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EFFECTS OF BIOPHILIC ELDERLY CARE BUILDINGS ON THE HEALTH OF ELDERLY PEOPLE

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Abstract

With the aging of the population, China's demand for elderly care buildings is growing, but the design of the building space environment still needs to be further optimized. Combined with the current problems of insufficient natural landscape configuration, spatial patterning and lagging construction of elderly-friendly facilities in elderly care buildings, under the policy background of active aging, the concept of constructing biophilic elderly care buildings is proposed. At present, it has become a trend to integrate biophilic elements into buildings. In this paper, quantitative research is used to investigate elderly people in five representative elderly care buildings in Beijing City, China. Then, according to the survey results, the researcher analysed the application of Nature in the Space, Nature Analogues, and Nature of the Space strategies in architecture, and summarizes the biophilic design elements and their locations suitable for elderly care buildings. At the same time, it summarizes the health benefits of the elderly in physical recovery, mental health, and cognitive ability in elderly care buildings, and establishes a path for biophilic design to affect health. The application of biophilic design strategies in the interior space of elderly care buildings has high construction potential and application value and provides a new direction for the creation of elderly care building environments.

Keywords: Active aging, Biophilic design strategies, Elderly care buildings, Elderly people, Health promotion.

1. Introduction

By the end of 2021, there will be 267.36 million people in China who are 60 years of age or older, making up 18.9% of the country's total population. Of these, 200.56 million will be 65 years of age or older, making up 14.2% of the country's total population; by 2030, there will be 360 million elderly people in China who are 65 years of age or older, making up roughly 25% of the country's total population [1]. The issue of caring for the elderly will worsen.

With the changes in the economic environment and the cognition of age, the society's attitude towards aging has gradually changed from negative to positive. Dogra et al. [2] describes that from the perspective of active aging, not only should the physical health of the elderly be considered, but also the realization of the emotional needs, environmental creation, social participation, personal values and social security of the elderly should be considered comprehensively to ensure the improvement of the overall quality of life of the elderly.

Lenzi and Perucca [3] argue that most of the elderly in cities live in "reinforced concrete" buildings at present, and their living space is becoming more and more depressing and boring. The relationship with nature is gradually alienated, and problems such as physical function degeneration and emotional loss are inevitably accelerated. Biophilia is human instinct and contact with nature is a basic need of human beings, and it is no exception for the elderly. Gaekwad et al. [4] mention that contact with nature not only enriches the lives of the elderly, but also improves their physical condition, and meets the basic requirements of active aging: "health, participation, and security". From the perspective of active aging, we focus on the nature-friendliness and biophilia of elderly care buildings, so as to mend the broken relationship between the elderly and nature, improve their health and living environment, and promote the sustainable development of the urban ecological environment.

2. Problems Existing in Elderly Care Buildings at Present

Feng et al. [5] describe that the mode of providing for the aged in China has been diversified, and the buildings for providing for the aged have also been expanded into various types, such as apartments for elderly people, rehabilitation centres for elderly people, and activity centres for elderly people. The existing research on elderly care buildings in China lacks mature theory as the basis, and most of them are conducted in literature review papers, but lack of specific investigation. This paper adopts quantitative research method, based on mature theory, and conducts research in representative places to make the results as representative and universal as possible.

2.1. Insufficient allocation of natural landscape in elderly care buildings

With the vigorous development of urban development and construction, the living environment of human beings has undergone tremendous changes, and at the same time, it has gradually alienated from the natural environment. Pol [6] mentions that according to the research of environmental psychology, both urban natural environments and artificial environments will have positive or harmful effects on the behaviour, interpersonal relationships, and psychological state of the elderly. In the narrow and boring living environment, it will not only have a serious impact on the mental health of the elderly but also increase their mental illness.

2.2. Building space design is too modular

At present, the design of elderly care buildings often adopts modular layout, and the functions of living and activities are rigidly organized, ignoring the needs of the elderly to communicate with others and contact with nature, and their feelings are nowhere to be pinned. Lin and Yan [7] describe that the current Code for Design of Residential Buildings for the Elderly of China Government (GB50340-2016) also has some problems, such as the standard management system can't meet the requirements of market development, and too much emphasis on the control requirements at the index level, which leads to the over-modularity of the space design of elderly care buildings and the lack of spiritual creation. Chiu and Hsieh [8] argue that it is difficult for the elderly to meet their emotional needs due to the decline of memory, and a single boring building space will not only worsen this situation but also increase the probability of mental illness for the elderly and accelerate the loss of memory.

2.3. The construction of elderly care buildings is lagging behind

The lack of barrier-free facilities in current elderly care buildings is a common problem. Based on the findings of China's fourth sample study on the living conditions of senior citizens in both urban and rural areas, 60% of the elderly believe that the construction of the living environment is lagging and that the housing is not suitable for the elderly [9]. Due to the insufficient configuration of facilities suitable for the elderly, the elderly have many inconveniences in their daily lives, which makes them prone to negative psychology such as depression and inferiority, and is not conducive to the construction of active aging. Under this situation, attention should be paid to providing a supportive and accessible environment [10].

3. Biophilic Elderly Care Buildings

On the basis of in-depth analysis of the elderly care building, combined with the demand of active aging policy, the concept of bio-friendly old-age buildings is put forward to meet a series of new requirements for the design of elderly care buildings in the new era.

At the end of the 20th century, Wilson [11], an ecologist, and conservationist at Harvard University, put forward the concept of biological property, which was defined as the inherent tendency of human beings to be associated with the natural system, especially with the characteristics of other life in non-human environment. Panlasigui et al. [12] mention that both the design of biological property and the design of bio-friendly buildings need to follow certain basic principles, namely, repeatedly and continuously contacting with nature, encouraging emotional attachment to a specific environment and place, promoting positive interaction between man and nature, and encouraging the expansion of the relationship and sense of responsibility between human and natural communities.

Karaman and Selçuk [13] argue that the biophilic elderly care building focuses on the research of the relationship between nature and health in the built environment on the basis of biophilic building. In order to meet the physical, psychological, and cognitive health needs of the elderly, it creates a direct and indirect experience of nature and a place spiritual experience, and at the same time increases aging facilities to ensure the daily activities needs of the elderly and maintains a close relationship between the natural environment and the elderly [14].

3.1. Insufficient allocation of natural landscape in elderly care buildings

In 1964, Fromm [15] proposed the term "biophilia". Wilson proposed the "Biophilia Hypothesis" in 1984, pointing out that humans have an instinctive tendency to be close to nature [16]. In 1982, Ulrich's Stress Reduction Theory believed that contact with natural elements can activate the parasympathetic nervous system, leading to a decrease in heart rate, blood pressure, skin electricity and salivary cortisol levels, achieving the effect of relieving psychological stress and physiological relaxation [17]. Kaplan proposed the Attention Restoration Theory, believing that the natural environment restores directed attention by providing attraction, allowing people to have a restorative experience and improve the cognitive performance of direct attention [18]. Based on different research perspectives, the two major restoration theories explain the mechanism of natural environment restoration, define the environmental restorative effect in three aspects: cognitive ability, physiological recovery, and mental health, and lay the foundation for the study of architectural space environment as shown in Fig. 1.

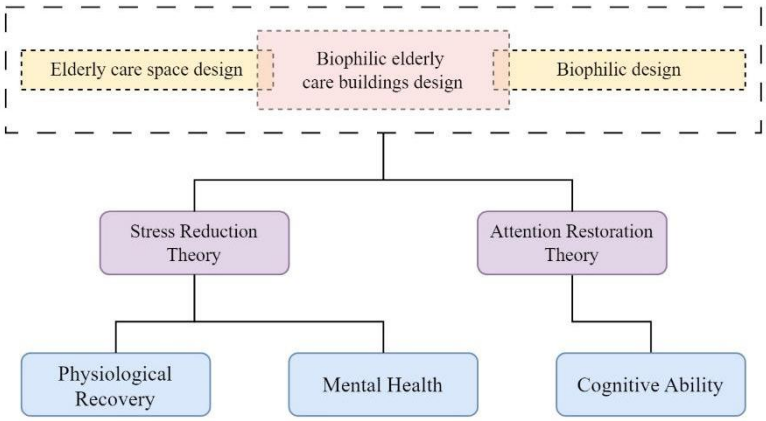

Fig. 1. Theoretical basis of biophilic elderly care buildings.

Kellert et al. [19] integrates nature into the architectural environment and proposes six elements of biophilic design (environmental characteristics, light and space, natural patterns and processes, natural shapes and forms, place-based linkages, and the changing dynamic between nature and humanity) and 72 attributes. Ryan et al. [20] summarizes these attributes into three categories, namely Nature in the Space, Nature Analogues, and Nature of the Space.

3.2. Nature in the space

Zhong et al. [21] describe that the strategy of Nature in the Space refers to directly introducing natural elements into the building space to enhance the connection and feeling between people and nature. Nature in the Space is the basic strategy of the interior biophilic design of elder care buildings, that is, directly using natural elements and resources to create comfortable elder care buildings and give play to the direct role of nature. Kellert [22] argues that the roof garden, central courtyard, outdoor corridor, three-dimensional greening, indoor environment, balcony

windows and other locations of the building can be used to introduce sunlight, air, sound, wind, water, animals and plants, and natural systems into the building to mobilize people's visual, auditory, olfactory, perceptual, tactile, taste and other sensory systems, realize the interaction between the elderly, buildings and nature, and make elder care buildings closer to nature.

3.3. Nature analogues

Richardson and Butler [23] describe that the Nature Analogues design strategy refers to creating architectural forms and spaces through analogies of natural principles and forms without actual contact with nature in architectural design. By imitating natural materials, biological forms and biological forms in nature, and natural changes, in elderly care buildings, through the facades and landscapes of the exterior of the building, as well as the interior space, internal details, landscapes, and spatial structures of the building, it brings physical and psychological comfort to the elderly [24].

3.4. Nature of the space

Barbiero and Berto [25] argue that the Nature of the Space design strategy refers to designing the building space to be the same as the natural element space, so as to improve people's comfort and health. Totaforti [26] describes that taking Nature of the Space as an extension strategy of the indoor biophilic design of elder care buildings, the indirect role of nature is brought into play, windows, balconies and other open spaces are used to build spaces with prospects, and spaces with a sense of mystery and security are created inside the building. Guardrails are set up at balconies, stairs, and other locations to create places to avoid dangers. Through the design strategy of nature in space, a space atmosphere similar to nature is created to bring a more comfortable experience to the elderly.

4. Method

This research used a quantitative research method to explore the relationship between biophilic design elements and the health of the elderly. The main reason for choosing a quantitative research method is that it can provide a structured and objective way to quantify and analyse the elderly's perception of biophilic design elements and their impact on health. The research site is in Chaoyang District, Beijing, the capital of China. The researchers selected two representative apartments for elderly people respectively named Guangda and Yikang, two rehabilitation centres for elderly people respectively named Wuyuan and Changyou and one activity centre for elderly people named Xianghe.

The survey was conducted from 9: 00 am to 5: 00 pm from 15th to 20th June 2024, and the subjects were elderly people over 60 years old in these five buildings. The content of the questionnaire is presented in paper, and the font is large and bold, which makes it easier for the elderly to read. The sampling method is non-probabilistic random sampling, and the researcher randomly selected 357 responses (206 males and 151 females).By means of methodical data gathering and examination, we aimed to explore the effects of three different types of biophilic building environments, Nature in the Space, Nature Analogues, and Nature of the Space, on the physiological recovery, psychological health, and cognitive ability of the elderly.

4.1. Data collection

This research used a questionnaire survey as the main data collection tool to evaluate the influence of biophilic design elements in elder care buildings on the health of the elderly in China. The questionnaire design combined demographic information, biophilic design patterns and included elements, and elderly health elements. In addition, a five-point Likert scale was used to gauge respondents' attitudes and perceptions in the questionnaire, which was developed based on the literature review and perception statements. Table 1 shows the particulars of the questionnaire.

Table 1. The particulars of the questionnaire.

Section	Description	Literature
Demographic Information	It includes 3 questions, exploring age, gender, and education level.	-
Nature in the Space	Tangible contact with natural features.	[20-24, 26]
Nature Analogues	Interaction with pictures or depictions of the natural world.	
Nature of the Space	Spatial linkages are used in the experience of location and space to improve wellbeing.	
Health of the Elderly	Physiological Recovery Mental Health Cognitive Ability	[17, 27]

To ensure the breadth of data collection and the accuracy of the questionnaire, this study adopted a combination of online and offline methods to conduct the survey. The online questionnaire was mainly distributed through WeChat groups. This method helps to collect data quickly and widely while reducing regional restrictions. For offline respondents, the research team provided paper questionnaires. This mixed method aims to maximize the coverage of the survey and ensure the participation of different groups. In addition, the research team asked the staff in the elder care buildings to assist the elderly in filling out the questionnaire, which helped to improve the accuracy and reliability of the data.

4.2. Data analysis method

First, frequencies, means, and standard deviations were calculated using descriptive statistical analysis to compile the respondents' answers to the questionnaire's items. This stage gave us a general idea of the respondents' opinions regarding biophilic building design features. Furthermore, to ascertain the support for the research hypotheses and to examine the statistical association between biophilic design components in buildings and older adults' health, correlation and regression analysis were employed.

5. Results and Discussion

5.1. Demographic information

The study first conducted a careful descriptive analysis of the demographic information of the 357 respondents (206 males and 151 females), seeking to comprehend how their opinions on the research issue were impacted by these background circumstances.

Through descriptive statistics, we noticed that the backgrounds of the elderly in elder care buildings are extremely diverse, which may affect their perception of biophilic design elements in buildings and thus affect their health as shown in Tables 2 and 3.

Table 2. Gender and age group cross-analysis.

Age Group/ Gender	Male (58%)	Female (42%)
60-69 years (49%)	28%	21%
70-79 years (30%)	17%	13%
80 and above years (21%)	13%	8%

Table 3. Education level and age group cross-analysis.

Education Level/ Age Group	60-69 years (49%)	70-79 years (30%)	80 and above years (21%)
Primary school and below (34%)	9%	11%	14%
Secondary school (48%)	30%	12%	6%
Bachelor's degree and above (18%)	10%	7%	1%

5.2. Descriptive analysis

As shown in Table 4, by evaluating and analysing the data of Nature in the Space, Nature Analogues, and Nature of the Space, the following conclusions can be drawn.

Table 4. Elderly people' opinions of biophilic design elements.

Variables	Items	N	Minimum value	Maximum value	Average value	Standard deviation
Nature in the Space	Plant	357	1	5	4.68	0.763
	Animal	357	1	5	2.94	1.339
	Sunlight	357	1	5	4.95	0.914
	Water	357	1	5	3.67	2.654
	Air	357	1	5	4.73	0.860
	Natural Landscape	357	1	5	4.06	0.714
Nature Analogues	Natural Image Simulation	357	1	5	3.48	2.853
	Natural Materials	357	1	5	4.35	3.056
	Natural Shape	357	1	5	3.06	2.547
	Natural Colour	357	1	5	3.75	1.246
	Simulated Light	357	1	5	3.98	3.642
	Simulated air	357	1	5	3.04	2.759
	Natural Change Process	357	1	5	3.23	2.951
Nature of the Space	Sense of Belonging	357	1	5	4.74	1.859
	Sense of Security	357	1	5	4.82	2.563
	Sense of Participation	357	1	5	4.39	2.178
	Sense of Achievement	357	1	5	4.11	1.927

Elderly people have the highest desire for Nature of the Space, and the highest requirement is for a sense of security. This requires that elder care buildings have complete facilities for the elderly and emergency equipment to ensure the safety of the elderly. Johansson et al. [28] believe that the second is a sense of belonging, which can be divided into public space, semi-public space, and private space according to the elderly's needs for life and making friends. Indoor public space design: public space includes the foyer and living room.

Rijnaard et al. [29] describe that this area can be decorated with potted plants, bouquets, etc., and the landscape view of the balcony can be fully utilized to direct the landscape view to the outdoors, as a transition space for indoor and outdoor biophilic landscapes as shown in Fig. 2. Indoor semi-public space design: semi-public space includes dining rooms, activity rooms and other spaces. This type of space must ensure the needs of the elderly to communicate and ensure a certain degree of privacy [30].

The activity room is a place for the elderly to participate in collective activities. Plant partitions should be used as much as possible to create flexible and changeable micro spaces to facilitate the elderly to carry out various activities. Zekri and Jamalzadeh [31] argue that the restaurant should reduce plant partitions and focus on creating plant landscapes with soothing odours to reduce the tension of dining activities as shown in Fig. 3. Private space design: As a private space in the lives of the elderly, the bedroom should be designed to meet multiple needs such as comfort and age friendly. Paque et al. [32] believes that by placing plants that soothe the senses and configuring facilities suitable for the elderly with natural materials, a comfortable resting environment can be created as shown in Fig. 4.

Fig. 2. Maggie's recuperation centre.

Fig. 3. Ju Nursing Home in Shanghai.

Fig. 4. Yuqi Nursing Home in Xi'an.

The elderly also have high expectations for Nature in the Space, especially in terms of air, plants, and natural landscapes, which requires good air quality in elder care buildings and good air exchange between indoor and outdoor areas. In terms of plants, it is necessary to ensure that the elderly can directly contact as many plants as possible and ensure plant diversity. De Boer et al. [33] describe that Singapore's urban elderly farm combines biophilic buildings with elderly care buildings through micro-agricultural transformation, combined with flexible and high-density agricultural planting facilities, which can not only meet the living needs of the elderly, but also enrich the spiritual experience of the elderly as shown in Fig. 5.

Fig. 5. Singapore's urban elderly farm.

Although the values of Nature Analogues are not high, natural materials can also be selected if the funds are sufficient. In terms of decoration, the interior space of the elderly care building should use materials close to nature to enhance the biophilicity of the building [34]. The biophilicity of interior decoration is mainly reflected in the selection of walls, floors, and furniture. By comprehensively considering the characteristics and psychological needs of the elderly, we can determine the interior decoration materials that are close to nature. When choosing wall materials, we should try to choose simple and soft colours without too much decoration. Samir [35] believes that the floor can be made of wood to extend the outdoor natural environment and create a biophilic indoor environment. Jun and Choi [36] argue that furniture made of natural materials is mostly streamlined, spiral and other streamlined shapes, which can meet the visual comfort of the elderly.

According to the Table 5, the physiological recovery and mental health indexes of the elderly are very high, indicating that the use of biophilic design elements in elderly care buildings will obviously improve the health level of the elderly.

Table 5. Health of the elderly.

Items	N	Minimum value	Maximum value	Average value	Standard deviation
Physiological Recovery	357	1	5	4.38	2.043
Mental Health	357	1	5	4.89	2.174
Cognitive Ability	357	1	5	3.95	2.749

5.3. Reliability analysis

Cronbach's alpha is used in this research to assess the scale's reliability. The questionnaire's overall Cronbach's alpha value is 0.958, over the required minimum of 0.700. According to Table 6, the questionnaire has excellent credibility and good consistency because each variable's Cronbach's alpha value is over 0.700.

Table 6. Reliability analysis.

Variable	Value of Cronbach's alpha	Number of Items
Nature in the Space	0.867	6
Nature Analogues	0.724	7
Nature of the Space	0.895	4
Health of the Elderly	0.929	3

5.4. Validity analysis

As shown in Table 7, the survey data's KMO test result is 0.913, which is higher than 0.70 and indicates that the questionnaire is suitable for factor analysis. The Bartlett sphericity test findings show that the estimated chi-square value is 35.023, and the significance probability is 0.000 ($P<0.01$). The validity structure of the scale is therefore considered to be sound.

In summary, this research revealed the significant impact of the specific biophilic building design elements on the health of the elderly through systematic quantitative analysis. It provides more detailed and in-depth practical guidance for this research. In order to encourage healthy lives and sustainable building development, this research also highlights how crucial it is to take into account the requirements of various groups and use a variety of approaches when designing elder care facilities.

Table 7. KMO and bartlett's test.

KMO		0.913
Bartlett's Test of Sphericity	**Approx. Chi-Square**	35.023
	df	132
	Sig.	.000

6. Conclusion

Through the above analysis, three kinds of bio-friendly design strategies can significantly affect the health of elderly people in elderly care buildings. By incorporating biophilic elements into elderly care buildings, we can provide a richer natural experience and enhance the participation and health of the elderly. At the same time, based on Attention Restoration Theory and Stress Reduction Theory, researchers have summarized the psychological and behavioural characteristics of the elderly. According to the design strategies of Nature in the Space, Nature Analogues, and Nature of the Space in Biophilic Design, in terms of policy making, the government and relevant departments can effectively stipulate the internal functions and spatial division of the building to ensure that the elderly can improve their physical recovery, mental health and cognitive ability in elderly care buildings.

By rationally combining various natural elements, we can meet the diverse needs of the elderly. Not only can they see nature visually, but they can also participate in nature. At the same time, we should focus on the maintenance and administration of elderly care buildings, improve the sustainable development of buildings, and provide a long-term stable and friendly environment for the elderly.

However, we are also conscious of the difficulties and issues that exist today, such inadequate funding and subpar administration. We have suggested remedies to these issues, including enhancing social involvement and government assistance, raising the standard of management in pertinent senior care facilities, and promoting sustainable growth.

7. Limitation

This study is only conducted in China. Due to regional and cultural differences, the results may not be applicable to other countries.

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