Research Paper

Residential Public Space Environment Enhancement Strategies Supporting Outdoor Activities for the Elderly in Winter

Take the Winter City of Harbin as an Example

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Abstract

Outdoor activity is an essential condition to promote the physical and mental health of the elderly, and the harsh winter weather conditions in cold regions significantly impact on the activity behavior of the elderly in the public space. As the primary carrier of outdoor activities for the elderly, how the residential space responds to the activity features of the elderly needs urgent attention. In order to explore how the activity characteristics of the elderly in winter can guide the design of outdoor spaces in settlements, this study selects six sample settlements in Harbin, a winter city in China, and conducts field research in winter. Based on this, we propose the planning strategies for public spaces in cold urban settlements in terms of activity perception, needs of the elderly, and climate protection.

Keywords

The elderly, Characteristics of outdoor activities, Winter

1. Background

COVID-19 has drawn the attention of the global academic community to public health security and health issues (Xu, 2020). The blue paper on geriatric health, " ANNUAL REPORT ON ELDERLY HEALTH IN CHINA (2020-2021)," points out that the health problems of China's elderly population cannot be ignored, with multiple chronic diseases coexisting in over 3/4 of residents over 60 years of age (Liu, 2021). As the elderly grow older, their health awareness gradually increases. However, the transformation of their physiological and psychological conditions leads to limited activity behaviors, and more older people want to age at home and be active close to home (Carlson *et al.*, 2012). As the spatial carrier for the residents to survive, the public space is the main place for the elderly to conduct outdoor activities and get close to nature, which significantly affects the physical and mental health of the elderly (Jiang, 2020). Building a quality and comfortable residential environment is conducive to improving the physical and mental health of the

elderly, reducing the economic burden of social and medical care, and enhancing the interaction between neighbors (Fan, Das and Chen, 2011; Chen *et al.*, 2016).

Factors such as climate and residential environment can influence the activity characteristics of older adults (Togo *et al.*, 2005; Sugiyama and Ward Thompson, 2008), including time of activity, frequency of activity (Marselle, Irvine and Warber, 2013), and type of activity (Xue and Duan, 2012). It has been shown that the construction of public spaces in settlements can not only mitigate the negative effects of cold weather and safeguard the outdoor activities of the elderly, but also improve the physical and mental health of the elderly by promoting walking activities and increasing effective social opportunities (Bedimo-Rung, Mowen and Cohen, 2005; Kearney, 2006; Joseph *et al.*, 2006). However, there is still a lack of research on how settlement environments in cold climates respond to the characteristics of outdoor activities of the elderly. Winter cities have long winter durations, low temperatures, short sunshine hours, and more snowfall. The elderly are relatively weaker and more sensitive to cold air, so they have higher requirements for the residential environment.

Data from "The Statistical Bulletin of National Economic and Social Development of Harbin City in 2021" show that by the end of 2021, Harbin had an aging population of 2.345 million people aged 60 and above, accounting for 24.9% of the city's population (Harbin Municipal People's Government, 2022). As a typical cold city in China, Harbin's winter severity index score is as high as 51, with severe winter weather conditions. However, there are still problems in the supply, quality and layout of public space and facilities in existing settlements in Harbin. Therefore, it is necessary to strengthen the construction of residential public spaces to create an aging-appropriate residential leisure environment and enhance outdoor spaces' attractiveness for the elderly in winter (Ward Thompson, 2013).

2. Research program design

2.1. Sample settlements selection

By analyzing the development history of Harbin settlements (Yu and Kang, 2017), this study decided to select settlements built between 2000 and 2010 as the sample settlements. The settlements built during this period have the most extensive existing stock, the largest proportion of residents, and a significant improvement in the environmental quality. These settlements were completed at least ten years ago, which makes the environmental problems more prominent, so the renovation and construction of these settlements will have high social value and economic benefits. Other selection criteria for the sample settlements are as follows: from the analysis of the distribution of urban residents, the selected settlements are located in the main urban area of Harbin where about 70% of the residents live, including Nangang District, Daoli District, Daowai District, and Xiangfang District. From the residential population density analysis, the selected settlements' occupancy rate is above 75%, which is close to saturation. From the analysis of the population structure of residents, settlements with relatively large elderly population and reasonable distribution of elderly residents in terms of gender, occupation, economic status and other social attribute characteristics were selected as sample settlements, so that elderly residents with different individual characteristics can objectively evaluate the settlement environment differently.

Combined with the above selection basis and field research, we selected the sample settlements as Haifu Kangcheng, Aijian Ziyuan, Taifu Changancheng, Fushun Shangdu, Fenglan Guoji, Zhongbei Chuncheng. The basic information of the selected settlements is shown in Table 1.

Table 1. Basic information of the sample settlements. Source: Author.

	Haifu Kangcheng	Aijian Ziyuan	Taifu Changancheng	Fushun Shangdu	Fenglan Guoji	Zhongbei Chuncheng
Location	Daoli District	Daoli District	Daowai District	Nangang District	Nangang District	Xiangfang District
Build time	2005	2003	2008	2006	2010	2004
Main layers	6F, 13F	18F, 30F	7F	30F	33F	7F, 18F
Floor area ratio	1.9	1.47	1.81	3.47	4.29	2.8
Greening rate	30%	37%	40%	35%	35%	41.9%

2.2. Research time selection

Harbin has the largest span of the cold season, encompassing November to March of the following year. Weather.com data shows that the average temperature in Harbin in December is about -16°C. Adverse weather conditions such as severe cold, snow and ice significantly impact on the livability of Harbin, and the slippery ground and freezing temperatures caused by snow and ice exacerbate barriers to travel for older adults. To encourage the elderly to carry out activities in winter, the feasibility of field research as the premise, and the full consideration of the effects of different temperatures and weather conditions, we finally selected two weeks from mid to end of December 2020 as the research period. Among them, the average temperature of the research period was -17℃, the average body temperature was -23℃, and the weather conditions covered a variety of conditions such as sunny, cloudy, snow showers, and sunny with clouds, etc.

2.3. Research Methodology

Three main research methods were applied in this study. The first one was a questionnaire survey, which included the demographic attributes and outdoor activity characteristics of the elderly residents, and the factors affecting the development of activities. The investigators used Accidental Sampling to randomly distribute 40 questionnaires in each sample settlement, and a total of 240 questionnaires were collected from 6 settlements. Finally 226 valid questionnaires were obtained. The second method is the interview, which aims to understand the evaluation of elderly people's use of public space, their demand intention and suggestions for improvement. The third one is the behavioral observation statistics, which mainly observes and records the occurrence time, duration and venue of the elderly activity programs. The activity data in winter is obtained by field observation, and the data in other seasons is mainly obtained by interview.

3. The relationship between outdoor activities and public space for the elderly in winter

3.1. Characteristics of people participating in outdoor activities in winter

Combined with field observations, it is found that the main users of public space in winter settlements in cold cities are older people, and the proportion of men and women is basically equal, as shown in Figure 1. Among them, seniors aged 65-74 are the most numerous, accounting for 40%, while those aged 55-64 and 75 and above account for 24% and 36%, respectively. Statistics on the length of time respondents have lived in their current place of residence show that 86% of respondents have lived in that place of residence for more than 2 years. Statistics on the monthly income of the elderly show that the economic situation of these individuals varies considerably and that a better financial status indicates to some extent that they have more autonomy in their choices and are better integrated into the social group. The education level and home care model of elderly residents affect their social skills and emotional state, and indirectly affect

the health status of the elderly. Among seniors who engage in outdoor activities in winter, the highest number of seniors with high school and post-secondary education at 31% and the highest number of seniors living with their spouses at up to 38%.

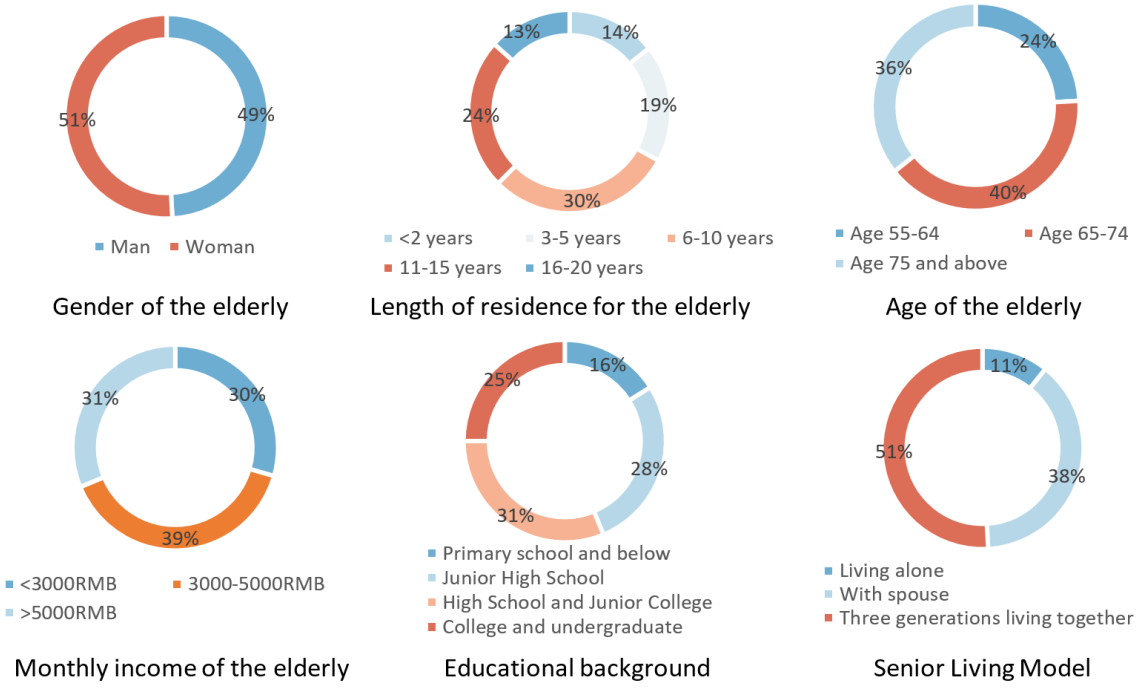

Figure 1. Statistics on the basic characteristics of the surveyed elderly. Source: Author.

3.2. Characteristics of outdoor activities of the elderly in winter

3.2.1. Types of outdoor activities for the elderly in winter

Referring to Jan Gehl's "Life between Buildings", and taking into account the motivation and degree of social support for older people to carry out activities in the residential area, this study classifies the types of activities into three types: necessity activities, spontaneous activities, and social activities. The types of outdoor activities of the elderly were classified as shown in Table 2, and the proportion of different types of activities was counted as shown in Table 3. It was found that the proportion of elderly residents involved in spontaneous activities was the highest regardless of the season, and there were differences in the types of activities in different settlements. In winter, the proportion of elderly residents involved in spontaneous activities (including single person activities such as fitness, walking and sunbathing) was as high as 71.4%; the proportion of elderly residents involved in social activities (community activities such as square dance and Tai chi) was the second highest at 25.0%. However, the proportion of elderly people involved in necessary activities (including activities such as childcare) was 3.6%. By comparing the types of outdoor activities of older adults in different seasons, it was found that the elderly still tended to engage in outdoor activities spontaneously, even in the severe winter weather conditions. Combined with the interviews, we know that the social attribute of outdoor activities can weaken the inhibitory effect of cold winter climate on activities to a certain extent.

Table 2. Types of winter outdoor activities for the elderly. Source: Author.

Number	Activity Type (Major Categories)	Activity Type (Minor Categories)	Activities
1	Necessary activities	Childcare	Sledding and building snowmen with toddlers
		Fitness Activities	Equipment fitness, Running, Walking
2	Spontaneous activities	Ball Sports	Basketball, Table tennis, Badminton
		Leisure and Entertainment	Instrumental performance, Sunbathing
		Board Games	Play chess, Play poker, Play mahjong
3	Social Activities	Dance Gymnastics	Square dance, Tai chi, Social dance, Gymnastics
		Small gatherings	Chatting, Gatherings of small groups

Table 3. Proportion of outdoor activities involving the elderly in winter. Source: Author.

	Childcare	Fitness Activities	Ball Sports	Leisure and Entertainment	Board Games	Dance Gymnastics	Small gatherings
Haifu Kangcheng	5.1%	43.6%	0.0%	15.4%	5.1%	28.2%	2.6%
Aijian Ziyuan	2.8%	47.2%	13.9%	25.0%	0.0%	2.8%	8.3%
Taifu Changancheng	5.0%	42.5%	0.0%	22.5%	2.5%	25.0%	2.5%
Fushun Shangdu	2.9%	60.0%	0.0%	28.6%	0.0%	5.7%	2.9%
Fenglan Guoji	2.9%	44.1%	20.6%	8.8%	2.9%	17.6%	2.9%
Zhongbei Chuncheng	2.5%	47.5%	7.5%	5.0%	2.5%	30.0%	5.0%
Statistics by minor subcategory	3.6%	47.3%	6.7%	17.4%	2.2%	18.8%	4.0%
Statistics by major categories	3.6%		71.4%			25.0%	
Statistics by major categories (other seasons)	0.9%		67.9%			31.2%	

3.2.2. Time of outdoor activities for the elderly in winter

The statistics of the elderly who did outdoor activities at different times in the residential area showed that the activity periods of the elderly were greatly influenced by their personal habits and climate, as shown in Table 4, and the overall activity frequency in winter was lower and the duration was shorter, as shown in Figure 2. Due to the harsh climate conditions in winter in cold regions, outdoor activities of the elderly are basically concentrated between 8:00 and 14:00. In contrast, in other seasons, the elderly choose to be active more often after 18:00, when the climate is cooler and more comfortable. By comparing the length and frequency of outdoor activities of the elderly in different seasons, it was found that most of them increased their activity length from about 1 hour in winter to 1.5 or even 2 hours in other seasons, and their activity frequency increased from 7.63 times per week in winter to 11.19 times per week in other seasons. Based on the above data, it is inferred that the willingness of elderly people in Harbin to engage in outdoor activities under the influence of the severe cold climate in winter is still relatively strong. However, the adverse weather conditions and the long period of snow and ice coverage have forced the elderly residents to reduce the time they spend on personal outdoor activities or neighborhood interaction, which objectively or subjectively causes the phenomenon of insufficient frequency, shorter length and reduced social interaction of elderly people's outdoor activities in winter.

Table 4. Time bucket of the elderly outdoor activities. Source: Author.

	Before 6:00	6:00-8:00	8:00-10:00	10:00-12:00	12:00-14:00	14:00-16:00	16:00-18:00	18:00-20:00	After 20:00
Winter	0.0%	5.4%	35.7%	48.2%	5.4%	21.4%	0.9%	11.6%	0.0%
Other Seasons	0.0%	33.9%	9.8%	5.4%	1.3%	6.3%	24.1%	50.0%	0.9%

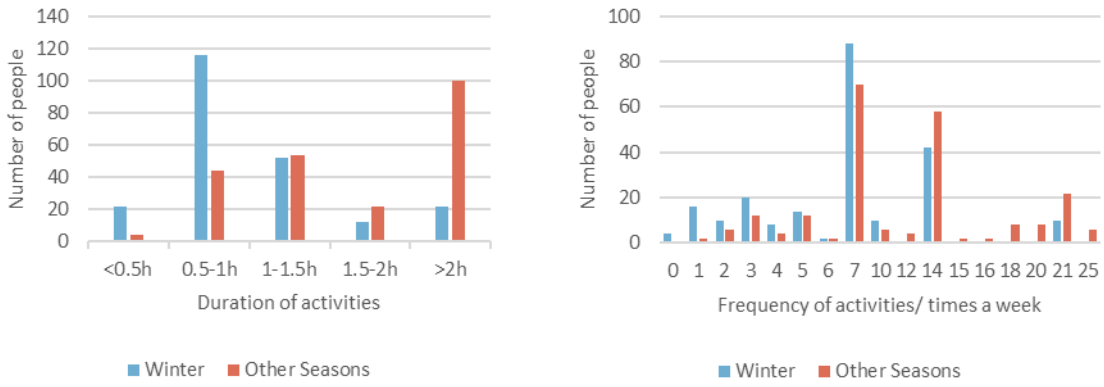

Figure 2. Length of outdoor activities for the elderly in different seasons (left) & Frequency of outdoor activities for the elderly in different seasons (right) . Source: Author.

3.3. Relationship between outdoor activities and spatial sites for the elderly in winter

3.3.1. Concerns of the elderly about the environment of activity places in winter

The statistics of the public facilities suggested by the elderly in the six sample settlements to be added to the public space are shown in Figure 3. The cold city of Harbin has low winter temperatures and harsh weather conditions, resulting in the highest demand for thermal insulation and warmth facilities for outdoor activity venues for the elderly. Older residents have the second highest demand for barrier-free and resting facilities because of the deterioration of their physiological functions and limited mobility, preventing them from continuous outdoor activities.

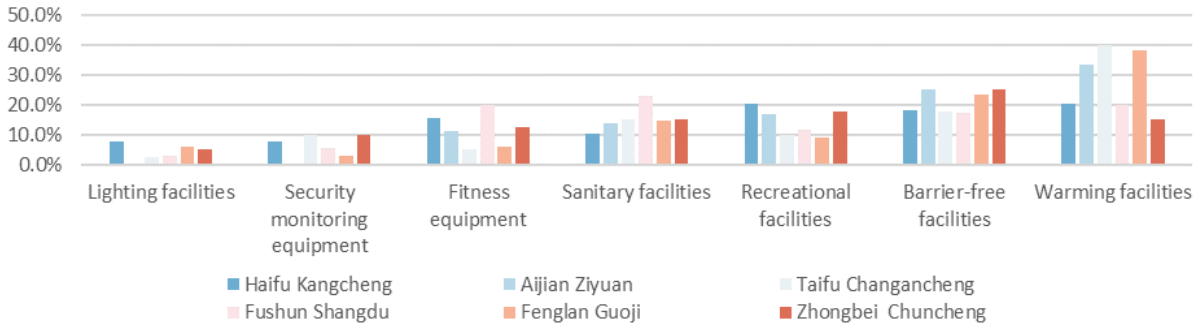

Figure 3. Additional public facilities suggested by the elderly in the settlement. Source: Author.

The results of the environmental factors affecting the outdoor activities of the elderly in the six sample settlements are shown in Figure 4. Three main aspects were mentioned: weather conditions, site conditions and management. In the interviews, a large number of elderly people mentioned that they would try to go out less when the roads were slippery in snowy weather. The scale of the activity sites and the number of public facilities were the most important concerns of the elderly, followed by the interior design of the place and the degree of landscape improvement. Some of them mentioned in the interviews that the level of property management was far from the initial period of settlement.

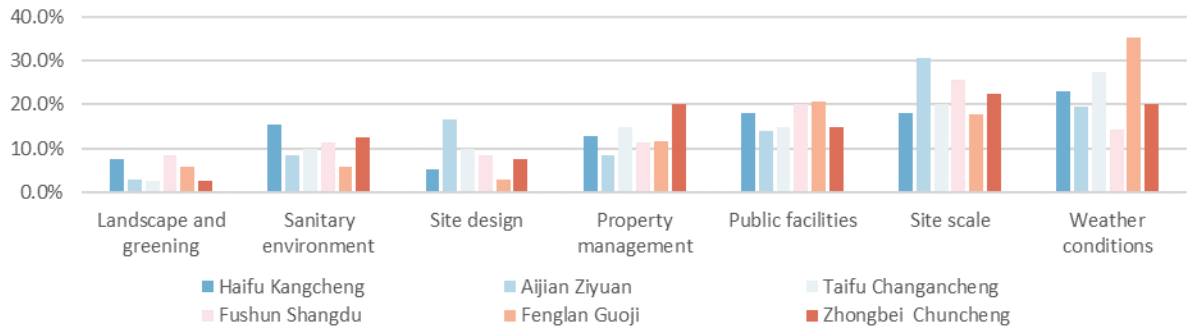

Figure 4. Influential factors affecting outdoor activities of the elderly. Source: Author.

3.3.2. Relationship between the activity characteristics and the public space in winter

The type of venue determines whether outdoor activities for the elderly can be carried out effectively. The outdoor activities of the elderly mainly occurred in the five types of venues in Table 5. The proportion of the elderly participating in different outdoor activities varied due to the different types of venues in different settlements, as shown in Figure 5. The most popular activity sites for the elderly in winter are fitness activity sites and hard squares, followed by structure squares. Older people generally carry out fitness activities such as equipment exercise, running and walking, ball games in fitness activity sites, dance and gymnastic activities such as square dance, aerobics and tai chi in hard squares, small gatherings and board games in structure squares, and activities such as childcare and recreation in landscape element squares and soft squares.

The size of the site and the adequacy of the facilities affect the time and frequency of outdoor activities for older adults. Activity venues of adequate size and facilities can effectively extend the length and frequency of outdoor activities for the elderly.

Table 5. Types of settlement sites. Source: Author.

	Landscape Elements Sites	Fitness space	Structure sites	Soft Square	Hard Square
Haifu Kangcheng	flowerbeds	fitness equipment	gazebo, sculpture	none	yes
Aijian Ziyuan	flower beds, trees	ball facilities, fitness equipment	seats, gallery	none	none
Taifu Changancheng	flowerbeds, ponds	fitness equipment	gazebo, gallery	yes	yes
Fushun Shangdu	flowerbeds, fountains	fitness equipment	seats, gallery	none	yes
Fenglan Guoji	ponds, trees	ball facilities, fitness equipment	seats, gazebo	none	yes
Zhongbei Chuncheng	flower beds, trees	ball facilities, fitness equipment	seats, gazebo	yes	yes

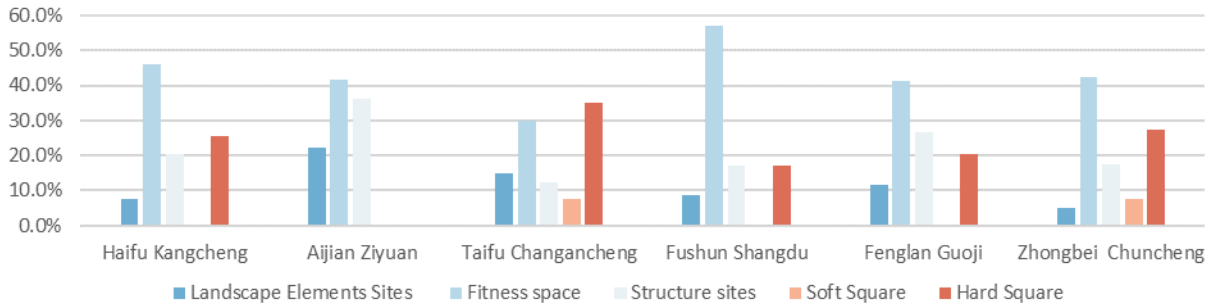

Figure 5. Distribution of outdoor activities for the elderly in winter in different types of sites. Source: Author.

4. Public space environment enhancement strategies for settlements in winter cities

4.1. Coordinate public space and create a comfortable environment

Planners should pay attention to the integrated planning of public spaces in settlements to facilitate opportunities for interaction among the elderly population. Based on ensuring the scale and quantity of activity venues, the public space of the settlement should be entirely laid out with interaction spaces and traffic flow lines connecting other indoor activity spaces, so as to integrate outdoor activity behaviours into the daily interaction movement of senior residents, increase the opportunities for senior residents to enter the public space and enhance the attractiveness of outdoor activities in winter. After fully understanding the climatic background of Harbin city in winter, on the one hand, planners can achieve changes in microclimate environments such as temperature, humidity and sunlight through environmental creation measures such as modifying microtopography and planting plants to improve the diversity and comfort of cold settlement spaces. On the other hand, the accessibility and safety of public space in cold settlements can also be improved by strengthening reasonable road network structure, road scale design and promoting barrier-free facilities. Focusing on improving the environmental quality of cold settlements can create a good and comfortable public space environment for elderly residents and increase their motivation to engage in outdoor activities.

4.2. Consider the needs of the elderly and configure protective facilities

On the one hand, planners should give full consideration to the level of refinement and accessibility design of facilities in public spaces in order to facilitate meeting the unique needs of elderly groups of different ages and physical health conditions. On the other hand, they should also consider the harsh winter climatic conditions of the cold regions for specialization and territorial adaptation of existing activity sites, which can be achieved by creating aging-friendly public space, constructing barrier-free facility systems, and strengthening humanized micro-enhancement. The activity sites of the public space of the settlements should include at least two main functions: one is the main activity area, that is, the main place for outdoor activities; the other is the related auxiliary area, including sitting and resting, isolating the main activity area and undertaking part of the traffic function. By constructing small structures and enriching winter greenery to form a wind and snow barrier, we can make up for the deficiency of the cold resistance of the elderly and effectively extend the length of outdoor activities for the elderly (Mengel *et al.*, 2020). In addition, in the planning and design process of the public space, we should show the natural beauty as much as possible and pay attention to the post-maintenance management. By regularly clearing the snow and ice and adopting anti-slip paving materials and other aging-friendly measures, we can reduce the negative impact of the cold winter climate on the outdoor activities of the elderly and improve the perception and satisfaction of the elderly with the public space.

4.3. Strengthen climate protection and enhance activity well-being

In the winter city, there is a significant difference in temperature between the four seasons, resulting in a large seasonal difference in the needs of elderly residents for their residential environment. Public spaces in winter settlements are often underutilized. In order to encourage outdoor activities for the elderly in winter and balance the level of activity behavior in different seasons, the potential of the public space environment to change with the seasons and how public space can support outdoor activities in winter should be considered at the beginning of planning and design. Specific measures to meet the change of public space functions with the seasons include flexible conversion of winter space functions, the establishment of shelter systems, and activation of winter-specific landscape resources.

Flexible conversion of winter space functions means that the public space in settlements can be changed flexibly according to different seasons, such as turning fountains and other water landscapes in summer into ice skating rinks in winter. Establishing shelter systems means installing sheltered nodes in public spaces in order to improve the winter outdoor activity experience of older residents and effectively extend the length of outdoor activities. Activating winter-specific landscape resources means that temporary structures can be built using natural winter landscapes such as ice and snow, which is conducive to enhancing the freshness and happiness of activities for elderly residents.

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