2014

ISSN : 0974 - 7435 Volume 10 Issue 10

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(10), 2014 [4778-4787]

Based on logistic growth curve of the development of chinese sports population research

Xiaoming Zhang

Public Physical Education Department, Inner Mongolia Normal University, Huhhot 010020, Inner Mongolia, (CHINA)

ABSTRACT

In this paper, the Chinese sports population age structure, sex characteristics, cultural characteristics, and analyzes the different areas of the gap between rural and urban areas, and pointed out that at present most of the Chinese sports population is 16 to 45 years old, college and senior high school students, influenced by economic development, presents the characteristics of "the Middle East and west" less. Secondly, by using the method of correlation analysis, quantitative analysis of the correlation between the number of different sports system and economic factors, by comparing the size of the Pearson correlation coefficient of correlation between economic development and the larger the number for further screening. Finally, using the method of logistic growth curve about the number of sports system prediction model is established, by studying the correlation analysis of professional sports technical institute, sports schools and amateur sports school three factors of historical data, prediction mathematical equations, to 2012 three years after five years the number of changes to make predictions, and draw the conclusion: five years after 2012 professional sports technical institute and the number of sports schools is on the rise, while the number of amateur sports schools have a certain degree of decline.

KEYWORDS

Sport population; Correlation analysis; The pearson correlation coefficient; The logistic growth curve.

FOREWORD

Whether a country is rich, the development of undertakings of physical culture and sports is one of the evaluation index. And the development of sports population is the key factor. From the new China was founded, China has attached great importance to sports, and subject to the influence of the national fitness activities, the enthusiasm of the masses to participate in physical exercise is higher and higher, the Chinese sports population is growing. So far, there have been many scholars studied on the development of Chinese sports population.

XiaoHuanYu in the study of contemporary Chinese sports population, combined with China's current social structure, access to a large number of literature, analyzes the basic features of Chinese sports population, and the social structure is a connection between the sports population is part of the society, its development will inevitably affected by the development of the society, in the study of sports population must consider the influence of social factors; Buddhistmas when studying sports population problem, through the analysis of the basic concepts of sports population, classifying sports population, and finally put forward of the sports population statistical standards; Jian-wen he in the study of sports population theory, on the basic characteristics of the sports population and the concept has carried on the comprehensive review, and combining the predecessors' research data to further improve the results of the study, so as to get a comprehensive review of the sports population theory; Pang yuan yu in the study of Chinese sports population, through the analysis of the basic characteristics of sports population, combined with the contemporary China's national conditions, puts forward the future direction of the development of Chinese sports population; Zhi-wen miao analysis of contemporary Chinese sports population, the structure of Chinese sports population were studied, and based on the current social development, combined with the sociological theory, put forward the new structure of Chinese sports population.

This paper first analyzes the basic situation of sports population in China, by studying its age structure, sex characteristics, cultural characteristics, as well as the different areas of the gap between rural and urban areas, points out the present situation of Chinese sports population for most of the sports population of 16 ~ 45 people, mostly in the college and senior high school students, and under the influence of economic factors appear less "in the Middle East and west". Secondly, by using the method of correlation analysis, compare the size of the Pearson correlation coefficient, quantitative analysis of the correlation between the number of different sports system and economic factors. Finally, using the method of logistic growth curve about the number of sports system prediction model is established, the prediction mathematical equations were obtained through the analysis of relevant historical data, and five years after 2012 kinematics and amateur sports school, sports professional sports institute of technology to predict the number of changes.

MODEL CONSTRUCTION

Sporting population is the fundament and motive power of the development of Chinese sporting vocation. Studying the aging structure, gender structure and culture structure of sporting population can be of help to make further analysis about the recent condition of sporting population. At the same time, we can find and solve problems during this process.

The basic features of chinese sporting population

The aging structure of chinese sporting population

The slogan “Sports can strengthen a country” has been widely spread since China declared its independence and China has realized the slogan relatively well. People’s enthusiasm for sports becomes

stronger and stronger and the sporting population successfully makes its augmentation. “Everybody does sports” is no longer an empty word. In daily life, exercisers are ubiquitous. If you want to learn the situation of Chinese sports, the best way is to learn the aging distribution of sporting population. Figure1 is Our country sports population age structure. The statistics are from the yearbook of Chinese statistics, State Physical Culture Administration and Internet investigations, etc.

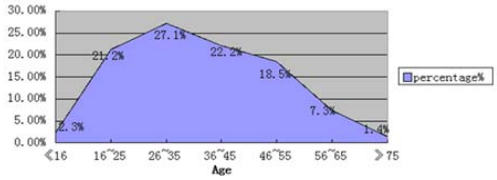

Figure 1 : Our country sports population age structure

From Figure1 we can know that the aging distribution of Chinese sporting population ranges mainly from 16~45, then 46~55. People who are under 16 and over 55 do fewer sports relatively. The reason why the distribution characteristic is like that is influenced mainly by culture level, physical quality and spirit, etc. People of 16~45 years old are mainly young and middle-aged, so doing sports is a must during their spare time. People who are under 16 and over 55 are mainly children and old. Doing sports is a little bit risky no matter from the internal factor for the aspect of physical quality or the external factor of the security of sporting facilities. As a result, they do less exercise relatively. Consequently, the sporting population of this age group is less.

In order to encourage people who are under 16 and over 55 to do sports, the government should strengthen the construction of sporting facilities to guarantee the security. People of this age group should enhance their sporting spirit and in this way, they can raise the quality of body and life.

The gender structure of chinese sporting population

Gender issues are important issues we must face in the development of Chinese sporting cause. Through investigating gender issues, we can analyze the degree of cognition and participation towards sports from different gender in people groups. From the aspect of gender, we can reform the sporting system and construct suitable sporting facilities for people groups in different gender to raise people’s enthusiasm for sports. In this way, the sustainable development of Chinese sporting cause is promoted. TABLE 1 shows some details from the sex ratio of sporting population. The statistics are from the yearbook of Chinese statistics, State Physical Culture Administration and Internet investigations, etc.

TABLE 1 : The sex ratio of sporting population

Classification	Sporting population		Male sporting population/ Male population	Female sporting population/ Female population
	male	female		
Percentage	56.6%	43.4%	20.2%	15.8%

Consequently, in order to analyze the degree of cognition and participation towards sports from people group of different gender, the statistics above was made into Figure2 to get further analysis and conclusion:

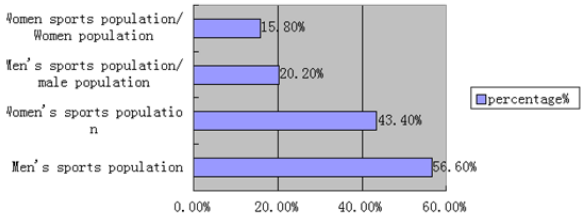

Figure 2 : Sports population sex ratio is a bar chart

From this bar chart we can see that, in Chinese sports population, men are in a larger group, in 56.6 percent. The rate of men's sports population and male population are larger than the rate of women's sports population and women population, which is to say, men attach more importance to sports than women and the passion of men to learn and participate in sports is higher than women. This phenomenon is more obvious in Chinese sports. Male athletes are in a large quantity in some big sport events like football, basketball while female athletes majoring in some sports like aerobics and lala gym. When we analyze the reason we find that it is because the restriction from the idea of the traditional culture and the physical factors of women which makes the women's development in the sports circle restrict in some degree.

The cultural structure of chinese sports population

Cultural level is the most important thing which influences the level of a person even a nation's consciousness. As for the development of sport, the cultural level of the sports population therefore influences their sport consciousness, and thus influences the development of sport. Different cultural groups have different faith and different cognition towards sport. Studying the characteristic of cultural structure of the sport population is beneficial to find the existing problems in the development of the Chinese sport. After we find the problems, we can work out solutions to the sport population in different cultural levels.

So in order to analyze the cultural structure of Chinese sport population, we look up plenty of statistics from the Chinese statistical yearbook, the reports of State Physical Culture Administration and the internet, we draw a pie chart like Figure 3, and after the analysis we come to this conclusion:

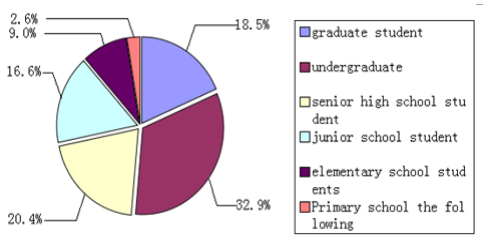

Figure 3 : Our country sports population structure of culture

From this pie chart Figure 3 we can see that among the Chinese sport population, the undergraduate and senior high school student are both in a large proportion and the graduate student, junior school student and elementary school student are in a smaller proportion, while the primary school the following only take a proportion of 2.6 percent. This phenomenon shows that the whole cultural level of Chinese sport population is comparatively high especially in the Chinese degrade athletes. At present, the number of Chinese national athletes and international athletes is growing which shows that the cultural quality if Chinese sport population is higher and Chinese sport career is developing towards a high level.

The region feature of the chinese sport population

With the different development levels in different areas, the Chinese sport population have obvious region feature. The analysis of the region feature of the sport population which mainly includes the difference among the East, the Middle and the West and also the sport population gap caused by the urban-rural gap is beneficial for us to take different sport development policies according to different region features, and thus makes the Chinese sport career develop in the whole country. TABLE 2 is the basic information of the region feature of the Chinese sport population and the percentage refers to the sport population accounts for the total population. The statistic is coming from the Chinese statistical yearbook, the reports of State Physical Culture Administration and the internet and etc.

TABLE 2 : The region feature of the sport population

	Region			Urban and Rural	
	East	Middle	West	Urban	Country
percentage%	21.5%	21.4%	8.1	28.9%	12.4%

According to the analysis of the statistics in the chart, we come to the conclusion:

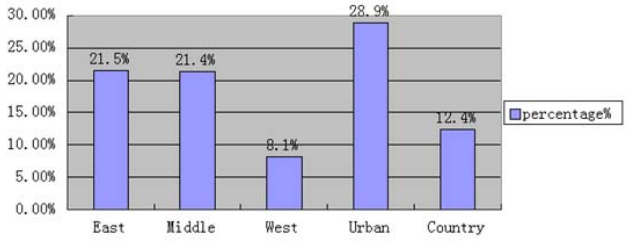

Figure 4 : Sports population of the area

From this histogram Figure4, we can see: as for the area distribution, the Chinese sport population has a character of “more people in the Middle and the East, less people in the West”. As for the urban-rural distribution, there is more sport population in the country, about 28.9percent, while in the country there is only 12.4percent. This is mainly influenced by the development of the

area economy and the traditional culture, which makes the slow developing areas’ sport career, develop relatively slow. In the meantime, this shows that the development of the sport population is closely related to the degree of the development of the society’s economy.

The analysis of the chinese sport population based on the correlation analysis

Based on the research of the basic information about the Chinese sport population, the Chinese sport population has a close connection with the development of the society’s economy. While in China, there are many forms of sport population which mainly includes Professional, Sport Institute of Technology, Sports School, Competitive Sports School, Amateur Sports School, and Single Sports School and so on. We come to the further analysis of the connection between the varying number of people and the economy based on the sport population in these organizations. TABLE 3 shows the

TABLE 3 is a chart about the varying number of people in sports system in China between 2008~2012. The statistics come from the China Statistical Yearbook:

TABLE 3 : The statistics of population to different sports system

	2008	2009	2010	2011	2012
Per capita GDP（Yuan）	23708	25608	30015	35198	38420

Professional, Sport Institute of Technology	2988	3056	3480	4671	6126
Sports School	15797	15870	15971	16912	16305
Competitive Sports School	389	476	486	323	398
Amateur Sports School	25897	24571	24392	24169	21657
Single Sports School	357	348	330	371	316
Training Base	3743	3875	3927	3323	3892
Stadium	15579	15398	15776	16315	14993

The guiding ideology of the related analysis

The method is to conduct correlation analysis to the two or more correlative variable factors.

To related analysis request every factors are related or comparable, the range contains almost every parts of our life.

Pearson correlation coefficient is one of the related analyses, and it use for showing statistics between two variables, and for ration calculation of the similarity between two variables. And the formula is as follows:

$$\rho(X,Y)=\frac{\operatorname{cov}(X,Y)}{\sigma_x\sigma_y}=\frac{E\left((X-\mu_x)(Y-\mu_y)\right)}{\sigma_x\sigma_y}$$

$$\mu_x=E(X),\sigma_X{}^2=E(X-\mu_x)^2=E(X^2)-E^2(X)$$

So, Pearson correlation coefficient can be also write as:

$$\rho(X,Y)=\frac{E(XY)-E(X)E(Y)}{\sqrt{E(X^2)-E^2(X)}\sqrt{E(Y^2)-E^2(Y)}}$$

When two variables' Pearson correlation coefficient go near to 1 or -1, the two variables are related in most parts or closely. When it approaches to 1, means the two variables positive correlation, and on the contrary, when it approaches to -1, means the two variables negative correlation.

Data processing and results

In the study of sports system population, we make the sports system populations as an observable variable, and build the correlation coefficient formula between sports system populations and GDP of per capita. We use SPSS to dispose the data in the form, and get the result of TABLE 4:

TABLE 4 : The pertinence of coefficient

Control variable		Professional sport skill school	Sports school	Competitive sports school	Amateur sports school	Unidirectional sports school	Training base	gym
GDP of per capita	Pearson correlation coefficient	.953*	.759	-.43	-.878	-.362	-.24	-.034
	significance（both sides）	.012	.137	.469	.050	.549	.690	.957

We can conclude from TABLE 4 that in seven physical education system institutions, Professional sport skill school, Amateur sports school and Sports school have the most pertinence with GDP of per capita. It established the prediction to the sports system institutions population in the next step.

The prediction to the sports system institutions population based on logistic curve

Based on the analyses that mentioned above, we choose the most effected sports system institution (Professional sport skill school, Amateur sports school and Sports school) to predict its population. We can predict the population between 2013 and 2017 by Logistic Curve.

The guiding ideology of logistic curve

The diversification velocity of things in different period are not the same. The sports system institutions population of China diversification uncertainty in the process of time. We adhibit Logistic Curve here that it have extensive use in representing these kinds of uncertainty development tendency questions.

The usual mathematical model of Logistic Curve is:

$$\frac{dy}{dt} = ry(1-\frac{y}{L}) \quad \textbf{(1)}$$

Y is the predict value, L is its limit value, r is increase constant, and r>0.

Solve the equations we can get:

$$y = \frac{L}{1+ce^{-rt}} \quad \textbf{(2)}$$

Mark the usual form of Logistic Curve as:

$$y_t = \frac{1}{K+ab^t}, K>0, a>0, 0<b\neq 1 \quad \textbf{(3)}$$

The estimate of the parameter in Logistic Curve goes to $y_t^{'} = \frac{1}{y_t}$, as:

$$y_t^{'} = K + ab^t \quad \textbf{(4)}$$

Trisect n observed values in time series, it have m terms in every part, as $n = 3m$.

Part one: $y_1, y_2, y_3, \cdots, y_m$

Part two: $y_{m+1}, y_{m+2}, y_{m+3}, \cdots, y_{2m}$

Part three: $y_{2m+1}, y_{2m+2}, y_{2m+3}, \cdots, y_{3m}$

In this, the sum of trend in every parts is equal to the relevant sum of observed values, so we get the parameter estimate, the trinity method steps as follows:

Mark each part of the sum of observed values as:

$$S_1 = \sum_{t=1}^{m} y^{'}{}_t,\ S_2 = \sum_{t=m+1}^{2m} y^{'}{}_t,\ S_3 = \sum_{t=2m+1}^{3m} y^{'}{}_t, \quad \textbf{(5)}$$

With:

$$\begin{cases} S_1 = \sum_{t=1}^{m} \hat{y}_t = \sum_{t=1}^{m} (K + ab^t) = mK + ab(1 + b + b^2 + \cdots + b^{m-1}) \\ S_2 = \sum_{t=m+1}^{2m} \hat{y}_t = \sum_{t=m+1}^{2m} (K + ab^t) = mK + ab^{m+1}(1 + b + b^2 + \cdots + b^{m-1}) \\ S_3 = \sum_{t=2m+1}^{3m} \hat{y}_t = \sum_{t=2m+1}^{3m} (K + ab^t) = mK + ab^{2m+1}(1 + b + b^2 + \cdots + b^{m-1}) \end{cases} \quad \textbf{(6)}$$

$$(1 + b + b^2 + \cdots + b^{m-1})(b - 1) = b^m - 1$$

Then:

$$\begin{cases} S_1 = mK + ab\dfrac{b^{m-1}}{b-1} \\ S_2 = mK + ab^{m+1}\dfrac{b^{m-1}}{b-1} \\ S_3 = mK + ab^{2m+1}\dfrac{b^{m-1}}{b-1} \end{cases} \quad \textbf{(7)}$$

So get the result:

$$\begin{cases} b = \left(\dfrac{S_3 - S_2}{S_2 - S_1}\right)^{\frac{1}{m}} \\ a = (S_2 - S_1)\dfrac{b-1}{b(b^m - 1)^2} \\ K = \dfrac{1}{m}\left[S_1 - \dfrac{ab(b^m - 1)}{(b-1)}\right] \end{cases} \quad \textbf{(8)}$$

In addition, when predict the data; we should inspect it with following method:

$$\frac{y_{t+1} - y_t}{y_t - y_{t-1}} \approx b \quad \textbf{(9)}$$

Data processing of logistic curve and conclusion

From $y_t' = \dfrac{1}{y_t}$ we can get the changed data of 2008~2012 in TABLE 5:

TABLE 5 : Data form changed by logistic curve

	Year	2007	2008	2009	2010	2011	2012
$y_t'/\times 10^3$	Professional sport skill school	0.347	0.335	0.327	0.287	0.214	0.163
	Sports school	0.0641	0.0633	0.0630	0.0626	0.0591	0.0613
	Amateur sports school	0.0392	0.0386	0.0407	0.0410	0.0414	0.0462

By (5) we get: $S^1_1 = 0.682, S^1_2 = 0.614, S^1_3 = 0.377$

$S^2_1 = 0.1274, S^2_2 = 0.1256, S^2_3 = 0.1204$

$S^3_1 = 0.0778, S^3_2 = 0.0817, S^3_3 = 0.0876$

By (8) we get: $b^1 = 1.867, a^1 = -0.005111, K^1 = 0.35468$

$b^2 = 1.6999, a^2 = -0.0001453, K^2 = 0.1281$

$b^3 = 1.5128, a^3 = 0.000796, K^3 = 0.0748$

So, the Logistic Curve mathematical model of sports system institutions population is:

$$\begin{cases} y^1_t = \dfrac{1}{0.35468 - 0.00511 \times 1.867^t} \\ y^2_t = \dfrac{1}{0.1281 - 0.0001453 \times 1.6999^t} \\ y^3_t = \dfrac{1}{0.0748 + 0.000796 \times 1.5128^t} \end{cases}$$

When we predict sports system institutions population of China in 5 years after 2012, we can substitution value t into the formula above. If we predict y_{2013}, then we get $t = 2013 - 2004 + 1 = 10$ and the result in TABLE 6:

TABLE 6 : Prediction of sports system institutions population of china

	2013	2014	2015	2016	2017
Professional sport skill school	6135	6219	6258	6301	6325
Sports school	16413	16525	16797	17105	17297
Amateur sports school	21579	20681	20432	19837	19693

We draw the population prediction above to the broken line in Figure 5 for the better analyze of trend in sports system institutions:

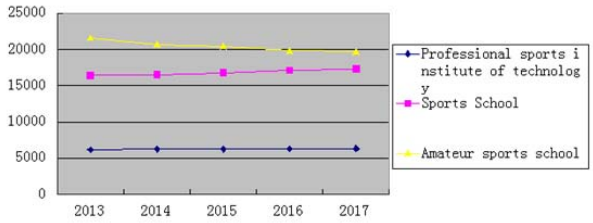

Figure 5 : The number of sports system institutions

Through the analysis to the statistics of broken line Figure 5 above, we can make the conclusion of: population of Professional sport skill school have increased in 5 years after 2012, but the population

of Amateur sports school reduced to a certain extent. As a whole, population of Amateur sports school is in the majority, but in a trend od descend. They should take some actions like strength the publicity of sports, reform manage system, perfect the facility of sport to keep the population of Amateur sports school.

CONCLUSION

(1) This essay firstly analyzed the basic condition of Chinese sports population. It mainly including the age structure, gender character, culture character, and differences among different zones of sports population. So that we conclude that: the majority of Chinese sports population is in the age from 16 to 45, and most of them are students in senior high school and college. And with the effect of economic development, it appears more in the East than the West, it is more distinctness between the city and the countryside.

(2) Based on the analysis of the basic information of sports population, we used correlational analysis method to analyze correlation of different sports system population and economic factor in a ration. In compare of Pearson correlation coefficient, we chose the most effected ones (Professional sport skill school, Amateur sports school and Sports school) to predict the population by economy.

(3) We use the Logistic Curve method to build the model of prediction of sports system population. Through the analysis of historical data of Professional sport skill school, Amateur sports school and Sports school in 2007-2012, we get the predict formula, and predict the changes in population in 5 years after 2012. In that we concluded, population of Professional sport skill school have increased in 5 years after 2012, but the population of Amateur sports school reduced to a certain extent.

REFERENCES

[1] Chen Po, Qin Zhong-Mei, Yin Ying, Xia Chong-De; Correlation Analysis of Current Situation of Regional Athletics Sports Development and Society Population Structure in China[J], Journal of Beijing Sport University, **30(12)**, 1610-1613 **(2007)**.

[2] Guo Hong; Summary on Chinese Sports Population Research Since 1980s[J], China Sport Science and Technology, **43(3),** 36-40 **(2007)**.

[3] Li Hong, Xue Hai-Hong, Feng Wu-Long; Sociological Analysis of Comparison of Chinese Population with the Sports Population of Chinese[J], Journal of Xi'an Institute of Physical Education, **24(4)**, 25-28 **(2007)**.

[4] Li Lin, Yang Jie, Yang Tian, Xu Lie-Hui; A Research on the Sustainable Development of Evaluation Index System of Regional Sports Industry[J], Journal of Beijing Sport University, **9**, **(2010)**.

[5] Miao Zhi-Wen, Qin Chun-Lin; Sociological Analysis of Contemporary Chinese Sports Population Structures[J], Journal of Physical Education, **13(1)**, 119-121 **(2006)**.

[6] Xiao Huan-Yu, Fang Li; Concept, Classification and Statistical Criteria of Sports Population[J], Sports Science Research, **26(1)**, 7-10 **(2005)**.

[7] Xiao Huan-Yu, Weng Zhi-Qiang, Chen Yu-Zhong; Basic Characteristics of Social and Sports Population Structures of Contemporary China[J], Journal of Shanghai Physical Education Institute, **29(2)**, 10-14 **(2005)**.

[8] Xue Jin-Xia, Wang Jing-Tong; Analysis on Development Level of Competitive Sports of Eastern China in the "Eleventh Five-Year" Period[J], Bulletin of Sport Science & Technology, **19(4),** 57-59 **(2011)**.

[9] Yan De-Yi; Development of Sports for all under Circumstance of Building Well-off Society[J], Journal of Wuhan Institute of Physical Education, **40(1)**, 15-19 **(2006)**.