

2014

# BioTechnology

*An Indian Journal*

FULL PAPER

BTAIJ, 10(10), 2014 [4716-4725]

## Research of the sustainable development of public participation in physical exercise basing on the AHP method

Cuilan Li, Xianhe Zhou, Huijun Song\*

Institute of Physical Education, Jilin Normal University, Siping 136000, Jilin, (CHINA)

### ABSTRACT

The physical exercise is a large activity, participating in physical exercise has become the inevitable choice of the national fitness at present, and it is also an indispensable part of public life. This paper analyzes the basic situation of public participation in physical exercise at present. We find that the enthusiasm of the public participation in physical exercise is very high at present and most people attach great importance to physical exercise, through the research of public participation in physical exercise time, the age structure of the participators and their cultural level. By using analytic hierarchy process, we can establish the class hierarchy of public participation in physical exercise condition and analyze the influential degree on the public physical training of the four factors of their per capita income, the public's awareness of physical exercise, the government's construction for the sports facilities and as well as the personal time. By comparing the weight size, we finally draw the conclusion: the majority of the public is very positive to participate in physical exercise, only a small number of people are not very positive to participate in physical exercise. It also shows that as the national fitness program developed, there has been more and more people participating in physical exercise, the status of physical exercise in public life has further improved as well, China's sports undertakings has developed to some certain extent.

### KEYWORDS

Physical exercise and analytic hierarchy process; Class structure; Sustainable development; National fitness.



## INTRODUCTION

As the extensive development of national fitness, the public participation in physical exercise has become a trend. Public participation in physical exercise can not only fundamentally improve the physical quality of the masses' physical and mental health, at the same time, but also is a kind of promotion for the development of undertakings of physical culture and sports, so the study of the public physical exercise never end.

In the study of the elderly physical exercise made by Li Liang, he took the dangerous of physical exercise as the main cognitive perspective, through consulting a large number of literature, and field visits, he put forward that the physical exercise has an important influence on the elderly health, but at the time the exercise has certain risks, these require that the government must take full consideration of risk problems in constructing exercise facilities as appropriate; Xia Xiangwei's research of physical exercise and health also consult a large number of literature, and through the quantitative analysis of the correlation between physical exercise and physical fitness size, he put forward that physical exercise has important influence to the improvement of quality of the body; in the study of physical exercise made by Wang Xue, she visited the local communities investigate, after combining with literature, she found that there is inevitable connection between physical exercise and the old people subjective well-being, so promoting physical exercise in the coming year of expansion is the best choice for the elderly happiness index; In the study of urban adults' physical exercise capacity evaluation made by Li Wenhui, she got the conclusion through the establishment of adult physical exercise ability evaluation framework, analyzing all the factors that affect adults' exercise, and comparing the influence degree of various factors on the research object, then testing the evaluation model; Wang Lina studied the effects of physical training on college students' physical quality, combining with the conclusion of predecessors and survey data, then she put forward that there is a certain degree of influence between the physical training on college students' and their self describing, and on the basis of the analysis of the influence factors, she described the relationship between college students' body and the influence, thus she concluded that in order to speed up the college students' all-round development we should actively carry out the college students' physical exercise.

In this paper, we concluded that the public participate in physical exercise has almost become a trend; most of the young and middle-aged people, including students, working class have already joined in the ranks of physical exercise by comparing the time for the masses to participate in the exercise, the age distribution of the participators and their cultural level. Secondly, we use the analytic hierarchy process to further the quantitative analysis, through the analysis of the influential degree of physical exercise per capita income, the public's awareness of physical exercise and the government's construction of sports facilities as well as the personal time, we can find that the public's awareness of physical exercise is becoming more and more enthusiasm at the present stage, physical exercise has become a project for young and old, by comparing the size of the relative weight, also we can see the development of Chinese sports undertakings has further improve, which makes the Chinese sports has a obvious improvement in the position of world sport.

## ESTABLISHMENT OF THE MODEL

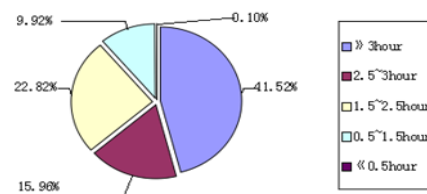
Most sports not only act as the role of sports events, but also is an entertainment projects combining ornamental, entertaining, and exercise as a whole. Such as badminton, soccer, basketball, volleyball, aerobics, lala gym, they are all the best choice of the public physical exercise. However, their choices of the way and time to take exercises are not the same when the public carry on the exercise, which mainly includes the exercising with colleagues, friends, family, and personal exercise, or attend training classes and club, etc.

In order to get a comprehensive analysis of China's public participation in physical exercise, we get TABLE 1 survey data through the China statistical yearbook, State Physical Cultural Administration, Internet survey, as is shown in TABLE 1.

**TABLE 1 : Time of public participation in physical exercise**

projects	» 3 hours	2.5~3 hours	1.5~2.5 hours	0.5~1.5 hours	« 0.5 hours
badminton	42.6%	23.70%	15.4%	10.2%	8.10%
soccer	43.7%	5.8%	25.6%	11.6%	13.3%
basketball	39.7%	18.6%	20.5%	13.5%	7.8%
aerobics	41.3%	19.2%	26.9%	7.5%	5.1%
lala gym	40.3%	12.5%	25.7%	6.8%	14.7%
mean value	41.52%	15.96%	22.82%	9.92%	0.10%

TABLE 1 mainly research on the badminton, football, basketball, gymnastics, la-la gym, these five projects are more close to the public life of sports, we deal with the above statistics and get the further analysis then we can calculate the average percentage, and draw a pie of Figure 1 as follows:



**Figure 1 : Public participation in physical exercise time**

By analyzing the above Figure 1 we can see: we can see most Chinese people participate in physical exercise in 3 hours, accounting for 41.52% of the total, the next is 1.5 ~ 2.5 hours, occupied 22.82%, in addition 2.5 ~ 3 hours occupied 15.96%. 0.5 ~ 1.5 hours occupied 9.92%. therefore, we can see the physical exercise in public life of china develop well, most people hope to participate in physical exercise together with friends and family, and they prefer to participate in a long time even more than three hours, all these helps to promote the development of China's sports undertakings to a certain extent.

### The characteristics of people involved in sports

At present, the exercise has been widely spread in China, and loved by the masses. Participators of physical exercise are growing fast. Study the population of physical exercise, including the of participators' degree and their age characteristics, which has very important significance to carry out physical training, make analysis of the development of present stage of physical exercise, finding out the existing problems and expand the influence of physical exercise in China.

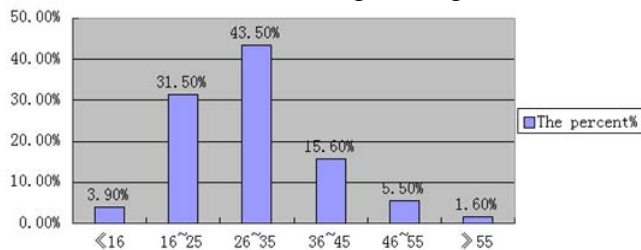
Physical exercise is a large crowd class project; it is suitable for people of all ages, from young to old. In the study of the age features of the population in physical exercise help us in view of the age distribution, and set up suitable facilities for different groups of physical exercise, which provides service to the masses. Now through the China statistical yearbook, state general administration of sports, and the Internet survey, we can obtain the survey data in the following TABLE 2.

**TABLE 2 : The age structure characteristics of participators in physical exercise**

age	« 16	16~25	26~35	36~45	46~55	» 55
-----	------	-------	-------	-------	-------	------

proportion %	3.9%	31.5%	43.5%	15.6%	5.5%	1.6%
--------------	------	-------	-------	-------	------	------

Analyze the statistics of TABLE 2 and draw Figure 2, get the conclusion:



**Figure 2 : Participate in physical exercise population age distribution**

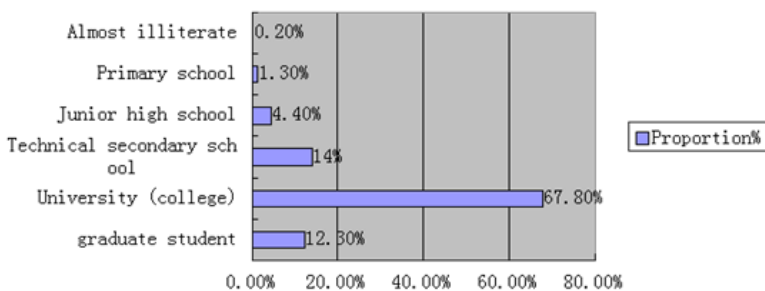
From the above Figure 2 we can see that the age of Chinese participators is concentrated on 26 to 35 years old, there are also more people at 16 to 25 ages, accounted for 31.5%, and the people under the age of 16, or over 55 years old are less. The reason why this happen is that, on the one hand, considering the old people and the children’s physical quality, some physical exercise is not suitable for them to attend; on the other hand, the age16 ~ 35 years old group mainly consist of adolescents and adults, comparing their physical quality, and physical exercise consciousness with the elderly and children’s, they are higher. In the future, we should build more facilities for the elderly and children in order to promote the physical exercise influence in the masses, thus strive to make the whole people to participate in the exercise.

In the context of the national fitness project, social people from all walks of life have been involved in the physical exercise; there are intimate relationships between the participators and their sports consciousness to some extent, while education is one of the a good instructions to show the sports consciousness. Therefore, studying the characteristic of population that taking part in physical exercise helps to promote a key step for the sustainable development of physical exercise among the masses. The following TABLE 3 is the statistic of China statistical yearbook, the state general administration of sports, and the Internet survey of research data.

**TABLE 3 : The culture level of the population that participate in physical exercise**

	Postgraduate	University and college	Secondary	Junior high school	Primary school	Almost illiterate
percentage %	12.3%	67.8%	14%	4.4%	1.3%	0.2%

Analyze the statistics of TABLE 3and draw Figure 3, get the conclusion:



**Figure 3 : Participate in physical exercise population culture level**

By analyzing the statistical Figure 3, we can see that most of the population of Chinese participators in sports is in university and college degree, accounting for 67.8%, and then followed by technical secondary school degree, high degree is relatively small. This also explains that less high school and junior high school students take part in physical exercise because they are under the influence of learning burden, the population of college students participates more; in the crowd, most of the participators in physical exercise are also of much higher levels of knowledge.

### Public participation in physical activity research based on analytic hierarchy process

Public participation in physical exercise are influenced by multiple factors, such as citizens' per capita income, the public's awareness of physical exercise, personal rest time, and sports facilities construction situation and so on. This paper established the hierarchical analysis model, and give a quantitative situation of public participation in physical exercise through the establishment of the target layer, criterion layer and the relations between layers, finally it is concluded that the current Chinese public participation in physical exercise.

Analytic hierarchy process (AHP) is based on the requirements and properties of the problems, the factors which may affect the development of problem can be divided into the target layer, criterion layer and scheme layer, and form a hierarchical level of the structure, and through comparing the various factors within the same level in pairs, we can determine the next layer relative to the weight of a target layer. Through the analysis of each layer, we find the order of target layer, criterion layer and layer scheme by various factors, which is the degree of the importance of the factors relative to the overall goal.

**Target layer** : the condition of public participation in physical exercise

**Criterion layer** : The influence factors of scheme.  $C_1$  Citizens' per capita income,  $C_2$  the public's awareness of physical exercise,  $C_3$  Construction of exercise facilities,  $C_4$  Personal rest time.

**Scheme layer** :  $A_1$  represents very positive,  $A_2$  represents positive,  $A_3$  represents general,  $A_4$  represents not too positive

Thus we can get Figure 4:

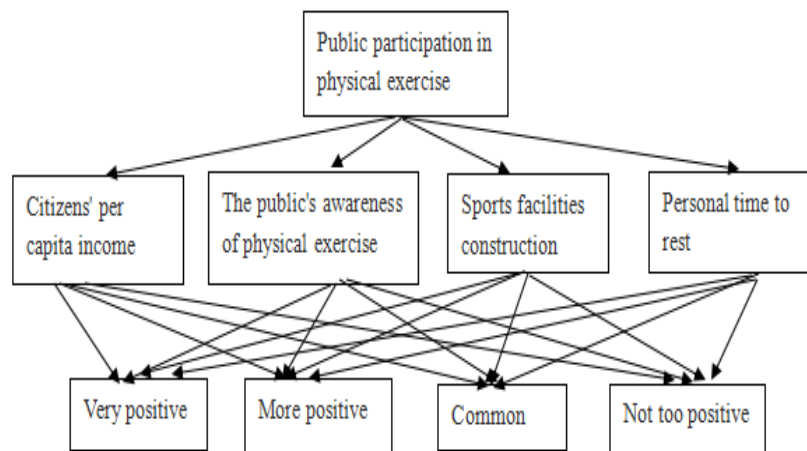


Figure 4: Hierarchical structural model

### Factor analysis

**Citizens' per capita income**

Citizens' per capita income determines the level of their life. People will enjoy the material life and begin to pursue the spiritual life, only when the living standards are improved, high quality life is the guarantee of the high spiritual life. Thus, the per capita consumption is the basis of the physical exercise, and is also one of the key factors that influencing the public participation in physical exercise.

**The public's awareness of physical exercise**

From the perspective of philosophy, there are inalienable relations between consciousness and matter. On the basis of meeting the material life, the public sports consciousness is one of the important factors that affect the exercise. Higher sports consciousness, at the same time, the results of the public during exercise is not the same.

**Construction of sports facilities**

The condition of sports facilities construction is the basis of the satisfactions of the undertakings of physical culture and it has decided the public choices. Whether the undertakings of physical culture develop good or not, one of its main performances is the sports facilities construction. At present, in China there have been public physical exercise equipment building in the large communities.

**Personal rest time**

Whether the public can actively take exercise, and have time to take exercise, to a certain extent, are also affected by individual schedules. If they work long hours, and have to do the overtime work in normal after work, it is hard for them to spend time on exercise. In general, most of the participators in exercise are old people, children, and some working-class, especially the young people had little time to exercise. Thus, in a sense, the personal time has influenced the physical exercise of public life.

**The construction of comparison matrices in pairs**

The construction of comparison matrices in pairs means that we compare the factors in pairs, and express the important degree of each layer corresponding to each of these elements in a layer of various elements through matrix. Here we refer to the operational research, using 1 ~ 9 scale rate to represent.

**TABLE 4 : the meaning of 1~9 scale**

scale $a_{ij}$	definition
1	Factor i and factor j are of same importance
3	Factor i is of a bit importance than factor j
5	Factor i of importance than factor j
7	Factor i of great importance than factor j
9	Comparing with factor j, factor i is absolutely important
2, 4, 6, 8	The corresponding scale values in the middle state
The reciprocal of the above number.	If we comparing factor i with factor j, factor i, the value is: $a_{ji} = 1/ a_{ij}, a_{ij} = 1$

According to the above TABLE 4, we set the judgment matrix A is:

$$A = \begin{pmatrix} 1 & 3 & 3 & 3 \\ \frac{1}{3} & 1 & 5 & 5 \\ \frac{1}{3} & \frac{1}{5} & 1 & 1 \\ \frac{1}{3} & \frac{1}{5} & 1 & 1 \end{pmatrix}$$

Clearly, A is the reciprocal matrix.

And the judgment matrix of the constructed scheme layer that relative to the criterion layer. As is shown in the TABLE 5-8:

**TABLE 5 : Judgment matrix of the criterion layer**

	$C_1$	$A_1$	$A_2$	$A_3$	$A_4$
$A_1$		1	2	3	5
$A_2$		1/2	1	1/3	3
$A_3$		1/3	3	1	2
$A_4$		1/5	1/3	1/2	1

**TABLE 6 : Judgment matrix of the criterion layer**

	$C_2$	$A_1$	$A_2$	$A_3$	$A_4$
$A_1$		1	2	3	3
$A_2$		1/2	1	1/3	3
$A_3$		1/3	3	1	2
$A_4$		1/3	1/3	1/2	1

**TABLE 7 : Judgment matrix of the criterion layer**

	$C_1$	$A_1$	$A_2$	$A_3$	$A_4$
$A_1$		1	3	3	5
$A_2$		1/3	1	2	3
$A_3$		1/3	1/2	1	2
$A_4$		1/5	1/3	1/2	1

**TABLE 8 : Judgment matrix of the criterion layer**

	$C_1$	$A_1$	$A_2$	$A_3$	$A_4$
$A_1$		1	2	3	2
$A_2$		1/2	1	1/3	4
$A_3$		1/3	3	1	2
$A_4$		1/2	1/4	1/2	1

**The calculation of the relative weights of the comparing element of the criterion layer**

**The consistency check**

Consistency index:  $CI = \frac{\lambda_{\max} - n}{n - 1}$

Random consistency index: There will be multiple matrixes randomly, we add all the consistency indexes of each matrix and take the average of them and get  $RI$  .

**TABLE 9 : Random consistency index**

$n$	1	2	3	4	5	6	7	8	9	10	11
$RI$	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

The ratio of consistency index: if  $CR = \frac{CI}{RI} < 0.1$ , The construction of comparison matrices  $A$  pass the consistency check.

**Calculation of weight**

As for  $A$  , we get the following process:

$$\begin{array}{l}
 \xrightarrow{\text{Column vector normalization}} \begin{pmatrix} 0.866 & 0.945 & 0.5 & 0.5 \\ 0.288 & 0.315 & 0.83 & 0.83 \\ 0.288 & 0.063 & 0.167 & 0.167 \\ 0.288 & 0.063 & 0.167 & 0.167 \end{pmatrix} \\
 \xrightarrow{\text{According to the row sum}} \begin{pmatrix} 2.811 \\ 2.263 \\ 0.685 \\ 0.685 \end{pmatrix} \xrightarrow{\text{The normalized}} \begin{pmatrix} 0.703 \\ 0.566 \\ 0.171 \\ 0.171 \end{pmatrix} = W^0
 \end{array}$$

Then, through the formula  $A \times W^0$ , we can get  $\lambda^0_{\max} = 4.246$

In the same way, the order of the corresponding largest eigenvalue and feature vectors of the judgment matrix of the rule layer:

$$\lambda^1_{\max} = 3.64, W_1 = \begin{pmatrix} 0.244 \\ 0.244 \\ 0.512 \\ 0.487 \end{pmatrix}; \lambda^2_{\max} = 3.29, W_2 = \begin{pmatrix} 0.657 \\ 0.251 \\ 0.092 \\ 0.068 \end{pmatrix};$$

$$\lambda^3_{\max} = 3.31, W_3 = \begin{pmatrix} 0.648 \\ 0.204 \\ 0.148 \\ 0.136 \end{pmatrix}; \lambda^4_{\max} = 3.31, W_4 = \begin{pmatrix} 0.648 \\ 0.204 \\ 0.148 \\ 0.125 \end{pmatrix}$$

Through calculation, maximum eigenvalue of the comparison matrices  $A$  is  $\lambda_{\max} = 4.246$ ,  $RI = 0.90$  According to the consistency index  $CI = \frac{\lambda_{\max} - n}{n - 1}$ , we can get that  $CI = \frac{4.242 - 4}{4 - 1} = 0.081$  Because  $CR = \frac{CI}{RI} = \frac{0.081}{0.90} = 0.089 < 0.1$ , so The construction of comparison matrices  $A$  pass the consistency check. In the same way, we can know that the judgment matrix of the criterion layer pass the consistency check too.



### The calculation of the combination of weight vector

Because,  $W^1 = (w_1, w_2, w_3, w_4)$ , and  $W = W^1 \times W^0$ , we can get:

$$W = \begin{pmatrix} 0.553 \\ 0.308 \\ 0.104 \\ 0.035 \end{pmatrix}$$

### CONCLUSIONS

We can analyze the result calculated by the above combination weighting: in the study of public participation in physical exercise situation, there are 55.3% of the public are very actively involved in the physical exercise, there are 30.8% of the public have positive attitude of participating in physical exercise, the average is 10.4%, only 3.5% of the public are not very positive to participate in physical exercise. This also proves that as the development of the national fitness program, the enthusiasm of the public participation in physical exercise is higher and higher, the status of physical exercise in public life has been further improved, which helps to develop the undertakings of physical culture and sports.

(1) In this paper, we first analyzed the time of public participation in physical exercise and the quality of the crowd itself, through the comparison of the masses' participating time, and make analysis of the age distribution and cultural level of the masses that taking part in physical exercise, we concluded that the public participate in physical exercise has almost become a trend, most of the young and middle-aged people, including students, working class have already joined in the ranks of physical exercise.

(2) Basing on the public participation in physical exercise, we use the analytic hierarchy process to get an further analysis of the situation, by comparing the average per capita income, the public's awareness of physical exercise and the government's construction of the sports facilities as well as the personal time of the public physical training, we can get conclusions: there has been more and more people participating in physical exercise, the public awareness of physical exercise is becoming more and more enthusiasm, exercise has become a project for young and old, which to a certain extent, also played a important role in promoting sports undertakings on a sustainable development.

### REFERENCES

- [1] 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).
- [2] Xiao Huan-Yu, Fang Li; Concept, Classification and Statistical Criteria of Sports Population[J], Sports Science Research, **26(1)**, 7-10 (2005).
- [3] Miao Zhi-Wen, Qin Chun-Lin; Sociological Analysis of Contemporary Chinese Sports Population Structures[J], Journal of Physical Education, **13(1)** 119-121 (2006).
- [4] 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).
- [5] Guo Hong; Summary on Chinese Sports Population Research Since 1980s[J], China Sport Science and Technology, **43(3)**, 36-40 (2007).
- [6] 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).
- [7] 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).
- [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] 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).