

Evaluation of the Spatial Pattern of Fitness and Leisure Venues at the City Scale

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Abstract

Original Research Article

Reasonable layout of fitness and leisure places is an important part of the implementation of the national fitness strategy. The analysis of the spatial pattern and influence mechanism of fitness and leisure places from the perspective of city has certain guiding significance for optimizing urban planning and construction and rationally allocating sports resources. This paper uses kernel density, buffer zone, inverse distance interpolation, Kriging interpolation, geographical detector and other geographical spatial analysis methods to analyze the spatial distribution pattern and distribution causes of five types of fitness and leisure places in counties (cities, districts) under the jurisdiction of Jinhua City. It is found that the overall spatial distribution characteristics of fitness and leisure places in Jinhua City are 'core-periphery', and different forms of fitness and leisure places show different distribution characteristics. The spatial pattern of fitness and leisure places in Jinhua City has the characteristics of relying on traffic arteries and high-density population areas, and has a positive correlation with the spatial layout of housing prices. Jinhua fitness and leisure places generally have good traffic accessibility.

Keywords: Fitness And Leisure Places, Spatial Pattern, Influence Mechanism, City Area.

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0 INTRODUCTION

A better life is the eternal theme of human survival. The pursuit of a higher level of quality of life leads to the development and progress of society. Health is the basic condition for individuals to pursue a better life. People's pursuit of career, reputation, wealth and so on is based on health. People's health is the foundation of national prosperity and national prosperity. More and more studies have shown that the formation of many chronic diseases is related to the lack of physical activity and poor lifestyle. Maintaining a good lifestyle, actively participating in physical fitness activities, and adhering to scientific physical exercise are important ways to actively prevent diseases and promote health. National fitness is not only an important way and means to improve people's health, but also plays an important role in promoting people's national development, displaying national cultural soft power, and promoting high-quality economic and social development.

Domestic and foreign scholars' research on fitness and leisure places mainly focuses on two aspects. By analyzing the regional population density, family size, gender, education level and other demographic

information to study the distribution of fitness and leisure venues [1-4]. According to the government's policies and regulations, some scholars have studied the planning and construction of fitness and leisure places [5]. In general, there are different influence mechanisms in the formation of the spatial pattern of fitness and leisure places. Most foreign scholars focus on the study of population density, traffic accessibility, etc [6]. 2) The research on the influence of the spatial layout of fitness and leisure places on individual participation in physical exercise mainly focuses on the influence of the distribution of fitness and leisure places on individual sports event selection, travel distance, travel mode and participation frequency. Higgerson *et al.*, [7, 8], pointed out that increasing the proportion of non-profit leisure sports facilities around the community has a significant effect on improving the sports population of residents and effectively solving the inequality of opportunities in the process of sports participation. In general, there is a two-way influence between the spatial layout of fitness and leisure venues and the individual's willingness to participate in fitness and leisure sports. Different types of fitness and leisure venues and facilities have a positive or inhibitory effect on the participants.

From a macro perspective, the research from the perspective of big data such as sports facilities, the number of sports venues and the number of population has certain value for evaluating the overall development level of fitness and leisure facilities and comparing the construction of leisure sports facilities at home and abroad, but it lacks reference value in the specific spatial layout. In terms of research methods, there are few studies on the application of geographical spatial analysis method in the formation of spatial pattern of fitness and leisure places, and most of them focus on a single place. From the perspective of the research area, the existing research mostly studies the layout of sports facilities from a national perspective, and there are few studies on the city scale. Based on this, the research starts from the material attributes of fitness and leisure places in Jinhua City, explores the spatial pattern of fitness and leisure places of different levels and types, and the relationship between the spatial layout and different influencing mechanisms [9].

1 RESEARCH DESIGN

1.1 Type Division of Fitness and Leisure Places

To explore the spatial pattern of fitness and leisure places in Jinhua, the research basis is to define the attributes of various leisure sports facilities and places. Based on the main attributes of the place, combined with the needs of practice and research, the research divides Jinhua's fitness and leisure places into five categories: urban (county, district) public sports venues, street / township / community sports venues, enterprises and institutions sports venues (except schools), school sports venues, and commercial fitness and leisure venues for data research and analysis.

1.2 RESEARCH METHODS

1.2.1 Nuclear Density Estimation

Kernel density estimation, KDE. It is a non-parametric estimation model. It studies the data distribution characteristics from the data samples without any assumptions on the data distribution [11]. This is in line with the characteristics of the research data and the unrestricted distribution of various sports venues. KDE uses kernel function to weight the unknown region points, explores the hot spot area of the target distribution through automatic search, and uses distance attenuation to measure the change of the target object density [12]. Taking the formation of the spatial pattern of five types of fitness and leisure places in Jinhua's subordinate counties (cities and districts) as an example, the distribution map of various fitness and leisure places was obtained by kernel density estimation method, and the overall spatial pattern and distribution characteristics of fitness and leisure places in Jinhua were revealed.

The KDE expression is [13]:

$$f(x) = \frac{1}{nh^d} \sum_{i=1}^n K \left[\frac{1}{h} (x - x_i) \right]$$

1.2.2 Buffer Analysis

Buffer analysis is an important part of geographic information system (GIS) spatial analysis technology. Its core function is to describe the possible impact of the target object on the surrounding environment in the geographical sense [14]. In this study, a 1km buffer zone was set up on the main traffic roads in the study area, and the distribution maps of five types of fitness and leisure places in the buffer zone were drawn. The proportion of various types of fitness and leisure places distributed within and outside the radiation range of the buffer zone was calculated, and the overall judgment of the traffic accessibility of fitness and leisure places in Jinhua City and the differences in the distribution of various types of fitness and leisure places at the level of traffic accessibility were completed.

1.2.3 Inverse Distance Interpolation Method

Inverse distance interpolation is a mature spatial interpolation method. The inverse distance weighted (IDW) method is used to show the relationship between population distribution and the spatial pattern of fitness and leisure places in Jinhua City. According to the population and area of townships and communities (streets) in Jinhua provided by Jinhua Statistical Yearbook (2022), the real population density of counties (cities and districts) in Jinhua is obtained. The population density of Jinhua city was obtained by interpolation calculation with inverse distance weighting method. Finally, the comparison information between the population density of the survey area and the population density of the distribution area of 5 types of fitness and leisure places was obtained, and the relationship diagram was drawn to answer the different distribution characteristics of fitness and leisure places under the dependent variable of population density. The IDW expression is:

$$Z_x = \frac{Z_i}{d_i^k} \sum_{i=1}^s \frac{1}{d_i^k}$$

1.2.4 Kriging Interpolation Method

Kriging interpolation is a widely used interpolation method in spatial interpolation. The study uses the ordinary Kriging method to insert the spatial point data of unknown fitness and leisure places in the known housing price space to estimate, obtain the real estate price values in the distribution areas of various fitness and leisure places, draw a relationship diagram, and answer the distribution differences in the real estate price dimensions of various stadiums. Its expression is:

$$Z(S_0) = \sum_{i=1}^n \lambda_i Z(S_i)$$

1.2.5 Geodetector

Geographical detector is an important tool to detect the causes and formation mechanism of spatial pattern, and factor detector can be used to detect whether a certain factor can form a certain spatial distribution characteristics and influence. Through the method of geographical detector, this paper calculates the influence mechanism of traffic accessibility, population density, real estate price and other factors on the formation of spatial pattern of various leisure sports venues, and answers the internal relationship between the formation of spatial pattern of various fitness and leisure venues and different elements.

$$P_{D.H} = 1 - \frac{1}{n\sigma_H^2} \sum_{i=1}^m n_{D.i} \sigma_{H_{D,i}}^2$$

1.3.1 Research Area Summary

Jinhua, formerly known as Wuzhou, is a prefecture-level city in Zhejiang Province, the central city of the Yangtze River Delta, and the central city of the central and western regions of Zhejiang Province. It is located in the eastern part of the Jinqi Basin and is known as the 'heart of Zhejiang'. It has jurisdiction over two districts of Wucheng (including development zone) and Jindong (Jinyi New District), three counties of Wuyi, Pujiang and Pan'an, and four county-level cities of Lanxi, Yiwu, Dongyang and Yongkang, with a total land area of 10,942 square kilometers. The main reasons for choosing Jinhua City as the analysis object are as follows: 1). The sports industry in Jinhua City has developed rapidly, and the proportion of the added value of the sports industry in GDP has ranked first in the province for six consecutive years. 2) Jinhua City, as a 'City of Doubles', has relatively perfect sports facilities.

1.3.2 Data Source and Processing

The research data were collected from the Point of Interest (POI) of Baidu map platform in 2023 with the help of geographic crawler software, including the name, address, type, latitude and longitude of the place. Based on the "Classification of Sports and Related Industries (Trial)" formulated by the National Bureau of Statistics and the State General Administration of Sports, the keywords are selected and the information collection software is used to obtain the information of sports facilities or places in batches. The captured POI data were screened and eliminated [17], and exported to the EXCEL table. The collected information was encoded and analyzed, and the geographic coordinate transformation was performed. The POI data and Jinhua City Road were uniformly registered in the WGS-1984 coordinate system to obtain the geospatial location of the place information. Some missing or suspected data were collated or supplemented by Tencent maps and Gaode maps [18].

2 RESEARCH RESULTS

2.1 The Overall Distribution Structure of Fitness and Leisure Places

Calculate the number of fitness and leisure places in Jinhua City, and generate a nuclear density distribution map of fitness and leisure places (Fig.1). Figure 1 shows that the overall pattern of fitness and leisure places in Jinhua is 'core-periphery'. There are two 'cores', namely Wucheng District and Yiwu City, and a belt connection with Jinyi New District as the axis is formed. There are a small number of secondary core areas in other counties (cities) [19], with a narrow radiation range and uneven spatial distribution. Overall, Jinhua the leisure place is distributed in a point shape, and there is a large tilt.

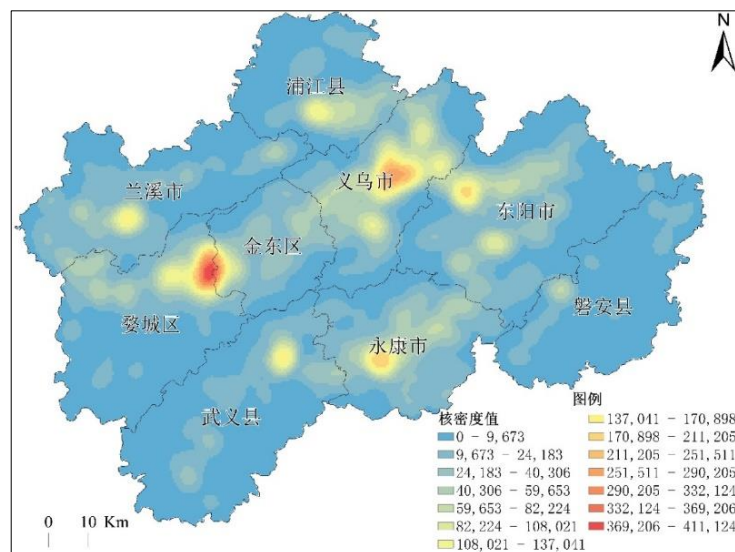


Fig. 1: Kernel density of spatial distribution of fitness and leisure places in Jinhua City

2.1.1 Distribution Structure of Different Types of Fitness and Leisure Places

The data distribution map of fitness and leisure venues (Figure 2) shows that: 1) The public sports venues at the city (county, district) level are multi-core distributed. Wucheng District, Yongkang City, Yiwu City and Pujiang County are the main core areas, and Lanxi City, Wuyi County and Pan 'an County form sub-core areas. 2) The distribution of street / township / community-level sports venues is relatively scattered, forming a high-density area in Wucheng District and a sub-density area in Yiwu City and Dongyang City. 3) The sports venues of enterprises and institutions are

distributed in a multi-core distribution [20]. The high density values are concentrated in Wucheng District and Yiwu City, and spread from the high concentration area to the east and west sides. 4) The school sports venues are distributed in groups [20]. The groups refer to Wucheng District and Yiwu City. The bands are Lanxi City-Wucheng District, Jindong District-Yiwu City, Pujiang County-Dongyang City, Dongyang City-Wuyi County, respectively. 5) Commercial fitness and leisure places show a clear point banded distribution [21]. Among them, Wucheng District, Yiwu City, Dongyang City and Yongkang City are the four points with the highest nuclear density.

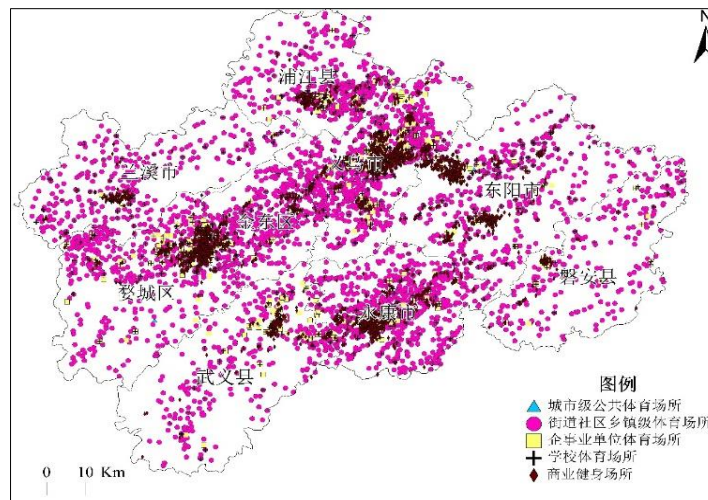


Figure 2: Distribution map of different types of fitness and leisure places in Jinhua City

2.2 The Spatial Distribution Law of Fitness and Leisure Places

2.2.1 The Spatial Distribution of Fitness and Leisure Places is Concentrated in High-Density Areas of Residents

According to the 'Jinhua Statistical Yearbook (2022)', the population of each county (city, district) and the area of townships and communities (streets) in Jinhua

City were obtained, and the population density of each county (city, district) was obtained. Through the inverse distance weighting method interpolation calculation, the regional population density [9], is obtained, and the population density distribution map of each county (city, district) in Jinhua City (Figure 3) and the population density map of the distribution area of five types of fitness and leisure places are formed.

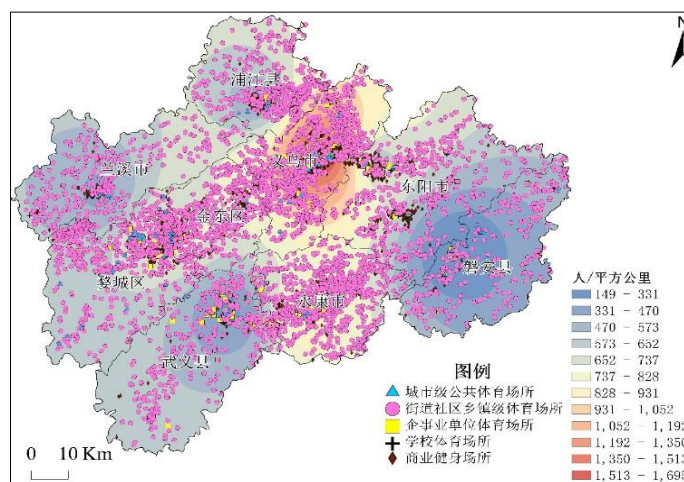


Fig. 3: The relationship between the distribution of fitness and leisure places and population density in Jinhua City

The formation of the spatial pattern of different types of fitness and leisure places has a high degree of fitting with the population distribution of each county (city, district) in Jinhua. The average density of the resident population in Jinhua City in 2022 is 648 people / km². The average population density of high-density areas of fitness and leisure places in Jinhua City is 1104 people / km². The population density of high-density gathering areas of fitness and leisure places is 1.7 times the total population density. The average population density of urban (county, district) -level public sports venues, street / township / community-level sports venues, sports venues of enterprises and institutions (except schools), school sports venues, and commercial fitness and leisure venues are 851 people / km², 943 people / km², 822 people / km², 902 people / km², and 984 people / km², respectively. The results show that the fitness and leisure places in Jinhua are concentrated in areas with high population density, which is closely related to the distribution of resident population in each county (city, district).

2.2.2 Fitness and Leisure Places Rely On the Distribution of Traffic Arteries

Accessibility is an important reference factor for residents to choose fitness places, which directly affects the motivation of fitness participants. GIS-based buffer zone analysis is one of the important methods for accessibility evaluation. Using ArcGIS10.8 software to analyze and process the elements of Jinhua 's administrative boundary and traffic road network, and draw a buffer zone in the range of 1km according to the distribution of major traffic arteries in the city (see Fig.4). From the perspective of the proportion of various sports venues located in the 1km buffer area of the main traffic trunk line, 95.5 % of the public sports venues at the city level (county, district), 95.2 % of the commercial fitness and leisure venues, 91.7 % of the sports venues of enterprises and institutions, 89.4 % of the school sports venues, and 71.3 % of the street / township / community sports venues. Overall, 79 % of the sports venues are located within the 1km buffer range of the main traffic trunk lines, and generally have good traffic accessibility.

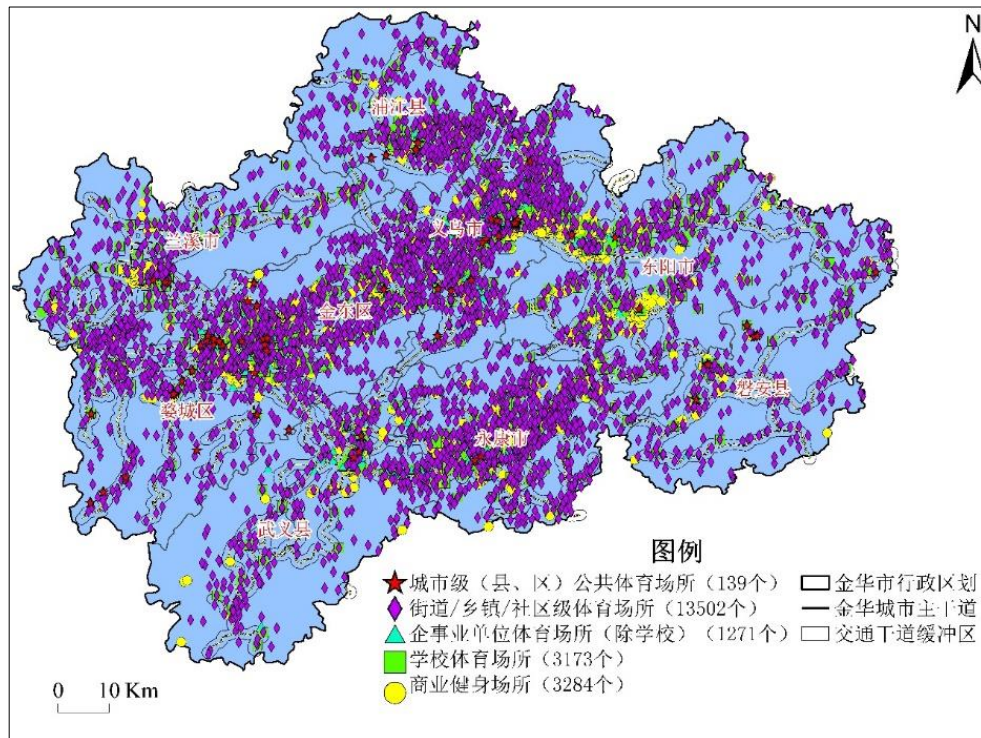


Fig. 4: The relationship between the distribution of fitness and leisure places and the main traffic arteries in Jinhua City

2.2.3 The Relationship between the Spatial Pattern of Fitness and Leisure Places and the Price of Residential Areas and Real Estate

According to the middle finger cloud data platform (CREIS), the data of 4901 communities in each county (city, district) of Jinhua City were studied and obtained. After calculating the number of fitness and leisure places in the 1km buffer zone, the relationship between fitness and leisure places and residential areas

was obtained (Fig.5). 59.9 % of the fitness and leisure places are in the 1km buffer area of residential areas. Among them, 94.2 % are commercial fitness and leisure places, 75.5 % are public sports places at the city (county, district) level, 45.1 % are street / township / community sports places, 85.2 % are enterprises and institutions sports places (except schools), and 76.7 % are school sports places.

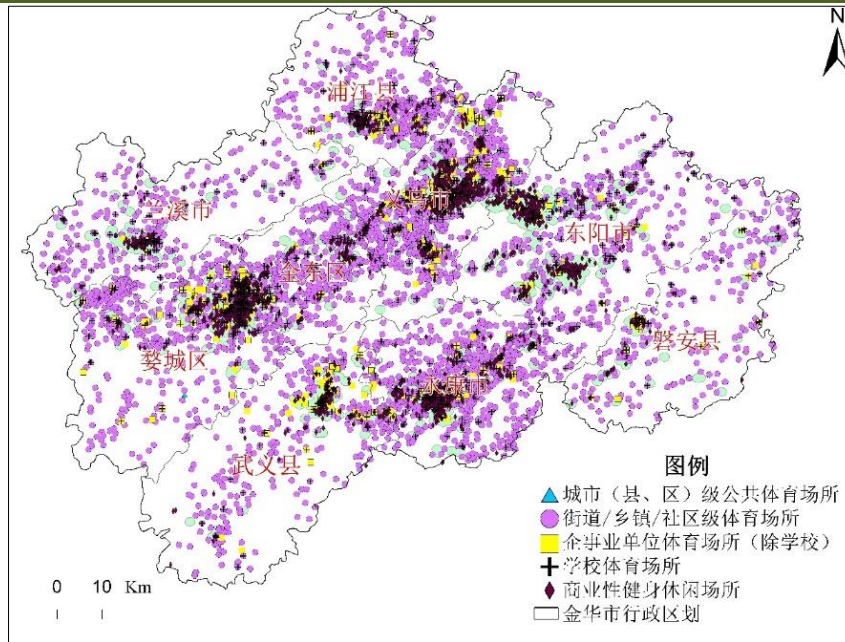


Fig. 5: The relationship between the distribution of fitness and leisure places and residential areas in Jinhua City

The sports fitness environment has gradually become an important factor in choosing the living environment. The price of residential real estate reflects the recognition of the living environment in some areas. The study transforms the housing price data by log, and uses the quadratic function algorithm to avoid the interference of local variation on the global trend. The sample data shows a normal distribution, and the variation shows spatial autocorrelation in each region. It

can be seen that there is a certain positive correlation between the fitness and leisure places in Jinhua and the distribution of housing prices. Combined with ArcGIS10.8 software, ordinary Kriging interpolation was performed on the sample data to draw the spatial distribution pattern of commercial housing prices in Jinhua City from April to May 2023 (figure 6) and its relationship with the distribution of fitness and leisure places (figure 7).

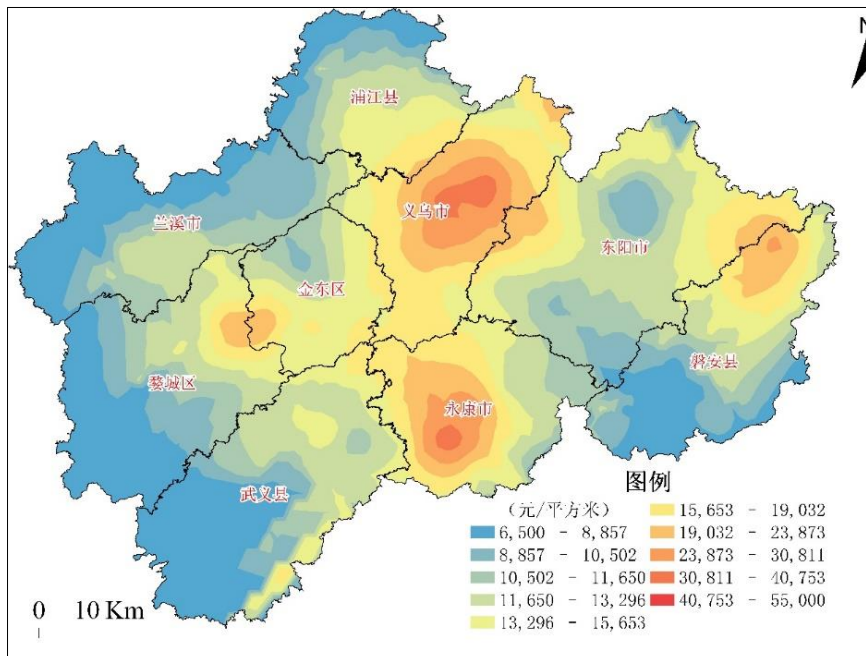


Fig. 6: Spatial distribution pattern of commercial housing prices in Jinhua counties (cities, districts)

Statistics show that the average price of commercial housing in Jinhua counties (cities and districts) from June 2022 to May 2023 is relatively

stable, which can eliminate the interference caused by special circumstances. According to recent data, the average house price of 9 counties (cities and districts) in

Jinhua from April to May 2023 is 16584 yuan / m². The average house price of each county (city and district) from April to May is from high to low: Yongkang City 26180 yuan / m², Yiwu City 23982 yuan / m², Wucheng District 17543 yuan / m², Jindong District 16697 yuan / m², Pujiang County 14312 yuan / m², Dongyang City 12558 yuan / m², Lanxi City 11963 yuan / m², Wuyi County 11561 yuan / m², Pan 'an County 8000 yuan / m². The average house price in the dense distribution area of sports venues within the city is 20517 yuan / m², which is 1.23 times the average house price. Among

them, the average price of public sports venues in urban (county, district) areas is 25479 yuan / m², the average price of commercial fitness and leisure venues is 24262 yuan / m², the average price of street / township / community sports venues is 22693 yuan / m², the average price of school places is 22186 yuan / m², and the average price of enterprises and institutions (except schools) is 20797 yuan / m². The price of real estate is synchronized with the intensity of sports venues. Incremental relationship.

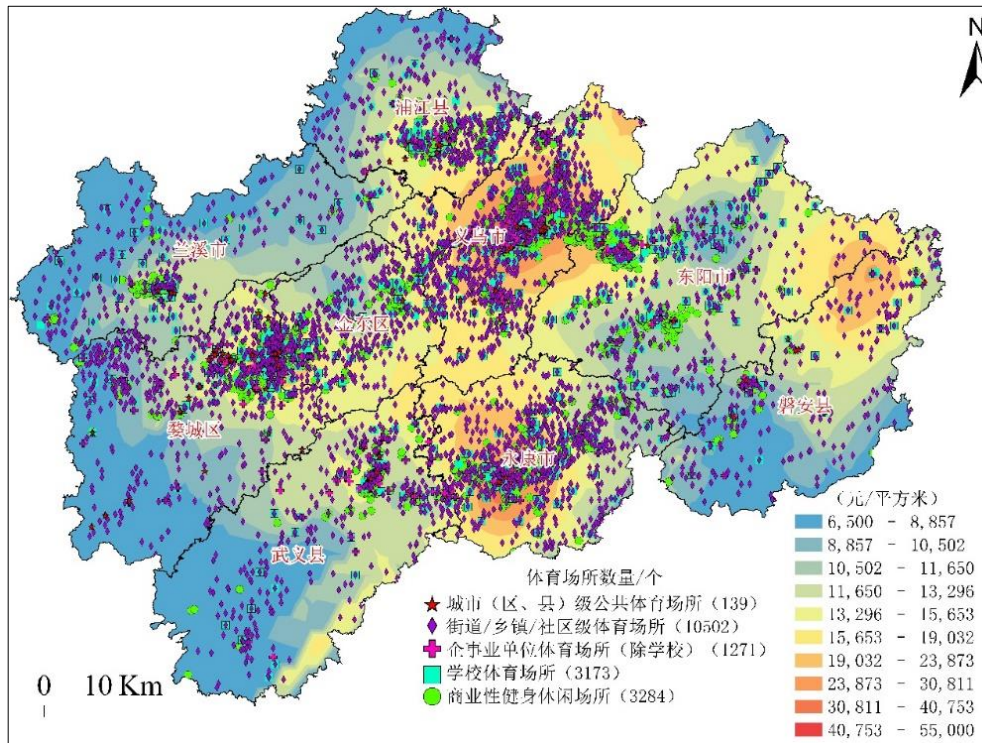


Fig. 7: The relationship between the distribution of fitness and leisure places and the price of commercial housing in Jinhua City

3. Evaluation on the Formation of Spatial Pattern of Fitness and Leisure Places in Jinhua City

3.1 The Formation and Problems of Spatial Pattern of Different Types of Fitness and Leisure Places

The nuclear density analysis shows that: 1) the city (county, district) level public stadium takes Wucheng District as the core, showing the multi-core distribution characteristics of one main and four vices. Public sports venues at the city (county, district) level are an important space for carrying large-scale events and large-scale national fitness activities, and also an important platform for promoting the coordinated development of competitive sports and mass sports. Jinhua Sports Center, Yiwu Meihu Sports Center, etc. are representatives of Jinhua city (county, district) level public sports venues. As a material carrier for residents' leisure, sports and fitness, and local sports events, the local government should promote the balanced development of municipal sports venues and facilities. 2) The agglomeration degree of street / township /

community-level sports venues is relatively scattered, forming a highly concentrated area in Wucheng District. There are major defects in such places in Pan 'an County, which are in a relatively weak radiation zone and have not formed sufficient fitness and leisure places. The formation of this phenomenon may be related to the slightly backward economy of Pan 'an County, the high altitude of the geographical area, the low population density and the difficulty in forming large-scale agglomeration. 3) Enterprises and institutions sports venues (except schools), Wucheng District and Yiwu City formed a high value aggregation. Enterprises and institutions should give full consideration to the health of employees and good physical quality needs while developing rapidly, and the units should be equipped with relatively perfect sports service facilities. 4) Wucheng District and Jinyi New District where the school stadium is located are highly concentrated, and other counties (cities, districts) are evenly distributed. School sports venues as an important part of China's

sports facilities, but also as a social resource, with the national fitness campaign to promote, effectively revitalize the school sports facilities resources, become crucial.5) The order of agglomeration degree of commercial fitness and leisure places is Yiwu City, Wucheng District and Yongkang City. The agglomeration degree of Yiwu in this kind of places has exceeded that of Wucheng District. Commercial fitness and leisure places are an important part of the national fitness public service system. Compared with the problems of single function and poor accessibility of public sports facilities, commercial fitness and leisure places can provide more complete and diversified facilities.

3.2 Spatial Pattern Formation and Population Density of Fitness and Leisure Places

The relationship between the distribution of fitness and leisure places and population density in Jinhua City shows that the population density of commercial fitness and leisure places is 984 people / km², which is higher than the density values of 851 people / km² in urban (county, district) public sports places, 943 people / km² in street / township / community sports places, 822 people / km² in enterprises and institutions sports places (except schools), and 902 people / km² in school sports places. It shows that the market-oriented commercial fitness and leisure places show a good development trend. The four types of fitness and leisure places with social supply and government supply as the main source need more development momentum [9]. Compared with the average population density of 648 people / km² in Jinhua City, the population density of high concentration areas of various fitness and leisure places is significantly higher than this average value, indicating that the distribution of fitness and leisure places is more dependent on population density.

3.3 Spatial Pattern Formation and Traffic Accessibility of Fitness and Leisure Places

The research on the traffic accessibility of fitness and leisure places in Jinhua shows that 79 % of the sports venues are located within the 1km buffer range of the main traffic trunk lines, and generally have good traffic accessibility. There are two reasons for the good traffic accessibility of sports venues and facilities: First, the governments at all levels in Jinhua attach great importance to the improvement and development of the public transport system, focusing on the efficiency of residents ' travel; second, the construction site selection of various sports venues is more favored in areas with convenient transportation. In the layout and location of national fitness and sports facilities, it is necessary to consider the setting of public transportation system, especially around the bus station, to build a network of venues and facilities suitable for walking and fitness. It is also necessary to fully consider the different travel

modes of the masses to meet the diverse needs of fitness travel.

3.4 Spatial Pattern Formation of Fitness and Leisure Places and Real Estate Prices

The research on the relationship between the formation of the spatial pattern of fitness and leisure venues in Jinhua and the price of real estate shows that the average price of real estate in the highly dense area of sports venues in Jinhua is 20517 yuan / m², which is 1.23 times the average price of real estate in Jinhua. Among them, the real estate price and the density of sports venues in the distribution area of fitness and leisure venues in Jinhua City show a synchronous increasing relationship. By analyzing the supply sources of five types of fitness and leisure places, it is found that the main supply methods come from social supply and government supply of fitness and leisure places, which have relatively small impact on the fluctuation of real estate prices. Commercial fitness and leisure venues are based on market supply as the main source, and their location and layout are affected by community environmental factors [24]. Higher real estate prices will put greater pressure on their operating costs. In general, the distribution area of various sports venues is 1.23 times the average real estate price in the city, indicating that the formation of the spatial pattern of fitness and leisure venues in Jinhua is positively correlated with regional economic development, human environment and real estate prices.

4. CONCLUSION

Inspired by the theories and methods of comprehensive disciplines such as sports geography and sports humanities and sociology, this paper summarizes and analyzes the spatial pattern, quantity and composition of fitness and leisure places in Jinhua City, and finds that: 1) The overall spatial distribution characteristics of fitness and leisure places in Jinhua City are ' core-periphery ', forming a radiation trend from strong to weak, showing a point-like distribution. 2) The formation of the spatial pattern of fitness and leisure places in Jinhua City has the characteristics of relying on traffic arteries, residential areas, and high-density areas. 3) There is a certain positive correlation between the formation of the spatial pattern of fitness and leisure venues in Jinhua and the real estate price. The housing price in the high-density gathering area is 1.23 times the average housing price in Jinhua. 4) Jinhua fitness and leisure places have good traffic accessibility, and 79 % of fitness and leisure places are located in the 1km buffer zone of traffic arteries.

Through the above mechanism analysis, in order to meet the people 's growing fitness and leisure needs, the following three aspects should be achieved: 1) Speed up the construction of fitness and leisure facilities in the city, promote the accurate positioning of sports facilities, and change the low coverage of fitness and

leisure areas. Problems such as narrow radiation range. 2) Optimize the relevant policies and regulations of commercial fitness and leisure venues, add registration benefits for commercial fitness and leisure venues, and promote the complementarity between commercial fitness and leisure venues and public sports venues. 3) Speed up the construction of urban rail transit, based on rail transit stations, promote the development of surrounding fitness and leisure places, and achieve complementary advantages of resources.

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