A 15-minute Living Circle from the Perspective of Epidemic and Post-epidemic Cities- the Case of Beijing

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Abstract. In the context of the ongoing epidemic, cities face significant challenges due to their high density, lack of public services, and inadequate health care resources, and the '15-minute city' can provide a turnaround. This paper explores how '15-minute cities' can help cities cope with the epidemic in terms of accessibility, crowd reduction, and public service provision. At the same time, the paper takes Beijing as an example, and through the creation of a 'buffer zone' and kernel density analysis of poi data, finds that the construction of '15-minute cities' or '15-minute living circles' in Beijing is lacking in the suburbs, where people need to enter the city centre to access public services and goods, leading to unnecessary congestion. This leads to unnecessary congestion and congestion. Finally, three types of '15-minute neighbourhoods' are explored. Through analysis, this paper finds that larger, enclosable neighbourhoods are the most appropriate for Beijing's future, particularly in the case of suburban expansion.

1. Introduction

In a world where the new pneumonia epidemic is still raging, cities are the focus of the outbreak because of their high density as the most important gathering places for modern humans. In this context, the concept of the "15-minute city" or "15-minute living circle" has been raised again. The concept of the '15-minute city' or '15-minute living circle' has been introduced as a way of coping with the reduction of crowded places and the proximity of public services, medical care, and necessities in an epidemic or post-epidemic era. This paper takes Beijing as an example, and analyses the problems of public services and unbalanced distribution of resources in Beijing through GIS, based on 2022 POI data. The paper also analyses the role of the "15-minute living circle" in helping to prevent and control epidemics in Beijing and to build a greener and more livable city in the post-epidemic era, and envisages several models of "15-minute communities" that may be suitable for the future development of Beijing.

2. Cities and COVID-19

COVID-19 has been raging around the world for three years now, with outbreaks occurring to varying degrees in major cities around the world. Bans on public gatherings, lockdowns of communities, etc. are commonplace in cities, and COVID-19 has had a huge economic impact on cities. In fact, the global economy is in recession.

As we can see, cities are very vulnerable to epidemics, during which access to supplies, public services, etc., is greatly restricted for the population. This is mainly due to several reasons.

2.1 Traffic congestion

Throughout history, most cities have established a pattern of dependence on the automobile [1], which often leads to ill-conceived planning that separates residents from their jobs and homes and the services they need from their communities. This leads to unnecessary traffic congestion, carbon emissions and crowding.

2.2 The density of the city

The high density of cities is one of the key factors in the development of modern cities. As Edward Glaeser wrote in *The Triumph of Cities* [2], The gathering of people is a cradle of knowledge, innovation and wealth. Additionally, due to the scale effect, cities are able to provide their residents with goods and services at a cheaper cost and higher quality, drawing an increasing number of people there and causing cities to grow denser. However, density is also the birthplace of epidemics in terms of infectious diseases.

2.3 Lack of public services and infrastructure.

In cities with high population densities, there is often an inadequate supply of services such as health care and community services. This is especially true in rapidly expanding cities and in developing countries with high population densities. When an epidemic strikes, the influx of infected people into the healthcare system makes it impossible for the healthcare system to serve other

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patients properly, which ultimately leads to the collapse of the healthcare system.

3. Introducing the 15-minute city concept

In the aftermath of the epidemic, cities needed to find solutions to these problems and to provide goods and services to their residents in the midst of the epidemic. One of the key concepts that has been reintroduced is the '15-minute city' or '15-minute community'. This concept was developed to create a city where residents could meet their basic needs within a 15-minute walk or ride. Moreno supports that residents will be able to enjoy a higher quality of life where they will be able to effectively fulfil six essential urban social functions to sustain a decent urban life. Those include: (a) living, (b) working, (c) commerce, (d) healthcare, (e) education and (f) entertainment [3]. This was followed in September 2017 by the publication of the Beijing Urban Master Plan (2016-2035), which sets out the goal of achieving full coverage of the "quarter-hour community service circle" by 2035. As you can see, Beijing's urban planning also incorporates Moreno's view that the 15-minute city concept can lead to more rational urban planning, more comfortable urban living, reduced traffic congestion, and reduced emissions. In addition to this, the 15-minute living circle can also be useful when dealing with the COVID-19 epidemic.

4. A study on the status of 15-minute communities in Beijing

In the context of the epidemic, Beijing was used as an example to see the accessibility of Beijing's communities to healthcare services, using POI data from March 2022.

4.1 Research methodology

POI data. The point of Interest refers to a meaningful point on a map, and generally refers to the point data in the Internet electronic map, which basically contains four attributes: name, address, coordinates, and category, with high accuracy, and can reflect the existence status of features in real time.

The POI data in this paper were crawled from the internet (including Baidu Map and Gaode Map), and 679414 data were obtained after filtering and cleaning. Among them, a total of 14,615 are residential houses as well as neighborhoods, which can be seen to be highly concentrated in downtown Beijing. At the same time, 10,866 health care service delivery points were obtained.

Kernel density analysis. Kernel analysis is a non-parametric method of spatial analysis that calculates the density of an element in its surrounding neighbourhood. For a particular element in space, the attribute distribution is defined as a circle of radius h (threshold), decaying with distance (the decay is determined by the kernel function), with a maximum density at the centre and a limiting distance density of 0. The sum of the integrals of the densities within the threshold is the attribute value of the central point. The attribute value of an independently distributed point is 1. Each element point in the region is calculated accordingly and the densities at the same location are superimposed to obtain the density of the distribution of the element over the whole region. Assuming that x1, x2, …, xn are independently and identically distributed samples drawn from a population with a distribution density function f, and that f is estimated to be f (x) at point x, we have the following equation:

$$f(x) = \frac{1}{nh}\sum_{i=1}^{n} k\left(\frac{x-x_i}{h}\right) \quad (1)$$

Where: k () is the kernel function; h>0 is the bandwidth; and x-xi is the distance from the estimated point x to sample xi [4].

In this study, we will use kernel density analysis to examine the distribution of healthcare facilities in Beijing.

4.2 Data study

A kernel density analysis of poi data in Beijing, classified by 'healthcare', shows a high concentration of facilities and shops offering healthcare-related services in the central city, with a high degree of imbalance (figure 1).

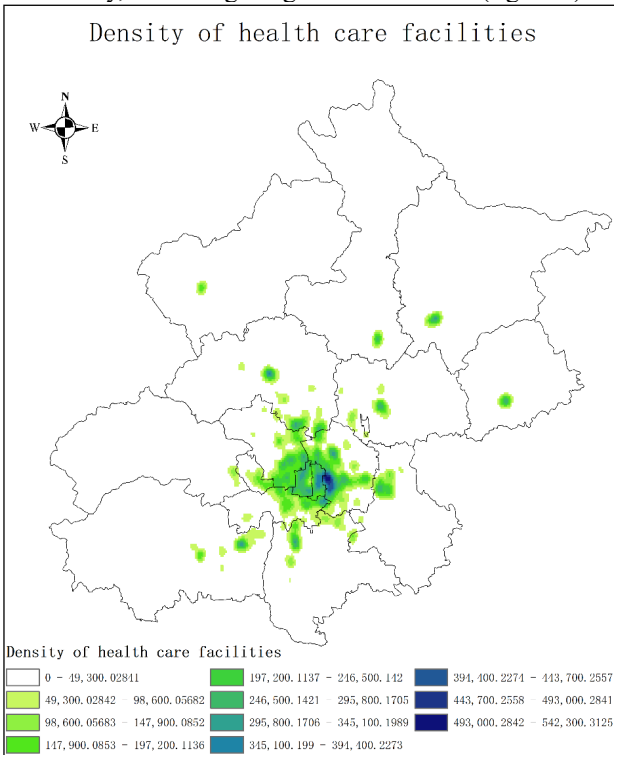

Fig. 1. Density of health care facilities (Original)

GIS was then used to create a 'buffer zone' of 1000m around points of interest of the houses and neighbourhoods and to calculate how many 'healthcare' facilities fell within the 'buffer zone'. This measures the proximity of these communities to health care resources.

Due to the wide range of 'healthcare' categories in the POI classification, including pharmacies, community health centres, specialist hospitals, general hospitals and so on. Therefore, a community is considered to be eligible when the number of 'healthcare' facilities within 1000 m

is greater than 5. The map (figure 2) shows the distribution of communities with fewer than 5 health care facilities.

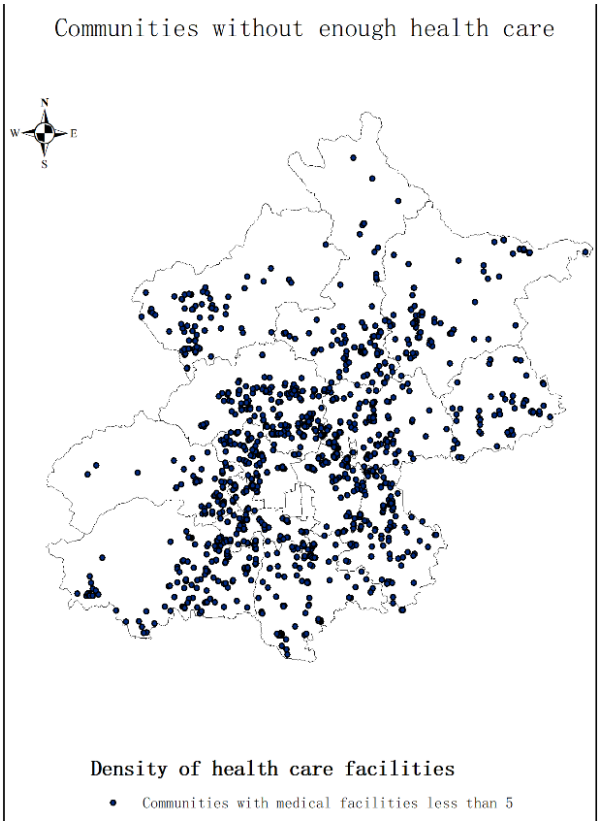

Fig. 2. Communities without enough health care (Original)

All the substandard communities are in suburban areas, which demonstrates the uneven distribution of public services at the health care level. These suburban communities, although less crowded and at slightly lower risk of contracting the new crown than the central city, face enormous difficulties in the event of a shocking, blockaded new crown epidemic due to insufficient medical resources. At the same time, the government has to incur greater costs in providing medical coverage and sending medical staff to these communities under lockdown.

As we can see from other scholars' studies, Beijing's high-quality '15-minute communities', i.e., communities with a wide range of facilities and services, are mostly concentrated in central urban areas [5]. The lack of public services in these communities is exacerbated by the fact that most of the communities in need of improvement are located on the outskirts of the city, and that the population of these communities is growing rapidly. This unequal distribution can result in residents of these areas (outside the 4th ring to within the 6th ring) having to drive or take public transport to the city centre areas in order to access quality public services as well as goods. This can result in significant traffic congestion and carbon emissions from transport, as well as unnecessary congregations that are most dangerous during an epidemic.

In our analysis of POI data, we see that Beijing suffers from a huge imbalance in the distribution of public services and other facilities, including medical services, and therefore the need to build truly effective and accessible '15-minute communities' across the city would be a huge help in improving the lives of residents, preventing and controlling epidemics, and creating a green and liveable city.

5. Possible application models for “15-minute communities” in the context of outbreak prevention and control

The COVID-19 outbreak provides a new scenario for the application of the 15-minute living circle [6], which has clear advantages over traditional high-density cities or urban planning based on car access in terms of reducing the concentration of people and providing basic household goods and services. Its emphasis on accessibility and resilience is well suited to communities under lockdown.

For example, in Beijing, restrictions on public transport and car travel due to epidemic prevention have led to an increase in the use of bicycles, with some bicycle shops seeing a 30% increase in sales year-on-year and some online shops seeing a 50% increase in sales year-on-year [7]. This has promoted the physical health of residents, while also bringing a renewed emphasis on cultural and artistic venues, parks, and public spaces that are often normally overlooked [8]. This new demand for soft mobility and community-based urban services shows us the possibilities and benefits of the '15-minute community'.

However, because of the epidemic prevention policies, some residents lack access to some goods and services during the community closure [9]. In addition to this, the epidemic has led to a significant number of people wanting to avoid having to travel to crowded shops. These not only causes difficulties for the residents' lives, but also puts huge pressure on the various shops and service providers in the community as well as on the financial side of the government.

It is therefore envisaged that if there are shops and service providers within a 15-minute radius that can meet the basic needs of the community's residents, during the blockade, although residents are not free to go out and eat at shopping malls or restaurants, as long as the operation of these shops is guaranteed, then the needs of the residents can be met through distribution. This eliminates the need for the government to deploy resources from elsewhere in a unified manner, resulting in a shortage of supplies or a longer time required, and also greatly reduces the cost to the government.

5.1 Possible "15-minute city" model

Urban complexes. A case study of this type of community is the mega-community "Huaguoyuan" in Guiyang City, Guizhou Province, which is known as "the largest community in Asia", with 220 super high-rise buildings, 500,000 residents, and 20,000 enterprises in a planned area of 10 square kilometres. There are several bus hubs, BRT stations, tunnels, bridges, main roads, etc. It can be said that it is already a "city in the city". “Huaguoyuan” is an extreme example of a city with many drawbacks, its

biggest problem being its high density. But it offers an idea that is different from the traditional Chinese semi-enclosed community in that it integrates residential, commercial, art and culture, business offices, tourism and intelligent living services, which is closer to the idea of a '15-minute city'.

However, it still faced a shortage of supplies during the epidemic [10], with its high density leading to a high risk of transmission and a large population making the rationing of supplies very difficult.

Large-scale, gatable communities. The ideal model for such a community would be a university campus, with adequate food, medical and other services, and the ability to switch between closed and semi-closed access to the community. Equipped with "smart city" related sensors, APPs, etc., the community would be able to keep abreast of residents' needs and health conditions, which would help prevent and control measures, while greatly reducing the pressure on the government. The government only needs to send medical staff to transport infected people and carry out nucleic acid testing, as supplies and other needs can be met within the community.

In the post-epidemic era, this model should be promoted as it is not as dependent on location and is well suited to developing or expanding suburban areas. It fits well with the trend of Beijing's population gradually shifting from the city centre to the suburbs [11] and can provide a good living environment and supporting facilities for these residents, thus avoiding the burden on transport and public service facilities caused by their frequent trips to the central city in order to access public services. It can effectively alleviate the imbalance in the distribution of public services in Beijing and create a "15-minute community" with accessibility and livability on the outskirts of the city. The cost of creating a '15-minute community' is much lower than in the city centre because of the low cost of land in the suburbs, and as the population in the suburbs grows, more profit will be made from the shops and services in the community.

Smaller communities. These communities are often small, with small areas and small populations, and are unable to meet the basic necessities of life within the community, relying on public services and goods from outside the community. The ideal model for such communities would be to share one or more sets of public services with other small communities, and these services would largely need to be provided by the government. They should, therefore, ideally be established near the city centre, so that they can enjoy the more comprehensive services and commercial facilities of the city centre. These communities are also the most dependent on the government when it comes to epidemic preparedness and control, and almost all services and goods supplies will need to be arranged by the government. In the short term, it is difficult to reduce the cost of epidemic preparedness in these small communities.

However, as most of these small communities are located in the centre of the city and are well-equipped with nearby facilities, they can move towards Mareno's "15-minute city" in the post-epidemic era.

5.2 What kind of "15-minute city" do we need?

In general, in China's current urban context, the realisation of a "15-minute city" requires a community-centred approach. For larger communities, the "15-minute city" plan requires that there are basic medical facilities, retail shops and entertainment and recreational facilities within 15 minutes of the community that specifically serve the community, as well as schools that can cater for the schooling of the community's children. For smaller communities, they need to share these basic services with other communities, but smaller communities are usually located close to the city centre and therefore tend to have better infrastructure services at this stage.

Of the three models mentioned above, the second, larger community model, is the most suitable for Beijing and can address the city's looming problems of population shift to the suburbs and uneven distribution of public services and other resources. The central city, because of its more adequate public services and various facilities, is more capable of responding to epidemics and safeguarding the needs of residents and needs to focus on the suburban areas.

The "15-minute city" places great demands on planners, especially for smaller communities, to rationalise the layout of the city so that the infrastructure is within 15 minutes' travel time of each community. In the future, as the city's amenities continue to be enriched, improved and smartened, they will also need to be able to make full use of advanced communication and sensor technologies, so that the "15-minute city" will gradually break down the boundaries of the community and turn the city into a whole "15-minute smart city".

6. Conclusion

The Newcastle pneumonia epidemic has had a huge impact on cities, and the problem of inadequate supply of supplies to residents in the context of epidemic prevention and control has arisen worldwide. This is a result of the high density of the city, the inadequate supply of public services and infrastructure, and poor distribution. In an analysis of Beijing's POI data, it was found that medical services in Beijing are highly concentrated in the central city, and that the communities that have access to adequate medical services within 1000 meters are also concentrated in the central city. The introduction of the '15-minute city' concept is intended to help the city better cope with the new epidemic and meet the needs of residents for supplies and medical services. In the post-epidemic era, it will also help Beijing evacuate its population to the outskirts of the city, providing residents with more public services and more public space for leisure, reducing traffic congestion and creating a greener and more livable city.

The data analysis used in this paper only deals with medical facilities and does not cover other components of the "15-minute city" such as shops and leisure parks. Further analysis of this data will be required in the future to fully evaluate the development of the "15-minute city". At the same time, the ability of the 15-minute city to respond to epidemics needs to be tested in practice.

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