basketball, volleyball, football excellent sports teams' athletes numbers dynamic development change analysis and comparative research", Pang Jian-Min stood in China "three big balls" development history, analyzed current stage "three big balls" development status, by consulting lots of literatures, made comprehensive analysis of China "three big balls" development influential economic factors, excellent athletes cultivation, coaches and other factors, and pointed out speeding up China "three big balls" development should focus on coaches' selection and cultivation, organize a team of high quality, good techniques' excellent athletes<sup>[3]</sup>; In the article "China 'three big balls' sliding and reserve talents cultivation", by analyzing current stage China "three big balls" sliding phenomenon, utilizing consulting literatures and mathematical statistical method, Wu Jin-Yuan got that in order to speed up China "three big balls" development must focus on reserve talents cultivation and provided excellent athletes for China<sup>[1]</sup>; In the article "Chinese excellent athletes and reserve talents exchanging schemes' research", Zhao Yu-Ting and others by researching Chinese excellent athletes and reserve talents quantity, cultural standard and age structures as well as others, combined with lots of literatures and data, finally got Chinese excellent athletes and reserve talents exchanging schemes, which made contributions to Chinese sports development<sup>[7]</sup>.

The paper on the basis of researching China's "three big balls" development status, references formers summarized experiences and literatures, starts from football, basketball, volleyball development influence factors' perspectives, utilizes grey correlation method, establishes China "three big balls" development influential correlation degree model, analyzes economic factors, reserve talents cultivation factors and field construction factors and others influences on their development, and then gets China should focus on reserve talents cultivation in some time in future, constantly improve referees, coaches qualities, establish a high quality talents cultivation team, and build foundation for China "three big balls" development.

### China "three big balls" development influential grey correlation degree model

No doubt, China "three big balls" are football, basketball and volleyball. China "three big balls" development influence factors are various, according to China "three big balls" development status, their development influence factors are mainly GDP that is economic factors, field investment construction, excellent athletes amount that is reserve talents factor, humanistic culture factor, competition system, referees and coaches quality factors and so on. If speed up China "three big balls" development, it must start from each aspect factor, make comprehensive consideration, Figure 1.



Figure 1: "Big three" sports in our country

In grey system analysis method, grey correlation degree analysis is one of the most basic methods, it is on the basis of system influential each factor change, by calculating each factor and system correlation degree and comparing sizes, and then gets one method that factor influence size to system. The significance of grey correlation degree analysis is based on system overall development changes, if system changes and factor changes trends are consistent, then the two correlation degree is larger: if system changes are inconsistent with factors changes trends, or have certain differences, then the two correlation degree is smaller.

China "three big balls" development mainly includes football, basketball and volleyball, economic factor (per capita GDP), reserve talents (number of excellent athletes) and field construction are main influence factors, every factor different

development trends will surely restrict “three big balls” development trend. Grey correlation analysis use for analyzing recent five years’ “three big balls” Olympic Games obtained medals numbers’ correlation with above three kinds of main factors and their features, which provides references for China “three big balls” development researching.

### Data processing

Below TABLE 1-4 are China “three big balls” influential three main factors data tables, data is from China’s statistical yearbook and internet data.

**TABLE 1: China 2008~2012 year GDP**

Year	2008	2009	2010	2011	2012	Average value
GDP	314045.4271	340902.8126	401512.7952	473104.0486	518942.1073	409701.4382

**TABLE 2: China “three big balls” excellent athletes’ amount**

Year	2008	2009	2010	2011	2012	Average number of people
Football	520	519	517	515	514	517
Basketball	651	655	660	664	669	660
Volleyball	398	388	378	369	359	378

**TABLE 3: China “three big balls” performances in 2008、2012 Olympic Games and history**

Item	Football		Basketball		Volleyball	
	Women’s football	Men’s football	Women’s basketball	Men’s basketball	Women’s volleyball	Men’s volleyball
Performance in 2012 session	Didn’t qualify to Olympic Games	Didn’t qualify to Olympic Games	The sixth	Eliminate in the group stage	The fifth	Didn’t qualify to Olympic Games
Performance in 2008 session	Eliminate in the group stage	Eliminate in the group stage	The fourth	Top eight	Third winner	The fifth
Historical medals winning status	Zero gold medal, one silver medal, zero bronze medal	Never get medals	Zero gold medal, one silver medal, one bronze medal	Never get medals	Two gold medals, one silver medal, three bronze medals	Never get medals
Sum total		1		2		6

**TABLE 4: China “three big balls” training fields’ numbers**

	Football	Basketball	Volleyball
Number of halls	0	2281	275
Number of fields	4274	326141	39135
Sum total	4274	328422	39410

In order to easy carry on grey correlation degree model establishment, draw above table into following TABLE 5:

**TABLE 5: Influence factors statistical table**

	Gross number of medals	Per capita GDP (2008~2012 average value)	Reserve talents	Field construction
Football	1	40970.44	517	4274
Basketball	2	40970.44	660	328422
Volleyball	6	40970.44	378	39410

**Establish model**

(1) Record China "three big balls" influence factors feature behaviors sequence as following:

$x_i' = (x_i'(1), x_i'(2), x_i'(3))^T, i = 1, 2, 3$ , from which correlation factor line sequence is:

$$x_1' = (40970.44, 40970.44, 40970.44);$$

$$x_2' = (517, 660, 378); x_3' = (4274, 328422, 39410)$$

Thereupon, it can get: 
$$x_i' = \begin{pmatrix} 40970.44 & 40970.44 & 40970.44 \\ 517 & 660 & 378 \\ 4274 & 328422 & 39410 \end{pmatrix}$$

(2) Define reference sequence

Take China "three big balls" historically achieved medals numbers sequence  $x_0'$  as reference sequence,

$$x_0' = (1, 2, 6)$$

(3) Initialization method data processing

Utilize formula  $x_i(k) = \frac{x_i'(k)}{x_i'(1)}$ , to handle with relative factors line sequence, result is as following :

$$x_1(k) = \frac{x_1'(k)}{x_1'(1)} = \frac{(40970.44, 40970.44, 40970.44)}{40970.44} = (1, 1, 1);$$

$$x_2(k) = \frac{x_2'(k)}{x_2'(1)} = \frac{(517, 660, 378)}{517} = (1, 1.28, 0.73);$$

$$x_3(k) = \frac{x_3'(k)}{x_3'(1)} = \frac{(4274, 328422, 39410)}{4274} = (1, 76.84, 9.22)$$

(4) Calculate  $\min_{1 \leq i \leq 3} \min_{1 \leq k \leq 3} |x_0' - x_i(k)|, \max_{1 \leq i \leq 3} \max_{1 \leq k \leq 3} |x_0' - x_i(k)|$

Input  $x_1(k) = (1, 1, 1), x_2(k) = (1, 1.28, 0.73), x_3(k) = (1, 76.84, 9.22),$

$x_0' = (1, 2, 6)$  into above formula and get:

$$\min_{1 \leq i \leq 3} \min_{1 \leq k \leq 3} |x_0' - x_i(k)| = 5.10, \max_{1 \leq i \leq 3} \max_{1 \leq k \leq 3} |x_0' - x_i(k)| = 74.91$$

(5) Calculate "three big balls" development correlation coefficient

And correlation coefficient computational formula:

$$\zeta_i(k) = \frac{\min_{1 \leq i \leq n} \min_{1 \leq k \leq m} |x_0'(k) - x_i(k)| + \rho \times \max_{1 \leq i \leq n} \max_{1 \leq k \leq m} |x_0'(k) - x_i(k)|}{|x_0'(k) - x_i(k)| + \rho \times \max_{1 \leq i \leq n} \max_{1 \leq k \leq m} |x_0'(k) - x_i(k)|}$$

Among them,  $\rho$  is resolution ratio, and  $\rho \in (0, 1), \rho = 0.5, \rho$  gets bigger and then relation is bigger.

Input  $|x'_0(k) - x_i(k)|$  each value, and can solve:

$$\zeta_1 = (1.14, 1.01, 0.989); \zeta_2 = (1.14, 1.11, 0.996); \zeta_3 = (1.14, 0.38, 1.05)$$

(6) Calculate correlation degree

Use correlation degree computational formula  $r_i = \frac{1}{m} \sum_{k=1}^m \zeta_i(k)$ , input

$$\zeta_1 = (1.14, 1.01, 0.989), \zeta_2 = (1.14, 1.11, 0.996), \zeta_3 = (1.14, 0.38, 1.05) \text{ And get:}$$

$r_1 = 1.046, r_2 = 1.082, r_3 = 0.857$ , and then it gets following data TABLE 6:

**TABLE 6: “Three big balls” historical performance grey correlation degree value**

	Per capita GDP	Reserve talents	Field construction
Correlation degree	1.046	1.082	0.857

(7) Evaluation result

By above table, it is clear that maximum influence on China “three big balls” development is reserve talents that number of excellent athletes, its correlation degree is 1.081, secondly is per capita GDP, field construction, their grey correlation degrees are respectively 1.046, 0.857. Computation of grey correlation degree can define three factors influence degrees on China “three big balls” development. Though assign different resolution coefficients, it will get different correlation degrees values, their sizes orders will not change, correlation sequence is essence of correlation analysis. Though three factors and China “three big balls” development have big or small correlation degrees, each correlation degree has no big difference that when make comprehensive evaluation on China “three big balls” development trend, three factors should be taken into comprehensive consideration as well as combine with other factors to evaluate them.

### COMPREHENSIVE EVALUATIONS ON CHINA “THREE BIG BALLS” DEVELOPMENT INFLUENCE FACTORS

#### Economic factor

Football as a kind of public sport, it is a kind of sports event and also a kind of social activities, social economic development status surely will have certain impacts on its development. From beginning to end, economy always is a strong backing of sports development, only national economy improves, people’s living standard promotes, and then sports may develop.

Compare with world sports powers, as Brazil, Argentina, America, France and others, all are major economic countries, their economy rapidly develops and at the same time sports also rapidly develop. In addition, these world major countries market power supports on sports industry are also great. Only develop both economy and market simultaneously, sports development will be higher, faster and stronger. Therefore, obviously, economy will become of indispensable main factors that restrict China “three big balls” development.

In order to better compare China economic development and world economic development status, it specially lists faster economic developed countries year

2008~2012 per capita GDP growth status, data is from 2013 China’s statistical yearbook and internet data. As following TABLE 7:

**TABLE 7: 2008~2012 world countries per capita GDP growth status**

Year Per capita GDP (dollar) Country	China	America	Britain	South Korea	Japan
2008	3738.2	37629	19978	16980	26874
2009	4025.6	37873	24763	18793	27961
2010	4718.4	39875	26758	19747	28774
2011	5533.1	41290	27685	19875	29786
2012	6039.6	42576	28877	20473	30430

Its broken line Figure 2 is as following:

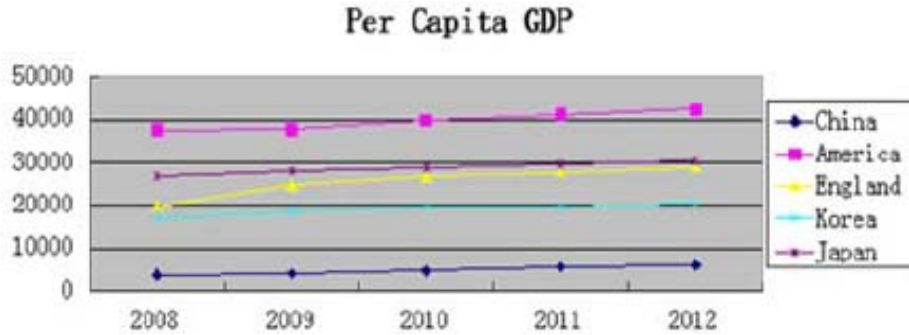


Figure 2: Per capita GDP growth chart

From Figure 2, it can clearly see that though China’s per capita GDP is in the rising trend, compare to America, Japan, Britain and South Korea, it still not very high, which affects China sports development to a certain degree, and then further affects “three big balls” spread in whole nation.

**Field construction**

As foundation of talents cultivation, good training fields’ conditions are helpful for cultivating excellent athletes. Therefore, field constructions naturally become one of nation sports development important factors. To China “three big balls” development, field construction, it contains field facilities, geographic position, fields amount and others that all are called as decisive factors for its rapidly development. From TABLE 4, it is clear that Chinese football, basketball and volleyball fields numbers present following features:

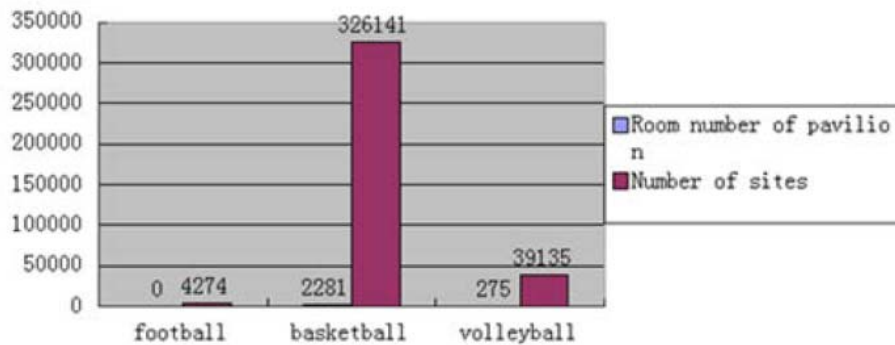


Figure 3: China's "big three" compared to the construction of figure

From Figure 3, it is clear that China’s present football fields are relative fewer by comparing to basketball and volleyball, from which basketball courts are most, secondly is volleyball court. In current stage football development is hotspot of China, so as to develop football, China ought to get the root, strengthen football fields investment, positive encourage teenagers to participate in football, enlarge football position in the heart of people, improve its impact and then make contributions to football development.

**Reserve talents**

To rapidly develop China “ three big balls”, get rid of present unoptimistic statuses in Olympic Games and other competitions, it should pay high attention to excellent athletes cultivation, focus on reserve talents construction, so that establish relative whole cultivation system, and select excellent athletes for Chinese sports. It is a general procedure that competitive sports development should go through. According to correlated investigation indication, world champions mostly started physical exercises since children sports school, and carried out normative series of training, as TABLE 8.

TABLE 8: Until year 2012 athletes’ development amount by events and grades

Event	Sum total	Woman	International level		Master of sports		First class		Second class	
			Master of sports	Woman	Master	Woman	Athletes	Woman	Athletes	Woman
Football	4124	944			59	9	1049	198	3016	737
Basketball	5577	1843			78	30	911	301	4588	1512
Volleyball	2908	1226	9	7	49	18	599	208	2251	993

At present, we should establish complete reserve talents cultivation system, positive carry on sports training; plan a set of feasible talents cultivation schemes. And meanwhile, make full use of universities sports facilities, scientific and technological resources, as well as colleges' sports talents, preparation of sports team to pave the way for reserve talents cultivation.

**Referees factor**

Referees as judges in the court, is a sport competition judge, whether it can adhere to referees law, judge according to law is closed linked to a referees' professional qualities, levels and morality attainments. And meanwhile, referees are also one of key factors to decide a competition winning or losing, are important factors to promote a nation sports development. Number of referees is also predominantly plays decisive roles. In addition, referees age structure, professional technology, cultural attainments and others, all have certain impacts on whether it can fair and just to do competition judgment. Below Figure is China's present referees age structure Figure 4:

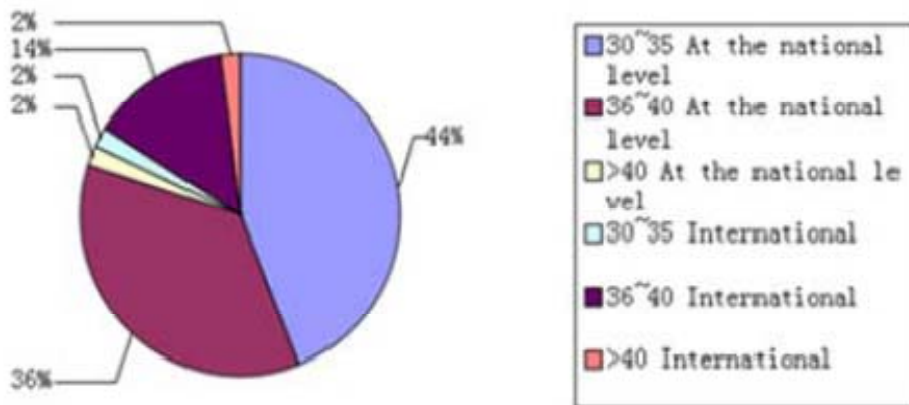


Figure 4: The referee's age structure

From above Figure 4, it is clear that Chinese referees' international referees are little with respect to national level referees, three age phases totally only occupy 18%, while national level referees proportions are bigger, totalities occupy 82%. On a whole, China's referees' ages are mostly below 40 years old, above 40 years old referees total proportions are only 4%. In some time in future, in order to promote China "three big balls" development, further promote Chinese sports, we should focus on referees cultivation and selection, multiple cultivate international level referees, and train existing referees, strengthen referees quality education, all-round promote and build versatile referees from culture, technology and other aspects.

**Coaches factor**

An excellent team surely has excellent coaches, in training process; coaches directly affect athletes' quality. It is proved by facts that lack of cultural knowledge, not comprehending modern training theory are key factors that hinder coaches to do technical and motion guiding to athletes. Master scientific training method, carry on scientific training are necessary ways to cultivate excellent athletes. Below TABLE 9 is status of number of coaches that have high professional titles during year 2004~2012, data is from 2012 China sports statistical yearbook.

TABLE 9: Number of senior title of professional coaches

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012
Football	47	42	49	49	52	47	34	40	54
Basketball	47	45	37	26	28	32	47	47	66
Volleyball	50	51	50	39	38	34	58	68	67

In order to easily observe changing trend of number of senior title of professional coaches, now handle with table data, draw it as following broken line Figure 5:

From below Figure 5, it is clear that China "three big balls" coaches' numbers changes are unstable, since 2010, numbers are increasing. Among them, football coaches numbers are little with respect to basketball and volleyball, is one of main problems that Chinese sports development should solve in future. Coaches' team's existence and development are



strong backing to promote China "three big balls" development, in the increasing fierce competition's sports development, it should strengthen excellent coaches cultivation, and then make preparation for athletes cultivation.

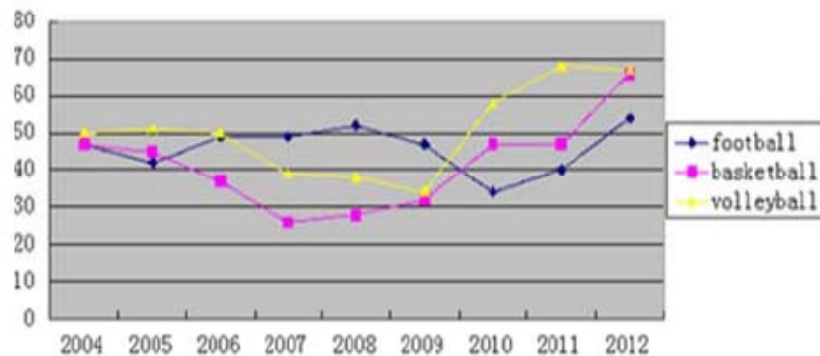


Figure 5: Get the number of senior title of professional coaches

## CONCLUSION

The paper based on grey correlation degree analysis, makes comprehensive analysis of China "three big balls" development influential economic factors, reserve talents factor, field construction factor, by comparing correlation degree sizes, it gets conclusion, and points out reserve talents factor is a key factor that constraints China "three big balls" development, with some time in future, develop Chinese sports should focus on excellent athletes cultivation, start from basic and make contributions to turn around China "three big balls" collective falling tendency. Based on China "three big balls" development influential gray correlation degree model, on the basis that model gets conclusion, it comprehensive evaluates economic factor, reserve talents factor, field construction factor, referees and coaches factor, makes supplement on model results, and analyzes and then gets that it should make all-round reformation for the purpose for speeding up development, and then grasp each link problems, solve problems, and finally get all-around development. Combine with football, basketball and volleyball themselves features that are large investment, little medals number, big investment of field facilities, it stands on current stage China's sports development status, makes comprehensive evaluation, analysis, and uses mathematical methods to study their development influential main factors, and then gets a conclusion that development should rely on cultivating excellent reserve talents.

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