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Article

Study on the Accessibility of Community Sports Facilities in Fuzhou, China

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Abstract: With the coordinate data of community sports facilities in Fuzhou and the Geographic Information System platform, this paper developed a research framework of accessibility from three aspects of distribution, service coverage and access equality level. In addition, based on this, this paper analyzed the level and characteristics of the accessibility of community sports facilities within the third ring road of Fuzhou, China. The results showed that the community sports facilities within the third ring road of Fuzhou basically achieved the coverage of being within a ten-minute walking distance, but there were still some deficiencies regarding to the distribution of facilities and the equality level of accessibility. In addition, the results showed poor spatial matching between the number of facilities and population. A shortage of community sports facilities was found in the old central urban area, leading to poor accessibility. It is suggested in this paper that an overall improvement could be carried out through urban renewal.

Keywords: GIS; community sports facilities; accessibility; distribution; service coverage; equality level

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1. Introduction

In 2015, the United Nations Summit on Sustainable Development approved a new agenda called Transforming Our World: 2030 Agenda for Sustainable Development [1], which put forward 17 goals for sustainable development and provided countries with strategic standards for sustainable development. China has also formulated an indicator system for sustainable urban development in China based on SDGs (Sustainable Development Goals) and its own national conditions [2]. One of the goals is to ensure a healthy lifestyle and promote the well-being of people of all ages. The corresponding secondary goal is to ensure the provision of medical and health care, as well as residents' recreational activities [2]. The specific indicator for this goal is the number of mass sports activities. Many studies have proved that regular physical exercise is of great benefit to improving people's physical and mental health and can reduce the incidence of various diseases and psychological problems while promoting health [3–5]. The World Health Organization put forward the vision of More Active People for a Healthier World in the Global Action Plan on Physical Activity 2018–2030, and clearly pointed out that physical activity has multiple health, social and economic benefits and can contribute to achieving the 2030 Sustainable Development Goals (SDGs) [6]. Ever since the Chinese government put forward the National Fitness Plan 20 years ago, China has been committed to promoting the Healthy China Strategy and has formulated policy documents such as the National Fitness Plan (2021–2025) [7] with a determination to build a comfortable and efficient sports environment to promote the comprehensive development of mass fitness activities.

Sports include competitive sports, mass sports and school sports. The corresponding activity space of the three constitutes the urban sports facilities. Among them, mass sports are a type of sports that takes physical exercise and physical entertainment as the means of promoting people to take active physical exercise in daily life. The equipment and places built to accommodate mass sports are collectively called mass sports facilities. The development of mass sports facilities in China is integrated with the concept of national fitness. According to the scale of venues and the level of sports activities, this can be divided into provincial-, municipal-, district- and community-level sports facilities, of which the community sports facilities are the most basic units for building national fitness. Community sports refers to the regional mass sports carried out in a local vicinity under the jurisdiction of the corresponding committee subdistrict offices, taking the natural environment and sports facilities as the material basis to meet the sports needs of community members. The sports fields, venues and supporting buildings planned and built in the community are called community sports facilities, which are the key material components in the implementation of the national fitness program. As the most basic unit of people's lives, community sports naturally become the top priority of sports facilities construction.

At present, the unbalanced and insufficient allocation of community sports facilities and the growing needs of residents for physical exercise are becoming the main contradiction in the development of community sports [8]. Relevant documents such as The Outline of the "Healthy China 2030" Plan and The Opinions on Strengthening the Work of Urban Community Sports issued in recent years have emphasized the need to promote community sports construction. In addition, the promotion of the idea of a "15-min life circle" further integrates community sports facilities into the daily life of the public. A 15-min life circle refers to the range of residential areas divided on the principle that residents' material and cultural needs can be satisfied within a 15-min walk [9]. It can be seen that community sports play a key role in promoting the development of national fitness and building a convenient community life circle. As a component of public service facilities, whether the distribution of sports facilities is reasonable or not is directly related to the fair and efficient allocation of government public service resources, the quantity and quality of public services and whether the goal of "equality of basic public services" can be achieved [10]. Studying the accessibility of community sports facilities can help in understanding whether the sports needs of residents are met and can also objectively evaluate the service capacity and supply quality of community sports facilities. This has realistic guiding significance for the planning and construction of community sports facilities in Fuzhou and other cities of a similar size in China and provides a set of appropriate methodologies for sports enterprises, sports personnel and urban planners in Fuzhou, promotes the development of the Fuzhou sports industry and has a certain practical significance for the popularization of national fitness.

The study of accessibility originated from the classical location theory, aiming to measure the location of a certain element entity point, line or region in space [10]. Hansen put forward the concept of accessibility for the first time and defined it as the possibility of the interaction opportunity of each node in the traffic network [11]. With the wider application of accessibility, its concept and connotations have evolved more flexibly. Different application fields and different research objects have different understandings and expressions towards accessibility. The common definitions of accessibility are listed as follows: (1) accessibility refers to the number of target objects that can be obtained or approached within a certain space; (2) accessibility refers to the degree of difficulty in overcoming spatial resistance; and (3) accessibility refers to the interaction or action potential between spatial points. Accessibility is not only affected by geographical or spatial distance but also by the economy, information and behavior [12]. However, in essence, accessibility describes the "ease of getting from one place to another". How to acquire as many resources and services as possible through minimal effort is the basic law of human activities, and accessibility is an important concept in describing this law. To sum up, with the help of the definition of the accessibility of public service facilities [10], this paper defined the accessibility of community sports facilities as the difficulty of people's access to community sports facilities, focusing on the "quality" and "quantity" of public services in a certain area.

Accessibility can also be divided into location accessibility and personal accessibility. The former refers to the scope of a location or service, which is affected by land use, transportation and other factors; the latter refers to the degree of difficulty for individuals to reach the destination under the constraints of time and space. Accessibility can also be divided into an objective level (transportation or communication accessibility) and subjective level (psychological accessibility) [12]. The subjective level of accessibility is also considered as perceptual accessibility [13,14]. Relevant studies have focused on the differentiation and matching degree of perceptual accessibility and objective accessibility with various measurement methods [8,15,16]. Spatial accessibility emphasizes the spatial attribute of accessibility and ignores non-spatial factors such as personal preferences and stratum [10]. Accessibility research is applicable to a wide range of objects, which can be divided into: (1) Accessibility at the intercity scale. The objects of accessibility research are large-scale transportation networks such as aviation, railway and highway networks [17–19]; (2) Accessibility at the urban scale. This is dominated by various public service facilities, such as public transport facilities [20], medical services [21,22], green parks [12,23], schools [24,25], elderly care [26] and sports facilities [27]. Their accessibility evaluation is an important basis for planning, site selection and urban design [28–30]; (3) Accessibility at the building scale. This includes architectural groups, gardens and indoor spaces. Space Syntax is often used as a measurement tool [31,32]. The research object of this paper was the accessibility of community sports facilities that belonged to public service facilities at the urban scale.

Understanding the influencing factors of the accessibility of public facilities is helpful in selecting appropriate accessibility measurement methods. To sum up, the factors that affect the accessibility of urban public facilities are as follows: (1) The distribution of public facilities. This includes the location and quantity of public facilities as well as the road networks between residents and facilities and the types of vehicles used during the process of getting to the facilities. In the study of accessibility, this is summarized as resistance, with distance, time or cost as the basic factors. Many studies have confirmed that the greater the spatial resistance, the lower the accessibility. Several studies on the accessibility of urban parks have shown that the frequency of public visits to parks decreases with distance [12]; (2) The service capacity of public facilities. The service attribute of public facilities requires them to provide services for citizens conveniently and fairly. In recent years, policies such as the "15-min life circle" and "10-min fitness circle" have been put forward in the research on the planning of public facilities, which is also the guidance strategy to ensure the accessibility of citizens based on the service ability of facilities. In addition, public facilities with a large scale, high grade and stronger service capacity are more attractive to citizens and can attract more people from a longer distance [12]; (3) The characteristics of residents. This includes population data and individual characteristics. Population data mainly refers to the distribution of the population. The layout of public facilities needs to be adjusted according to the population to ensure equal access opportunities. Based on the "people-oriented" concept, more attention must be paid to the equality of accessibility [33]. Therefore, demographic characteristics should also be integrated into accessibility analysis [34–36].

From the main influencing factors of accessibility, the key issues of accessibility research can be summarized into three parts: the starting point, process and destination, each with corresponding measurement methods. (1) Destination. The destination refers to the public service facility. The accessibility can be measured based on the basic characteristics of public service facilities. Common methods include statistical index and kernel density analysis [37]; (2) Process. The core of the definition of accessibility is the resistance during the process of arrival and the difficulty of overcoming the resistance. Therefore, much attention has been paid to finding appropriate methods to evaluate the process. At present, common methods include the buffer zone [36,38], network analysis [39,40] and gravitational model [41,42]; (3) Starting point. The starting point is each urban resident who is the target user of urban public facilities. Under the guidance of the "people-oriented" concept, how public facilities can provide equal services to all citizens reasonably has become the pressing research focus. The equality of accessibility needs to combine the number and distribution of facilities and population to reveal whether access opportunities are equal.

At present, the common research methods are the Gini coefficient [43,44] and location entropy analysis [43].

There has been a considerable amount of research on the accessibility of public service facilities such as health care, education and green facilities. However, there is a lack of documentation that focuses on sports facilities, which is also a component of urban public service facilities, as the main object of study. The attention to community sports facilities is particularly insufficient. Most of the previous studies have focused on the analysis of the equilibrium of accessibility [45–47], ignoring the relationship between the number of people that can be served by the facility and the number of residents within the service scope. Only a few studies have focused on the equality of sports facility distribution [44,46]. In this paper, by summarizing the common research content and influencing factors of accessibility based on existing documents, we constructed the logic and framework of research on the accessibility level and characteristics of sports facilities. Existing studies on community sports facilities in China have mostly been focused on megacities such as Beijing, Shanghai, Guangzhou and Shenzhen, and there is a clear gap in the research on second-tier cites such as Fuzhou, which is so numerous and so representative in China. In order to fill the research gap, this paper selected community sports facilities in Fuzhou as the research object and used ArcGIS to analyze the accessibility of community sports facilities within the third ring road of Fuzhou to explore the existing problems and their causes.

2. Data and Methods

2.1. Study Area

Fuzhou, a typical second-tier city in China, was the experimental city of the second batch of "Double Urban Repairs" and the first batch of "Community Physical Examination". In addition, as a national historical and cultural city with the spatial layout of a "Landscape City" and the central city of the Economic Zone of the West Coast of the Straight, the study of community sports space distribution in Fuzhou had more complexity and particularity. The study area of this research was limited to the area within the 3rd ring road of Fuzhou (Figure 1), including Gulou District, Jin'an District, Taijiang District, Cangshan District and part of Minhou District. Since only a very small portion is located within the 3rd ring road, the Minhou District was not discussed in this paper. Influenced by Fuzhou's efforts to develop urban greenways based on the characteristics of a "Landscape City" in recent years, the current research on public service facilities in Fuzhou has mainly focused on green infrastructure [48,49]. In addition, there are also documents focusing on the planning layout of community activity space for the elderly [50] and the spatial distribution of medical facilities in Fuzhou [51]. Only a few studies have reported on sports facilities in Fuzhou [52,53], revealing the obvious deficiencies in both depth and breadth. Among them, the literature taking community sports as the research object has discussed users' satisfaction [54] and the development mode [55]. No comprehensive analysis on the accessibility of community sports facilities in Fuzhou has been conducted yet.

2.2. Data Sources

The distribution data of non-profit sports facilities managed by subdistrict offices or neighborhood committees were collected and integrated into ArcGIS. Preliminary screening was conducted based on the study area (the area within the 3rd ring road), and intellectual sports facilities such as chess rooms, mahjong clubs and linear sports facilities such as fitness trails, runways and cycling paths were excluded. The reason for excluding linear sports facilities was their large difference from point-type venues in terms of spatial forms and the way people exercise. Furthermore, there are numerous fitness paths of varying lengths that have been built. In contrast, the development of sports venues that provide possibilities for a wider range of sports has been relatively weak. After selection, there were 403 community sports facilities within the 3rd ring road of Fuzhou (Figure 2), and the classification statistics are shown in Table 1. Population data were adopted from the seventh national population census in 2020.

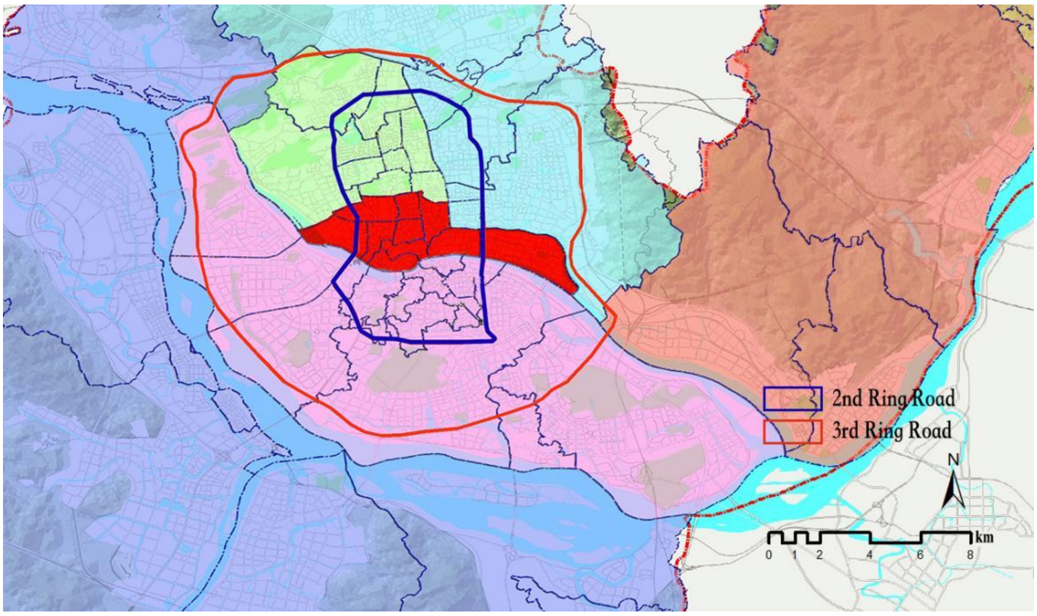

Figure 1. Study area.

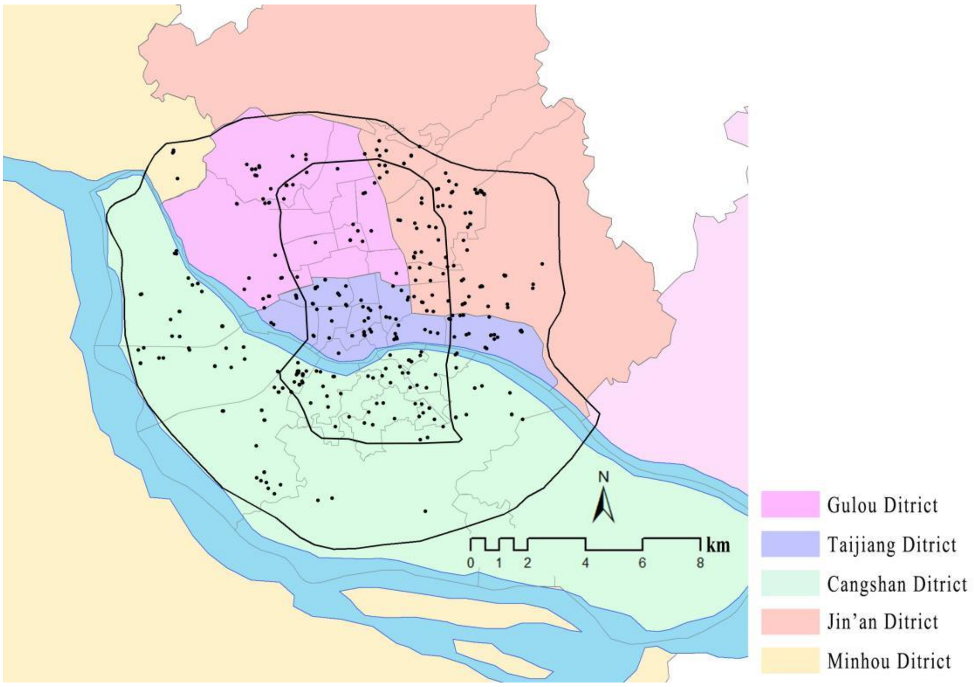

Figure 2. Distribution of community sports facilities in Fuzhou after selection.

Table 1. Statistics of community sports facilities in each administrative district within the 3rd ring road.

	Gulou District	Jin'an District	Taijiang District	Cangshan District	Minhou District	Total
Ball game facilities	34	52	39	85	5	215
Fitness training facilities	5	6	23	47	0	81
Aquatic facilities	14	17	3	23	0	57

Table 1. *Cont.*

	Gulou District	Jin'an District	Taijiang District	Cangshan District	Minhou District	Total
Comprehensive facilities	0	24	0	8	0	32
Other facilities	1	1	16	0	0	18
Total number of public sports facilities	54	100	81	163	5	403
Area inside the 3rd Ring road (km^2)	44.42	38.90	21.27	108.41	4.01	217.38
Supply quantity per land area (PCs/km^2)	1.22	2.57	3.81	1.5	1.25	1.85

2.3. Research Methods

2.3.1. Research Framework

The research on the accessibility of community sports facilities focused on the accessibility of one or several community sports facilities in a certain range of area. Through the literature review, the major factors influencing accessibility were concluded as the distribution and service capacity of facilities and the characteristics of residents, referring to the location, types and number of facilities and the population of each subdistrict from the database used for measurement. The most direct way to reflect the level of accessibility was whether the facilities were evenly distributed in the geographic space and whether there were blank areas or clusters, namely, the distribution of facilities. Furthermore, community sports are the sports venues closest to citizens' life. An essential feature of community sports is that they are integrated into daily life so that it must be guaranteed to arrive at them in a short time, that is, the service coverage of facilities. In addition, it was necessary to combine the usage characteristics of the facilities such as capacity, daily usage frequency and the distribution of residents in the area in order to ensure convenient and comfortable access for all residents, which refers to the equality level of accessibility.

The distribution of facilities, the service coverage of facilities and the equality level of accessibility constitute different aspects of the accessibility of community sports facilities, which were progressive but imperfectly overlapping in the research hierarchy. The distribution of facilities is the most basic and direct aspect of the accessibility of facilities. It is only related to the number and the spatial location of the facilities, which was indispensable for depicting the overall accessibility characteristics. Compared with distribution, the service coverage of facilities was a better indicator of the relationship between spatial distribution and actual use requirements. It demonstrated the access convenience of facilities at each point within the study area. The equality level of accessibility takes target users in and goes further on the basis of distribution and service coverage to improve the deficiency that they do not take the number of people served by each facility into consideration, and it reflects the relationship between facility accessibility and population distribution. However, the equality level of accessibility cannot replace the distribution and service coverage of facilities. All three are different aspects of measuring accessibility, and together they build a more comprehensive research framework combing with the dimensions of space, time and social aspects for the accessibility of community sports facilities (Figure 3). To sum up, this research took Fuzhou city as the case, and took the numbers, types and coordinates of community sports facilities in Fuzhou as the data sources to study the level and characteristics of their accessibility from the three aspects of the distribution of facilities, the service coverage of facilities and the equality level of accessibility.

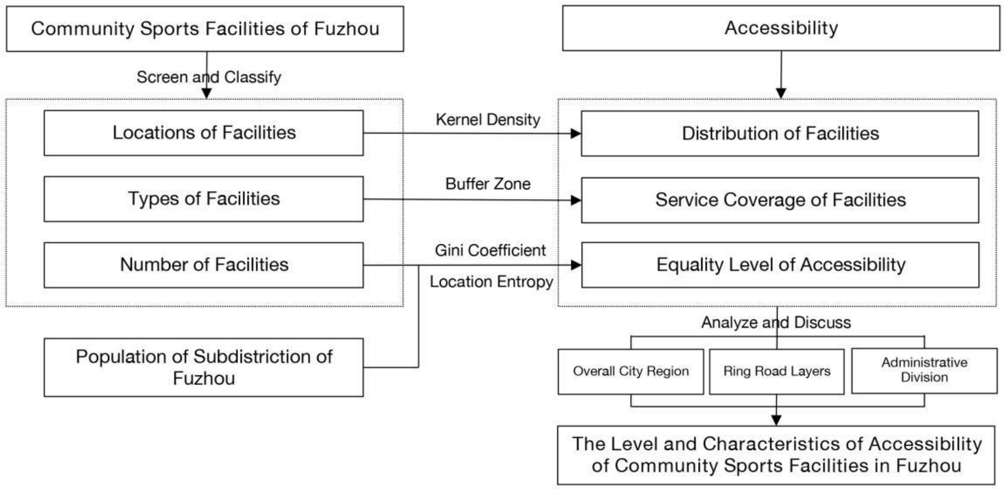

Figure 3. Research Framework.

2.3.2. Research Methods

The research methods were selected from the characteristics of the distribution of facilities, the service coverage of facilities and the equality level of accessibility. Through the literature review, it was seen that the key issues concerned by accessibility studies could be summarized as the starting point, process and destination. In the three aspects of accessibility constructed in this study, the distribution of facilities echoed the destination of accessibility. The data to be measured included the number, location and type of community sports facilities. In this research, we used the kernel density to measure the distribution of facilities. The kernel density analysis originated from point pattern analysis, which is a commonly used analysis method in the field of spatial analysis [56,57]. However, the traditional point analysis model is limited by the homogeneity of the plane space, and it is difficult to reflect the complex urban space situation using this model. Therefore, the cluster-analysis-based method that can be used to characterize the distribution hotspots and the density and trend of point groups has gradually become the mainstream [58]. Kernel density analysis is based on the first law of geography [59], that is, the closer things are, the higher connection they have, which is also known as the "distance attenuation effect" [60]. It is an important statistical analysis method for extracting the distribution characteristics of geospatial facilities. This research used the kernel density analysis tool in ArcGIS to calculate the density of community sports facilities in Fuzhou and conduct the spatial smoothing of discrete data to form a continuous distribution density map, which was used to intuitively display the characteristics and trends of the spatial distribution of community sports facilities in Fuzhou.

The service coverage of facilities can be classified into the measurement factor of accessibility processes. For community sports facilities, the time required for citizens to travel to the nearest community sports facilities is an important factor in evaluating accessibility. Based on this, this paper selected buffer zone analysis as the research method. A buffer zone is a kind of topological data of a spot type. The analysis method for a group or a class of map elements (points, lines or surfaces) to form a polygonal entity with a certain range according to the set distance conditions around this group of elements can directly reflect the real distance around the elements and is often used to solve proximity problems of various types [61]. In addition to the analysis of the service scope of public facilities, buffer zone analysis can also be used to study the radiation impact scope of hazardous materials and resource-sensitive areas [62]. Buffer zone analysis can transform a spatial distance into a process time and combine it with walking speed to reflect accessibility, which is consistent with the construction and promotion of a "ten-minute fitness circle" in the current planning of community sports facilities in Chinese cities. This paper took each facility as the center and drew the service area on a map with the distance of a certain walking time as the radius to reflect the coverage of the facility service area within an adaptable walking time to find the blind areas of service.

The equality level of accessibility is related to the starting point of accessibility. In accessibility studies, the inclusion of target users shifts the accessibility analysis from space-oriented and facility-oriented to user-centered. The maximum number of users of each facility is limited by its capacity, and even when full coverage is achieved in the area, it does not mean that all people in the area can have access to the service. Populations are unevenly distributed in spatial areas with partial aggregation and dispersion. The number of facilities should be increased in population gathering areas to equalize the access opportunity of everyone. One of the methods to measure equality is the Gini coefficient. The Gini coefficient is a comprehensive statistical indicator named after Gini, and it is known as the main indicator for measuring economic inequality in economics [63]. It is also often used to evaluate the fairness of distribution of various types of social resources and public welfare, such as health resource [64,65] and education resource allocation [66]. The Lorenz curve was first proposed by M.O. Lorenz under the inspiration of Leo Chiozza Money [63]. It is a common method for calculating the Gini coefficient. This paper used the Lorentz curve to calculate the Gini coefficient. By using the cumulative percentage of households as the horizontal axis and the cumulative percentage of revenue as the vertical axis, the curve obtained by plotting the correspondence between the two is the Lorenz curve. The calculation of the Gini coefficient is based on the Lorenz curve (Gini coefficient = $A/(A + B)$), which can reflect the degree of social income inequality more intuitively and precisely. The area between the line of perfect equality and the Lorenz curve is A, and the area between the line of perfect equality and line of perfect inequality is A + B. The ratio of the two is called the Gini coefficient. The value of the Gini coefficient is between 0 and 1, where 0 represents absolute equality, while 1 represents absolute inequality. The smaller the value, the more equality it represents, and the larger the value, the more inequality it represents. The Lorenz curve and Gini coefficient can be used to reflect the social equity degree of urban public facilities resource allocation, but they cannot show the specific pattern of spatial matching between the distribution of community sports facilities and the distribution of population. Therefore, this paper introduced the concept of location entropy as a supplement. Location entropy was first proposed by P. Haggett and was applied to location analysis [67]. The location entropy of community sports facilities referred in this paper to the ratio of the community sports facilities resources per capita enjoyed by the population in a spatial unit to the community sports facilities resources per capita enjoyed by all the people in the entire research scope [68]. The calculation formula of location entropy is $LQ_j = (T_j/P_j)/(T/P)$, where LQ_j represents the location entropy in a space unit j, T_j represents the total number of community sports facilities in the space unit j, P_j represents the total number of residents in the space unit j, T represents the total number of community sports facilities in the total study area and P represents the total number of residents in the study area. If the location entropy is greater than 1, the per capita level of community sports facilities in the space unit is higher than the overall level within the entire research scope, and if it is less than 1, it means it is lower than the overall level. In this paper, we combined the Gini coefficient and location entropy to analyze the equality level of accessibility.

3. Results

Based on the previous discussion, in the following text, we analyzed the level and characteristics of the accessibility of community sports facilities in Fuzhou from three aspects: the distribution of facilities, the service coverage of facilities and the equality level of accessibility. The analysis results were compared and discussed from scales of the overall city region, ring road layers and administrative division to present the level and characteristics of accessibility of the community sports facilities in Fuzhou and reveal the problems and shortcomings as well as their corresponding reasons.

3.1. Distribution of Facilities

Using the quantity and coordinate information provided in the Fuzhou community sports facility database and combining them with the population data and the calculation of the statistic index, we could quickly obtain the basic distribution information of the facilities. There were 403 community sports facilities in Fuzhou as of 2021. The average number of community sports facilities per square kilometer within the third ring road of Fuzhou City was 1.85, with an average of 1.42 facilities per 10,000 people.

Then, the coordinate information of Fuzhou community sports facilities was imported into ArcGIS, and the distribution density of the facilities was presented with the kernel density analysis tool. Kernel density was used to estimate the distribution density and identify spatial hot spots, which were classified into five levels using the natural breaks (Jenks) classification method: high-density areas, sub-high-density areas, medium-density areas, medium-low-density areas and low-density areas. Among them, the red zone in the following figure indicates the high-density area of community sports facilities, with only one being shown. The orange zone represents sub-high-density areas, which were mainly concentrated within the second ring road, and low-density areas were mostly located in the outside ring of Fuzhou (Figure 4).

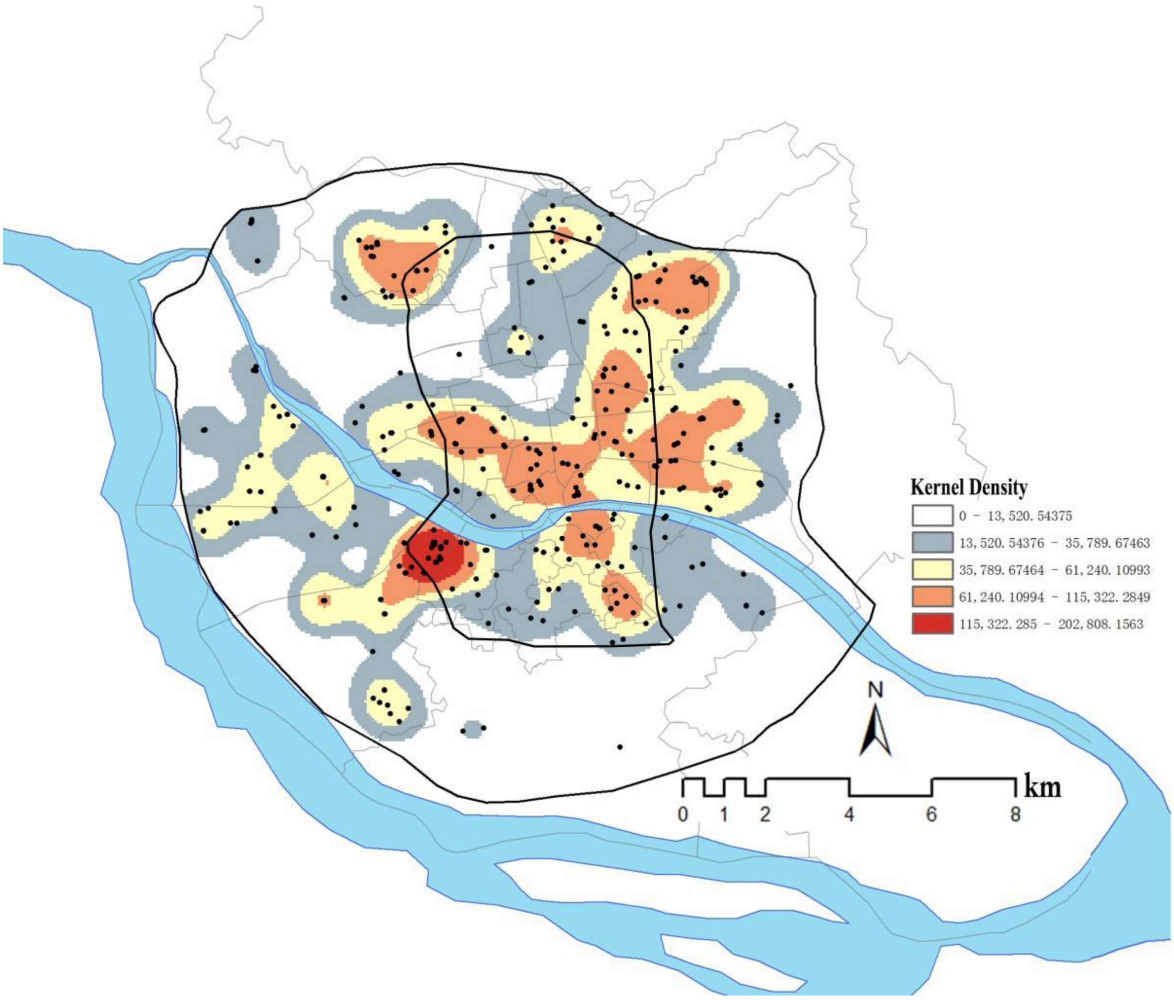

Figure 4. Kernel density estimation.

3.2. Service Coverage of Facilities

This study used buffer zone analysis to measure the service coverage of facilities. The buffer zone analysis in this paper converted the spatial distance into time according to a typical person's walking speed and drew the service radius for each facility with the walking distance of an appropriate time (10 min/5 min), which represented the service range that each sports facility could provide within an adaptable time. Although the buffer zone analysis did not take into account the real road distance and traffic resistance, which could be different from the actual situation, the buffer zone analysis method was still chosen to study the accessibility of community sports facilities in Fuzhou due to its efficient and intuitive calculation and expression. Moreover, it was highly compatible with the current strategy of setting up 10-min/15-min community life circles. ArcGIS was used to make buffer zones of 1000 m and 500 m for the Fuzhou community sports facilities to roughly represent the areas within 10 min/5 min of walking (Figure 5). The 1000 m buffer zone covered 79.31% of the total area within the third ring road and 99.47% of the total area within the second ring road. In addition, the closer to the central urban area, the more comprehensive the coverage was, with the buffer zone within the second ring providing nearly full coverage. However, there were still blank regions in the areas near the third ring expressway. Within the third ring road, the percentage of the area covered by the 500 m buffer zone dropped significantly to only 50.61%, but the percentage of the area within the second ring road still reached 81.18%.

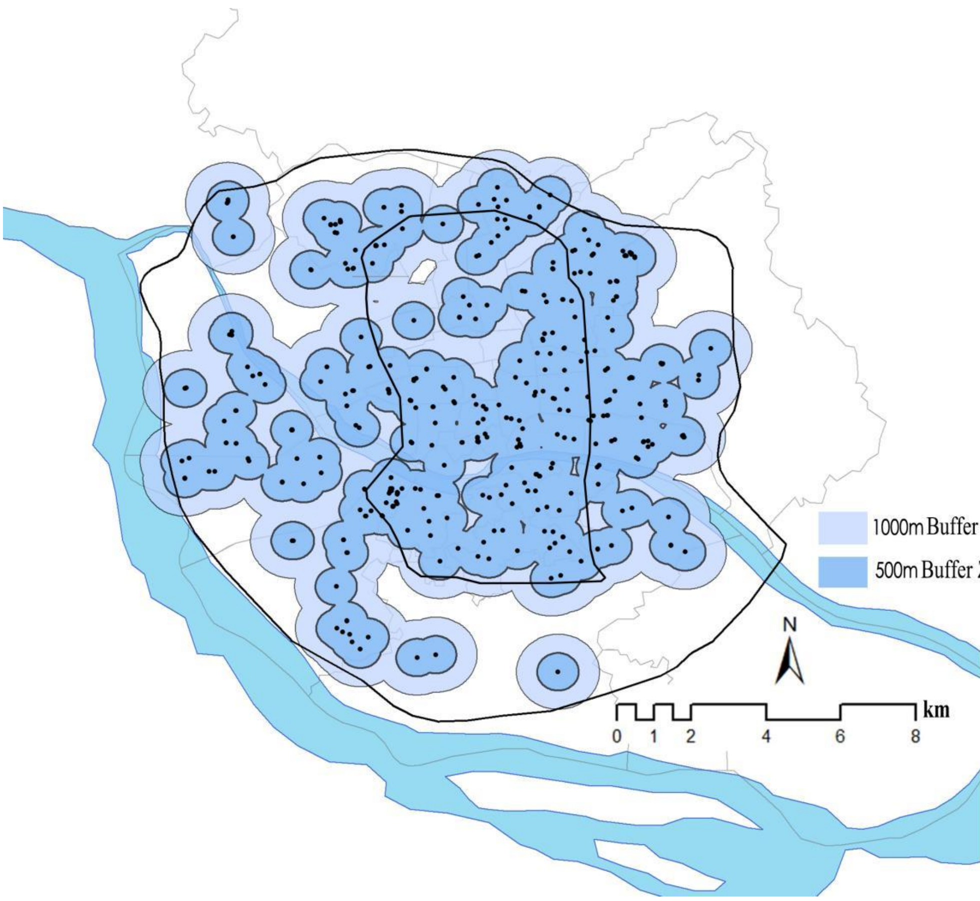

Figure 5. The coverage of 1000 m buffer zone.

3.3. Equality Level of Accessibility

The equality level of accessibility refers to the matching degree between the distribution of facilities and the population. The target users of public service facilities are urban residents, and therefore whether residents can make fair use of facilities is also an important part of evaluating the accessibility. This paper used the Gini coefficient and location entropy to evaluate whether access opportunities were equal.

According to the number of community sports facilities per 10,000 people, the 39 subdistricts within the third ring road of Fuzhou were ranked from the lowest to the highest. In addition, the number of people per 10% of the resident population were taken as an interval for sectional statistics and accumulation, and the cumulative proportion of the corresponding community sports facility resources was finally obtained (Table 2). The 20% of the total citizens with the lowest average number of community sports facilities could only enjoy 2% of the city's community sports facilities. In contrast, the 20% of the total citizens with the highest average number of community sports facilities could enjoy 39% of the city's community sports facilities.

Table 2. Cumulative table of the proportion of resident population sharing community sports facilities resources.

Cumulative Proportion of Resident Population	Cumulative Proportion of Community Sports Facility Resources
10%	0%
20%	2%
30%	7%
40%	13%
50%	23%
60%	33%
70%	47%
80%	61%
90%	78%
100%	100%

The Lorenz curve (Figure 6), drawn according to the data in Table 2, reflected the equality level of the accessibility of community sports facilities resources in Fuzhou, and there was a large gap between the Lorenz curve and the line of perfect equality. According to the calculation formula, the Gini coefficient of the difference in the accessibility of community sports facilities within the third ring road in Fuzhou is 0.372, which represented a relatively reasonable equality level of accessibility according to the international standard of the Gini coefficient, but this was still close to the "warning line" of 0.4.

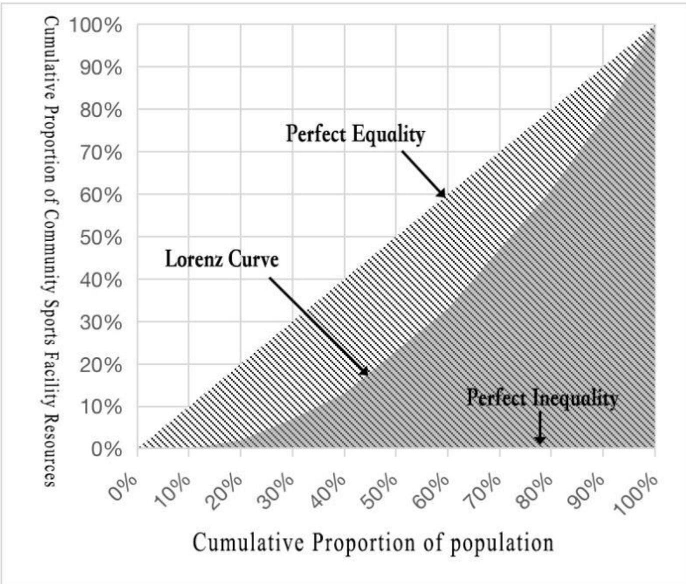

Figure 6. Lorenz curve of resource allocation of community sports facilities in Fuzhou.

After calculating each subdistrict's location entropy according to the location entropy formula, the calculation results were imported into ArcGIS to obtain the location entropy map of the community sports facilities in Fuzhou. According to the natural breaks (Jenks) classification method, it was divided into five levels, and a darker color represented a higher location entropy, or in other words, a better resource possession situation. From the graph, we can see that the subdistricts with a lower location entropy were basically located within the second ring road, mainly in Gulou District, and the areas between the second ring road and the third ring road, especially in Jin'an District and Cangshan District, had a higher street location entropy (Figure 7).

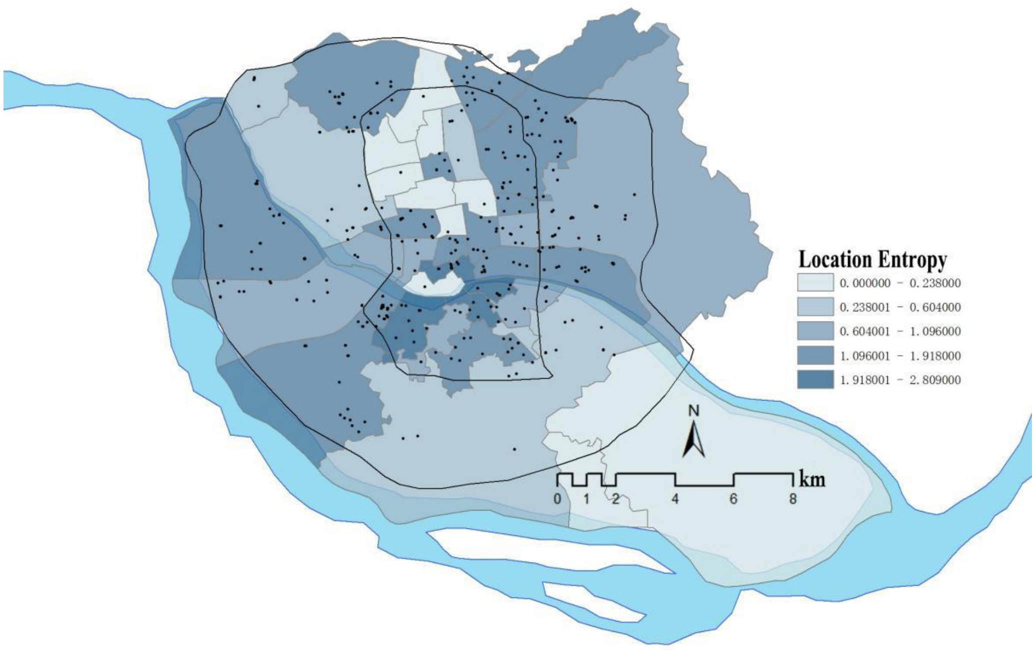

Figure 7. Location entropy distribution map of community sports facilities in Fuzhou.

4. Discussion

4.1. Level and Characteristics of Accessibility of Community Sports Facilities in Fuzhou

Based on the distribution data of the Fuzhou community sports facilities, the above research explored the accessibility of the Fuzhou community sports facilities from the perspectives of distribution, service coverage and equality level, covering the starting point, process and destination of Fuzhou's citizens to the nearest community sports facilities to their residences. In addition to comprehensively assessing the accessibility level of the Fuzhou community sports facilities, the results were also be related to the accessibility factors from these three perspectives, which revealed the reasons that affected the accessibility level and characteristics more directly.

The statistic index and the kernel density showed that the number of community sports facilities was insufficient, and the distribution was unbalanced. In general, the closer to the central urban area, the higher the density, however, there was still blank area in some central areas within the second ring road (Figure 4). There was an obvious uneven distribution of the community sports facilities in Fuzhou, with the yellow region of medium-density areas covering less than half of the whole area. The medium-low- and low-density areas covered more than half of the whole area, indicating that community sports facilities were sparsely distributed in more than half of the areas, and the number of facilities shared by residents in these areas was inadequate. The method of buffer zone analysis was used to examine the accessibility of the community sports facilities in Fuzhou. The coverage of the 1000 m buffer zone reached 79.31%, which meant that nearly 80% of the residents in the area could get to the nearest community sports facilities within ten minutes, reflecting the relatively good level of service coverage of the facilities. By overlaying the kernel density estimation chart with the buffer zone analysis map, it can be seen that the high-density areas were covered by the buffer zone area, while some of the low-density areas were also covered, indicating that some areas had a fair accessibility despite the low distribution density (Figure 8). This showed that in the evaluation of accessibility, both the distribution and service coverage of facilities could only one-sidedly evaluate the accessibility level. The community sports facilities in Fuzhou achieved a relatively good adaptability in terms of the access time but showed a poor equilibrium of the sports facilities. The difference between the two could be further compared to the matching degree of the community sports facilities and population distribution, that is, the equality level of accessibility, for analysis and interpretation. The research results of the Gini coefficient and location entropy were used to measure the equality level of accessibility and showed an unsatisfactory result. The Gini coefficient was 0.372, which was close to the "warning line", and 19/39 subdistricts had a location entropy less than 1, indicating that nearly half of the subdistricts had a per capita occupancy of community sports resources below the average level of the city.

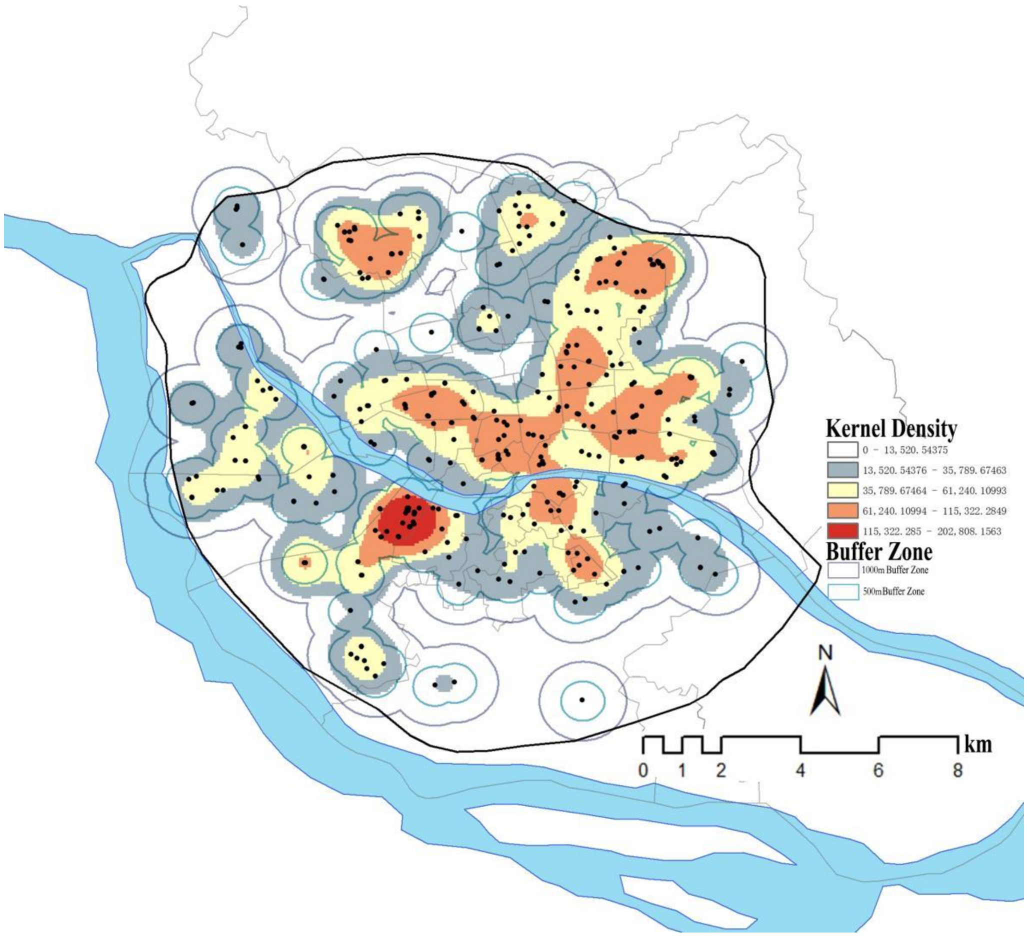

Figure 8. Superposed graph of kernel density estimation and buffer zone analysis.

In general, the accessibility level of the community sports facilities in Fuzhou was not good. The only relatively satisfactory result was obtained in the analysis of the service coverage of facilities. Major deficiencies appeared in the measurement of the distribution of facilities and the equality level of accessibility. The basic reason lay in the lack of community sports facilities. In addition, the equality level of accessibility reflected the matching degree between the number of facilities and the population distribution, which meant that even if the number of sports facilities was sufficient, the equality of accessibility could not be guaranteed. The distribution, service coverage and equality level are equally important in accessibility evaluation. However, the current guidance and policies for the planning of sports facilities in China only emphasize the number of sports facilities and the service coverage of sports facilities [69,70], ignoring the importance of equal access, which may lead to difficulties for some residents to obtain the services provided by community sports facilities.

4.2. The Regional Level and Characteristics of Accessibility of Community Sports Facilities in Fuzhou

The accessibility of the community sports facilities in Fuzhou also reflected significant regional characteristics. The two ring roads of Fuzhou divide the city into the area within the second ring road and the area within third ring road. The aforementioned analysis showed that the area within the second ring road was better than the areas between the second and third ring roads in all three of the aspects of distribution, service coverage and equality level. The red region for the high-density area and the orange region for the sub-high-density areas in the kernel density estimation chart were almost concentrated in the areas within the second ring road, and the coverage rates of the 1000 m and 500 m buffer zones within the second ring road were 99.47% and 81.18%, respectively, while the coverage rates of the kernel density and buffer zones in the areas between the second and third ring roads were significantly lower than those in the areas within the second ring road. The accessibility characteristics of the community sports facilities in Fuzhou in terms of the ring road layers were consistent with the urban development process of Fuzhou. The urban area within the second ring road has been developed for decades and has a higher degree of resident clustering, and the urban public service facilities are more complete, while the area outside the second ring road has been developed later and has a lower distribution degree of various types of public resources, including community sports facilities. This layer feature also appears in relevant distribution studies on public service facilities in other cities, such as in Suzhou [46], Shenyang [39] and Beijing [71].

However, it is worth paying special attention to the fact that there was a blank region in the distribution of community sports facilities in the northwest corner of the second ring road, which was mainly located in Gulou District where the development of community sports facilities was mainly limited by the space of the old city. This led to another important regional characteristic of the accessibility of community sports facilities in Fuzhou, namely the uneven accessibility of community sports facilities in the old urban areas. Fuzhou, also known as the Min Capital, has been developing for more than 2200 years, starting with the construction of Yecheng by Wuzhu, the king of Minyue, in 202 BC, followed by the construction of Luocheng during the Tang Dynasty, Jiacheng during the later Liang Dynasty and Waicheng during the Song Dynasty, forming an urban spatial pattern of “Three Mountains and Two Towers”. The Gulou district has been the capital of Fuzhou since ancient times and remains the political, economic and cultural center. However, the level of accessibility of the community sports facilities in Gulou district was not in line with its central position. The most prominent problem was the lack in terms of the numbers of facilities, with the lowest total of 54, which was 1/3 of the total in Cangshan district. As the urban core of Fuzhou, Gulou District has a large population and therefore the density of public service facilities should be appropriately enhanced. The kernel density estimation showed that there was only one sub-high-density area in Gulou District, with most of the areas being medium-low- and low-density areas, which were extremely unevenly distributed. Among the ten subdistricts with the lowest location entropy, six were from Gulou (Table 3), accounting for more than half of the total number of subdistricts in Gulou, most of them being mainly composed of old communities with long construction dates. However, a large number of people living in the urban core area, which is an area that is supposed to be prosperous and convenient, were unable to enjoy public welfare sports facilities and had to make use of commercial sports facilities or go to other neighborhoods far away for exercise. This was due to the backwardness of the public service facilities in old communities, in which it is difficult to fit enough sports space into confined public spaces. The same problem also occurs in other cities in China. For example, the distribution of community sports resources in Shanghai shows the characteristics of lower density in the city center and higher density along the city's periphery. This is also because the central city has been developed for a long time, with a high population density and complex land use situation, making it difficult to realize matching between the population and facilities [44].

Table 3. Ranking and categories of location entropy.

	District	**Gulou**	**Gulou**	**Gulou**	**Gulou**	**Gulou**	**Gulou**	**Taijiang**	**Taijiang**	**Cangshan**	**Cangshan**
The ten subdistricts with the lowest location entropy	Subdistrict	Antai	Guxi	Gudong	Huada	Nanjie	Shuibu	Cangxia	Chating	Chengmen	Luozhou
	Location entropy	0	0	0	0.174	0.175	0.166	0.199	0.238	0	0
	Category	Subdistrict that are mainly old communities built in earlier years								New urban area in early stages of development	
	District	Cangshan	Cangshan	Taijiang	Cangshan	Taijiang	Taijiang	Jin'an	Jin'an	Taijiang	Taijiang
The ten subdistricts with the highest location entropy	Subdistrict	Shangdu	Linjiang	Houzhou	Cangqian	Aofeng	Shanghai	Yuefeng	Wangzhuang	Xingang	Yingzhou
	Location entropy	2.809	2.347	2.326	2.055	1.918	1.759	1.700	1.691	1.669	1.660
	Category	Subdisricts that are mainly new residential complexes built after 2000 after the urban renewal and new town expansion									

Taijiang District also has a long history. Since Taijiang was developed from the Min River during the Song Dynasty, it has been a place where ships have traveled and merchants have gathered. Both being old urban areas, Taijiang and Gulou showed a clear difference in the level of accessibility of community sports facilities. The average number of community sports facilities in Taijiang was the highest in Fuzhou, and the kernel density estimation showed that Taijiang District as a whole was evenly distributed. Most of Taijiang was composed of sub-high-density areas, and the whole district could be covered by a 1000 m buffer zone, indicating that residents could reach the nearest community sports facility within 10 min. Among the ten subdistricts with the highest location entropy, five were from Taijiang District (Table 3), accounting for half of the total number of subdistricts in Taijiang, further verifying the reasonableness of the accessibility of the community sports facilities in Taijiang District.

The process of Fuzhou urban renewal is one of the reasons for the huge accessibility difference in the community sports facilities between Gulou District and Taijiang District. Beginning with the Chating neighborhood's renewal, Taijiang has experienced the Cangxia shantytown renovation, the urban renewal of the Liuyi Middle Road, the industrial space renewal of the Ninghua and Aofeng Subdistricts, as well as the Shangxiahang historical and cultural district conservation planning. Among those renewal projects, there was the demolition and reconstruction of dilapidated houses, the functional replacement of industrial spaces to financial and commercial spaces and the overall spatial enhancement of the historical and cultural districts. As a result, the urban public facilities and space quality in Taijiang have taken a big leap forward, with a large number of new buildings, green areas and squares offering the possibility of placing sports fields in the community. Due to spatial constraints, Gulou District has experienced a limited transformation area in all successive urban renewal campaigns. Most of the renewal projects in Gulou have been the protective regeneration of historical and cultural districts, and the renewal of old communities has mostly focused on micro aspects such as facade transformation. The contradiction between the space and form required for sports venues and the lack of stock land in Gulou is the main reason for the shortage of community sports facilities accessibility. Therefore, for old urban areas, urban renewal is an effective means for improving the accessibility of community sports facilities, especially under the background that many cities in China are undergoing large-scale urban renewal. Special attention should be paid to the number and layout of community sports facilities to improve the overall accessibility during the process of urban renewal. This has also been mentioned in relevant studies on sports facility planning and guiding policies [72].

By comparison, the accessibility of facilities in new urban areas was more balanced. The urban layout was adjusted to develop to the east and south according to the Fuzhou Urban Master Plan (1995–2010). Cangshan District and Jin'an District are the main administrative districts that have been affected by the "Eastward and Southward Expansion" strategy, where a large number of rural homesteads, farmlands and industrial lands have been transformed into residential area. Located in the south of Fuzhou, Cangshan is the largest administrative district within the third ring road. Except for the newly built large residential areas under the "Eastward and Southward Expansion" strategy, the densely populated areas along the Min River in Cangshan, represented by Shangdu Subdistrict, were comprehensively upgraded in the old housing areas (shantytowns) renovation launched in 2000. In addition, a large number of new residential complexes were also built, and after more than ten years of development these community developments have become quite mature. Compared with the old settlements built in the 1990s, these communities have more ample public space. Meanwhile, having been influenced by the promulgation of The Outline of the National Fitness Plan, some communities have enjoyed a better distribution of community sports facilities as they have begun planning at the early stage. In the kernel density estimation diagram, the only high-density area in the city was in Cangshan District, covering Shangdu Subdistrict and Jinshan Subdistrict. The five subdistricts with the highest location entropy included Shangdu, Linjiang and Cangqian in Cangshan District, and their location entropy was greater than 2. Among them, Shangdu, Linjiang and Cangqian were also the three subdistricts with the best accessibility of medical facilities in Cangshan District [51]. However, the areas along the outer edge of the city near the third ring road mainly consist of the industrial parks of Cangshan District. These areas still need to be updated, including such subdistricts as Jianxin, Gaisan, Luozhou and Chengmen, where the distribution density of community sports facilities was extremely low.

Jin'an District is located in the northeast of Fuzhou. Its regional development has been similar to that of Cangshan District. The east second ring road zone has built a large number of new residential complexes as well as commercial and financial facilities in the urban eastward expansion, which has greatly improved the overall quality of public facilities and space in the area. Wangzhuang and Xiangyuan Subdistricts in Jin'an District have built a large number of new modern communities after the renovation of dilapidated housing in 2009. Compared with the other districts, the accessibility of the community sports facilities in Jin'an was more balanced in all aspects, with it having the second ranking in both the total number and the ground average of facilities, and the five subdistricts in Jin'an had a location entropy greater than 1, indicating that the overall accessibility in Jin'an District was better than normal.

5. Conclusions and Recommendations

5.1. Conclusions

This research took the accessibility of the community sports facilities in Fuzhou as the research topic and adopted the methods of kernel density analysis, buffer zone analysis, the Gini coefficient and location entropy to establish the accessibility analysis framework from three perspectives: the distribution of facilities, the service coverage of facilities and the equality level of accessibility. Through the above analysis, it was found that the overall accessibility of the community sports facilities in Fuzhou was unsatisfactory, especially in the distribution and the equality level of accessibility. This provided specific direction guidance for the improvement of the current situation and for the future development of the community sports facilities in Fuzhou, that is, while increasing the number of facilities, special attention should be paid to the matching of facilities' distribution and population distribution, so as to improve the equality level of accessibility. Only in this way can sports facilities play a greater role and provide fair services to all citizens. From the perspective of regional characteristics, the areas with a weak accessibility of community sports facilities in Fuzhou were located outside the second ring road and in Gulou District located in the old urban areas, which should be the key areas for the follow-up improvement of sports facilities. Based on the discussion of regional development characteristics, it was found that urban renewal plays an important role in improving the accessibility of community sports facilities in old urban areas.

5.2. Strengths and Limitations

This research started from key influencing factors in the accessibility research, namely the starting point, process and destination, and combined the characteristics of community sports facilities to reorganize the three aspects of accessibility, namely the distribution of facilities, the service coverage of facilities and the equality level of accessibility and established the accessibility research framework accordingly. Although these are common contents in accessibility research, by establishing the relationship between these three aspects and the basic elements of accessibility research of starting point, process and destination, the shortcomings of accessibility could be discovered in a more comprehensive and intuitive way, which improved the efficiency and integrity of the accessibility research. This was a thorough approach that was general, applicable to different types of facilities and geographic domains and the measurement methods could be adjusted accordingly. At the same time, combined with the specific analysis of the accessibility of Fuzhou community sports facilities, it was explained that these three aspects were equally important and irreplaceable. The framework based on the three aspects provided a more comprehensive perspective for accessibility research and further refined and classified the research content of accessibility.

However, there were still some limitations in this study. Firstly, the database of this study only contained the number and location data of the community sports facilities in Fuzhou. Therefore, the research and discussion mainly focused on spatial accessibility, and there was no analysis of non-spatial elements. Non-spatial elements are mostly related to perceived accessibility. The accessibility of people in terms of psychological cognition is quite different from that based on spatial elements. In the future, non-spatial elements should be included in the research to further improve the accessibility research framework. Secondly, the data types of sports facilities in this study need to be further enriched, and more types of data should be included such as the area of sports facilities, the number of sports grounds and road network data, which will help to promote the objective degree of the research conclusions and get closer to the actual situation of urban space.

5.3. Recommendations

In response to the current problems in the accessibility of the community sports facilities in Fuzhou, the following recommendations are put forward:

1. The distribution of community sports facilities should match the distribution of the resident population: In addition to further increasing the number of community sports facilities, special attention should be paid to improving the equality level of accessibility. The matching of population with sports facilities has not been fully considered, leading to the inability of community sports facilities to serve all residents in a fair and reasonable manner. As a matter of fact, when increasing the number of community sports facilities, the correlation between the population distribution and facility supply should be fully considered, in order to improve the equality level of access to public resources and effectively increase the frequency and duration of residents' sports exercises to promote the vigorous development of mass sports.
2. Improving the level of the accessibility of community sports facilities through urban renewal: Fuzhou's urban construction is in a double-track parallel development stage of urban renewal and new town expansion, which coincide with the weak areas of community sports distribution in Fuzhou. The regional characteristics analysis showed the positive effect of urban renewal on improving the accessibility of community sports facilities. Planning various public service facilities, including planning

community sports facilities according to the geographical space, facility characteristics and population distribution in the urban renewal process, could effectively improve the current problems in terms of accessibility. The focus of urban renewal is to combine the renewal of old communities and to revitalize the existing land in order to place sports venues. The composite utilization of land and the potential of opening school sports fields to the public could be considered. For communities under the conditions of a limited public space, integrating smart sports facilities could be an effective method. By strengthening the smart operation of sports facilities and combining them with other functions such as recreation and entertainment, lighting and landscaping, community sports facilities could be better integrated into the stock space of old urban areas in a more diverse and flexible way.

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References

1. Sustainable Development Goals. Available online: https://www.un.org/sustainabledevelopment/zh/development-agenda/ (accessed on 1 October 2022).
2. Wang, H.J.; Lan, Z.M. Construction, measurement and evaluation of urban sustainable development index system in China. *Bus. Econ. Res.* **2022**, *7*, 184–188.
3. Bourke, M.; Hilland, T.A.; Craike, M. A systematic review of the within-person association between physical activity and affect in children's and adolescents' daily lives. *Psychol. Sport Exerc.* **2020**, *52*, 101825. [CrossRef]
4. Zulyniak, S.; Williams, J.V.; Bulloch, A.G.; Lukmanji, A.; Patten, S.B. The association of recreational and non-recreational physical activity with mental health: A Canadian cross-sectional analysis. *J. Affect. Disord. Rep.* **2020**, *1*, 100021. [CrossRef]
5. White, R.L.; Babic, M.J.; Parker, P.D.; Lubans, D.R.; Astell-Burt, T.; Lonsdale, C. Domain-Specific Physical Activity and Mental Health: A Meta-analysis. *Am. J. Prev. Med.* **2017**, *52*, 653–666. [CrossRef]
6. World Health Organization. Global Action Plan on Physical Activity 2018-2030: More Active People for a Healthier World: At-A-Glance. 2018. Available online: https://apps.who.int/iris/handle/10665/272721 (accessed on 15 August 2022).
7. Circular of the State Council on Printing and Distributing the National Fitness Plan (2021–2025). Available online: http://www.gov.cn/zhengce/content/2021-08/03/content_5629218.htm (accessed on 1 October 2022).
8. Comber, A.J.; Brunsdon, C.; Radburn, R. A spatial analysis of variations in health access: Linking geography, socio-economic status and access perceptions. *Int. J. Health Geogr.* **2011**, *10*, 44. [CrossRef]
9. Design Standards of Urban Residential Area (GB50180-2018). Ministry of Housing and Urban-Rural Development of the People's Republic of China. Available online: https://www.mohurd.gov.cn/gongkai/fdzdgknr/tzgg/201811/20181130_238590.html (accessed on 17 October 2022).
10. Song, Z.N.; Chen, W.; Zhang, G.X.; Zhang, L. Spatial accessibility to public service facilities and its measurement approache. *Prog. Geogr.* **2010**, *29*, 1217–1224.
11. Hansen, W.G. How Accessibility Shapes Land Use. *J. Am. Inst. Plan.* **1959**, *25*, 73–76. [CrossRef]
12. Liu, C.F.; Li, X.M.; Han, D. Accessibility analysis of urban parks: Methods and key issues. *Acta Ecol. Sin.* **2010**, *30*, 5381–5390.
13. Pot, F.J.; van Wee, B.; Tillema, T. Perceived accessibility: What it is and why it differs from calculated accessibility measures based on spatial data. *J. Transp. Geogr.* **2021**, *94*, 103090. [CrossRef]
14. Khan, A.A. An integrated approach to measuring potential spatial access to health care services. *Socio-Econ. Plan. Sci.* **1992**, *26*, 275–287. [CrossRef]
15. Curl, A.; Nelson, J.; Anable, J. Same question, different answer: A comparison of GIS-based journey time accessibility with self-reported measures from the National Travel Survey in England. *Comput. Environ. Urban Syst.* **2015**, *49*, 86–97. [CrossRef]
16. Scott, M.M.; Evenson, K.R.; Cohen, D.A.; Cox, C.E. Comparing Perceived and Objectively Measured Access to Recreational Facilities as Predictors of Physical Activity in Adolescent Girls. *J. Hered.* **2007**, *84*, 346–359. [CrossRef]

17. Gutierres, J.; Gonzales, R.; Gomes, G. The European High-speed Train Network: Predicted Effects on Accessibility Patterns. *J. Transp. Geogr.* **1996**, *4*, 227–238. [CrossRef]
18. Bowen, J. Airline hubs in Southeast Asia: National economic development and nodal accessibility. *J. Transp. Geogr.* **2000**, *8*, 25–41. [CrossRef]
19. Cross, M.; Nutley, S. Insularity and Accessibility: The Small Island Communities of Western Ireland. *J. Rural. Stud.* **1999**, *15*, 317–330. [CrossRef]
20. Scheurer, J.; Curtis, C.; Mcleod, S. Spatial accessibility of public transport in australian cities: Does it relieve or entrench social and economic inequality? *J. Transp. Land Use* **2017**, *10*, 911–930. [CrossRef]
21. Nobles, M.; Serban, N.; Swann, J. Rejoinder: Spatial accessibility of pediatric primary healthcare: Measurement and inference. *Ann. Appl. Stat.* **2014**, *8*, 1961–1965. [CrossRef]
22. Guagliardo, M.F. Spatial accessibility of primary care: Concepts, methods and challenges. *Int. J. Health Geogr.* **2004**, *3*, 3. [CrossRef]
23. Zainol, R.; Wang, C.; Wood, L.C.; Zulkia, D.R.; Nellis, S. Gis-aided accessibility assessment for community park planning: Youth-friendly neighborhood parks in Subang Jaya, Malaysia. *J. Archit. Plan. Res.* **2017**, *34*, 216–227.
24. Hu, S.; Xu, J.; Zhang, X.; Gao, H. Temporal Accessibility Based Educational Facilities Even Development Evaluation: Huai'an New City Planning Example. *Planners* **2012**, *28*, 14.
25. Han, Y.H.; Lu, Y.L. Accessibility Assessment and Planning of Public Service Facilities for Education: A Case Study on Senior High Schools in Yizheng City. *Sci. Geogr. Sin.* **2012**, *32*, 822–827.
26. Tao, Z.L.; Chen, Y.; Dai, T.Q. Measuring spatial accessibility to residential care facilities in Beijing. *Prog. Grography* **2014**, *33*, 616–624.
27. Xiao, T.; Ding, T.; Zhang, X.; Tao, Z.; Liu, Y. Spatial Accessibility to Sports Facilities in Dongguan, China: A Multi-Preference Gaussian Two-Step Floating Catchment Area Method. *Appl. Spat. Anal. Policy* **2022**, 1–22. [CrossRef]
28. Evans, G. Accessibility, Urban Design and the Whole Journey Environment. *Built Environ.* **2009**, *35*, 366–385. [CrossRef]
29. Papa, E.; Silva, C.; Brömmelstroet, M.T.; Hull, A. Accessibility instruments for planning practice: A review of European experiences. *J. Transp. Land Use* **2015**, *9*, 53–75. [CrossRef]
30. van Heerden, Q.; Karsten, C.; Holloway, J.; Petzer, E.; Burger, P.; Mans, G. Accessibility, affordability, and equity in long-term spatial planning: Perspectives from a developing country. *Transp. Policy* **2022**, *120*, 104–119. [CrossRef]
31. Zhang, H. Analysis on the Accessibility of Green Activity Space on Campus Based on Space Syntax: The Case of Faculty of Information Science in Wuhan University. *South Archit.* **2015**, *1*, 114–118.
32. Cao, W.; Xue, B.; Wang, X.-C.; Hu, L.-H. A Study on the Spatial Organization Characteristics of Ho Family Garden in Yangzhou Based on Space Syntax Theory. *Landsc. Archit.* **2018**, *25*, 118–123.
33. van Wee, B. Accessibility and equity: A conceptual framework and research agenda. *J. Transp. Geogr.* **2022**, *104*, 103421. [CrossRef]
34. Zhang, X.; Lu, H.; Holt, J.B. Modeling spatial accessibility to parks: A national study. *Int. J. Health Geogr.* **2011**, *31*, 10. [CrossRef]
35. Carlson, K.; Owen, A. Accessibility: Distribution across diverse populations. *J. Transp. Land Use* **2021**, *14*, 1209–1224. [CrossRef]
36. Langford, M.; Higgs, G.; Radcliffe, J.; White, S. Urban population distribution models and service accessibility estimation. *Comput. Environ. Urban Syst.* **2008**, *32*, 66–80. [CrossRef]
37. Spencer, J.; Angeles, G. Kernel density estimation as a technique for assessing availability of health services in Nicaragua. *Health Serv. Outcomes Res. Methodol.* **2007**, *7*, 145–157. [CrossRef]
38. Mallick, R.K.; Routray, J.K. Identification and accessibility analysis of rural service centers in Kendrapara District, Orissa, India: A GIS -based application. *Int. J. Appl. Earth Obs. Geoinf.* **2001**, *3*, 99–105. [CrossRef]
39. Li, X.M.; Liu, C.F. Accessibility and service of Shenyang's Urban Parks by Network Analysis. *Acta Ecol. Sin.* **2009**, *29*, 1554–1562.
40. Nicholls, S. Measuring the accessibility and equity of public parks: A case study using GIS. *Manag. Leis.* **2001**, *6*, 201–219. [CrossRef]
41. Yang, Q.; Xu, J. An Analysis Model of Public Service Facilities Based on Attraction Accessibility. *Planners* **2015**, *31*, 96–101.
42. Talen, E. Neighborhoods as Service Providers: A Methodology for Evaluating Pedestrian Access. *Environ. Plan. B Plan. Des.* **2003**, *30*, 181–200. [CrossRef]
43. Tang, Z.L.; Gu, S. An Evaluation of Social Performance in the Distribution of Urban Parks in the Central City of Shanghai: From Spatial Equity to Social Equity. *Urban Plan. Forum* **2015**, *2*, 48–56.
44. Wang, L.; Zhou, K.C. Performance Assessment of the Distribution of Community Sports Facility from the Perspective of Healthy Equity—A Case Study of the Central City of Shanghai. *J. Hum. Settl. West China* **2019**, *34*, 1–7.
45. Wu, W.L.; Li, X.U.; Zhang, Y.Y.; Liu, H.J.; Xu, Y.N. GIS-Based Analysis of the Accessibility of Urban Public Sports Facilities. *Sport. Res. Educ.* **2014**, *29*, 39–43.
46. Ma, X.H. *Research on Spatial Layout of Community Sport Facility Based on General Accessibility—Taking Gusu District of Suzhou as an Example*; Suzhou University of Science and Technology: Suzhou, China, 2019.
47. Xu, K. *Analysis of Accessibility of Community Sports Facilities Based on GIS—Take Hangzhou City West as an Example*; Zhejiang University of Technology: Hangzhou, China, 2017.
48. Huang, H.; Yu, K.Y.; Gao, Y.L.; Liu, J. Building Green Infrastructure Network of Fuzhou Using MSPA. *Chin. Landsc. Archit.* **2019**, *35*, 70–75.

49. Ma, Y.; Ma, Q.W.; Li, M.Y.; Yu, P.Y. Relationship between spatial distribution of urban green infrastructure and residents'behavior of seeking medical treatment on the scale of community life circle—Case study of downtown Fuzhou City. *Landsc. Archit.* **2018**, *25*, 36–40.
50. Ma, Y.; Wu, R.H.; Wang, Z.Y.; Li, M.Y. Study on the planning and layout of community geriatrics based on ABM: A case study of downtown Fuzhou. *Urban Dev. Stud.* **2019**, *26*, 18–25.
51. Liao, Z.Q. *Urban Medical Facilities Spatial Accessibility and Layout Optimization Research—A Case Study in Cangshan, Fuzhou*; Fujian Normal University: Fuzhou, China, 2016.
52. Chen, H. *Research of Resource Utilization of Gymnasiums and Stadiums in Fuzhou City of University*; Fujian Normal University: Fuzhou, China, 2007.
53. Ji, Y.Y. *The Investigation of Fuzhou Sports Park Landscape Construction and Evaluation*; Fujian Agriculture and Forestry University: Fuzhou, China, 2013.
54. Zhang, H. *The Satisfaction and Demand and Personalized Development Path of Community Sports' Public Service—Take Fuzhou Comprehensice Community as Example*; Fujian Normal University: Fuzhou, China, 2014.
55. Zhu, W.L.; Zhu, Q. Patterns of sustainable development for community sports in Fuzhou City. *Fujian Sport. Sci. Technol.* **2003**, *3*, 12–14.
56. Oliveira, D.P.; Garrett, J.H., Jr.; Soibelman, L. A Density-based Spatial Clustering Approach for Defining Local Indicators of Drinking Water Distribution Pipe Breakage. *Adv. Enginering Inform.* **2011**, *25*, 380–389. [CrossRef]
57. Krisp, J.M.; Durot, S. Segmentation of Lines Based on Point Densities:An Optimisation of Wildlife Warning Sign Placement in Southern Finland. *Acid. Anal. Prev.* **2007**, *39*, 38–46. [CrossRef]
58. Yu, W.H.; Ai, T.H. The visualization and analysis of POI features under network space supported by kernel density estimation. *Acta Geod. Gartographica Sin.* **2015**, *44*, 82–90.
59. Borruso, G. Network Density Estimation: A GIS Approach for Analysing Point Paterns in a Network Space. *Trans. GIS* **2008**, *12*, 377–402. [CrossRef]
60. Sheather, S.J.; Jones, M.C. A Reliable Data-based Band- width Selection Method for Kernel Density Estimation. *J. R. Stat. Soc. Ser. B Stat. Methodol.* **1991**, *53*, 683–690.
61. Navinsek, B.; Panjan, P.; Milosev, I. Industrial applications of CrN (PVD) coatings deposited at high and low temperatures. *Surf. Coat. Technol.* **1997**, *97*, 182–191. [CrossRef]
62. Peng, H.; Xu, L.M. Buffer Zone Analysis and Eco-environmental Impact Assessment. *J. Tianjin Norm. Univ. (Nat. Sci. Ed.)* **2004**, *2*, 34–37+48.
63. Xu, K. How Has the Literature on Gini's Index Evolved in the Past 80 Years. *China Econ. Quartely* **2003**, *3*, 757–778. [CrossRef]
64. Zhang, Y.Q.; Tang, G.L.; Wang, W.C.; Liu, L.; Zhao, Z.W.; Guo, B.T.; Wu, Y.Z.; Yi, D. Application of Gini Coefficient and Theil Index in Study on Equity of Health Resources Distribution. *Chin. J. Health Stat.* **2008**, *3*, 243–246.
65. Guo, Q.; Wang, X.H.; Li, X.H.; Ma, H.Y.; Wang, S.; Xu, L.W.; Li, Y.Y. The Lorenz Curve, Gini Coefficient and Their Application Study on Fairness of Resource Allocation for Community Health Services. *Chin. Health Econ.* **2006**, *1*, 50–53.
66. Zhang, C.Z.; Huan, Z.J.; Li, Z.H. An Empirical Study on Education Equality Based on Education Gini Coefficient in China: 1978–2004. *Tsinghua J. Educ.* **2006**, *1*, 10–14+22.
67. Zong, G.; Hu, L.H. Research on the Development of Beijing's Tertiary Industry Based on the Theory of Location Entropy. *China Mark.* **2010**, *13*, 47–49.
68. Zhao, Y.F.; Li, Y.B.; Wang, L. Research on Accessibility and Social Equity of Urban Parks in Ningbo Based on GIS. *Geomat. Spat. Inf. Technol.* **2021**, *44*, 93–97.
69. The Special Plan for Public Sports Facilities in Fuzhou (2018–2035). Available online: http://tyj.fuzhou.gov.cn/zz/zwgk/gzdt_3967/202010/t20201028_3578601.htm (accessed on 1 October 2022).
70. The Planning Outline of "Healthy China 2030". Available online: http://www.gov.cn/xinwen/2016-10/25/content_5124174.htm (accessed on 1 October 2022).
71. Li, J.; Feng, C.C. Spatial Balance Analysis on Urban Public Service in Beijing City. *Areal Res. Dev.* **2017**, *36*, 71–77.
72. Chen, T.T.; Wei, Z.C.; Chen, Z.Y. Spatial Equality of Fitness Facilities and Improvement. *Planners* **2015**, *31*, 17–23.