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Research Article

Accessibility of Rehabilitation Facility: Evaluation Based on Spatial Big Data in Xiamen

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With the help of spatial calculation and numerical analysis, this paper reveals the spatial distribution of rehabilitation infrastructures and the accessibility difference in the city Xiamen. The calculation of Moran's *I*, *Z* value, and *P* value are, respectively, −0.229787, −0.122751, and 0.902304 for health facilities and −0.159235, 0.186166, and 0.852315 for fitness facilities. Such calculation results indicate an uneven pattern and varied accessibility numerical values. The reasons for this influence are diverse, but it is worth noting that the two-step floating catchment area (2SFCA) calculation shows that compared to fitness facilities, the standard deviation of accessibility numerical value of health facilities decreased significantly, which indicates that the accessibility of health service facilities is becoming better, while the change of accessibility of fitness facilities is not obvious. It is pointed out this is due to society's insufficient attention and education on daily health. For better rehabilitation under the pandemic, the importance of fitness facilities should be noticed.

1. Introduction

Currently, with the spread of COVID-19, improving individual immunity is one of the main measures to fight the virus [1]. At the same time, mankind is also facing the pressure of climate change and energy transition [2–5]. Rehabilitation infrastructures such as stadiums play an important role in improving the immunity of individuals, as well as providing important physical facilities for the recovery and rehabilitation of people infected with COVID-19 [6, 7]. Over the past two years, China's COVID-19 prevention efforts have added a lot of rehabilitation infrastructure, both for physical health and routine medical care. A large number of rehabilitation facilities or buildings are also facing new requirements for siting, that is, in a more environmentally friendly way. Specifically, future rehabilitation facilities will need to be built more low-carbon to reduce pressure on energy and transport systems. This is because the starting point of the construction of rehabilitation facilities is to provide convenient and easily accessible services for people, which in essence requires less transportation time. Shorter travel time also means lower carbon emissions. Therefore, the Chinese government has put "accessibility" and "low-carbon (or sustainability)" as the requirements for future rehabilitation facility construction.

The spatial distribution and accessibility of rehabilitation facilities are directly related to the opportunity and convenience of residents to obtain health services and affect the health level and quality of life of residents. The lower accessibility of public leisure and sports facilities will increase the time and cost for residents to obtain health. Especially for vulnerable groups, it will not only increase their living burden but also may reduce the frequency of their access to health, affecting their quality of life [8–12]. In recent years, China's investment in the health service industry continues to increase, but due to the acceleration of urbanization, the new population in medium-sized and large cities continues to increase, making the existing health resources difficult to meet the needs of citizens, and the contradiction between supply and demand becomes more prominent. Therefore, how to carry out accessible and sustainable planning and layout of rehabilitation facilities, improve their accessibility, and resolve the pressures on energy systems has become the research purpose of this paper. According to Wu and Lu [13], the rehabilitation facilities studied in this paper are limited to medical and health facilities and sports and fitness facilities closest to residents' health among rehabilitation facilities. It mainly includes: (1) large and medium-sized rehabilitation facilities within the street scope, such as large and medium-sized hospitals, parks, and squares; (2) health facilities residents can access around the living area, such as clinics, pharmacies, fitness clubs, and so on; and (3) public welfare health and sports centres at all levels, such as public health service centres (stations) and public sports centres (as shown in Tables 1 and 2).

Research on accessibility needs to make use of the concept proposed by Hansen [14]. Accessibility refers to the opportunity for interaction between nodes in the transportation network. Following this concept, there are abundant research on accessibility at present, among which spatial accessibility is the most noted. Spatial accessibility takes distance (space distance or time) as the influence factor and measures the convenience of obtaining facilities and services through relevant calculation models. It can intuitively reveal the balance of spatial distribution of facilities and identify the area of facilities' supply and configuration. At present, most of the emerging research attempts to integrate big data, mobile Internet, and other new technologies. The reason is that a large number of real-time, multidimensional, and spatiotemporal observation data in cities are increasing, such as network review data, POI data, mobile phone positioning data, real-time internet map data, and so on. Compared with traditional data, POI data has the advantages of large data volume, strong timeliness, and high accuracy, which greatly improves the convenience and scientificity of relevant research [15]. For example, Hou and Chen [16] believe that land use data are greatly limited by timeliness, so it adopts POI data provided by Baidu and the kernel density method to consider commercial-road intersection points, which ultimately improves the accuracy of identifying commercial centres in Nanjing. Wang et al. [17] used POI data to study the distribution of stadiums and gymnasiums in Nanjing, found that the accessibility and fairness indices of public sports facilities in Nanjing differed greatly, and verified this conclusion with LISA and Moran index. The analysis of W. Wang and M. Wang [18] and other studies on finance, tourism, and rural settlements also used POI data and related concepts of geographical accessibility, which ultimately provided a good reference for local policymaking. The use of such emerging data sources makes it possible to study the situation of individuals or populations at microcosmic and spatial scales, including their daily behaviour, disease or health status, choice of health services, and relationship with various environmental factors.

There are many research results available in this field, and the techniques used are sufficiently diverse. However, due to differences in time and space, it is not known whether the research results obtained are applicable to some rapidly developing regions, such as the chosen study area Xiamen in this paper. Xiamen city is located in east China and southeast of Fujian Province. From the island (Xiamen Island), Gulangyu island, west Coast Haicang Peninsula, North Jimei Peninsula, East Coast Xiang'an Peninsula, Dadeng Island, Xiaodeng Island, inland Tongan, Jiulong River, and other components. By 2020, Xiamen has six districts under its jurisdiction, with a total land area of 1,700.61 square kilometres and a sea area of more than 390 square kilometres. The built-up area covers 397.84 square kilometres (Figure 1). According to the 7th National Census, Xiamen has a permanent population of 5,163,970 as of midnight on November 1, 2020. In 2020, Xiamen achieved a GDP of 638.402 billion RMB. Xiamen, as an excellent tourist city in China, is rich in tourist resources. In 2019, it received 100,128,700 domestic and foreign tourists, an increase of 12.5% over the previous year. However, Xiamen, as an important coastal city in China, is also one of the regions where the virus is most likely to spread, despite its economic growth and rapid urbanization due to its abundant tourism resources. The health of residents in the region plays an important role in the prevention and control of the epidemic in inland China and other neighbouring provinces, which is why Xiamen has become one of the regions with the most health policies for residents. In the plans of livelihood facilities announced in 2020, there are four major livelihood plans: Xiamen's near-term construction plan for educational facilities (2019–2023), Xiamen's medical and health facilities plan (2020–2035), Xiamen's recreation and sports facilities plan, and Xiamen's regional tourism plan. Among them, the concept of "Healthy Xiamen" is emphasized in the planning of health and sports facilities.

Considering the importance of Xiamen, we believe that it is necessary to investigate the situation of rehabilitation facilities in this area with spatial methods. Previous studies have proved that advanced big data technologies based on Python and other platforms provide great data collection assistance for spatial analysis. This enables our research to refer to previous studies, such as Hou and Chen [16] and Wang et al. [17]. This paper therefore argues that by conducting a study of rehabilitation facilities closely related to residents' health in this representative region, the spatial distribution and accessibility differences of rehabilitation services can be visually revealed, so as to provide a reference for policymakers to optimize the layout. The second part of this paper is the introduction of our spatial analysis methods; the third part is the analysis and discussion of this paper; and the fourth part is the conclusion.

2. Materials and Methods

2.1. Spatial Autocorrelation Method. Common methods to measure spatial clustering characteristics of geographic point data include the spatial autocorrelation method and variation coefficient of the Voronoi polygon area, among

Table 1: Quantity distribution of rehabilitation facilities in Xiamen.

Districts	Medical	Sports	Total	Proportion (%)
Siming District	1,885	1,499	3,384	31.42
Haicang District	579	399	978	9.08
Huli District	1,263	802	2,065	19.18
Jimei District	1,057	789	1,846	17.14
Tong'an District	1,016	493	1,509	14.01
Xiang'an District	617	370	987	9.17
Total	6,417	4,352	10,769	100.00

Table 2: Components of rehabilitation facilities in Xiamen.

Classifications	Subclassifications	Quantity	Total	Proportion (%)
Medical facilities	Emergency centre	7	6,420	59.49
	Disease prevention agency	10		
	Health care service places	1,504		
	Medical and health care sales shop	2,600		
	Clinic	1,216		
	Specialized subject hospital	771		
	The general hospital	183		
	Other medical facilities	129		
Sports facilities	Vacation and health resort	78	4,372	40.51
	Large outdoor stadium	13		
	Park plaza	31		
	Sports and leisure service places	720		
	Leisure and rehabilitation places	523		
	Commercial fitness facilities	1,205		
	Sports venues	1,648		
	Other sport-related facilities	154		

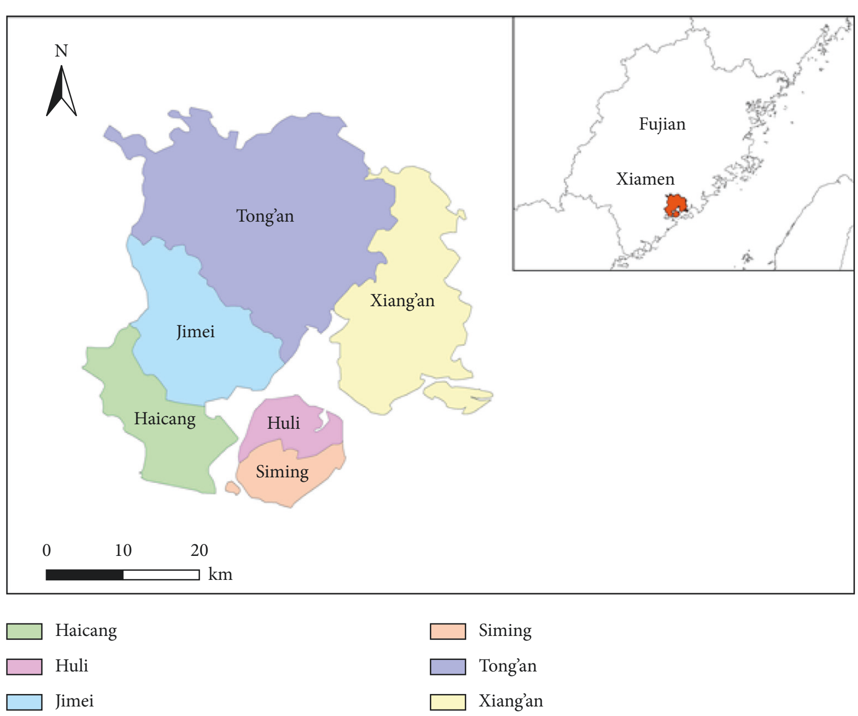


Figure 1: Location of Xiamen city.

which the spatial autocorrelation method is a relatively mature research method [19, 20]. The spatial autocorrelation method is used as an indicator for exploratory spatial analysis to test spatial correlation and agglomeration problems, which can reflect the similarity between individual geographical units and neighbouring geographical units throughout the study area. As the main objective of this study is to provide statistics on the accessibility of urban recreational and sports facilities to the residents of Xiamen, the Moran index of urban facilities using the spatial autocorrelation method is the simplest and most accurate way to calculate the relationship between spatial distance and the influence of facilities. In order to analyze the spatial clustering degree of public recreation and sports facilities in Xiamen, Moran's I index, a commonly used global autocorrelation index, was used to test whether the public recreation and sports facilities in Xiamen had the clustering characteristics as a whole. The following calculation formula of Moran's I index is adapted from Xue et al. [21]:

$$\text{Moran's}\, I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}(Xi-\overline{X})(Xj-\overline{X})}{S^2\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}}, \tag{1}$$

where $S^2 = 1/n\sum_{i=1}^{n}(Xi-\overline{X})^2$; $\overline{x} = 1/n\sum_{i=1}^{n}x_i$; Xi and Xj are the numbers of public rehabilitation facilities in the i and j streets respectively; Wij represents the spatial weight matrix of each street; and n is the total number of streets.

The value range of Moran's I is $[-1, 1]$. If global Moran's $I > 0$, it indicates that there is a spatial positive correlation between the research objects, that is, the values of the research objects in space are high-high adjacent or low-low adjacent. Moran's $I < 0$ indicates that there is a spatial negative correlation phenomenon, that is, the value distribution of the research object is high-low adjacent in space. Moran's $I = 0$ indicates that there is no correlation between research objects. According to the above analysis, this paper uses GeoDa to calculate Moran's I of "medical and health" facilities and "sports and fitness" facilities in Xiamen.

2.2. Kernel Density. Spatial autocorrelation analysis can only distinguish the spatial clustering degree of geographic point data but cannot identify its distribution. According to the research findings of scholars, the kernel density method is more advantageous than other density expression methods (such as Voronoi diagram density, etc.) in the characterization of POI characteristics due to the location influence of Tobler's First Law of Geography. In view of this, the kernel density estimation method is used to analyze the spatial distribution of public recreation and sports facilities in Xiamen. The kernel density method was first proposed by Rosenblatt in 1995 and Emanuel Parzen in 1962. The calculation principle is to obtain the graph of the continuous change of the density of the research object by assigning different weights to the research elements. According to Bai et al. [22], its expression is

$$f_n(x) = \frac{1}{nh}\sum_{i=1}^{n}K\left(\frac{x-x_I}{h_n}\right), \tag{2}$$

where n is the number of samples, h_n is the bandwidth, and $K(X - x_i/h_n)$ is the kernel function. In this paper, Kernel density estimation under the Spatial Analyst tool of ArcGIS 10.2 is used to measure and analyze the Kernel density of Xiamen's public rehabilitation facilities, and finally, the spatial distribution characteristics of Xiamen's public recreation and sports facilities are obtained.

2.3. The Two-Step Floating Catchment Area (2SFCA) Method. The two-step floating catchment area method calculates the accessibility of public service facilities in two steps based on supply place and demand place. In terms of calculating accessibility, 2SFCA has been proved to be a spatial computing method with high accuracy. We use it mainly because the purpose of this article fits the concept of 2SFCA. Specifically, the attenuation of facility service capacity with distance is considered, and the effective search radius is increased [23]. The specific calculation steps are as follows:

Step 1: Take the centre of gravity of each supply place j, select or assume a space distance d_0, form its space scope, and calculate the number of demanders at each demand point k within this scope. By referring to the Gauss equation and adding up the weights, the number of potential demanders of supply place j can be obtained, and then the area of supply place is divided by the total number of potential demanders to calculate the supply-demand ratio R_j as follows:

$$R_j = \frac{S_j}{\sum_{k\in\{d_{kj}\leqslant d_0\}}G(d_{kj}, d_0)P_k}, \tag{3}$$

where d_{kj} is the distance between demand point k and supply point j, d_0 is the space distance set by the supply ground, P_k is the number of demanders (i.e., $d_{kj}\leqslant d_0$) in the search area, S_j is the total supply of point j, and $G(d_{kj}, d_0)$ is the distance decay function of the influence of point source elements on space elements, namely Gaussian equation, and the calculation method is shown in the following equation:

$$G(d_{kj}, d_0) = \begin{cases} \dfrac{e^{-\frac{1}{2}\times\left(\frac{d_{kj}}{d_0}\right)^2} - e^{-\frac{1}{2}},}{} & d_{kj}\leqslant d_0 \\ 1 - e^{-\frac{1}{2}}, & d_{kj} > d_0 \end{cases} \tag{4}$$

Step 2: For each demand place i, given space distance d_0, its space scope is formed. The supply-demand ratio R_l of supply place l falling within this scope is weighted by the Gaussian equation, and then the weighted ratio is added up to obtain the spatial accessibility A_i^F of demand place i.

$$A_i^F = \sum_{l\in\{d_{il}\leqslant d_0\}} G(d_{kj}, d_0)R_l, \tag{5}$$

where R_l is the supply-demand ratio of supply point i in the search area ($d_{il} \leqslant d_0$) of demand place (l) and d_{il} is the distance between the demand point i and the supply centre of gravity l. Other indicators are the same as equation (3). The larger A_i^F is, the more accessible it is. The spatial accessibility then was calculated by such Gaussian 2SFCA method. The two-step floating catchment area method can be interpreted as the number of rehabilitation facilities per capita in the research unit.

3. Results and Discussion

3.1. Overall Characteristics. In this paper, GIS spatial analysis was used to analyze the kernel density of 10,769 rehabilitation facilities in Xiamen. A total of 10,769 items of data in this paper were obtained from China AutoNavi Map by Python, and all data are open source. This method of data acquisition has been widely adopted by geographical literature in recent years, mainly because of its timeliness and accuracy. The present study followed Wang et al. [24] to realize the data acquisition from China AutoNavi Map. As shown in Figure 2, the calculation of Moran's I, Z value, and P value are, respectively, −0.229787, −0.122751, and 0.902304 for health facilities and −0.159235, 0.186166, and 0.852315 for fitness facilities. Such calculation results indicate an uneven pattern and varied accessibility numerical values. Apart from Moran's I, one of the main factors affecting the estimated kernel density is the distance threshold. After several tests, the distance threshold (bandwidth) was selected as 1 km to generate the kernel density distribution map of rehabilitation facilities in Xiamen (Figure 3). According to the analysis, the number of clustering areas of rehabilitation facilities in Xiamen are divided into five levels: extremely high density, high density, medium density, low density, and extremely low density. Among them, the intersection area of Huli District and Siming District belongs to extremely high-density and high-density area of quantity distribution. The agglomeration areas of urban business centres in other administrative regions, such as Haicang, Jimei, Tong'an, and Xiang'an, are high- and medium-density distribution areas of rehabilitation facilities. As the distance from the commercial centre increases, rehabilitation facilities outside the city are mostly distributed in low-density and extremely low-density areas. In general, the kernel density distribution of rehabilitation facilities in Xiamen is "high in the south and low in the north, high on the island, and low on the coast." There is a serious imbalance in spatial distribution, and the distribution of nucleus density of rehabilitation facilities on the island is much higher than that in inland areas.

Considering that rehabilitation facilities include medical and health facilities and sports and fitness facilities and the nature and spatial distribution of each type of facility are quite different, the accessibility results of these two types of rehabilitation facilities are analyzed.

4. Spatial Accessibility of Medical Type

4.1. Shortest Space Distance. The calculation results of spatial accessibility of medical and health facilities in urban areas of Xiamen are shown in Figure 4(a). The spatial distance between the centroid of each street and the point of public medical and health facilities in the main urban area of Xiamen is 0.261642~207.0575 km. Among them, Xinglin Station, Xiamen North Railway Station, Xiamen North Railway Station, Xiamen Gaoqi Station, and Xiamen Gaoqi International Airport have the shortest distance to public medical facilities, indicating that they have the best spatial accessibility. The accessibility to public medical facilities in Haicang, Jimei, Tong'an, and the northern part of Xiang'an was the worst, with the average space distance exceeding 50 km.

4.2. Shortest Time Distance. The calculation results of the time accessibility of public medical and health facilities in the main urban area of Xiamen are shown in Figure 4(b). The time from the centroid of each street to the point of public medical and health facilities in the main urban area of Xiamen is between 0.34 and 58.73 min. Among them, the medical and health centre in Huli Street and Fengnan Farm in Tong'an District have the shortest time and the best accessibility. The least accessible is Tingxi Town Medical and Health Center in Tong'an District, which takes 58.73 minutes.

To sum up, it can be seen from Figures 4(a) and 4(b) that the spatial accessibility of medical and health facilities in Xiamen is unevenly distributed. Medical and health facilities with high spatial and temporal accessibility are evenly distributed in the central part of Xiamen city and Siming District and Huli District in the south. Low accessibility is distributed in the eastern, northern, and western peripheral areas of Xiamen city. From the results of spatial distance accessibility and temporal distance accessibility, the spatial similarity between them is relatively high. The results show that the medical facilities themselves are the main factors affecting accessibility. This is mainly due to the convenient transportation in the central urban area and the shorter distance for residents to travel.

5. Spatial Accessibility of Sports Type

5.1. Shortest Space Distance. The calculation results of spatial distance accessibility of sports and fitness facilities in Xiamen are shown in Figure 5(a). It can be concluded from calculation results that the spatial distance between the centroid of each street in Xiamen and the points of rehabilitation facilities is between 0.043607 and 34.50959 km. The spatial accessibility is the best in the central part of Xiamen city, the southern part of Xiang'an District, and the border area between Siming District and Huli District, while the accessibility is the worst in Jimei District, the northern part of Tong'an District, and the north-eastern part of Xiang'an District.

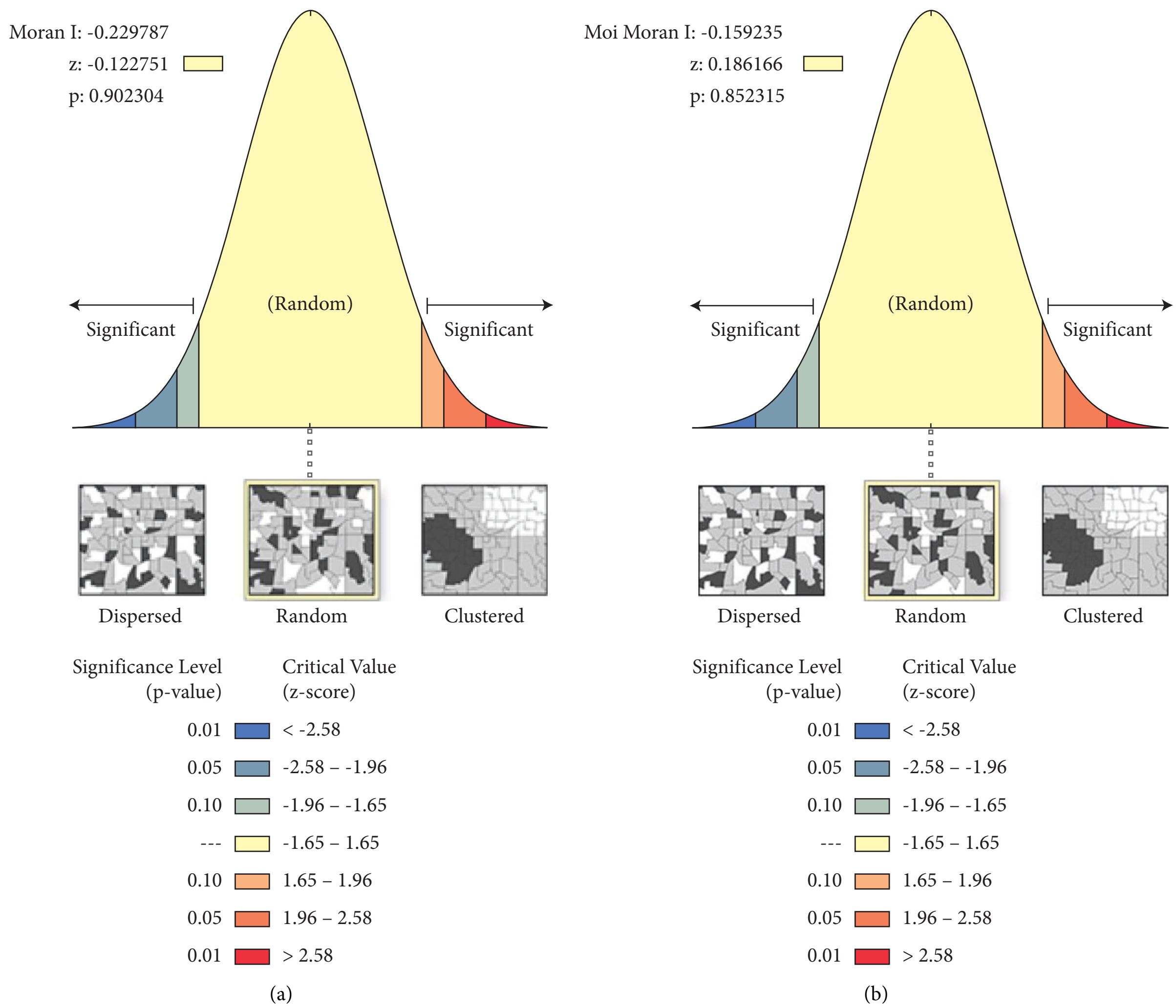
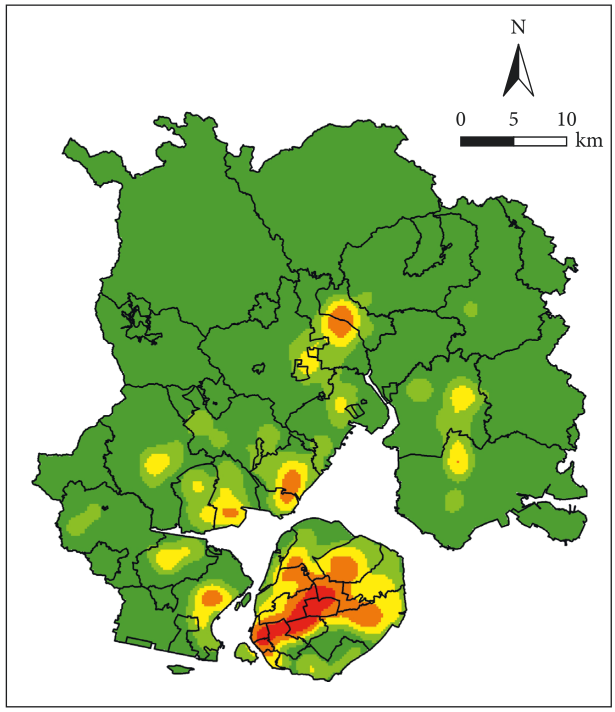


FIGURE 2: Spatial autocorrelation results: (a) medical and (b) sports.

5.2. Shortest Time Distance. The calculation results of the time accessibility of public sports and fitness facilities in Xiamen are shown in Figure 5(b). It can be seen from calculation results that the time from the centroid of each street to the point of public sports and fitness facilities in Xiamen ranges from 0.26 min to 136.19 min. Among them, Siming District and Huli District, the two main island areas of Xiamen, have the best time accessibility, basically meeting the standard of 15 min life circle. The worst time accessibility is the public sports and fitness facilities in the peripheral areas of Xiamen city.

Combined with Figures 5(a) and 5(b), it can be found that the spatial accessibility distribution of public sports facilities in Xiamen presents obvious spatial heterogeneity: public sports and fitness facilities with high spatial distance accessibility and time accessibility are evenly distributed in Siming and Huli Districts, the main island in the south of Xiamen. The areas with low accessibility are distributed in the peripheral areas of land cities in Xiamen. The results of spatial accessibility and temporal accessibility of sports and fitness facilities are similar to those of medical and health facilities, that is, they are almost the same in space, which also indicates that the factors of sports and fitness facilities themselves are the main factors affecting accessibility. The spatial similarity of public sports and fitness facilities is high, which indicates that the main factor affecting accessibility results is public sports and fitness facilities themselves. This is mainly because the distribution area of sports and fitness facilities are located in the economically developed, convenient transportation, and densely populated urban centre; therefore, its accessibility is high.

5.3. Accessibility of Public Medical Facilities. According to the results of spatial accessibility calculated with a travel limit time of 15 min (as shown in Figure 6(a)), it is obvious that the spatial accessibility of public health service facilities in Xiamen varies greatly with low continuity and uneven distribution. The values of accessibility ranged from 0.000025 to 0.779099, with an average value of 0.155825. The most accessible streets were Wucun Street and Yundang Street in Siming District, Huli Street in Huli District, and Haicang Street in Haicang District. The streets in Xiang'an and Tong'an Districts and some streets in Jimei District are the worst in accessibility.



Kernel Density

- 0 - 76,046.375
- 76,046.376 - 248,879.047
- 248,879.048 - 490,844.787
- 490,844.788 - 926,383.12
- 926,383.121 - 1,755,979.943

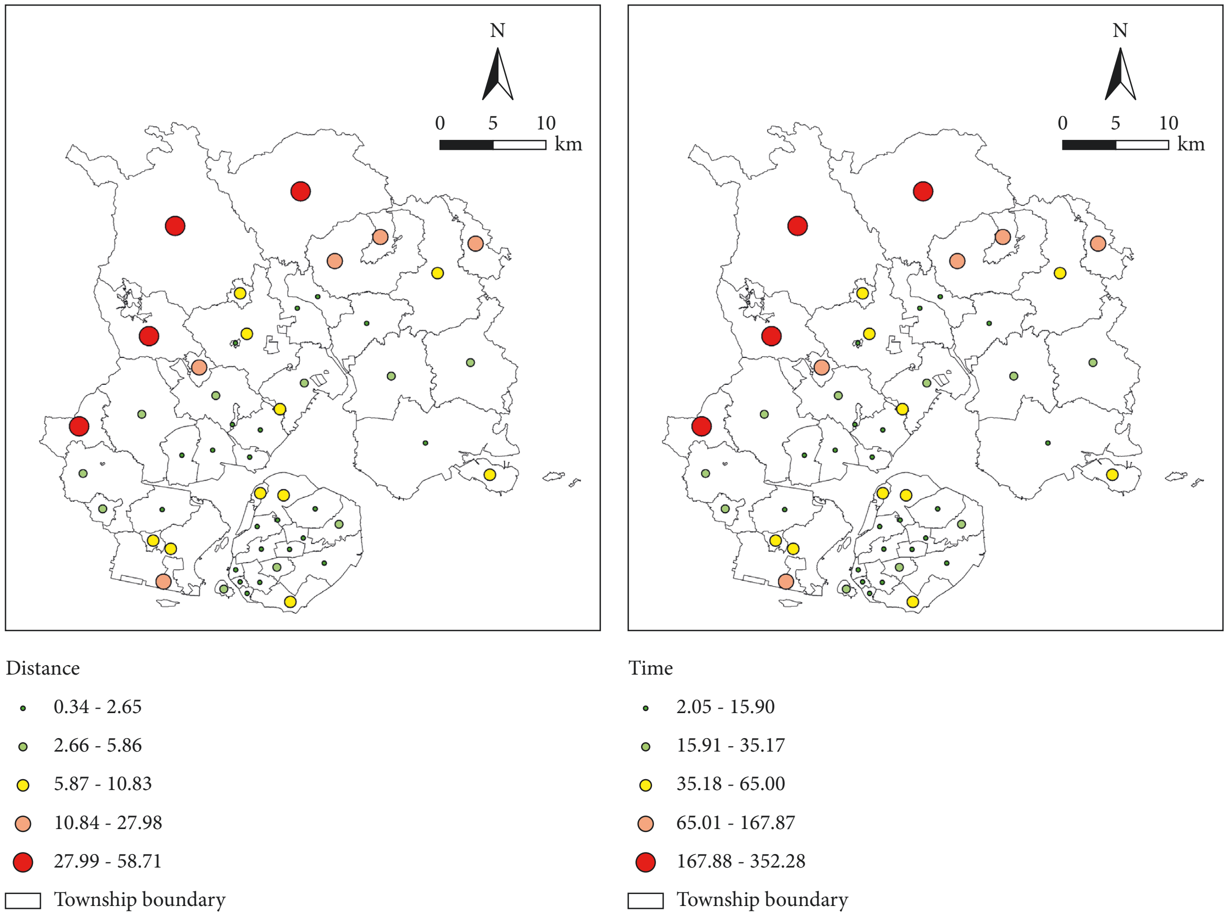
Figure 3: Kernel density.

As shown in Figure 6(b), the spatial accessibility of public health service facilities in Xiamen is distributed between 0 and 0.165415, with an average value of 0.033083, according to the results of spatial accessibility calculated with 30 min as travel limit time (Figure 6(b)). Yuandang in Siming District had the highest accessibility value (0.165415). The street with the worst accessibility has an accessibility value of 0, which is Lianhua Town in Tong'an District.

A comparative analysis of Figures 6(a) and 6(b) shows that: (1) with the increase in time distance, spatial accessibility of public health service facilities in Xiamen becomes better. As travel time increases and the range of public health services expands, residents have more opportunities to choose medical treatment. (2) The accessibility of marginal streets in Xiamen decreases with the increase of time distance. On the contrary, some streets in the central urban area showed a trend of improvement, and the accessibility increased significantly from 15 min to 30 min. (3) With the increase of time distance, the change of accessibility value tends to be slow, and the difference in spatial accessibility of public health service facilities becomes smaller. The standard deviation of accessibility decreases from 0.010300 for 15 min to 0.009707 for 30 min, indicating that the spatial difference of accessibility decreases with time and the degree of spatial smoothness increases.

5.4. Accessibility of Public Sports Facilities. The spatial distribution of accessibility of public fitness facilities in Xiamen is uneven and different in each district according to the results of spatial accessibility calculation based on the travel limit time of 15 min. The values of time accessibility ranged from 0 to 0.600522, with an average value of 0.120104. According to Figure 7(a), the streets with the best accessibility were Wucun Street in Siming District and Huli Street in Yundang District. The streets with the worst accessibility were Lianhua Town in Tong'an District, Fengnan Farm, and Xindian Street in Xiang'an District.

According to the results of spatial accessibility calculated by taking 30 min as travel limit time, the accessibility of public fitness facilities in Xiamen is characterized by uneven spatial distribution and great difference. The values of time accessibility ranged from 0 to 0.480081, with an average of 0.096016. As can be seen from Figure 7(b), Wucun Street in Siming District and Dianqian Street in Huli District have the



(a) (b)

Figure 4: Accessibility of public medical facilities: (a) distance accessibility and (b) time accessibility.

best accessibility, while Lianhua Town, Fengnan Farm, and Xindian Street in Xiang'an District have the worst accessibility. It shows that the accessibility of fitness clubs in Xiamen city has obvious spatial differentiation.

By comparing Figures 7(a) and 7(b), it can be seen that: (1) overall, the spatial accessibility of public fitness facilities in Xiamen has a little change, and even some streets have no change. For example, the accessibility of Lianhua Town, Fengnan Farm, and Xindian Street in Xiang'an District is always the worst, indicating that the accessibility is greatly affected by the number and spatial location of fitness clubs. (2) The accessibility of the marginal streets in Xiamen becomes worse with the increase of time, while the accessibility of some streets in the central city increases. (3) With the decrease in accessibility, the spatial accessibility difference of public fitness facilities tends to narrow. According to the calculation results of accessibility for 15 min and 30 min, the standard deviation of accessibility decreased from 0.007316 for 15 min to 0.004251 for 30 min, indicating that the spatial difference of accessibility had a narrowing trend, but this trend was not obvious in space.

5.5. Discussion: Causal Relationship. Based on the above results, it can be found that in Xiamen, compared with public fitness facilities, the standard deviation of the accessibility of public health service facilities is significantly lower, indicating that the accessibility of public health service facilities is improving, while the accessibility of public fitness facilities does not change significantly. This result raises concerns about rehabilitation in the context of the pandemic. Although the importance of health care facilities is obvious, urban planning is often closely related to the needs of the public. Therefore, exploring the inadequacy of fitness facilities requires more consideration of residents. Understanding the reasons why residents do not like to exercise will help us provide more detailed guidelines for action. In order to test, this study contacted a university in Xiamen and tentatively conducted interviews with 20 residents around the school and collected their opinions on fitness facilities. Please note that this supplementary study is only for a preliminary exploration of the reasons, and we will discuss this issue separately in the follow-up study. The average age of the people who participated in the pilot survey

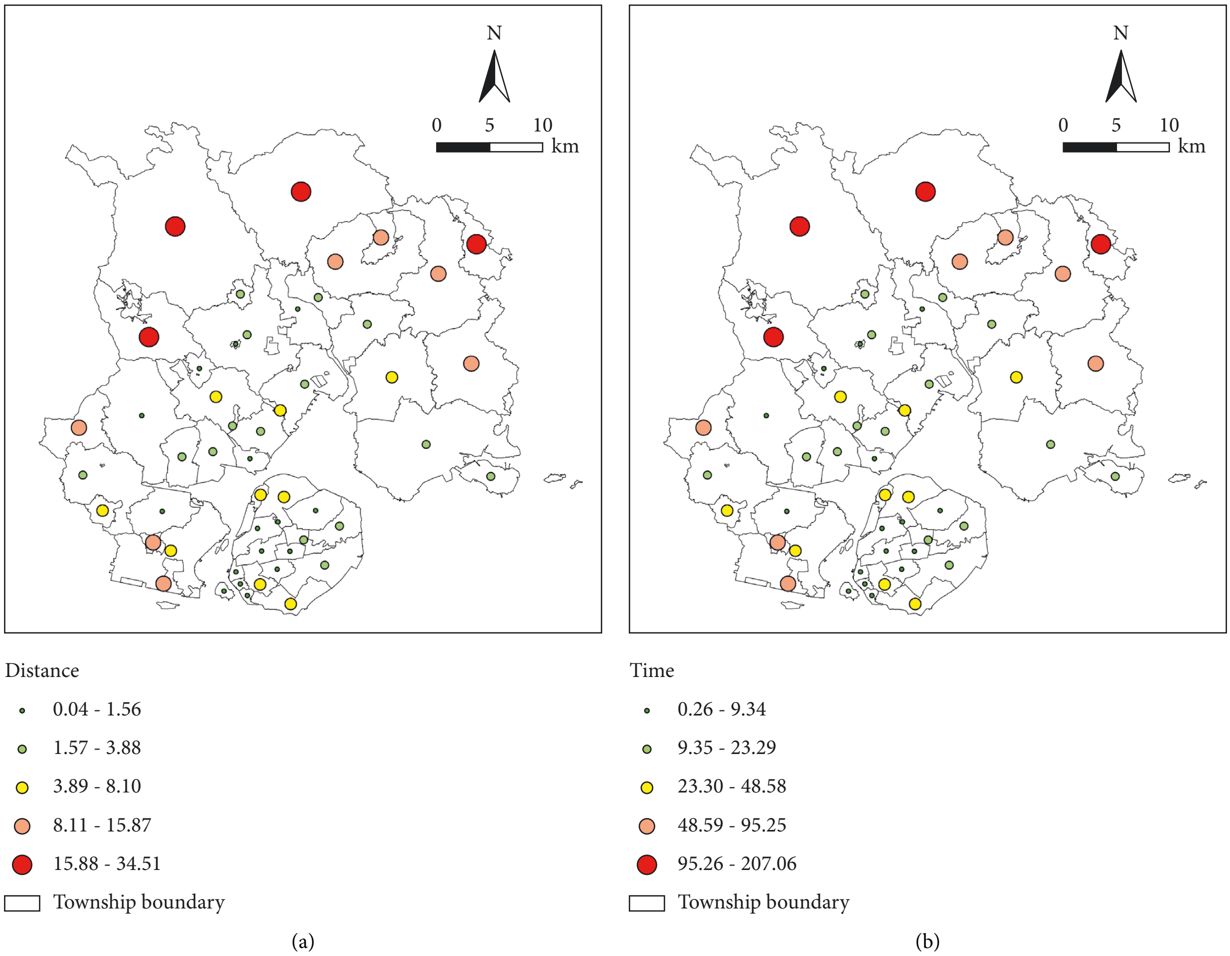


FIGURE 5: Accessibility of public sports and fitness facilities: (a) distance accessibility and (b) time accessibility.

was 35 years old, mainly due to the general youth of the people around the school. But it is enough as an exploratory pilot study. Finally, the analysis of the text of the interviews shows that the main factors affecting the fitness activities of community residents are as follows: laziness, lack of guidance, lack of interest, busy work, lack of confidence, lack of facilities, and fear of injury. Based on this preliminary understanding, we believe that the lack of facilities is not the main reason affecting residents' fitness, but the influence of psychological factors and knowledge factors is the leading factor causing the lack of fitness, which in turn affects residents' actual demand. Based on the practice theory, material accessibility is only one of the components of practice, and the rest also need the joint action of "meaning" and "competence" elements to achieve the final "practice." Therefore, although the study in this paper is a discussion about facilities, combined with this survey, we believe that further research is needed in the future to determine the psychological factors that affect residents' fitness needs. On the whole, it is certain that the realization of fitness practice must improve the overall awareness of residents and health education.

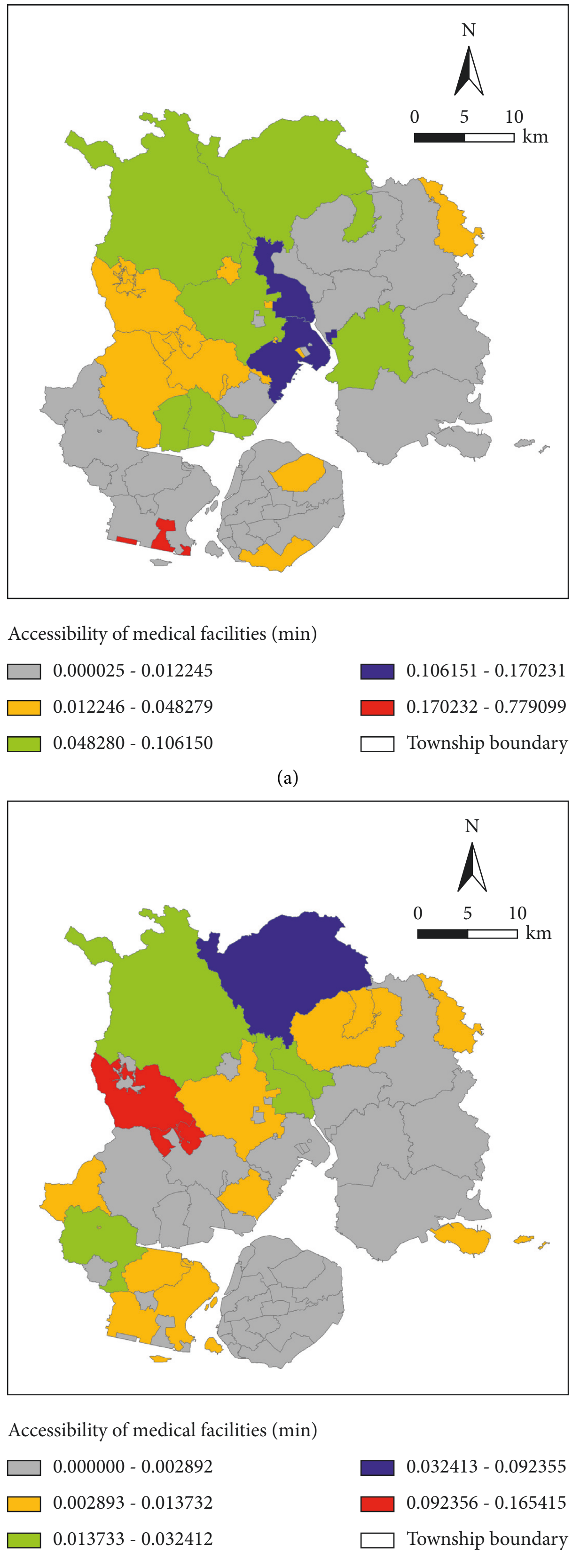


Figure 6: Accessibility of public medical facilities: (a) 15 min and (b) 30 min.

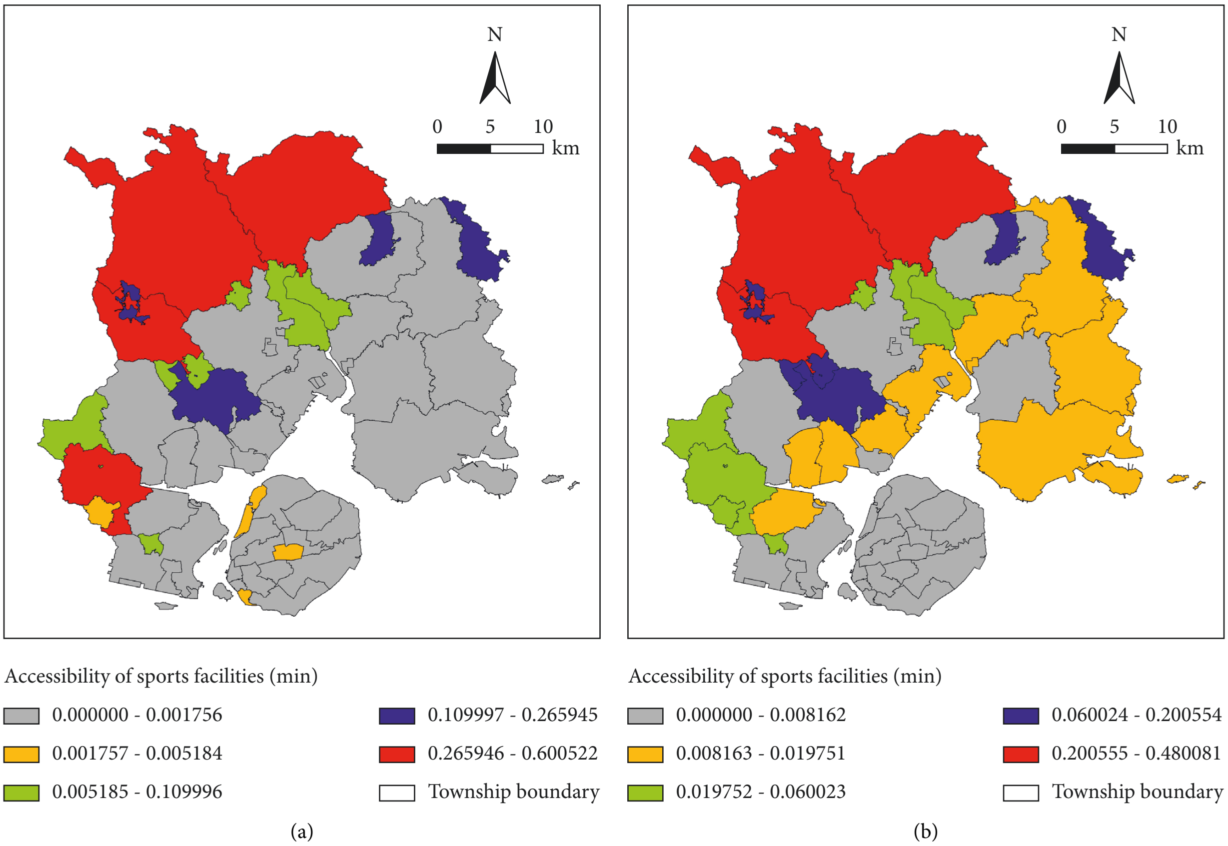


Figure 7: Accessibility of public sports facilities: (a) 15 min and (b) 30 min.

6. Conclusions

In this study, the accessibility of rehabilitation facilities in Xiamen was analyzed by using the nearest distance method and the 2SFCA method, and the following conclusions were drawn:

(1) The spatial distribution of accessibility of rehabilitation facilities in Xiamen is uneven, and accessibility varies greatly among streets.

(2) Under the nearest distance method, the highest accessibility was Yundang, Wuncun, and Wundang in Siming District; Huli, Dianqian, and Haicang in Huli District; and Haicang in Haicang District. The streets with the lowest accessibility are Lianhua Town, Fengnan Farm, and Xindian Street in Xiang'an District. This is due to the fact that the streets with high accessibility are close to the centre of the main urban area and the road traffic network is relatively perfect, while the streets with low accessibility are far away from the main urban area and the traffic accessibility is poor. This indicates that the accessibility of rehabilitation facilities is related to distance and transportation networks.

(3) According to the calculation results of the two-step floating catchment area (2SFCA), there are the following similarities and differences in the spatial accessibility of public health service facilities and public fitness facilities in Xiamen. Similarities: The spatial accessibility of the two facilities is not evenly distributed, and the accessibility of different streets varies greatly. With the increase of time, the spatial accessibility difference of public health service facilities and public fitness facilities becomes smaller. In both cases, street accessibility near the main urban centre increased, while street accessibility at the edge of the main urban area decreased. Differences: Compared with public fitness facilities, the standard deviation of accessibility of public health service facilities decreased significantly, indicating that the street accessibility of public health service facilities became better, while the street accessibility of public fitness facilities did not change significantly. The results of our further pilot interviews showed that residents' awareness may be an important factor potentially leading to this result, and further research is needed to analyze the driving factors of residents' fitness practice in the future.

(4) From the results of accessibility, there are some differences between the calculation results of the nearest distance method and 2SFCA because the distance is the main factor in the calculation of the

nearest distance method, while the two-step mobile search method not only considers the distance factor, but the factors of service capacity and population demand of rehabilitation facilities are also considered. In real life, residents' choice of rehabilitation facilities is not only affected by travel distance but also affected by the service capacity of rehabilitation facilities. Therefore, for the accessibility analysis of rehabilitation facilities in Xiamen, the 2SFCA method is more accurate and effective than the nearest distance method, which is more in line with the actual situation.

The traditional accessibility calculation method, accessibility index, through subjective investigation and measurement of public facilities, carries out spatial quantification of accessibility; the quantification results contain a great subjectivity. In this paper, the 2SFCA calculation is completed based on POI data, user access data, and GIS software. This method not only considers the service capacity of rehabilitation facilities but also takes into account a large amount of sample data so that the analysis results can more accurately and clearly indicate the accessibility of rehabilitation facilities in each street. However, there are still deficiencies in the calculation of accessibility of rehabilitation facilities in this paper. For example, in reality, residents' demands for community rehabilitation facilities are also affected by multiple factors such as population age, education level, income level, and living environment. Therefore, the above factors can be incorporated into the accessibility analysis in further studies to study the influence of these factors on residents' preference in selecting community-based rehabilitation facilities.

Data Availability

Requests for access to the data used to support the findings of this study should be made to Jie Wang (jie.wang.13@outlook.com).

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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