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Research on the Demand and Space Optimization in Elderly-Friendly Landscape Design

Xinyi Guo[1]

[1] *Yunnan College of Business Management, Kunming 650106, China*

ABSTRACT

With the accelerated development of China's aging population, the quality of life and health status of the elderly has gradually become the focus of social attention. In particular, the continuous growth of the elderly over 65 has made optimizing the aging-friendly environment increasingly prominent. According to statistics, by the end of 2021, the population of China aged 65 and above has exceeded 200 million, accounting for 13.05% of the total population (Chu et al., 2023). This trend not only puts higher demands on the allocation of social public resources but also triggers in-depth thinking on the adaptability of urban space. In this context, how to build a livable environment that meets the physiological and psychological needs of the elderly and optimizes their leisure activity space has become an important issue that needs to be solved urgently. This study focuses on key factors such as the behavioral characteristics, social needs, and supporting facilities of the elderly and explores the aging-friendly landscape design strategy to improve the comfort, safety, and participation of the elderly in outdoor activities. The research results have important practical significance for improving the living environment of the elderly and promoting the construction of a healthy elderly care system.

Keywords: *Elderly needs, Landscape design, Space optimization.*

1. INTRODUCTION

With the continuous development of society, the issue of population aging is becoming increasingly prominent and has far-reaching impacts on various aspects of society. This phenomenon involves not only changes in population structure but also affects the social, economic, cultural, and physical environments of cities, permeating people's daily lives. How to improve the quality of life for the elderly and optimize their living and activity spaces has become an important issue that urban development must confront [1].

Early research on the activity spaces of the elderly laid the foundation for subsequent explorations. For example, in the 1980s, the large-scale development of Continuing Care Retirement Communities (CCRC) in the United States provided references for the planning and design of elderly communities [2]. Against this backdrop, scholars began to focus on the planning and design of activity spaces for the elderly. For instance, in 1985, the book "Environmental Planning and Design for the Elderly: Problems, Guidelines, and Methods" systematically organized the activity spaces of the elderly, becoming an important starting point for research in this field [3].

Currently, disciplines such as architecture, urban and rural planning, and landscape architecture have conducted research on the living environment of the elderly from different perspectives. The fields of architecture and urban and rural planning mainly focus on building design standards, spatial layout, and the configuration of elderly care facilities, while landscape architecture pays more attention to the adaptability of outdoor environments for the elderly. For example, research on the behavioral characteristics of the elderly, planning of activity spaces, and arrangement of recreational facilities continues to enrich. Meanwhile, studies on the adaptability of landscapes under different climatic conditions and the evaluation of outdoor environments are also increasing [4]. Overall, with the advancement of urban public space construction and the increasing emphasis on ecological environment quality, the adaptability needs of the elderly to landscape

environments have become more prominent, further promoting the development of related research.

2. NEEDS OF THE ELDERLY

The physiological and psychological needs of the elderly are closely related and influence their activities and life experiences in public spaces. Physiological needs determine the comfort and safety of the environment, while psychological needs affect their social interactions and emotional satisfaction. To improve the quality of life for the elderly, public space design must not only focus on physical factors such as barrier-free facilities, lighting conditions, and environmental legibility but also consider psychological needs such as a sense of belonging, social interaction, and information access, ensuring that the elderly are fully satisfied on both material and spiritual levels [5].

2.1 Physiological Needs

The physiological characteristics of the elderly place certain limitations on their activities and create more specific requirements for the surrounding environment, mainly reflected in the following aspects: acoustic environment, light environment, wind-sheltered environment, barrier-free design, ergonomics, environmental legibility, and safety.

2.1.1 Acoustic Environment

The elderly have a relatively weaker ability to adapt to external environments compared to younger people and tend to prefer quiet and private spaces. In the design of parks or urban open spaces, noise interference should be minimized, and chaotic environments should be avoided. For example, in the design of Shanghai Jing'an Sculpture Park, the elderly activity area is located away from the main roads, and combined with green plants and water features to reduce noise impact, providing a quiet place for the elderly to rest.

2.1.2 Light Environment

The light environment includes both natural and artificial light. Sufficient sunlight not only enhances the visual comfort of the elderly but also promotes calcium absorption, preventing osteoporosis. For example, some areas of the Summer Palace in Beijing are equipped with ample sunlit resting spaces, using light-transmitting corridors and open lawns to allow the elderly to comfortably engage in activities under the warm sun. Artificial light environments should avoid strong glare and use soft, uniform lighting to reduce discomfort caused by vision decline.

2.1.3 Wind-Sheltered Environment

The wind speed directly affects the time the elderly spend in outdoor spaces, especially in northern cities, where strong winds can cause discomfort and even affect health. For example, in Harbin's Central Street, public seating and walkways are surrounded by low vegetation and enclosed corridors, effectively reducing wind speed and making outdoor activities more comfortable during the cold season. In park planning, wind channels should be reduced through green barriers and semi-enclosed seating to enhance the livability of the space.

2.1.4 Barrier-Free Design

Barrier-free environments are an essential aspect of age-friendly public space design, enhancing the mobility of the elderly and promoting social inclusivity. For example, Ueno Park in Tokyo, Japan, features an accessible pathway system with ergonomically designed ramps, wheelchair lanes, and barrier-free rest areas, ensuring that the elderly can use public facilities safely and smoothly. In urban renewal projects in China, it is also important to focus on improving the continuity of pathways and the completeness of barrier-free facilities, avoiding issues such as large height differences or restricted access.

2.1.5 Ergonomic Environment

With increasing age, the height, reach, physical strength, and endurance of the elderly all decline. Therefore, when designing public spaces, it is essential to fully consider ergonomics. For example, in Xuanwu Lake Park in Nanjing, the height of benches has been optimized to be suitable for the elderly to sit down and get up, reducing the burden on their joints. In addition, public facilities such as handrails, buttons, and door handles should also be designed to meet the usage habits of the elderly, enhancing the comfort and convenience of the space.

2.1.6 Environmental Legibility

The elderly often experience memory decline and are prone to getting lost in unfamiliar environments, especially in large green spaces or areas lacking visual landmarks. Therefore, enhancing the legibility of the environment is crucial. For example, Lianhuashan Park in Shenzhen uses vivid color contrasts, clear path markings, and distinctive landmark landscapes to help the elderly quickly identify directions. In spatial design, it is possible to enhance the legibility of the space by setting up conspicuous signage systems, using different materials for paving, and creating visual focal points with vegetation and sculptures.

2.1.7 Safety Needs

The elderly have relatively weaker mobility, reduced sense of balance, and slower reaction times, thus requiring a higher level of environmental safety. Key elements to enhance safety include barrier-free ramps, anti-slip flooring, handrail installations, and adequate night lighting. For example, in the West Lake Scenic Area in Hangzhou, anti-slip tiles have been installed along the walkways, and handrails have been added at critical locations such as steps and ramps to improve walking safety for the elderly. Additionally, water features in parks should incorporate safety precautions, such as installing appropriately high fences or designing shallow water areas to prevent accidental falls.

2.2 Psychological Needs

The psychological needs of the elderly adjust with changes in lifestyle, mainly reflected in the needs for goal variation, a sense of belonging, information, dependence, and social interaction. To enhance the psychological satisfaction of the elderly and improve their quality of life, public space design should provide suitable environments and activities [6].

2.2.1 Need for Goal Variation

After retirement, the focus of the elderly shifts from work to family and personal interests, with more leisure time available. They need new sources of joy and cultural entertainment activities to maintain physical and mental activity. Urban parks and green spaces, as important venues for the daily activities of the elderly, should offer a variety of fitness, entertainment, and social spaces. For example, Taoranting Park in Beijing features a Tai Chi square, a calligraphy and painting corridor, and a chess area, creating diversified leisure conditions for the elderly to find suitable interests and maintain a pleasant state of mind.

2.2.2 Need for a Sense of Belonging

Due to role changes and declining physical functions, the elderly are prone to feelings of loss and seek social recognition and emotional support. They desire acceptance and participation in group activities to gain a sense of belonging. For example, Shanghai Fuxing Park regularly organizes senior choir, dance troupe, and calligraphy exchange activities, allowing the elderly to integrate into the community and strengthen emotional connections with each other. In urban public space design, open communication areas and interactive landscape installations can be set up to encourage social interaction among the elderly and enhance their social participation.

2.2.3 Information Needs

The elderly wish to stay informed about social dynamics and pay attention to changes in their surroundings. Therefore, the convenience of information access channels is particularly important to them. In the planning of urban parks, information dissemination facilities such as bulletin boards, newsstands, and multimedia display screens can be increased. For example, Yuexiu Park in Guangzhou has set up electronic information screens in the main squares and leisure corridors, which broadcast news, weather forecasts, health knowledge, and other content on a rolling basis, enabling the elderly to access the latest information at any time. In addition, setting up guide signs and event preview boards along scenic trails also helps improve information accessibility and meet the elderly's needs for knowledge and social participation.

2.2.4 Dependency Needs

As they age, the physical functions of the elderly gradually deteriorate, their control over the external environment weakens, and their need for a sense of security increases. They hope to have something to rely on in their daily lives, with family, friends, and hobbies being important sources of emotional attachment. Public space design should provide warm and comfortable

environments to enhance the sense of belonging and security for the elderly. For example, some parks in the West Lake Scenic Area in Hangzhou have installed emergency call buttons next to pavilions and benches and arranged volunteer patrols to provide additional safety guarantees for the elderly. In addition, increasing friendly social spaces, such as interest group activity areas specifically for the elderly, also helps to enhance the psychological support system for the elderly.

2.2.5 Need for Social Interaction

After retirement, the social circles of the elderly tend to shrink, but they still crave communication and maintaining social connections. Regular participation in social activities not only helps them stay informed about new social trends but also enhances their sense of security and happiness. In the design of urban parks, interactive spaces such as chess areas, fitness squares, and cultural corridors can be added to promote communication among the elderly. For example, the "He Ming Teahouse" in Chengdu's People's Park has become an important social venue for local seniors, where they can drink tea, chat, and exchange social news, forming a stable social network.

3. LANDSCAPE DESIGN

Landscape design has a significant impact on the living environment of the elderly. Rational greening, ground paving, water body design, and lighting configuration can not only improve the quality of space but also meet the physiological and psychological needs of the elderly. Scientific and reasonable landscape design should find a balance between functionality, comfort, and aesthetics, allowing the elderly to engage in activities and rest in a safe and comfortable environment.

3.1 Greening Design

The arrangement of plants plays an important role in the comfort of the elderly's activity spaces and should be scientifically planned in combination with the physiological characteristics of the elderly and the functional requirements of the landscape space.

3.1.1 Combination of Trees and Shrubs

Greening design should primarily feature trees and shrubs while avoiding excessive obstruction of sightlines to ensure the openness and safety of the space. It is advisable to select tree species with large canopies and high branching points, such as ginkgo and plane trees, to ensure the comfort of the activity space beneath them.

3.1.2 Functional Greening Configuration

Large-scale greening should be implemented around plazas to serve as spatial separation and environmental regulation. Greening not only provides shade and aesthetic enhancement but also creates reasonable spatial transitions to prevent interference between different functional areas. For example, in Beijing's Temple of Heaven Park, tall trees are planted along the garden paths to form a natural barrier, which not only preserves the openness of the plaza but also provides a pleasant environmental atmosphere.

3.1.3 Seasonal Variation and Landscape Expression

Plaza greening is an important part of landscape design and plays a decisive role in shaping the overall spatial atmosphere. For the greening configuration of large-scale activity spaces, deciduous trees such as maple and zelkova should be chosen. These tree species provide ample shade in summer, and after shedding their leaves in winter, they allow sunlight to penetrate, offering comfortable resting conditions for the elderly. Additionally, ground cover plants and flowers can be combined to create seasonal landscapes, enriching the environment and enhancing the visual pleasure of the elderly.

3.2 Ground Paving

Plaza ground paving is an important element in shaping the sense of spatial order and has a significant impact on the walking safety and spatial perception of the elderly.

3.2.1 Visual Guidance and Spatial Scale

Since the vertical field of vision of the elderly is relatively narrow, patterned paving can be used in the design to enhance spatial legibility and provide a sense of scale. For example, the West Lake Music Fountain Plaza in Hangzhou uses different colored paving materials to delineate functional areas, enabling people to quickly understand the spatial layout and improving the elderly's adaptability to the environment.

3.2.2 Paving Methods and Safety

Ground paving can be implemented in three ways: composite, monolithic, and unit-repetitive, to meet different landscape needs. When designing, it is essential to consider the mobility convenience of the elderly. The ground should be kept flat without height differences, avoid using slippery materials, and reasonably control the drainage slope (recommended not to exceed 3%) to prevent water accumulation and slipping hazards. Additionally, anti-slip permeable bricks or fine-textured paving materials can be used to enhance the safety and comfort of the ground.

3.3 Water Feature Design

Water features play multiple roles in park environments, such as cooling, increasing air humidity, and enriching visual landscapes. Different forms of water features can create various environmental atmospheres.

3.3.1 Forms of Water Features

Depending on the spatial requirements, different water feature design techniques such as fountains, cascades, running water, and still water can be employed. For example, Xuanwu Lake Park in Nanjing combines still water surfaces with local fountains to create a contrast between dynamic and static elements, making the landscape more vivid while also providing quiet spaces for contemplation.

3.3.2 Barrier-Free Water Feature Experience

In the design of water features, the needs of the elderly should be considered by setting up appropriate water-edge platforms or low railings to ensure safety. Additionally, comfortable viewing spots can be provided by integrating pathways and seating arrangements, allowing the elderly to safely and conveniently enjoy the mental and physical relaxation that water features offer.

3.4 Facility Configuration

Public facilities are an essential part of the activity spaces for the elderly, and rational layout can improve the efficiency and comfort of space usage.

3.4.1 Seating and Shade Facilities

It is necessary to provide sufficient seating for the elderly, combined with tree shade or shelters to arrange resting spots. For example, People's Park in Chengdu has set up benches along the main pathways and added covered seating areas to ensure that the elderly can rest comfortably in different weather conditions.

3.4.2 Functional Auxiliary Facilities

Public spaces should be equipped with drinking facilities, information boards, and barrier-free storage lockers to meet the daily needs of the elderly. For example, Baiyun Mountain Scenic Area in Guangzhou has installed drinking fountains of different heights at various attractions, which are convenient for ordinary elderly people to use and also take into account the needs of wheelchair users. In addition, arranging storage lockers and clothing hooks at park entrances or around main squares can enhance usability.

3.5 Lighting Design

As vision deteriorates with age, the rationality of environmental lighting becomes particularly important for the elderly.

3.5.1 Optimization of Lighting Levels

Nighttime lighting should be enhanced to increase brightness and reduce dark areas, ensuring the safe movement of the elderly. For example, the Bund Riverside Walkway in Shanghai has installed low-position lighting fixtures on both sides of the walkway, which not only ensures adequate ground illumination but also avoids glare caused by high-position lights. Additionally, lighting design should focus on key spaces such as pathways, rest areas, and entrances/exits to ensure safety during nighttime activities.

3.5.2 Visual Comfort

Soft warm-toned lighting should be used to reduce the irritation of strong light on the eyes of the elderly. For example, the Olympic Forest Park in Beijing uses warm yellow lighting throughout the park, which provides good illumination while creating a comfortable nighttime environment. Moreover, motion-sensor lights can be added around corridors and seating areas to enhance the convenience and energy efficiency of lighting.

4. NODE DESIGN BASED ON BEHAVIOR AND ACTION DOMAINS

When designing activity spaces for the elderly, it is essential to fully consider their physiological characteristics and behavioral habits, while also paying attention to the needs of special groups such as wheelchair users and cane users. Rational node design can not only optimize spatial experience but also enhance social interaction and activity convenience for the elderly.

4.1 Scenographic Design Approach

Space design suitable for the elderly involves not only shaping forms and optimizing ecology but also in-depth research on their behavioral patterns and psychological needs, integrating the interaction mechanisms between "person-person" and "person-environment" into scene creation. For example, in the parent-child interaction area of Shanghai Century Park, activity facilities suitable for both the elderly and children are set up to create an atmosphere of intergenerational interaction. The elderly can rest in the seating area, maintaining an appropriate distance from their playing grandchildren while engaging in interactive communication, thereby enhancing their sense of psychological belonging.

During design, the physiological and psychological characteristics of the elderly, as well as the match between spatial functions and usage behaviors, should be comprehensively considered. For example, in the layout of leisure nodes in parks, multi-level activity spaces can be introduced so that the elderly can both sit quietly and participate in light exercise, improving the adaptability of the site.

4.2 Sensory Experience Optimization

As the elderly age, their sensory abilities such as vision, hearing, and smell gradually deteriorate. Therefore, space design needs to enhance sensory stimulation to increase the perceptibility of the environment. For example, in the Olympic Forest Park in Beijing, fragrant plants such as lavender and osmanthus are planted along the garden paths to enhance the olfactory experience. At the same time, low-frequency speakers are set up along the walking paths to play natural white noise, making the environment more inclusive.

In terms of color usage, the elderly's color discrimination ability declines, and their need for light increases. Therefore, high-contrast color combinations and warm-toned light sources can be used. For example, in square paving and signage systems, yellow or orange markings can be used to increase visibility and enhance the sense of direction. In water feature design, dynamic water flow or visualized fountains can be utilized, such as the musical fountain in Guangzhou Huacheng Square. The changes in water flow enhance both visual and auditory sensations, making it easier for the elderly to perceive environmental changes.

4.3 Interactive and Shared Space Design

The elderly enjoy interacting with nature, especially animals, such as bird-walking or feeding pigeons. However, traditional bird-walking methods, like hanging birdcages high up, can make it difficult for the elderly to take them down or put them up. Therefore, in the design, it is possible to combine plant configuration to set up multifunctional bird racks. For example, in People's Park in Chengdu, low bird racks are designed near the benches, which are convenient for the elderly to hang birdcages. The increase of green plants around the seats makes it a landscape node that integrates interaction, rest and appreciation.

In addition, the design of public space seats should encourage social interaction, for example, by using enclosed or L-shaped layouts, so that the elderly can naturally face each other and communicate. The traditional garden seat layout of the Humble Administrator's Garden in Suzhou reflects this concept, forming several small gathering points in combination with the garden landscape to enhance the social experience of the elderly.

4.4 Ergonomic Optimization

Due to differences in mobility, the elderly have different requirements for the height, size and material of facilities. For example, in Liyuan in Wuxi, handrails of different heights are set up in the waterside area to meet the needs of healthy elderly people, those with mild mobility limitations and wheelchair users.

In the detailed design of landscape facilities, the height of the seat should be controlled between 40-45cm to make it easy for the elderly to get up. The seat surface should be made of anti-slip materials and combined with backrest design to improve comfort. The lighting system should ensure uniform night lighting, avoid forming overly bright or dark

areas, and at the same time reduce glare problems. The setting of storage racks should also comply with ergonomics, for example, controlling the cabinet door height between 60-100cm to facilitate the elderly to store and retrieve items.

5. CONCLUSION

With the acceleration of population aging, improving the environmental quality of outdoor leisure spaces has become an important direction for the development of elderly care spaces. High-quality outdoor environments not only provide comprehensive health and elderly care services for the elderly but also align with the development concept of China's characteristic Continuing Care Retirement Communities (CCRC). Elderly care communities are centered around five core functions: "medical care, housing, elderly care, entertainment, and learning," most of which directly involve the age-friendly design of outdoor spaces. Therefore, creating high-quality landscape environments that meet the physical and mental needs of the elderly has become an important research topic in landscape design.

An age-friendly and livable environment should have ample sunlight, fresh air, and comfortable activity spaces, while also paying attention to the behavioral needs and psychological care of the elderly in landscape design. Age-friendly design is not only reflected in the overall layout but also in the optimization of barrier-free details, such as controlling the slope of pathways, setting up seating, providing shaded areas with greenery, and designing lighting systems. Refined and human-centered design can effectively enhance the user experience of the elderly, providing them with higher levels of comfort and security in outdoor spaces.

In the future, the construction of age-friendly landscape environments will require the integration of more interdisciplinary knowledge, including sociology, psychology, medicine, and nursing, to establish a more comprehensive health management-oriented landscape design system under the framework of the "big health" strategy. The integration of different disciplines will help form more scientific and precise design methods for age-friendly spaces, better meeting the diverse living needs of the elderly.

In terms of functional zoning, age-friendly outdoor spaces should be designed based on the behavioral characteristics of the elderly to create different levels of social and activity areas. Depending on the varying needs for social interaction, these can be categorized into large social spaces (suitable for square dancing and group fitness activities), small communication spaces (for sitting and chatting, as well as card and chess games), private leisure spaces (to meet the needs for solitude), and transitional spaces (connecting different activity areas). Regarding fitness functions, the site can be divided into ball game areas (for sports like gateball and table tennis), fitness equipment areas (equipped with rehabilitation training equipment), dance fitness areas (for square dancing and aerobics), and traditional health-preserving exercise areas (suitable for Tai Chi, Qigong, and the Five-Animal Frolics). In addition, a walking system, seating and rest areas, and green landscape spaces run throughout the entire site, providing the elderly with a continuous and comfortable outdoor experience.

Through systematic age-friendly landscape planning, future outdoor leisure environments will better meet the health needs of the elderly, enhance their social interaction, and improve their quality of life, providing strong support for building a "healthy aging" society.

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