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RESEARCH

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Research on government regulation methods for the spatial layout of retail pharmacies: practice in Shanghai, China

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Abstract

Background In China, retail pharmacies are critical sources for obtaining medications and play a vital role in residents' daily access to drugs and treatment of common illnesses. Effectively guiding the placement of these pharmacies in areas of need through government regulation is crucial for enhancing medication access. In this study, we used population and retail pharmacy spatial distribution data from Shanghai to design guidance and supplementary methods for optimizing the spatial layout of retail pharmacies and medical insurance designated pharmacies based on regional characteristics.

Methods Population distribution, road traffic network, administrative division and retail pharmacy data from Shanghai in 2018 were collected from relevant government departments. ArcGIS 10.3 was used to map the retail pharmacies and population distribution. Based on the spatial distribution of population and the service standards of pharmacies, service circles with insufficient pharmacies were identified, and supplementary methods for retail pharmacies and medical insurance designated pharmacies were developed.

Results In 2018, Shanghai had 3009 retail pharmacies, each serving an average of 6412 residents. The city was divided into 2188 basic pharmaceutical service circles, each within a 15-minute walking distance. The results indicated that there were 1387 service circles without any pharmacies, 151 of which had populations exceeding 5000. Additionally, 356 service circles had pharmacies but lacked medical insurance designated ones. After supplementation, 841 retail pharmacies were planned to be added in residential areas. Compared with before, the coverage area and population served of the pharmacies increased significantly.

Conclusions This study mapped the spatial distribution of population and retail pharmacies in Shanghai, and designed government guidance and supplementary methods for optimizing the layout of retail pharmacies. The findings offer valuable insights for government agencies in low- and middle-income countries to improve the spatial distribution of retail pharmacies.

Highlights

1. Analysis of the spatial distribution of retail pharmacies.

2. Development of supplementary methods for optimizing the distribution of retail pharmacies and medical insurance designated pharmacies based on population density and geographical accessibility.

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3. After supplementation, the service areas and the service population of retail pharmacies and medical insurance designated pharmacies increased compared to before.

Keywords Retail pharmacies, Spatial layout, Government regulation, GIS

Introduction

Retail pharmacies in developing countries are primary sources of medication and healthcare advice for community residents [1–4]. Previous studies have shown that the widespread use of retail pharmacies may be attributed to a series of factors, such as accessibility, suitability, prompt service delivery, flexibility in payment terms, flexible purchasing options and operational hours [5–9]. In China, retail pharmacies are a common channel for obtaining drugs and play an essential role in residents' daily medication and common disease treatment [10–12]. Since 2017, the growth rate of drug sales in retail pharmacies has been higher than that in hospitals, reaching 491.6 billion in 2021, accounting for approximately 27% of the total drug retail market. Besides dispensing medicines, retail pharmacies also offer a wide spectrum of services, including patient counselling, screening tests, immunization services, wellness programmes, and education programmes [13–16].

Retail pharmacies primarily operate in an independent retail market and are not generally considered to be part of the larger health system [17]. Therefore, despite the potential of retail pharmacies in the fields of disease treatment and health consultation has been widely recognized, they are often overlooked in the relevant national health strategies, policies and regulations. In developed countries, the distribution of retail pharmacies is primarily regulated by market forces with minimal government intervention, which may lead to two main issues: (1) Due to low population density and a lack of facilities and pharmacists, there are few retail pharmacies in rural and remote areas, resulting in insufficient access to medication services for low-income vulnerable groups living in these areas [18]. Studies have shown that pharmacy deserts are more common in remote and rural areas than elsewhere, leading to a severe shortage of pharmaceutical services in these areas [19, 20]. (2) The distribution of retail pharmacies in areas with high population density is usually dense, and relying solely on market regulation may trigger vicious competition [21]. Previous studies have shown that retail pharmacies that rely solely on market regulation may lead to monopolies and malicious competition, which can easily lead to product quality issues [22, 23] and even to illegal activities such as manufacturing and selling counterfeit and substandard drugs and illegal sales of addictive prescription drugs. Therefore, the introduction of government regulations is indispensable for effectively regulating and supervising the drug retail market, which would be helpful for significantly improving the service of retail pharmacies and the accessibility of medication.

Currently, different countries have different government regulatory measures for retail pharmacies, mainly focusing on admission approval and layout planning, as well as whether qualified pharmacies are included in medical insurance designated pharmacies (refer to pharmacies that has signed service agreement with medical insurance agency, where drugs purchase can be settled through medical insurance accounts). In terms of admission approval and layout planning for retail pharmacies, government departments in countries with stricter regulations usually formulate strict measures to restrict the entry of newly opened pharmacies. For example, to operate in South Africa, a pharmacy must obtain a licence from the National Department of Health. The entry criteria are primarily distance from other dispensing services (not within 500 m) and density (at most 2 pharmacies per 10 000 residents, with exceptions for shopping malls and rural towns) [24]. In Spain and Italy, the State plans the opening of new pharmacies considering population criteria and the distance between them. In France and Belgium, only population criteria are used; in Austria, population criteria and distances between pharmacies are applied [25]. In countries with a more liberal approach, such as the United Kingdom and the Netherlands, there are no restrictions on the opening of pharmacies [26]. For the insurance inclusion measures for retail pharmacies, the national medical insurance department often contracts with qualified community pharmacies to dispense medicines to outpatients [20]. The purpose of the abovementioned government intervention measures is to improve the accessibility of drugs to residents. However, if the government intervenes excessively, this may affect market vitality and be detrimental to the development of retail pharmacies. Therefore, how to appropriately leverage the regulatory role of the government and guide retail pharmacies to locate in more needed and efficient regions is an important issue that urgently needs to be addressed.

The main contents of the study are as follows: (1) we displayed the distribution of retail pharmacies and medical insurance designated pharmacies in basic pharmaceutical service circles within 15-minute walking distance based on population density, and pinpointed those underserved service circles to provide reference for subsequent distribution planning. (2) Considering the population served and the operational status of pharmacies, we developed a method to calculate the appropriate distance intervals and optimal scale of retail pharmacies in different types of areas. (3) As for those underserved service circles, we design a supplementation method for retail pharmacies and designated medical insurance pharmacies. Our research will be benefit to assist government in planning the spatial layout of retail pharmacies in the next stage, and provide guidance for those new retail pharmacies to set reasonable spacing and scale.

Methods

Data sources

All the data came from the relevant government departments in Shanghai in 2018. The detailed information is as follows:

> The population distribution data included the county, street, neighborhood committee, building ID and name, and building longitude and latitude where the population resides. The data came from the Population Management Office of the Public Security Bureau.
> The road traffic network data included all highways, expressways, main roads, secondary roads, branch roads, and internal roads. The data came from the Institute of Surveying and Mapping.
> The administrative division data included administrative boundary maps of districts and counties, as well as administrative boundary maps of townships and streets. The data came from the Institute of Surveying and Mapping.
> The retail pharmacy data included basic information about the retail pharmacies, such as name and detailed address, and business information about the retail pharmacies, such as opening date, business nature, building floorage, number of pharmacists, business scope, medical insurance designated pharmacies or not, etc. The data came from the Municipal Commission of Commerce and the Medical Insurance Bureau.

Analysis procedures

Step 1: Mapping pharmacies and population

We used ArcGIS 10.3 software to map the retail pharmacies, population, road network and administrative areas. The above operations can be achieved through the steps "menu → file → add data → add XY data" in the geographic information system.

Step 2: Dividing the basic pharmaceutical service circles

A basic pharmaceutical service circle is the minimum planning unit in which residents can access pharmaceutical services within a specific walking distance. According to the standards of the World Health Organization (WHO), we divided the planning area into grids of the same size with a radius of 15-minute walking distance.

Step 3: Establish connections between residents, retail pharmacies and basic pharmaceutical service circles

Retail pharmacies were divided into medical insurance designated pharmacies and non-designated pharmacies based on whether they were contracted with medical insurance department. We used the spatial connectivity tool of ArcGIS to establish spatial connections between residents, retail pharmacies and basic pharmaceutical service circles, and calculated the number of residents, retail pharmacies, and medical insurance designated pharmacies in each service circle.

Step 4: Analyse the distribution of retail pharmacies in basic pharmaceutical service circles

We analysed the distribution of retail pharmacies and medical insurance designated pharmacies in basic pharmaceutical service circles based on population density: (1) In combination with the number of retail pharmacies and the population density, we analysed the density of pharmacies in each service circle and identified grids with insufficient pharmaceutical services. (2) Based on the medical insurance coverage information of retail pharmacies, we identified the distribution of medical insurance designated pharmacies. The above operations can be achieved through the steps "ArcToolbox → analysis tools → overlay → spatial join" in ArcGIS.

Step 5: Calculate the appropriate spacing and size of retail pharmacies

(1) Calculate the appropriate spacing of retail pharmacies. Assuming that the distance between retail pharmacies is A (distance restrictions between pharmacies), we calculated the maximum number of retail pharmacies that can be accommodated in each basic pharmaceutical service circle under uniform distribution. Combined with the service population standards of each pharmacy, the maximum number of people that can be served in each pharmaceutical service circle was calculated. If the population in the service circle exceeds this value, the spacing restrictions for pharmacies should be relaxed. (2) Calculate the appropriate size of retail pharmacies. We selected pharmaceutical service circles with a reasonable distribution of retail

pharmacies and calculated the average size of retail pharmacies with stable operation for more than two years and no violation records as a reference value for the appropriate size of retail pharmacies. The calculation steps were as follows: first, we selected those service circles with sufficient pharmaceutical services based on step four; Second, we identified retail pharmacies that had survived well and were in a healthy competition within these selected service circles; Third, we calculated the average size of pharmacies that met the above requirements as the reference value for the appropriate size of retail pharmacies.

Step 6: Determine the supplementary methods for retail pharmacies and medical insurance designated pharmacies

Based on step 4, we identified basic pharmaceutical service circles with insufficient retail pharmacies and then calculated the number of pharmacies that needed to be added based on the service population standards of retail pharmacies. In addition, we designed supplementary methods for accessing medical insurance designated pharmacies according to the steps in Fig. 1.

Statistical analysis

Adjusted two-step floating catchment area (2SFCA) method

We adjusted the traditional two-step floating catchment area (2SFCA) method to analyze the accessibility of retail pharmacies as the basis for planning the spatial layout of retail pharmacies. The specific steps are as follows: First, we took the location of any retail pharmacy (j) as the center and established a search area with a radius equal to a 15-minute walking distance (d0) from this pharmacy. We checked whether the service area of the pharmacy covered all residential areas within this region. Second, we took each basic pharmaceutical service circle (i) as the basic unit and search for all retail pharmacies within this region. We then checked whether the service population of these pharmacies meets the potential demand within each basic pharmaceutical service circle.

Spatial autocorrelation analysis

We used spatial autocorrelation tests to calculate the Global Moran's I to determine whether there was clustering of retail pharmacies in the spatial distribution. The Moran's I value ranges from − 1 to 1. The values that are closer to 1 indicate strong positive spatial autocorrelation, revealing clustered parameters. The values that are close to -1 show that the pattern of the parameter is dispersed. If the Moran's I value is 0, it shows that the parameter is random and hence there is no spatial correlation in the distribution of the measured parameters. The calculation formula is as follows:

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(x_i - \overline{x})(x_j - \overline{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}\sum_{i=1}^{n}(x_i - \overline{x})^2}$$

where n is the number of spatial units, $x_i$is the accessibility level of spatial unit i; and W_{ij} is the spatial weight matrix, representing the spatial proximity between two spatial units.

We also used the local spatial autocorrelation method to get the local Moran's I to showed the differences in retail pharmacy distribution between different spatial units and their neighboring units. The expression is as follows:

$$I = \frac{n(x_i - \overline{x})\sum_{j=1}^{n} W_{ij}(x_j - \overline{x})}{\sum_{i}(x_i - \overline{x})^2}$$

Results

Spatial distribution of retail pharmacies

There were 3009 retail pharmacies in Shanghai, distributed in 209 subdistricts and towns, with an average of 18 pharmacies per subdistrict or town, serving an average of 6412 residents per retail pharmacy. The distribution of retail pharmacies exhibited the following characteristics: (1) The density of pharmacies in the central urban area was relatively high, with more than 2 pharmacies per square kilometer, while the density of pharmacies in the suburbs was relatively low, with fewer than one pharmacy per square kilometer (see Fig. 2). (2) Among the 3009 retail pharmacies, 714 were medical insurance designated pharmacies (approximately 23.73%), of which 208 were in urban areas, and 506 were in suburban areas. In terms of the coverage rate, 9.01% of the central urban area was not covered by medical insurance designated pharmacies within a 15-minute walking distance, while 79.03% of the suburban area was not covered (see appendix 1). (3) The density of pharmacies around commercial centers and large-scale medical institutions was high (see appendix 2).

Grid division of the basic pharmaceutical service circle

Grid shape selection of the basic pharmaceutical service circle

The grid shape of the basic pharmaceutical service circle needs to meet the following requirements: (a) seamlessly cover the planning area; (b) effectively express the service area scope of the pharmacy. We compared the grid coverage effects of three shapes, namely, circular, square and hexagonal (see Fig. 3): (1) *Circular shape*. If a circular shape is used as the basic shape for dividing pharmaceutical service circles, the problem becomes that the grid cannot seamlessly cover the planning area. The grids may either intersect or leave gaps between them; (2) *Square shape.*

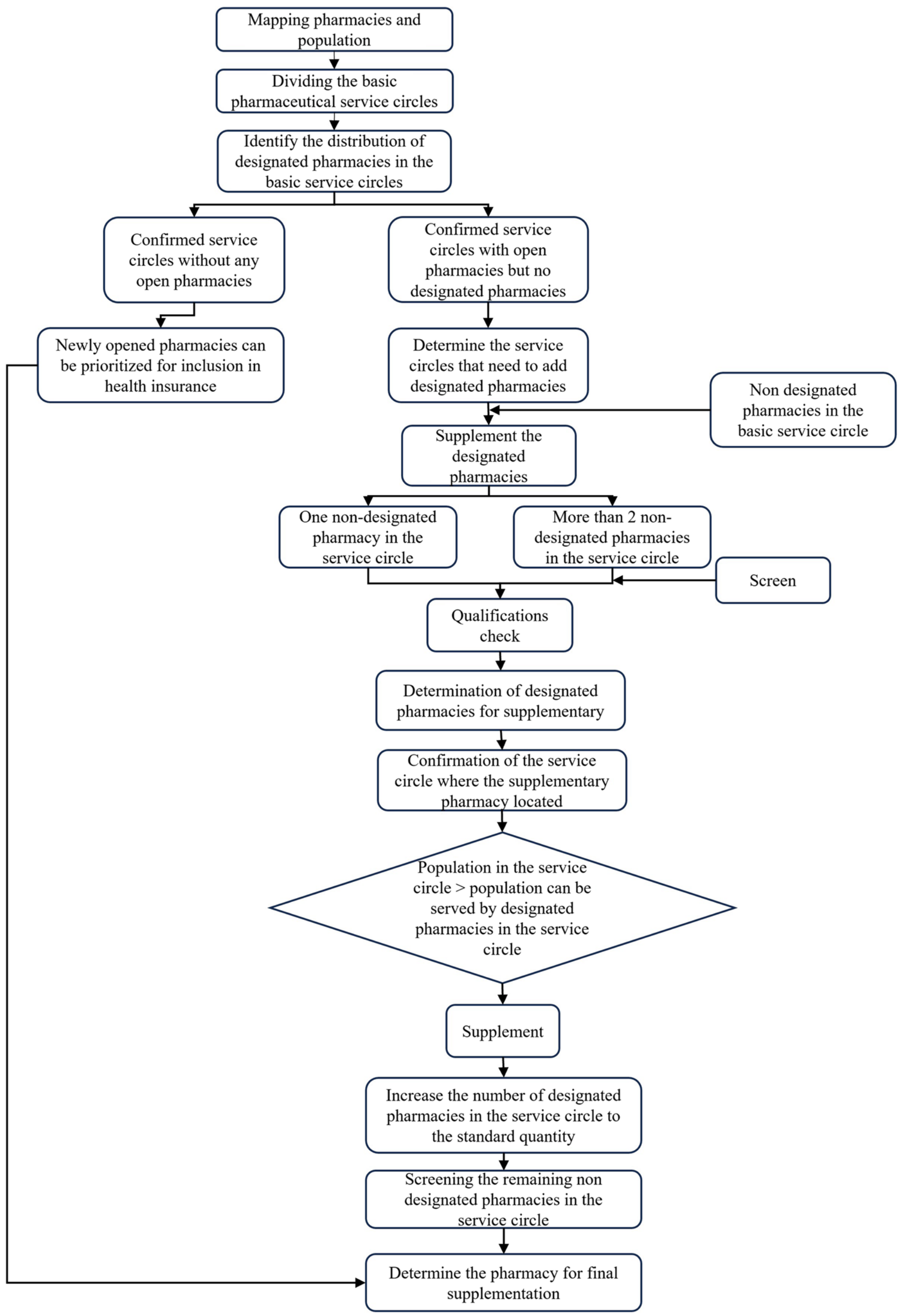

Fig. 1 Supplementary flowchart of medical insurance designated pharmacies

Square-shaped grids can seamlessly cover the geographical area to be planned without intersecting or leaving gaps. However, the radius of a square shape is not a fixed value and cannot reflect the specific service range of the pharmacy well; (3) *Hexagonal shape.* To overcome the shortcomings of the above two shapes and combine their strengths, the intersecting parts of two circles were replaced with straight lines to obtain the inscribed hexagon of the circle. The hexagonal grids can seamlessly cover the planning area without overlap, meeting the requirements well.

Mapping the basic pharmaceutical service circles

We used the standard that “residents could obtain medication within 15 minutes walking distance” to map basic pharmaceutical service circles. Specifically, assuming that

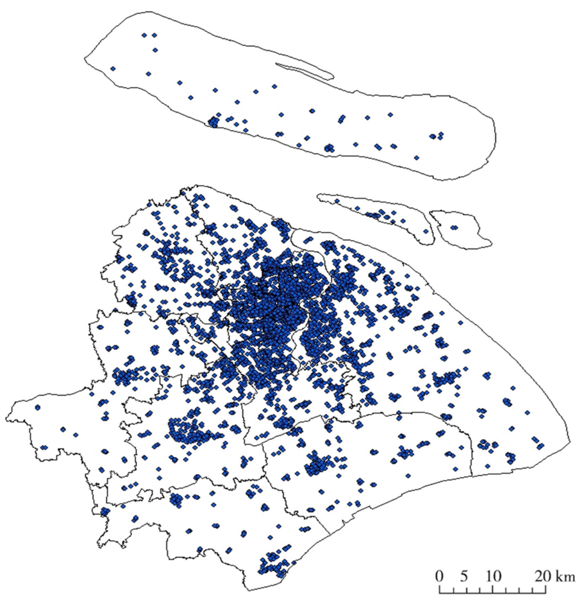

Fig. 2 Distribution of retail pharmacies in Shanghai

the speed of walking is 6,000 m per hour, the 15-minute walking distance is approximately 1500 m. Considering that most walking routes include corners, 1500 m should constitute a Gaussian distance, equivalent to a straight-line distance of approximately 1060 m. We used 1060 m as the radius and calculated that the hexagonal area of each basic pharmaceutical service circle was equal to $S = \frac{3\sqrt{3}}{2} * r^2 \approx 2.92$ square kilometers. Starting from the westernmost end of the city, we mapped hexagonal grids with a radius of 1060 m as the basic pharmaceutical service circles, and ultimately divided the entire city into 2188 basic service circles (see Fig. 4).

Distribution of retail pharmacies in basic pharmaceutical service circles

In this study, we used pharmaceutical service circles within a 15-minute walking distance as the basic planning units. Based on population density, we analyzed the distribution of retail pharmacies in basic pharmaceutical service circles and identified service circles where pharmacies were insufficient. There were three types of pharmaceutical service circles without enough pharmacies (see Table 1): (1) Pharmaceutical service circles had no open pharmacies. Among the 2188 basic pharmaceutical service circles, there were 1387 service circles without any open pharmacies, 151 of which had a population of more than 5000 (see Figs. 5 and 6). (2) Pharmaceutical service circles had open pharmacies but no medical insurance designated pharmacies. Among the 2188 basic pharmaceutical service circles, 356 service circles had open pharmacies but no medical insurance designated pharmacies (see Fig. 7).

Clustering of retail pharmacies

The results of the global spatial autocorrelation analysis showed that the Global Moran's I was 0.55 ($P < 0.05$), indicating significant spatial clustering of retail pharmacies across the city. Those basic pharmaceutical service circles with dense distribution of retail pharmacies also have densely distributed retail pharmacies in the surrounding service circles.

The results of the Local spatial autocorrelation analysis (see Fig. 8) showed that the whole central urban areas and the red-marked suburban areas exhibit high-high clustering, where regions with dense distribution of retail pharmacies were also surrounded by regions with similar distribution of retail pharmacies. Conversely, most suburban areas exhibit low-low clustering, where regions with fewer pharmacies are surrounded by regions with similarly low numbers of pharmacies.

Moreover, we analyzed the spatial clustering of retail pharmacies using different administrative units (see Fig. 9): including about basic pharmaceutical service areas within a 15-minute walking distance, townships and streets, 58 medical service areas, and administrative divisions. The results indicated that the distribution of retail pharmacies exhibited significant spatial clustering for the first two units, with Moran's I of 0.61 and 0.35 respectively ($p < 0.001$). For the latter two units, the Moran's I coefficients were 0.08 and -0.04 respectively ($p > 0.05$), indicating that the spatial clustering of pharmacy distribution was not significant.

Appropriate spacing and scale of retail pharmacies

Appropriate spacing of retail pharmacies

The results of the last part showed that areas with dense populations, such as city centers, exhibit a high-high spatial association pattern for retail pharmacies, demonstrating significant clustering. Besides, retail pharmacies around medical service centers didn't show significant clustering. Therefore, distance restrictions for pharmacies in such areas should be adjusted accordingly. Before 2020, most provinces had distance restrictions for newly opened pharmacies. For example, Shanghai required a distance of more than 300 m between newly opened retail pharmacies and existing retail pharmacies [27], while Beijing required a distance of more than 350 m. This study used a distance restriction of 300 m between pharmacies as an example, and each 15-minute basic pharmaceutical service circle ($r = 1060m$, $S \approx 2.92\ km^2$) could have 37 retail pharmacies at most, which may make it difficult to meet the medication needs in densely populated areas. Thus, the study was designed to optimize

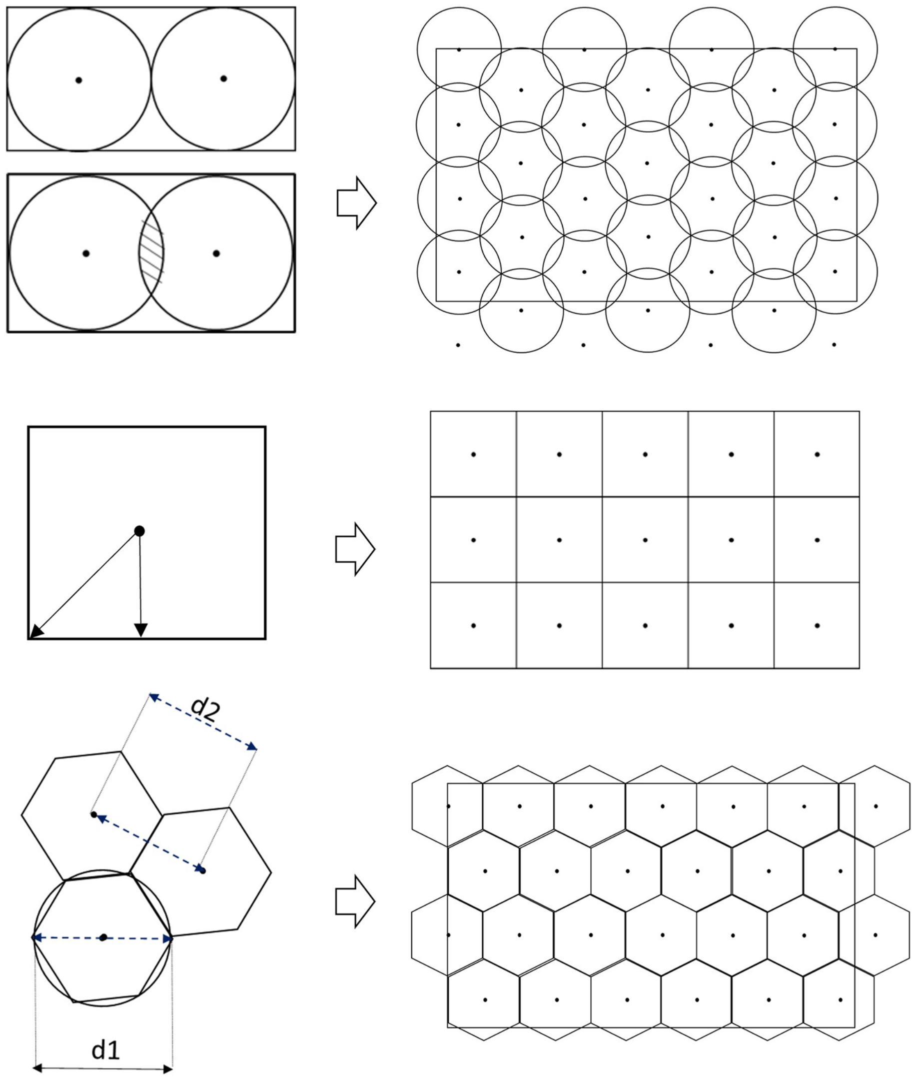

Fig. 3 Different shape selections of the basic service circles and the coverage effect

distance restrictions between pharmacies in the following areas: (1) residential areas with high population density. According to the standard that each pharmacy could serve 5000 people, each basic pharmaceutical service circle could serve 185,000 people at most when the distance restriction between pharmacies is 300 m. Thus, if the population of the basic pharmaceutical service circle exceeds 185,000 people, which means that the population density is greater than 63,356 people per square kilometer, then the distance limit between pharmacies should be relaxed. The study also simulated the situation in which the distance restriction between pharmacies was 350 m and 400 m, as shown in Table 2. (2) pharmaceutical industrial clusters, including medical institution cluster areas, municipal medical centers, and regional medical centers. Medical resources are relatively concentrated in these regions, and the demand for drugs is high due to the spillover effect of medical institutions. As the main institutions for dispensing drugs, retail pharmacies need to be added to meet higher drug requirements in these areas. Thus, distance restrictions between pharmacies should be lifted in these areas to promote the agglomeration of the pharmaceutical industry.

Appropriate scale of retail pharmacies

This study suggests that the development of retail pharmacies in a certain region should meet the following conditions: (1) the density of pharmacies in the region should meet the drug demand of the population; (2) the retail pharmacies in the region should operate well and

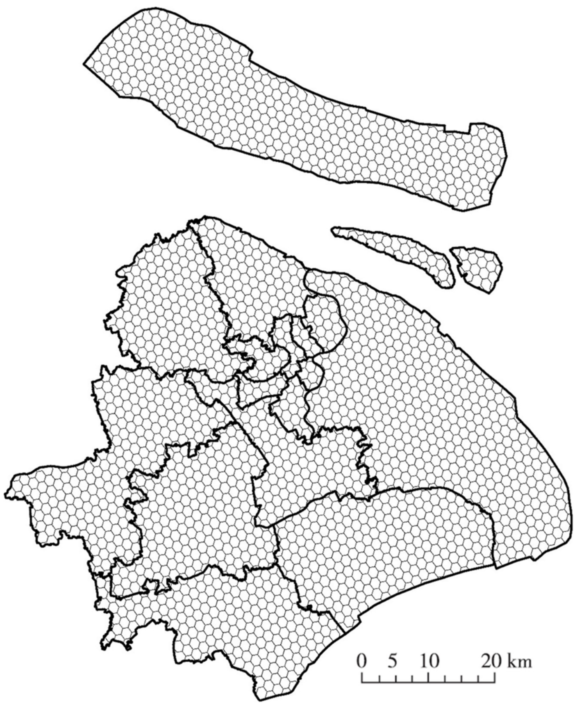

Fig. 4 Basic pharmaceutical service circles within a 15-minute walking distance

remain stable. If the retail pharmacies in a region meet the above requirements, the average size of the retail pharmacies in that area can be used as the recommended appropriate size.

In Shanghai, there were 2188 basic pharmaceutical service circles, which included approximately 3009 retail pharmacies. According to the standard that each retail pharmacy could serve 5000 people, there were a total of 333 service circles that had enough pharmacies to meet the drug needs of the population in the region. In the above service circles, there were 482 retail pharmacies in 2016 and 715 retail pharmacies in 2017 in total. We identified the detailed information of 310 retail pharmacies through the number of geometrical product specifications (GPS) certificates. After qualification review, all pharmacies had been operating for more than two years without any violation records and were considered to be in good operation condition. These 310 retail pharmacies were distributed in 194 service circles, 117 of which were in benign competition, which means that all the retail pharmacies in these service circles had been operating well and maintaining stability for more than two years. We calculated the average size of 181 retail pharmacies in the above 117 service circles as the reference value for the appropriate size of retail pharmacies. Among them, 17 retail pharmacies were located in the central urban area, with an average construction area of 110.42m^2, including 1.35 licenced pharmacists; 164 were located in non-central urban areas, with an average construction area of 98.5m^2, including 1.05 licenced pharmacists.

Table 1 Distribution of retail pharmacies in the basic pharmaceutical service circles

Types of pharmaceutical service circles	Number
Service circles had no open pharmacies	1387
with a population of < 5000 people	1236
with a population of 5000–10,000	112
with a population of 10,000–20,000	38
with a population of >20,000	1
Service circles had open pharmacies but no medical insurance designated pharmacies	356
Service circles had medical insurance designated pharmacies	445
Total	**2188**

Supplementation of retail pharmacies and medical insurance designated pharmacies

Supplementation of retail pharmacies

To ensure the accessibility of medication for residents, we designed the following schemes to supplement pharmacies in those service circles with insufficient drug supply identified in the above results: (1) Service circles had no open pharmacies. If the population of these service circles exceeds 5000 people, the medication demand of residents in these areas can support the development of more than one open pharmacy. The Commerce Committee will guide social capital to open retail pharmacies in such areas as priority, and implement incentive policies to give qualified pharmacies the opportunity to be included in medical insurance designated pharmacies. (2) Service circles where the drug supply cannot meet the medication needs of residents. According to the standard that each retail pharmacy could serve 5000 people, 841 retail pharmacies were planned to be added to residential areas to meet the medication needs of residents. The density of the retail pharmacies after supplementation is shown in Fig. 10.

Supplementation of medical insurance designated pharmacies

To improve the affordability of medication for residents, we designed the plan to supplement medical insurance designated pharmacies in the following two types of service circles: (1) Service circles had no medical insurance pharmacies. Based on the above results, a total of 356 service circles had retail pharmacies but no medical insurance designated pharmacies. The medical insurance agency could select qualified retail pharmacies from

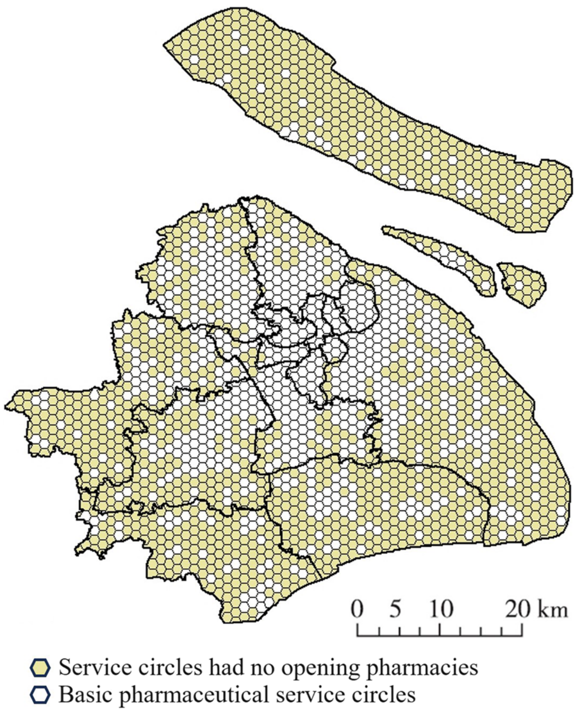

Fig. 5 Basic pharmaceutical service circles had no open pharmacies

these service circles to be included in medical insurance designated pharmacies, and 356 designated pharmacies could be added at most. (2) Service circles had only one medical insurance designated pharmacy with a population exceeding 20,000. The population density in some central urban areas was high, and it was difficult for the medical insurance designated pharmacies to meet the demand. We designed a supplementary plan based on the standard of increasing one medical insurance designated pharmacy per 20,000 people, and 192 medical insurance designated pharmacies should be added to 122 service circles (see Fig. 11).

After supplementing the medical insurance designated pharmacies as planning, the coverage area of these pharmacies increased significantly. Before planning, there were service blind spots within a 15-minute walking distance circles from medical insurance designated pharmacies, with 1.05% of the central urban population and 32.36% of the suburban population not covered (see appendix 1). After planning, the coverage of medical insurance designated pharmacies expanded, allowing 100% of urban residents and 82.23% of suburban residents to reach a medical insurance designated pharmacy within 15 min walking distance. Additionally, the uncovered suburban areas did not include residential areas with a population density exceeding 5,000 per square kilometer (see appendix 3).

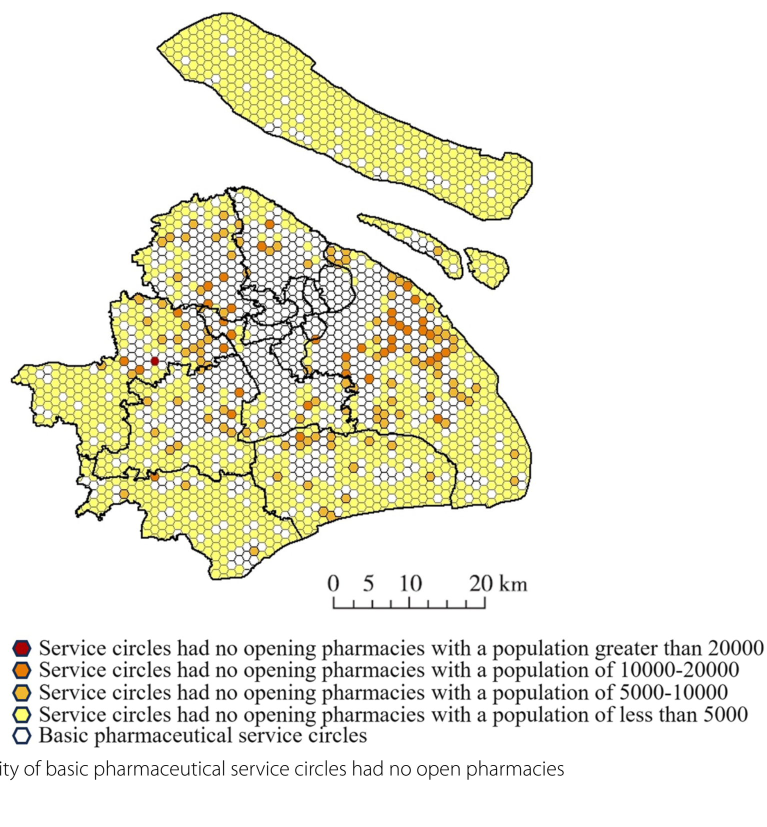

Fig. 6 The population density of basic pharmaceutical service circles had no open pharmacies

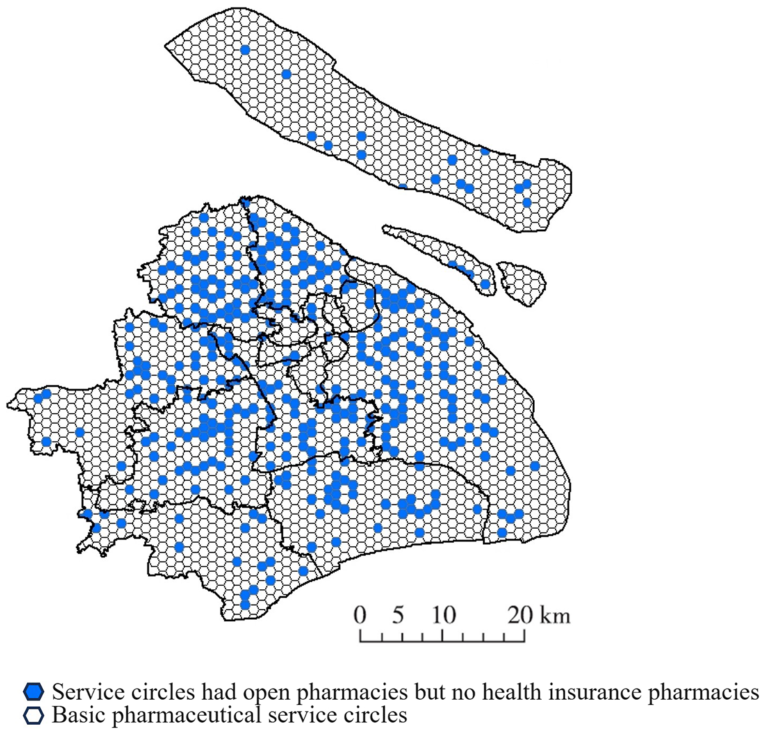

Fig. 7 The service circles had open pharmacies but no medical insurance designated pharmacies

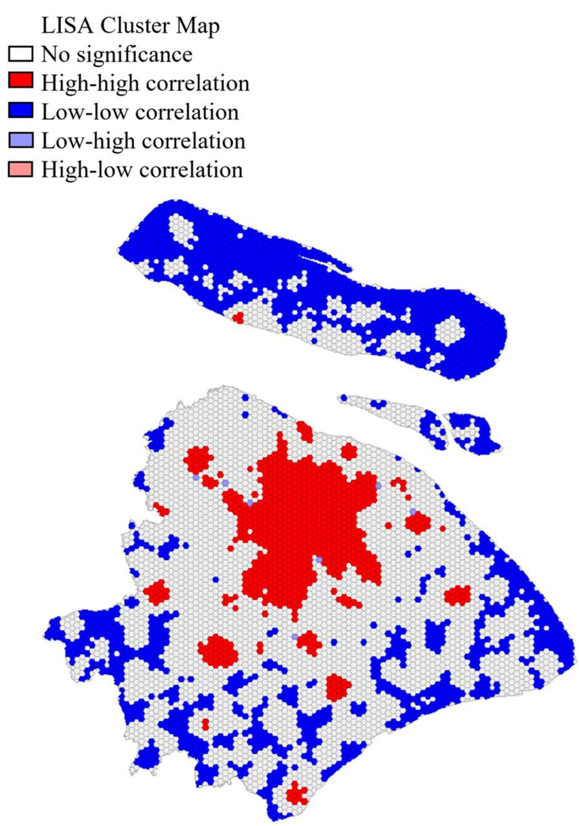

Fig. 8 Local spatial autocorrelation of retail pharmacies

Discussion

The research group has been collaborating with the municipal government in Shanghai since 2016. Based on population distribution data and geographic layout data of retail pharmacies, we identified those areas with insufficient pharmaceutical service. Then, we calculated the appropriate size of retail pharmacies and the suitable distance between pharmacies according to regional features, and designed supplementary methods for retail pharmacies and medical insurance designated pharmacies. The outcomes of this study can provide important references for the government to regulate the spatial layout of retail pharmacies to improve the fairness, accessibility, and affordability of obtaining medication for residents.

This study has good foresight for the layout planning of retail pharmacies in China. In China, the government's regulation of the spatial layout of retail pharmacies has undergone a shift from more interventionist to more liberal. Before 2020, most regions had strict regulations on distance restrictions between retail pharmacies, aimed at preventing vicious competition and resource waste among pharmacies. However, the fixed distance restriction has the following limitations: (1) regions with different population densities have the same distance restriction between retail pharmacies, resulting in insufficient pharmaceutical service in areas with high population densities; (2) the distance restriction

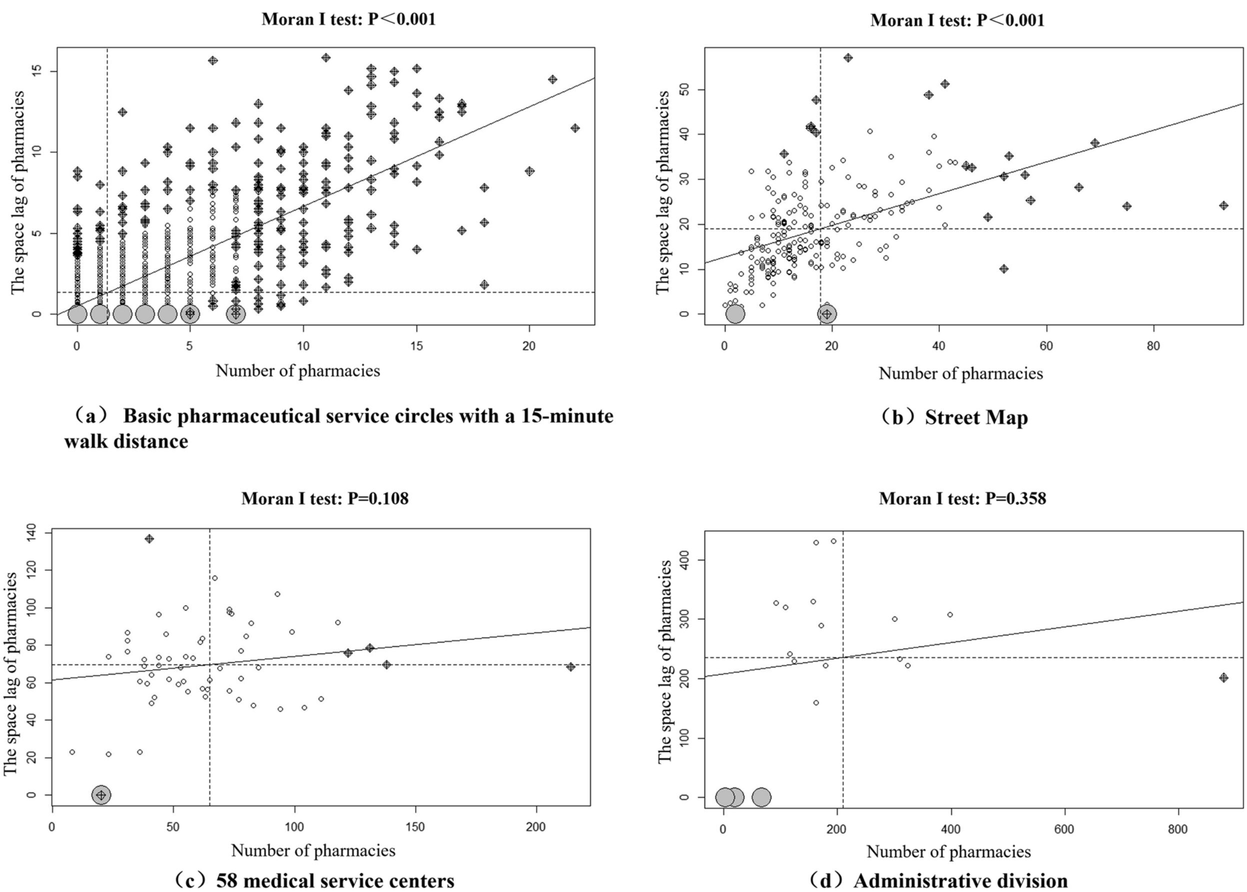

Fig. 9 Spatial correlation of retail pharmacies under different analysis units

Table 2 The situation of different distance restrictions between pharmacies in basic pharmaceutical service circles

Distance limitations	Maximum number of retail pharmacies can be included	Maximum number of people can service	Maximum population density
≥ 300 m	37	185,000	63,356
≥ 350 m	30	150,000	51,369
≥ 400 m	23	115,000	39,383

of retail pharmacies protects the interests of already opened pharmacies, leading to a lack of competition among those early opening pharmacies. Thus, in 2018, the research group proposed eliminating distance restrictions between pharmacies in areas with high population density and pharmaceutical industry clusters and piloted it in Shanghai. In 2020, the Chinese government issued a national policy to lift distance restrictions between pharmacies nationwide [28].

In terms of the regulatory methods of the government, we designed a series of policies for government departments to guide the spatial layout of retail pharmacies: (1) the Commerce Committee should issue guidance reports on the spatial layout of retail pharmacies regularly to the public, including suggested service circles that need to be layout preferentially and appropriate size of retail pharmacies to guide new pharmacies in a rational layout and scale setting; (2) the healthcare security administration should supplement medical insurance designated pharmacies based on research results, including increasing the number of medical insurance designated pharmacies in densely populated areas, and encouraging enterprises to prioritize opening pharmacies in areas without retail pharmacies through incentive measures of prioritizing

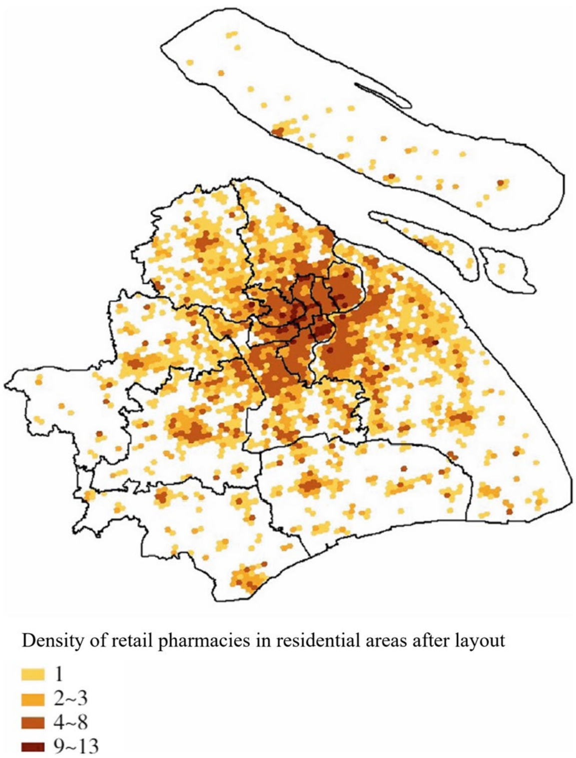

Fig. 10 The density of the retail pharmacies after supplementation

inclusion in medical insurance designated pharmacies. After supplementing retail pharmacies and medical insurance designated pharmacies, the service area and service population of pharmacies increased significantly, effectively improving the accessibility, convenience, and affordability of medication for residents.

The above practice is consistent with previous research. In the field of spatial planning, the European Commission considered that "as a quantitative measure, limitation on the number of pharmacies is not an appropriate means to ensure a good supply of drugs, and may even be counterproductive in this regard" [26]. Therefore, the positions expressed by the European Commission thus far have aimed at relaxing the regulation of pharmacies and bringing them closer to a more liberal model. Studies have also shown that it is important to correlate the different access dimensions, including geographical distribution, to measure access to medicines more comprehensively. As mentioned by Penchansky and Thomas, access is multidimensional [29]. Most studies have shown that increased pharmacy density is associated with increased access to medicines, and high-income areas were noted to have increased access to pharmacies. Therefore, the density of pharmacies in low-income and rural areas is relatively low, and the accessibility of drugs is poor. The study increased the distribution of pharmacies and included more medical insurance designated pharmacies based on population density and the actual needs of each area, which would help to improve the accessibility of drugs.

This study fills an important gap in the government's guidance on the geographical layout and appropriate spacing and scale of retail pharmacies in developing countries. Previous studies have shown that geographical accessibility is important for achieving access, commonly measured as the geographical distribution of pharmacies within a region and the density of pharmacies per population [24]. Moreover, the geographical location of pharmacies is also a core dimension for measuring health equity, which also reflects its importance [30]. Although the importance of geographical accessibility for retail pharmacies has been widely recognized, there is little literature on the spatial planning of pharmacies. Most of the existing research comes from high-income countries, and research in low-income and middle-income countries is relatively limited. This may be related to the difficulty of timely updating of pharmacy census data in such countries due to limited resources [23]. This study selected a city in eastern China as a sample area to design regulatory methods for the spatial layout of retail pharmacies, which provide an important reference for the geographical layout planning of retail pharmacies in low-income and middle-income countries.

This study has the following limitations. First, the different ways of dividing basic pharmaceutical service circles affect the distribution of pharmacies. For example, this study mapped basic pharmaceutical service circles starting from the westernmost point of the planning area with a radius of 15-minute walking distance. If the basic service circles are not mapped as described above, such as starting from the northernmost point or with different radius, different results may result. Second, the geographic spatial layout planning of retail pharmacies is based on the complete and accurate acquisition of needed data, such as pharmacy and population data. Thus, these data information needs to be updated timely.

Conclusion

This study mapped the distribution of the population and retail pharmacies in Shanghai and designed guidance methods for the spatial layout of retail pharmacies. On the one hand, we calculated the distance restrictions and appropriate scale of retail pharmacies based on population density and drug demand in different regions, which can serve as a basis for the Commerce

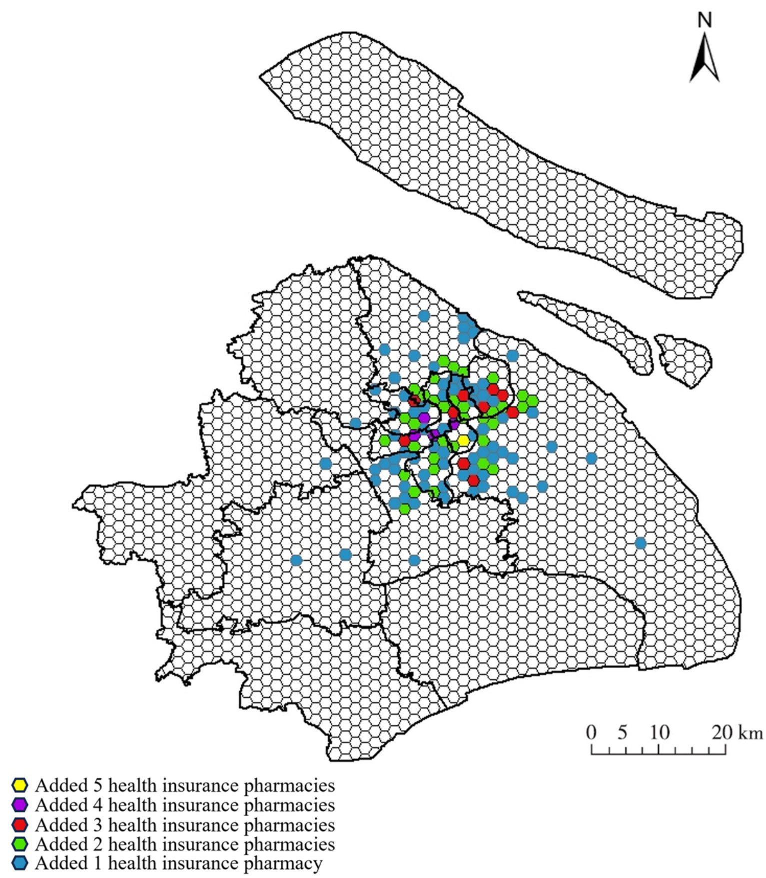

Fig. 11 Supplemental plan of medical insurance designated pharmacies

Committee to issue pharmacy layout guidelines. On the other hand, we designed supplementary methods for retail pharmacies and medical insurance designated pharmacies, which can assist relevant government departments in planning the spatial layout of retail pharmacies in the next stage.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12939-024-02254-9.

Supplementary Material 1.

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Authors' contributions
Q. W. and T. Z. contribute to the conceptualization, methodology and original writing. R.D. and Q.Y. participated in the data analysis and manuscript correction. All authors took part in revising the article and gave final approval of the version to be published.

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Availability of data and materials
Data will be made available on request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Goel P, Ross-Degnan D, Berman P, Soumerai S. Retail pharmacies in developing countries: a behavior and intervention framework. Soc Sci Med. 1996;42(8):1155–61.
2. Rutta E, Liana J, Embrey M, Johnson K, Kimatta S, Valimba R, et al. Accrediting retail drug shops to strengthen Tanzania's public health system: an ADDO case study. J Pharm Policy Pract. 2015;8(1):23.
3. Sabde YD, Diwan V, Saraf VS, Mahadik VK, Diwan VK, De Costa A. Mapping private pharmacies and their characteristics in Ujjain district, Central India. BMC Health Serv Res. 2011;11(1):351.
4. Chimbuco BN, Ferreira MA, Sacomboio ENM, Ekundi-Valentim E. Community Pharmacy Services in Malanje City, Angola: a Survey of practices, Facilities, Equipment, and staff. Pharmacy. 2022;10(2):35.
5. Kamat VR, Nichter M. Pharmacies, self-medication and pharmaceutical marketing in Bombay, India. Soc Sci Med. 1998;47(6):779–94.
6. Igun UA. Why we seek treatment here: Retail pharmacy and clinical practice in Maiduguri, Nigeria. Soc Sci Med. 1987;24(8):689–95.
7. Smith F. The quality of private pharmacy services in low and middle-income countries: a systematic review. Pharm World Sci. 2009;31(3):351–61.
8. Frempong BK, Amalba A, Donkor N, Akuffo KO. Regulatory compliance among over-the-counter medicine sellers facilities within the Upper East Region of Ghana. J Pharm Policy Pract. 2021;14:72.
9. Stenson B, Syhakhang L, Eriksson B, Tomson G. Real world pharmacy: assessing the quality of private pharmacy practice in the Lao people's Democratic Republic. Soc Sci Med. 2001;52(3):393–404.
10. Feng Z, Ye Y, Ye H, Tang Z. Changes in pharmaceutical retail market and regional inequality of community pharmacists accessibility in mainland China: a retrospective cross-sectional study. BMJ Open. 2022;12(11):e063739.
11. Deng J, Wen Z. Annual report on China's pharmaceutical distribution industry [Chinese]. Beijing, China: Social Sciences Academic Press (China); 2020.
12. National Bureau of Statistics. Total retail sales of consumer goods increase by 12.5% in 2021. http://www.stats.gov.cn/xxgk/sjfb/zxfb2020/202201/t20220117_1826441.html.
13. Qato DM, Zenk S, Wilder J, Harrington R, Gaskin D, Alexander GC. The availability of pharmacies in the United States: 2007–2015. PLoS ONE. 2017;12(8):e0183172.
14. Rudavsky R, Pollack CE, Mehrotra A. The geographic distribution, ownership, prices, and scope of practice at retail clinics. Ann Intern Med. 2009;151(5):315–20.
15. Hesso I, Gebara SN, Kayyali R. Impact of community pharmacists in COPD management: inhalation technique and medication adherence. Respir Med. 2016;118:22–30.
16. Newman TV, Hernandez I, Keyser D, San-Juan-Rodriguez A, Swart ECS, Shrank WH, et al. Optimizing the role of community pharmacists in managing the health of populations: barriers, facilitators, and Policy recommendations. J Manag Care Spec Pharm. 2019;25(9). https://doi.org/10.18553/jmcp.2019.25.9.995.
17. Piquer-Martinez C, Urionagüena A, Benrimoj SI, Calvo B, Martinez-Martinez F, Fernandez-Llimos F, et al. Integration of community pharmacy in primary health care: the challenge. Res Social Administrative Pharm. 2022;18(8):3444–7.
18. Qato DM, Daviglus ML, Wilder J, Lee T, Qato D, Lambert B. Pharmacy deserts are prevalent in Chicago's predominantly minority communities, raising medication access concerns. Health Aff (Millwood). 2014;33(11):1958–65.
19. Law MR, Dijkstra A, Douillard JA, Morgan SG. Geographic Accessibility of Community pharmacies in Ontario. Healthc Policy. 2011;6(3):36–46.
20. Okoro RN. Comparative analysis of private Retail Community Pharmacies' participation in the National Health Insurance Scheme of Nigeria and Ghana: implications for Access to essential Medicines. Ethiop J Health Sci. 2019;29(3):401–8.
21. Osenton T. The death of demand: finding growth in a saturated global economy. Upper Saddle River, New Jersey: FT; 2004.
22. Jin Wu. Research on distribution and development strategy of retail drugstores in China. China Pharm. 2013;24(17):1627–9.
23. Bilka M, Duarte AP, Lábaj M. Entry and competition of retail pharmacies: a case study of OTC drugs sales and ownership deregulation1. Ceska Slov Farm. 2023;72(1):11–20.
24. Ward K, Sanders D, Leng H, Pollock AM. Assessing equity in the geographical distribution of community pharmacies in South Africa in preparation for a national health insurance scheme. Bull World Health Organ. 2014;92(7):482–9.
25. Miramontes Carballada Á, Lois-González RC. Liberalization and governance in the geographical distribution of pharmacies in Spain. Int J Environ Res Public Health. 2022;19(1):34.
26. González Alonso I, Bara MP. Modelos De farmacia en la Unión Europea. Análisis comparativo. Farmacia Profesional. 2008;22(8):10–5.
27. Shanghai Municipal Health Commission. Reply to the proposal of No. 0585 representative of the Fifth Session of the 15th Municipal People's Congress. 2021. https://wsjkw.sh.gov.cn/rddbjydf/20210608/8076c5b8858043dcb8fa4cbec3aea749.html.
28. General Office of the State Council. Notice of the General Office of the State Council on Printing and Distributing the Key Task Division Plan for. Deepening the Reform of Decentralization, Management, and Service and Optimizing the Business Environment of the National Television and Telephone Conference. http://www.gov.cn/zhengce/content/2020-11/10/content_5560234.htm.
29. Penchansky R, Thomas JW. The Concept of Access: definition and relationship to consumer satisfaction. Med Care. 1981;19(2):127–40.
30. Hosseinpoor AR, Bergen N, Magar V. Monitoring inequality: an emerging priority for health post-2015. Bull World Health Organ. 2015;93(9):591.

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