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Senior-Friendly Transportation Strategies in Guangzhou Under the Goal of All-Age-Friendly City

WANG Zexia, ZHANG Xiaoming, LIAO Shunyi, WU Yunjing

Guangzhou Urban Planning & Design Survey Research Institute, Guangzhou 510120, Guangdong, China

Abstract: Creating a senior-friendly transportation environment is of great significance to the planning of all-age-friendly cities and communities. Taking Guangzhou as an example, this paper analyzes the spatial distribution and travel behaviors of the elderly by conducting both qualitative and quantitative analysis using mobile location data, demographic data, and facility satisfaction data. The results show that Yuexiu District, Liwan District, and Haizhu District have the highest proportion of the elderly and the strongest demand for senior-friendly facilities, but the accessible transportation facilities are not aligned well with the travel demand of the elderly. Based on the analysis of the travel behaviors of the elderly, the paper discusses senior-friendly transportation countermeasures and the layout of accessible transportation facilities in urban public spaces and community-based living circles. The paper proposes an integrated “door-to-door” design strategy, providing a forward-thinking approach to senior-friendly transportation planning amid regular pandemic prevention and control measures. DOI: 10.13813/j.cn11-5141/u.2022.0025-en

Keywords: all-age-friendly city; travel behavior; living space for the elderly; senior-friendly transportation; Guangzhou

0 Introduction

As the urban social economy and medical level improve, the aging trend in China has become increasingly obvious. How to establish an urban environment for the elderly is an important issue that society faces today. The *Proposal of the CPC Central Committee on Formulating the 14th Five-Year Plan for National Economic and Social Development and the Vision of 2035* points out that national strategies for actively coping with population aging should be implemented. According to the data of the 7th National Population Census (hereinafter referred to as the 7th Census), 18.7% of the people are 60 years old or above, of which 13.5% are 65 years old or above. In addition, the report of the Office of China's National Committee on Aging shows that China's aging population is expected to reach 500 million in the middle of the 21st century^[1]. As a first-tier city, Guangzhou has a developed economy and is rapidly developing. Among its permanent residents, 11.41% of them are 60 years old and above, which has increased by 4.66% compared with that of the 6th Census. The intensified aging poses more challenges to Guangzhou's urban operation and quality improvement.

The construction of all-age-friendly cities should fully consider the needs of the elderly and protect their rights and

interests from all aspects. As an important part of urban functions in the *Athens Charter*, transportation has become a key indicator to measure all-age-friendly cities. In 2022, it was mentioned in the *National Planning for the Development of the Aged Undertaking and the Elderly Care System in the 14th Five-Year Plan* issued by the State Council that efforts should be intensified on the senior-friendly renovation of urban roads, transportation facilities, public transport tools, etc., and a senior-friendly intelligent transportation system should be developed in an all-round way to provide a convenient and comfortable travel environment for the elderly^[2]. The elderly feature impaired physical functions and have a high demand for accessible environments in terms of physiology and behavior. Therefore, it has become an important research content of transportation for the elderly to ensure the smooth travel of the elderly and realize “door-to-door” integrated construction.

Taking the travel characteristics and needs of the elderly as the starting point, this paper combines mobile positioning big data, satisfaction surveys of accessible facilities, and other data and studies the characteristics of the living space agglomeration and the distribution and construction of accessible facilities for the elderly. In addition, the paper provides a solution to match the travel needs of the elderly with the

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First author: WANG Zexia (1994–), female, from Anshan, Liaoning Province, master's degree, planner, and her main research direction is quantitative research on urban planning. E-mail: 18840852351@163.com

Corresponding author: ZHANG Xiaoming (1976–), male, from Lanxi, Zhejiang Province, master's degree, senior engineer, director of the Institute of Transportation Planning and Design. His main research interests include urban transportation planning, logistics planning, transportation hub planning and design, etc. E-mail: zhangxiaoming@gzpi.com.cn

layout of the senior-friendly transportation facilities from the perspectives of urban space and residential community and explores the impact mechanism and optimization strategy of senior-friendly traffic environmental construction, which provides a path reference for actively building all-age-friendly cities.

1 Overview of existing research

Other countries have conducted many studies on senior-friendly transportation countermeasures. They have used questionnaires, mobile phone signaling, and other data to analyze the travel characteristics and influencing factors of the elderly and proposed senior-friendly transportation strategies in terms of financial support, transportation policies, facility upgrading, etc. Most of the relevant studies in China summarize the travel purpose, frequency, and other characteristics of the elderly based on experience from other countries and adopt questionnaires, comprehensive traffic surveys, and other methods, but there is a lack of in-depth research on the living space distribution and travel rules of the elderly, and less attention has been paid to the allocation of accessible facilities.

1.1 Travel characteristics of the elderly

The travel research of the elderly in cities mainly focuses on travel characteristics, influencing factors, and spatial distribution characteristics of travel behavior^[3]. Quantitative analysis shows that travel time consumption, travel distance, and travel frequency of the elderly decrease with age^[4]. In addition, the leisure time of the elderly has increased, and the purpose of their travel has changed from work-oriented to life-oriented. The activities mainly include medical treatment, shopping, social networking, etc^[5]. The survey shows that in terms of cultural and entertainment travel, the group aged 70–74 years old is 9.4 times that of the group aged 40–44 years old, and the former is 3.2 times that of the latter in terms of shopping^[6]. Elderly people in big cities will participate in activities such as taking their grandchildren to school and buying vegetables, and their activities are mostly concentrated in the community-based living circle^[7]. Qualitative analysis shows that the elderly mostly go out during non-peak hours of the day, and the distribution is relatively uniform^[7]. In terms of transportation mode, research results in China and abroad are different. The level of public transit services in some developed countries is low, and elderly people rely heavily on cars to travel but rarely use public transportation^[8]. In China, the elderly gradually give up the self-driving mode of transportation that requires high capacity and prefer walking and public transportation^[9].

According to the travel survey during the outbreak of the pandemic, the proportion of people aged 60 years old and above who choose to travel on foot is higher than that of other

age groups^[10]. In addition, the travel distance of people with low mobility by public transportation is usually within 1 km, and the travel frequency and travel time consumption are reduced accordingly. Furthermore, their satisfaction with public transportation facilities has significantly reduced^[11].

1.2 Improvement of senior-friendly transportation facilities

The optimization of transportation facilities is an important part of building an all-age-friendly city, and the establishment of a senior-friendly transportation system has become a topic of concern for many scholars. For example, on the basis of the travel characteristics of the elderly, strategies for optimizing the layout of transportation facilities for the elderly are proposed, which involve the accessibility of public transit stations, improvement of transportation environments, and optimization of accessible transportation facilities^[12]. There are also analyses on the characteristics of communication and behaviors of the elderly based on the survey data, and some thoughts are put forward on the optimization of road public facilities and road transportation environments^[13]. In addition, studies have found that in communities with excellent living facilities, most elderly people prefer walking, and safety and convenience have become important factors in choosing travel destinations^[14].

1.3 Research on senior-friendly transportation strategies

The transportation policy for the elderly in the United States follows the principle and sequence of legislation, administration, institution establishment, fund guarantee, and public guidance. In 2012, the appropriation related to the transportation provisions for the elderly reached 1.4 billion dollars (about 9.4 billion CNY), accounting for 71% of the total relevant appropriation under the *Older Americans Act*^[15]. Singapore encouraged multiple sectors to participate in senior-friendly transportation actions and united them to participate in the formulation of senior-friendly transportation policies in terms of the system and mechanism. In addition, it launched the Action Plan for Successful Aging in 2016, and the government has supported the senior-friendly transportation construction^[16]. Singapore also set up a Silver Zone (a safe transportation zone for the elderly) to plan and transform land use, vehicle driving, walking, facility systems, operation management, and so on, and it has ensured the travel safety of the elderly by controlling the external transportation environment^[17]. In order to reduce traffic accidents related to the elderly, Japan has formulated senior-friendly transportation strategies, such as improving supporting transportation facilities for elderly pedestrians, strengthening transportation safety education, and developing driving assistance support systems for elderly drivers^[18].

The United States is highly motorized, while the proportion of elderly people traveling by private cars in China is low. Through the survey on the travel behavior of the elderly

in China, it is found that the main travel mode of the elderly aged 60 years old and above in Beijing is walking, followed by bicycles, buses, and trolley buses [15]. Compared with the diversified supply policies of transportation for the elderly in other countries, the travel policy guarantee for the elderly in Chinese cities is relatively single, and the accessible facilities for public transportation are slightly insufficient. The facility allocation rate is low, and the management and maintenance system is not complete. Therefore, we should actively develop public transportation, attach importance to the construction of public transportation informatization, and pay attention to the accessible design of the transportation system, so as to create a safe and convenient pedestrian transportation environment [6]. In addition, the elderly greatly rely on the community-based living circle, so we should create diversified walking spaces and enhance the continuity, comfort, and identifiability of the walking spaces in communities [19].

2 Travel characteristics and living space distribution characteristics of the elderly in Guangzhou

2.1 Data description

The international definition of the elderly is basically based on the retirement age (60 or 65 years old). The retirement age in China is 60 years old for men and 55 or 50 years old for women. The retirement age has been enhanced, and the health level of the elderly has been improved. Furthermore, some studies have found that the travel characteristics of the elderly aged 61–65 years old are not significantly different from those aged 19–60 years old [20]. Therefore, 65 years old and above are defined as the age range identified by mobile signaling. This group of people basically has no commuting needs, and thus can more accurately reflect the travel characteristics of the elderly.

The mobile positioning big data of mobile phones in Guangzhou were used to record user location points every hour on September 20, 2020, and a total of 12.568 million signaling data were obtained. 631 000 elderly people were identified, and their locations at 1:00–4:00 were marked as their residences. According to data from the 7th Census, there are 1.46 million people aged 65 years old and above in Guangzhou, and the signaling recognition data of mobile phones accounts for 43.2% of the actual population, which is representative. According to the routine schedules of the elderly and the operation time of public transportation, the research period is set as 5:00–22:00 to calculate the linear travel distance and number of the elderly traveling actively per hour, and the movement with a linear distance of more than 100 m is recorded as a trip.

2.2 Travel characteristics of the elderly

The survey results show that 9:00–11:00 and 16:00–17:00

are the activity concentration periods for the elderly (Fig. 1). This is slightly different from the active periods (6:00–7:00, 9:00–11:00, and 14:00–17:00) obtained in other studies [6]. After users who do not go out on that day are excluded, the average linear travel distance of the elderly in the morning is about 2.4 km, and that in the afternoon is about 1.68 km. During peak hours (9:00–10:00), 556 000 elderly people who have gone out are identified. In addition, during the active period of 9:00–11:00, the linear travel distance of 78.8% of the elderly is less than 1 km, or in other words, these people actually stay at home, while only 12.9% of the elderly travel with a linear distance of more than 4 km, which is considered as a middle and long distance. It indicates that the elderly have a strong dependence on home-centered community space (Fig. 2). Users who travel with a linear distance of more than 1 km during the active periods of the day account for 21.2%. According to the coverage of the 15-minute life circle and the walking speed of the elderly, it is believed that the users who travel with a linear distance of more than 1 km have used transportation tools (bicycles, buses and trolley buses, subways, cars, etc.). In view of the low proportion of elderly people who drive cars in China, it can be inferred that about 21.2% of the elderly have used public transportation. This value is slightly lower than that drawn in the survey of residents' travel behaviors in Nanjing. Specifically, 25% of the elderly have used public transportation [7].

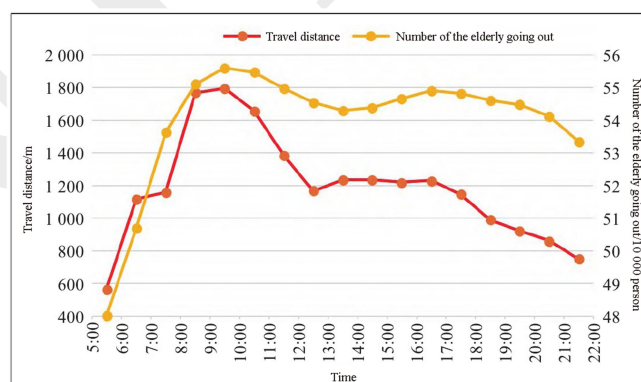


Fig. 1 Average travel distance and number of the elderly going out

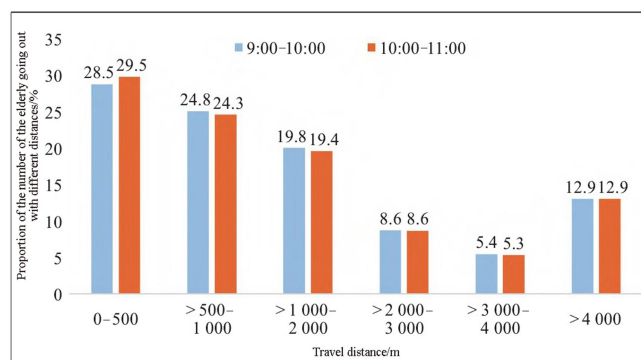


Fig. 2 Number of the elderly going out with different travel distances between 9:00 and 11:00

Therefore, the range of daily activities of the elderly is relatively small since the outbreak of the pandemic. The travel period is not the morning and evening peak hours, which is different from the company-to-house activity space generated by the daily commuting of young people. The activities of the elderly are usually home-centered and carried out within 1 km reached by walking. The survey results show that the daily travel frequency of the elderly is 1.47. This result is similar to the daily trips with a value of 1.40 obtained through the questionnaire in Nanjing [7]. However, the result is greatly different from the daily trips of the elderly with a value of 3.67 [21] measured by GPS data in Shanghai. The reason for this difference may be that GPS data is sensitive to distance, and some short-distance trips will be identified and recorded, but the definition of a trip in this study refers to a linear distance exceeding 100 m, which excludes short-distance trips. In the meantime, due to the large time granularity of analysis, some short-time trips are omitted, so the identified frequency is lower than that of GPS data. In the questionnaire survey, there is also the phenomenon that respondents will ignore the short-distance and short-time trips (e.g. going downstairs and throwing waste), so the travel frequency identified in this study is close to the questionnaire data.

Influenced by the current age structure and inertia, the aging population in Guangzhou will still be on the rise for a period of time, and the new generation of elderly people will have better physical conditions and richer daily activities, which will inevitably increase the number of trips and thus bring more requirements on transportation facilities and service levels. Research shows that 48.5% of the elderly are willing to travel for medium and long distances when the transportation service is improved [3]. Therefore, improving public transportation plays a positive role in promoting the travel of the elderly, and the layout of senior-friendly transportation facilities is the key to future urban transportation development. From the current travel characteristics, we can see that the elderly's activity space is relatively limited, and the community-based living circle is still the most important place for daily activities. The elderly have a strong demand for the community road system and accessible transportation facilities inside the community service buildings for the elderly. Therefore, it is an urgent task to build a senior-friendly community transportation system.

2.3 Distribution characteristics of living space of the elderly

According to the data of the 7th Census, the elderly aged 65 years old and above in Guangzhou mainly live in three districts: Yuexiu District, Liwan District, and Haizhu District (hereinafter referred to as the old urban areas), and they account for more than 31.2% of the total elderly, while the demographic structure of the peripheral urban areas is relatively young. According to the population data from the “four standards and four actuals”^①, there are 1.993 million

residents actually living in the inner ring, including 499 000 elderly people aged 60 years old and above, with an aging degree of 25.0%. The super high aging rate puts forward higher requirements for infrastructure construction.

The ArcGIS hotspot analysis tool (Getis-OrdGi*) is used to explore the agglomeration of the elderly in the old urban areas and identify the cluster distribution of high-value and low-value elements in space (Figs. 3 and 4). The results show that the middle and south of Yuexiu District, the northeast of Liwan District, and the north of Haizhu District are high-value residential areas for the elderly, covering an area of about 1 926 hm² and involving 756 neighborhood committees. In the subsequent planning, attention should be paid to the coherent design of public transportation in these areas and the construction of accessible facilities within the community-based living circle, and demonstration sites of the senior-friendly community should be built to achieve the integrated construction of “door-to-door” travel for the elderly.

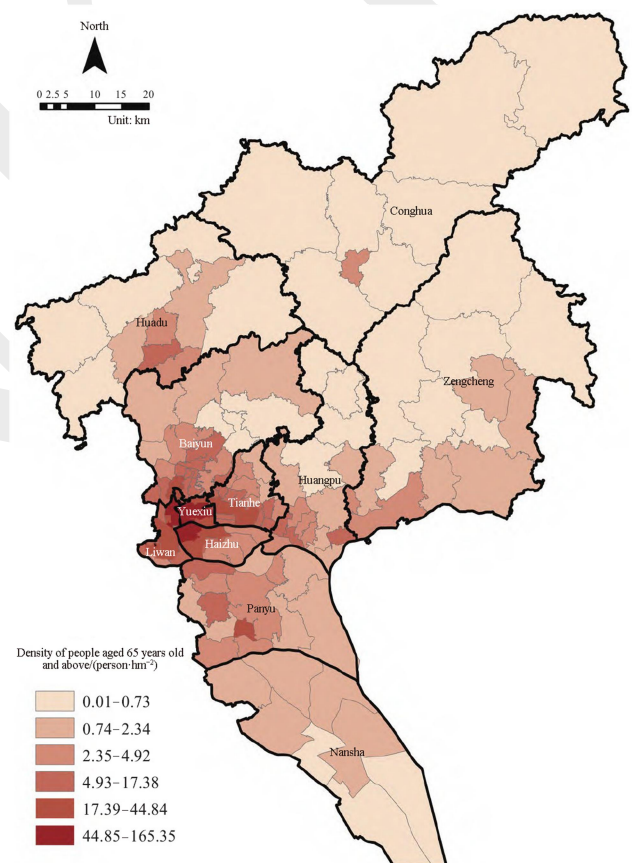


Fig. 3 Spatial distribution of living space for the elderly

3 Current situation of senior-friendly transportation facility construction in Guangzhou

As a big city with a high aging rate, the spatial aggregation of the elderly puts forward higher requirements for the construction of an accessible environment in Guangzhou.

However, the senior-friendly facilities in the old urban areas with the highest aging rate face serious problems, with the widespread phenomenon of emphasizing construction over management. In particular, the accessible facilities in public spaces such as roads and squares are often occupied and damaged. The accessible travel of the elderly depends not only on the layout of a single facility but also on the continuous closed-loop travel environment developed by the systematic construction of road facilities and public transportation, and damage to any link will cause obstacles to the elderly with travel difficulties.

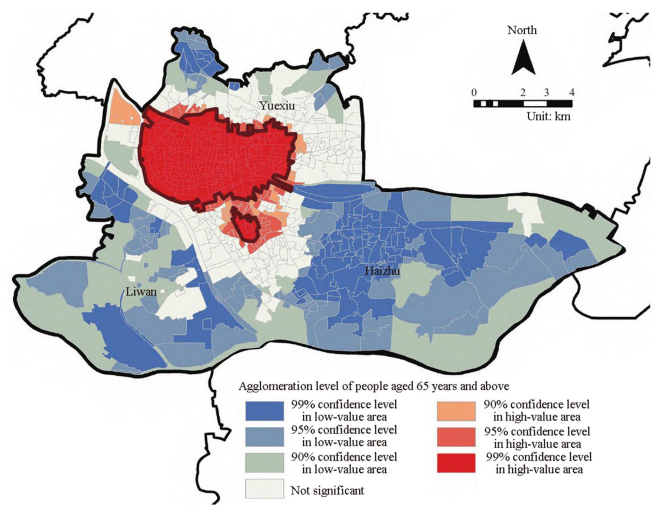


Fig. 4 Agglomeration characteristics of the elderly in the old town areas

3.1 Urban public facilities

In terms of public facility construction, it is found by the *Survey Report on Accessible Environment Satisfaction in Guangzhou of 2021* [22] that subway stations, hospitals, rehabilitation institutions, and bus stations are places where citizens in Guangzhou often use accessible facilities according to the feedback results of 7 335 questionnaires, but the level of facilities still needs to be strengthened, and accessible facilities at key nodes still need to be improved. Citizens in the old urban areas have a high demand for the reconstruction of transportation facilities such as pedestrian overpasses, pedestrian underpasses, bus stations, subway stations, and railway stations. However, residents in Huadu, Zengcheng, Conghua, and other peripheral areas think that public facilities such as parks, government halls, and nursing homes need to be improved, and they are satisfied with transportation facilities such as subway stations and bus stations (Table 1). In addition, 40% of the residents in Yuexiu District believe that pedestrian overpasses need to be optimized. The proportion of citizens who think that bus stations, subway stations, pedestrian underpasses, and railway stations need to be optimized is 32%, 28%, 19%, and 14%, respectively. On the whole, the satisfaction of residents in the old urban areas with transportation facilities is lower than that of residents in the

peripheral urban areas, which indicates that although the actual space demand of the elderly in the old urban areas is higher, the existing facilities are difficult to meet it.

Table 1 Accessible facilities to be upgraded in each district

Districts	Facilities
Yuexiu District	Pedestrian overpasses, bus stations, subway stations, pedestrian underpasses, and railway stations
Liwan District	Pedestrian bridges, parks, scenic spots, and subway stations
Haizhu District	Pedestrian overpasses and subway stations
Tianhe District	Pedestrian overpasses, subway stations, pedestrian underpasses, public cultural and sports facilities, and farmer's markets
Baiyun District	Pedestrian overpasses, subway stations, pedestrian underpasses, railway stations, and public restrooms
Huangpu District	Pedestrian overpasses, subway stations, ferry terminals, and airports
Panyu District	Pedestrian overpasses and airports
Huadu District	Hospitals/rehabilitation institutions, public cultural and sports facilities, government halls, kindergartens, primary and secondary schools, and nursing homes/welfare houses
Nansha District	Nursing homes/welfare houses
Zengcheng District	Farmer's markets, parks, scenic spots, new/reconstructed/expanded communities, kindergartens, primary and secondary schools, and colleges and universities
Conghua District	Parks, scenic spots, and government halls

In terms of road construction, the accessible facilities of roads in the old urban areas are seriously damaged, and the utilization efficiency is low. In addition, the lack of detailed elaboration in the construction process has led to the inconvenient travel of the elderly to some extent, especially wheelchair users. At present, there are 369 pedestrian overpasses in the city, of which 11 pedestrian overpasses are equipped with accessible facilities, and the construction rate is only 3.0%. There are 77 pedestrian underpasses, and the construction rate of the accessible facilities is only 7.8%. It indicates that the pedestrian overpasses and underpasses all over the main roads of the city are not conducive to the travel of the elderly. Taking Yuexiu District as an example, there are 45 pedestrian overpasses, but there are only five overpasses have accessible ramps, with a setting rate of only 11.1%, and the setting rate of elevators is only 4.4%. Although this proportion is slightly higher than that of the whole city, as an urban district with the highest proportion of elderly people, its service capacity of facilities is obviously insufficient. The sidewalks in Yuexiu District are also seriously damaged. There are problems such as insufficient road width and no curb ramps. Through the investigation on the sidewalks in Yuexiu District, it is found that 17.3% of the roads have an effective width of less than 2.0 m at the narrowest part, and 46.3% of the cross-street refuge islands have no accessible ramps, which makes pedestrians have to walk on motorways and thus poses a great security threat to the elderly who are slow to move.

In terms of urban public transit, the allocation rate of accessible facilities for buses in Guangzhou is insufficient. There are about 4 000 accessible vehicles with low floors and low entrances in the old urban areas, accounting for 35% of the total number of vehicles. Some newly purchased buses have reserved positions to place wheelchairs, but they lack

maintenance of the accessible facilities and training for drivers and conductors. In addition, the promotion of intelligent technologies such as the pass code and code scanning for vehicle taking during the pandemic has brought inconvenience to the elderly.

On the whole, the living space of the elderly in the old urban areas has a high degree of concentration, but it has a low degree of matching with the actual space supply, and the service capacity of public transportation facilities is relatively insufficient, making it difficult for the elderly to travel long distances. The living space of the elderly in the surrounding new urban areas is relatively scattered, and the construction of public facilities is late, with a low damage rate. Although the number of existing facilities is less than that in the old urban areas, it can still meet the demand, which indicates a coexistence of weak demand and weak supply [23].

3.2 Senior-friendly transportation facilities in communities

Elderly care in living cities is the will of most elderly people. Since 2011, Beijing, Shanghai, and other cities have successively proposed the “9073” and “9064” policies [2], which encourage 90% of the elderly to live out their lives in retirement at home. Therefore, the construction and upgrading of community-based senior-friendly facilities are the key to building a senior-friendly community. As the main activity place for the elderly, the community-based living circle undertakes the functions of shopping and social activities. The convenient and safe travel environment and effective connection with external public transportation greatly affect the space and scope of daily activities of the elderly. Therefore, the convenient design of the transportation environment in the community-based living circle determines the activity quality of the elderly. A large number of communities in Guangzhou lack elevators, wheelchair ramps, and other infrastructure, which causes inconvenience to the daily activities of the elderly. The configuration of the accessible transportation facilities inside the community-based elderly care buildings is investigated, and the result shows that the level of senior-friendly facilities in the elderly care buildings is not high, and the configuration rate of a single type of accessible transportation facility is only 48% at the highest. The community-based elderly care buildings in the old urban areas are the most intensive, but the configuration of the internal accessible transportation facilities is not optimistic, and a large number of elderly care buildings lack accessible transportation facilities (Fig. 5). The statistics on the configuration of five types of common basic accessible transportation facilities (accessible passages, accessible signs, accessible parking spaces, accessible elevators, and wheelchair ramps at the entrance and exit) show that only 7.1% of the community-based elderly care buildings are equipped with accessible elevators and wheelchair ramps at the same time, and only 1.4% of them are equipped with accessible parking spaces (see Fig. 6).

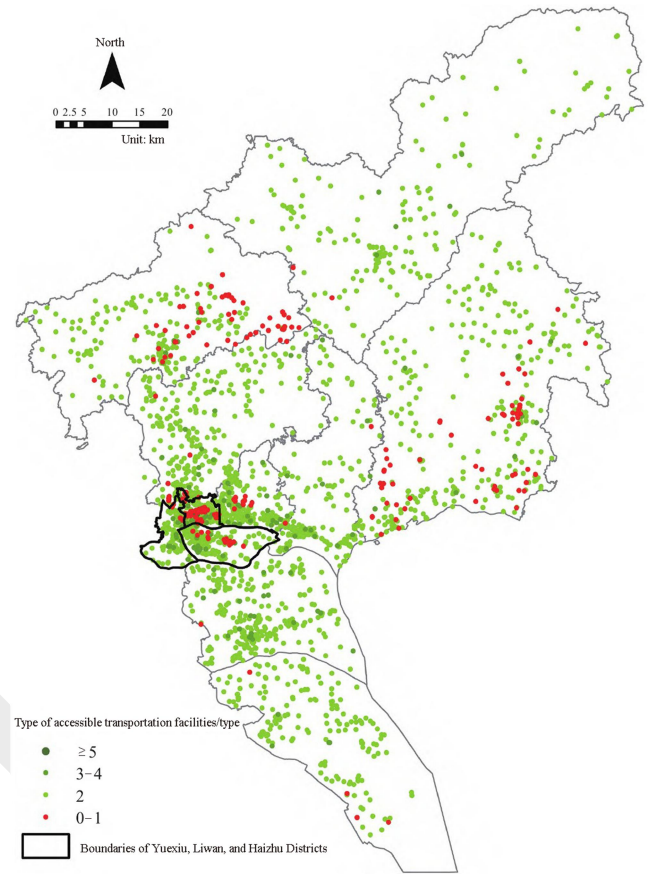


Fig. 5 Number and spatial distribution of accessible transportation facilities for community-based elderly care buildings

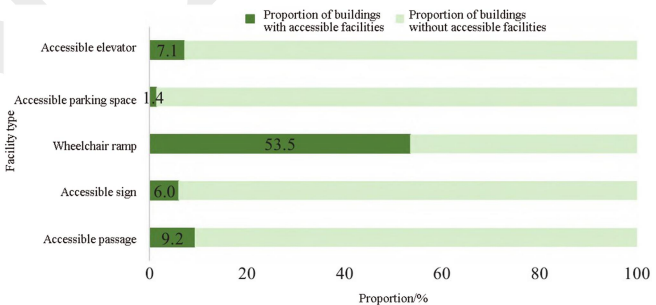


Fig. 6 Proportion of community-based elderly care buildings with accessible transportation facilities

In a word, the accessible facilities in the streets of the old urban areas of Guangzhou have a high damage rate and low utilization rate, and the elderly with physical impairment cannot take part in long-distance activities. In addition, it is difficult to install elevators in a large number of old communities, which makes the activities of the elderly limited to their homes. In addition, although there are a large number of community-based elderly care buildings in the old urban areas where the elderly are concentrated, accessible transportation facilities are inadequate, and poor maintenance exists in the later period, which results in a low utilization rate.

3.3 Inadequate senior-friendly transportation facilities

The travel of the elderly mainly involves a short distance. On the one hand, the nearby facilities can satisfy daily activities, and on the other hand, the public transport service is difficult to meet the needs of medium and long-distance travel for the elderly. Guangzhou pays less attention to senior-friendly transportation, and the fragmentation of facility management is obvious, which thus fails to improve the relevant management and service capabilities according to the characteristics and needs of the elderly. The absence of clear responsible persons leads to insufficient regular maintenance of facilities, which reduces the utilization efficiency of facilities.

The transformation of accessible facilities in residential communities lacks policy and financial support, and thus it is less motivated. Since the construction of the all-age-friendly community has paid no attention to top-level design, the planning layout and space design have failed to comprehensively consider senior-friendly transportation. The accessible facilities of the community road system are incoherent, and the internal transportation connection of the buildings is weak, which affects the daily life of the elderly.

Whether it is urban space or the residential community, compared with the construction of new transportation facilities, the upgrading and updating of old transportation facilities have a higher economic cost, and it is often difficult to promote the transformation due to the ownership and economic problems involving multiple stakeholders. In addition, there is no relevant technical standard for the construction of senior-friendly transportation facilities in Guangzhou or policy support similar to Singapore's silver zone, which makes the construction of a senior-friendly transportation environment difficult^[17].

4 Senior-friendly transportation strategy

The construction of a senior-friendly transportation environment in cities and communities is fundamental to ensuring the travel quality of the elderly. With the goal of improving the accessibility and participation of the elderly in transportation, this paper proposes a senior-friendly transportation strategy according to the current situation of Guangzhou and puts forward suggestions for optimizing and improving urban senior-friendly transportation facilities.

4.1 Urban senior-friendly transportation strategy

The government will take the lead in strengthening the top-level system design and formulate guidelines and technical standards for senior-friendly transportation planning and design, so as to make up for the deficiencies of senior-friendly transportation indicators in current standards. All departments will attach importance to the construction of

senior-friendly transportation facilities in planning approvals, so as to ensure the travel rights and interests of the elderly^[24].

At the construction level, the integrated closed-loop design of facilities is emphasized, which focuses on removing travel barriers for the elderly. The traditional arrangement of accessible facility points is transformed into a systematic layout to create an integrated accessible transportation environment. In key urban areas, a senior-friendly transportation environment with zero height difference in blocks, zero distance between communities, no obstacles in sites, and no threshold for information will be built. The smooth and all-age-friendly streets are built, and accessible improvement design is carried out for the living-type roads in areas where the elderly frequently gather. Meanwhile, auxiliary facilities of the streets will be improved, such as enhancing the information recognition of traffic signals and extending the green light time of signal lights for pedestrians around the elderly community^[24]. The construction of information accessibility is strengthened. The identifiability of public transport signs is enhanced based on the cognitive system of the elderly, and the visual navigation system of stations is improved. Special service facilities for the elderly are provided. For example, during the outbreak of the pandemic, in order to provide convenience for the elderly to operate intelligent systems, a traditional + intelligent strategy was developed to ensure smooth travels for the elderly^[25].

Smart services are provided, and an all-age-friendly urban information service platform is built. Big data is used to identify the activity characteristics of the elderly, children, disabled people, and other users, and the actual needs of the elderly, disabled people, and other groups are analyzed in combination with various data on Guangzhou's population, transportation, and facilities, so as to establish an all-age-friendly urban information service platform with the travel database of the elderly, disabled people, and other vulnerable groups as the core, which has provided technical products for subsequent transportation planning and accessible facility configuration. As a result, the social service objectives can be implemented through the spatial allocation of facilities.

4.2 Travel strategy of community-based living circles

According to the travel characteristics of the elderly, the "door-to-door" integrated construction is carried out in the community-based living circles, so that the accessible design of community-based activity places can cover all elements to create senior-friendly community pilots.

Policy innovation is supported. The construction of the accessible transportation environment is included in the plot ratio reward system of construction projects, which breaks through the limitation that traditional construction projects rely on follow-up supervision, reconstruction, and supplementary construction. A multi-dimensional system guarantee and fund guarantee system is established, and it is promoted

through the proposal of the People's Congress that the elderly's family accessible transformation costs should be included in the special tax deduction.

Community-based accessible facilities are systematically laid out. In terms of facility construction, the accessibility of various service facilities for the elderly is ensured, especially that of day-care centers, canteens, and other gathering points of daily activities for the elderly, which is the key point of senior-friendly transportation improvement. The walking system in and around the community is improved, so as to separate people and vehicles while meeting the standards and ensure the safe travel of the elderly with mobility difficulties. The optimization and upgrading of accessible facilities are continuously promoted in combination with the reconstruction of old communities, and attention has been paid to the construction and supervision of accessible facilities in residential areas. In terms of improving the transportation inside buildings, the government should introduce a cost-sharing scheme for installing elevators, give economic subsidies in the early stage, and simplify the application procedure for installing elevators, so as to facilitate the smooth progress of work [26].

A feasible construction plan is formulated. A senior-friendly construction goal is set in view of the cluster areas of the living space for the elderly. Comprehensive planning and overall arrangement are implemented for the road accessible facilities, accessible information exchange, and accessible community services, and reasonable partition and time sequence transformation are carried out to achieve full coverage of accessible environmental construction in key communities. For the built communities that fail to meet the current senior-friendly design standards, they require necessary and reasonable transformations in batches according to the travel needs of the elderly, the disabled, and other groups with low mobility. The newly-built community shall be constructed in strict accordance with the accessible design standard and equipped with necessary accessible facilities.

4.3 Construction zoning of senior-friendly transportation transformation

According to the distribution of the aging population, the degree of concentration of the elderly, the distribution of facilities, and other factors, Guangzhou proposes the construction zoning of senior-friendly transportation transformation, and involved areas are divided into key transformation areas, senior-friendly development areas, and urban-rural integrated construction areas. Among them, the key transformation areas are the areas where the proportion of the elderly aged 65 years old and above exceeds 10%, and the population density is higher than the average. In addition, accessible facilities in the areas are seriously inadequate. In the future, high-value contiguous areas of the elderly are selected to build elderly community pilots. The senior-friendly development areas refer to the periphery of the old urban areas with more elderly people and areas with high

facility coverage but a low degree of maintenance and management. Subsequently planning aims to optimize and improve the senior-friendly facilities. The urban-rural integrated construction areas are those with future urban functions and population reception, such as suburbs or villages in peripheral urban areas, and it refers to areas with large demand potential for accessible communities in the long term. The three areas are reconstructed in batches and in sequence, which can provide a reasonable construction basis for the senior-friendly travel environment of Guangzhou (Fig. 7).

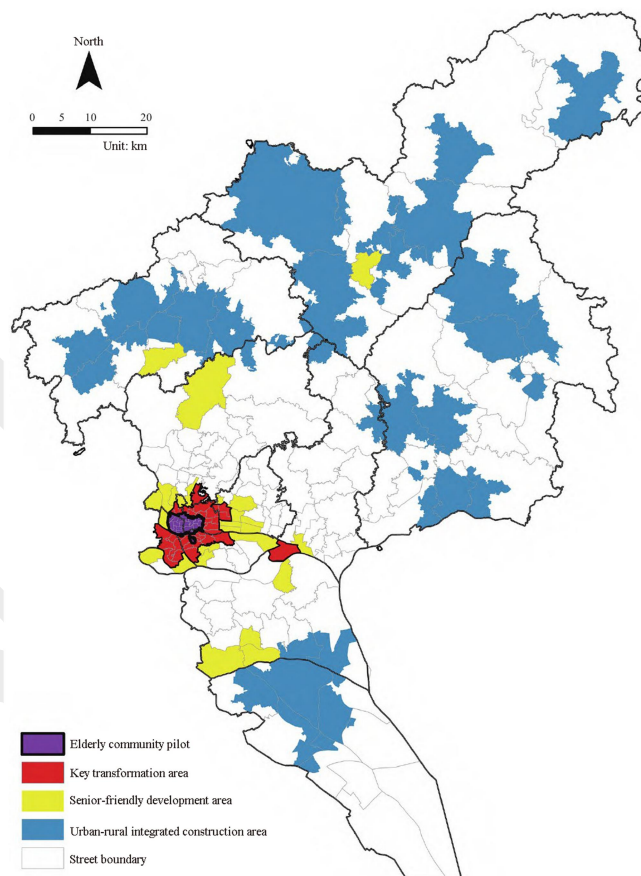


Fig. 7 Construction zoning of senior-friendly transportation transformation

5 Conclusion

With the basic goal of building an all-age-friendly city, we discuss coping strategies for senior-friendly transportation from the urban space and community levels and integrate multivariate data to establish an information service platform for all-age-friendly cities with the elderly travel database as the core, so as to provide technical products for the follow-up senior-friendly transportation planning and accessible facility allocation.

In terms of urban space, the spatial agglomeration and travel characteristics of the elderly are discussed through qualitative and quantitative analysis, the matching degree

between the spatial distribution of the elderly and the corresponding facilities is explored, and planning suggestions are proposed from the aspects of the configuration of public transportation facilities, road-based accessible environmental construction, and information accessible environmental construction.

A healthy and safe community-based senior-friendly travel system should be created, and the accessible design of the community-based welfare facilities for the elderly and that inside the building should be systematically connected, so as to ensure the continuity of the facilities around buildings, community elderly centers, and vegetable markets and realize the “door-to-door” integrated design. Reconstruction and construction zones should be set up to ensure the rationality of the implementation of the plan.

The daily travel activities of the elderly are regular and complex, and the samples have errors in terms of precision and time dimensions. Therefore, future research plans to conduct in-depth research on the activity characteristics of the elderly in the form of interviews, questionnaires, and so on, so as to put forward senior-friendly transportation strategies more adaptive to local conditions.

Note

- ① “Four standards and four actuals” refers to the special urban governance action with the main contents of standard operation drawings, standard building codes, standard address databases, standard basic grids, actual population, actual houses, actual organizations, and actual facilities.
- ② Shanghai has proposed the “9073” elderly care allocation, namely, home-based care for 90% of the elderly, community-based care for 7% of the elderly, and institution-based care for 3% of the elderly. Beijing has proposed the “9064” elderly care allocation, namely, home-based care for 90% of the elderly, community-based care for 6% of the elderly, and institution-based care for 4% of the elderly.

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