

Research on Design Strategies for Age-friendly Furniture Based on Physiological and Behavioural Surveys of Chinese Elderly People

Yun Zhang^{1,2,*}

¹Faculty of Applied and Creative Arts, Universiti Malaysia Sarawak, Kota Samarahan, Sarawak, 94300, Malaysia

²Academy of Fine Arts and Design, Yulin Normal University, Yulin, Guangxi, 537000, China
zhangyun321789@163.com

*Corresponding author

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Abstract: Population ageing is an irreversible globalisation trend in the 21st century. Population ageing stems from the dynamics of a declining proportion of young people and an increasing proportion of older people in the total population resulting from lower fertility and longer life expectancy. The disconnect between research and design is an ongoing problem in the field of age-friendly furniture. This study focuses on the relationship between the elderly and furniture in China in design, aiming to explore how to meet the physiological and psychological needs of the elderly through the optimization and innovation of furniture product functions. Based on the investigation and analysis of the physiological and behavioral characteristics of the elderly, this study explores the design strategy of age-friendly furniture to provide age-friendly furniture products suitable for the elderly to live and use, which will promote the application of age-friendly design in the field of elderly furniture products.

1. Introduction

According to the World Population Prospects report published by the Population Division of the United Nations Department of Economic and Social Affairs (2019), the 65-year-old population is the fastest growing age group globally. This age group is 9 per cent of the total population in 2019 and is expected to reach 12 per cent by 2030 and 16 per cent by 2050. For a long time, the increase in the ageing population has been treated as a "social problem".

Therefore, a key driver behind the work presented in this paper is therefore the underlying assumption that older people themselves and society would benefit from furniture that supports and enriches older people's wellbeing and ability to remain independent for as long as possible. This study attempts to address the issue of age-friendly furniture design in the context of the physiological and behavioural characteristics of the elderly in China. We analyze and explore the methods of age-appropriate furniture through the instinctive, behavioral, and reflective dimensions of the elderly, and by combining the physical and psychological characteristics as well as the

emotional needs of the elderly. The purpose of this paper is to explore how to meet the physiological and psychological needs of the elderly through the optimization and innovation of the function of furniture products, and ultimately to study and propose the design principles and specific countermeasures for the elderly-friendly furniture.

2. Literature Review

2.1 Overview theory of Aging-friendly furniture in china

In the context of China's ageing, a number of studies have been conducted on the indoor environment and facilities for the elderly. Furniture is a product category that has been steadily used by the elderly population and has been subdivided into a new category of furniture - "furniture for the elderly". Its research mainly focuses on the design method of Aging-friendly furniture, intelligent furniture, barrier-free design, ergonomics, physiology and behaviour, as well as the design of elderly furniture under different aging modes.

In fact, from the current research on age-friendly design, incorporating age-friendly design into the home environment is a behavioral approach to building innovative elderly care lifestyles. Miao Ke and Yang Yun (2020) proposed a conceptual design for home products based on the behavioral patterns of elderly people during the assistance and care periods [1]. In addition, Zhou Chengmin, Zhao Hanxiao, Stefano Follesa, Liang Shuang et al. (2020) proposed a design method for elderly furniture that caters to the needs of self-care elderly people, based on the hierarchy of needs theory. They further elaborated on the issues that elderly people pay more attention to in the process of elderly home design [2]. In this process, the design of suitable old furniture is considered particularly important for the development of suitable old homes [3]. At the same time, Feng Xinhao, Ma Yuxiang, and Wu Zhizhi (2020) drew on Japan's aging furniture products to analyze the shortcomings of China's existing aging furniture. By combining the advantages of Japanese aging furniture and the characteristics of traditional Chinese furniture, they summarized the impact of Japanese aging furniture on China's aging furniture [4]. This can serve as a reference for the design and development trend of aging furniture in China.

On the other hand, HuangXF and OuyangXX (2017) based on the survey results as the basis for the design, to further strengthen the design process, so that the "user-centred" throughout the whole process of design, to increase the social recognition of the design and brand awareness [5]. For the elderly-friendly furniture design research neighbourhood, Liang Ming (2018) pointed out that furniture is the most important thing in the life of the elderly, which greatly affects their quality of life, and through the field research on the elderly furniture market, the design trend of elderly furniture for the domestic furniture market was derived [6].

In fact, the ultimate plan of the product is to design and develop furniture for the elderly in conjunction with the Product Service System (PSS), FuQ and WangS (2016) conducted a research on suitable furniture for the elderly based on their psycho-physiological peculiarities, to improve their social conditions, psycho-emotions and so on in their daily lives, so as to promote the development of suitable furniture for the elderly and to better serve them [7].

2.2 Aging-friendly Furniture Trend in Global Scenario

In the 21st century, compared with China, as developed countries, Europe, the United States, Japan and other countries have entered the ageing society before China.

The European furniture industry is a key driver of sustainable growth and makes a significant contribution to Europe's overall economic health, competitiveness, creativity, innovation, employment and exports [8]. One of the technologies being developed is an Ambient Assisted

Living (AAL) monitoring system that provides personalised support services and healthcare in the home [9].

In Japan, in the 1980s, scholars made recommendations on the dimensions of living rooms for the elderly and summarised and promoted the concept of barrier-free design of furniture for the elderly. The Handbook of Barrier-Free Architectural Design, written by Eihei Takahashi (2003), has advanced the concept of barrier-free design, and has promoted the design of living environments and furniture for the elderly and the handicapped. In the 2015 book "Residential Barrier-Free Adaptation Design," edited by the Japan Institute for Senior Citizen Residence, a book that addresses existing elderly care facilities and furniture design in Japan, the book provides a detailed insight into the impact of physical changes in the elderly on furniture design. Philipp Meuser analyses the spatial design scales and design points for ageing in living environments for the elderly and persons with disabilities and in multigenerational housing from the perspective of barrier-free design.

In addition, the U.S. product designers also based on the physiological characteristics of the elderly to design a functional furniture to meet the needs of the elderly, which is based on the special physiological changes in the elderly as a design entry point. At the same time, the United States NEWport furniture brand from the establishment of more than 60 years of development history, its main electrical functional sofas for the elderly combined with the principles of ergonomics and mechatronics design methods to bring the elderly a comfortable and pleasant to use the experience, the formation of a mature and core competitiveness of the industry chain.

Germany's Tekvorcare has been involved in various fields around ergonomics, and their design and production of nursing beds have been widely acclaimed in Europe and the United States. Their nursing beds are not only comfortable and safe, but also fit the body structure of the elderly. At present, it has already taken shape in the European and American markets [2].

In general, Europe, the United States, Japan and other developed countries for the elderly furniture design concept is relatively mature, the research practice and the level of intelligent technology to a higher degree of development, can be combined with the physiological and psychological characteristics of the elderly to establish a more rigorous, standardized design theory and apply it to the design practice. China has presented certain theoretical basis and practical results for the design of ageing-friendly products, especially the design of household products. However, some researches have carried out design improvement and practice for the details of certain ageing-friendly product design, but lack of theoretical design strategies, analytical design methods and summarized principles, and the design thinking process of malefactors is not holistic and comprehensive enough.

3. The Research Methods

In general, research methodology involves a mixed method approach to identifying, collecting and analyzing research data. This mixed approach includes both qualitative and quantitative methods to achieve the research objectives and research questions.

3.1 Questionnaire

Questionnaire survey is the most basic and important quantitative method to investigate the lifestyle of a specific group of people. The purpose of the questionnaire survey is to understand the basic information, behavioral status quo and life needs of the elderly, which covers the needs of the elderly physiological and behavioral characteristics of the furniture design, the results of the survey

were sorted and analyzed to provide basic information for the research. The questionnaire was distributed in two ways: online and on-site, and a total of 1200 questionnaires were distributed. The information obtained from this research is real and reliable, and the feedback received provides valuable information for the design of elderly furniture in nursing homes.

3.2 Interview

Interviewing is a basic research method that allows the researcher to have direct contact with the participants [10, 11]. Kennedy and Vargus (2001) suggested that an in-depth interview study could improve the information obtained from the questionnaire [12].

The cities in which the survey was conducted in this paper were selected as representative aging cities in China's eastern coastal areas and developed central regions, where the impacts and contradictions brought about by aging are prominent because of their development. Furniture design interviews for older people start directly from the subjective perspective of older people to understand their needs. The main purpose of the interviews was to understand the daily life behaviors of the elderly as a group, to understand the main problems that occur when the elderly use furniture and the potential needs of elderly users for furniture products.

3.3 Data collection and analysis

The data collection of this study was carried out in some provinces and cities in China, questionnaire surveys and interviews were conducted on the lifestyles of specific groups of people, and the psychological, physiological and behavioral activities of the elderly groups in nursing homes in China were analyzed in order to form a theoretical basis for the design of age-friendly furniture and to discover the determinants of the design of age-friendly furniture. Through data analysis, scientific inference is made to solve the basic problems of the current elderly furniture and summarize the design strategy of the elderly furniture.

4.1 Survey respondents

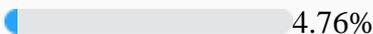
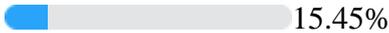
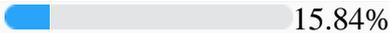
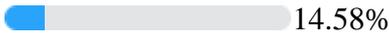
The respondents of the survey were all home-bound elderly people over 60 years of age, with slightly more men than women, but equally divided. In order to make the results of the survey representative of a wider age range of older people, the investigators took care to obtain as balanced a number of participants as possible across multiple age groups when distributing the questionnaire.

4.2 Physiology and Behavior of the Elderly

4.2.1 Classification of different physical conditions

Elderly people have judgment on their physical condition. According to the results of the study, nearly 50% of the elderly consider themselves to be in very good health, and nearly 45% of the elderly are not able to take care of themselves completely, and need their relatives, babysitters, crutches, etc. as a means of assistance. This is also related to the national conditions of China in earlier times, when the masses were still worried about food and clothing and were tired of running around, so naturally they fell sick to a greater or lesser extent, and their bodies needed to be taken care of by others (As shown in table 1).

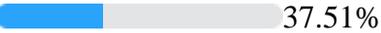
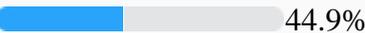
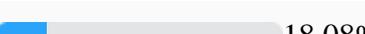
Table 1: Survey Physical Conditions of Elderly People

options	total	proportions
I can take care of myself.	508	 49.37%
Totally dependent on others for care and incapable of self-care.	49	 4.76%
Partially incapable of self-care and requires care from time to time.	159	 15.45%
Need children or nanny care.	163	 15.84%
Need to rely on assistive devices such as crutches, handrails, etc.	150	 14.58%
Other	0	 0%
Number of valid entries for this question	1029	

4.2.2 Physiological conditions of the elderly

In the course of the survey, many elderly people were more or less unhealthy, with most of them suffering from poor eyesight, poor hearing, and inflexibility, which are also the common problems of most elderly people. From the table below, we can see that more than 60% of the samples were "unchecked" in terms of poor eyesight and difficulty in seeing. The proportion of selected samples is 37.51%. From the point of view of poor hearing and hearing problems, there are relatively more "unchecked" samples, with a proportion of 55.10%. The percentage of selected samples is 44.90%. In terms of the distribution of arm weakness and inflexibility of hand movement, the majority of the samples were "unchecked", with a proportion of 65.50%. Another 34.50% of the samples were selected.(As shown in table 2)

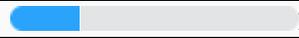
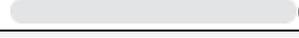
Table 2: Survey Physiological Conditions of Elderly People

options	total	proportions
Poor eyesight, can't see well.	386	 37.51%
Can't hear well and have a hearing problem.	462	 44.9%
There is weakness in the arms and inflexibility in hand movements.	355	 34.5%
There is weakness in the legs or inflexibility of the legs and feet.	186	 18.08%
Pain in the lower back, with difficulty in bending.	306	 29.74%
Bad cervical spine or cervical spondylosis.	309	 30.03%
Poor memory and easy to forget things.	298	 28.96%
Number of valid entries for this question	1029	

4.2.3 Physical Behavioral conditions of the Elderly

As shown in table 3, the majority of the sample (36.05%) considered their physical and behavioral condition to be "vulnerable", while only 25.36% of the elderly considered themselves to have normal healthy behavior. At the same time, 14.58% of the elderly people needed assisted care.

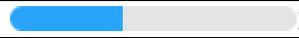
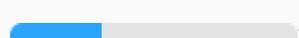
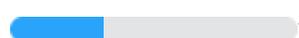
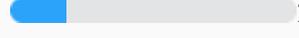
Table 3: Survey Behavioral Conditions of Elderly People

options	total	proportions
Health Behavioral Capacity	261	 25.36%
independent capacity	247	 24%
Vulnerable capacity	371	 36.05%
Auxiliary Nursing	150	 14.58%
Other	0	 0%
Number of valid entries for this question	1029	

4.2.4 Daily Behavioral Activities for the Elderly

From the analysis of the results of the interviews with the elderly and the questionnaire survey, it is clear that recreation and leisure activities are the most important daily activities for the elderly, occupying most of their time in the community. However, the types of daily activities are unique to older adults at different levels of aging. In the research, most of the elderly people take reading books and newspapers, writing and painting as their main daily activities, accounting for about 50%, followed by close to 40% who still work or go to squares and parks for leisure, followed by about 32% who choose to swipe their cell phones, watch TV and listen to the radio (As shown in table 4).

Table 4: Survey Daily Behavioral Activities of Elderly People

options	total	proportions
do the housework	411	 39.94%
Watching TV and listening to the radio	331	 32.17%
Playing with cell phones (Tiktok, Snapchat)	340	 33.04%
Reading and writing calligraphy	520	 50.53%
play a musical instrument	281	 27.31%
physical fitness	288	 27.99%
Chat with others	204	 19.83%
Song and Dance (Square Dance)	208	 20.21%
Chess, Mahjong	182	 17.69%
Take a walk in the park or square	402	 39.07%
Go to the senior center.	209	 20.31%
Other	61	 5.93%
Number of valid entries for this question	1029	

4.3 Familiarity and design appeal of age-friendly furniture

4.3.1 Age-friendly Furniture Interest Level Survey

From the research results of the question "Are you interested in age-friendly furniture products", there are relatively more "somewhat interested" in the sample, with a proportion of 54.32%. More

than 80% of the elderly have the idea of experiencing suitable age-friendly furniture, of which more than 25% of the people expressed great interest, of which a little interest in the elderly accounted for more than 50%, only about 20% of the people are not interested in age-friendly furniture products, which is also related to the idea of the old generation resisting unfamiliar products (As shown in Table 5).

Table 5: Survey Interest Leve of Elderly People

options	total	proportions
not interested in	204	19.83%
a little interested	559	54.32%
very interested	266	25.85%
Number of valid entries for this question	1029	

4.3.2 Most likely reason for your interest in a particular piece of age-friendly furniture

Since the elderly belong to a special group, their interest and choice of furniture have different needs from the norm. Age has a significant impact on seniors, and those with physical ailments have different needs for furniture use than those who are healthy. The proportion of the sample choosing both style and material exceeded 20%, while appearance and price received less attention, so the design of age-appropriate furniture is in line with the interest of the elderly group in furniture needs to be targeted (As shown in Table 6).

Table 6: Results of frequency analysis

item	options	frequency	Percentage (%)	cumulative percentage (%)
Most likely reasons for interest	material	243	23.62	23.62
	eco-friendly	196	19.05	42.66
	Style	208	20.21	62.88
	favorable price	67	6.51	69.39
	Other	69	6.71	76.09
	Multi-functional	60	5.83	81.92
	Nice appearance	58	5.64	87.56
	Practical and durable	64	6.22	93.78
	big brand	64	6.22	100.00
Total		1029	100.0	100.0

4.3.3 Quantitative results of older people's design aspirations for age-friendly furniture

In terms of focusing on the design demands of the elderly on suitable furniture for the elderly, it can be found that 348 people said that they pay attention to the comfort of suitable furniture for the elderly, accounting for 33.82%. 280 people said that they pay attention to the convenience of suitable furniture for the elderly, accounting for 27.21%, 219 people said that they pay attention to the safety of suitable furniture for the elderly, and aesthetics is not a point of concern for the elderly, accounting for only about 8%. This is in strong contrast to the idea of "value control" of modern young people, and the elderly pay more attention to the practicality of things (As shown in Table7).

Table 7: Results of frequency analysis

item	options	frequency	Percentage (%)	cumulative percentage (%)
What aspects are most valued	aesthetically pleasing	89	8.65	8.65
	safety	219	21.28	29.93
	comfort	348	33.82	63.75
	convenient	280	27.21	90.96
	Other	93	9.04	100.00
Total		1029	100.0	100.0

5. Discussion

Through the above investigation and complete research and analysis on the physiological and behavioral characteristics of the Chinese elderly, the interaction between them and the furniture, as well as the design demands of the elderly furniture, the author will put forward the following thoughts on the design principles and strategies of the elderly furniture.

5.1 The design of the relevant use functions of the elderly-friendly furniture should be humanized

Humanistic care in design is to respect the elderly group and to satisfy their own psychological and physiological needs, and so is the design of age-friendly furniture. In the design of age-friendly furniture, in order to facilitate the use of the elderly and enhance their self-confidence, designers must stand in the perspective of the elderly for age-friendly design, to satisfy the elderly's love of life, so that they can maintain a more lasting vision of independent living. For example, based on the body size of the elderly, physiological functions and daily behavioral status, in the use of the function of the elderly should be given full consideration to ergonomics, ease of operation, versatility, and convenience and other functions, these humanized design is the core of the design of furniture for the elderly.

5.2 The colors, materials and shapes should meet the physiological and behavioral needs of the elderly

As the elderly age, their physiological functions and behavioral abilities decline, and their sensitivity to color and ability to discriminate become weaker. In the design of furniture for the elderly should give full consideration to the diversity of colors and the differences in materials, to avoid easy to cause mood swings of the elderly. For example, choose the color purity and brightness of the bottom of the green material for use, at the same time the color and material should be coordinated and unified with the overall interior space. Secondly, for the aging furniture appearance design, in addition to meet the basic use of the function, should also through the scale control, structural support and visual sense of the elderly to use peace of mind, to avoid excessive worry, affect the psychological, convenient for the elderly daily life. At the same time, the appearance of furniture should be simple and elegant, and the visual form should reflect the affinity so that the elderly can get a sense of affinity and comfort.

5.3 Enhance the sense of emotional resonance through form design

As a medium of emotional communication, the elderly furniture should not only have the basic function as a product, but also need to use the figurative external form and functional interaction to express the feelings, and bring individuals closer to each other's heart distance. Its direct view and touch of the form is an important factor in determining the first impression of the elderly on the furniture. Its direct view and touch of the form designer determines the important factors of the first impression of the elderly to the furniture. In the form design of furniture for the elderly should pay attention to the daily aesthetic needs of the elderly, behavioral habits and gentle and comfortable visual collocation, so that it is easier to reflect the emotional resonance of furniture for the elderly. For example, a piece of furniture products for the elderly into a kind of affectionate daily action speech, such as caressing, touching, or looking at their own or their partners, these furniture form design with the help of the form of communication between people and furniture, the exchange of feelings and perceptual touch to complete, so that the furniture and the elderly to produce the emotional resonance and the spirit of the transfer.

5.4 Safety needs for design for accessibility

Safety is the primary consideration in the design of age-friendly furniture. With the growing age, the body of the elderly gradually aging, behavioral activities will also change, resulting in the use of furniture in the event of accidents, to the elderly daily life to bring unpredictable safety hazards. Therefore, according to the changes in the physiological and behavioral characteristics of the elderly for the elderly furniture accessibility design can enhance the psychological sense of security of the elderly at the same time also bring convenience to the elderly daily life. First of all, in the furniture modeling to be more to use no sharp corners, smooth modeling, in order to reduce because of accidents or the elderly own health reasons such as bumps, bruises and other accidental injuries occur, pay attention to the ease of use, intuitive. Secondly, the furniture size should be reasonable and follow the ergonomics of the elderly. Ergonomic size is the basis of the design of elderly furniture, but also the safety and comfort of the expression of the landing point. The size of the structure of the furniture for the elderly should be designed to meet the physiological characteristics of the elderly users and the proportion of their body shape. In addition, the safety of the structure should also be considered, for example, in the design of support and leaning furniture, the tilt angle of the chair surface, armrests and backrests and the combination structure should be considered.

5.5 Application of Intelligent Design

The development of the smart home has given furniture design a higher level of design ideas, but also makes intelligent furniture has become a form of furniture that people are generally interested in and love to use, the proportion of the elderly continues to rise to the intelligent furniture design to expand the scope of the use of the object. Suitable for the elderly furniture design also needs a certain amount of intelligent design to reduce or even eliminate the elderly in the use of furniture in the process of difficulties in the design type emphasizes from the "human" point of view, not only in line with ergonomics and human psychological characteristics, but also with the functional needs of its products. Based on the use of modern digital information processing and communication technology, smart home mainly collects different types of signals in real time through sensors, and the controller processes the collected signals according to the predetermined procedures, such as recording, logical judgment and information feedback, etc. The controller processes the information and reports it to the information management platform, and then makes corresponding actions through the executive devices and transmission devices to meet the needs of users. The controller

will process the information and report it to the information management platform, and then make corresponding actions through the executive device and transmission device to meet the needs of users. It should be noted that the elderly furniture in the intelligent design must be simple and easy to operate too much intelligent equipment will make the elderly feel overwhelmed, increasing their burden of use [13].

6. Summary

The impact of age on the elderly is significant. With the natural growth of age, the human body's physiological functions and behaviors show a series of weaknesses, and the ability to adapt to the spatial environment is also reduced. These changes have a great impact on the behavioral activities and daily life status of the elderly, therefore, suitable furniture for the elderly must be linked to the physiological and behavioral characteristics of the elderly.

This paper provides a certain amount of actual survey data for China's exploration of ageing-friendly design, takes the physiological and behavioral characteristics of the elderly as the starting point and destination for constructing ageing-friendly furniture design, and puts forward practical strategies for ageing-friendly furniture design, which can actually promote the development of the aging industry and thus improve the quality of life and self-confidence of the elderly.

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