Relating medical space equity and residents' characteristics

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Abstract. This paper explores the relationship between spatial equity in health care and residents' characteristics, with a particular focus on income levels in Hong Kong. Using a modified Gaussian two-step floating catchment area (2SFCA) approach, this study assesses the availability and quality of health care services, evaluates the impact of spatial equity on health outcomes, and provides recommendations for policymakers to enhance equitable access to health care. The results show significant differences in health care access across household incomes, highlighting that low-income residents often face barriers to quality health care.

Keywords: Medical Accessibility, Spatial Equity, Income Disparities, Healthcare Services, High-Density City's Income Gap.

1. Introduction

1.1. Research Background

The global healthcare landscape is facing numerous challenges and trends that are impacting how healthcare is delivered and accessed. One of the major issues facing healthcare systems worldwide is the rising cost of healthcare, which is weighing on both developed and developing countries [1]. Healthcare resources are valuable and in limited supply, especially in high-density cities. Careful considerations, therefore, should be given to where and how these resources are allocated. Like other public resources, the strategic placement of healthcare facilities can greatly impact the overall health and well-being of a community, highlighting the importance of caution and careful planning in these decisions.

In Hong Kong, access to healthcare is an issue of widespread concern. With the aging population and the increase in chronic diseases in Hong Kong, ensuring access to healthcare has become increasingly urgent. However, some studies have shown that even though Hong Kong's medical system is considered relatively advanced in Asia, there are still some challenges and inequalities [1]. Therefore, research on access to healthcare in Hong Kong has become an important basis for the formulation and improvement of medical policies to ensure that all residents can enjoy high-quality, equal and sustainable healthcare services [1]. Resource limitations and policy decisions may hinder efforts to address inequalities in medical space allocation and healthcare access based on income levels [2].

1.2. Research Objectives, Methods and Gaps

In order to gain a deeper understanding of whether the medical accessibility of Hong Kong residents is related to income, that is, whether there is spatial inequality, the study mainly set three research objectives:

1. Explore the differences in the availability and quality of medical services based on residents' income levels.

2. Evaluate the impact of medical spatial equity on healthcare outcomes and health disparities.

3. Provide recommendations for policymakers and healthcare providers to improve medical spatial equity and ensure that all residents have equal access to healthcare regardless of their income level.

Research has shown that individuals from lower-income communities often have less access to quality healthcare services, leading to disparities in health outcomes [3]. One research gap in this area may be the lack of research that examines the specific impact of health spatial equity on residents' income.

1.3. Significance

This study is significant because it highlights the importance of addressing disparities in access to healthcare facilities and services based on residents' income levels. By studying the relationship between equity in healthcare spaces and residents' income, policymakers and healthcare providers can better understand the barriers that prevent marginalized communities from accessing quality healthcare. This study can inform efforts to improve healthcare infrastructure and ensure that all individuals, regardless of their socioeconomic status, have equal access to healthcare resources. Ultimately, this study can help reduce health inequalities and improve the health of under-served populations. In addition, the report provides a comprehensive review of the equity of healthcare services in Hong Kong, providing insights into the fairness of the healthcare system. The goal is to ensure that every citizen has equal access to healthcare services, especially in the post-epidemic era.

2. Literature References

2.1. Defining Spatial Equity

Spatial equity, defined as the reduction of spatial disparities in living levels, is a key objective of urban and regional development policies [1]. This concept is particularly relevant in the context of the United States, where there are significant geographic inequalities in socioeconomic, environmental, and institutional factors[1]. This framework considers the balance between demand and supply for urban services at various spatial scales.

However, disputes regarding the definition of spatial equity persist [3]. By acknowledging and addressing these controversies, both researchers and policymakers can develop more effective strategies to promote spatial equity in the delivery of healthcare services [3].

First, Hong Kong's medical resources are relatively limited. The dense population and high medical demand have led to a surge in the number of hospital visits, and the waiting time will naturally be longer. Secondly, the appointment system requires patients to make appointments in advance, but due to the shortage of medical resources, the appointment cycle is often extended, and patients need to wait for a long time to get diagnosed and treated [1]. At the same time, it is also necessary to promote the reform of the medical system, improve efficiency, and optimize resource allocation to ensure that patients can get medical help in a timely manner [4]. Because private medical services are usually more expensive, this may create a situation where a part of the society cannot afford these services [4]. This requires finding a balance between private and public medical services to ensure that the whole society can benefit from the progress of health and healthcare services [5].

2.2. Defining Tertiary Planning Unit

Given the complex situation of Hong Kong, where the research is taking place, with its high population density, how to define the research scale and administrative boundaries is also an issue that requires careful consideration.

When conducting research on urban scale, it is very important to determine the administrative boundaries. Also, take into account the cooperation and coordination of surrounding areas to avoid contradictions and conflicts caused by unreasonable boundary division [5].

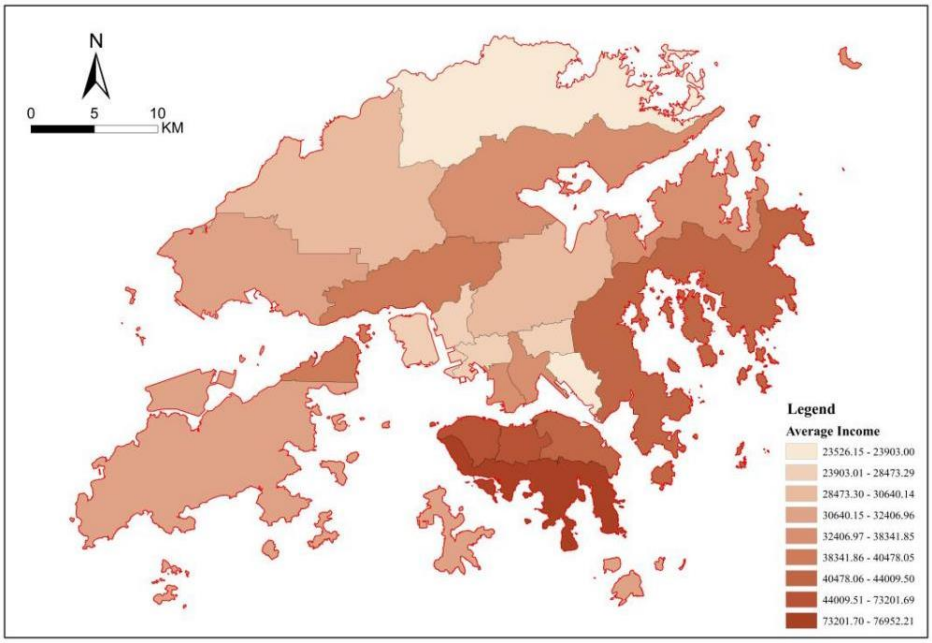

Fig. 1 Average monthly household income in Hong Kong by 18 districts TPU

As show in Figure 1, there is measurable differences between the average monthly income of Hong Kong households according to the administrative boundaries of Hong Kong's 18 districts. According to the map, we know that the districts with the lowest average monthly income of Hong Kong households are North District and Kwun Tong District. However, according to the 2021 Hong Kong Census data, some families in Kwun Tong District are still in the middle class of Hong Kong [6]. Smaller administrative boundaries are better for city-scale research due to the unique characteristics and challenges they present [5]. These smaller cities often face rapid population growth, which can lead to a variety of administrative changes [7]. Despite these challenges, smaller cities can still provide public goods efficiently, particularly when they are consolidated into larger municipalities [8].

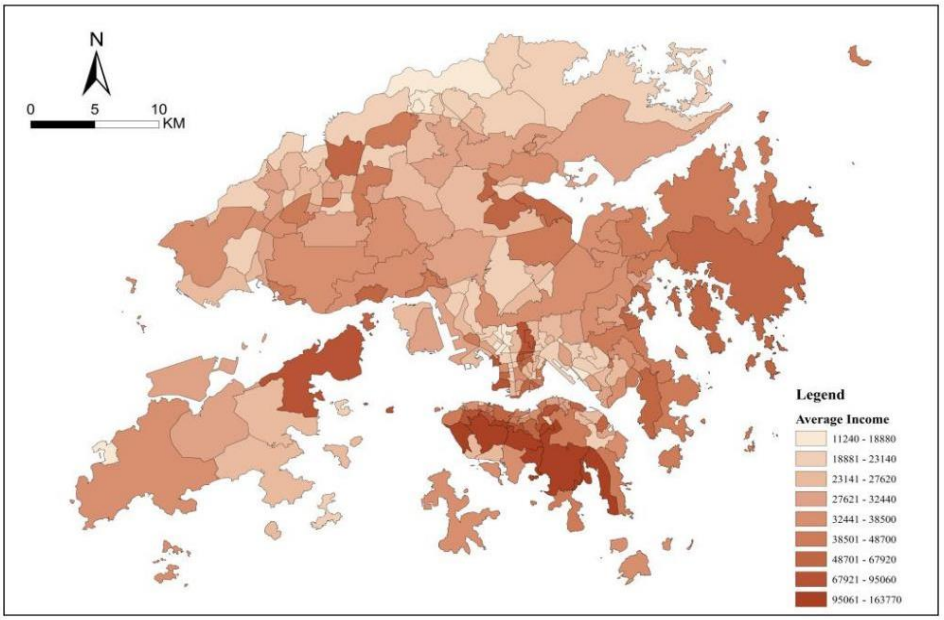

Fig. 2 Average monthly household income in Hong Kong by Smaller TPU

In Figure 2, shows the division of smaller TPUs at the next level according to 18 districts. Compared with Figure 1, the smaller TPU has continuity and integrity, which can reduce errors and ensure the effective allocation of urban management and service resources. And the smaller administrative boundaries take into account the cooperation and coordination of surrounding areas.

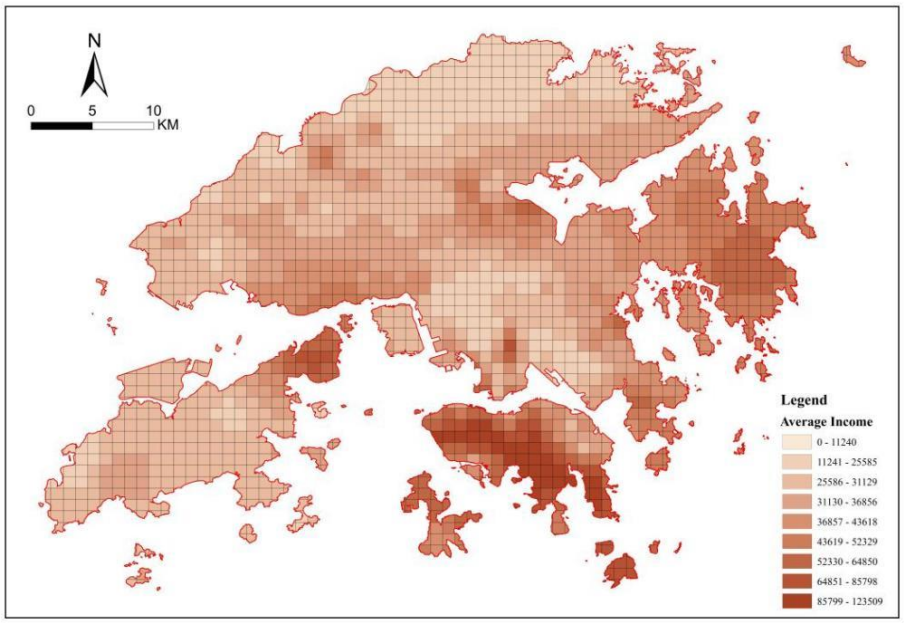

Fig. 3 Average monthly household income in Hong Kong by Fishnet

As Figure 3 shown, using smaller research units is undoubtedly a wiser choice. This will help us better grasp regional differences, formulate practical planning solutions, and improve planning flexibility and adaptability. Only through refined scale analysis can urban planning truly play its due role.

2.3. Importance of Driving Accessibility

In Hong Kong, we often talk about medical accessibility, but the focus is mainly on the convenience of driving to medical institutions, while the impact of public transportation is rarely mentioned. This phenomenon may be because driving is seen as a more convenient and comfortable option, especially with Hong Kong's well-developed roads and parking facilities.

Medical accessibility by car is crucial in emergency situations. In an emergency, every minute can mean the difference between life and death. If a patient cannot get to the hospital for treatment as quickly as possible, the consequences can be catastrophic. Therefore, it is crucial to have a vehicle that can quickly reach a medical institution [9]. Medical accessibility by car can save precious time in an emergency. In an emergency, every moment is precious [10]. If a patient cannot get to the hospital quickly, the best time for treatment may be missed, leading to worsening of the condition or even death. With medical accessibility by car, hospitals can better organize resources [11], handle emergencies in a timely manner, and ensure that every patient can receive timely treatment.

In summary, medical accessibility by car plays a vital role in emergency situations. It not only saves time and ensures that patients receive timely treatment, but also improves the hospital's emergency response capabilities [12]. Therefore, all regions should attach importance to the accessibility of medical care by car to ensure that every patient can receive timely and effective treatment in an emergency [13].

3. Methodology

3.1. Analytical Framework

Figure 4. below shows the process of analysis. The analysis process of this study can be divided into five stages. To evaluate the accessibility of medical services, a two-step floating catchment area model (2SFCA) will be used. This analysis focuses on two common travel modes: walking and driving, with time cutoffs of 5 minutes, 10 minutes, and 15 minutes, respectively.

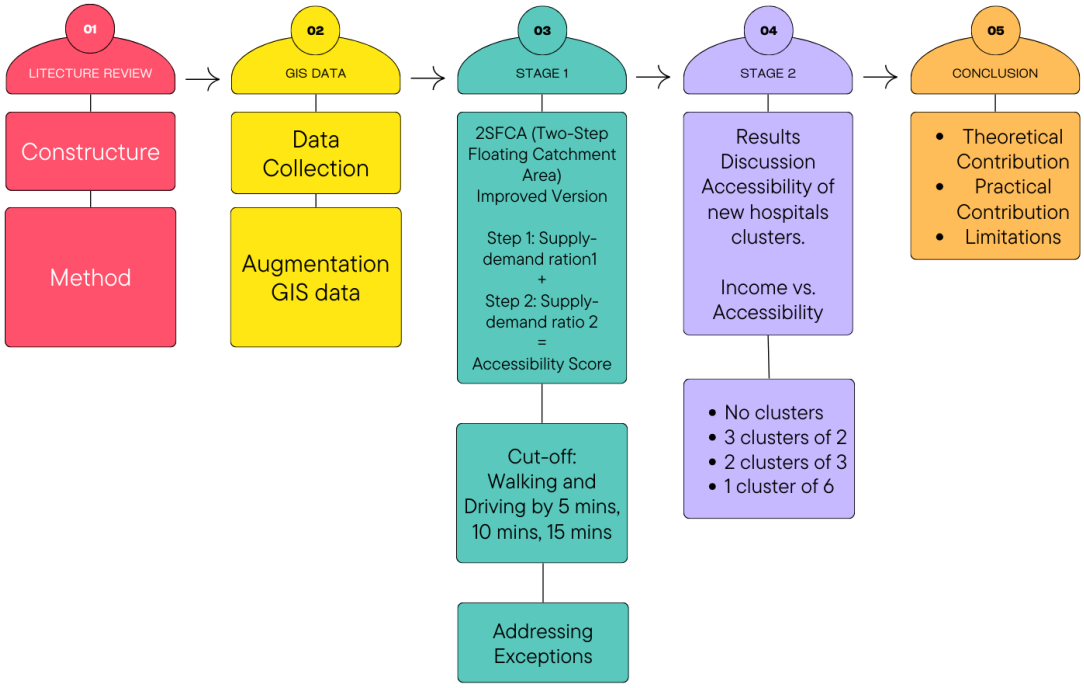

Fig. 4 Analytical Framework

3.2. Two-step Floating Catchment Area

Two-step floating catchment area (2SFCA) is a model of spatial interaction used to measure spatial accessibility to a provider. The 2SFCA method has been widely used in healthcare accessibility research due to its ability to estimate demand and allocate services [14]. However, it has been enhanced to address specific issues. These enhancements have made the 2SFCA method more robust and effective in healthcare accessibility research.

Step 1:For each supply point *j*, search for all demand points *i* within the search radius *d0* centered on *j* and calculate the supply-demand ratio (*Rj*):

$$R_j = \frac{S_j}{\sum_{i \in \{d_{ij} \leq d_0\}} P_i}$$

dij represents the distance between demand point i and supply point *j*;

Sj represents the supply scale of supply point *j*;

Pi represents the demand scale of demand point *i*.

Step 2: for each demand point *k*, search all supply points *j* with *k* as the center and within the radius *d0*, and add up all supply-demand ratios *Rj* to get the accessibility of demand point *k*:

$$A_k^F = \sum_{j \in \{d_{kj} \leq d_0\}} R_j$$

dkj represents the distance between demand point *k* and supply point *j*.

Step 3:Sum of the supply-to-demand ratio (*Rj*) for all facility points *j* within the spatial scope.

$$A_i^F = \sum_{i \in \{d_{ij} \leq d_0\}} G(d_{kj}, d_0) R_j$$

The Gaussian function is proposed as a decay function to address the limitations of a fixed constant in defining catchment areas [15]. The application of a generalized kinematic catchment model, which divides the catchment into a network of sub-catchments, also requires the consideration of decay functions in simulating flows [16].

4. Results

4.1. Accessibility Score Comparison

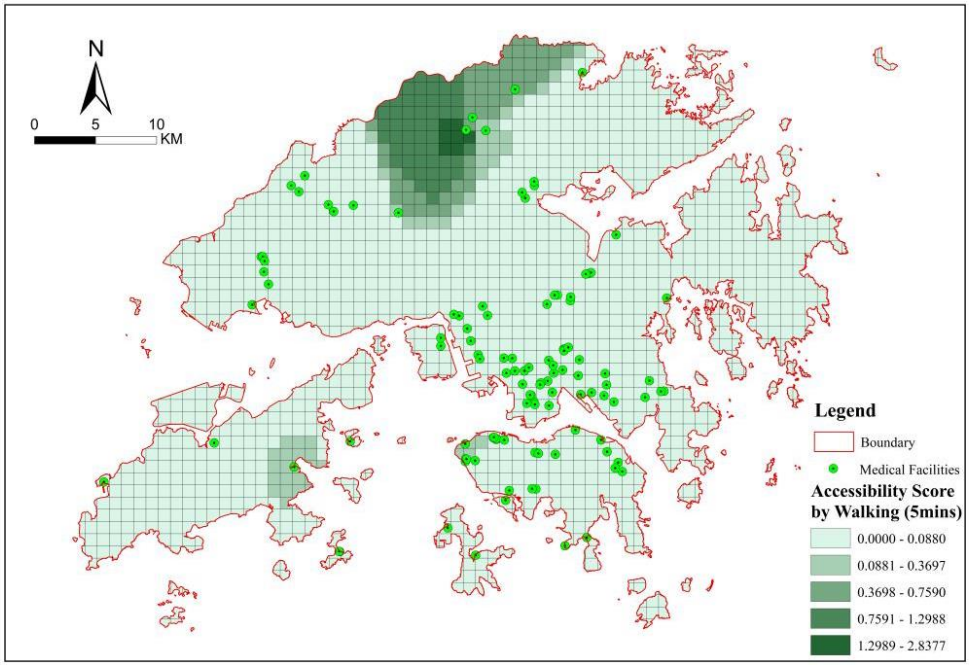

Fig. 5 Accessibility Score by Walking in 5 mins (Fishnet TPU)

As Figure 5 shown, the only area with high accessibility in Hong Kong Island is the northwest. The southeast of the Outlying Islands and the Central and Western District are also accessible, while the rest of the places have very low accessibility scores. This is worth our reflection and consideration.

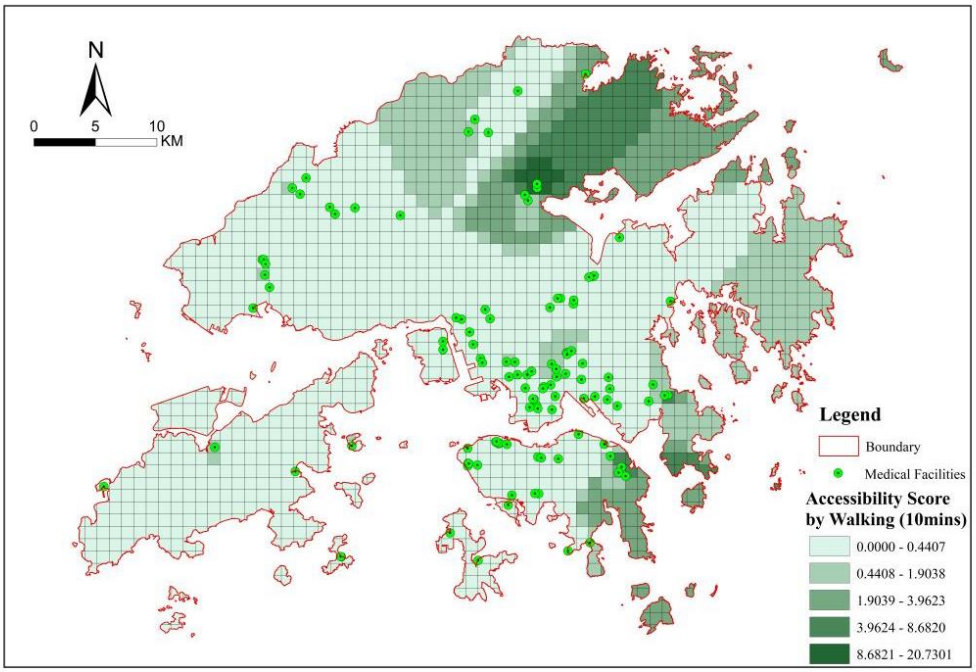

Fig. 6 Accessibility Score by Walking in 10 mins (Fishnet TPU)

For Figure 6, the central part of Oura District has the highest accessibility score. Oura District and the eastern part of Kita District are in the second tier.

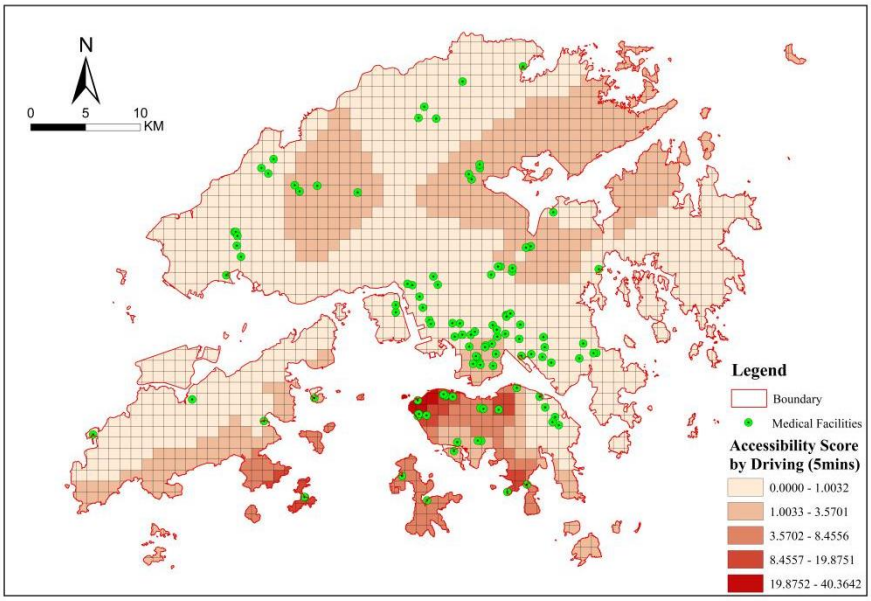

Fig. 7 Accessibility Score by Driving in 5 mins (Fishnet TPU)

For 5 mins driving accessibility as Figure 7 shown, most of it is the same as the previous TPU, with an additional part in Yuen Long District and an additional part in Tai Po District.

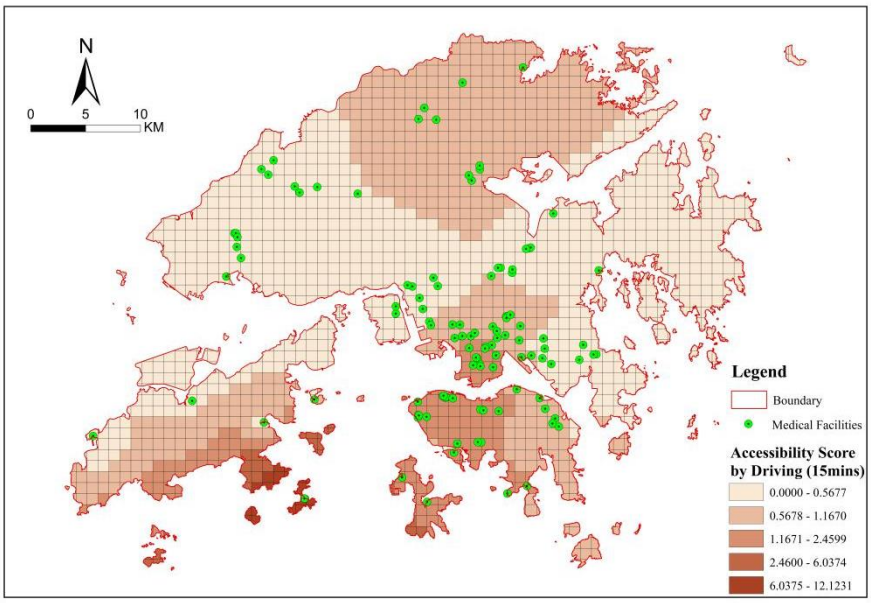

Fig. 8 Accessibility Score by Driving in 15 mins (Fishnet TPU)

As Figure 8 shown, the southeastern part of the Outlying Islands District has the highest driving accessibility, while the Central and Western District, Wan Chai District, the western part of the Southern District, Yau Tsim Mong District and the southern part of the Outlying Islands District are the second highest accessibility areas.

4.2. Discussion on Proposals of Hospital Clustering

Overall, the location of this hospital is in the northern metropolitan area of Hong Kong, which is highly consistent with the development intention of the Hong Kong government. In the future, the northern metropolitan area will be built into a development space dominated by logistics (cross-border transportation, port re-planning) and high-end technology parks [17]. Relying on the planning of this area, the new hospital can not only better serve local residents, but also form a benign interaction with industries such as logistics and technology, and help the overall development of the northern metropolitan area [18].

4.3. Discussion on Medical Accessibility and Household Income

Access to quality healthcare is an important aspect of ensuring good health outcomes for individuals and communities. A key factor affecting access to healthcare is household income. Household income levels can be a significant barrier to healthcare access for many people. This study examines the location of clusters of low-rent housing in Hong Kong, thereby bringing better surrounding infrastructure to low-income people and helping low-income people have better healthcare accessibility.

5. Summary

5.1. Theoretical Contribution

To improve the test of spatial equity of healthcare, this study uses the Gaussian two-step floating catchment area (2SFCA) method, which is an improvement on the traditional 2SFCA. This improvement helps address the limitations of previous methods and provides a more accurate way to measure the spatial equity of healthcare. This study enhances the existing body of knowledge by employing an improved Gaussian two-step floating catchment area (2SFCA) method, which addresses the limitations of traditional accessibility measurement techniques. This methodological advancement allows for a more nuanced analysis of spatial equity in healthcare, particularly in high-density urban settings like Hong Kong.

5.2. Limitations

HK is a high density city with various transportation modes such as MTR and ferry. Income gap greater than mode of transportation would vary but not directly correlating with transportation modes. This study intentionally focused on walking and driving, yet more modes of transportation can be considered and studied in the future. Moreover, clustering can relate to new town development, TOD etc. can be further considered with other factors. Due to the complexity of Hong Kong's hospital facilities, departments and the types of diseases that can be treated, there is no way to obtain official statistical data, so no detailed classification was performed in the study.

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