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Research on the age-friendly renewal of public space in historic blocks under the background of community life circle

Case Study Report

Research on the age-friendly renewal of public space in historic blocks under the background of community life circle

A case study of Xicheng District in Beijing

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Abstract

There are a large number of historic blocks and a high proportion of seniors in Beijing Xicheng District, which is an important area where modern life and traditional space meet. With its renewal and construction, public space has become the key to reshape the historic blocks' living atmosphere. However, do these public spaces meet the living needs of most residents? Under the advocacy of community life circle, we will return to observing residents' daily life and space needs to explore age-friendly renewal for the historic blocks.

This paper takes seniors as the research object, selects the public space in the historic blocks of Beijing Xicheng District to explore the impact of public space and seniors' behaviors. The survey results show that:

1. The distribution of public space in the historic blocks is unbalanced, showing differences in quantity, area, function and other aspects.

2. Through the observation of seniors' behavior characteristics, it is found that behavior with high percentage and frequency of occurrence should be taken into consideration of behavioral needs.

3. Discussing the impact of spatial form on different behaviors' frequency, it is found that space area, number of seats, number of facilities, etc. are important factors that affect the seniors' behavior.

Keywords

Historic blocks, Public space, Seniors' behaviors, Age-friendly renewal, Community life circle

1. Introduction

As an important location for carrying urban culture and development, historic blocks are usually located in the old city area, close to the city's traditional commercial, cultural, and landscape centers, and gather memories of the city's times. However, with the advancement of urban modernization, a prominent contradiction has formed between the increasing living demand of residents and the supporting supply of historic blocks. Problems such as crowded living environment, backward infrastructure, and lack of activity venues make the neighborhood gradually lose its former living atmosphere. Therefore, in the exploration of the protection and renewal of historic blocks, improving the living environment has become a new focus of attention.

1.1. Public space issues in historic blocks

In the construction of community life, urban public space has become an important place for people to participate in daily life. Preserve the traditional pattern of historic blocks often makes it difficult to discover more public spaces. Take Beijing's historic blocks as an example. Due to the high density of population, public space and population numbers are not matched.

1.2. Seniors' Behavior in historic blocks

China has entered an aging society since 2000. By 2019, there were 253.88 million people aged 60 or above, accounting for 18.1% of the total population, and people aged 65 or above accounting for 12.6%, showing a rapid growth of aging. According to statistics, about 84% of seniors in China live in communities built before 2000. (Ju & Lu, 2017) The earlier the house is built, the greater the density of seniors. As a typical living community in the early stages of old city, historic blocks have gathered a large number of aging population due to the housing system, economic conditions, physical and psychological reasons. Therefore, the research on the ageing of public spaces in historic blocks should be paid attention to. At present, the research on ageing in public spaces is based on traditional investigations, which explore the behavior needs of seniors from psychological, physiological, and social aspects; further research, multiple regression analysis is one of the common models to explore the relationship between crowd behavior and spatial characteristics (Wang et al., 2019; Sun et al., 2020), and objective data analysis has not been fully applied to the research of public spaces in historic blocks.

1.3. Update direction of community life circle background

In 2018, China's "Urban Residential District Planning and Design Standards" pointed out that the characteristics of residents' temporal and spatial behavior were used as the standard for the division of residential spaces and the allocation of public facilities, and proposed a "5min-10min-15min" community life circle structure. The proposal of the new standard replaces the traditional concept of residential area, promotes the community life circle as the main content of community planning practice, which focuses on the research of public service allocation and public space optimization. Under the guidance of community life circle, historic blocks as an early residential community unit should also receive special attention, especially from the residents' living needs.

This research takes public spaces in historic blocks as the object, and forms the cognition of its current layout and type characteristics. For seniors living in historic blocks, what are their daily behaviors in participating in public spaces? What daily behaviors often occur? Does the form of public space affect the seniors' behavior? These are extremely important for the improvement of the aging environment in historic blocks. On the one hand, it can reactivate the life scene and enhance vitality; on the other hand, it can combine the real needs of seniors to optimize the allocation of resources and spaces in the historic blocks' life circle.

2. Materials and methods

2.1. Study area

The historic blocks in Beijing's Xicheng District were chosen as the research area to explore the public space and behavior used by seniors. The reasons for the selection are as follows:

1. The Beijing Government approved the "Protection plan of 25 historical and cultural conservation areas in Beijing old City", twelve of them are located in Xicheng District, which is a typical area of Beijing's historic blocks.

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2. At the end of 2019, the population of Xicheng District was 1.137 million, and people aged 65 or above accounted for 25.2%. There are a large number of seniors, which has practical significance for the research on the ageing of public space in this area.
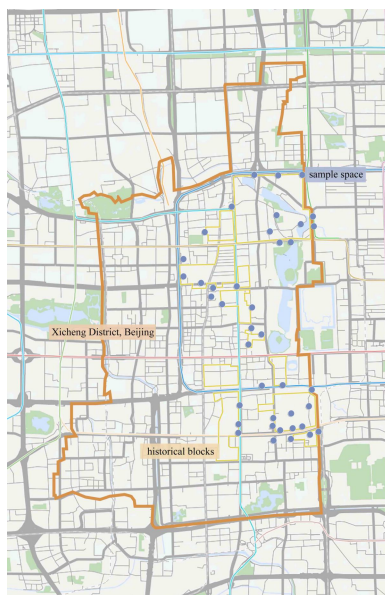

Figure 1. Study Area and Distribution of Sample Space. Source: Author's own graph.

2.2. Data collection

Data collection includes two aspects:

1. Determine 40 public space samples of historic blocks, measure their morphological indexes and collect relevant data;

2. Continuously observe and record seniors' daily behavior, and extract valid data.

2.2.1. Spatial data

Based on the investigation and literature review, eight objective indexes of spatial form were selected, involving four aspects: space construction, facility configuration, green landscape, and surrounding environment.

Table 1. Objective Indexes of spatial form. Source: Author's own data.

Space construction	Facility configuration	Green landscape	Surrounding environment
Space area[1]	Number of seats[2]	Green coverage rate	Height of surrounding buildings
Degree of space enclosure[3]	Number of facilities	Species number of colors within large area in the line of sight	Width of adjacent streets[4]

1. Space area (unit: m²)

2. Seats are counted in person units.

3. Degree of space enclosure：① The space enclosed by one side, with weak limitation, acts as a barrier to the sight in one direction; ② The space enclosed by two sides, guiding people's sight and behavior, forming a fluid space without a sense of staying; ③ The L-shaped corner space with two sides has a certain closure and produces an obvious sense of domain; ④ The U-shaped vertical interface forms a space enclosed on three sides, and the beginning is extroverted; ⑤The enclosed space on all sides has a strong sense of closure.

4. The average width of the street adjacent to the space.

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2.2.2. Behavioral data

The daily behavior of seniors in 40 sample spaces was continuously observed (no less than 0.5 hours per sample space and avoiding breakfast, lunch, or dinner time). Through the observation of seniors' behavior, image recording, spatial annotation and other methods, survey the activity needs and preferences of seniors to obtain data.

2.2.3. Data processing

The seniors' behaviors are summarized in field observations, so some behaviors are accidental. The data should be optimized to reflect trends as closely as possible. SPSS software is used to divide the behavior data into bins, using "highest", "high", "medium" and "low" to classify, make continuous variables into ordinal variables. Spatial data also adopts similar methods to optimize processing.

2.3. Data analysis

2.3.1. Spatial analysis

Using GIS analysis platform, with the public space of each historic block as the main body, analyze the accessibility and agglomeration characteristics of public space and service facilities, and carry out visual expression.

2.3.2. Behavioral analysis

Based on data statistical analysis methods, explore the types, regularity, incidence and frequency of seniors' behaviors in public spaces.

2.3.3. Impact analysis

The research uses public space form indexes as independent variables and the frequency of behavior types as dependent variables to construct an ordinal logistic regression model. The model interprets the regression analysis results through odds ratios, which characterizes the possibility that the dependent variable will change from low to high for each additional unit of the independent variable. Through model construction, it explores the impact of spatial form on the frequency of seniors' behaviors, and obtains the public space form indexes suitable for the ageing renewal.

3. Result

3.1. Public space analysis

The public space of historic blocks in Xicheng District is widely distributed, showing differences in density, quantity, area and function.

From the perspective of community life circle resources and space allocation, the public space within 15 minutes of service can basically cover all historic blocks. The public space and its surrounding service facilities form a density core and two sub-density cores, with certain differences in quantity allocation. Among them, the core of the elements density is formed around Xidan business circle, which is mainly affected by the spread of business functions, and services such as commerce, catering and transportation facilities are more abundant; Public space, transportation, entertainment and living facilities gather along Zhushikou West Street, while commerce and catering facilities gather in Dashilan Commercial Street. In addition, public space, entertainment, and catering facilities gather in the southern part of Shichahai Street, living and commerce facilities gather in Xinjiekou South Street. The distribution is greatly affected by land use functions and road traffic.

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Table 2. Summary of Elements of Public Service Facilities in life circle. Source: Author's own data.

Facilities type	Facilities subdivision	POI number
Public space	Public spaces such as rest, fitness, entertainment, and recreation	40
Traffic Facilities	Bus stations, subway stations, parking lots, etc.	486
Recreational Facilities	Sports venues, senior activity rooms, concert halls, theaters, recuperation centers, etc.	352
Living Facilities	Beauty salons, material delivery, maintenance sites, post offices, laundry shops, etc.	451
Commerce Facilities	Supermarkets, convenience stores, shopping centers, fruit and vegetable markets, etc.	556
Catering Facilities	Fast food restaurants, snack bars, Chinese and foreign restaurants, pastry shops, tea halls, etc.	596

a. Nuclear density analysis of public space   b. Nuclear density analysis of traffic Facilities   c. Nuclear density analysis of recreational Facilities

d. Nuclear density analysis of living Facilities   e. Nuclear density analysis of commerce Facilities   f. Nuclear density analysis of catering Facilities
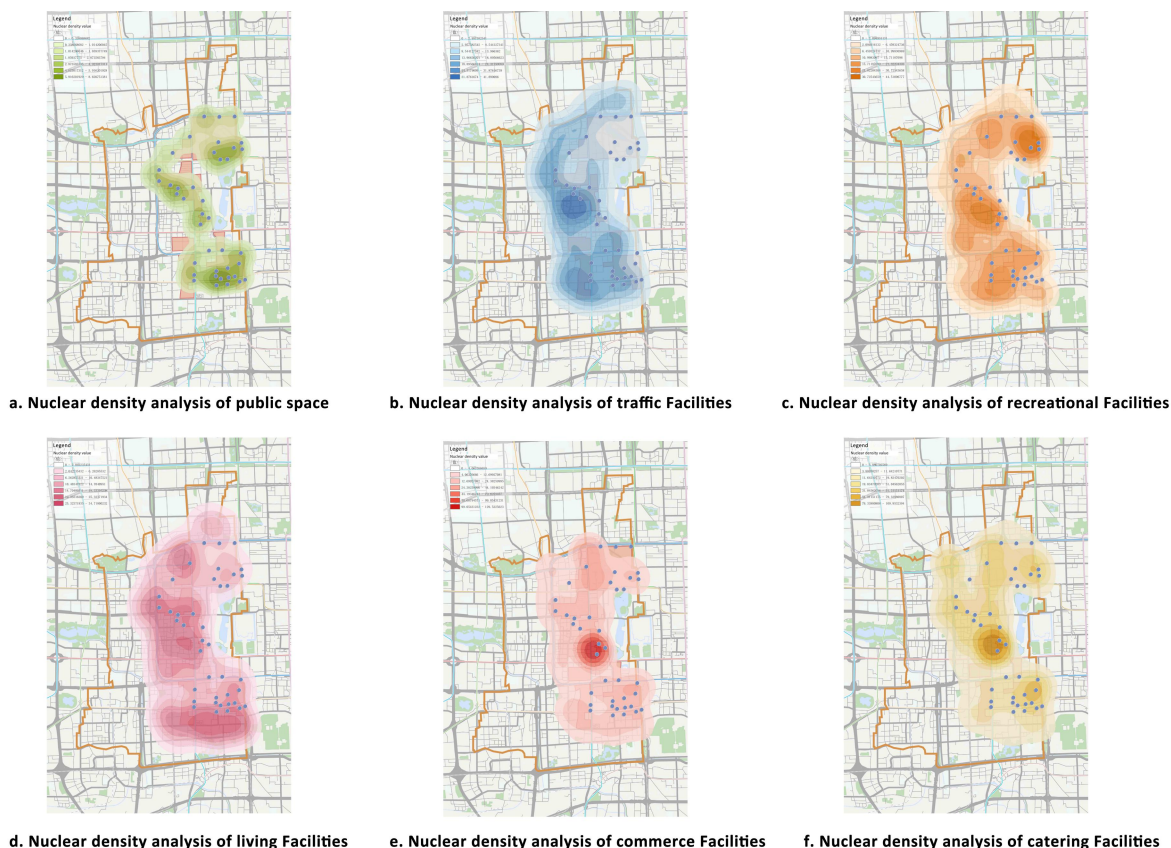
Figure 2. Nuclear Density Analysis of Public Service Facilities. Source: Author's own graph.

From the perspective of the positional relationship between public space and block, public space can be summarized into three types: block interior, block periphery, and block intersection. Due to the characteristics of traditional street texture and dense building distribution, there are more pointed spaces inside the blocks; Linear spaces or point spaces are distributed along the road in the periphery of the blocks; Block intersections are mainly area and point spaces, combined with the distribution of traffic

stations and public facilities. Combined with the supply of public space infrastructure and the use of people, public space types can be summarized into five types of rest, fitness, entertainment, recreation and comprehensive activity.
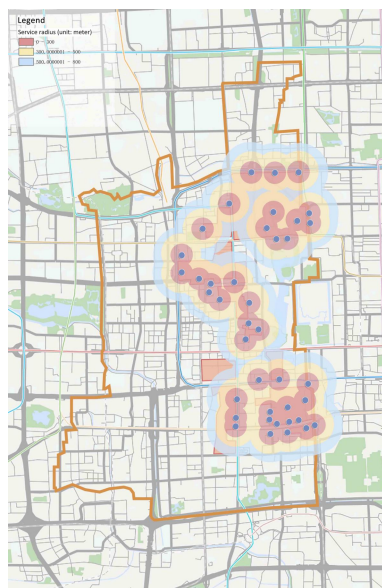

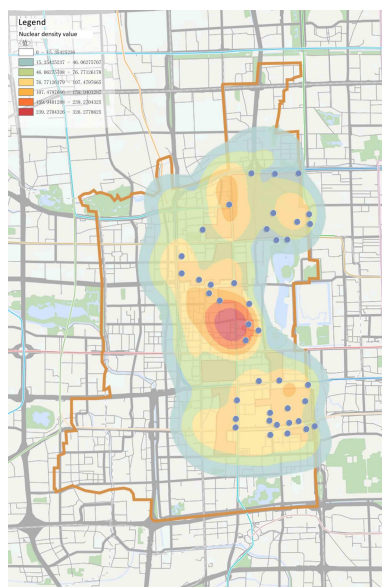**Figure 3. Analysis of Public Space Service Radius. Source: Author's own graph.**

Figure 4. Superposition Analysis for Nuclear Density of Public Service Facilities. Source: Author's own graph.

3.2. Behavioral activity analysis

The behavior data of seniors adopts an image recording method, and is coded by type. Combined with the analysis of survey data, it can be found that seniors can accept a longer travel distance and time when they are looking after children, dancing, singing and watching, while they tend to choose a close public space when they sit at leisure, talk and walk the dog.

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Table 3. Coding of seniors' behaviors and interpretation. Source: Author's own data.

Encoding	Interpretation
Buy and sell things	Setting up a stall or talking and buying as a customer
Talk	/
Dance, sing and watch	Playing Musical Instruments, dancing and singing to the music and watching others play
Eat something	/
Look after children	Any behavior related to look after children
Pass by	Passing by the space without staying(including persons standing in the field who cannot be distinguished from other acts)
Play cards/chess or watch	Participating in playing cards/chess or just watching others play
Use mobile phones	People who use mobile phones include playing with them, making calls and so on
Fitness	People who use fitness equipment and exercise on their own
Sit at leisure	/
Walk the dog	/

Figure 5. Analysis of seniors' behaviors and travel rules. Source: Author's own data.

3.2.1. Incidence for different behavior types(Percentage of occurrence)

Among the 40 sample spaces, "pass by" occurred in 36 sample spaces, accounting for 90%, occupying the first place in all behaviors; "sit at leisure" occurred in 24 sample spaces, which has a greater percentage of occurrence; In addition, "talk", "look after children" and "fitness" are also relatively high, which are 55%, 50%, and 35% respectively.
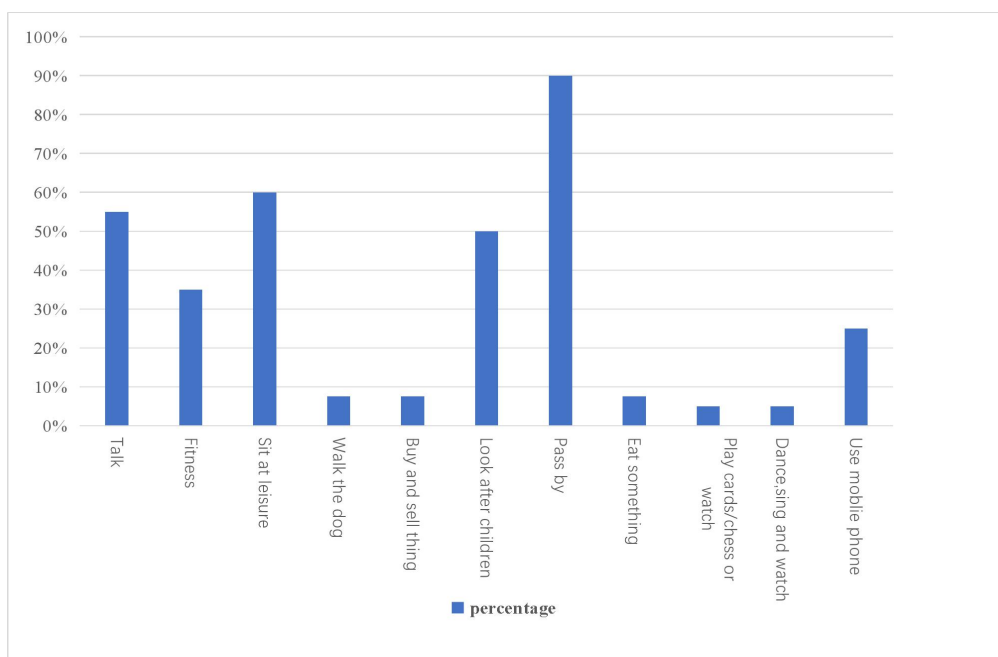
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Figure 6. Incidence for different behavior types(Percentage of occurrence). Source: Author's own data.

It can be concluded that when the public space of historic blocks is remodeled for aging, the needs of high-incidence behaviors should be given priority, because they are most likely to occur.

3.2.2. Mean level of frequency of occurrence for different behavior types

Xuyang Sun and others selected the sample space of high-frequency behaviors for statistical analysis, found that the high-incidence behavior and its frequency did not conform to the normal distribution, so they used the median value to measure the trend of occurrence frequency, demonstrating the importance of high-frequency behavior. In this paper, due to the large difference in data values (for example, "fitness" behavior data fluctuates between 0-156), it is difficult to simply use the median to calculate, so the occurrence frequency of behavior is assigned to show the average level.

Table 4. Medians of the frequency of occurrence for different behaviors. Source: Author's own data.

	Talk	Sit at leisure	Buy and sell things	Look after children	Eat something	Dance, sing and watch
Median	3.00	2.00	1.00	1.00	1.00	1.00
	Use mobile phones	Pass by	Walk the dog	Fitness	Play cards/chess or watch	/
Median	1.00	5.00	1.00	1.00	1.00	/

The analysis found that "fitness", "use mobile phones", "look after children" are highly likely to occur, but in most cases their frequency is very low. The incidence and frequency of "dance, sing and watch" and "play cards/chess and watch" are not high. Once they happen, a large number of people will gather, which supports the accuracy of Xuyang Sun's analysis results.

3.3. The impact of public space form on the seniors' behaviors

This research categorizes the seniors' behaviors in field observation into three types: static, dynamic, and group. Because some behavioral data lacks a considerable sample size, we hope to increase the sample

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support in the analysis process by summarizing behavior types. Group behavior has the characteristics of small possibility but a large number, which may be related to the time, hobbies and neighborhood activities of seniors. Therefore, choose static and dynamic behaviors to perform ordinal logistic regression analysis with the public space form.

Table 5. Behavior types of seniors. Source: Author's own data.

behavior type	Interpretation	Kinds of behaviors
Dynamic behavior	Small range behavior for seniors	Walk the dog, pass by, fitness
Static behavior	A wide range or large amount of physical behavior for seniors	Use mobile phone, eat something, look after children, buy and sell things, sit at leisure, talk
Group behavior	Group behaviors with more than three people	Play cards/chess or watch, dance, sing and watch

3.3.1. Static behavior data analysis

In the ordinal logistic regression analysis, space area, number of seats, height of surrounding buildings, and degree of space enclosure are the main spatial form indexes that affect the static behavior of seniors in public space, as shown in Table 6:

1. Space area: smaller-scale space (295-900 ㎡) compared with large-scale space (>3445 ㎡), the frequency of static behavior in large-scale space may be higher (OR=0.021<1, P= 0.003<0.05). The functional divisions of large-scale public spaces are more diverse, providing more space for the elderly to rest, sit, chat, and take care of children; But in some historic blocks with few public spaces, due to space constraints, only small-scale spaces are distributed. Seniors with limited mobility also choose to take outdoor rest, sunbathing, and babysitting in these spaces.

2. Number of seats: the space with a small number of seats (≤12) compared with the space with a large number of seats (>30), the space with more seats (>30) may have a higher frequency of static behavior (OR=0.068<1, P=0.041<0.05).

3. Height of surrounding buildings: compared with the surrounding buildings height of more than 13m, the frequency of static behavior in the space with the surrounding buildings height of 6-13m may be higher (OR=64.259>1, P=0.039<0.05). The reason is that the surrounding buildings height of 6-13m is moderate, which can not only form a good sense of space restriction and recognition, but also avoid the sense of space depression caused by excessively high buildings.

4. Degree of space enclosure: the space enclosed by one side compared with the space enclosed by four sides, the frequency of static behavior in the space enclosed by four sides may be higher (OR=0.008<1, P=0.009<0.05). The space enclosed by two sides compared with the space enclosed by four sides, the frequency of static behavior in the space enclosed by four sides may be higher (OR=0.021<1, P=0.051). The space enclosed by all sides is generally enclosed by buildings, walls, and green landscapes to form a relatively quiet space atmosphere. Seniors are more inclined to choose such spaces for static behavior activities.

Table 6. Result of the ordinal logistic regression analysis for the impact of spatial form on the frequency of static behavior. Source: Author's own data.

Objective indexes of spatial form	Sig.[a]	Odds ratio	95% wald confidence interval for Exp(B)	
			Lower	Upper

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Space area				
≤ 294 ㎡	0.626	0.404	0.011	15.393
295-900 ㎡	0.003	0.021	0.002	0.267
901-3445 ㎡	0.395	0.375	0.039	3.582
> 3445 ㎡	.	1	.	.
Number of seats				
≤ 12	0.041	0.068	0.005	0.897
13-30	0.624	0.564	0.057	5.570
> 30	.	1	.	.
Green coverage rate				
≤ 44.6%	0.525	0.457	0.041	5.122
44.7%-66.9%	0.189	4.370	0.485	39.407
≤ 66.9%	.	1	.	.
Species number of colors within large area in the line of sight				
≤ 3	0.399	0.349	0.030	4.017
4	0.848	0.730	0.030	18.055
≥ 5	.	1	.	.
Height of surrounding buildings				
≤ 5m	0.961	0.960	0.185	4.973
6-13m	0.039	64.259	1.239	3333.490
> 13m	.	1	.	.
Width of adjacent streets				
≤ 5m	0.303	4.784	0.244	93.854
6-22m	0.139	6.096	0.557	66.768
> 22m	.	1	.	.
Number of facilities				
none	0.200	0.235	0.026	2.155
exist	.	1	.	.
Degree of space enclosure				
1. The space enclosed by one side	0.009	0.008	0.000	0.307
2. The space enclosed by two sides	0.051	0.021	0.000	1.020
3. The L-shaped corner space with two sides	0.298	0.084	0.001	8.871
4. The U-shaped space with three sides	0.157	0.085	0.003	2.581
5. The space enclosed by all sides	.	1	.	.

a. Sig could demonstrate if the result is statistically significant. In general, if it is less than 0.05 (P < 0.05), the result is statistically significant. Otherwise, the result is statistically insignificant.

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3.3.2. Dynamic behavior data analysis

In the dynamic behavior of seniors, the frequency of "pass by" is very high, but it may be related to factors such as accessibility and convenience. The amount of data will affect the result judgment of the overall dynamic behavior, so the "pass by" data is removed for calculation. The result shows that space area, green coverage rate, width of adjacent streets and number of facilities are the main spatial form indexes that affect the dynamic behavior of seniors in public space, as shown in Table 7:

1. Space area: The frequency of dynamic behavior in small-scale space (≤294 ㎡) is higher (OR=1.438>1, P=0.000<0.05). The small-scale space is better than other spaces because there are many small-scale public spaces in historic blocks, which are more suitable for meeting the daily activity needs of seniors with limited mobility.

2. Green coverage rate: The frequency of dynamic behavior is higher in low green coverage space (≤44.6%) (OR=317.343>1, P=0.009<0.05). It shows that the occurrence of dynamic behavior is mainly in public space with the coverage of low green coverage and high pavement.

3. Width of adjacent streets: Compared with the widest adjacent street (>22m), the frequency of dynamic behavior may be higher in public spaces with relatively wide streets (6-22m). (P=0.001<0.05). Combined with field interviews, it can be concluded that behaviors such as walking the dog, fitness generally occur near streets with appropriate widths. Because of fewer vehicles and crowds, it is safer to perform dynamic behaviors.

4. Number of facilities: The frequency of dynamic behavior in the space with facilities is higher (OR=317.343>1, P=0.006<0.05). According to the specific number of facilities in different spaces, the more the number of facilities, the higher the frequency of dynamic behavior, so does the possibility of occurrence.

Table 7. Result of the ordinal logistic regression analysis for the impact of spatial form on the frequency of dynamic behavior. Source: Author's own data.

Objective indexes of spatial form	Sig.[a]	Odds ratio	95% wald confidence interval for Exp(B)	
			Lower	Upper
Space area				
≤ 294 ㎡	0.000	1.438	2.937	0.007
295-900 ㎡	0.000	0.003	0.000	0.072
901-3445 ㎡	0.019	0.039	0.003	0.592
> 3445 ㎡	.	1	.	.
Number of seats				
≤ 12	0.105	0.138	0.013	1.510
13-30	0.059	0.050	0.004	0.616
> 30	.	1	.	.
Green coverage rate				
≤ 44.6%	0.009	317.343	4.231	23802.404
44.7%-66.9%	0.833	1.282	0.128	12.841
≤ 66.9%	.	1	.	.
Species number of colors within large area in the line of sight				

≤ 3	0.185	12.208	0.303	491.968
4	0.163	22.273	0.283	1750.654
≥ 5	.	1	.	.
Height of surrounding buildings				
≤ 5m	0.550	1.831	0.252	13.292
6-13m	0.054	0.005	4.299	0.484
> 13m	.	1	.	.
Width of adjacent streets				
≤ 5m	0.513	3.073	0.106	88.670
6-22m	0.001	388.294	12.441	12118.660
> 22m	.	1	.	.
Number of facilities				
none	0.002	0.006	0.000	0.157
exist	.	1	.	.
Degree of space enclosure				
6. The space enclosed by one side	0.506	0.284	0.007	11.650
7. The space enclosed by two sides	0.226	11.540	0.220	606.594
8. The L-shaped corner space with two sides	0.080	0.009	4.461	1.764
9. The U-shaped space with three sides	0.774	0.589	0.016	21.979
10. The space enclosed by all sides	.	1	.	.

a. Sig could demonstrate if the result is statistically significant. In general, if it is less than 0.05 ($P < 0.05$), the result is statistically significant. Otherwise, the result is statistically insignificant.

4. Summary and Prospect

4.1. Strategies and Suggestions

4.1.1. Flexible layout of a multiform public space system

Related research suggests that the delineation of community life circle is not restricted by planning boundaries, but should be embodied in an organic combination of potential activity space and actual activity space, geographic environment and residents' behavior.

1. The community life circle of historic blocks should be laid out as much as possible in combination with the current public space, and public service elements should be arranged near the comprehensive public space to form the service core.

2. Build a multiform public space system of points, lines and areas inside and outside the block, so as to promote the flexible use of potential space.

3. Strengthen the construction of identification system to improve the accessibility, recognizability and sharing of public spaces.

4.1.2. Benign interaction between different behaviors and space

Guided by seniors' behavioral needs, we should establish a benign interactive relationship between different behaviors and public spaces, and promote the occurrence of different behaviors from the perspective of public space location, form, and function.

1. Point space is limited by area, so flexible setting for landscape enclosure and facilities use should be considered to realize the different use of behaviors.

2. The linear space distributed along the road should fully consider the accessibility, traversability and safety of its surrounding environment.

3. The area space is positioned as a comprehensive public space, forming a reasonable design of functional zoning, pedestrian circulation, facility configuration, etc., and considering the surrounding service facilities and block entrances.

4.1.3. Ageing promotion of diverse space facilities

At the level of public space design, we should consider the use feelings brought by the environment, landscape and facilities for the seniors.

1. Convenient entrances and landscape enclosure facilities shall be added outside the space to avoid the interference of people and traffic flow.

2. The small public space inside the block should pay attention to the multi-effect use of the green landscape and activity facilities.

3. The public space outside the block should strengthen the dynamic and static activity zoning, with green landscape, node signs, infrastructure, barrier-free design, etc., to enhance the use experience of seniors.

4.2. Future research

This research is a small-scale case survey conducted in a relatively large area. The public spaces of all historic blocks within the research area have been observed, which can generate more comprehensive quantitative data. Transforming the spatial and behavioral characteristics observed on the spot into index data, we can further explore the quantitative relationship between the seniors' behavior and space form scientifically, so as to provide a reference basis for the age-friendly renewal of public space in the historic blocks.

In addition, due to the limitation of space and resources in historic blocks, we propose that its community life circle should be laid out in combination with the current public space. This will arouse the attention of how the concept of community life circle is used in special areas. We hope that the protection and renewal of historic blocks is not limited to physical space, but should also concern the residents' life services and quality.

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