

# Creating Inclusive Community for the Elderly and Children: Spatio-Temporal Behaviour, Influence Mechanism and Space Optimisation

Guanqiong Che, Xu Lan

(Lecturer Guanqiong Che, Tianjin Chengjian University, No.26, Jinjing Road, Xiqing District, Tianjin, China, cgq2022@tcu.edu.cn)  
(Professor Xu Lan, Tianjin Chengjian University, No.26, Jinjing Road, Xiqing District, Tianjin, China, cgq2016@tju.edu.cn)

## 1 ABSTRACT

Intergenerational childcare, meaning the grandparents helping to take care of the grandchildren, is a common phenomenon in China since we are going through aging population, as well as increasing work pressure on parents. Therefore, the elderly and children, who spend the longest time in the community and use the space and facilities the most frequently, are the group of people that should be prioritized to be satisfied and guaranteed in communities. Considering the physiological and psychological characteristics of the elderly and children, they have special needs for community space and facilities, such as higher demands for diversified service facilities within walking distance and higher demands for safety. However, the community design do not takes their needs into full consideration yet, in terms of inappropriate structural scale, mismatch between service facilities supply and demands, and lacking of engaging and playful space. Therefore, it's urgently needed to have a better understanding of the activity patterns and needs of the elderly and children, as well as the influence mechanism of community space and environment, so as to create a more inclusive community.

In this regard, this study adopts a human-centered perspective under the guidance of Time Geography and Environmental Behavior theories, focusing on five issues: (1) what's the spatio-temporal activity patterns of the elderly and children; (2) what's the influence mechanism of the community environment on such activity patterns; (3) what's the differences of the activity patterns and influences mechanisms considering socio-economic property and community categories; (4) configuration and approaches to inclusive community; (5) design and renewal suggestions to create inclusive community for the elderly and children.

Firstly, 12 typical communities in Tianjin are selected including different house types and geographic location. Spatio-temporal activity of the elderly and children are collected through questionnaire, interview and unmanned aerial photograph, and are imported to ArcGIS for spatio-temporal distribution visualization. Different activity patterns are summarized using cluster analysis. For communities closer to city center, multi-time activities in the community for the elderly with infants, multi-destination activities for the elderly with infants and young children, and afternoon activities for the elderly with young children are typical types. For communities in the suburbs, multi-time activities in the community are more common.

Secondly, a community space index system is established to calculate the density, scale, accessibility and coverage rate of service facilities and public space within the 15-minute community. Then, correlation and regression are used to analyze the influence of community space index on different activity patterns separately. In general, floor area ratio, road network density, green ratio, accessibility to amenities and education facilities, distance to subway station make a significant impact on the outdoor activity duration, distance and destination of the elderly and children.

Thirdly, heterogeneous mechanisms of space index on different activity patterns are identified. (1) To communities with high floor area ratio, road network density and green ratio, whatever they are located near the city center or in the suburb, the elderly and children spends more time outdoor, and most of their activities are within the community. (2) To communities with high accessibility to education facilities, their activity reach increases. To communities near the city center with diversified service facilities, the destination of the elderly and children are more varied and the walking distance is longer compared to communities located in the suburb.

Finally, with the aim to promote more diverse and convenient outdoor activities for the elderly and children, three spatial planning and renewal strategies are proposed. (1) The first path is driven by the densification of service facilities within walking distance, which is suitable for newly built communities in suburbs. (2) The second path is driven by the improvement of landscape design of the community's public space, as well as the optimization of the community's space structure and walking routes, which is suitable for older communities. (3) The third path is driven by increasing the accessibilities of education and recreation facilities within 15-minute community, which is suitable for communities especially in suburbs.

Keywords: space optimization, influence mechanism, spatio-temporal behavior, the elderly and children, inclusive community

## 2 INTRODUCTION

Against the background of China's aging population and the generalization of dual-income families, the proportion of intergenerational childcare is gradually increasing. Studies show that more than 40% of families with young children between the ages of 1 and 5 years have grandparents involved in childcare, making intergenerational childcare one of the most dominant forms of childcare in China at present<sup>1-2</sup>. “The 14th Five-Year Plan and the 2035 Vision and Goals Outline clearly propose the implementation of a national strategy to actively address population ageing, and the improvement of the daily life service facilities with a focus on “the elderly and children”. As communities are the basic units of urban governance and residents' lives where they spend approximately 70% of the day, it has become an important issue to optimize community living space with a focus on serving “the elderly and children”, and to solve the mismatch between the demand for integrational childcare and the supply of community living space and service facilities. In the face of the rapidly changing demographic structure and the special physical and mental development needs and activity characteristics of the elderly and children, community living spaces are faced with difficulties as an inappropriate structural scale, a lack of recreational and playing space, and a mismatch of service facilities, making it difficult to effectively satisfy the needs of the “elderly and children” for a shared and inclusive community living space<sup>3-4</sup>.

To optimize and adjust community living space for the intergenerational childcare, the initial task is to master the daily activity characteristics and patterns of the elderly and children within the community, followed by identifying the elements and mechanisms of community living space on different activity patterns of the elderly and children<sup>5</sup>. On this basis, targeted spatial design strategies such as spatial index control, service facility configuration, and environment upgrading can be proposed to improve the accessibility of the service facilities, as well as to provide safe and diversified places for recreational and educational activities for the elderly and children.

This study makes comprehensive use of interdisciplinary research paradigms as environmental behavior analysis, spatio-temporal geography, as well as space planning and design, and builds a three-dimensional analysis framework composed of “subject-the elderly and children, object-community space and service facilities, and the link between them-daily activities of the elderly and children within the community”. For the subject, the research focuses on the socio-economic characteristics and demand of the elderly and children for community space and service facilities. For the object, 15-minute walking distance from home is used as the community where most daily activities of the elderly and children take place. 8 categories of POI data are collected and calculated in terms of density, diversity and distance, to analyze and assess the built environment of the community. For the activity, which presents specific patterns in a given community setting, the research focuses on studying the daily activity patterns of the elderly and children, including the activity time, location and events, and whether the patterns vary with their socio-economic characteristics. On this basis, the influence mechanism of the community built environment on the activity patterns is analyzed. So as to identify the key spatial influencing elements and the influencing path, as well as mismatches between the supply of community living space and the demand of the elderly and children. Then more precise space optimization design strategies can be proposed to provide theoretical reference and policy inspiration for the creation of inclusive community for the elderly and children.

## 3 RESEARCH REVIEW

### 3.1 Research Theory of Adaptation between Intergenerational Integration and Community Living Space

#### 3.1.1 The theoretical perspective of intergenerational integration within the community

Relevant theories include pluralistic welfarism, social support network, etc., aiming to explain the necessity and feasibility of the integration of the elderly and children from multi-dimensional perspectives of individual physical and mental development, community governance, and so on. Research has shown that the needs of the elderly and children are common, and the advantages are complementary. Through appropriate environmental design and activity organization, it can help to enhance the communication and interaction

between the elderly and children and realize mutual help and assistance. Cohn-Schwartz (2023)<sup>6</sup> analyzed under the guidance of Contact theory and concluded that the interaction between the elderly and children can help to promote the elderly group to have more diversified cognitions and attitudes toward aging, and the contact with optimistic people can help to promote more positive attitudes toward aging among older adults. Using the strengths perspective and social support theory, Ta Na and Zhang et al. (2023)<sup>7</sup> indicated that the interaction between the elderly and children is not only conducive to providing diversified help and support for the elderly, but also helps to realize mutual assistance and reciprocity between the elderly and children, which is an important way for community cohesion and optimization of community self-governance.

### 3.1.2 Research paradigm on the adaptation of community living spaces for intergenerational integration

These researches take environmental behavior and hierarchy of needs as the theoretical basis, and takes the interaction behavior of the elderly and children as the starting point to analyze the demand, use, and evaluation of the elderly and children on community living space. Li Han (2021)<sup>8</sup> and Lv Yuan (2021)<sup>9</sup> take the interaction behavior patterns of the elderly and children as the starting point and analyze the supportive and hindering roles of community space. Other scholars combine social psychology research methods to analyze the relationship between the community physical environment and the subjective feelings of the elderly and children. Jiang Xiaoyan (2022)<sup>10</sup> adopts the “anchor point theory” of spatial cognition, pointing out that spatial cognition is a multi-staged and gradual process, and the first to be noticed are the “anchor points” with high relevance and symbolism to the elderly and children, so attention should be paid to pocket parks, Therefore, attention should be paid to the environmental design of community anchors such as pocket parks, community convenience stores, etc., and use them to guide and connect other activity sites.

## 3.2 Research on the Needs and Interactive Activities of the Elderly and Children in the Community

### 3.2.1 Needs and activity characteristics of the elderly and children

These researches mainly use on-site observation, questionnaire survey, participatory interviews, etc., to conduct research on the spatio-temporal behavior and the interaction between the elderly and children within the community. Tang et al. (2023)<sup>11</sup> pointed out that the activity space of the elderly and children has a high level of residential proximity, which is mainly concentrated in the five-minute walking range, including community public space, service facilities, walking paths, and green space next to the house, and so on. Another study pointed out that to children at different ages, the contents of the interaction between the elderly and children are different, so as their needs to community space. Xu Shuning (2023)<sup>12</sup> indicated that for infants within 3 years of age, the interaction between the elderly and children is mainly concentrated within the 5-minute walking range around the house, and the content of the interaction is mainly caregiving and accompanying, with a higher demand for sitting and resting facilities, greening, and safe play facilities; for children aged 4-7, the elderly and children can participate in activities together, including fitness, play, and socialization, with a higher demand for the safety and diversification of the overall community environment.

### 3.2.2 The influence mechanism of community on the activity and integration of the elderly and children

These researches mainly focus on analyzing the influence of community living space components and spatial organization on the outdoor activities of the elderly and children within the community. Davern et al. (2020)<sup>13</sup> pointed out that community land use, population density, and elderly's awareness of community space have a significant effect on the frequency of interaction between the elderly and children. Canedo-García (2021)<sup>14</sup> pointed out that face-to-face interactions between the elderly and children have a positive effect on the physical, psychological, and social skills of both age group, yet differences in individual characteristics affect the frequency and satisfaction of interaction. Oetzel (2023)<sup>15</sup> pointed out that stable interaction partners and frequency of interaction are crucial, especially when the elderly and children have a higher sense of autonomy of organizing and taking part in the interaction activities, the more conducive to the improvement of interaction satisfaction. Xu Shuning (2023)<sup>12</sup> pointed out that the level of interaction between the elderly and children is affected by individual factors and community space. At the individual level, the extraversion of grandparents and children, more willingness and initiative to interact, as well as higher degree of trust to neighbors have a significant positive correlation with the level of interaction between the elderly and children. In addition, at the community space level, the design and set-up of

community center open-space, which can accommodate a variety of activities and residents of different ages, has a positive impact on the interaction and satisfaction of the elderly and children.

### 3.3 Research on Design Strategies for Elderly and Children-Friendly Community Spaces

#### 3.3.1 Overall design of community space for the integration of the elderly and children

Considering the physiological and psychological characteristics of the elderly and children, safety and composability of community living space are the most important keywords. Zheng Yu (2021)<sup>16</sup> proposed the design of all-age parks that can accommodate to resting and playing, delicate pocket parks, and children-friendly parks which are fun and explorable to meet the diversified recreational needs of the elderly and children. Washington et al. (2019)<sup>17</sup> suggested transforming vacant spaces and facilities into shared kitchens, vegetable gardens, art spaces, etc. to accommodate diversified activities and promote interaction for the elderly and children. Zhong et al. (2020)<sup>18</sup> pointed out that, in addition to the design of community physical spaces such as safe and convenient walking environment and sufficient public activity venues, the organization of coherent activities also has a positive effect on the interaction between the elderly and children.

#### 3.3.2 Refined design of community public activity space for the integration of the elderly and children

Based on the psychology of design, Ma Zhuyi (2022)<sup>19</sup> adopted an affective design methodology and proposed that the design of community spaces should be based on three dimensions: form and scale, function and utility, and symbolism and metaphor, to enhance the sense of pleasure and self-identity during the interaction between the elderly and children. Washington et al. (2019)<sup>17</sup> analyzed the interactive activities of the elderly and children in the parks and found that, as children grow older, the interaction between the elderly and children decreased accordingly, but the effective interaction between the elderly and children plays an important role in the development of children's social interaction ability. So it is proposed that the parks should be supplemented with challenging playing facilities, which need the guidance of the elderly to enhance the interaction between the elderly and children.

In conclusion, a large number of researches have been carried out on various aspects of the design of elderly and child-friendly community. Yet the following issues remain to be further explored. Firstly, the outdoor activity patterns and heterogeneity of the elderly and children in different community environments need to be supplemented. Existing researches mainly focus on the elderly and children in a single community or community public space, and few studies have systematically compared and summarized the similarities and differences in the activities and patterns of the elderly and children in different community environments. Secondly, the influence mechanisms of the community space on the elderly and children under different community environments need to be further explored. Existing studies have mainly explored the influence of community public activity space on the integration of the elderly and children, and few studies have systematically considered the influence of the whole elements of community living space at multiple scales. Thirdly, the optimization path of community living space for the integration of the elderly and children needs to be further clarified. Existing researches focus on the elderly and children-friendly space design within a single community, and few studies have clearly proposed different space optimization paths based on differences in community environments for the integration of the elderly and children.

## 4 METHODOLOGY

### 4.1 Study area

Tianjin is a mega-city and is planned as a national central city. According to the “Tianjin Urban Renewal Planning Guidelines (2023-2027)”, the core area of Tianjin is densely populated, the quality of living space is in urgent need of renovation and upgrading, and the shortcomings of public service facilities, such as elderly care, childcare and other public facilities, are yet to be replenished. In this background, seven typical communities with different locations, different construction years and complete age structures are selected as the study area (Fig. 1)(Table 1).



Fig. 1: Study Area

Number	Community name	Construction year	Community size (ha)	Population size
1	Ying Jiangli	1985	7.18	4374
2	Hong Shengli	1986	5.13	3306
3	Jia xinli	1995	5.89	3789
4	You Ai Nanli	1988	7.29	7346
5	Bi huali	1997	9.55	4238
6	Han jingyuan	2008	7.3	4638
7	Sunshine 100 International New Town	2004	10.34	6249

Table 1: Overview of the study area

#### 4.2 Data collection

The built environment data of the community is obtained by POI data mining and remote sensing image maps. POI data is obtained from Gaode-map mining in June, 2024. According to <Urban Residential Planning and Design Standards> initiated by Ministry of Housing and Urban-Rural Development of China, as well as the spatio-temporal activity characteristics of the elderly and children, 8 categories of POI data are included, namely, commercial services, educational services, health care services, public sports services, public cultural services, elderly care services, public transport station and parks. The image map is obtained through google map and is used to extract the green space and analyze the green ratio.

The daily activities of the elderly and children within the community are obtained by questionnaire, semi-structured interview and on-site observation. The questionnaire consisted of four parts: individual socio-economic characteristics, daily activity time, daily activity space, and activity content. The socio-economic characteristics include age, gender, and educational level of the elderly and children, etc. Activity time includes period, average duration, and frequency of outdoor activities. Activity space includes average walking distance to activity space, and type of activity venues. Activity content includes purpose of the activity, and interaction between the elderly and children (Table 2). The questionnaires were distributed and collected from April to July 2024 in the study area from the elderly and children who were active in the public space during different times of the weekdays and weekends.

#### 4.3 Data processing and analysis

Hierarchical analysis and factor analysis are used to establish a community space index system including density and floor area ratio of residence and service facilities, accessibility of service facilities, green coverage and road network density (Table 3). In these indices, green coverage ratio is calculated using SegNet, the other space indices are calculated within 15-minute walking range, and are normalized and visualized in ArcGIS. The spatio-temporal activity patterns of the elderly and children within the community are analysed using TwoStep Cluster algorithm since the spatio-temporal activity data of the elderly and children includes both categorical variables and continuous variables. In this model, 13 variables as shown in Table 2, which represent the spatio-temporal activity characteristics of the elderly and children, such as outdoor activity period and frequency, activity distance and venues, as well as activity types, etc. were imported to check their contributions to the categorization results (Fig. 2).

Content of the questionnaire		Options	
Socio-economic attributes	Gender	Male/Femal	
	Age	40-50/50-60/60-70/ 70 years and over	
	Education background of the elderly	Elementary school/Junior high school/middle school/ /college/Bachelor's degree and above	
	Education background of the grandchild	Infant/kindergarten/elementary school	
Spatio-temporal activity data	Activity time	Period (multiple choices)	6 : 00-9 : 00/9 : 00-12 : 00/12 : 00-15 : 00/15 : 00-18 : 00/18 : 00-21 : 00
		Duration	0.5h and below/0.5-1h/1-1.5h/1.5-2h/2h and above
		Frequency	Almost daily/ at least 2-3 times a week/1 time a week/barely
		Days	Weekday/weekend/weekday and weekend
	Activity space	Distance (multiple choices)	0-300m(from home)/300-500m/500m-1000m/1000m and above
		Venues (multiple choices)	Within the community
	Outside the community		commercial service facilities/education service facilities/catering service facilities/square/park/public transport station
	Activity content	Purpose (multiple choices)	Leisure/exercise/education/shopping
		Interaction (multiple choices)	Walk with a stroller/ play with children/take care of the children/chat/take exercise

Table 2: Spatio-temporal activity data acquisition of the elderly and children

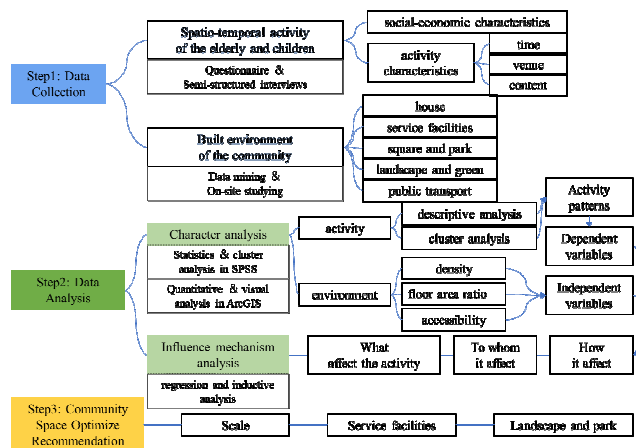


Fig. 2: Analysis Process

Primary indicators	Secondary indicator
housing	density
	floor area ratio
commercial services	density
	floor area ratio
	Accessibility (walking distance from the house)
educational services	density
	floor area ratio
	accessibility
health care services	density
	floor area ratio
	accessibility
public sports services	density
	floor area ratio
	accessibility
public cultural services	density
	floor area ratio
	accessibility
elderly care services	density
	floor area ratio
	accessibility
public transport station	density
	accessibility
parks	accessibility
green coverage ratio	-
road network density	-

Table 3: Community Space Indicator System

## 5 RESULT

### 5.1 Descriptive statistics of the elderly and children surveyed

#### 5.1.1 Socio-economic attributes of the survey sample

According to statistical analysis of the returned questionnaires on spatio-temporal behavior of the elderly and children in SPSS 26.0, female elderly accounts for 70.2% of the sample. In the analysis of age structure, the respondent group is mainly concentrated in 60-69 years old, accounting for 62.4%, followed by 50-59 years old, accounting for 23.3%, and there are fewer people over 70 years old and 40-49 years old, accounting for 11.3% and 3% respectively.

In the analysis of the educational background of the elderly interviewed, 41.4% has an educational background of elementary school and below, 29.9% has junior high school, 19.6% has senior high school and middle school, 5.9% has college, and 3.2% has a bachelor's degree or above.

In the analysis of the education level of the children carried, children who had been enrolled in kindergarten and the younger children who are not enrolled in kindergarten are the largestest group, accounting for 38.7% and 33.8% respectively. While elementary school children account for 27.5%. In the analysis of family structure, the respondent group mostly has three generations living together, accounting for 59.1% of all samples, followed by those living with their spouses (28.7%). The group that the elderly and children living together and those living alone account for a small percentage of the sample, which is 11.3% and 0.9% respectively (Fig. 3).

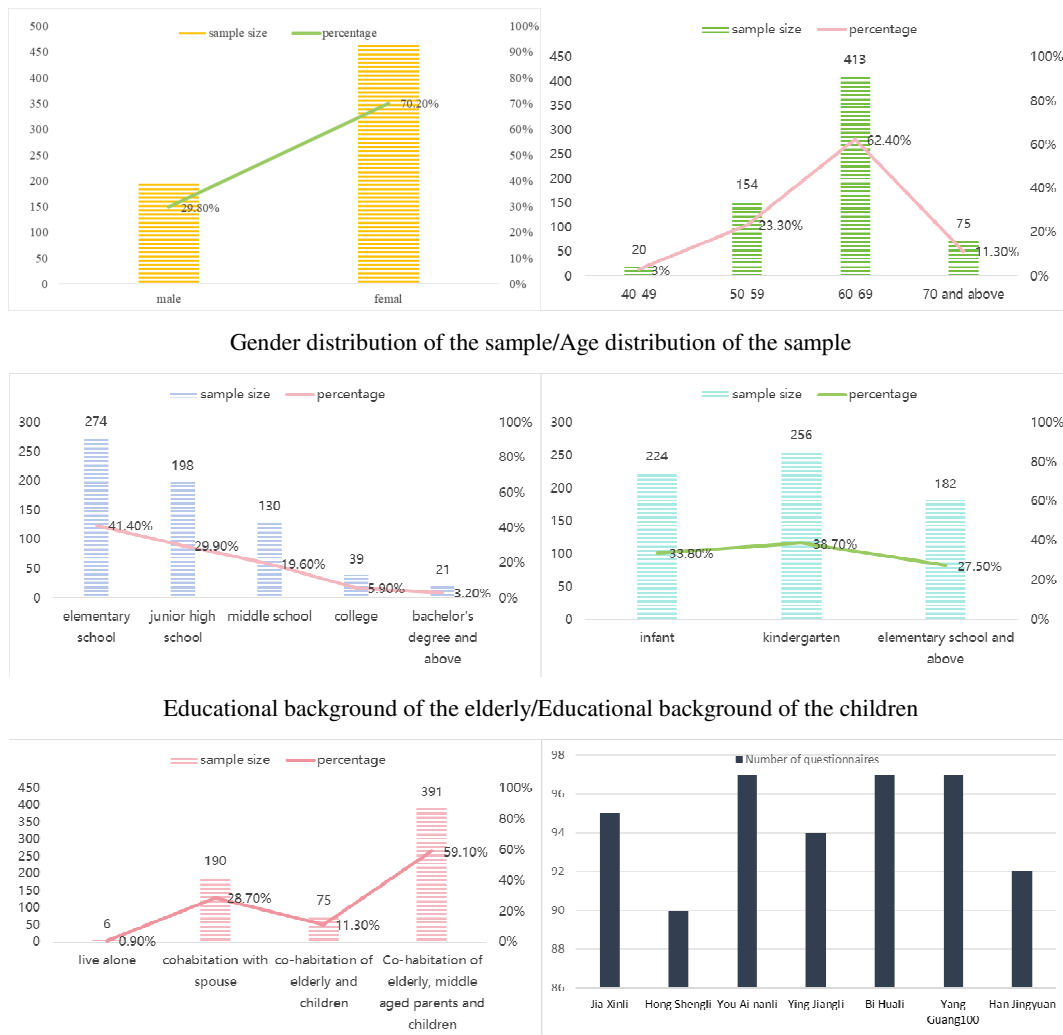


Fig. 3: Socio-economic attributes of the survey sample.

5.1.2 Descriptive statistics of spatio-temporal activities of the elderly and children

(1) Characteristics of the activity time

In terms of time period of activity, the elderly and children are more active between 15:00 and 18:00, accounting for 78.1% of the total number of respondents. The second largestest group are those who chose to be active between 9:00 and 12:00, accounting for 44.1%. Those who chose to be active between 18:00 and 21:00, and between 6:00 and 9:00 are fewer, accounting for 13.4% and 9.8% respectively. While only 1.4% chose to be active between 12:00 and 15:00.

In terms of activity duration, the mostly chosen are 1-1.5h and 0.5-1h, which accounts for 32.2% and 22.5% of the surveyed sample. The proportion of the elderly and children’s activity duration as 1.5-2h, and 2h and above are 22.1% and 22.2% respectively. And only 1.1% of the elderly and children usually takes outdoor activities for less than 0.5h. The average activity duration of the old and young population was 1.606h, with a maximum value of 4h, a minimum value of 0.4h, a median value of 1.5h, and a standard deviation of 0.647.

Regarding the frequency of activities, the proportion of elderly and children declines as the frequency of activities decreased. 54.4% of elderly and children are active almost every day, 29.9% are active 3-4 times a week, 15.1% are active 1-2 times a week, and only 0.6% choose the “hardly go” option.

(2) Characteristics of the activity space

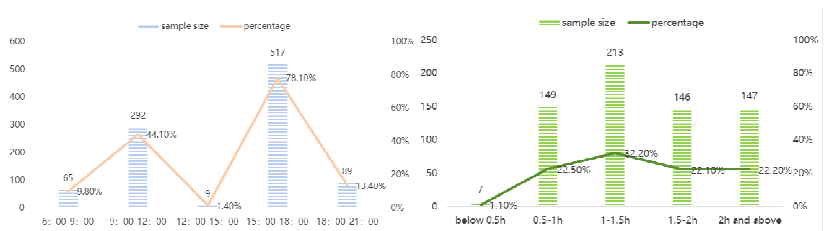
In terms of activity distance, the elderly and children prefer to take activities within short-distance. 93.8% of the surveyed sample choose to take activities within 300 meters from their homes, and the proportion who choose 300-500 meters and 500-1,000 meters from their homes are 41.2% and 24.8% respectively, with only 5.7% choose to take activities at places beyond 1,000 meters from their homes.

In terms of activity venues, the squares and parks within the community are the most chosen option, accounting for 73.3% of the surveyed sample. This is followed by parks and squares outside the community, educational facilities and downstairs space in front of the house, accounting for 59.7%, 58.2% and 55.3% respectively. Catering facilities and shopping facilities were chosen by 33.4% and 20.5% of the surveyed sample respectively. Fewer group choose community stores and canteens, as well as subway stations, accounting for 13%, 4.2% and 0.9% respectively. It is worth noting that 27.5% of the activity venues for the elderly and children involved roads within the community.

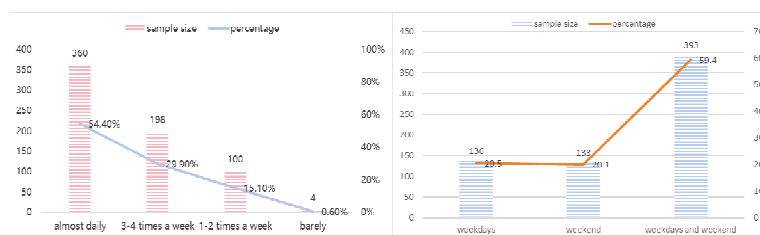
(3) Characteristics of the activity contents

In terms of activity types, those who choose recreational activities, accounting for 95.3% of the total sample. Educational and shopping activities are chosen by 58.9% and 34% respectively.

In terms of the interaction between elderly and children, a great portion of elderly choose “looking after children”, which accounts for 91.8%. The next most common activity was “chatting and communicating”, accounting for 48.3% of the total sample. The proportions of those who choose to “play together with children” and “do fitness activities” are 28.2% and 23.1% respectively, while the proportion of those who chose to “take a walk with a stroller” is 17.8%(Fig.4).



Activity time period/Activity time duration



Activity frequency/Activity days



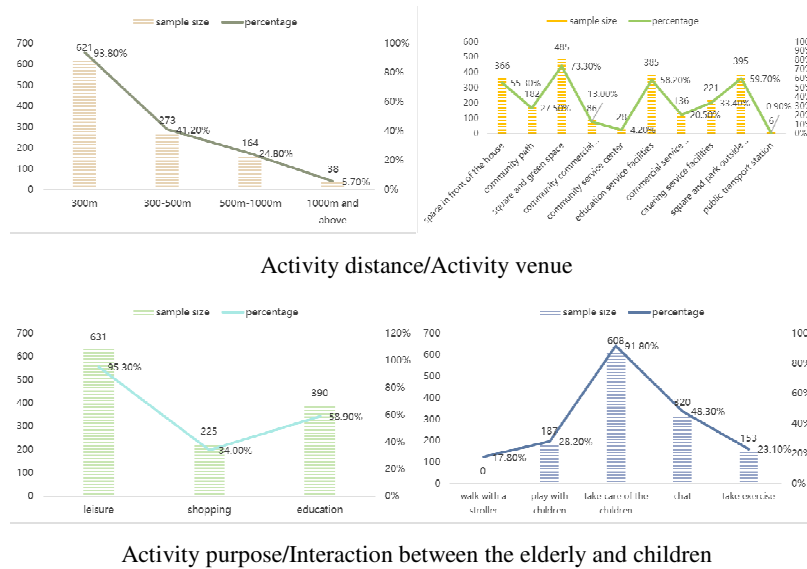


Fig. 4: Spatio-temporal activity characteristics of the elderly and children

### 5.2 Portraits of the elderly and children

The results showed that when three clusters were generated, the centers of each category differed significantly, and the clustering result was significant (Fig.5). According to the variable significance diagram, variables such as activity period, activity frequency, educational activities, activity duration, and activity distance of 500m to 1000m from home are the important variables to distinguish the three categories (Fig.6).

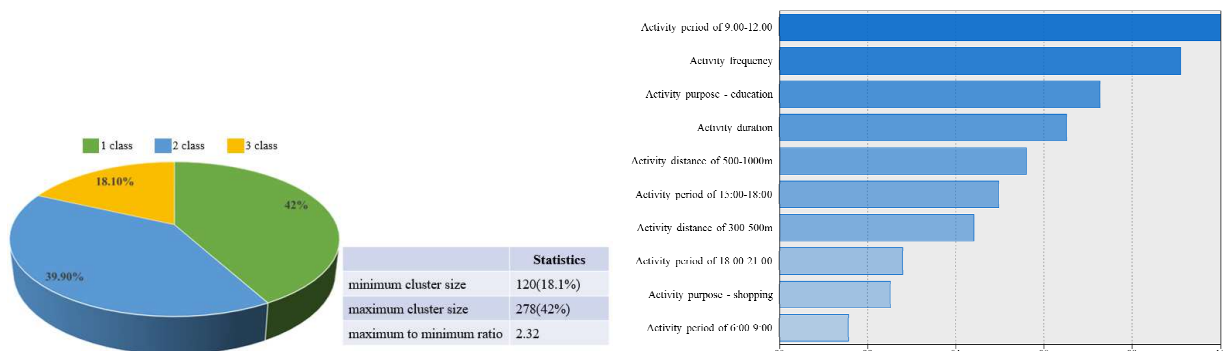


Fig. 5 (left): Cluster size and percentage. Fig. 6 (right): Importance of predictor variables.

#### 5.2.1 The multi-time period and short-distance active group

This group is the most numerous in this research, accounting for 42% of the total research sample. In this group, children are younger, mostly not enrolled in kindergarten. The average outdoor activity duration is 2.01h a day. The activity time is more flexible compared to the other two groups, involving different time period of the day, with a higher concentration in 9:00-12:00 and 15:00-18:00. The weekly outdoor activity frequency is high, as shown in the interviews, the frequency is basically daily if there is no rain or snow. In terms of activity space, the space within five-minute walking distance around home are visited the most frequently, including the park, square and road within the community. Besides, the convenience store, supermarket, shopping mall and parks within 10 to 15-minutes of walking are also frequently visited destinations. The primary purpose of outdoor activity is recreation, followed by shopping and education.

#### 5.2.2 The afternoon short-distance activity group

This is the second largest type of research population, accounting for 39.9% of the whole research sample. In this group, children are mostly in the kindergarten and elementary school enrollment stage, and the elderly mostly pick up the children after school and take outdoor activities on the way back home or around the neighborhood. The frequency of activities is basically once a day, which takes place from 15:00 to 18:00 in general, and the average activity time duration is 1.29h a day. The outdoor activities take place around the neighborhoods mostly, and there are also some activities that are a little further from home, which mainly

depends on the distance between the school and home. In terms of the type of activity, it's mainly playful and educational.

### 5.2.3 Low-frequency and multi-purpose activity group

This group accounts for 18.1% of the total research sample, which is the smallest proportion. This group is mostly elderly people with elementary school and kindergarten-aged children. The outdoor activity time is not fixed, which takes place mostly at weekends around 9:00-12:00 and 15:00-18:00 and lasts 1.38h in average. In comparison with the other two groups, this group has a wider outdoor activities range, with both long-distance and short-distance activities involved. The type of activity is mainly amusement, followed by education and shopping.

## 5.3 Community space influencing factors of elderly and children's spatio-temporal activity

To the multi-time period and short-distance active group, in terms of activity duration, the higher the community greening rate, the longer the activity duration for people especially with infants, while the higher the community floor area ratio and the closer the community is to the subway station, the shorter the activity duration. In terms of activity distance, the higher the educational stage of children, the higher density of the road network and the higher the community floor area ratio, the more medium-distance activities of the baby-carrying population compared to those of the proximity population. In terms of the type of activity, the higher the greening rate, road network density and floor area ratio, the higher the probability that the elderly and children choose to play within the community. The higher the accessibility of play and leisure facilities, and the closer the community is to the subway station, the more diverse types of activities of the elderly and children.

To the afternoon short-distance activity group, in terms of activity duration, the higher the community greening rate and the higher the accessibility of educational and cultural facilities, the longer the activity duration to the elderly especially with school-age children, while the higher the community floor area ratio, the shorter the activity duration. In terms of active distance, the lower the accessibility of community educational and cultural facilities, the lower the community greening rate, and the higher the accessibility of amusement and recreational facilities, the higher the probability of choosing destinations at a greater distance. Regarding the type of activity, the higher the density of the road network, greening rate and community floor area ratio, the higher the probability that the elderly and children choose to play within the community. The closer the subway station, the diverse the type of activities.

To the low-frequency and multi-purpose activity group, in terms of activity duration, the higher the density of the community road network and more diverse the community play and leisure facilities, the longer the activity duration. As regards activity distance, the higher the accessibility of community amusement and recreation facilities, the higher the probability of taking activities within the community. In terms of activity types, the higher the accessibility of amusement and leisure facilities, the diverse the activity types (Table 4).

3 clusters of the elderly and children	Characteristics of spatio-temporal activities	Floor area ratio	Accessibility to education services	Accessibility to recreation services	Road density	Green ratio	Distance to public transport station
multi-time period and short-distance active group	Activity duration	-0.36	-	-	-	0.749	-0.278
	Activity distance	1.578	-	-	2.263	-	-
	Activity type	-3.535	-	3.945	-4.559	-5.615	3.543
afternoon short-distance activity group	Activity duration	-0.167	0.167	-	-	0.321	-
	Activity distance	-	-3.111	2.258	-	-2.158	-
	Activity type	-2.203	-	-	-4.329	-3.076	3.566
Low-frequency and multi-purpose activity group	Activity duration	-	-	0.368	0.424	-	-
	Activity distance	-	-	-5.206	-	-	-
	Activity type	-	-	4.363	-	-	-

Table 4: Influencing factors on spatio-temporal activities within the community of the elderly and children

## 6 DESIGN STRATEGIES FOR ELDERLY AND CHILDREN-FRIENDLY COMMUNITIES

### 6.1 Establishing fine-scale and multi-level community outdoor activity space for the elderly and children

According to the analysis of the activity distance and preferred space of the elderly and children, it can be seen that the activity range of the elderly and children is mainly 0-500 meters away from their homes, especially within the range of 300m, and the high green ratio and high road connectivity within this scale have a positive effect on the outdoor activity duration of the elderly and children. In addition, besides parks and squares within the community, the space in front of the house, pathway and corner space in the community are also important parts of the daily activity space, which need to be renovated in terms of safety and enjoyability for the elderly and children. Therefore, on one hand, a finer layers of community scale should be made at the macroscopic level, and the design criteria and key features of each level ought to be proposed. On the other hand, a more refined design of the space in front of the house, as well as the landscape of the community green space and corner space should be carried out at the microscopic level, so as to improve the safety and connectivity of the community roads (Table 5).

Scale level	Service radius (m)	Design specification
residential neighborhood	300	Safety road, diversified playgrounds and rest facilities, versatile landscape, high green ratio
5-minute living area	500	Diversified and accessible recreational, educational and shopping services
10-15minute living area	1000-1500	Safety road, high accessibility to diversified service facilities and public transport

Table 5: Design strategies and specifications for fine-scale community

### 6.2 Improving the diversity of service facilities for the elderly and children in and around the community

According to the factors influencing the community activities of the elderly and children, the higher the accessibility of playgrounds, educational services and public transport stations, the longer the outdoor activity durations and the more diversified of their activities. Therefore, on the one hand, play and rest facilities can be supplemented to the public activity space in the community, for example, revitalizing vacant and inactive public rooms in the community and transforming them into drawing rooms, chess and cards rooms, reading spaces where the elderly and children can participate and interact together, and making use of the community's marginal space to improve landscape or add play and fitness facilities, in order to provide diversified places for the elderly and children to play and rest.

## 7 CONCLUSION

In general, with regard to the characteristics of temporal and spatial activities, the activity time preferred by the elderly and children are 9:00-12:00 and 15:00-18:00, among which, for the elderly with school-age children, they are more inclined to be active from 15:00 to 18:00. The duration of their activities mostly lasts 1-2 hours. The scope of daily activities is mainly within the community, usually within 500 meters from home, especially within 300 meters. Public squares, parks and green spaces within the community are the most important activity places for the elderly and children, followed by parks and squares as well as educational service facilities outside the community, and then dining and shopping service facilities outside the community. For children of school age, public spaces around the school, as well as the path between school and home are also the main activity areas. In addition, it should be noted that the space in front of the house and the community roads are also the main activity places for the elderly and children. In terms of activity content, play and leisure are the main activities, followed by education and shopping. In terms of the interaction between the elderly and children, when the children are at younger ages, the elderly mainly take care of the children, chat and communicate with each other, and take a walk with the baby carriage. As the children grow older, the proportion of the elderly and children taking exercises and playing games together increases.

With regard to the portraits of the community activities of the elderly and children, based on the results of the cluster analysis, they can be summarized into three categories, namely the multi-time period and short-distance active group, the afternoon short-distance activity group, the low-frequency and multi-purpose activity group, which account for 42%, 39.9% and 18.1% of the total research sample respectively. According to the order of importance of the predictor variables, it can be seen that the variables of 9:00-

12:00 activity period, activity frequency, activity duration, educational activities, and 500m to 1000m activity distance are important variables to distinguish the three groups.

Regarding the influencing factors, road network density, green ratio, floor area ratio, distance to subway stations, and accessibility of recreational facilities as well as science and education facilities have a significant impact on the daily spatial and temporal activities of the elderly and children within the community. Specifically, for outdoor activity duration, the higher the green ratio, road network density, and accessibility of recreational facilities, the longer the duration of outdoor activities. In terms of the differences in influencing factors among the three groups, the green ratio of the community has a greater positive influence on the activity duration of the elderly and children who are active in short-distance from home; the density of the road network and the accessibility of recreational facilities have a greater positive influence on the activity duration of the low-frequency and multi-purpose elderly and children; while the floor area ratio has a negative influence on the outdoor activity duration of the elderly and children who take activities within a short-distance from home, but the level of influence is not high.

For activity distance, high road network density, high accessibility of recreational facilities, and high floor area ratio are associated with a greater activity range and longer distance for the elderly and children, while high accessibility of science and education facilities and high green ratio are associated with a greater tendency for the elderly and children to engage in activities within the community.

As for the types of activities, the higher the accessibility of recreational facilities and the closer the subway station, the more diversified the activities of the elderly and children are, including not only playing in the community, but also carrying out activities outside the community in educational, shopping, catering and other service facilities; whereas, with a high green ratio, a high density of the road network, and a high floor area ratio, the probability that the elderly and children carry out outdoor activities within the community is higher.

## 8 DISCUSSION

This research focuses on promoting inclusive community space for the elderly and children. By taking typical communities in Tianjin as examples, the research follows the analytical steps of “categorizing spatial and temporal behavior patterns of the elderly and children – analyzing spatial influence mechanisms – proposing spatial design strategies”, which provides a science-based method to realize the construction of human-oriented and inclusive community for the elderly and children. However, this study has only considered the spatial elements of the community when analyzing the influencing factors on the community spatial and temporal activities of the elderly and children, and has not given enough consideration to the non-spatial elements of the community such as community governance and interpersonal relationships<sup>20</sup>. At the same time, the combination of variables affecting the spatio-temporal activities of the elderly and children has not been analyzed in depth, and the path of building an inclusive community for the elderly and children under different environmental and socio-economic conditions is not yet clear.

In future researches, on one hand, non-spatial elements, such as socio-economic and cultural environment, community governance, as well as neighborhood relations have yet to be incorporated into a unified analysis system, so as to comprehensively analyze the effects of the relevant elements on the community activities of the elderly and children in terms of their direct, indirect, and interactive influences. On the other hand, on the basis of analyzing the influencing mechanisms on the activities of the elderly and children in different types of communities, Qualitative Comparative Analysis (QCA) can be used to identify and refine typical paths for the integration of the elderly and children in different community environments, so as to provide more targeted and operational guidance for creating communities that better serve the elderly and children.

## 9 REFERENCES

- Zhang Hao, Lan Tianze. Exploring the construction of integrated community from the “neighborhood community” perspective: ideas, issues and strategies. In: *Urban Development Studies*, Vol.31, Issue 1, pp.50-55. BeiJing, 2024.
- Li Han, Fu Benchen. Study on Behavior Setting Analysis and Design System of Intergenerational Integration in Urban Residential Environment. In: *Architectural Journal*, Vol.68, Issue S1, pp.63-68. BeiJing, 2022.
- Rémillard-Boilard, S.; Buffel, T.; Phillipson, C. Developing Age-Friendly Cities and Communities: Eleven Case Studies from around the World. In: *Public Health*, Vol.18, Issue 1, pp.133-152. London, 2021.

- Sánchez-González, D.; Rojo-Pérez, F.; Rodríguez-Rodríguez, V.; Fernández-Mayoralas, G. Environmental and Psychosocial Interventions in Age-Friendly Communities and Active Ageing: A Systematic Review. In: *Public Health*, Vol.17, Issue 22, pp.8305-8317. London, 2020.
- Zhang Lu, Ye Zhu. All-age Regeneration Strategy of Existing Residential Areas Based on the Compound Feature of the Aged and the Young. In: *Urban Development Studies*, Vol.27, Issue 10, pp. 109-115+133. BeiJing, 2020.
- Cohn-Schwartz, E; Sagi, D and Meiry, L. Planning for old age by graduates of a master's gerontology program in Israel. In: *Innovation in aging*, Vol.25, Issue 7, pp.452-471. Oxford, 2023.
- Zhang, X; Tang, YF and Chai, YW. Spatiotemporal-Behavior-Based Microsegregation and Differentiated Community Ties of Residents with Different Types of Housing in Mixed-Housing Neighborhoods: A Case Study of Fuzhou, China. In: *Land*, Vol.12, Issue 9, pp.1654-1673. Switzerland, 2023.
- Li Han, Fu Benchen. Behavioral patterns of intergenerational interactions and environmental support in public spaces of urban settlements. In: *Urban Problems*, Vol.39, Issue 5, pp.73-83. BeiJing, 2021.
- LV Yuan, CAO Xiao Fang, LI Jing, ZHANG Jian. Research on the Mode of Community Public Space Shared by the Elderly and Children. In: *Architectural Journal*, Vol.67, Issue S1, pp.80-85. BeiJing, 2021.
- JIANG Xiaoyan, ZHU Xiaolei. Study on the Interactive Behavioral Setting of the Elderly and the Young in Commercial Living Streets in Communities: Empirical Research of Three Cases in Guangzhou. In: *South Architecture*, Vol.41, Issue 5, pp.91-99. Guangzhou, 2022.
- Tang P., Yang D., Dong N. The Effect of Intergenerational Parenting Mode on Children's Outdoor Activities: A Case Study of Downtown Shanghai Communities. In: *Sustainability*, Vol.15, Issue20, pp.1468-1481. Switzerland, 2023.
- Xu Shuning. Research on the Optimization of Community Public Space Environment to Promote Inter-generational Communication. Zhejiang University. Hangzhou, 2022.
- Davern, M., Winterton, R., Brasher, K., Woolcock, G. How Can the Lived Environment Support Healthy Ageing? A Spatial Indicators Framework for the Assessment of Age-Friendly Communities. In: *Public Health*, Vol.17, Issue17, pp.7685-7699. London, 2020.
- Canedo-García, A, García-Sánchez, JN, Díaz-Prieto, C, Pacheco-Sanz, DI. Evaluation of the Benefits, Satisfaction, and Limitations of Intergenerational Face-to-Face Activities: A General Population Survey in Spain. In: *International Journal of Environmental Research and Public Health*, Vol.18, Issue18, pp.43-58. Switzerland, 2021.
- Oetzel, JG, et al. Enhancing health outcomes for Māori elders through an intergenerational cultural exchange and physical activity program: a cross-sectional baseline study. In: *Frontiers in public health*, Vol.11, Issue1, pp.113-128. Switzerland, 2023.
- ZHENG Yu, FANG Kailun, HE Haoyu, YUAN Yuan. Research on the Strategy of Healthy Community Micro-regeneration from the Perspective of Age-friendly and Child-friendly Community: A Case Study of Sanyanjing Community in Guangzhou. In: *Shanghai Urban Planning Review*, Vol.30, Issue1, pp.31-37. Shang Hai, 2021.
- Washington, T.L.; Flanders Cushing, D.; Mackenzie, J.; Buys, L.; Trost, S. Fostering Social Sustainability through Intergenerational Engagement in Australian Neighborhood Parks. In: *Sustainability*, Vol.16, Issue11, pp.412-437. Switzerland, 2019.
- Zhong S., Lee C., Foster M. J., Bian J. Intergenerational communities: A systematic literature review of intergenerational interactions and older adults' health-related outcomes. In: *Social Science & Medicine*, Vol.264, Issue23, pp.79-91. England, 2020.
- Ma Zhuyi. Research on the Emotional Design of Shared Spaces for the Elderly and Children in Urban Residential Communities. Northeast Normal University. Ji Lin, 2022.
- Fang M.L., Sixsmith J., et al. Co-creating inclusive spaces and places: Towards an intergenerational and age-friendly living ecosystem. In: *Front. Public Health*, Vol.10, Issue23, pp.120-141. London, 2023.