# COUPLED SYNERGISTIC DEVELOPMENT OF THE SPORTS INDUSTRY AND URBAN PARK ECOLOGICAL ENVIRONMENT

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## ABSTRACT

*The quality of sports and leisure has received the attention of local sports departments. The construction of sports parks has become a new hot spot to enhance the image of the city and develop sports. Therefore, this paper studies the coupled and synergistic development of the sports industry and urban park ecology. First, the current situation of urban sports parks in China is analyzed. Then the affiliation numerical method was introduced into the evaluation of park ecology. Finally, we calculate the acquisition index and evaluation and use it to analyze the ecological and environmental effects of plant communities. The results showed that in Manduhai Park, Hohhot, the temperature change of plant communities first rose and then slowly decreased, with the highest temperature at 4 pm and the lowest at 8 pm, and the cooling rate was 3.34%~5.05%. The relative humidity was highest at 8:00 a.m. and lowest at 4:00 p.m., with a humidification rate of 1.82% to 12.18%. Wind speed is the highest at 12:00 noon and the lowest in the morning and evening; the human body feels the best comfort in the morning at 8:00, and feels uncomfortable around 12:00 and 16:00, with a variation range of 71.77±2.73 to 73.19±2.54; the research found that 42% of the visitors chose leisure and sports activities; followed by 39% for entertainment and games, and 12% for cultural activities again. Thirty-one percent of the visitors were satisfied with the leisure and sports facilities, 31% thought they were average, 28% reached only basic satisfaction, and 10% were not satisfied with the leisure and sports facilities.*



## KEYWORDS

*Sports industry; Urban Park; Ecological environment; Coupled synergistic development; Satisfaction*



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# INDEX




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# 1. INTRODUCTION

Currently, China is facing a period of change in the transformation of its economic system and social structure [1]. In this process, the Chinese "progressive" reform, which starts from shallow to deep, from easy to difficult, and "crossing the river by feeling the stones", has now entered a critical stage [2-3]. However, although China's economy has achieved world-renowned success, the ecological and environmental problems faced by the country have become extremely serious. This, coupled with the comparative advantage of resource endowments between regions and the unevenness of economic development, has led to the blind pursuit of economic aggregates among localities at the expense of the ecological environment [4-5]. The green space of the city residents is squeezed by the profit space of the businessmen. If the government plays a market role in providing ecologically beautiful recreation areas, it will allow people to enjoy the tranquility brought by nature, which is bound to have a significant improvement in the psychological condition and quality of life of the nation [6].

Therefore, the emergence of urban sports parks caters to the needs of modern cities and urban residents. It not only has the functions of a general park, but also can combine green space and sports organically, providing more fun-filled sports activities, and good opportunities for urban residents to exercise [7-10]. Of course, with the development of sports, green and ecological development is the general trend. Modern people go to the gym to exercise, go to the gymnasium to play ball, just to "spend money to buy health", but it shows that people pay more and more attention to their physical and mental health [11]. With the progress of the times, people further pursue personalized leisure and recreation, and sports and fitness environments, and want to pursue the highest level of harmony between humans and nature. However, at present, the ecological environment of Chinese urban sports parks is a prominent problem, resulting in the phenomenon of "cold doors" in Chinese sports parks [12-13].

To change this dilemma, the ecological value of urban sports parks should be reconceptualized and affirmed, and the theme of "sports" should be strengthened. The future development of urban sports parks should be examined from a "human-centered" ecological perspective [14-15].

There are more studies related to recreational sports parks at home and abroad. For example, literature [16] verified the feasibility of transforming parks into sports parks by combining the actual situation of parks around the world and elaborating the design scheme of sports parks by combining specific parks from the perspective of landscape design. The literature [17] takes the perspective of benign industrial development to build sports parks based on leisure tourist attractions to promote the benign interaction between tourism and sports industries, as well as the development of both. The literature [18] proposed the basic requirements and design principles for healthy exercise spaces, argued that healthy exercise spaces should not be too large, and developed the minimum land area required for exercise areas. The literature [19] argued that there are fewer research results about exercise places and environments


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for community residents. And in community sports practice, the top three places for the distribution of physical activity sites are parks, community venues and street corners. In the literature [20], through ecological principles, the construction of the Nanhai National Fitness Sports Park was carried out with sports facilities as the core content, creating a theme park where green space and sports places are integrated, with a perfect overall functional system, integrating sports, fitness and leisure. Researchers believe that expanding green fitness and leisure activity space in the process of urbanization is an important task for sustainable urban development. The literature [21] addresses the current problem of the single function of community parks, repositioning their functions and reconfiguring their resources to strengthen the function of community parks for physical exercise, and making some suggestions on the setting of programs, the cost of operation, and the opening hours. The literature [22] analyzed the evolution of the system, mainly from the perspective of historical evolution. It also proposed the concept of a community park leisure ecosystem and confirmed the existence of a community park leisure ecosystem dominated by leisure activities in community parks through case studies. The literature [23] found that moderate recreational sports can reduce symptoms of depression and anxiety, improve self-image, social skills, and have a beneficial effect on both mental health and cognitive function. The literature [24] studied the relationship between park recreational sports and the physiological and psychological health of older adults. The study found a direct relationship between park recreational exercise and lower systolic blood pressure. The literature [25] states that although there is a long-term relationship between recreational sports and health, the mechanism of the effect of leisure on health remains unclear and more empirical results are needed to prove that the type of leisure has a significant positive correlation with health. A comparison between the two parks in Nijmegen and Amsterdam in the literature [26] concluded that the main forms of sports and classes of people active in different parks are different, but people expect to resolve these conflicts through cultural integration and use this public space equally. Based on the aforementioned national and international literature, it can be seen that the fastest-growing research related to the field of leisure is currently: tourism, sports and health. In addition to continuing to expand and deepen the research areas of parks, recreation, and tourism, more attention is also being paid to the relationship between leisure and health and the impact of leisure culture [27-28]. The study of leisure sports and sports parks in China has stepped into a multidisciplinary and multi-faceted research level, including the attention of researchers from various disciplines such as kinesiology, landscape architecture, and economics, and it can be said that sports and leisure research, has gradually become a very popular research topic [29-30].

This paper addresses the coupled synergistic relationship that currently exists between urban sports and park ecology. The numerical method of affiliation is substituted in the research process, and finally, the index and evaluation are obtained by calculation, and the ecological and environmental effects of plant communities are analyzed in this way. Meanwhile, this paper takes Manduhai Park in Hohhot as the research object, and analyzes the characteristics of daily changes in meteorological


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factors of its park's plant community, the characteristics of changes in human comfort, and the satisfaction of the park's leisure and sports facilities, to realize the research on the coupling and synergistic development of urban sports and park ecology.

## 2. ANALYSIS OF THE CURRENT SITUATION OF URBAN SPORTS PARKS IN CHINA

A total of 39 urban sports parks are investigated in this paper, among which 19 are directly named as sports parks, while others are equipped with sports facilities in certain areas. These 39 urban sports parks basically represent the construction and development of urban sports parks in China as shown in Table 1.

**Table 1 (part I).** Construction and development of urban sports parks in China

| Park name | Jiande City Gantan Sports and Fitness Plaza | Quzhou Citizen Fitness Park | Ledu County Sports Park | Guiyang Baiyun Park | Wenfeng Garden, Duyun City | Korla Riverside Sports Park | Urumqi Sports Park | Manduhai Park, Hohhot | Hengyang West Lake Park | Pingluo County Sports Park |
|---|---|---|---|---|---|---|---|---|---|---|
| Park area /m² | 133333 | 840000 | 500000 | 430000 | 176267 | 3000 | 55300 | 180000 | 190000 | 100000 |
| The area of sports facilities / m² | 22667 | 9980 | 200000 | 400000 | 10000 | 1500 | 18400 | 1126 | 30932 | 60000 |
| Number of sports that can be carried out | 16 | 12 | 7 | 10 | 28 | 20 | 7 | 20 | 20 | 12 |
| Number of social sports instructors | 37 | 15 | 5 | 8 | 12 | 20 | 25 | 8 | 50 | 8 |
| Annual number of people participating in physical fitness / million | 36 | 12 | 712 | 29 | 100 | 14 | 25 | 65 | 100 | 10 |
| Park fees | Free | Free | Free | Free | Free | Free | Free | Free | 30Yuan | Free |
| Number of activities per year | 25 | 50 | 10 | 30 | 10 | 10 | 20 | 25 | 50 | 10 |
| Site facility maintenance system | Exist | Exist | Exist | Exist | Exist | Exist | Exist | Exist | Exist | Exist |
| Major fitness injury | No | No | No | No | No | No | No | No | No | No |


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**Table 1 (part II).** Construction and development of urban sports parks in China

| Park name | Dongguan Sports Park | Tianjin Wangchuanchang Sports Park | Qinhuangdao Forest Sports Park | Yantai Sports Park | Lanzhou Sports Park | Yichang Binjiang Park | Beach Fitness Scenic Spots on Both Sides of the Yangtze River | Chengdu Repulse Bay Swimming Pool | Beidaihe Olympic Avenue Park | Happy Mountain Forest Park |
|---|---|---|---|---|---|---|---|---|---|---|
| Park area /$m^2$ | 189600 | 60000 | 306667 | 1328000 | 60000 | 170000 | 1000000 | 72000 | 155600 | 13333333 |
| The area of sports facilities / $m^2$ | 60000 | 30000 | 41898 | 300000 | 35164 | 2000 | 120000 | 15000 | 38000 | 33333 |
| Number of sports that can be carried out | 12 | 12 | 8 | 12 | 13 | 15 | 12 | 8 | 18 | 20 |
| Number of social sports instructors | 5 | 30 | 10 | 32 | 31 | 40 | 43 | 200 | 36 | 5 |
| Annual number of people participating in physical fitness / million | 30 | 90 | 1 | 150 | 30 | 45 | 157 | 200 | 2 | 35 |
| Park fees | 1Yuan | 0.3Yuan | Free | Free | 5 Yuan | Free | Free | 20 Yuan | Free | 10 Yuan |
| Number of activities per year | 30 | 10 | 10 | 20 | 126 | 6 | 10 | 20 | 24 | 30 |
| Site facility maintenance system | Exist | Exist | Exist | Exist | Exist | Exist | Exist | Exist | Exist | Exist |
| Major fitness injury | No | No | No | No | No | No | No | No | No | No |


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**Table 1 (part III).** Construction and development of urban sports parks in China

| Park name | Sun Yat-sen Mausoleum White Horse Stone Carving Garden | Wanlv Garden | Wenchang Park | Dunhua Beishan Forest Sports Park | Jilin City Paotaishan Sports Park | Stalin Park, Daoli DistrictHarbin | Nantong Sports Park | Galaxy Sports Park | Xiushan History and Culture Park | Mawu Road Park, Jianshan District |
|---|---|---|---|---|---|---|---|---|---|---|
| Park area /$m^2$ | 350000 | 724880 | 20533 | 300000 | 105000 | 65000 | 8000 | 7600 | 7600 | 90000 |
| The area of sports facilities / $m^2$ | 15000 | 20300 | 3000 | 56000 | 3000 | 20000 | 60000 | 4000 | 18000 | 4000 |
| Number of sports that can be carried out | 10-20 | 10 | 8 | 1 | 4 | 50 | 25 | 5 | 13 | 0 |
| Number of social sports instructors | 14 | 20 | 10 | 5 | 4 | 96 | 60 | 10 | 18 | 0 |
| Annual number of people participating in physical fitness / million | 200 | 40 | 30.5 | 20 | 0.3 | 300 | 120 | 11 | 12.8 | 300 |
| Park fees | 10 Yuan | Free | Free | Free | Free | Free | Free | 1 Yuan | 15 Yuan | Free |
| Number of activities per year | 50 | 0 | 25 | 40 | 10 | 9 | 60 | 6 | 16 | 0 |
| Site facility maintenance system | Exist | Exist | Exist | Exist | Exist | Exist | Exist | Exist | Exist | Exist |
| Major fitness injury | No | No | No | No | No | No | No | No | No | No |


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**Table 1 (part IV).** Construction and development of urban sports parks in China

| Park name | Beijing Chaoyang Park | Longtan Park, Chongwen District, Beijing | Quanzhou Puxi Riverside Sports Park | Baoji Weihe Park | Anhui Bengbu City Park | Ma'anshan Xishan Lake Park | Minhang Sports Park | Zhongshan Park, Shahekou District, Dalian City | Taiyuan Fenhe Park | |
|---|---|---|---|---|---|---|---|---|---|---|
| Park area /m² | 2887000 | 492000 | 5320000 | 1485 | 69000 | 1400000 | 839160 | 113000 | 3000000 | |
| The area of sports facilities / m² | 170000 | 30922 | 139333 | 1260000 | 10000 | 6000 | 333000 | 15000 | 570000 | |
| Number of sports that can be carried out | 10 | 28 | 12 | 19 | 15 | 16 | 46 | 10 | 16 | |
| Number of social sports instructors | 9 | 196 | 3 | 42 | 19 | 32 | 45 | 80 | 15 | |
| Annual number of people participating in physical fitness / million | 80 | 10 | 20 | 480 | 70 | 300 | 42 | 175 | 300 | |
| Park fees | 5 Yuan | 2 Yuan | Free | Free | Free | Free | Free | Free | Free | |
| Number of activities per year | 1000 | 25 | 12 | 13 | 300 | 3 | 120 | 12 | 50 | |
| Site facility maintenance system | Exist | Exist | Exist | Exist | Exist | Exist | Exist | Exist | Exist | |
| Major fitness injury | No | No | No | No | No | No | No | No | No | |

Through a survey of 39 cities that issued questionnaires, China has a total area of 34,816,300 m² of sports facilities, with an average of 696,300 m² per park. these areas include sports field areas, water areas, path areas, etc., due to the inconsistent caliber of parks in reporting area indicators, as well as misrepresentation. Therefore, this data can only be a reference data. According to the statistics of the 2000 and 2010 China Mass Sports Survey, 87% of the morning and evening practice points for mass sports activities in China are located in urban parks. The data from 20 urban sports parks surveyed in this paper show that the parks with the most sports programs in China can carry out more than 40 sports programs. For example, Stalin Park in Daoli District, Harbin, and Minhang Sports Park, Shanghai, can carry out 49 and 46 sports and fitness programs, respectively [31]. Among the 39 urban sports parks


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investigated in this paper, 15 parks can carry out 11-15 sports and fitness programs, accounting for 34% of the overall number. 14 parks can carry out 16-20 physical fitness programs, accounting for 31% of the overall. The sum of the two is 65%, so most sports parks in China can carry out 11-20 physical fitness programs [32].

# 3. PARK ECOLOGY BASED ON SUBORDINATE DEGREE NUMERICAL METHOD

## 3.1. INDEX CALCULATION AND EVALUATION

The ambient air quality index (GB3095-2012), the grading evaluation standard of forest ambient air negative ion concentration, and the human comfort level classification standard established by the China Meteorological Administration are used as evaluation criteria [33]. Among them, the human comfort index $I_{CHB}$ is calculated by the following formula.

$$I_{CHB} = (1.8t + 32) - 0.55\left(1 - 0.01H_r\right)(1.8t - 26) - 3.2\sqrt{v} \quad (1)$$

In the above equation, $t$ denotes the average temperature; $H_r$ denotes the relative humidity; $v$ denotes the average wind speed, m/s.

## 3.2. STUDY OF ECOLOGICAL AND ENVIRONMENTAL EFFECTS OF PLANT COMMUNITIES

The ecological and environmental effects of plant communities were evaluated by using the affiliation function value method in fuzzy comprehensive evaluation [34]. The affiliation function value was calculated as follows.

$$U\left(X_i\right) = \left(X_i - X_{\min}\right) / \left(X_{\max} - X_{\min}\right) \quad (2)$$

If the indicator is negative, the calculation formula is

$$U\left(X_i\right) = 1 - \left(X_i - X_{\min}\right) / \left(X_{\max} - X_{\min}\right) \quad (3)$$

Where $U\left(X_i\right)$ denotes the affiliation function value of the ecological effect of sample site $i$, $X_i$ denotes the measured value of an index of sample site $i$, $X_{\max}$ and $X_{\min}$ denote the maximum and minimum values of an index of the sample site, respectively. The mean value of the affiliation function of each index of the selected sample site is used as a criterion to determine the ecological effect of the sample site, and the larger the mean value, the better the ecological effect of the sample site [35].


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### 3.3. DATA PROCESSING

Microsoft Excel was used to count and analyze the monitoring data; Origin 2019 was used to draw correlation charts; SPSS 25.0 was used to conduct correlation analysis (Pearson correlation test) and principal component analysis; the affiliation function value method was used to calculate the integrated ecological and environmental effects affiliation function values [36-37].

## 4. RESULTS AND ANALYSIS

This paper takes Hohhot City Manduhai Park, with latitude and longitude (40°42'N, 111°42'E), located in Saihan District, Hohhot City, Inner Mongolia Autonomous Region, as the research object, which also serves the functions of forest germplasm resources preservation, ornamental recreation, scientific research and teaching. It has an altitude of 1056m, covers an area of 22hm$^2$, and has a temperate continental climate, with an average annual temperature of 5.8°C and an annual rainfall of 300~450mm. There are more than 500 species of plants in the garden, belonging to 53 families and 122 genera, including coniferous species, broad-leaved species and sandy plants.

In August 2021, a clear and breezy day was selected for 5 d of continuous field monitoring. The monitoring time was from 8:00 am to 18:00 pm, with 2h intervals, and 6 times a day, and the meteorological factors, atmospheric particulate concentration ($C_{APM}$), negative air ion concentration ($C_{NAI}$) and human comfort ($I_{CHB}$) were monitored simultaneously at a total of 6 sample sites in the park. The sampling height was about 1.5 m. The meteorological factors of each plant community were measured by a KestrelNK4500 portable meteorological instrument, and the average values were taken three times. The TurnkeyDustmate dust monitor was used to measure the TPS, $PM_{10}$, $PM_{2.5}$ and $PM_1$ concentrations at each site, and after the instrument readings were stabilized, the data were read from four directions, southeast and northwest, respectively. After repeating each direction 3 times, the final average value was taken.

### 4.1. CHARACTERISTICS OF DAILY CHANGES IN METEOROLOGICAL FACTORS OF PLANT COMMUNITIES

Six sample sites in the park were selected, S1, S2, S3, S4, S5, and CK, and the meteorological factors (temperature, relative humidity, and wind speed) were collected from these six sites, and the daily variation characteristics of plant community meteorological factors (temperature, relative humidity, and wind speed) were compared and analyzed, as shown in Figure 1.


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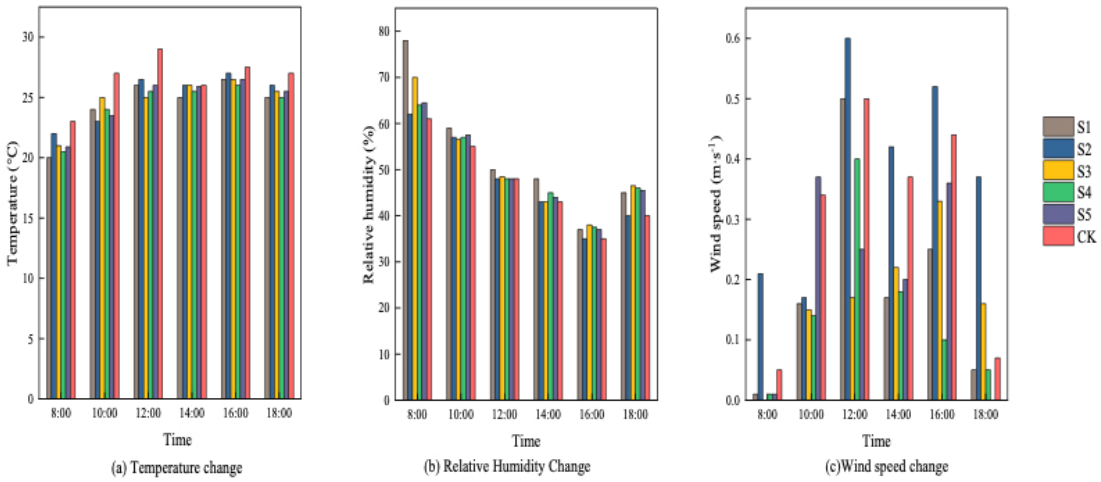


**Figure 1.** Daily variation of meteorological factors in plant communities

1. Temperature. As can be seen from Figure 1(a), the temperature of each plant community varied in a similar trend during the day, rising first and then slowly decreasing. The peak temperature occurred at around 16:00 and the lowest at around 8:00. The average daily temperature of each sample site was significantly lower than that of the control site, with a cooling rate of 3.34% (sample site S2) ~ 5.05% (sample site S1). This may be related to the simple plant community structure, low depression, poor shading effect and weak transpiration in sample plot S2, which eventually led to higher temperature in the sample plot.

2. Relative humidity. As shown in Figure 1(b), the relative humidity of each plant community peaked at about 8:00 and was lowest at about 16:00. The trend of daily average relative humidity was basically the same, and the change curve was "V" shaped. The average daily relative humidity of each plant community was significantly higher than that of the control site, with the humidification rate ranging from 1.82% (sample site S2) to 12.18% (sample site S1). This is mainly because the depression degree of sample plot S1 is larger than that of sample plot S2, the air convection is weakened and transpiration is more obvious. The diffusion of water vapor within the plant canopy was affected, the rate was reduced, and the rate of humidification was increased.

3. Wind speed. From Figure 1(c), it can be seen that the wind speed variation trend of each plant community is different, and the wind speed mostly peaks at 12:00 in the day, and the wind speed is the lowest in the morning and evening. The wind speed variation curve of sample site S2 fluctuated the most and S4 fluctuated very little. Most of the sample sites had lower average daily wind speed than the control site, which proved that the trees, canopy and branches in the green space had a certain effect of shading and reducing the wind speed. The wind speed of S2 was higher than that of the control site, which is presumed to be due to the relatively small degree of depression in the green


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area and the weak shading effect of trees, resulting in enhanced air convection.

## 4.2. PLANT COMMUNITY $I_{CHB}$ DAILY CHANGE CHARACTERISTICS AND EVALUATION

After collecting human comfort from a total of six sample sites in the park, the daily change characteristics of human comfort of these plant communities were compared and analyzed, as shown in Figure 2.

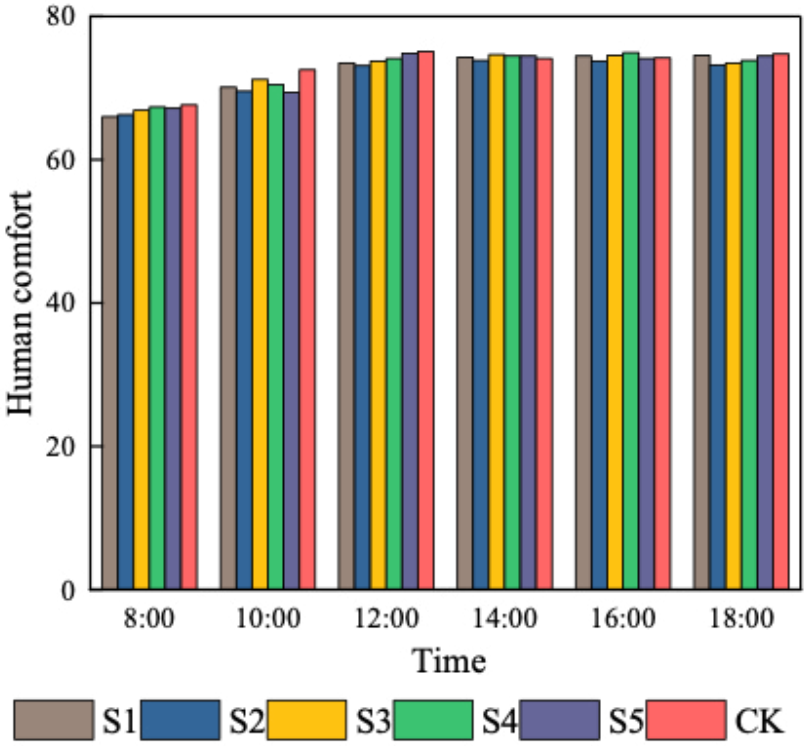


**Figure 2.** Daily variation of plant community

From Figure 2, we can see that the change trend of $I_{CHB}$ in each place is similar, and the change curve is inverted "V" shape. The comfort level was best in the morning at 8:00 a.m., uncomfortable around 12:00 a.m. and 16:00 a.m., and more comfortable at other times. The daily average $I_{CHB}$ variation ranged from 71.77±2.73 to 73.19±2.54. The daily average $I_{CHB}$ of the plant community was significantly lower than that of the control site, i.e., the park green space could effectively improve $I_{CHB}$ with the highest improvement rate of 1.94%.

According to the human comfort scale, the daily average $I_{CHB}$ in the tree garden was in the VI range, i.e. "slightly hot". At around 8:00, all sample plots $I_{CHB}$ were in the "comfortable" range. At around 10:00, some of the sample sites $I_{CHB}$ were in the "comfortable" range, while the rest of the sample sites $I_{CHB}$ were in the "slightly hot" range. After 10:00, all the sample areas $I_{CHB}$ continued to rise, and most of the sample areas $I_{CHB}$ were in the "slightly hot" range, and very few sample areas were


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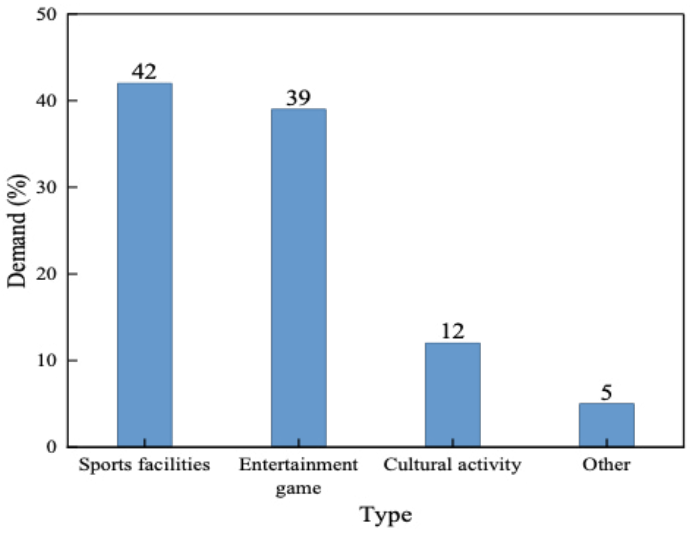
uncomfortable. From 16:00 to 18:00, $I_{CHB}$ decreased slowly, and most of the sample sites were in the "slightly hot" range. Therefore, recreational activities in the tree garden were not recommended from 10:00 to 16:00. The duration of physical comfort in each site lasted 8.5-10h during the day, which was about 1.5h longer compared to the control.

## 4.3. SURVEY ON SATISFACTION WITH PARK LEISURE AND SPORTS FACILITIES

The collected literature was analyzed, screened and judged, and a questionnaire was created for local visitors based on a field study of the current situation of sports and leisure in Manduhai Park in Hohhot. The questionnaires were consulted several times with experts in sports event planning, organizational research, and environmental protection research. Based on the feedback from the pre-survey respondents, the questionnaire was revised, supplemented and integrated before being finalized and developed. The results showed that the correlation coefficient of each option of the questionnaire was $\geqq 0.8$ and the reliability of the questionnaire was significant. At present, a total of 500 questionnaires were distributed and 429 were collected. Among them, 382 questionnaires were valid, and the effective recovery rate was 76.4%. The data collated shows that in terms of age distribution, the elderly (over 60 years old) are the main visitors to Manduhai Park in Hohhot. They have more leisure time, and the park provides them with a good environment for human interaction and eliminates the feeling of emptiness at home.

The demand situation of park visitors for park facilities and their satisfaction with park leisure and sports facilities are plotted as shown in Figure 3.




(a) Demand for leisure and sports facilities in parks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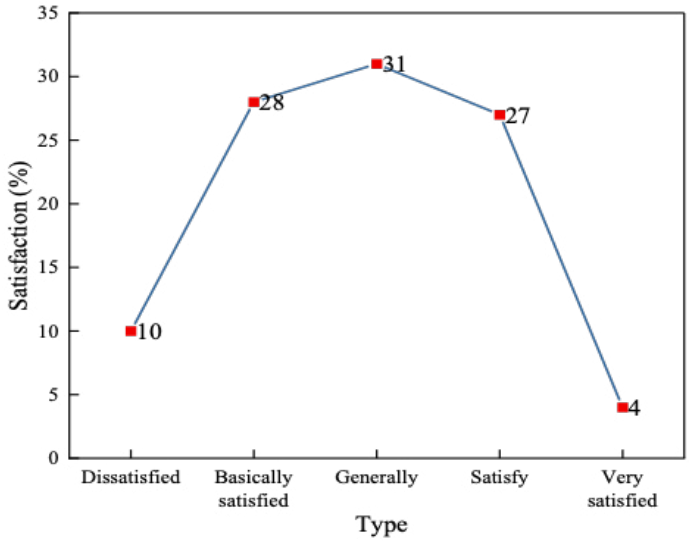


(b) Satisfaction with park leisure and sports facilities

**Figure 3.** Demand for and satisfaction with leisure and sports facilities in parks

The data collated and analyzed in Figure 3(a) shows that the highest proportion of visitors chose leisure and sports activities at 42%, followed by recreational games at 39%, and then cultural activities at 12%. Additional activities according to the needs of visitors can extend their stay in the park and improve the utilization rate of the park.

In Figure 3(b), it can be seen that 31% of the 382 questionnaires are satisfied with the leisure and sports facilities in Hohhot Manduhai Park, 32% of the visitors think the leisure and sports facilities are average, 28% of the visitors are only basically satisfied with the leisure and sports facilities, and 10% of the visitors are not satisfied with the leisure and sports facilities. This degree shows that the existing leisure and sports facilities, can't meet the requirements of people to sports and leisure parks to the maximum extent, so in terms of leisure and sports facilities update and the needs of visitors, the park managers should be strengthened.

## 5. DISCUSSION

At present, sports and leisure projects are reflected in the ecological environment of urban parks. On the one hand, visitors can choose their favorite sports and leisure facilities in the parks and play sports to strengthen their bodies. On the other hand, the continuous optimization of the ecological environment of urban parks also attracts a lot of have to come to the parks to view the garden scenery. The combination of sports and leisure projects and the ecological environment of the park has largely achieved their coupled synergistic development.

If we want to further strengthen the coupled and synergistic development of the two, we need to use the foundation of resource integration, start from ecology, culture and economy, deeply strengthen the material infrastructure, and coordinate and


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integrate ecology, culture and economy, to realize the purpose of promoting culture with ecology, promoting economy with culture and protecting ecology with economy. Consolidate existing ecological resources and develop recreational sports programs based on them. Using the existing recreational sports resources of the National Forest Park as a model, we enhance the ecological resources of the watershed and mountains to promote the common development of recreational sports programs. Use media publicity and sports event programs to enhance the public's awareness of ecological recreational sports. Based on the existing ecological resources, create leisure sports with ethnic cultural characteristics and develop ethnic sports for leisure without intruding into the main connotation of ethnic culture. Introducing ethnic culture in the form of leisure sports, pulling ethnic exchanges, promoting regional economic prosperity, building the material basis of leisure sports in China's ecological cities, and arousing the awareness of mass participation.

## 6. CONCLUSION

This paper takes Hohhot Manduhai Park as the research object, and analyzes the daily change characteristics of meteorological factors of plant communities, daily change characteristics of human sensory comfort of plant communities, and the results of a satisfaction survey of leisure and sports facilities in the park in Hohhot Manduhai Park, and obtains the following conclusions.

1. As for the daily variation characteristics of plant community meteorological factors, the temperature change of the plant community first rose and then slowly decreased, with the highest temperature at 4:00 pm and the lowest at 8:00 pm, and the cooling rate was 3.34%~5.05%. This may be related to the simple plant community structure, low depression, poor shading and weak transpiration in sample plot S2, which eventually led to the increase in temperature in the sample plot. The relative humidity was highest at 8:00 a.m. and lowest at 4:00 p.m. The rate of humidification was 1.82%~12.18%, which was mainly because the depression of sample plot S1 was larger than that of sample plot S2, air convection was weakened, transpiration was more obvious, water vapor diffusion within the plant canopy was affected, the rate was reduced, and the rate of humidification increased. The wind speed was highest at 12:00 noon and lowest in the morning and evening. The average daily wind speed of most of the sample sites was lower than that of the control sites, which proved that the trees, canopies and branches in the green areas had a certain effect of shading and weakening the wind speed. The wind speed at sample site S2 was higher than that at the control site, presumably because of the relatively small depression in the green space and the weak shading effect of trees, resulting in enhanced air convection.

2. Regarding the daily variation of plant community human comfort characteristics, the best human comfort was found at 8:00 in the morning, and discomfort was felt around 12:00 and 16:00. The variation of human sensory


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comfort ranged from 71.77±2.73 to 73.19±2.54, and the park green space could improve the highest rate of comfort by 1.94%. Therefore, from 12:00 to 16:00, sports and recreational activities are not recommended in the tree garden.

3. Regarding the results of the survey on satisfaction with leisure and sports facilities in parks, the survey found that 42% of visitors chose leisure and sports activities. The next entertainment game accounted for 39%, and again cultural activities accounted for 12%. It can be seen that most of the visitors come to urban recreation and sports parks mainly for recreation and sports activities, indicating that visitors pay more attention to their health issues. Thirty-one percent of the visitors were satisfied with the leisure and sports facilities, 31% thought they were average, 28% reached only basic satisfaction, and 10% were not satisfied with the leisure and sports facilities. The main reason for this situation is that the sports facilities in city parks have not been updated according to modern popular sports over time, and the lack of routine maintenance of the facilities has resulted in serious weathering of the sports facilities and human damage by visitors, making many of the sports facilities unusable.

## REFERENCES

(1) Lv, J., Li, Y. P., Huang, G. H., et al. (2022). Planning Energy Economy and Eco-environment Nexus System Under Uncertainty: A Copula-based Stochastic Multi-level Programming Method. Applied Energy, 312, 118736.

(2) Li, Y., Zhang, X., Cao, Z., et al. (2021). Towards the Progress of Ecological Restoration and Economic Development in China's Loess Plateau and Strategy for More Sustainable Development. Science of The Total Environment, 756(10), 143676.

(3) Conejo, A. N., Birat, J. P., Dutta, A. (2020). A Review of the Current Environmental Challenges of the Steel Industry and Its Value Chain. Journal of Environmental Management, 259(Apr.1), 109782.1-109782.20.

(4) Wang, C., Li, Q., Lu, Y., et al. (2019). Simulating Transport, Flux, and Ecological Risk of Perfluorooctanoate in a River Affected by a Major Fluorochemical Manufacturer in Northern China. Science of the Total Environment, 657(MAR.20), 792-803.

(5) Park, J. I., Lee, et al. (2017). Examining the Spatial Patterns of Green Industries and the Role of Government Policies in South Korea: Application of a Panel Regression Model (2006-2012). Renewable and Sustainable Energy Reviews.

(6) Yu, L., B., et al. (2016). Internet Plus Relationship between Traditional Sports Industry and Sports Industries. Basic & Clinical Pharmacology & Toxicology.

(7) Boyce, S. H., Murray, A., Scott, D. L. (2016). O-11 Genghis Khan Ice Marathon: Preparation and Strategy for Exercise in an Extreme Cold Environment in a Group of Experienced Ultrarunners. British Journal of Sports Medicine, 50(Suppl 1), A6.2-A6.


https://doi.org/10.17993/3cemp.2023.120252.305-324

(8) Marques, A., J., André, Martins, J., et al. (2014). PP8 - Sedentary Behaviour and Physical Activity Patterns of Urban Adolescents: A Study Using Ecological Momentary Assessment. British Journal of Sports Medicine, 48(Suppl 3), A8.3-A9.

(9) Johnson, T. F., Hordley, L. A., Greenwell, M. P., et al. (2021). Associations between COVID-19 Transmission Rates, Park Use, and Landscape Structure. Science of the Total Environment, 789.

(10) Arenas-Castro, S., Sillero, N. (2021). Cross-scale Monitoring of Habitat Suitability Changes Using Satellite Time Series and Ecological Niche Models. Science of The Total Environment, 784, 147172.

(11) Cai, Z., Li, W., & Cao, S. (2021). Driving factors for coordinating urbanization with conservation of the ecological environment in China. AMBIO.

(12) Saunders, M. E., Peisley, R. K., Rader, R., et al. (2016). Pollinators, pests, and predators: Recognizing ecological trade-offs in agroecosystems. Ambio, 45(1), 4-14.

(13) Zemva, T. M., et al. (2019). Effect of sex and slaughter weight on meat and fat quality of the Krškopolje pig reared in an enriched environment. Animal Production Science.

(14) Hurst, P. L., et al. (2017). Reproducibility of outdoor 5 km running time-trial in a competitive environment. British Journal of Sports Medicine.

(15) Thevis, M., Walpurgis, K., Thomas, A. (2020). Analytical Approaches in Human Sports Drug Testing: Recent Advances, Challenges, and Solutions. Analytical Chemistry, 92(1), 506-523.

(16) Chen, X. T., Jones, I. A., Park, C., et al. (2020). Use of Platelet-Rich Plasma for the Improvement of Pain and Function in Rotator Cuff Tears: Response. The American Journal of Sports Medicine, 48(6), NP39-NP41.

(17) Risnen, A. M., Tanja, K., Jari, P., et al. (2020). There Is No Relationship Between Lower Extremity Alignment During Unilateral and Bilateral Drop Jumps and the Risk of Knee or Ankle Injury: A Prospective Study. The Journal of Orthopaedic and Sports Physical Therapy.

(18) Yun, G. K., Shim, J., Kim, D., et al. (2019). Cover Image, Volume 29, Issue 10. Scandinavian Journal of Medicine & Science in Sports, 29.

(19) Ska, B., Wsy, C., Hjk, A., et al. (2019). Highly sensitive non-enzymatic lactate biosensor driven by porous nanostructured nickel oxide. Ceramics International, 45(17), 23370-23376.

(20) Jeong, J. Y., Min, S. K., Park, K. M., et al. (2018). Location of Rotator Cuff Tear Initiation: A Magnetic Resonance Imaging Study of 191 Shoulders. American Journal of Sports Medicine.

(21) Hulme, A., Mclean, S., Salmon, P. M., et al. (2018). Computational methods to model complex systems in sports injury research: Agent-Based Modelling (ABM) and Systems Dynamics (SD) modelling. British Journal of Sports Medicine, 53(24).

(22) Kim, S. H., Park, Y. B., Ham, D. W., et al. (2017). No influence of femoral component rotation by the lateral femoral posterior condylar cartilage remnant


https://doi.org/10.17993/3cemp.2023.120252.305-324

technique on clinical outcomes in navigation-assisted TKA. Knee Surgery, Sports Traumatology, Arthroscopy, 25(11), 1-9.

(23) Kim, T., Park, J. C. (2017). Short-term effects of sports taping on navicular height, navicular drop and peak plantar pressure in healthy elite athletes: A within-subject comparison. Medicine, 96(46), e8714.

(24) Cho, J. Y., Kim, K. H., Park, H., et al. (2017). Abstract 21392: Comparison Between Overweight With Preserved versus Reduced Muscle Mass in Young Trained Athletes. Circulation, 136.

(25) Chung, S. W., Park, H., Kwon, J., et al. (2016). Effect of hypercholesterolemia on fatty infiltration and the quality of tendon-to-bone healing in a rabbit model of a chronic rotator cuff tear: Electrophysiological, biomechanical, and histological analyses. The American Journal of Sports Medicine, 44(5), 1153-1164.

(26) Park, S. E., Karnav, et al. (2017). Intratendinous rotator cuff tears: prevalence and clinical and radiological outcomes of arthroscopically confirmed intratendinous tears at midterm follow-up. The American Journal of Sports Medicine, 43(2), 415-22.

(27) Yoon, K. H., Lee, H. W., Park, S. Y., et al. (2020). Meniscal Allograft Transplantation After Anterior Cruciate Ligament Reconstruction Can Improve Knee Stability: A Comparison of Medial and Lateral Procedures. The American Journal of Sports Medicine, 48(10), 036354652093877.

(28) Kim, K. S., Park, K. J., Lee, J., et al. (2018). Injuries in national Olympic level judo athletes: an epidemiological study. British Journal of Sports Medicine, bjsports-2014-094365.

(29) Park, D. H., Moon, S. D., Kang, S. K., et al. (2018). Acute toxicity of copper to three species of freshwater organisms for prospective ecological risk assessment of Korean aquatic environments. British Journal of Sports Medicine, 41(1), 2-7.

(30) Leppänen, M., Pasanen, K., Kulmala, J. P., et al. (2017). Knee Control and Jump-Landing Technique in Young Basketball and Floorball Players. International Journal of Sports Medicine, 37(04), 334-338.

(31) Heaney, P. J. (2019). At the blurry edge of mineralogy. American Mineralogist, 100(1), 3-3.

(32) Park, Y. E., Sang, H. S. (2018). Gradual correction of idiopathic genu varum deformity using the Ilizarov technique. Knee Surgery, Sports Traumatology, Arthroscopy, 21(7), 1523-1529.

(33) Kingfisher Lighting appoints exceptional Sports Lighting Manager, Neil Johnson. (2017). Electrical Engineering.

(34) Bamba, Y., Kusano, K., Yamamoto, T. T., et al. (2017). Study on Triggering Process of Solar Flares Based on Hinode/SOT Observations. The Astrophysical Journal, 778(1), 48-48.

(35) Yunqiao, Zhou, Tieyu, Wang, Zhaoze, & Jiang, et al. (2017). Ecological effect and risk towards aquatic plants induced by perfluoroalkyl substances: bridging natural to culturing flora. Chemosphere.


https://doi.org/10.17993/3cemp.2023.120252.305-324

(36) Strock, N., Koltun, K. J., Mallinson, R. J., et al. (2020). Characterizing the resting metabolic rate ratio in ovulatory exercising women over 12 months. Scandinavian Journal of Medicine & Science in Sports, 30(8).

(37) Sang, J. S., Lee, H. W., Kang, I. K., et al. (2019). Load imbalances existed as determined by a sensor after conventional gap balancing with a tensiometer in total knee arthroplasty. Knee Surgery, Sports Traumatology, Arthroscopy, 28(12).


https://doi.org/10.17993/3cemp.2023.120252.305-324