# Research on the Spatial Distribution Characteristics of Sports Field in China Based on the Data of the 6th Sports Field Survey

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Abstract: Based on the data of the 6th national field survey, this paper takes the number of sports field in 31 provinces, cities and autonomous regions of China as the object, to analyze and discuss the spatial distribution characteristics of sports sites in China by using the method of spatial measurement. The results show that the global Moran' s I value is 0.25559, which indicates that the distribution of sports fields in China has obvious spatial aggregation characteristics.
Key words: sports fields; Spatial dependence; Spatial econometric model

## 1. INTRODUCTION

The introduction of the 2014 document " Opinions of the State Council on Accelerating the Development of Sports Industry and Promoting Sports Consumption" ( State issue [ 2014 ] No. 46 ). It has brought great opportunities to the development of Chinese sports industry and national fitness has become a national strategy. At this time, it is of great practical significance to deeply discuss the current situation of the allocation level of sports resources in China in order to promote the rapid development of China's sports cause. The level of construction of sports fields can not only reflect the level of social and economic development of a country or region, but also reflect the level of civilization and people's livelihood of the country or region. At the same time, the sports field is also an important carrier for the vast number of residents to build up their body and improve their health. As the rapid development of Chinese national economy, the promotion of residents' health awareness and the expansion of their fitness needs, the requirements for the space of sports activities and the setting of stadiums and gymnasiums are also getting higher and higher. With the rapid development of sports cause in China, a series of problems such as the rationalization of the distribution of sports fields and the equalization of urban and rural distribution have become important decisions that the government must face. As an important part of China's sports facilities, a reasonable layout of the sports fields is of great significance to the development of sports cause. Through the research on the distribution of sports fields and facilities in 31 provinces, cities and autonomous regions in China, this study attempts to explore the spatial dynamics of sports field construction and development in various provinces and regions and then provide policy suggestions for reasonable development and utilization of sports fields and facilities.

## 2. REVIEW OF THEORY AND RESEARCH

The distribution of sports fields has always been one of the focuses of research on sports resources at home and abroad. Foreign scholars tend to predict the future development trend of the layout of sports fields by analyzing the layout, evolution process and characteristics of sports fields. Tracy [ 16 ] and others summed up the conclusion that the trend of suburbanization in the field layout has been reversed and returned to the urban central region through analyzing the characteristics of the current sports field layout in the period of American cities and major leagues. He put forward that the main factors affecting the change of field layout are government intervention, city revitalization plan, trend of economic benefits, control of team franchise, demographic factors and so on. Through the research on the field layout, government workers can draw up and adjust the field layout plan based on the conclusions to avoid huge economic losses caused by blind construction of the field. Daade [ 17 ] and others believe that the venue address selection is closely related to the regional space. Therefore, many site selection problems need to be studied from the perspective of geography so as to improve the accuracy of venue construction site selection. Domestic scholars' research on the current situation of the layout of sports fields. The earliest research in China can be traced back to 1981. Yang Yu and Zhang jinnian [ 15 ] visited the four regions of north China, east China, central south and northwest China to investigate the current situation of the layout of sports fields. But unfortunately the research was limited to a general introduction and a single comparison of the current situation of the layout of some urban fields without the further discussion of the characteristics of the layout of sports fields and

the reasons for its formation. So far, our country has conducted a total of six national sports field surveys and accumulated more comprehensive sports field data, which has become an important reference material for scientific researchers to study sports field. Existing literature research shows that: There is a general problem of unreasonable and unbalanced distribution of sports fields. Through the research on the problems existing in our country's community sports facilities, Yin Ling [18] ( 2008 ) pointed out that the shortage of the total amount of sports fields and facilities is the bottleneck restricting the sustainable development of the urban national fitness. The allocation of resources is not balanced, the design is not well targeted, and the function is relatively single. Gao Yali, Yang Tao, Quan Deqing, Cai jun, and Wei juanli [19] conducted an in-depth analysis through statistical analysis of the development and utilization of national sports fields from 2008 to 2009, using research methods such as mathematical statistics and comparative analysis.The summary concludes that there are some problems in the development and utilization of sports fields, such as vague base of the total number, unreasonable regional distribution and structure, etc.

China launched the sixth national sports fields survey in 2014. Judging from the bulletin of the sixth national sports fields survey, there are obvious differences in the distribution of sports fields in China. Therefore, this paper selects the number of sports fields in 31 provinces, cities and autonomous regions of China as the research object, taking full account of geographical dependence, namely spatial autocorrelation, to provide a perspective of spatial econometric research for the study of sports field distribution.

## 3. DATA, SAMPLES AND RESEARCH METHODS

### 3.1 Data and samples

This paper uses the annual data of provinces ( provinces, autonomous regions, and municipalities directly under the central government ), and the samples are taken from the 2013 census data. Main sources of data: ( 1 ) 6th national sports fields census ( 2014 ); ( 2 ) China statistical yearbook ( 2014 ); ( 3 ) China sports statistics yearbook ( 2013 - 2014 ); ( 4 ) provinces ( autonomous regions and municipalities ) statistical yearbook ( 2013 - 2014 ). In addition, due to the availability of data and the relevance of sports fields, Hong Kong, Macao and Taiwan regions have been excluded, resulting in the formation of layout data on the distribution of sports fields in China. Besides, there are many factors that affect the number ( distribution ) of fields, including natural factors and social factors, etc. Referring to other relevant research literature, at the same time, in view of the availability of data, the following variables are selected:

(1) The level of sports fields. This study chooses the number of sports fields to represent the level of sports fields. The data comes from the 6th national sports venues survey, which is conducted in individual units.

(2) Resident population. The resident population selected in this article is taken from the resident population of all provinces and regions in China statistical yearbook in 2013. The unit is $10^4$ people.

(3) Economic level. This study chooses gross domestic product ( GDP ) to measure the level of economic development. In order to eliminate the influencing factors of prices, the GDP of that year is adjusted to the actual GDP based on 2013 according to the GDP index. The data comes from the 2014 China statistical yearbook. The unit is $10^4$ yuan.

(4) Area of sports fields. The area of sports fields studied in this paper is the actual area of the construction of sports fields. The data comes from the 6th national sports venues survey. The unit is $km^2$.

( 5 ) Field type. Sports fields are mainly divided into indoor field and outdoor field. This study chooses the number of outdoor field and indoor sports field to represent the types of field. The data comes from the 6th national sports census, which is conducted in individual units.

( 6 ) Number of urban and rural fields. The number of urban and rural fields reflects the equalization of sports fields in urban and rural areas. Based on the feasibility of the available data, this paper chooses the cumulative number of urban fields and the cumulative number of township cities to represent the number of urban and rural fields. The data comes from the 6th national sports fields survey.

(7) Investment amount. The amount of investment in sports field in this study includes financial allocation, subject matter public welfare funds, self-financing by the unit and other income. The data comes from the 6th national sports field census. The unit is $10^4$ yuan.

(8) Other factors. Based on the results of the 6th national sports field census, this study includes the number of field practitioners and the number of audience seats as other factors affecting the distribution of fields. The units are person and individual respectively.

Because the above index variables have different units and different degrees of variation, therefore, in SPSS23.0 software, all data of dependent variables and independent variables are standardized. The data standardization method used in this study is Z - score standardization method, which standardizes the data based on the mean and standard deviation of the original data. Its formula is equal to:

$$Z = \frac{\text{standard?deviation} - \text{mean}}{\text{standard?deviation}}$$

The standardized data results are shown in table 1

Table 1 Results of standardized data on field distribution indicators of 31 provinces in China

| Provinces | Number of fields | Resident population | Per capita GDP | Number of outdoor fields | Number of indoor fields | Number of urban fields | Number of rural fields | Covered area | Investment amount | Number of field practitioners | Audience seats |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Heilongjiang province | -0.697 | -0.184 | -0.166 | -0.318 | -0.724 | -0.492 | -0.874 | -0.379 | 0.269 | -0.222 | -0.174 |
| Xinjiang autonomous region | -0.740 | -0.752 | -0.335 | -0.487 | -0.740 | -0.798 | -0.472 | -0.554 | -0.660 | -0.726 | -0.682 |
| Shanxi province | 0.306 | -0.258 | -0.336 | -0.400 | 0.427 | -0.396 | 1.401 | -0.339 | -0.335 | 0.283 | -0.106 |
| Ningxia autonomous region | -1.149 | -1.334 | -0.589 | -0.643 | -1.171 | -0.977 | -1.168 | -1.062 | -0.827 | -1.109 | -1.217 |
| Tibet autonomous region | -1.302 | -1.458 | -0.672 | -0.741 | -1.324 | -1.185 | -1.193 | -1.261 | -0.919 | -1.290 | -1.360 |
| Shandong province | 1.350 | 1.949 | 0.471 | -0.065 | 1.542 | 0.912 | 1.763 | 2.381 | 1.995 | 1.133 | 1.729 |
| Henan province | 0.834 | 1.833 | -0.416 | -0.446 | 1.035 | 0.409 | 1.347 | 0.570 | -0.471 | 1.290 | 0.129 |
| Jiangsu province | 1.938 | 1.300 | 0.899 | 3.560 | 1.473 | 2.625 | 0.342 | 2.036 | 1.914 | 1.109 | 1.125 |
| Anhui province | 0.012 | 0.610 | -0.700 | -0.121 | 0.038 | 0.063 | -0.076 | 0.143 | -0.428 | -0.292 | -0.204 |
| Hubei province | 0.742 | 0.527 | -0.439 | 0.332 | 0.773 | 0.797 | 0.475 | 0.261 | -0.444 | 0.205 | 0.275 |
| Zhejiang province Heilongjiang province | 2.013 | 0.418 | 1.100 | 2.937 | 1.685 | 1.601 | 2.229 | 0.401 | 0.364 | 1.227 | 0.775 |
| Jiangxi province | 0.384 | 0.065 | -0.625 | -0.059 | 0.447 | 0.208 | 0.586 | 0.032 | -0.593 | 0.082 | -0.061 |
| Hunan province | 0.134 | 0.527 | -0.558 | -0.087 | 0.170 | 0.167 | 0.048 | 0.221 | -0.292 | -0.018 | 0.323 |
| Yunnan province | 0.192 | 0.125 | -0.826 | -0.391 | 0.297 | -0.304 | 0.972 | -0.107 | -0.564 | -0.327 | 0.181 |
| Guizhou province | -0.574 | -0.304 | -1.025 | -0.661 | -0.516 | -0.685 | -0.256 | -0.769 | 0.819 | -0.368 | -0.690 |
| Fujian province | 0.278 | -0.206 | 0.215 | 0.532 | 0.208 | 0.079 | 0.544 | -0.061 | -0.345 | -0.524 | 0.138 |
| Guangxi autonomous region | 0.598 | 0.136 | -0.683 | -0.466 | 0.771 | 0.227 | 1.075 | -0.150 | -0.071 | 0.483 | 1.691 |
| Guangdong province | 2.621 | 2.279 | 0.837 | 1.303 | 2.703 | 3.135 | 1.152 | 3.279 | 3.603 | 3.802 | 3.242 |
| Hainan province | -1.131 | -1.247 | -0.540 | -0.720 | -1.135 | -0.968 | -1.137 | -0.707 | -0.895 | -0.917 | -1.200 |
| Jilin province | -0.881 | -0.576 | -0.258 | -0.393 | -0.917 | -0.745 | -0.900 | -0.472 | -0.656 | -0.528 | -0.594 |
| Liaoning province | -0.024 | 0.017 | 0.287 | 0.013 | -0.030 | 0.210 | -0.407 | 0.352 | 0.622 | -0.077 | 0.746 |
| Tianjin | -1.019 | -1.038 | 1.264 | -0.507 | -1.051 | -0.833 | -1.088 | -0.681 | -0.600 | -1.015 | -1.053 |
| Qinghai province | -1.249 | -1.361 | -0.581 | -0.733 | -1.265 | -1.096 | -1.210 | -1.154 | -0.817 | -1.215 | -1.288 |
| Gansu province | -0.627 | -0.637 | -0.821 | -0.643 | -0.579 | -0.767 | -0.246 | -0.730 | -0.821 | -0.674 | -0.816 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Shaanxi province | -0.353 | -0.209 | -0.578 | -0.532 | -0.292 | -0.376 | -0.231 | -0.482 | 0.072 | -0.104 | -0.207 |
| Inner Mongolia autonomous region | -0.764 | -0.667 | 0.354 | 0.005 | -0.866 | -0.464 | -1.084 | -0.455 | -0.267 | -0.799 | 0.006 |
| Chongqing | -0.338 | -0.496 | -0.492 | -0.501 | -0.281 | -0.151 | -0.569 | -0.477 | 1.091 | -0.372 | 0.317 |
| Hebei province | 0.335 | 1.081 | -0.100 | -0.302 | 0.441 | 0.013 | 0.793 | 0.856 | -0.479 | 0.470 | -0.265 |
| Shanghai | -0.397 | -0.697 | 3.281 | 1.174 | -0.688 | 0.118 | -1.162 | -0.457 | 0.172 | -0.082 | -0.833 |
| Beijing | -0.911 | -0.806 | 2.691 | -0.218 | -0.987 | -0.676 | -1.089 | -0.324 | -0.252 | 0.001 | -0.450 |
| Sichuan province | 1.361 | -0.661 | -0.422 | 0.559 | 0.348 | 0.436 | 0.088 | -0.185 | 0.574 | 0.524 | 0.524 |

### 3.2 Spatial autocorrelation test method

Sptial Autocorrelation refers to the potential interdependency between observed data of some variables in the same distribution area. The first law of geography points out: Everything is related to other things, but what is near is more relevant than what is far away. The closer the spatial locations are, the more convergent the attributes are and the more similar the spatial phenomena are. This correlation is called Spatial Dependency.[1] In this study, the prediction of the distribution of the number of sports fields will be affected by spatial dependence. They are not independent of each other but related to each other. Therefore, the global spatial correlation statistic Moran' s I is introduced. The key to distinguish spatial autocorrelation statistics from traditional geographic statistics is to introduce a spatial weight matrix. The calculation formula of Moran' s I is :

$$I = \frac{\sum_i^n \sum_{j \neq i}^n W_{ij}(X_i - \overline{X})(X_j - \overline{X})}{S^2 \sum_i^n \sum_{j \neq i}^n W_{ij}}$$

Among them, n is the number of sample regions, $S^2 = \frac{1}{n}\sum_{i=j}^{n}\left(X_i - \overline{X}\right)^2$, $X_i$ is the attribute value of the i region, $\overline{X}$ is the average value of all attribute values, and $W_{ij}$ is the spatial weight matrix. The value of global Moran' s I is between - 1 and 1, and greater than 0 is a positive correlation, and the closer it is to 1, the stronger the positive correlation is, that is, there is a strong similarity between adjacent spatial units; less than 0 is a negative correlation, and the closer to - 1, the stronger the negative correlation, that is, there is a strong difference between adjacent spatial units; close to 0 or equal to 0 indicates that adjacent spatial units are irrelevant.

## 4. ANALYSIS ON SPATIAL AUTOCORRELATION OF THE DISTRIBUTION OF SPORTS FIELDS IN CHINA

The spatial autocorrelation analysis of the distribution of sports fields is to investigate whether the distribution of fields is spatially clustered or contiguous. This investigation is based on the premise of spatial econometric modeling. If there is significant spatial autocorrelation in the test, then the next step will be analyzed by means of metrological method. What needs to be clarified is that this article uses the accumulated number of fields in various regions to characterize the distribution of sports fields. The spatial autocorrelation test method usually uses the global Moran' s I test, which finds that the global Moran' s I is 0.25559. The Z statistical test quantity is 2.3399, larger than 5 % of the statistical value of significance level is 1.96 , the probability of no autocorrelation is 0, which indicates that the distribution of sports fields in China has significant spatial autocorrelation and spatial dependency.That is, the distribution of sports fields in China is not random, but has certain spatial laws, mainly showing spatial clustering and heterogeneity. The uneven distribution of sports fields shows that it is feasible to use spatial econometric analysis method to analyze the distribution law and characteristics of sports fields in China.

Based on the analysis of the data from the 6th national sports venues survey, the number of sports fields in all provinces, cities and autonomous regions in China is classified into four categories to produce a four-partite map ( figure 1 ). It can be clearly seen that regions of the same level show spatial clusters, which shows that the number of results in China's sports fields is not completely random, but there is spatial clustering between similar values. Positive spatial correlation indicates that adjacent regions also have similar spatial connection structures.

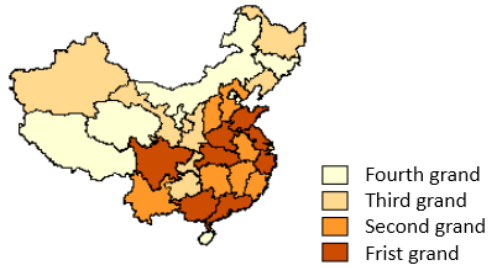


Figure 1 Four-partite map of the quantitative distribution of sports fields in China

Through Moran scatter diagram and Lisa diagram, the paper further analyzes the regional aggregation of sports fields distribution in China. From figure 2 and figure 3, it can be seen that the regions with high proportion of sports fields in China are mainly concentrated in east China, south China and Sichuan. The low proportion of sports is mainly concentrated in north China and southwest China, and the concentration in some areas has passed the significance test, which shows that there is obvious concentration phenomenon in the distribution of sports fields in China. Therefore, it is necessary to consider the spatial measurement model estimation of spatial dependence when using sports data to study the distribution of sports fields in China.

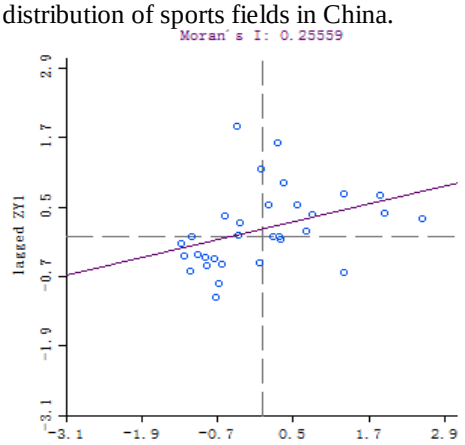


Figure 2 Scatter diagram of quantitative distribution of sports fields in China

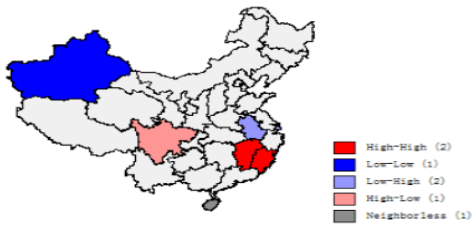


Figure 3 LISA aggregation diagram of the distribution of sports fields in China

## 5. CONCLUSIONS AND SUGGESTIONS

After the empirical analysis of the distribution characteristics of sports fields in China, the conclusions of this paper are as follows: The distribution of sports fields in various regions of China is obviously dependent on space, and when studying the distribution of sports fields in China, the space effect should be considered.

Based on the above research, it is suggested that: The development and use of sports field resources should take into consideration the specific geographical features, as well as the policies and development plans for the development of sports fields in neighboring regions. Taking into account the connotative development path of utilization of field resources and the rational development of new sports field resources. And to formulate the resources and protection policies of sports field resources from the perspective of the regional layout and allocation of sports field resources .

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