Research on the Interaction Space Evaluation of Aged Care Architecture in Villages and Towns from the Perspective of Inclusiveness: Take Wuyang County as an Example

Min zhou[1a], Fan Wu[2]*, and NaNa Zhu[3b]

[1]Min Zhou, School of Architectural and Artistic Design, Henan Polytechnic University, Jiaozuo 454000, Henan Province, China
[2]Fan Wu*, School of Architectural and Artistic Design, Henan Polytechnic University, Jiaozuo 454000, Henan Province, China
[3]NaNa Zhu, School of Architectural and Artistic Design, Henan Polytechnic University, Jiaozuo 454000, Henan Province, China

Abstract: As China's population keeps aging, the hollowing-out problem in villages and towns gradually becomes prominent, accompanied by the increasing number of residents in aged care architecture. As one social occasion, the interaction space of aged care architecture is of great significance for the elderly. The present study, therefore, collects and analyzes relevant evaluation indicators from the perspective of inclusiveness. The AHP-Fuzzy comprehensive evaluation method was adopted to construct an evaluation system for the interaction space of aged care architecture in villages and towns in China. In order to verify the system's accuracy and effectiveness, the evaluation of Xin'an Town in Wuyang County was carried out. The research is helpful for the design of interaction space of future aged care architecture in China and the improvement of the existing buildings, providing a certain reference for the inclusive evaluation of the interaction space of aged care architecture in villages and towns.

1. Introduction

In the 21st century, the degree of population aging in China is deepening day by day. According to the seventh National Population Statistics, the number of the elderly over 65 in China has reached 190 million, accounting for 13.5% of the total population[1]. With the intensification of the aging process in China in recent years, the decrease in the number of children in families, the changes in living environment, and a series of other factors, more and more elderly people in villages and towns have to choose to live in aged care architecture. Communication space is an indispensable part of the living environment of the elderly. Thousands of years of aged care ideas in China have made the elderly more inclined to the environment and things they are familiar with in their old-age life activities. In China's current pension institutions, whether public or private, the design of the interaction space for the elderly has not yet been taken into sufficient consideration. Comprehensive environmental behavior, environmental psychology and field research are adopted to make qualitative and quantitative research on the interaction space of aged care architecture in Wuyang County, which is of vital importance for the creation of a healthy social life for the elderly residents, efficient design and renewal of the space of aged care architecture, and effective configuration and improvement of public service facilities.

Based on the interaction space of the aged care architecture in villages and towns and the demand relationship generated by the increasing number of modern elderly residents, this paper selected the influencing factors from the aspects of physical space and human perception and drew on findings from previous studies, which was helpful to analyze the elements of social space types of aged care architecture, explore the accessibility types of inclusive communication space, and provide research and evaluation methods for the spatial elements of aged care architecture in the future. Pursuant to the theoretical elements of the inclusive design method and the AHP-Fuzzy comprehensive evaluation method, an evaluation model of the interaction space of the aged care architecture in townships and villages was established, the inclusiveness of its interaction space in Xin'an Town of Wuyang County was evaluated and analyzed, and the influencing factors and rationality of the inclusive design were clarified.

2. Evaluation of the inclusiveness of the communication space of the aged care architecture in townships and villages

2.1 Inclusive design concept

In 2005, the inclusive design was defined by the British Standards Institute as mainstream products or services that will be used as much as possible without special adaptation or design [2]. The elderly living in aged care

* Corresponding author: W15660595805@163.com
[a]cindyzhou@hpu.edu.cn, [b]2584788936@qq.com

architecture in China's townships and villages are not limited to people with good health, but also include the elderly and younger people with more or fewer diseases. In the communication space which includes the range of activities of all people, the feedback of inclusiveness on the public should be taken into consideration. In recent years, with the emergence of a large number of inclusive design methods, some scholars have used focus groups and empathic design methods to evaluate the inclusive design of the elderly in public spaces in state parks[3]. Most of the studies on inclusive design focused on children, the elderly or the disabled, starting from elements such as ergonomics, design toolkits, data tool evaluation, usage methods, etc., to developing evaluation element standards for different groups[4]. In addition, some scholars conducted design research on the environment, color, material, shape, and intelligence of architectural space, and provided theoretical method reference for the design research method and practical application of interior space.

2.2 Defining the communication space of aged care architecture in towns and townships

The concept of communicative space has been continuously mentioned and studied in the works of Jane Jacobs, Roger Barker, Jan Gehl and others since the 1960s[5]. Edward Twitchell Hall first introduced the concept of spatial relations and private space in The Hidden Dimension, studied the communication forms and distance laws in personal space and communication behavior, and divided interpersonal communication into four types respectively, namely, public distance, social distance, personal distance, and intimate distance, so as to distinguish the degree of communication[6]. Under the premise of taking the architectural space of aged care facilities as the scope of discussion, communication space is a comprehensive vocabulary, which takes human beings as the main subject, communication space as the object, and behavior as the medium, all of which together constitute the process of communication. Compared with young people, the elderly in townships and villages tend to have smaller social distances and communicate informally in aged care architecture, preferring to communicate psychologically and seeking spiritual partners and relationships (Table 1).

Table 1. Defining scope of communication space.

Social distancing	Distance	Type of activity	Location occur
Public distance	> 3.7m	Public events	Event hall
Social distance	1.2—3.7m	Greet each other. Stop to talk	Hallway. Hall
Personal distance	0.45—1.2m	Dining. Entertainment. Bathing. Indoor activities	Dining room. Public room. Bathroom
Close distance	0——0.45m	Walking together. Talking intimately. Interacting with each other	Bedroom. hallway. Activity room

2.3 Collection of evaluation indicators for the inclusiveness of the interaction space of the aged care architecture in towns and townships

2.3.1 Design of an evaluation tool for inclusive case study

The collection of inclusive assessment tools for this study is mainly derived from the examination of inclusive design questions developed by Levine shared in Nussbaumer's book Inclusive Design: A Universal Need and the optional research assessment provided by the Department of Natural Resources (DNR) of the State of Michigan [7]. This checklist contains building design guidelines provided in the Americans with Disabilities Act of 1990 (ADA), including signs, parking, walking routes, entrances and doorways, ramps, restrooms, dining and work surfaces, dressing rooms, kitchens, showers, service counters, passenger loading areas, elevators, stairs, laundry rooms, directional information signs, assembly areas, directional signs, and variable information signs. Spaces such as event halls, corridors, restaurants, common rooms, bathrooms, corridors, etc., selected by the defined scope, are listed in the following table (Table 2) in the list of inclusive design assessment tools provided by DNR and Nussbaumer et al.

Table 2. Design aspects related to interaction spaces in the Inclusive Design Checklist.

Design feature	Questions
Entrance and doorways	1.Is it easy to maneuver through the door with packages, strollers, small children, arthritic hands, canes, crutches, or wheelchairs?
	2.Is the pathway clear at the entrance?
	3.Is the entrance also an emergency egress?
	4.Is the accessible entrance separate or same for everyone?
	5.Is there plenty of clear floor space in the entrance of lobby?
	6.Is enough space allowed for groups of people to meet without blocking the entrance of affecting circulation?
	7.Are amenities adjustable or alternative heights?
Interior routes and surfaces	8.Does an elevator or ramp connect every level?
	9.Are transitional spaces devoid of obstacles?
	10. Are transitional spaces are wide enough to accommodate a group of people?
	11.Are all walking surfaces stable and firm?
	12. Are all walking surfaces smooth and leveled?
	13.Do all hard or resilient floor coverings have non-slip finishes?
	14.Are colors easy on the eyes?
	15.Are materials non-reflective?
Bathroom& Bedroom	16. If not all toilet rooms are accessible, are there signs that give directions to accessible toilet rooms?
	17.Is there slip resistant tile on floor?
	18.Towel bars are located at varied heights?
	19.Grab bars are given in toilet?
	20. Mirrors are located at such height to facilitate

seated people as well.
21. There are grab bars in shower areas?
22.There is a walk-in shower rather than a tub?
23.Are rooms easily accessible or adaptable for various needs?
24.Is at least one of each type of lodging accessible?
25.Does at least one sleeping area provide a 30"x48" area of clear space on both sides of the bed?
26.Is there adequate turning space of60" diameter circle or a T-shaped spacewithin a 60" square within each roomwith accessible features of the cabin?
27. Are rooms fully accessible of adaptable for various needs?

In the inclusive design evaluation tool provided by Nussbaumer and DNR, some evaluation indicators about the interaction space were selected for the evaluation and investigation of the interaction space of aged care architecture in Chinese townships. After communication in focus groups, further comprehensive analysis would be carried out.

2.3.2 Focus Groups

It is necessary to provide a variety of methods and theories in the studies of inclusiveness to improve its degree. The present study uses a combination of focus groups and inclusive design assessment tools. Clarkson et al. (2003), in their work, proposed that "focus groups provide opportunities for in-depth discussion and exploration of issues" and recommended maintaining a qualitative focus group [8]. In this study, due to the large differences in the number and age of residents of the six aged care architecture in Wuyang County, the elderly volunteers were recruited in each building with a total of 9 elderly people over the age of 65, including 5 males and 4 females. Compared with the elderly in urban areas, the elderly in rural areas were mostly engaged in physical labor and had more obvious physical function impairment, and hence, they had higher requirements for the inclusiveness of social spaces in aged care buildings. At the same time, they could provide more problems for the elderly with degenerated physical functions, which would in turn enhance the inclusiveness of the space for all. The interview questions included safety, transportation, comfort, accessibility, etc. The results showed that the elderly were most concerned about safety: "As they get older, their legs and feet are not fast, so they are afraid of bumping." In comparison, the comfort requirements of the elderly in townships are lower than those in cities, which are related to the influence of the surrounding environment.

The communication space obtained through the focus group does not comply with the standard principles of inclusive design, and the focus group evaluation is high in terms of basic facilities such as emergency evacuation passages and handrails in the shower area, but lower in humanistic care and caregiving aspects. The survey shows that the communication space of various buildings lacks basic humanized care design. It should be noted that in the evaluation, these buildings are relatively new and have been well-designed. According to the evaluation tools, there is still room for improvement in the communication space of the buildings, which supports the argument made by Clarkson et al. (2003) [9] that the aspects of this evaluation study will not only benefit people with disabilities, but also safeguard the quality of life of healthy elderly people in the space.

3. Research methods and indicator collection

3.1 Research methods

Through the analysis of the focus group interview method and the inclusive design evaluation tool, it is found that the quality of the communication space design had an impact on the satisfaction and occupancy rate of the elderly who stay in the aged care buildings. It is, therefore, necessary to introduce the space evaluation method to evaluate and analyze the communication space. Considering the possible deviations and influences caused by the single evaluation method, AHP-Fuzzy comprehensive evaluation method is used to establish a model for the interaction space of the aged care architecture in Wuyang County. Analytical Hierarchy Process (APH) is a multi-scheme optimization decision-making method proposed by American operations researcher Saaty TL and others in the 1970s. In this method, the overall goal is decomposed into multiple target element levels. By Fuzzy quantification of qualitative indicators, the target weights of elements at different levels can be obtained, and the final optimal scheme is selected by the weighted sum method with the highest score[10]. Fuzzy comprehensive evaluation method is adopted to evaluate the pros and cons of things affected by multiple factors after considering various influencing factors, which can systematically solve problems that are difficult to be quantified and non-deterministic[11]. The two can be combined into a comprehensive evaluation method, whose advantage is that it can make full use of the two single evaluation methods, avoid the subjective color of its own, and make it possible to learn from each other.

3.2 Selecting evaluation indicators to establish a system

By analyzing the content of the inclusive design tools above provided by Nussbaumer and DNR, the interaction space of the aged care architecture includes the main entrance, exit passages, activity halls, internal and external circulation routes, bedrooms, bathrooms, and other necessary spaces. For domestic scholars, Pan Qian believed that aggregation, regionality, and time should be taken into account in the communication space activities of the elderly[12]; Li Xue pointed out in her research that the communication space in the aged care architecture should pay attention to the safety and comfort of the elderly and provide psychological care [13]; Li Dandan took the perspective of ethnic minorities

as the starting point to analyze and discuss the physiology and psychology of ethnic minority elderly people in the social space in the aged care institutions[14]. On the basis of the definition of communication distance constructed in The Hidden Dimension, and the research of some domestic scholars on the communication space for the elderly, it is necessary to use subjective factors because the communication space is not just a rigid space for the elderly. Meanwhile, given the combination of objective and subjective factors, the connotation of communication space is far beyond the objective meaning. Starting from the four aspects of road entrance, space scale, use environment, and humanistic care, and taking safety, diversity, comfort, humanistic care, convenience, and economy as secondary indicators, third-level and fourth-level indicators are collected as shown in Table 3.

Table 3. Indicator chart.

First-level indicators	Secondary indicators	Three-level indicator	Four-level		
Evaluation system of communication space between old-age buildings in townships	Safety	Environment safety	Safe use environment	Material safety	Construction safety
		Manage security	Reserve duty officer	Have a first aid point	
		Behavioral safety	Anti-reflective	Anti-slip and anti-steep	With handrails
	Diversity	Supporting facilities	Rest facilities	Kitchen facilities	Furnishings
		Type of activity	Opening hours	Organization size	Indoor and outdoor activities
		Spatial function	Compound function	Organization	
		space experience	Decoration style	Color	No age limit
	Humanistic care	Service Level	Intimacy	Take care of	Physiological care
		Accessibility	Suitable for most people	Disabled Experience	
		Hygiene management	Support staff	Regular cleaning	
	Comfort	Space environment	Material usage	Static and dynamic partition	Spatial scale
		Physical environment	lighting	Sound insulation and noise reduction	Good ventilation
		Ambient atmosphere	Space enclosure	Wide sight	landscape vegetation
	Convenience	Dining convenience	Dining environment	Dining distance	Meal pick-up method
		Social convenience	Collective activity	Social distancing	Easy to touch
		Convenient transportation	Easy to evacuate	Easy to reach	Streamline is reasonable
	Economy	Function package	Multiple use	Cost-effective	
		Spatial scale	Area size	Old people acceptance scale	

Due to the small number of elderly people living in the aged care architecture in townships, a total of 400 questionnaires were distributed in the six buildings to screen the evaluation indicators, including 40 in Baohe Township, 40 in Wenfeng Township, 20 in Wuquan Town, and 60 in Wucheng Town, 80 from Mengzhai Town, and 160 from Xin'an Town. A total of 392 valid questionnaires were recovered with the secondary indicators screened first. The questionnaires were scored by using the Likert scale scoring method[15].

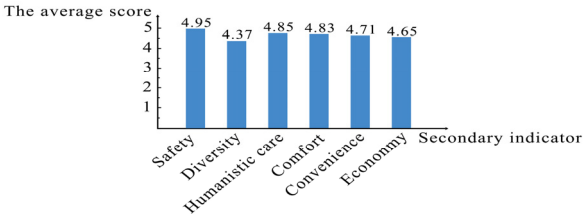

Fig 1. Scores of secondary indicators.

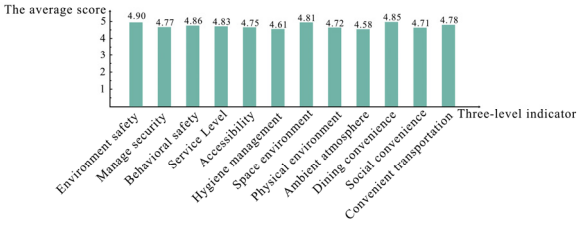

Fig 2. Three-level indicator scores.

According to Figure 1, it can be concluded that the four indicators of safety, humanistic care, comfort, and convenience were relatively important, thus the importance of the three-level indicators was carried out. As shown in Figure 2, according to the three-level evaluation indicators, the corresponding eight important tertiary indicators were selected, including environmental safety, behavioral safety, service level, accessibility, spatial environment, physical environment, catering convenience, and transportation convenience. The final index system was determined by screening (Table 4).

Table4. Indicator char.

First-level Weights	Secondary indicator	Three-level indicator	Four-level indicator
Research on the evaluation of the communication space of old-age buildings in townships	B1 Safety	Cl Environmental Security	Dl Safe use environment
			D2 Material Safety
			D3 Construction Safety
		C2 Conduct Safety	D4 Anti-reflective
			D5 Anti-skid and anti-steep
			D6 Has armrests
	B2 Humanistic Care	C3 Service Level	D7 Intimacy
			D8 Heart care
			D9 Physiological care
		C4 Accessibility	D10 Is suitable for most people
			D11 Disabled people have experience
			D12 Disabled Facilities
	B3 Comfort	C5 Space Environment	D13 Material Use

		D14 static and dynamic partition
		D15 Spatial Scale D16 lighting
	C6 Physical Environment	D16 lighting
		D17 Sound insulation and noise reduction
		D18 Good ventilation
B4 Convenience	C7 Dining Convenience	D19 Dining environment
		D20 Dining distance
		D21 Meal Picking Method
	C8 Has convenient transportation	D22 Easy to evacuate
		D23 Is easy to reach
		D24 Streamline is reasonable

4. Evaluation of AHP-Fuzzy comprehensive analysis method and case demonstration

4.1 AHP index weight calculation and testing

This paper needs to determine the three-level judgment matrix, whose establishment requires experts to analyze the relative importance of evaluation indicators. A sequential hierarchy was constructed by using the 1-9 scale method for division, namely, dividing the evaluation scale into nine levels. In particular, the values of 1, 3, 5, 7, and 9 indicate the former and the latter importance comparison, including generally important, slightly important, more important, relatively more important, and very important, while the values of 2, 4, 6, 8 mean that the degree of importance is between two adjacent levels. According to the above relationship and the importance value of different factors, judgment matrix was constructed like A-B, B1-(C1-C2), B2-(C3-C4), B3-(C5-C6), B4-(C7-C8), C1 -(D1-D3), C2-(D4-D6), C3-(D7-D9), C4-(D10-D12), C5-(D13-D15), C6-(D16-D18), C7-(D19-D21), C8-(D22-D24). The weights of each indicator are shown in Table 5 where the maximum value λmax was calculated by the square root method and the consistency ratio CR of each judgment matrix was checked (as can be seen in Table 6).

Table 5. Weights of each indicator.

First-level Weights	Weights	Secondary indicator	Weights	Three-level indicator	Weights	Four-level indicator	Weights
Research on the evaluation of the communication space of old-age buildings in townships	1.0	B1 Safety	0.4232	Cl Environmental Security	0.2116	Dl Safe use environment	0.1242
						D2 Material Safety	0.0685
						D3 Construction Safety	0.0189
				C2 Conduct Safety	0.2116	D4 Anti-reflective	0.0142
						D5 Anti-skid and anti-steep	0.0987
						D6 Has armrests	0.0987
		B2 Humanistic Care	0.2272	C3 Service Level	0.1704	D7 Intimacy	0.0730
						D8 Heart care	0.0730
						D9 Physiological care	0.0244
				C4 Accessibility	0.0568	D10 Is suitable for most people	0.0426
						D11 Disabled people have experience	0.0071
						D12 Disabled Facilities	0.0071
		B3 Comfort	0.2272	C5 Space Environment	0.1515	D13 Material Use	0.0248
						D14 static and dynamic partition	0.0450
						D15 Spatial Scale D16 lighting	0.0817
				C6 Physical Environment	0.0757	D16 lighting	0.0324
						D17 Sound insulation and noise reduction	0.0109

					D18 Good ventilation	0.0324
	B4 Convenience	0.1224	C7 Dining Convenience	0.0816	D19 Dining environment	0.0428
					D20 Dining distance	0.0272
					D21 Meal Picking Method	0.0116
			C8 Has convenient transportation	0.0408	D22 Easy to evacuate	0.0037
					D23 Is easy to reach	0.0185
					D24 Streamline is reasonable	0.0185

Table 6. Judgment Matrix Checklist.

Judgment Matrix	largest characteristic root（λmax）	Consistency Indicator (CI)	Relative Consistency (RI)	Consistency ratio (CR)	Test result
A-B	4.010	0.003	0.890	0.004	Pass
B1-(C1-C2)	2.000	0.000	0.000	null	Pass
B2-(C3-C4)	2.000	0.000	0.000	null	Pass
B3-(C5-C6)	2.000	0.000	0.000	null	Pass
B4-(C7-C8)	2.000	0.000	0.000	null	Pass
C1-(D1-D3)	3.009	0.005	0.520	0.009	Pass
C2-(D4-D6)	3.000	0.000	0.520	0.000	Pass
C3-(D7-D9)	3.000	0.000	0.520	0.000	Pass
C4-(D10-D12)	3.000	0.000	0.520	0.000	Pass
C5-(D13-D15)	3.009	0.005	0.520	0.009	Pass
C6-(D16-D18)	3.000	0.000	0.520	0.000	Pass
C7-(D19-D21)	3.054	0.027	0.520	0.052	Pass
C8-(D22-D24)	3.000	0.000	0.520	0.000	Pass

4.2 Evaluation based on Fuzzy comprehensive evaluation method

According to the above evaluation indicators and factors, the evaluation factor set U is constructed.: U= [u1, u2, u3⋯]. Through the previous index screening and related literature review, the indicators are divided into four levels, including 4 second-level indicators, 8 third-level indicators, and 24 fourth-level indicators. A set of comments V is established for explicit scoring. V= [Very good (v1), good (v2), average (v3), bad (v4), very bad (5)], where V1=5 points, V2=4 points, V3=3 points, V2=2 points, V1=1 points. The Fuzzy relationship is established from the factor set to the comment set, and the membership degree of each evaluation factor is obtained. Assuming that the evaluator has a score of V1 in the evaluation index D1, the index will be 5 on this evaluation level V1, and the rest will be 0. After the factor Fuzzy vector is obtained, the matrix relation R can be obtained by merging, as shown in Equation (1).

$$R = \begin{bmatrix} r11 & r12 & \cdots\cdots & r1m \\ r21 & r22 & \cdots\cdots & r2m \\ r31 & r32 & \cdots\cdots & r3m \\ \cdots & \cdots & \cdots\cdots & \cdots \\ rn1 & rn2 & \cdots\cdots & rn3 \end{bmatrix} \quad (1)$$

The comprehensive Fuzzy evaluation result of the research object M=W (the weight of the evaluation system index) × R (the corresponding Fuzzy relationship matrix), as shown in Equation (2).

$$M = W \times R = (W1,\ W2,\ W3) \times \begin{bmatrix} r11 & r12 & \cdots\cdots & r1m \\ r21 & r22 & \cdots\cdots & r2m \\ r31 & r32 & \cdots\cdots & r3m \\ \cdots & \cdots & \cdots\cdots & \cdots \\ rn1 & rn2 & \cdots\cdots & rn3 \end{bmatrix} = (M1,\ M2,\ M3) \quad (2)$$

According to the weighted average rule and in combination with the rating of the comment set, the score of the communication space of rural aged care architecture is calculated and the corresponding evaluation level is determined, as shown in Equation (3).

$$U_i = \sum_{i=1}^{5} u(y_i) v_i \Big/ \sum_{i=1}^{5} v_i \quad (3)$$

4.3 Demonstration of the interaction space of aged care buildings in Xin'an Town, Wuyang County

Based on the evaluation system established in the above chapters for the communication space of aged care architecture in towns and townships, this section uses examples to demonstrate the operability and accuracy of the system, uses the evaluation system to evaluate and score the communication space of aged care architecture in towns and towns, and comprehensively analyzes the scoring results.

Xin'an Town is located in the east of the intersection of Jiankang Road and S30 National Road in Wuyang County. The area of the nursing home is about 10,000 square meters with 80 houses. The total number of residents is 297, including 9 people in foster care. The male-to-female ratio is 276-to-21 with males occupying the vast majority. Relatively speaking, males have lower requirements for occupancy experience than females, instead, they are more concerned about the basic facility structure [16]. The communication space in the survey includes roads, restaurants, bathrooms, activity rooms, outdoor activity spaces, and bedrooms (Figure 3).

Figu 3. Field investigation of the Nursing Home in Xin'an Town, Wuyang County.

Considering the relatively small number of elderly people living in the aged care architecture, the same method of collecting indicators was adopted. A total of 200 questionnaires were distributed to the elderly and the staff in the aged care architecture, including 170 for the elderly and 30 for the staff. 194 questionnaires were collected with the 97% effective rate. By integrating the weights of various indicators and the Fuzzy vectors obtained from the questionnaire survey, the results of the evaluation system for the interaction space of aged care buildings in Xin'an Town, Wuyang County were constructed (Table 7).

Table 7. Evaluation index results of Xin'an Town, Wuyang County.

First-level Weights	Weights	Secondary indicator	Weights	Three-level indicator	Weights	Four-level indicator	Weights	Evaluation level					The average score
								V1	V2	V3	V4	V5	
Research on the evaluation of the communication space of old-age buildings in townships	1.0	B1 Safety	0.4232	Cl Environmental Security	0.2116	Dl Safe use environment	0.1242	0.48	0.36	0.16	0	0	4.32
						D2 Material Safety	0.0685	0.51	0.28	0.13	0.08	0	4.20
						D3 Construction Safety	0.0189	0.61	0.19	0.17	0.03	0	4.37
				C2 Conduct Safety	0.2116	D4 Anti-reflective	0.0142	0.69	0.21	0.09	0	0.01	4.56
						D5 Anti-skid and anti-steep	0.0987	0.79	0.09	0.11	0.01	0	4.67
						D6 Has armrests	0.0987	0.77	0.23	0	0	0	4.77
		B2 Humanistic Care	0.2272	C3 Service Level	0.1704	D7 Intimacy	0.0730	0.52	0.22	0.20	0.06	0	4.18
						D8 Heart care	0.0730	0.39	0.24	0.32	0.05	0	3.90
						D9 Physiological care	0.0244	0.74	0.17	0.08	0	0	4.66
				C4 Accessibility	0.0568	D10 Is suitable for most people	0.0426	0.53	0.13	0.10	0.21	0.03	3.92
						D11 Disabled people have experience	0.0071	0.25	0.38	0.32	0.03	0.02	3.80
						D12 Disabled Facilities	0.0071	0.28	0.44	0.21	0.07	0	3.93
		B3 Comfort	0.2272	C5 Space Environment	0.1515	D13 Material Use	0.0248	0.43	0.28	0.15	0.10	0.03	3.98
						D14 static and dynamic partition	0.0450	0.10	0.27	0.51	0.05	0.07	3.28
						D15 Spatial Scale D16 lighting	0.0817	0.09	0.31	0.19	0.31	0	3.03
				C6 Physical Environment	0.0757	D16 lighting	0.0324	0.38	0.27	0.30	0.05	0	3.98
						D17 Sound insulation and noise reduction	0.0109	0.22	0.28	0.34	0.10	0.06	3.43
						D18 Good ventilation	0.0324	0.26	0.35	0.28	0.10	0.01	3.74
		B4 Convenience	0.1224	C7 Dining Convenience	0.0816	D19 Dining environment	0.0428	0.38	0.23	0.20	0.16	0.03	3.76
						D20 Dining distance	0.0272	0.53	0.31	0.10	0.06	0	4.29
						D21 Meal Picking Method	0.0116	0.29	0.53	0.06	0.12	0	4.00

	C8 Has convenient transportation	0.0408	D22 Easy to evacuate	0.0037	0.61	0.31	0.05	0.03	0	4.49
			D23 Is easy to reach	0.0185	0.57	0.25	0.16	0.02	0	4.36
			D24 Streamline is reasonable	0.0185	0.27	0.25	0.20	0.20	0.08	3.43

According to the formula obtained above, the Fuzzy comprehensive evaluation M=W×R can be calculated.

4.3.1 Safety evaluation:

$$C1=AC1*RC1=(0.1242,\ 0.0685,\ 0.0189)\begin{bmatrix}0.48 & 0.36 & 0.16 & 0 & 0\\ 0.51 & 0.28 & 0.13 & 0.08 & 0\\ 0.61 & 0.19 & 0.17 & 0.03 & 0\end{bmatrix}$$

$$=(0.1061, 0.0675, 0.0320, 0.0060, 0)$$

$$C2=AC2*RC2=(0.0142,\ 0.0987,\ 0.0987)\begin{bmatrix}0.69 & 0.21 & 0.09 & 0 & 0.01\\ 0.79 & 0.09 & 0.11 & 0.01 & 0\\ 0.77 & 0.23 & 0 & 0 & 0\end{bmatrix}$$

$$=(0.1638, 0.0346, 0.0121, 0.0010, 0.0001)$$

$$B1=AB1*RB1=(0.2116,\ 0.2116)\begin{bmatrix}0.1061 & 0.0675 & 0.0320 & 0.0060 & 0\\ 0.1638 & 0.0346 & 0.0121 & 0.0010 & 0.0001\end{bmatrix}$$

$$=(0.0571, 0.0216, 0.0093, 0.0015, 0.0000)$$

$$Uc1=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.1061*5+0.0675*4+0.0320*3+0.0060*2+0*1}{0.1061+0.0675+0.0320+0.0060+0}=4.2935$$

$$Uc2=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.1638*5+0.0346*4+0.0121*3+0.0010*2+0.0001*1}{0.1638+0.0346+0.0121+0.0010+0.0001}=4.7060$$

$$Ub1=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.0571*5+0.0216*4+0.0093*3+0.0015*2+0.0000*1}{0.0571+0.0216+0.0093+0.0015+0.0000}=4.5006$$

According to the weighted average principle, the safety index of the interaction space of aged care buildings in Xin'an Town, Wuyang County is 4.5006, and the environmental safety index is 4.2935, both of which are better than the average. The material safety index is 4.7060, which is good and close to very good.

4.3.2 Humanistic care evaluation:

$$C3=AC3*RC3=(0.0730,\ 0.0730,\ 0.0244)\begin{bmatrix}0.52 & 0.22 & 0.20 & 0.06 & 0\\ 0.39 & 0.24 & 0.32 & 0.05 & 0\\ 0.74 & 0.17 & 0.08 & 0 & 0\end{bmatrix}$$

$$=(0.0845, 0.0377, 0.0399, 0.0080, 0)$$

$$C4=AC4*RC4=(0.0426,\ 0.0071,\ 0.0071)\begin{bmatrix}0.53 & 0.13 & 0.10 & 0.21 & 0.03\\ 0.25 & 0.38 & 0.32 & 0.03 & 0.02\\ 0.28 & 0.44 & 0.21 & 0.07 & 0\end{bmatrix}$$

$$=(0.0263, 0.0114, 0.0080, 0.0097, 0.0014)$$

$$B2=AB2*RB2=(0.1704,\ 0.0568)\begin{bmatrix}0.0845 & 0.0377 & 0.0399 & 0.0080 & 0\\ 0.0263 & 0.0114 & 0.0080 & 030097 & 0.0014\end{bmatrix}$$

$$=(0.0159, 0.0071, 0.0073, 0.0019, 0.0001)$$

$$Uc3=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.0845*5+0.0377*4+0.0399*3+0.0080*2+0*1}{0.0845+0.0377+0.0399+0.0080+0}=4.1681$$

$$Uc4=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.0263*5+0.0114*4+0.0080*3+0.0097*2+0.0014*1}{0.0263+0.0114+0.0080+0.0097+0.0014}=4.1869$$

$$Ub2=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.0159*5+0.0071*4+00073*3+0.0019*2+0.0001*1}{0.0159+0.0071+0.0073+0.0019+0.0001}=4.1393$$

According to the weighted average principle, the humanistic care index of the interaction space of aged care buildings in Xin'an Town, Wuyang County is 4.1393, the humanistic care service level index is 4.1681, and the barrier-free index of humanistic care is 4.1869, all of which are better than the average.

4.3.3 Comfort rating:

$$C5=AC5*RC5=(0.0248,\ 0.0450,\ 0.0817)\begin{bmatrix}0.43 & 0.28 & 0.15 & 0.10 & 0.03\\ 0.10 & 0.27 & 0.51 & 0.05 & 0.07\\ 0.09 & 0.31 & 0.19 & 0.31 & 0\end{bmatrix}$$

$$=(0.0225, 0.0444, 0.0422, 0.0301, 0.0039)$$

$$C6=AC6*RC6=(0.0324,\ 0.0109,\ 0.0324)\begin{bmatrix}0.38 & 0.27 & 0.30 & 0.05 & 0\\ 0.22 & 0.28 & 0.34 & 0.10 & 0.06\\ 0.26 & 0.35 & 0.28 & 0.10 & 0.01\end{bmatrix}$$

$$=(0.0231, 0.0231, 0.0225, 0.0060, 0.0010)$$

$$B3=AB3*RB3=(0.1515,\ 0.0757)\begin{bmatrix}0.0225 & 0.0444 & 0.0422 & 0.0301 & 0.0039\\ 0.0231 & 0.0231 & 0.0225 & 0.0060 & 0.0010\end{bmatrix}$$

$$=(0.0052, 0.0085, 0.0081, 0.0050, 0.0007)$$

$$Uc5=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.0225*5+0.0444*4+0.0422*3+0.0301*2+0.0039*1}{0.0225+0.0444+0.0422+0.0301+0.0039}=3.3599$$

$$Uc6=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.0231*5+0.0231*4+0.0225*3+0.0060*2+0.0010*1}{0.0231+0.0231+0.0225+0.0060+0.0010}=3.8098$$

$$Ub3=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.0052*5+0.0085*4+0.0081*3+0.0050*2+0.0007*1}{0.0052+0.0085+0.0081+0.0050+0.0007}=3.4545$$

According to the weighted average principle, the comfort index of the interaction space of aged care buildings in Xin'an Town, Wuyang County is 3.4545, and the comfort space environment index is 3.3599, both of which are generally higher. The comfort of physical environment index is 3.8098, which is generally on the upper side and close to better.

4.3.4 Convenience evaluation:

$$C7=AC7*RC7=(0.0428,\ 0.0272,\ 0.0116)\begin{bmatrix}0.38 & 0.23 & 0.20 & 0.16 & 0.03\\ 0.53 & 0.31 & 0.10 & 0.06 & 0\\ 0.29 & 0.53 & 0.06 & 0.12 & 0\end{bmatrix}$$

$$=(0.0340, 0.0244, 0.0120, 0.0099, 0.0013)$$

$$C8=AC8*RC8=(0.0037,\ 0.0185,\ 0.0185)\begin{bmatrix}0.61 & 0.31 & 0.05 & 0.03 & 0\\ 0.57 & 0.25 & 0.16 & 0.02 & 0\\ 0.27 & 0.25 & 0.20 & 0.20 & 0.08\end{bmatrix}$$

$$=(0.0178, 0.0104, 0.0068, 0.0042, 0.0015)$$

$$B4=AB4*RB4=(0.0816,\ 0.0408)\begin{bmatrix}0.0340 & 0.0244 & 0.0120 & 0.0099 & 0.0013\\ 0.0178 & 0.0104 & 0.0068 & 0.0042 & 0.0015\end{bmatrix}$$

$$=(0.0035, 0.0024, 0.0013, 0.0010, 0.0002)$$

$$Uc7=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.0340*5+0.0244*4+0.0120*3+0.0099*2+0.0013*1}{0.0340+0.0244+0.0120+0.0099+0.0013}=3.9792$$

$$Uc8=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.0178*5+0.0104*4+0.0068*3+0.0042*2+0.0015*1}{0.0178+0.0104+0.0068+0.0042+0.0015}=3.9533$$

$$Ub4=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.0035*5+0.0024*4+0.0013*3+0.0010*2+0.0002*1}{0.0035+0.0024+0.0013+0.0010+0.0002}=3.9524$$

According to the weighted average principle, the index of space convenience for aged care buildings in Xin'an Town, Wuyang County is 3.9524, the catering convenience index is 3.9792, and the transportation convenience index is 3.9533, all of which are generally on the upper side and close to good.

4.3.5 Overall Evaluation of Xin'an Town, Wuyang County

Formulas 4-2 and 4-3 which are used to obtain the comprehensive Fuzzy evaluation vector of the interaction space of aged care buildings in Xin'an Town, Wuyang County are as follows:

$$A=WA*RA=(0.4232,\ 0.2272,\ 0.2272,\ 0.1224)\begin{bmatrix}0.0571 & 0.0216 & 0.0093 & 0.0015 & 0\\ 0.0159 & 0.0071 & 0.0073 & 0.0019 & 0.0001\\ 0.0052 & 0.0085 & 0.0081 & 0.0050 & 0.0007\\ 0.0035 & 0.0024 & 0.0013 & 0.0010 & 0.0002\end{bmatrix}$$

$$=(0.0294,\ 0.0130,\ 0.0076,\ 0.0023,\ 0.0002)$$

$$UA=Ui=\sum_{i=1}^{5}u(yi)/\sum_{i=1}^{5}vi=\frac{0.0294*5+0.0130*4+0.0076*3+0.0023*2+0.0002*1}{0.0294+0.0130+0.0076+0.0023+0.0002}=4.3162$$

Considering all the indicators, the communication space of elderly buildings in Xin'an Town, Wuyang County is between relatively good and good. It considers the late construction time of aged care buildings in Xin'an Town, and takes into account the needs of the elderly in all aspects with safety guaranteed. However, there is still room for improvement in humanistic care and psychological care. On the premise of ensuring safety, it is also necessary to comprehensively consider the elderly with different behavioral abilities, different ages, and different genders from the perspective of inclusiveness, so as to ensure the living experience of the elderly in aged care architecture.

5. Discussion

Inclusiveness, as an emerging method for the elderly and the disabled, can greatly improve the happiness of the elderly. Just like the preparations started by the article research institute, establishing an evaluation index system for evaluating the current township pension buildings from the perspective of inclusive design can better explore the shortcomings and advantages of the current township pension building communication space. There are many advantages and disadvantages of the current communication space found in the data. For example, in the example demonstration in Chapter 5, it can be seen intuitively that the most basic security advantages of the communication space are very high, which can guarantee the safety of the daily activities of the elderly, but the humanistic care and comfort are low, and there are still unbalanced development problems. situation. This helps to increase people's attention to the psychological comfort of the elderly in townships, and we can also confirm that the elderly living in still need to optimize and improve the comfort of the environment and daily meals.

Among the elderly people who participated in the survey, most of them think that the communication space in the elderly care buildings is still a good modern design. This is due to the fact that the elderly in the villages and towns have experienced a hard life and long-term agricultural work since they were young, so they do not have high material and spiritual requirements. Security and basic living guarantees make it easier to obtain happiness. In terms of occupancy ratio, the female birth rate is low due to the backward thinking of "preferring children over daughters" in rural areas, and single men account for the vast majority. If they have children, they generally do not choose to live in senior care buildings. Women are more concerned about spirituality and environmental comfort than men. Due to the deepening of the aging population in our country, the development of rural elderly care buildings has also been rapid in the past two or three decades. The scope of consideration in buildings has shifted from basic security to the increasing psychological needs. Access permits should be strictly controlled for employees and the provision of professional disability services.

6. Conclusion

In our research, the evaluation of the communication space of township pension buildings is a comprehensive evaluation model, which comprehensively evaluates and analyzes the safety, humanistic care, comfort and convenience of the communication space of township pension buildings from an inclusive perspective. The evaluation system model is built. In the example demonstration, the research results at least show that the elderly and service staff who live in the building think

that the communication space of the existing township elderly care building still needs to be optimized. At present, as the degree of aging in our country continues to increase, the hollowness of towns and towns is serious. Although the implementation of the rural revitalization strategy in recent years has led to a decline in the population of towns and towns, the demand for elderly care buildings is still increasing, and the central and local governments are also accelerating the construction of elderly care buildings. The researched elderly care buildings in Wuyang County can represent the development trend of some elderly care buildings in the Central Plains of my country. Under the premise of basic safety protection, limited funds should be used as much as possible to consider the environmental comfort and psychological satisfaction of the interaction space of elderly care buildings. In the next few years, the number of elderly residents will continue to increase. We may also hope to further understand the communication space in the future and provide optimization suggestions for some potential errors without involving the basic safety issues.

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