Journal of Landscape Research 2024, 16(3): 21-26

Accessibility and Fairness of Public Service Facilities from the Perspective of Supply and Demand Coordination: A Case Study of Old Urban Area of Guangzhou City

CHEN Xu, LI Xin*

(Guangzhou Urban Planning and Design Co., Ltd., Guangzhou, Guangdong 510180, China)

Abstract The accessibility and fairness of public service facilities are important manifestations of the convenience and equality of urban public service resource allocation. Optimizing the layout of urban public service facilities is an inevitable requirement for promoting the construction of people centered cities. This paper takes the old urban area of Guangzhou as the research area, measures the accessibility of multiple types of public service facilities based on an improved two-step floating catchment method, and combines Palma Ratio and location quotient methods to explore the fairness of urban public service facilities from two dimensions: social equity and spatial equity, with supply and demand relationship analysis as the main line. Research has shown that: ① there is a significant spatial difference in the accessibility of public service facilities in the old urban areas of Guangzhou, and the comprehensive accessibility is generally higher in the central and southeastern regions of the old urban areas with fewer residential populations; ② from the perspective of social equity, the resource allocation of public service facilities in the old urban areas of Guangzhou is in a seriously unfair state (with a fairness index of 2.99), and there are also varying degrees of unfairness within the streets; ③ from the perspective of spatial equity, the location quotient of public service facilities in the old urban areas of Guangzhou shows a pattern of multil center circles decreasing, indicating a significant spatial mismatch between the accessibility supply side of public service facilities and the demand side of the residential population. The research conclusion will provide scientific basis for optimizing the allocation of urban public service facilities and ensuring the equalization of public services.

Keywords Public service facilities, Accessibility, Social equity, Space equity, Guangzhou City

DOI 10.16785/j.issn 1943-989x.2024.3.005

Urban public service facilities refer to basic facilities closely related to daily life of residents, such as education, medical care, culture, and sports. They are important spatial carriers of urban public services and important guarantees for convenient living of residents. Improving the accessibility and fairness of urban public service facilities, enabling urban residents to conveniently and fully enjoy public services, has become one of the important goals of high-quality urban development. General Secretary Xi Jinping has repeatedly emphasized that it should implement the people-centered development concept through effective measures, and coordinate and solve basic public service issues such as employment, income distribution, education, social security, medical care, housing, elderly care, and childcare. The Fifth Plenary Session of the 19th Central Committee also proposed to improve the life quality of the people, improve the social governance system of co construction, co governance, and sharing, solidly promote common prosperity, and continuously enhance the people's sense of gain, happiness, and security by improving the basic public service system. However, more emphasis was placed on land development and management during the early period of urban incremental expansion, while the balanced allocation of urban public service resources was neglected. As a result, there gradually emerged a contradiction between insufficient infrastructure supply and services and the growing public demand[1]. It is a necessary way to achieve equalization, inclusiveness, and convenience of urban public services by optimizing the spatial layout of urban public service facilities, and enhancing the accessibility and fairness of urban public service facilities.

Many scholars at home and abroad have conducted research on the accessibility and fairness of urban public service facilities. In terms of accessibility research, Hansen[2] first proposed the concept of accessibility in 1959, which refers to the magnitude of interactions between nodes and their ability to overcome spatial resistance. The accessibility of public service facilities reflects the convenience of people's access and use of public service facilities, as well as the ability of public service facilities to provide services to residents, which can intuitively reflect the usage of public service facilities. Current research mainly measures the accessibility level of public service facilities through indicators such as the total amount of public service facilities, per capita indicators (thousand person indicators), and facility coverage. The specific accessibility measurement methods mainly include buffer zone method, minimum neighbor distance method, gravity index method, network analysis method, and two-step floating catchment area method[3-6]. For example, scholars combine GIS network analysis methods to quantitatively analyze the accessibility of Shanghai Puxi Primary School by measuring the effective service scope of basic education facilities[7]. Overall, research on the accessibility of public service facilities is mostly based on the spatial layout of facilities on the supply side, while there is less attention paid to the fair performance of public service facility allocation from the demand side.

In terms of fairness research, fairness refers to the ability for everyone to be treated equally, regardless of other social attributes[8]. Due to differences in the spatial distribution of different social groups and urban populations, there are also varying demands for social resources. Therefore, compared to the spatial optimization layout on the supply side of facilities, the fairness of public service facilities emphasizes more on human needs and the "matching" between resident needs and the allocation of public service facilities. If supply and demand are unbalanced, it will lead to "unfairness" in resource allocation. The research on the fairness of public service facilities mainly includes social equity and spatial equity. Among them, social equity focuses on the distribution differences of facility resources among the population of

Received: May 1, 2024 Accepted: May 27, 2024

* Corresponding author.

each spatial unit, and its evaluation methods include Gini coefficient, Lorentz curve, range method, and concentration curve method[9-12]. Scholars such as Wang Lan et al.[13] combined Gini coefficient and Lorentz curve to analyze the accessibility of community elderly care facilities in the central urban area of Shanghai, in order to comprehensively evaluate the degree of unfairness in the distribution of community elderly care facilities. Space equity focuses on the "spatial matching" between facility resources and population distribution. For example, scholars use the methods of ordinal variable correlation analysis and factor space overlay analysis to measure the spatial fairness of park layout in Shanghai based on park spatial accessibility and resident demand index[14].

Existing research has extensively explored the accessibility and fairness of public service facilities through various methods, and has achieved rich results, which have certain practical significance for promoting facility equalization and building a fair society. However, there are still the following shortcomings: from the perspective of research types, many domestic and foreign studies only focus on the accessibility or fairness level of a single type of urban public service facility, lacking attention to the configuration of different types of public service facilities, and cannot fully reflect the accessibility and fairness level of the distribution of urban public service facilities; from the perspective of research scale, most existing studies focus on administrative regions, streets, or communities as research units, and excessively large spatial scales may affect research accuracy, making it difficult to accurately evaluate differences in the allocation of public service facilities within the space; from the perspective of research methods, existing studies mainly measure the spatial allocation of public service facility resources through the number of facilities, coverage, or straight-line distance, without comprehensively considering the actual travel situation of residents and the distance attenuation effect.

The old urban area of Guangzhou is taken as the research area, and population grid data with a resolution of 100 m is taken as the research unit. Combined with the actual travel situation of residents in Baidu Maps API, the improved Gaussian two-step floating catchment area method is used to measure the accessibility of various public service facilities in the area. Accessibility is the core indicator, and supply and demand relationship analysis is the main line. Palma ratio and location quotient are introduced to comprehensively evaluate the supply and demand matching of urban public service facility resources from the perspectives of social and spatial equity, providing reference basis for the rational allocation of urban public service resources.

1 Research area and data

1.1 Research area

In order to achieve the "new vitality of the old city", Guangzhou has made the renewal and renovation of the old urban area a key task. The renewal and planning scope of the old urban area of Guangzhou is taken as the research area, and whether the level of public service facilities in the area can meet the daily living needs of residents is explored, with certain representativeness and research significance. The old urban area of Guangzhou covers an area of about 54.04 km^2, including Huanshi Road−Hengfu Road−the south of Yongfu Road, the west of Guangzhou Avenue, Changgang Road −the north of Xingang Road, the Pearl River waterway of Baie Tan (Hedong Bridge)−the east of Tongde Chung, involving 17 streets in Yuexiu District, 12 streets in Liwan District and 10 streets in Haizhu District (Fig.1). As of 2021, the permanent population of the old urban area of Guangzhou was about 240,000.

1.2 Research data

Referring to relevant literature, the types of public service facilities that are closely related to residents' lives are selected, including medical, educational, cultural, and sports categories. POI (point of interests, POIs) data for four types of urban public service facilities are obtained through the Gaode Map platform API, and deduplication and correction of the obtained data are performed, resulting in a total of 1,014 POI points. The selection of various types of public service facilities is shown in Table 1.

The size and distribution of regional population reflect the overall spatial demand for public service facilities, and its data accuracy has a direct impact on the fairness results of public service facilities. There are many existing studies that use streets or community centers as spatial carriers to reflect the population distribution of the entire street or community. Some scholars also estimate the population size by combining mathematical models and population related information, and then rasterize it to reflect the spatial distribution of the population. However, due to the large scale of streets or community units, or the low resolution of population grid data, it is difficult to estimate the fairness of public service facilities more accurately based on population spatial needs. Therefore, based on the address information of all houses and population data in the old urban area of Guangzhou, this paper draws a population grid data with a resolution of 100 m to more finely reflect the spatial distribution of population (Fig.2).

The travel time for residents to reach public service facilities is obtained through the Gaode Map Platform API. Compared with traditional straight-line distance and travel time estimated based on ArcGIS network analysis and simulation, the Gaode Map Platform API can combine real-time road condition information, bus and subway operation conditions, to more accurately reflect the actual travel situation of residents, and thus make the accessibility measurement of facilities more accurate. Referring to the planning concept of "15 min community living circle", which aims to achieve 15 min accessibility to public service facilities such as medical treatment, education, culture, and sports, the maximum acceptable time cost for residents to reach public service facilities is set.

2 Research methods

2.1 Accessibility calculation of public service facilities: Gauss two–step floating catchment area method (G2SFCA)

The two-step floating catchment area method can comprehensively consider the supply of public service facilities and the scale of resident demand to evaluate the accessibility level of facilities, that is, the more public service facilities available to residents, the better their accessibility level. G2SFCA further considers the distance attenuation effect on the basis of traditional floating catchment area method. Specifically, the farther the supply and demand

Table 1 Classification information of urban public service facilities

Facility category	Number	Main content
Medical facilities	117	First-level hospital, second-level hospital, third-level hospital, health service center
Educational facilities	518	Kindergarten, primary school, middle school
Cultural facilities	189	Museum, art museum, library, cultural palace, exhibition hall, theater, concert hall
Sports facilities	190	Sports complex, basketball court, football field, swimming pool, table tennis hall, tennis court

points are, the weaker their facility service capacity is[15]. The specific calculation steps are as follows:

The first step is to calculate the supply-demand ratio of each public service facility point j, which is the service capacity of the public service facilities:

$$R_j = \frac{S_j}{\sum_{j \in \{t_{ij} \leq t_0\}} G(t_{ij}, t_0) r_i}$$

where R_j is the service capacity of public service facility point j; S_j is the scale of public service facility point j. Due to the fact that this paper mainly considers the differences in residents' needs and does not distinguish the differences in similar public service facilities, the scale of public service facilities is unified at 100 based on relevant research[16]. r_i is the population of demand point i that can be reached by walking to public service facility point j within 15 min; t_{ij} is actual travel time from demand point i to public service facility point j obtained using the Gaode Map API; t_0 is the predetermined time threshold, here is 15 min; G is time decay coefficient based on Gaussian function, and its calculation formula is as below:

$$G(t_{ij}, t_0) = \begin{cases} \frac{e^{-(1/2)*(t_{ij}/t_0)^2} - e^{-(1/2)}}{1 - e^{-(1/2)}}, \text{if } t_{ij} \leq t_0 \\ 0, \text{if } t_{ij} > t_0 \end{cases}$$

The second step is to calculate the sum of the supply−demand ratio for each demand point i reaching the public service facility point within 15 min, namely the accessibility of public service facilities at demand point i:

$$A_i = \sum_{j \in \{t_{ij} \leq t_0\}} G(t_{ij}, t_0) R_j = \sum_{j \in \{t_{ij} \leq t_0\}} G(t_{ij}, t_0) \frac{S_j}{\sum_{j \in \{t_{ij} \leq t_0\}} G(t_{ij}, t_0) r_i}$$

where A_i is accessibility of public service facilities at demand point i. The larger the value, the higher the accessibility level of public service facilities at the demand point.

Finally, the comprehensive accessibility of public service facilities at demand points is obtained through weighted averaging. Considering that the public service facilities selected in this paper are all infrastructure types closely related to the daily lives of residents, therefore, the weights of various types of public service facilities are set to be equal[17].

2.2 Analysis of social equity of public service facilities based on Palma rate

Due to the inherent similarity in the social equity connotations of income distribution and public service facility distribution, many studies use Gini coefficient and Lorentz curve methods to measure the social inequality in the accessibility distribution of public service facilities. However, the Gini coefficient and Lorentz curve focus too much on the distribution inequality of the middle population, and are not sensitive to the unfairness of the population at the top and bottom of the curve. A study has found that the ratio between the total income of the 10% highest income group and the total income of the 40% low-income group is the most sensitive reflection of changes in income distribution, namely Palma ratio[18]. Therefore, based on the Parma rate, a fairness model for public service facilities is constructed to measure the differences in accessibility of public service facilities in old urban areas. The specific calculation formula is as follows:

$$P_i = \frac{\overline{A_{itop\ 10\%}}}{\overline{A_{ibottom\ 40\%}}}$$

where P_i is the fairness index of public service facilities in geographical unit i; $\overline{A_{itop\ 10\%}}$ is population weighted accessibility values of public service facilities for the top 10% of the population within geographical units, ranked from high to low based on per capita accessibility of public service facilities; $\overline{A_{ibottom\ 40\%}}$ is the population weighted accessibility value of public service facilities for the top 40% of the population within a geographical unit, ranked in descending order based on per capita accessibility of public service facilities. According to the mathematical meaning of Palma rate, if the P value is 1, it means that the accessibility of public service facilities for the top 10% of the population is 4 times that of the bottom 40% of the population; if the P value is less than 1, it indicates a low level of unfairness in public service facilities; if the P value is greater than 1, it means that there is a significant gap in the allocation of public service facility resources and a certain degree of unfairness.

2.3 Analysis of spatial fairness of public service facilities based on location quotient

In order to further study the spatial matching degree between the accessibility of public service facilities and the distribution of resident population, based on the method of location quotient, the spatial differences in the fairness of public service facilities are analyzed[19]. The specific calculation formula is as follows:

$$L_n = \frac{(A_n / r_n)}{(A / r)}$$

where L_n is location quotient of spatial unit n; A_n is accessibility values of public service facilities in spatial unit n; r_n is the population in spatial unit n; A is the total accessibility of public service facilities within the research scope; r is the total population within the research scope. According to the mathematical meaning of location quotient, if the location quotient of a spatial unit is greater than 1, it indicates that the per capita accessibility of public service facilities in the spatial unit is higher than the overall level of the research scope; if the location quotient of a spatial unit is less than 1, it indicates that the per capita accessibility of public service facilities in the spatial unit is lower than the overall level of the research scope.

3 Research results and analysis

3.1 Accessibility analysis of multiple types of public service facilities

To visually represent the accessibility spatial pattern of various public service facilities, a spatial distribution map of accessibility is drawn based on the geometric classification interval method. As shown in Fig.3, there are significant spatial differences in the accessibility of public service facilities in the old urban area of Guangzhou. Among them, there are significant regional differences in the resources of educational facilities, showing a clear north−south difference. The high-value areas are more distributed in the southern part of the old urban area. The overall accessibility of sports facilities resources is high, showing a scattered distribution of multiple centers, with areas with high accessibility values concentrated in the eastern part of the old urban area. Cultural facility resources also have a high level of accessibility, and the areas with high accessibility are evenly distributed in the northeast of the old urban area. Moreover, there is a clear mismatch with the distribution of educational facilities, showing a distribution characteristic of "low in the south and high in the north". The accessibility level of medical facility resources is generally low, and the regional distribution is uneven. Except for the central and western parts of the old urban area, the accessibility level in other areas is relatively low.

Overall, the areas with low accessibility to comprehensive public service facilities are mainly concentrated in the northeast and northwest of the old urban area, including Kuangquan Street, Huanghuagang Street, and Meihua Village Street. This may be due to the high density of residential population in these areas, and the public service facilities available within a 15 min walk in this area are mainly educational and

cultural facilities, while the accessibility level of sports and medical facilities is low. Therefore, the per capita public service facility resources in the area cannot meet the needs of the high-density population, resulting in a poor accessibility level of comprehensive public service facilities in the region. The areas with high accessibility of comprehensive public service facilities are mainly distributed in the central and southeastern parts of the old urban area, and the maximum value is in Baiyun Street (0.34). Moreover, from the perspective of various public service facilities, the accessibility level of facilities in Baiyun Street is higher than that in other areas, indicating that the completion of various public service facilities in the area is relatively good, which can meet the daily living needs of residents in the area.

3.2 Social equity analysis of accessibility of public service facilities

From a regional perspective as a whole, the fairness index of public service facilities in the old urban area of Guangzhou is 2.99, which means that the accessibility of public service facilities per capita for the top 10% of residents is nearly 3 times higher than that for the bottom 40% of residents. It indicates a significant distribution gap in public service facility resources in the old urban area and a serious unfairness. This also reflects to some extent that the supply level of public service facilities in the old urban area of Guangzhou lags behind the daily living needs of residents. From the perspective of streets (Fig.4), there is also a significant gap in the fairness of public service facilities among the streets in the old urban area. Among them, the fairness of public service facilities in Guangta Street is the best (1.36), which is 54.52% lower than the overall level of the old urban area. This indicates that compared with the entire old urban area, the per capita accessibility of public service facilities enjoyed by the top 10% of residents in this area has relatively little difference compared to the bottom 40% of residents. Next are Jinhua Street (1.42) and Shamian Street (1.42), showing a relatively small gap in the allocation of public service facility resources. The distribution difference of public service facilities resources in Baiyun Street is the largest, with a public service facility fairness index of 11.64, which means that the per capita accessibility of public service facilities enjoyed by the top 10% of residents is more than 11 times higher than that enjoyed by the bottom 40% of residents, and its level of unfairness is much higher than the overall level of the old urban area. This is mainly because the Ersha Island area of Baiyun Street has extremely rich resources of public service facilities, including 1 medical facility, 6 cultural

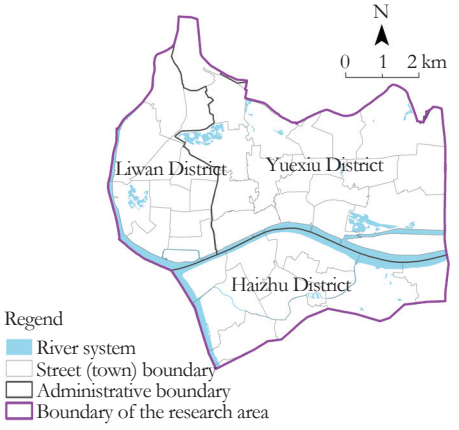

Fig.1 Scope of the research area

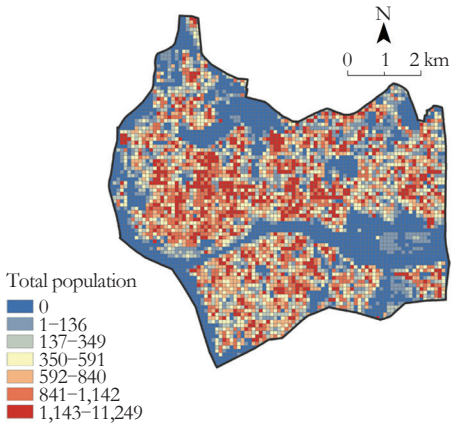

Fig.2 Population distribution in research scope

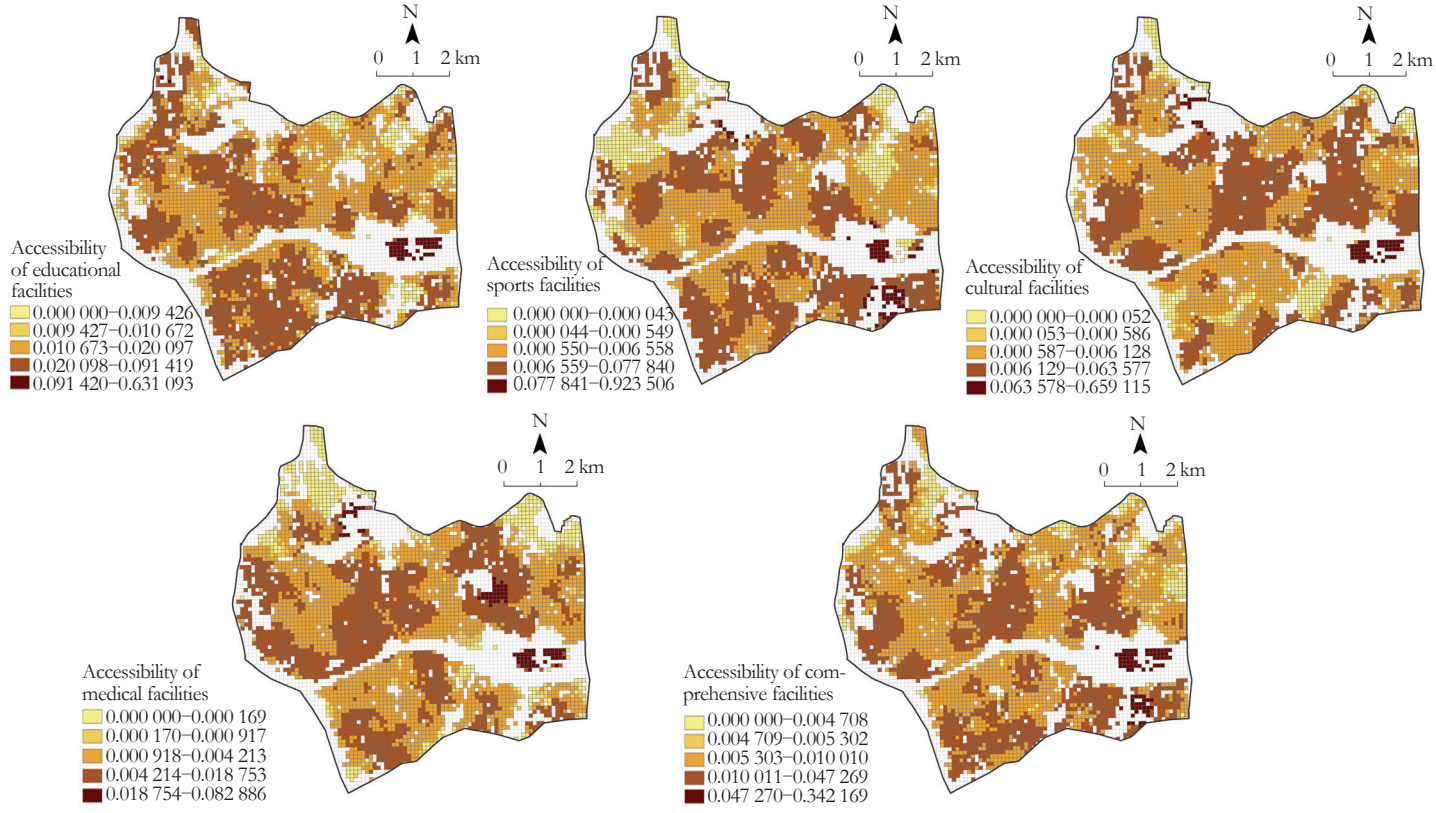

Fig.3 Spatial pattern of accessibility for various public service facilities in the old urban area of Guangzhou

facilities, 7 educational facilities, and 8 sports facilities. However, the permanent population of this area is less than 3,000, and the demand for public facilities services is relatively low. As a result, the per capita accessibility level of public service facilities in this area is significantly higher than other areas of Baiyun Street, which shows serious unfairness.

3.3 Spatial equity analysis of accessibility of public service facilities

To make the spatial pattern of fairness in public service facilities more intuitive, geographical units are divided into four levels based on location quotient, and a spatial distribution pattern map of public service facilities is drawn (Fig.5). Overall, there are significant regional differences in the location quotient of public service facilities in the old urban area of Guangzhou, showing a scattered distribution pattern of high and low values. Among them, Baiyun Street in Yuexiu District has the highest average location quotient (638.29), followed by Liuhua Street in Yuexiu District (111.39) and Xingang Street in Haizhu District (108.68), while Hualin Street in Liwan District has the lowest average location quotient (0.57), indicating that the per capita accessibility of public service facilities in this area is significantly lower than the average level in the old urban area. From the distribution of location quotient, the high values of location quotient are concentrated in the eastern part of the old urban area, including Dongshan Street, Xingang Street, Nonglin Street, etc. The low values of location quotient in most other areas indicate that the urban public service facilities in most regions of the old urban area are lower than the overall level of the old urban area. Moreover, there is varying degrees of spatial differentiation in the location quotient of different street units. Among them, Nanyuan Street, Dongshan Street, and Huanghuagang Street have the most severe differentiation, and the number of grids for their extremely high and extremely low location quotient is higher than other streets.

Overall, there is significant spatial heterogeneity in the spatial fairness of public service facilities in the old urban area of Guangzhou based on per capita facility accessibility, mainly manifested in the spatial mismatch between the accessibility value of public service facilities and the distribution of residential population. This spatial disparity in supply and demand also indicates that the level of public service facility resource allocation in the old urban area of Guangzhou is still measured by the "per capita" indicator, which may misestimate the fairness of public service facilities, thereby misleading the formulation of public service facility optimization policies based on this. Therefore, the spatial fairness of public service facilities based on the perspective of supply and demand is the only way to achieve equalization of urban public services.

4 Conclusions and suggestions

4.1 Conclusions

Four categories of basic public service facilities in the old urban area of Guangzhou are taken as the research objects, and the improved Gaussian two-step floating catchment area method is used to measure the accessibility of various public service facilities. Palma rate is introduced to evaluate the social equity performance of accessibility of public service facilities, and the spatial equity characteristics of accessibility of public service facilities are further analyzed using the location quotient method.

(1) The accessibility of public service facilities in the old urban area of Guangzhou shows significant spatial differences. The areas with low accessibility of comprehensive public service facilities are mainly concentrated in the northeast and northwest of the old urban area. The public service facilities available within a 15 min walk in this area are mainly education and cultural facilities, while the lack of sports and medical facilities overall cannot meet the needs of high-density population, resulting in poor accessibility of comprehensive public service facilities in the area. However, in the central and southeastern regions of the old urban area, due to sufficient resources of public service facilities and a small population, the accessibility of comprehensive public service facilities is generally higher.

(2) From the perspective of social equity, there is a significant distribution difference in the overall public service facility resources in the old urban area of Guangzhou (a fairness index of 2.99), which is in a serious unfair state. At the same time, there is also a significant gap in the fairness of public service facilities in various streets of the old urban area. Only Guangta Street, Jinhua Street, and Shamian Street show a small gap in the allocation of public service facility resources, while other streets show corresponding unfair distribution of public service facility resources.

(3) From the perspective of spatial equity, the location quotient of public service facilities in the old urban area of Guangzhou has significant spatial heterogeneity, showing a scattered distribution pattern of high and low values, and forming a pattern of multi center circles decreasing. This indicates that there is a spatial mismatch between the accessibility values of public service facilities and the distribution of residential population, and there are significant regional differences, indicating a significant room

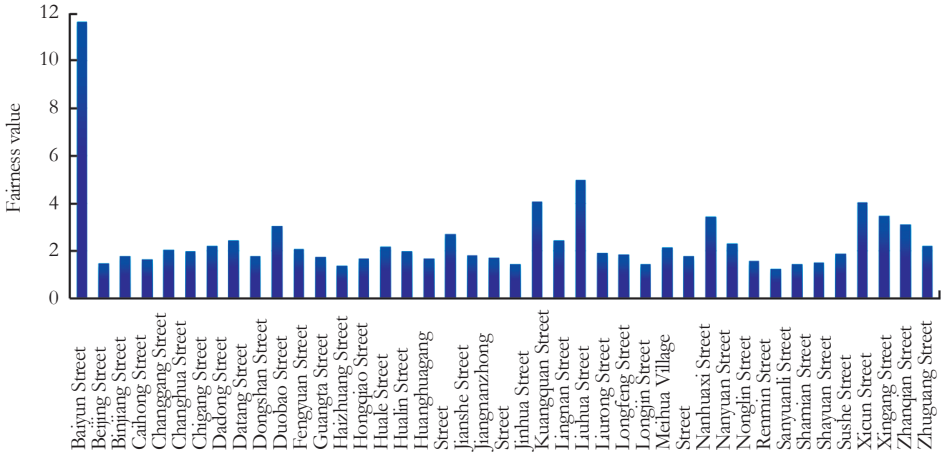

Fig.4 Fairness value of public service facilities in various streets of old urban area of Guangzhou

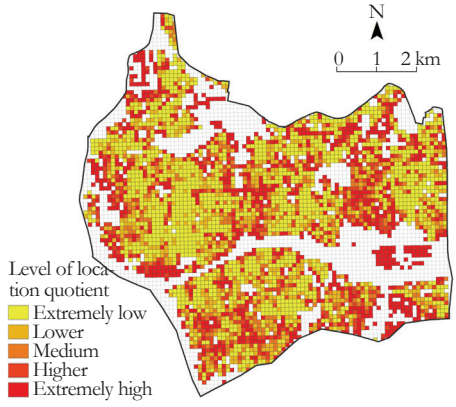

Fig.5 Spatial distribution pattern of per capita accessibility of public service facilities in old urban area of Guangzhou based on location quotient classification

for improvement.

4.2 Suggestions

With the rapid development of China's social economy, the existing configuration of public service facilities can no longer meet the actual needs of residents. Under the development concept of equalization and sharing of basic public services in cities, improving the allocation of public service facilities and enhancing their accessibility and fairness has become an inevitable requirement for urban planning and development. In view of this, the following suggestions are proposed.

(1) The configuration of public service facilities should fully consider the balanced distribution in space. If the configuration of urban public service facilities only focuses on the total demand of the regional population, overly focuses on the "per capita" indicator, and does not consider the convenience and accessibility of residents' use, it is easy to cause insufficient use of public service facilities, which limits the comprehensive benefits of urban public service facilities.

(2) It should promote the diversification and comprehensiveness of urban public service facility allocation. The allocation of public service facilities should not be limited to a single type of resource allocation. It is necessary to comprehensively consider the diverse living needs of residents, form a comprehensive system of multiple types of public service facilities, and maximize the comprehensive benefits of public service facility resources.

(3) It should achieve a balance between supply and demand of public service facilities in terms of quantity and space. While improving the accessibility of public service facilities, attention should also be paid to the total size and spatial distribution characteristics of the residential population, and the differences in resource allocation of public service facilities between regions should be reduced in both quantity and space, achieving a multi-dimensional balance between supply and demand of facilities.

This paper focuses on the spatial differences in accessibility of multiple types of public service facilities, and comprehensively evaluates the fairness of facility configuration from the perspectives of social and spatial equity. It helps to optimize the number, scale, and functional planning layout of public service facilities in the old urban area of Guangzhou, aiming to alleviate the pressure on facility services in the central urban area of Guangzhou to a certain extent. It also provides a scientific theoretical basis for improving the urban living environment, enhancing urban spatial vitality, and building a people-centered urban development.

References

[1] Cohen, B. (2006). Urbanization in developing countries: Current trends, future projections, and key challenges for sustainability. *Operations Research*, *28*(1-2), 63-80.

[2] Hansen, W. G. (1959). How accessibility shapes land use. *Journal of the American Institute of Planners*, *25*(2), 73-76.

[3] Hu, S. Y., Lu, Y. Q. & Hu, G. J. et al. (2021). Measuring accessibility and equity of medical resources in Shenzhen based on multi-source big data. *Economic Geography*, (11), 87-96.

[4] Yenisetty, P. T., Bahadure, P. (2021). Assessing accessibility to ASFs from bus stops using distance measures: Case of two Indian cities. *Land Use Policy*, 105567.

[5] Jiang, H. B., Zhang, W. Z. & Wei, S. (2017). Public service facility accessibility as influenced by public transportation in Beijing. *Progress in Geography*, (10), 1239-1249.

[6] Zhang, Z. B., Chen, L. & Da, X. J. et al. (2021). Spatial justice of public service facilities based on social stratification: A case study of the central urban area of Lanzhou. City Planning Review, *45*(12), 48-58.

[7] Tu, R., Zhou, R. & Wang, X. J. (2019). Research on the accessibility and equity of urban basic educational facilities: A case of primary schools in Puxi, Shanghai. Journal of Fudan University. *Natural Science*, *58*(6), 747-755.

[8] Dadashpoor, H., Rostami, F. & Alizadeh, B. (2016). Is inequality in the distribution of urban facilities inequitable? Exploring a method for identifying spatial inequity in an Iranian city. *Cities*, *52*, 159-172.

[9] Zhang, S., Liu, H. & Wang, H. C. (2022). Research on the equalization of institutional pension facilities layout in central urban area of Tianjin. *Modern Urban Research*, (1), 38-44.

[10] Chen, Y. J., Pang, J. & Lv, T. H. (2020). Spatial performance evaluation of public sports facilities in major districts of Hangzhou City. *Planners*, (16), 19-24.

[11] Wang, L., Zhou, K. C. (2019). Performance assessment of the distribution of community sports facility from the perspective of healthy equity: A case study of the central city of Shanghai. *Journal of Human Settlements in West China*, (2), 1-7.

[12] Behnam, T., Mohammad, H. M. & Hossein, H. et al. (2019). Multimodal accessibility-based equity assessment of urban public facilities distribution. Sustainable Cities and Society, 49(C).

[13] Wang, L., Zhou, K. C. & Wang, Z. H. (2021). Spatial distribution of community pension facilities from the perspective of health equity: A case study of the central city of Shanghai. *Human Geography*, *36*(1), 48-55.

[14] Yin, H. W., Xu, J. G. (2009). Analysis of accessibility and fairness in Shanghai park space. *Urban Development Studies*, *16*(6), 71-76.

[15] Hu, S., Song, W. & Li, C. et al. (2020). A multi-mode Gaussian-based two-step floating catchment area method for measuring accessibility of urban parks. *Cities*, 102815.

[16] Li, R. H., Gong, S. Z. & Gao, Y. (2021). Accessibility of public service facilities in Beijing and its impact on housing prices. *Acta Scientiarum Naturalium Universitatis Pekinensis*, 57(5), 875-884.

[17] Zhao, Y., Zhang, G. & Lin, T. et al. (2018). Towards sustainable urban communities: A composite spatial accessibility assessment for residential suitability based on network big data. *Sustainability*, *10*(12), 4767.

[18] Liu, D., Kwan, M. & Kan, Z. (2021). Analysis of urban green space accessibility and distribution inequity in the City of Chicago. *Urban Forestry & Urban Greening*, 127029.

[19] Tang, Z. L., Gu, S. (2015). Social performance evaluation of public green space distribution in the central urban area of Shanghai: From regional equity to social equity. *Urban Planning Forum*, (2), 48-56.

****

(Continued from P20)

life for the elderly and promote the aging friendly development of the community.

References

[1] Kang, Y., Hui, Y. Q. (2020). Research on the problems and perfection strategies of old-age care in central Beijing. *Urban Problems*, (9), 78-85.

[2] Li, H. P., Liang, Z. H. (2021). Research on spatial equilibrium of urban community elderly care facilities and its configuration. *Journal of Geo-information Science*, (3), 467-478.

[3] Zhang, J., Su, Y. & Lv, Y. (2020). Research on the functional classification and design strategy of aged care service stations under health China service system. *Architectural Journal*, (S1), 65-70.

[4] Ren, L. B., Wang, J. M. (2017). Social support and mental health of the elderly. *Chinese Journal of Gerontology*, (6), 1530-1533.

[5] Qu, J. Y. (2018). Influences on the old people's life quality by urban living environment: Taking Beijing City for example. *Urban Problems*, (12), 44-54.

[6] Jiang, W. K., Sun, J. J. (2022). Living arrangement,living environment and mental health of the urban and rural elderly:An analytical framework for the construction of age-friendly communities. *Urban Problems*, (1), 65-74.