

Spatial Distribution Balance and Walking Accessibility of Health Service Resources for the Elderly in Fuzhou City, China

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Abstract. With the aging of society, elderly health is increasingly valued. The spatial layout and accessibility of health service resources are of great significance for ensuring the health and living standards of elderly people living at home. Based on the data of the elderly population aged 60 and above in Fuzhou City in 2023, this study selects interest points such as tertiary hospitals, clinics, and rehabilitation centers, calculate the Gini coefficient using Excel 2013, and calculates spatial accessibility using QGIS. The results show that there is a certain imbalance in the spatial layout of health service resources in Fuzhou, and there are significant regional differences in accessibility. The accessibility is high in the central and eastern coastal areas, but low in remote areas such as the western and southern regions. It is suggested that the government of peripheral county towns should invest more funds in public health to meet the health needs of local people. Additionally, gradual population migration from older urban areas to newly developed urban zones should be encouraged. Constructing roads and providing shuttle services can also help improve the accessibility of health service institutions. These strategies will help create a more balanced and inclusive health service system for Fuzhou's aging population.

Keywords: Health Service, Accessibility, Two-Step Mobile Search Method, Spatial Distribution Characteristics.

1. Introduction

With the accelerated development of population aging in China, the elderly life quality has increasingly become the focus of social attention. Having a healthy body is the prerequisite for elderly people to pursue a high-quality life. When elderly people can easily reach health service institutions, they are more likely to receive regular health check-ups, timely treatment, and rehabilitation services, which are crucial for preventing and controlling chronic diseases and maintaining physical health. Therefore, the rational allocation and efficient utilization of elderly health service resources are directly related to the quality of life and happiness of the elderly [1-2].

Hansen first proposed the concept of accessibility in 1959. In a wide range of spatial and transportation fields, accessibility refers to the convenience of travel between two points in space [3-4], representing the amount of resistance (time and distance) overcome during the process from a certain location to a destination. The concept of accessibility not only includes the connection between the origin and destination, but also the characteristics and abilities of the studied population. This concept has a wide range of applications in fields such as housing, commerce, and healthcare. The accessibility of health service institutions can effectively evaluate the spatial allocation of medical and health service resources and services, identify areas with medical shortages for planning and improvement [5].

Fuzhou is a city with a long history and rapid development, also known as Rong City, located in the southeastern part of Fujian Province, China. In 2023, Fuzhou had a population of 1389989 people aged 60 and above, which is a very large population. Only 65% of the elderly are in a healthy state, while the remaining 35% are in an unhealthy or sub healthy state. Due to differences in regional economic development levels, urban planning layouts, transportation network conditions, and other factors, there is often an uneven spatial distribution of elderly health service resources, which makes it difficult for some elderly people to conveniently access the services they need [6].

Previous studies have evaluated the spatial accessibility of elderly care institutions in Fuzhou [7], but the phenomenon of elderly people living in elderly care institutions is not as common in China as in Western countries. Influenced by traditional Chinese thought, elderly people in China prefer to live with their children or at home rather than being sent to nursing homes. Therefore, this article aims to study the distribution balance of health service resources from the perspective of elderly people living at home, and select the preferred transportation modes of the elderly to evaluate the accessibility of these resources.

2. Background of Study Area

Fuzhou is the capital of Fujian Province in China, is located in the southeastern coastal region of China, facing Taiwan Province across the sea [8]. It includes Gulou, Cangshan, Taijiang, Jin'an, Mawei, Changle, Minhou, Pingtan, Fuqing, Yongtai, Mingqing, Lianjiang, and Luoyuan districts. Among them, the main urban areas of Fuzhou include Gulou District, Taijiang District, and Cangshan District. These old urban areas are the political, economic, and cultural centers of Fuzhou, with relatively complete urban infrastructure and mature industrial structure.

3. Data and Methods

3.1. Data sources

Health service resources are a broad concept, this study selected 3A grade hospital, clinics, and rehabilitation centers in Fuzhou city. The survey subjects of this article are elderly people living at home, so nursing homes are not within the scope of the study. It was found that most community health service centers are set up separately by street, with service areas located in residential areas within established streets, which are relatively fixed. Therefore, this study does not include community health service centers. The health service resources of each district were obtained from OpenStreetMap.

Table 1. Distribution of populations aged above 60 and health service resources in each districts of Fuzhou in 2023 (Original)

Districts	Elderly population (age>60)	Number of health service resources
Luoyuan	46047	1
Taijiang	82377	2
Fuqing	229530	8
Minhou	142040	5
Changle	134711	6
Pingtang	65448	3
Yongtai	57998	3
Mingqing	57060	3
Lianjiang	123421	9
Gulou	128142	13
Jin'an	123637	15
Cangshan	155033	21
Mawei	44545	7
Total	1389989	96

In addition, this paper collected the population data, aged 60 in Fuzhou in 2023, from the Fuzhou 2023 Statistical Yearbook (Table 1). While Fuqing has the largest elderly population (229530), it only has 8 health service resources, indicating a potential shortage. In contrast, Cangshan, with an elderly population of 155033, has 21 health service resources, reflecting better accessibility. Peripheral areas like Luoyuan and Taijiang, despite having smaller elderly populations (46047 and 82377 respectively), have only 1 and 2 resources, demonstrating a lack of adequate healthcare

services. Central districts such as Gulou, Jin'an, and Cangshan have a higher concentration of resources, aligned with their urbanization and healthcare needs. This highlights the need for more equitable distribution of healthcare services, especially in areas with larger elderly populations, such as Fuqing.

3.2. Methods

This paper uses QGIS 3.34.9 to create 10km*10km a grid within the city of Fuzhou, and uses this grid to analyze the path scope of the health service resources in the Fuzhou area to each region. The center point layer of the grid is set as the starting point layer, and the target points are health service institutions in Fuzhou. This study follows this step to generate the OD Matrix layer and selects the line segments within 50km. The Two-step Floating Catchment Area (2SFCA) model is used to calculate the accessibility.

3.2.1 Gini coefficient

The Gini coefficient was first proposed by Italy statistician and sociologist Corrado Gini in 1912. The Gini coefficient can be used to quantitatively analyze the spatial equilibrium of different regions and reflect the strength of the inequity [9]. The calculation equation of Gini coefficient is as follows:

$$G = 1 - \sum_{i=1}^n (X_i - X_{i-1})(Y_i + Y_{i-1}) \quad (1)$$

Where X represents the cumulative percentage of elderly population, Y represents the cumulative percentage of health service resources.

3.2.2 Spatial Accessibility Research

In terms of spatial accessibility research, this paper uses the traditional 2SFCA in QGIS to analyze POI data, and divides POI data into three categories: tertiary hospitals, clinics, and rehabilitation centers. The distance is set to 50km. The type of highway selected for this study includes Residential, path, track, footway, service and unclassified. The study utilized the service area tool of QGIS, starting from the hospital and based on a walkable road network with a speed set at 5km/h.

4. Results

4.1. Gini coefficients

The evaluation criteria for Gini coefficient vary in different regions around the world, and there is no international organization that can provide the most suitable Gini coefficient standard. However, many people agree with the following division: $G < 0.2$ is too average; $G = 0.2 \sim 0.3$ is relatively average; $G = 0.3 \sim 0.4$ is more reasonable; $G = 0.4 \sim 0.5$ is too large; $G > 0.5$, with a significant gap [10].

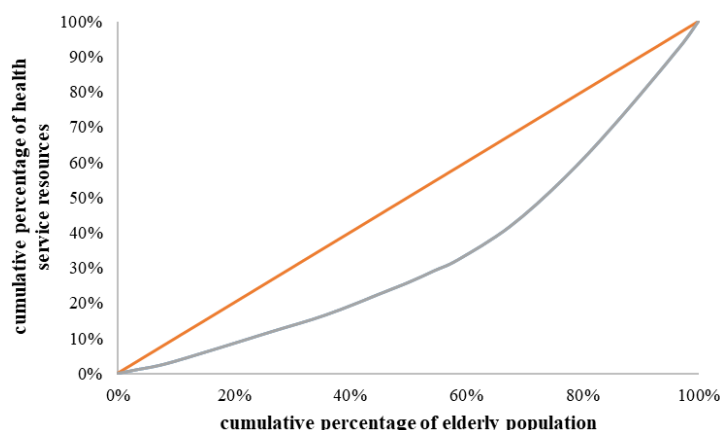


Figure 1. The spatial distribution balance of health management resources in Fuzhou from the perspective of elderly people. The orange straight line represents a completely equal distribution state, while the blue curve represents the actual distribution state (Original figure)

By calculation, the Gini coefficient G of the spatial distribution health service resources in Fuzhou City is 0.32343, which falls within the range of 0.3-0.4, indicating that the spatial distribution of hospitals in the region is relatively reasonable. Although there is a certain degree of imbalance, it has not reached the level of significant disparity or polarization.

The Lorenz curve of the spatial distribution of health management resources in Fuzhou from the perspective of the elderly based on the obtained X and Y values is shown in Figure 1. It shows that the actual distribution balance has a certain degree of deviation compared to the idealized one.

4.2. Spatial Accessibilities

Figure 2 is the accessibility distribution within 50km. It shows that the high accessibility index of health service resources is concentrated in the central urban area of Fuzhou, such as Gulou, Cangshan, and Taijiang. These areas have the most accessible health services, marked by the darker shades on the map. In contrast, the peripheral counties like Luoyuan and Lianjiang, highlighted by lighter shades, show relatively low accessibility. This confirms that nearly half of the region has minimal access to health services, indicating an uneven distribution of resources across the city. The map reinforces the spatial imbalances, particularly between the more developed central areas and the less accessible peripheral regions, where residents may face difficulties in obtaining timely medical care.

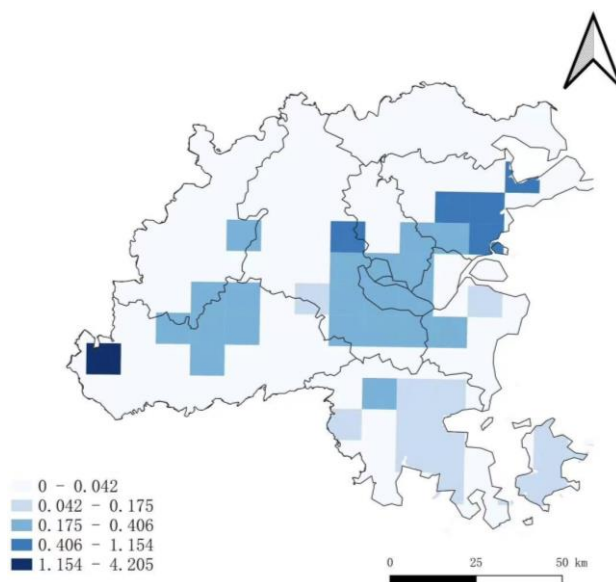


Figure 2. The accessibility distribution within 50km in Fuzhou city (Original figure)

5. Discussion

5.1. Distribution characteristics and causes of medical facilities

Figure 2 shows a significant imbalance in the accessibility distribution of health service resources in Fuzhou city. The accessibility is high in the central and eastern coastal areas, but low in remote areas such as the western and southern regions. This is related to the local economic development. The number of private hospitals in Fuzhou city, and even throughout China, is relatively small. Most hospitals are public hospitals, and the establishment of public hospitals is related to local government policies. Governments in economically underdeveloped areas invest less in public health, leading to a shortage of local medical institutions. Secondly, the local health service level is not high enough, making it difficult to attract professional talents to gather, which to some extent reduces the willingness of local residents to go and obtain services.

There are some common situations worth noting that some densely populated residential areas have few health service resources, or there are no residential buildings within a 30-minute walk of some health service resources (Figure 3).

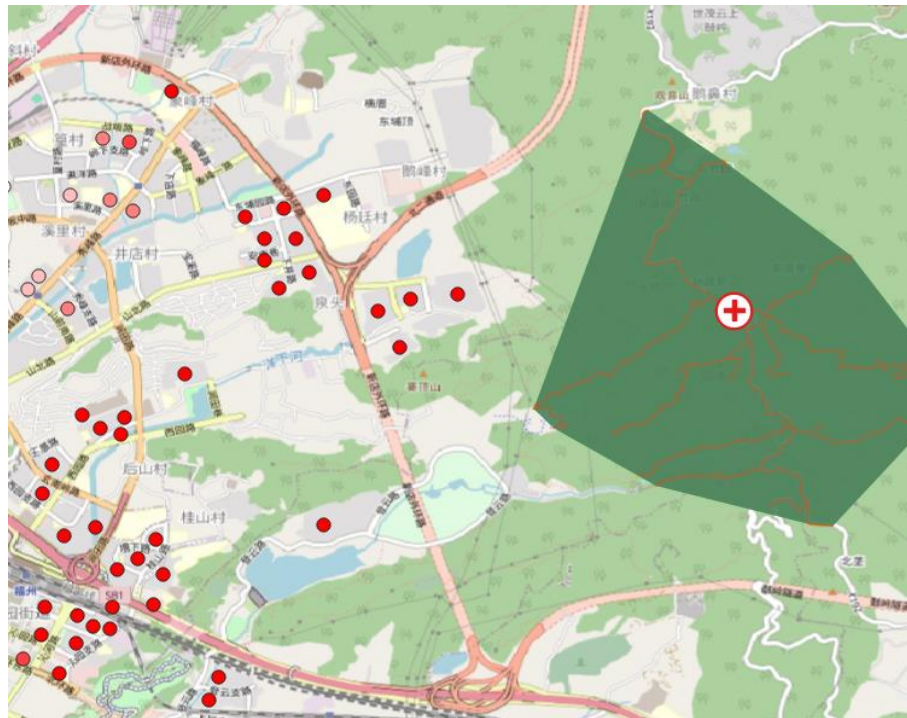


Figure 3. A case of mismatch between residential and hospital (Original figure)

This situation may occur in some old urban areas. In the process of urban development, the population density in the old city area is high and land is tight. There may not be enough land to build new health service resources, which leads to some areas with high population density lacking health service resources. The hospital is relatively remote and there are no residential buildings around it, which may be some forward-looking urban construction. There is no suitable land in the old city area to build a new hospital, so it is considered to establish a new development area.

5.2. Suggestions

Based on the distribution characteristics of health service institutions in Fuzhou and the current situation of aging population, this article proposes several suggestions:

First, in order to optimize the allocation of health service resources, an effective way is to increase investment, establish medical institutions and facilities, and improve the accessibility of health services in areas with scarce health service resources, especially in areas with severe aging. Particularly, priority should be given to districts like Fuqing, where there is a large elderly population but a scarcity of health service institutions. Targeted investments can ensure these regions are not left behind.

Second, it's instructive to accelerate the construction of transportation roads in the new district. Reasonable construction of surrounding roads can also improve the accessibility of health service institutions for those located far from residential areas. During road construction, special attention is paid to the installation of barrier free facilities, such as sidewalks, pedestrian overpasses, underground passages, etc., to ensure that the elderly can safely and conveniently pass through. Moreover, improving public transport routes that directly connect to health facilities can be crucial in mitigating long travel times, especially for those in peripheral regions.

Third, health service institutions can provide shuttle services for elderly people who have limited mobility or live far away. The elderly can call the health service the institution to schedule a time, and the institution will arrange a dedicated car or volunteer to transport the elderly to the service agency for health services. This can greatly improve the accessibility of elderly health service institutions.

Additionally, leveraging community volunteer networks to offer frequent shuttle services could further reduce the barriers for the elderly in reaching these facilities. Fuzhou's urban area is still under

continuous development, and the old urban area can consider gradually guiding population mobility to promote the development of new urban areas, such as the high-tech zone in Minhou County, in order to achieve a more balanced allocation of health service resources and make it easier for the elderly to obtain high-quality services. This strategy not only addresses immediate concerns but also ensures long-term sustainability in healthcare accessibility across Fuzhou.

6. Conclusion

This study uses QGIS to evaluate the accessibility of health service institutions within Fuzhou city. The distribution of health service institutions in Fuzhou cannot reach a balanced level. There is a certain degree of imbalance in the spatial layout of health service resources in Fuzhou, and there are significant regional anomalies in accessibility. The Gini coefficient of 0.32343 indicates a relatively reasonable distribution; however, a substantial portion of the area remains inaccessible, particularly in peripheral counties.

The main reasons for this problem are insufficient funds invested in the construction of local health institutions and a lack of public health human resources. In response to the current situation, this research proposes three suggestions: areas with low accessibility need to establish health service institutions. Traffic roads need to be built between residential areas and institutions that are far away. Health service institutions may consider offering shuttle services. These suggestions can to some extent improve the accessibility of health service institutions in the region.

References

- [1] Ding K, Liu Q. The rich connotation and practical value of Xi Jinping's important discourse on people's health. *J Fuzhou Univ (Philos Soc Sci Ed)*. 2022; 36 (01): 1-5.
- [2] Deng L, Shao J, Guo Y, et al. Accessibility of medical services in mountainous areas based on an improved two-step floating catchment area method: A case study of Shizhu County, Chongqing. *Prog Geogr*. 2015; 34 (06): 716-25.
- [3] Neutens T, Schwanen T. Equity of urban service delivery: A comparison of different accessibility measures. *Environ Plann A*. 2010; 42 (7): 1613-35.
- [4] Liu Y, Gu H, Lai X, et al. Analysis of the accessibility of medical facilities and supply-demand matching based on urban rail transit. *Res Dev Market*. 2023; 39 (05): 600-8.
- [5] Shen Y, Li L. Research progress on the accessibility of medical resources and residents' medical behaviors. *Sci Technol Rev*. 2020; 38 (07): 85-92.
- [6] Zhang H, Zhang Q, Li L. Research on the spatial accessibility of high-quality medical resources in county areas from the perspective of aging. *Chin J Med Manage Sci*. 2024; 14 (03): 45-52.
- [7] Yang L, Shui Y, Fan Y, et al. Research on the accessibility and coordination of elderly care institutions in the central urban area of Fuzhou. *Build Mater Technol Appl*. 2023; (01): 33-8. DOI: 10.13923/j.cnki.cn14-1291/tu.2023.01.009.
- [8] Li J, Lin Y, Zhang L, et al. Research on the spatial accessibility of subway stations based on the Gaode Map API: A case study of Fuzhou. *Logist Technol*. 2024; 47 (14): 10-15+68. DOI: 10.13714/j.cnki.1002-3100.2024.14.003.
- [9] Feng H, Wu M, Wang H. Study on the balance of health human resources allocation in Henan Province based on the Dagum Gini coefficient and Kernel density. *J Med Forum*. 2024; 45 (15): 1567-71. DOI: 10.20159/j.cnki.jmf.2024.15.001.
- [10] Zhan Z, Liu M, Zhu Y. Study on the changes in water use structure in Zhejiang Province based on the Lorenz curve and Gini coefficient. *Water Resour Dev Manag*. 2024; 10 (06): 59-64+71. DOI: 10.16616/j.cnki.10-1326/TV.2024.06.12.