Research Paper

Measurement of spatial equity

: a case study of nursing institution

Xin Sui, Tongji University; China
Yifan Yu, Tongji University; China
Liu Huhui, Tongji University; China

Abstract

Equity and justice have always been important norms in the field of urban planning. With the gradual deepening of understanding of residential environment, the research context of equity and justice related to location is becoming more and more sophisticated. Recently, varieties of subjects Including Public Health and Geography focus on the inequity of public resources in spatial distribution and how to measure the degree of this gap. In general, the mainstream measurement methods can be summarized into two categories: (1) The description of phenomenon caused by the spatial inequities, and accessibility is a typical method of this type. (2) the direct quantification of inequity, such as Gink Coefficient which is originated from the economics field and introduced into the measurement of health equity, and Getis-Ord General G, together with Moran' index is the most commonly method used into the general spatial autocorrelation. In this paper, based on the overall literature review of the concept of equity in the study using these methods and a summary of their specific context of the measurement using, nursing institution in Shanghai, China are regarded as a typical case to practice these methods and compare the differences in using. Meantime, the impact of the politics and planning related to this special facility is also been considered. Results show that, accessibility of nursing institution among elderly groups is much different under different research distance, and the overall trend seems like the research units in suburb appears higher accessibility than those in highly urbanized area. And Gink Coefficient helps us determine the proportion of the elderly population in different reachable areas in Shanghai is within a reasonable range. However, Global Moran' index provide reliable evidence that the existence of the aggregation combined by the high-value units. It indicates that there are inequities among the distribution of aged-nursing resources, and Local Moran I （LISA）help us to find the specific boundaries of these areas. In general, in the study of the equity related to location, accessibility can only reflect the differences phenomenon in distribution, but it is not clear to describe this gap to what extent, and it's difficult to achieve the possibility of comparison among different periods and different subjects. The Gini coefficient often focuses on the unfairness of the distribution of people, but ignored the aggregation characteristics of the spatial dimension, which the analysis of spatial autocorrelation can make up. All these methods proved that it's necessary to consider both the spatial distribution of supply and demand. And the discussion about equity related to location should be strictly qualified in study.

Keywords

Elderly nursing institution, Accessibility, equity

1. Introduction

Maximization of equity and efficiency is the most important prerequisite to ensure the public service facilities' service level, quality and citizens' benefits. Different from the traditional location theory which pursues the profit maximization of non-public products, public facility location theory holds the idea that equity and efficiency should be considered in the distribution of public resource. (Teitz Mbjpotrsa,1968) At the beginning of urbanization, the population size and density distribution among different cities or different districts are homogeneous and nearly identical, so that traditional methods to lay out the public service facilities such as thousand-person indicators and service radius can be basically satisfied the goal of "space equity". However, as the degree and speed of the urbanization processing, the groups with different social and economic attributes begin to gradually gathering in the specific space. And that is the reason why traditional methods could not meet the space equity's needs anymore. Meanwhile, the marketization procession also provides varieties of the patterns of public service supplement, this process may aggravate the degree of inequity among to people's access to public service.

While the development of public service facilities is diversifying, China's aging is also growing up. By the end of 2017, the total number of elderly people over the age of 60 in China reached 240 million, accounting for 17.3%, and the total number of elderly people over 65 years old reached 158 million, accounting for 11.4%. According to United Nations standards, when the proportion of people over 60 years old in a region reaches 10% of the total population or the proportion of people over 65 years old accounts for 7% of the total population, that means this area has entered an aging society. Due to the Spindle-shaped population structure, the degree and speed of China's aging will continue to grow in the near future. In this context, the study of aging urban countermeasures has gradually attracted more and more attention from urban planning scholars. Recently, relevant departments have promulgated a series of public policies ranging from architectural design to urban pension service provision, in order to guarantee the legitimate rights and benefits belong to the elderly.

Although the quantitative research on the spatial layout of public service facilities has attracted more and more attention in the world, quite a few scholars have carried out case studies on specific cities for nursing institutions. The existence of inequity has neglected the extent of this inequity and how it is reflected in specific space. Therefore, such research may reveal the lack of facilities or the surplus, However, it is difficult to make horizontal contrast which covers different cities or vertical contrast which covers different period.

Therefore, the main purpose of this paper is to summarize the current study about spatial equity of public service facilities, and to discuss the requirements of relevant policies in Shanghai's local elderly service system to explore whether Shanghai's elderly nursing service provided by elderly nursing institutions exists inequity and how degree it is. Shanghai's elderly nursing institutions have developed for a long time, with long-term construction experience and relatively perfect legal norms and technical standards.

In this paper, we will discuss the spatial equity of elderly nursing institutions in four parts. Part two reviews the existing research on the accessibility and f spatial equity of the public service facilities caused by distribution. And related researches from China are summarized, in order to propose a two-dimensional framework for the study of spatial equity of elderly

nursing institutions. In the third part, the method concluded from the second part is applied to the local case in Shanghai. Analysis and results are presented in part four together with a summary of key findings and important policy implications.

2. Research review: spatial equity related to location

"Spatial equity" is a complex concept. In the supply of public services, the core of its concern is "reasonable distribution of social group interests" or "method of social resource allocation" (Zhongxiao C ,2009)(Li J et al.,2015). As a blender of urban space resources, urban planners pay special attention to the issue of equity and justice related to space in the provision of public service. "Inequity means that the distribution of public services or facilities has institutional and systemic discrimination against certain special groups, but it is difficult to define equity."(Harries K et al.,1994), The existing methods of quantifying the spatial equity of public services are often reflected by the differences between regions. The choice of variables in the process of quantification can reflect the scholars' specific choice of the concept of spatial equity. Generally, the definition of spatial justice has not yet formed a unified definition (Klaus R,1998)， historical features(Haiyan J et al.,2011)and facility supplying procession are both taken into account. Today, more and more social factors are being considered in the analysis of spatial equity, accessibility is often used as a spatial indicator to measure this gap (Klaus R,1998)， Although the specific definition of spatial equity has not been formed, from the perspective of development, it presents a simple geographical spatial distribution to the matching between population and facilities to a specific evaluation that emphasizes different types and different levels of demand.（Junbo G et al.,2009）

At present, research on public service such as green space, health facilities, and educational facilities, especially kindergartens combined with China's conditions has achieved certain results. The issue of spatial equity in the public service facilities' distribution is essentially a discussion of the dialectical relationship between people (demand), facilities (supply), and location (the link between supply and demand), And citizens should be regarded as the final measure to measure the equity of the spatial layout of public service facilities. Therefore, in the, the practical significance of equity evaluation is to measure the absolute equity gap between public service distribution and spatial distribution in the population. The equity evaluation of public service facilities is a quantitative means of reflecting the equity of urban resource allocation, and is also an important basis for optimizing and adjusting the layout of facilities. Therefore, scholars often reflect the inequity of resource allocation through spatial differences in public services.

Now days, the evaluation of the spatial inequity caused by facilities' allocation can be divided into two categories: the description of inequity and the description of the degree of inequity. The former can intuitively reflect the relative supply of public service resources between different research areas. By reflecting the difference in relative supply to reflect the existence of inequality between regions, accessibility is the most important research medium in this type of research; the latter can directly measure this difference directly. It often draws on economics or spatial statistics to directly reflect the inequity of public service allocation under the spatial layout model.

Accessibility which is one of the main methods to describe the spatial inequity of public service allocation, is also a key concept in the evaluation of the spatial layout of public service facilities in the field of geography. Due to the diversity of methods and the different analytical concepts, accessibility itself has a rich definition. Accessibility emphasizes the resistance or ease between the start and the end. As quantitative research progresses, factors such as the size of the OD, the shape of the transportation network, and the road structure are gradually taken into account.

At present, the research on the accessibility of public service facilities has obtained rich research results in the fields of medical and health care, old-age services, and park green space, providing experience for the study of public service facilities in China. In the study of the concept of accessibility, accessibility can be used as a tool to directly measure the level of public service(Talen,1998)(Nicholls,2011)(Zhen L et al., 2007)(Zhuolin T et al.,2014), and as a spatial indicator of the research unit(Talen ,1997)(Park,2012)(Xiao Y et al.,2017), which can often expand the research ideas of the built environment, and the statistical method is accommodated. The two-step floating catchment area (2SFCA) and potential model are the most representative methods used to measure Public service facility service level caused by specific position pattern(Zhengna S,2010). On the other hand, these models are expandable to adapt different research needs, and they also can be adapted according to the characteristics of the facility itself. Thanks to the idea of two-step floating catchment, E2SFCA is easier to practice and understand (Zhuolin T ,2016). The characteristics of supply and demand are comprehensively considered. In this paper, E2SFCA is used to describe inequity of the elderly nursing institutions(Lianhong C,2014)(Aihua Z,2013)(Wei X et al.,2017).

In the terms of measure the degree of equity caused by the location, multiple disciplines have contributed. The study of the equity of health public services has always been one of the key contents in the research of public health where methods in economics are absorbed(Keqin R et al.,1998) , and formed a sound evaluation system. At present, the methods widely used in health services mainly include the Tyre index(Zhang Nan,2014), the concentration index, and the Gini coefficient and the Lorenz curve(Horev T,2004). With the implementation of the concept of equity and justice in the urban planning field, the logic of the measure of equity of health services has gradually been introduced into the study of the equity of other types of public service space in urban areas (Barbati M,2016).The results of accessibility are treated as the index to describe the differences in public services, and that allowed the spatial equity of the public facilities such as green space(Zilai T et al.,2015) ,elderly school and hospital etc, could be quantified(Yifan Y,2018).

The traditional economics measurement method can help us to find the gap between a certain service or resource caused by location in the population, which can reflect the inequity distribution of public resources due to the different spatial layout patterns. [4] In the field of urban planning and geography, scholars are more concerned with the spatial distribution difference of the inequity caused by the layout of public service facilities, which could be reflected by the degree of spatial clustering(Talen, 1997) In 1950s, Moran proposed the Moran's I Index (also known as the Global Moran Index), focusing on the spatial differences of factors, describing the overall distribution of elements in space, and judging the existence of agglomeration trends. To located the specific location of clustering, Anselin developed local Moran's I (LISA) based on the global Moran index(Anselin L,1995)(Zhang Songlin,1996)(Talen,1998).

As the age of aging continues to deepen, more and more Chinese scholars are beginning to pay attention to the of elderly service facilities. It is generally believed that the freedom of location of the elderly nursing institutions is more flexible, unlike the facilities used by residents daily. Due to the scarcity of land in the central urban area and the high land price, most urban elderly nursing institutions are located in the suburbs in China. In fact, this has led to the ineffectiveness of the service of the elderly nursing institutions. The elderly nursing institutions in the downtown area have higher occupancy rates compared to those in the suburbs, which indicate the mismatch between supply and needs (Wei D，2011). Older people have a high sense of dependence on the familiar community environment(Yao D,2015)，most of them want to enjoy the caring service in the community where they have been living.(Keenan T A,2010)That's the reason why location is still an important factor elderly are taking into account, Older people tend to choose a nursing institutions which is closer to home(GaoXao L,2013).

3. Methodology

3.1. Study area and data source

In this paper, Shanghai is the site where the study carried out. As one of the earliest cities entering aging society, Shanghai already has a certain amount elderly nursing institutions. We have obtained information on all current elderly nursing institutions in Shanghai, including the establishment time and carrying capacity. In this study, a total of 673 elderly nursing institutions in Shanghai were collected, with a total of 121,200 beds(Representing carrying capacity).

At the same time, we obtained local elderly population data of over 60 years old in Shanghai in 2000, 2010 and 2014 respectively. Among them, the population data for 2000 and 2010 are from the fifth and sixth census data, and the 2014 population data is from the police department. The population and facility data from the three periods are matched to ensure that supply and demand are in the same state.

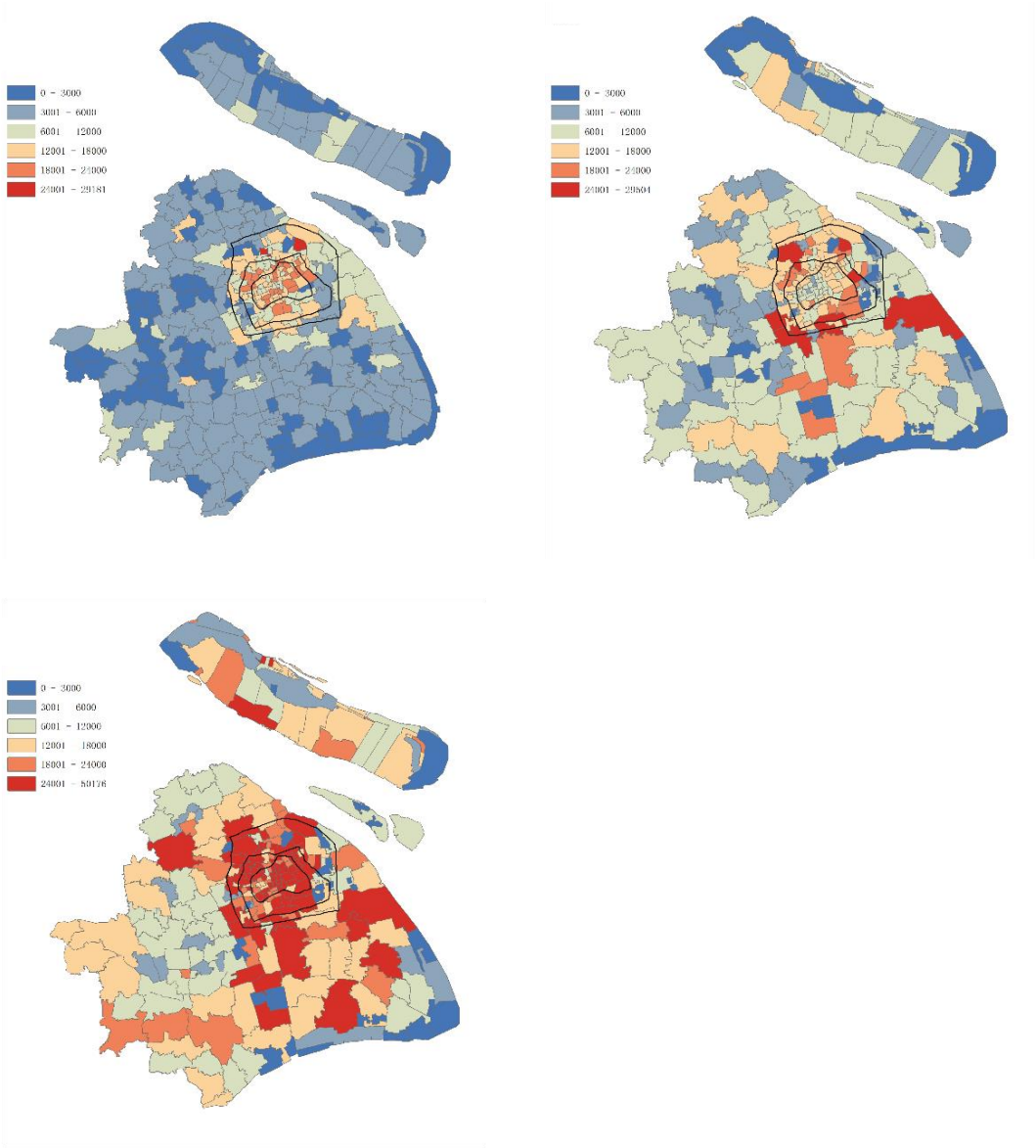


Figure 2 2000, 2010, 2014, Shanghai elderly distribution

The whole Shanghai is our research areas, and “jiedao” is our basic research unit, which is the most basic space unit for the configuration of elderly nursing institutions. According to the administrative regulations of Shanghai, in 2000, there were 331 “streets” in Shanghai, all of

them were taken into consideration. After 2010, there were total 230 “streets” in Shanghai, including 19 special streets used in industrial areas, no elderly living in there, was deleted, and the remaining 211 "jiedao" is our research unit. Figure 2 Shows the number of different “jiedao” elderly people in three periods. As we can see, the number of elderly people shows a trend from high to low from the center to the suburbs.

3.2. Measuring accessibility to parks

In this paper, the two-step floating catchment area search method is used to measure the accessibility of individual street care institutions, and is also a method to describe whether

there is inequity. The basic idea is that, under a given search radius d0, the first step, for each service supply point ji, search for all demand points in the range of d0, ki, calculate the supply-demand ratio Rj of each supply point j, In the second step, for each demand point ki, the search range, all the supply points ji in d0, the supply and demand of all the supply points ji in the range are compared with Rj, and finally the reachability Ak of each demand point is obtained. The formula is as follows:

First step:

$$R_j = \frac{S_j}{\sum_{k\in(d_{ij}\le d_0)} P_k}$$

Among them, Rj is the supply-demand ratio, Sj is the service capability of the supply point ji, and Pk is the population of the demand point k in the range of d0.

Second step:

$$A_i = \sum_{k\in(d_{ij}\le d_0)} R_j$$

Among them, Ak is the reachability of the demand point k in the range of d0. In order to simulate the attenuation effect from center point, this paper introduces a Gaussian function. The final model is as follows:

First step:

$$R_j = \frac{S_j}{\sum_{k\in(d_{ij}\le d_0)} P_k G(d_{kj}, d_0)}$$

Second step:

$$A_i = \sum_{k\in(d_{ij}\le d_0)} R_j G(d_{kj}, d_0)$$

And:

$$G(d_{kj}, d_0) = \begin{cases} \dfrac{e^{-\frac{1}{2}\times(\frac{d_{kj}}{d_0})^2} - e^{-\frac{1}{2}}}{1 - e^{-\frac{1}{2}}} & ,if \ \ d_{kj} \le d_0 \\ 0 & ,if \ \ d_{kj} \ge d_0 \end{cases}$$

Where G represents a Gaussian attenuation function, e is a natural logarithm, and the rest of the values have the same meaning as the formula above.

For the elderly nursing institutions, the number of beds is the core indicator for measuring the scale of their services, and also the direct conversion index for planning the land for the aged care institutions. Therefore, this paper selects the number of beds in the elderly nursing institutions as its scale parameters. In terms of the basic unit of research, in general, the basic allocation unit of the elderly nursing institutions as a public service facility is the street level. Considering the matching with the population data, the basic spatial unit of the

study is the street division of the Sixth census period. Since the direct demand population of the elderly nursing institutions is the elderly population, the geometric center of each street in Shanghai is obtained as the demand point of the elderly nursing institutions through the "element-point-pointing" tool in GIS, and the population of the elderly population over 60 years old is used as the demand point. The spatial indication of scale, involving population and facility data during the fifth census period, is treated in the same way.

In general, the determination of the search radius mainly needs to consider the factors of the facility itself and the mode of transportation. The minimum proximity distance, which is the maximum value of the shortest distance between all the supply points and the demand point, is one of the important basis for the selection of the search radius. In this case , The maximum distance from the central point of each street in Shanghai is 6010 meters. That means, at a search distance of 6010 meters, at least one elderly nursing institutions can serve all the streets. Considering the similarities between big cities, this paper selects6010 meters,9000 meters, and 18000 meters as the distance threshold of the search radius, and establishes a network database through Shanghai vector road network data. Since the road network data is difficult to obtain in different periods, all the road network-based spatial analysis in this paper adopts the 2014 Shanghai Road Traffic Network.

3.3. Measuring equity to parks

Accessibility can reveal the difference in the resource allocation of the elderly nursing institutions in various areas of Shanghai, but it is difficult to directly quantify the overall equity of the distribution of resources of the elderly nursing institutions in Shanghai. After comprehensive comparison, this paper selects the Gini coefficient and Lorenz curve method as a measure of the spatial equity difference between the services of the elderly nursing institutions, using the global and local Moran's I as a measure of the spatial equity difference between the spatial distribution of the elderly nursing institutions.

The Gini coefficient and the Lorenz curve are important methods for measuring income differences in the field of economics. They are the earliest applied to the equity of public medical resources in the study of the equity of public service facilities. In this paper, the accessibility of the elderly nursing institutions is used as the spatial variable of the elderly nursing institutions. As mentioned above, since the size of the supply point is represented by the number of beds, the accessibility value can actually indicate the number of beds per capita that can be obtained by the elderly in each street. Therefore, the meaning of the Gini coefficient of the accessibility of the elderly nursing institutions indicates that the distribution of the relative supply of the elderly nursing institutions in the elderly population is different under the influence of the spatial layout. Specifically, the lower the value of the Gini coefficient of the elderly nursing institutions indicates that Shanghai is located at different The more reasonable the proportion distribution of the elderly population in the sexual interval street town unit, and if the Gini coefficient of the accessibility of the elderly nursing institutions is greater than 0.4, it indicates that the elderly population in the high accessibility segment accounts for a small proportion of the elderly and is highly accessible. Sexual services are concentrated in a small number of elderly people, most of whom are in the accessibility of low-age care institutions, and the inequity distribution of the services provided by the elderly nursing institutions is significant.

The principle of the Lorenz curve is: the horizontal axis is the cumulative percentage of the population; the vertical axis is the cumulative percentage of the elements. The point on the

curve indicates the correspondence between the cumulative percentage of the population and the cumulative percentage of the elements. The Gini coefficient is the ratio of the area between the Lorenz curve and the diagonal to the area under the diagonal. The formula is:

$$G = 1 - \sum_{k=1}^{n} (P_K - p_{K-1})(R_k + R_{k-1})$$

Among them, R is the cumulative proportion of the elderly population variables in each street, and R is the cumulative proportion of the accessibility of the elderly nursing institutions. In general, the meaning of the Gini coefficient is to analysis the relationship between the distribution of a certain factor and the proportion of the population. In the study of public service facilities, since the statistical unit of the population has spatial attributes, the acquisition of public services related to it is also based on Spatial location, in this type of research, the meaning of the Gini coefficient actually refers to the difference in the distribution of population and public service factors under the influence of geographical distribution.

In general, the value of the Gini coefficient is between 0 and 1. When the value of the Gini coefficient is 1, it means that all the elements are concentrated in one person. Generally speaking, when the Gini coefficient is lower than 0.2, it is an absolute average, 0.2 to 0.3. It shows a comparative average. When the Gini coefficient is between 0.3 and 0.4, it indicates that the resource allocation is in a relatively reasonable range. When the Gini coefficient is greater than 0.4, it means that the resources have a large number of clusters in the distribution, and the inequity phenomenon More obvious.

The global and local Moran's I are used to evaluate the equity of the spatial distribution of pension institutions' resources. An element has a clustering feature in space, including a high agglomeration zone and a low agglomeration zone, which can indicate the spatial correlation of this element in geographical distribution. For public resources, the characteristics of their distribution are not only related to the facilities themselves, but also to the population distribution. Therefore, regardless of the demand distribution, the areas where the absolute supply of public services is only high can't reflect the supply under the influence of spatial layout. It is also difficult to demonstrate the spatial equity of the distribution of public service resources. The calculation method of accessibility of public service facilities gradually combines the matching of population and resources, taking into account the traffic and distance obstacles between the two, and the meaning of accessibility reflects the relative supply of public services. From a spatial point of view, under ideal conditions, the relative supply of public services between urban and rural areas should be in an equal state, and residents in any location should have the same access to public service facilities of a certain type of demand. The existence of high and low concentration areas of public service facilities means that there are agglomerations of advantages or disadvantages in space, indicating that geographical location affects the demand for public services, and there is significant inequity in the layout of facilities.

This paper mainly studies the accessibility of the elderly nursing institutions through the global and local Moran's I. Compared with other methods, Moran's I coefficient can not only judge the existence of spatial agglomeration, but also recognize the existence of abnormal space.

The formula for the global Moran's I is as follows:

$$I = \frac{n}{S_0} \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{i,j} z_i z_j}{\sum_{i=1}^{n} z_i^2}$$

Where zi is the deviation of the attribute of i from its mean value, wij is the spatial weight between i and j, n is equal to the total number of i, and the set of S0 bit space weights.

$$S_0 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}$$

Zi calculation formula is

$$z_i = \frac{I - E[I]}{\sqrt{V[I]}} = \frac{I - (-\frac{1}{n-1})}{\sqrt{E[I^2] - E[I]^2}}$$

It can be seen from the formula that including the spatial variable itself, the factors affecting the global Moran's I and the choice of the spatial weight matrix, considering the purpose of the study and the characteristics of the Shanghai administrative unit, this paper uses the proximity distance threshold to generate the spatial weight matrix. According to Geoda's calculation results, the farthest distance between each research unit is 8996 meters, and 9000 meters is obtained after rounding as the proximity distance threshold.

The global Moran's I range is from -1 to 1. When the global Moran's I is greater than 0, it means that there is a spatial positive correlation between the features in the study area, and the closer to 1 indicates the higher the degree of feature aggregation; when the global Moran's I is less than 0 , indicating that there is a spatial negative correlation between the elements in the research scope; when the global Moran's I is equal to 0, it means that there is no spatial correlation of the elements, and the elements are randomly distributed within the research scope. The reliability test for the global Moran's I should be determined by the p and z values. When P is less than 0.05 and Z is greater than the critical value of 1.96, the result is reliable, only 5% of the data has random possibility; when Z is less than 0, and through the significance test, indicates that there is a negative correlation, there may be low and high agglomeration and high and low agglomeration.

lobal Moran's I can verify whether there are spatial correlations among the elements in the study, but it cannot be determined in the distribution of high-value aggregation and low-value aggregation. Therefore, local Moran's I need to jointly determine the specific types and boundaries of spatial agglomeration.

The formula for local Moran's I is as follows:

$$I = z_i \sum_{j=1, j \neq i}^{n} w_{ij} z_j$$

Where zi and zj are values normalized by the region attribute, and other meanings are as above.

4. Analysis results

4.1. The equity caused by the location: study in elderly nursing institutions from Shanghai

By the end of 2017, there were 673 elderly nursing institutions in Shanghai that met the requirements of this study, with an annual population of 4.836 million [97], an increase of 14.3% compared with the end of 2014. In order to ensure the matching of research population data and facility data, In 2014, Shanghai's street population data increased to the end of 2017 according to the population weight of each street to match the facility data to ensure the comparability of research in different periods.

Taking 6010m, 9000m and 18000m as the search radius of the facilities, the spatial accessibility of Shanghai 2017 elderly nursing institutions was analyzed. The analysis results

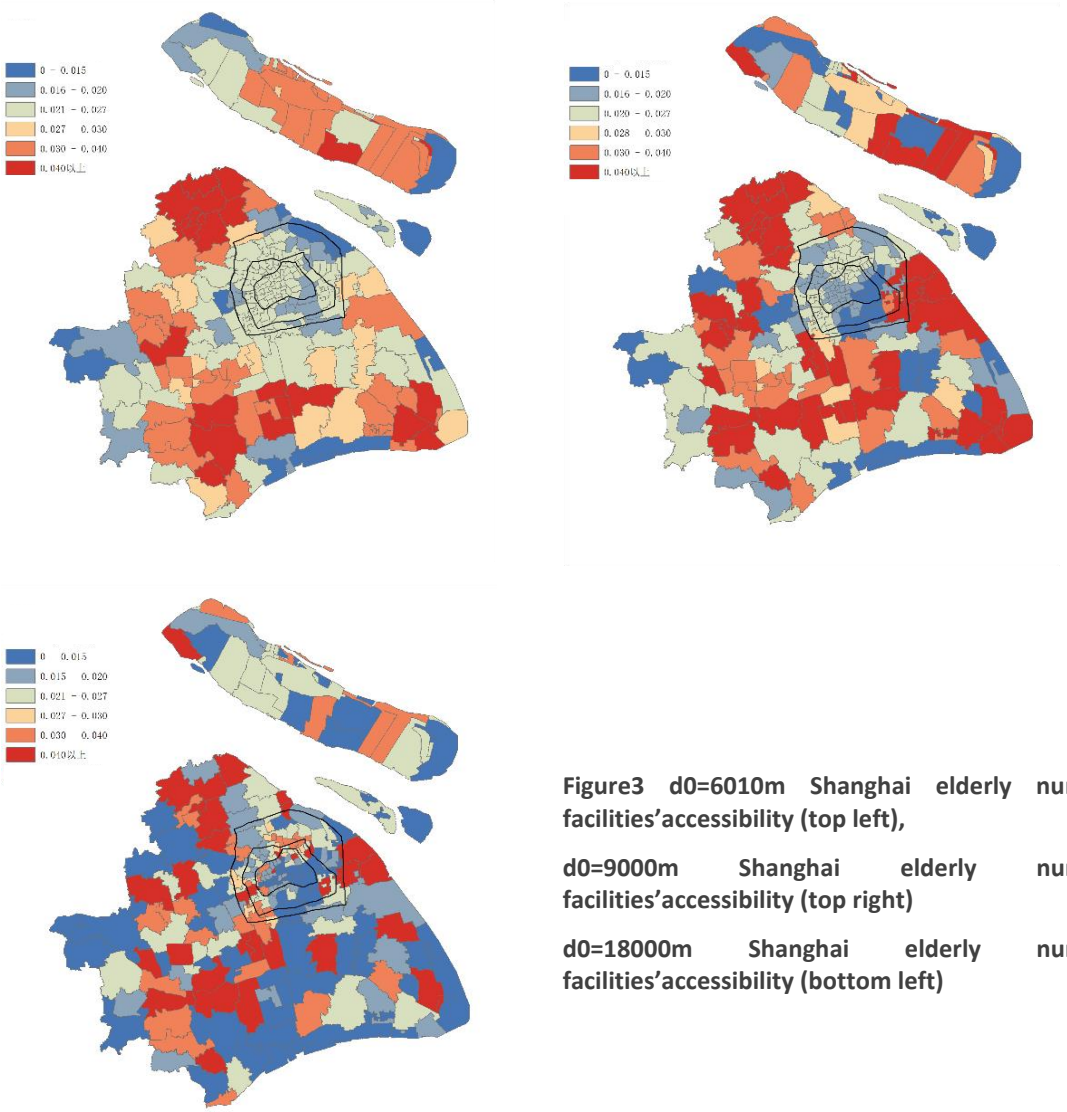


Figure3 d0=6010m Shanghai elderly nursing facilities'accessibility (top left),

d0=9000m Shanghai elderly nursing facilities'accessibility (top right)

d0=18000m Shanghai elderly nursing facilities'accessibility (bottom left)

are shown in the figure (Fig. 3).

It can be found that no matter the search radius, the accessibility between different streets in Shanghai is quite different. With the increase of the search radius, the regularity trend of this difference begins to appear, and the level of accessibility is high. The agglomeration of values in space is becoming more and more obvious. Regardless of the search radius, the accessibility of the elderly nursing institutions in Shanghai is obviously lower in the central city and higher in the suburbs. This trend is more obvious at the search radius of 9000 meters and 18,000 meters.

As far as the central urban area is concerned, the total number of beds in the elderly nursing institutions is insufficient, and the elderly nursing institutions in each street are also responsible for the services of the surrounding areas. In the range of travel distance d0=18000 meters, the elderly in the central city only have difficulty in improving the travel distance. More adequate services for the aged care institutions are available, because the absolute number of elderly people in the area is also high, and there is a competitive relationship between the use of the elderly nursing institutions in the streets, which is also consistent with the phenomenon that the old people in central city is hard to find a proper facility.

The suburbs show the opposite trend. The elderly population in these areas increases the cost of travel within the effective service of the elderly nursing institutions to obtain institutional pension services that meet the policy needs (Figure 3). Most of the elderly people in the suburbs can get more adequate services for the aged care institutions within 18,000 meters. Some streets are in the lower accessibility range under the condition of d0=6010 meters, and the accessibility increases with the increase of the search radius obviously.

Therefore, compared with the simple street as a statistical unit, the two-step mobile search method can more accurately reflect the actual aged care services that can be obtained in each street. The reachability map can intuitively reflect the differences in institutional resources obtained by each region. This difference represents the inequity of resources in the distribution of different regions.

Accessibility can only represent the existence of inequity from the phenomenon level. The result is the relative magnitude of population and resources. It is difficult to describe the specific inequity in general, and it lacks the support of horizontal or vertical comparison of the equity of facility space layout. Therefore, the Gini coefficient and the Lorenz curve are used to analyze the inequity caused by the distribution of elderly nursing institutions under different search radii (Fig. 4). Judging from the Gini coefficient of accessibility of elderly nursing institutions in 2017 (Fig. 4), regardless of the search radius, the Gini coefficient of accessibility of the elderly nursing institutions did not exceed 0.4, indicating that the overall pension institutions in Shanghai are in the elderly population. The distribution is relatively fair, which means that the absolute number of elderly people in the streets with high accessibility is in a relatively reasonable range, and the service resources of the elderly nursing institutions are not excessively concentrated in a few elderly groups.

The equity of the spatial distribution of the services of the elderly nursing institutions was evaluated by the global Moran's I (Fig. 4). The results show that under the condition of d0=6010 meters, the agglomeration trend is not obvious, and the global Moran's I index is close to 0 (0.008). And not significant, indicating that under the search radius of 6010 meters, the street units with different reachability values appear spatially randomly distributed.

From the perspective of the equity of spatial distribution, the elderly have the opportunity to obtain the resources of the elderly nursing institutions. Position is irrelevant. Under the conditions of d0=18000 meters and d0=9000 meters, the streets with similar accessibility of Shanghai elderly nursing institutions have a significant agglomeration trend in space, which means that for the elderly in different locations, the resources of the elderly nursing institutions are available. Significant differences. Comparing the values of global Moran's I and z values at three scales, as the search radius increases, the spatial agglomeration is also increasing, indicating that the inequity of spatial distribution is also increasing, especially at d0=18000 travel distance, The distribution of accessibility has a clear agglomeration trend in space.

Local Moran's I (LISA), as a complement to the global Moran's I, can reflect the specific agglomeration of specific elderly nursing institutions in Shanghai (Figure 5). According to the calculation results of local Moran's I, it can be found that the accessibility of the elderly nursing institutions in Shanghai has the following characteristics: 1, The low-accessibility cluster is mainly concentrated in the central city, while the high-accessible cluster is distributed in the suburbs, along with d0. The increase is more and more obvious. The high-accessibility cluster is gradually concentrated in the suburbs, and the low-accessibility unit gradually spreads from the central city. 2, As the search radius increases, the number of abnormal space units also decreases, gradually assimilation with the surrounding agglomeration core.

From the perspective of equity, this kind of differentiated spatial agglomeration means that the opportunities for accessing the resources of the elderly nursing institutions in different regions are different. The elderly in the low-value clusters have unfair spatial access to the services resources of the elderly nursing institutions.

It can be seen that as of 2017, from the perspective of demand, there is still a certain gap in the realization of the spatial distribution of the resources of Shanghai's elderly nursing institutions. From the point of view of population distribution, the high-accessible street-town unit carries a relatively reasonable number of elderly people, but from the perspective of spatial distribution, this difference is gradually increasing, which means low-reachability gathering area. The elderly population within the group bears more inequity in the services of the aged care institutions.

Relative to the description of the phenomenon itself, the local Moran's I calculation clearly defines the range of high-aggregation and low-aggregation areas with different search radius options. At present, the service of Shanghai's elderly nursing institutions is relatively fair in the distribution of people, but the spatial flatness is particularly significant. With the increase of the search radius, the suburban elderly space can obtain more resources for the aged institutions, but the elderly in the central city is difficult to achieve the same effect.

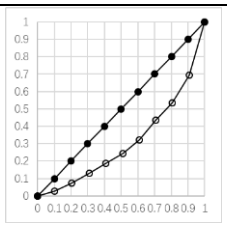
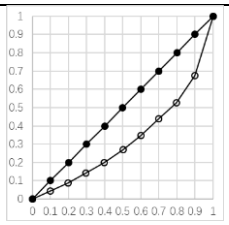
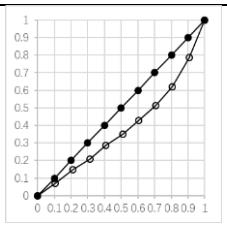
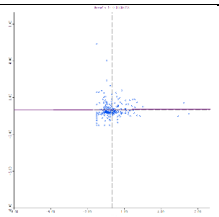
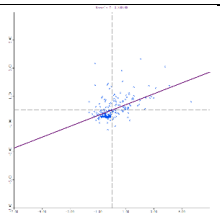
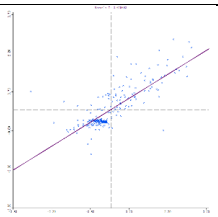
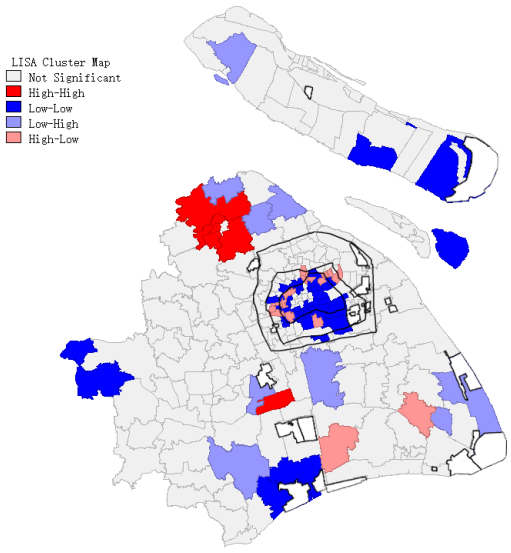
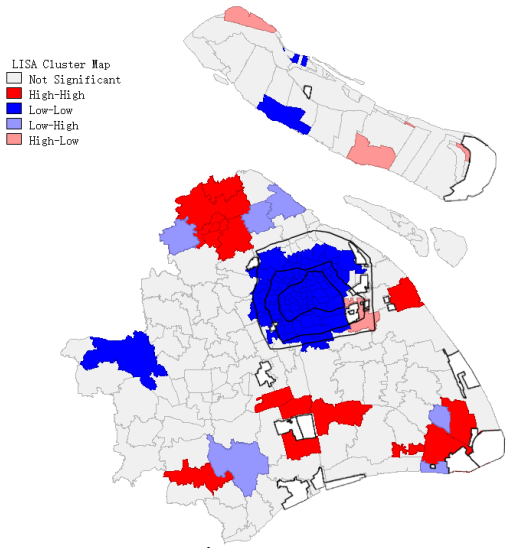
t=2017	d0=6010m	d0=9000m	d0=18000m
Gini Coefficient	0.38	0.35	0.23
Lorenz curve			
global Moran's I	I=0.008, Z=0.3, p-value: 0.3	I=0.39, Z=10.4, p-value: 0.001	I=0.61, Z=15.7, p-value: 0.001
Global Moran's I scatter plot			

Figure4 Comparison of the degree of equity with different search radii



d_0=6010 m



d_0=9000 m

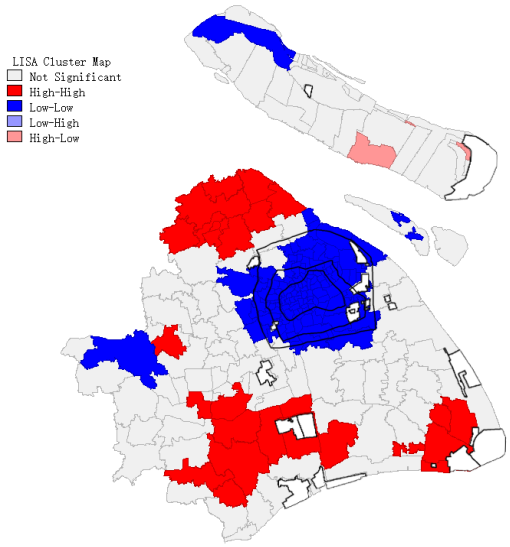


Figure5 Local Moran I of different search radius

4.2. The development of the equity caused by the location: study in elderly nursing institutions from Shanghai

From a development perspective, the emergence of spatial phenomena in cities is associated with specific historical periods, especially for public services. In urban development environments, there is a dynamic match between the growth of the total and the demand population. Relationships, diachronic comparisons help to help planners grasp the changes in the matching relationship between public service facilities and the demanding population during the construction process, and lay the foundation for further layout optimization in the future.

By comparing the equity of the spatial layout of the Shanghai elderly nursing institutions in d0=18000 meters in 2000, 2010 and 2014, the data of the population and elderly nursing institutions at the same time were matched to reflect the equity of Shanghai's elderly nursing institutions in different periods. Development.

From the perspective of the accessibility development in different periods (Figure.6), in 2000, the spatial differentiation of Shanghai's accessibility has begun to appear. The accessibility of the elderly nursing institutions has gradually changed from the central city to the suburbs. In terms of total volume, from 2000 to 2017, the accessibility of the elderly nursing institutions in Shanghai is increasing, and the total number of elderly nursing institutions in the high-accessibility range is increasing (Figure.7).

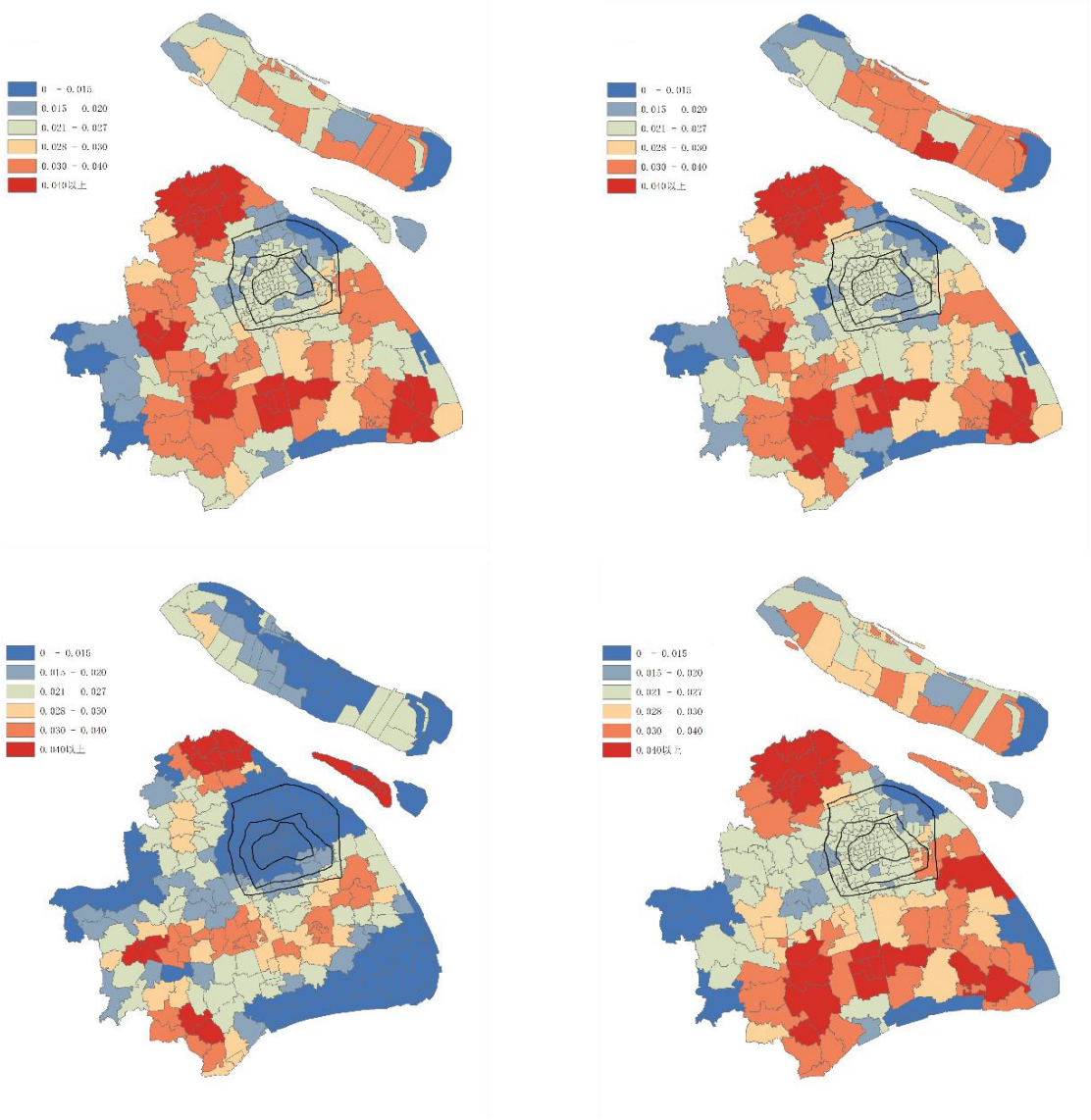


Figure 6 t=2000 Shanghai elderly nursing institutions' Accessibility (Top left), t=2010 Shanghai elderly nursing institutions' Accessibility (Top right) ,t=2014 Shanghai elderly nursing institutions' accessibility (bottom left) t=2017 Shanghai elderly nursing institutions' Accessibility (bottom right)

Accessibility can only represent the existence of inequity from the phenomenon . The result is the relative magnitude of population and resources, and it's difficult to describe the specific inequity in general. Therefore, Gini coefficient and Lorenz curve are used to analyze the degree of equity about the different service provided by the elderly nursing institutions, which is caused by the location, among the elderly (Figure.6). Although the distribution of accessibility between different research years showed a similar trend, from the perspective of the equity of the distribution of service population (Figure.3), Judging from the Gini coefficient of accessibility of Shanghai's elderly nursing institutions, in 2000, the Gini coefficient of the accessibility of different intervals in Shanghai reached 0.43. In the "big gap" interval, the number of elderly people in high-accessible streets is too low, and the inequity of population distribution is significant, but since 2010, this situation has improved.

The Gini coefficient of accessibility distribution gradually returns to the normal interval, which indicates that the coupling between the growth of the resources of the elderly nursing institutions and the changes of the distribution of the elderly is gradually increasing in recent years, and the limited supply of resources has achieved the role of promoting the equity of the distribution of the population.

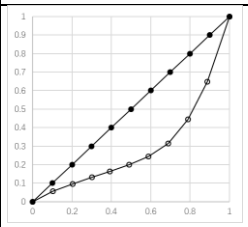
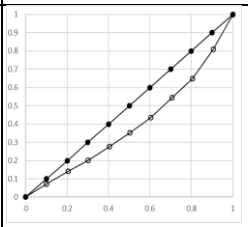
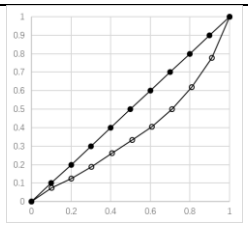
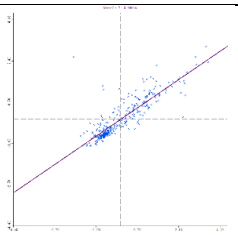
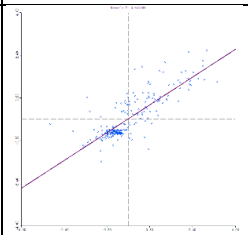
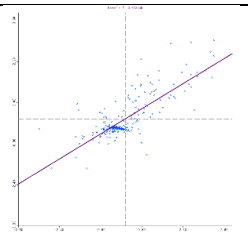
d0=18000 meters	2000	2010	2014
Gini Coefficient	0.43	0.21	0.26
Lorenz curve			
global Moran's I	I=0.68, Z=27.4, p-value: 0.001	I=0.61, Z=15.7, p-value: 0.001	I=0.65, Z=16.3, p-value: 0.001
Global Moran's I scatter plot			

Figure7 Comparison of the degree of equity with different years

Different from the improvement of the equity of the population distribution, in recent years, the improvement of the equity of the spatial distribution of the elderly nursing institutions has been minimal. The global Moran's I (Figure.7) is at a significant interval at each time ($p<0.001$, $Z>2.56$), and both are positive, indicating that at any time, at 18,000 search radius, Shanghai's elderly nursing institutions are reachable. The sexual distributions all show spatial positive correlation, the similarity units of the similarity show agglomeration in space, and the overall effect of agglomeration is similar, indicating that the spatial distribution of the accessibility values is not random, and the clustering of the research units The growth is

proportional, and the inequity of this spatial distribution is not only accidental, but the result of the long-term development of Shanghai's elderly nursing institutions and the elderly.

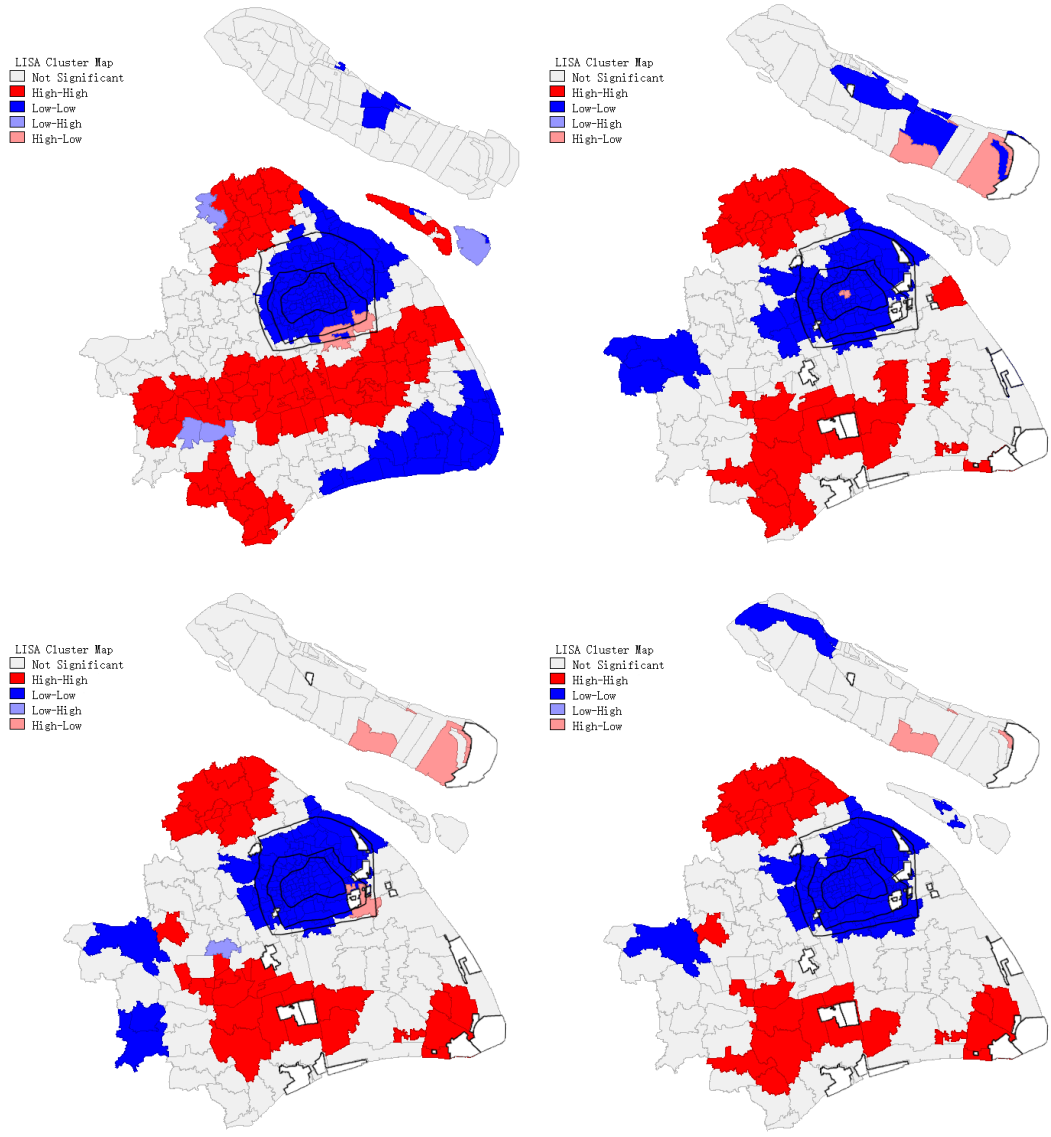


Figure8 Local Moran I of different search years, t=2000 (Top left), t=2010 (Top right) ,t=2014 (bottom left) t=2017 (bottom right)

This trend is analyzed by local Moran's I. From 2000 to 2014 (Figure.8), the overall trend is the trend of low-accessibility units concentrated in the central city and high-accessibility units concentrated in the suburbs. At the same time, it can be found that the distance of the high-accessible agglomeration area from the outer ring line boundary is gradually increasing, and gradually concentrated in the suburbs. Relatively speaking, the central city area has been in a low-accessibility gathering area, and the change is relatively low. Service has always existed. However, there are exceptions to the development of equity in service space. In 2000, the low-accessibility agglomeration space in the southern part of Shanghai gradually turned into a high-value clustering unit, indicating that the resource input of the elderly nursing institutions in this area is relative to the population. The growth is faster, the

investment in resources has achieved certain results, and it has reached a higher level of service in Shanghai. It can be seen that although the increment of the elderly nursing institutions in the city area is increasing, the inequity of the distribution of the service space of the elderly nursing institutions is also easing, but there are still areas where the equity and growth are faster than the increase in the demand population. The development of equity cannot completely replace the changes in local areas.

overall, from 2000 to 2014 (Figure.8), the inequity of the spatial layout of elderly nursing institutions showed a general trend of mitigation, and the differences in the distribution of services among the elderly groups were weakening, while the spatial distribution was inequity. But it is constantly focusing. The development of past elderly nursing institutions was based entirely on the lack of spatial planning. During this period, the formulation of public policies for elderly nursing institutions promoted the equity of their services in population distribution, which is common to market and policy supply. As a result, it is also inseparable from the cross-regional recommendations of the elderly population. Another convenience, this shows that the intervention of spatial planning has a high necessity to promote the equity of the redistribution process of public service resources. Per capita indicators and market mechanisms can follow the changes in demand to a certain extent, thus achieving the easing of inequity attributes of the distribution of service groups in the elderly nursing institutions, but this lack of analysis on the spatial level is difficult to optimize and solve strategies at sunrise, even It will aggravate the existence of inequity distribution of relative supply in the space. The latter not only exacerbates the inequity of the layout of public service facilities, but even causes waste of resources.

At the same time, it should be noted that from 2010 to 2014 (Figure.8), the inequity of the distribution of people in Shanghai's elderly nursing institutions and the inequity of spatial distribution have fluctuated slightly. The trend, on the one hand, shows that in recent years, the equity of the distribution of the services provided by the elderly nursing institutions has been well maintained, but the equity of the spatial distribution has not been well adjusted, and the overall pattern of the high and low accessibility spaces is On the other hand, this kind of volatility also reflects the instability of the equity pattern. Under the dual dimensions of time and space, the goal of building a new public service facility should not only make up for the gap in the low-service space unit, but We must also pay attention to the changes in overall spatial equity from a dynamic and global perspective.

5. Conclusion

At present, within the search radius of d0=18000 meters, Shanghai's elderly nursing institutions generally show a lower central urban accessibility and a higher suburban trend, but the distribution of old-age care services among the population is in a fair and reasonable range, but In terms of space, there is a significant agglomeration trend. The central urban area is a typical low-accessibility gathering area, while the suburbs form three high-level areas with Jiading Baoshan junction area, Songjiang Fengxian and Jinshan junction area, and Pudong Da Tuan town as the core. Daren gathering area.

From the perspective of development, compared with 2000, the distribution trend of the accessibility of the elderly nursing institutions in Shanghai has not changed much in recent years. In general, it still shows the characteristics of low suburban high in the central city, but

with the population. With the dynamic development of facilities, the equity of the distribution of old-age care services in the elderly has been significantly improved, and the disparity in 2000 has gradually turned to a relatively reasonable space. However, the inequity of spatial distribution has not been significantly improved, but it has become more focused on the scope. From the perspective of the migration of different agglomeration spaces, the southern part of Pudong New Area has been transformed from a remarkable low-accessibility cluster in 2000 to a high-accessibility cluster, indicating that the construction of the elderly nursing institutions has achieved remarkable results relative to the population growth. .

Compared with the overall elderly nursing institutions, the inequity of the population distribution and spatial distribution of the basic elderly nursing institutions is more significant, and this part of the content has not been effectively reflected in the existing planning, which can explain the disadvantages of the elderly population. For the group, it is more difficult to obtain fair resources for the elderly nursing institutions. They are at a more unfair interval in the provision of services for the aged care institutions at the basic demand level.

The evaluation method of accessibility can reflect the existence of inequity of resource distribution, and its high and low range can clearly reflect the spatial distribution difference of relative supply. Under the traditionally equal allocation of ideas, relying on administrative units as the basic statistical unit, it is difficult to take into account the complementary roles between the streets, so the actual service level of some streets will be too low or too high (Figure 3.9-3.10) , which in turn will cause interference to further spatial layout optimization. It can be seen that the choice of evaluation methods affects the accuracy of the understanding of the supply of public resources on the status quo. On the one hand, it is necessary to combine the characteristics of data to adopt a more accurate research method to reflect the status quo; at the same time, to study the layout of different types of public service facilities. In the middle, we should rationally and objectively analyze the characteristics of various facilities, and pay attention to the rigor in the choice of methods and parameters. At present, under the condition that the goal of the elderly nursing institutions in all streets of Shanghai has been basically completed, the accessibility can explain the matching relationship between supply and demand more accurately, and has more effective guiding significance for reflecting the supply situation of the facility.

Although accessibility helps to guide the further supply optimization of public service facilities, it cannot reflect the degree of inequity at the global scale, and it is difficult to clearly define the global distribution of limited resources. The existing equity evaluation of public service facilities can be divided into two aspects: population orientation and spatial orientation. The former reflects the differences in access to public services by different groups of people, while the latter reflects the agglomeration of public services in spatial distribution. The equity of public services in the distribution of people reflects the degree of overall matching between supply and demand, while the equity of spatial distribution can reflect the preference between

resource supply policies in different regions. The emergence of agglomeration areas of public service resources should attract the attention of planners. Based on a comprehensive analysis of future population, economic and industrial development trends, suggestions for further optimization and allocation should be made.

6. References

Aihua Z, Xiao F(2013)" Research on Accessibility of Emergency Evacuation Sites in Beijing Urban Area Based on Two-Step Mobile Search Method",Journal of Safety and Environment,Vol.13No.250-253.

Anselin L (1995)" Local Indicators of Spatial Association—LISA", Geographical Analysis, Vol.27No.93-115.

Barbati M(2016)" Equality measures properties for location problems", Optimization Letters, Vol.10No.903-920.

David, Hasegawa Naoki, Suzuki Bozhi (2011) "Preliminary Study on the Construction and Use of Beijing Aged Care Service Organizations——On the Rational Planning of the Construction of Aged Services Organization Urban Planning", Vol. 35No.60-67.

Gao Xiaolu (2013) "Preference Characteristics and Community Differences of Urban Residents in Aged Agencies", China Soft Science, Vol. 1No.23-32.

Haiyan J,Chunshan Z,Junbo G(2011)" Research Progress on the Fairness of Public Service Spatial Distribution in Western Cities", Urban planning, Vol. 35No. 72-77.

Harries K, Smith D Mjjoei(1994)" Geography and Social Justice", Journal of Economic Issues, Vol. 17 No. 335-344.

Horev T , Pesis-Katz I , Mukamel D B(2004)" Trends in geographic disparities in allocation of health care resources in the US", Health Policy, Vol.68No.0-232.

Junbo G, Chunshan Z (2009)" Theories and research progress of urban public service facilities supply in western countries", Global geography research, Vol. 18No. 81-90.

Keenan T A(2010)" Home and Community Preferences of the 45+ Population",AARP Research, Vol. 23No.68-72.

Keqin R, Wei X, Lixuan Q(1998)" Measurement Method of Health and Fairness", China Health Economics, Vol2.NO.30-32.

Klaus R. KunzmannI(1998)" Planning for spatial equity in Europe" International Planning Studies, Vol. 3 No. 101-120.

Li J, Xiaopei Y,(2015)" Social justice, benefit distribution and spatial planning",urban planning, Vol.39 No. 9-15.

Lianhong C.(2014)"Hospital Layout Evaluation Based on Gaussian Two-Step Mobile Search Method Spatial Accessibility Model", Chinese Hospital Management, Vol. 34No.31-33.

Nicholls Sarah(2001)" Measuring the accessibility and equity of public parks: a case study using GIS", Managing Leisure, Vol. 6No. 201-219.

Park S J (2012)" Measuring public library accessibility: A case study using GIS",Library & Information Science Research, Vol. 34No. 13-21.

Talen E(1998)" Assessing spatial equity: an evaluation of measures of accessibility to public playgrounds", Environment and Planning,Vol. 30No.595-613.

Talen Emily(1997)" THE SOCIAL EQUITY OF URBAN SERVICE DISTRIBUTION: AN EXPLORATION OF PARK ACCESS IN PUEBLO, COLORADO, AND MACON, GEORGIA", Urban Geography, Vol. 18No. 521-541.

Talen Emily(1998)" Visualizing Fairness: Equity Maps for Planners", Journal of the American Planning Association", Vol. 64No. 22-38.

Talen, & Emily(1997)" The social equity of urban service distribution: an exploration of park access in pueblo, colorado, and macon", Urban Geography, Vol.18No. 521-541.

Teitz M B,(1968)" Toward a Theory of Urban Public Facility Location", Papers in Regional Science, Vol.21 No. 35-51

Wei X, Yuan Z(2017)" The Spatial Distribution Pattern and Accessibility Evaluation of the Aged Service Facilities in Nanjing——Two-Step Mobile Search Method Based on Time Cost",Modern Urban Research,Vol2.NO.1-11.

Xiao Y , Wang Z , Li Z (2017)" An assessment of urban park access in Shanghai – Implications for the social equity in urban China",Landscape and Urban Planning, Vol. 157No.383-393.

Yao Dong (2015) "Study on Space Measures for Inhabited Elderly in Big Cities", Urban Planning Journal, 2015(4).

Yifan Yu, Xin Sui(2018)" Evaluation of the Spatial Distribution of Aged Service Facilities under the Vision of Fairness——An Empirical Study Based on the Elderly Education Facilities in Shanghai", Social Policy Research.

Zhang Nan, SunXiao jie, Li Cheng(2014)" Analysis of the Fairness of Health Resource Allocation in China Based on Theil Index", China Health Care Management, Vol31.NO.88-91.

Zhang Songlin, Zhang Kun(2016)" Research on Moran and G Coefficients of Spatial", Autocorrelation Local Indicators, Vol.27No.31-34.

Zhen L, Suiqiang G, Huihua J (2007)" Application of GIS-based two-step mobile search method in the evaluation of accessibility of medical treatment in Beijing" ,Surveying science, Vol. 32No. 61-63.

Zhengna S , Wen c, Guixiang g,(2010)"Spatial accessibility of public service facilities and its measurement methods",Progress in Geography, Vol. 29No. 1217-1224.

Zhongxiao C(2009)" The Realistic Interpretation of the Equity View of Economic Law in Contemporary China——An Interpretation of the Equalization of Basic Public Services", Contemporary jurisprudence,Vol. 23 No.92-99.

Zhuolin T, Yang C, Teqi D(2014)"Evaluation of Spatial Accessibility of Beijing Aged Facilities", Progress in Geography, Vol. 33No. 61-63616-624.

Zhuolin T, Yang C.(2016)"Research Progress of Two-Step Mobile Search Method and Its Extended Forms", PROGRESS IN GEOGRAPHY, Vol. 35No. 589-599.

Zilai T, Gu Wei(2015)" Social Performance Evaluation of Public Green Space Distribution in Shanghai Downtown Area: From Regional Equity to Social Equity",Urban Planning Journal.