

A Study on Lighting Environmental Evaluation of Senior Welfare Centers Based on biophilia

So Yeon Yang and Tae Kyung Lee

ABD, Dept. of Interior & Environmental Design, Pusan National University, Busan, South Korea

Associate professor, Dept. of Interior & Environmental Design, Pusan National University, Busan, South Korea

<https://doi.org/10.5659/AIKAR.2020.22.4.123>

Abstract Light is an essential environmental element for elderly people to do various activities. At senior welfare centers, healthy indoor lighting is especially necessary because the facilities are used by the elderly to perform their mostly indoor activities. The purpose of this study is to evaluate light environments at senior welfare centers for well-being lighting characteristics. We based the study on the 'Biophilia' theory, a concept related to health from happiness. Thus, this study is mainly based on literary review and survey research. For this, we conducted a location focused field study to identify the current state of the lighting environments at senior welfare centers in Busan, South Korea. First, we constructed structural questionnaire to evaluate lighting environment based on 'Light and Space' biophilia theory. Then, to survey subjective evaluation, the participant of research included total of 122 senior welfare center users. Based on the results of this research, the conclusions are as follows; 1) overall, it seems that the overall result of the light environmental evaluation seems to be high because the evaluated facilities in the case survey in large-scale were recently built elderly welfare centers. 2) most of the healing design elements are focused on the introduction of natural light and psychological influence. The satisfaction with actual natural light is evaluated to be high. Although shadow and reflected light are very important in discrimination and recognition of indoor space and wayfinding, the evaluation of reflected light and shadow was low for the study. 3) items that are related to the functionality of the light were highly evaluated, while the items that are related to the spatiality of the light were rated poorly. This study has its significance when examining the effects of light environments within the welfare center form of the perspective of senior citizens. It can be referenced when reconsidering the recognition of light environment as a major consideration factor to establish a desirable senior welfare center environment.

Keywords: Biophilia, Welfare Center, Environmental Evaluation, Lighting Environment Evaluation, Light and Space

1. INTRODUCTION

Since Korea entering the aging society in the 2000s, the Korean society was aged much faster than other countries and become an aged society 14.02% elderly population as of in August 2017(Statistics Korea, 2017). This aging speed was

accelerated with the aging of the baby boomer generation, which has a large population. Korea is expected to go into the super-aged society in 2026(Statistics Korea, 2017). Therefore, research on the welfare of the elderly is in urgent need. In particular, the baby boomer generation is called New Senior or Active Senior, which distinguishes it from the old generation in terms of a social, political and cultural experience Unlike precious generations, baby boomers have high incomes, are econ made of then children, and have an increased life expectancy. Another differ is their desire for hobby & leisure after retire. It can be see that their has been a change of perception about leisure where 'leisure life' has a big influence on life satisfaction. Therefore, it is necessary to study the leisure welfare facilities for the baby boomer generation, which is starting to enter the elderly stage in earnest.

Corresponding Author : Tae Kyung Lee
Department of Interior & Environmental Design, Pusan National University, 2, Busandaehak-ro 63beon-gil, Geumjeong-gu, Busan, South Korea

e-mail : sunney@pusan.ac.kr

This work was supported by a 2-Year Research Grant of Pusan National University.

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

2. STUDY CONTENTS AND METHODOLOGY

The United States, which entered the aged society before

Korea, has leisure facilities for seniors including Senior Center, Longevity Training, Adult Sports Camp, Theme-focused Retirement Communities, Hobby-craft Center, Time-sharing Complexes and Recreation Consulting Center. Japanese has senior welfare centers, recreation centers, and resorts for the elderly. In Korea, elderly welfare facilities include elderly community centers, elderly classrooms, elderly recreation centers, and senior welfare centers in accordance with Article 36 (2) of the Elderly Welfare Act(Jeon Gu Ha, 2009). In this study, physical environment for welfare facilities where elderly people spend most of their time for counseling, treatment, education, lectures, and meals, will be evaluate because are the representative of leisure welfare facilities for the elderly and overlap with leisure facilities for the elderly in developed countries.

As more people's economic status get better in Korea, the desire for a healthy lifestyle increases which leads to a demand for a better quality of life and a healthier living environment¹. This interest in the improved quality of life and sustainable health causes a demand for a healthy space². Since the body of the elderly is complex and has a characteristic of reacting slowly to the stimulation of the surrounding environment, the physical environment is very important and it has a correlation with the psychological and physical health of the elderly(Shin Yoon jhin, 2016). The elderly who use the senior welfare center and spend most of time indoors and it may have a direct correlation in health. Thus, the indoor environment of senior welfare centers is very important. Among various physical factors of indoor space, indoor light is the most important factor when changing the bio-rhythm(Lee Jung-Eun, 2004). It is seen to affect people severely in terms of emotion, memory, hormone formation, and etc(Ha Mi-Kyoung, Lim Bo-Lyun, 2005). In addition, the light environment is a physical element for the comfortable visual environment, perception, and cognition among the behavioral elements of environmental psychology. At a psychological element liant impacts anxiety, stress, dependency, and privacy(Yoo Sung-Hoon, Choi Sang-Hun, 2009)³. Elderly people may especially have an adverse reaction to visual perception due to degenerative sensory organs, therefore, light environment is very important because it is a factor that is directly related to safety.

With this renewed interest in a healthy living environment, many construction companies are introducing eco-friendly strategies and cutting-edge networking equipment to focus on health promotion and community life. With this interest, it is important that healthy living environment should include mental attributes and social concerns that can affect the quality

of life beyond the physical attributes for the user⁴. Many studies on the elderly in Korea have been conducted, however this studies are lacking on light environment for users. Studies on light have focused visual perception based on the color environment. Unfavorable indoor conditions can adversely affect a user's life and deteriorate the physical, mental, and social aspects that constitute a user's quality of life. Therefore, the quality of the indoor environment is very important in terms of providing users with a better quality of life⁵.

In this study, subjective evaluation of the indoor light environment of elderly welfare center including natural light and artificial light were carried out for the elderly. In order to conduct the subjective evaluation on the light environment, which is related to psychological and physical health, we evaluation tool of an indoor light environment(Yang So-Yeon, Lee Tae-Kyung, 2017) based on the 'Biophilia' theory as if related to physical, psychological and cognitive well-being among therapeutic theories for psychological comfort.

The purpose of this study is to improve the indoor light environment of senior welfare centers by evaluating it. This study has significance as foundation knowledge in planning future senior welfare centers.

3. PREVIOUS STUDY REVIEW

3.1. Elderly leisure welfare facility

3.1.1. Leisure of the Elderly

Generally, the concept of leisure is related to the voluntary behavior at one's own discretion during free time or non-compulsory time. It is the opposite concept of labor, and it has little relation to compulsion and randomness, and it is related to pleasant rest in mental and emotional aspects. In this section life expect will be studied in terms of lesuire athrities. The life expectancy of elderly people over 65 years old in Korea exceeded 80 years in 2010, and it reached 82.4 years in 2016 so the period of old age is becoming longer and longer(Statistics Korea, 2016). In order to maintain a meaningful life in the old age for a long period, it is necessary to choose leisure activities that meet the active leisure life and desires in preparation for problems such as functional decline, loss of roles, solitude, and alienation. Leisure activities of the elderly are an opportunity for social participation that is out of duty and through this, they can get away from alienation by working actively together. This is because the elderly can restore the pleasure of life by themselves and improve the quality of life through leisure activities. In currentaly, the area of senior leisure activities is expanding into social service activities that contribute to the society and the country beyond the entertainment and hobbies of old age.

¹ Na Na Kang, Tae Kyung Lee, Jeong Tai Kim. Characteristics of the Quality of Korean High-rise Apartments Using the Health Performance Indicator. *Indoor and Built Environment* 000:1-11,2012.

² Tae Kyung Lee, Jeong Tai Kim. Residents' responses on indoor environment quality and energy use in apartments. *Energy and Buildings*, 98, 34-38,2015.

³ Yoo Sung-Hoon, Choi Sang-Hun(2009), Table 6 analysis.

⁴ Na Na Kang, Tae Kyung Lee, Jeong Tai Kim, Chi Gyo Kim. Residents' and experts' perspectives for evaluation of importance of Health Performance Indicators in social housings. *Indoor and Built Environment*,23(1),150-160, 2014.

⁵ Sung Heui Cho, Tae Kyung Lee, Jeong Tai Kim. Residents' Satisfaction of Indoor Environmental Quality in Their Old Apartment Homes. *Indoor and Built Environment*, 20,16-25, 2011.

Accordingly, social interest and policy consideration for the leisure of the elderly is increasing recently.

This study aims to evaluate the environment of the elderly leisure facilities that can meet the rising leisure needs with the increase in the elderly population and expected life expectancy. According to the previous research, leisure activities of the elderly are as important as health and income guarantee, and the environment of the elderly leisure welfare facilities.

3.1.2. Leisure facilities for the elderly

According to Article 36 of the Elderly Welfare Act, the types of leisure welfare facilities for the elderly are divided into the senior welfare center, the community center for the elderly, and the elderly classroom. Among them, a senior welfare center is defined as the facility that aims to provide various informative activity and services for the elderly on general education, hobbies, and social participating activities, and etc., improve

Table 1. Previous Study of Senior Welfare Center Design

Researcher (Year)	Title	Contents of research	Research method
Choi Eun Hee (2017)	Analysis on space preference of senior welfare center based on the baby-boomers' lifestyles	Spatial Preference Analysis by Lifestyle Cluster and A Proposal for the Basic Direction of Interior Design based on the Preference of Interior Space Elements	Survey
Son Hye-Yun (2015)	A study of color designs for the educational spaces of welfare facilities for the aged	A Proposal for the Application of Color Design to Elderly Welfare Center through Color Evaluation and Influence of Color Scheme in Interior Education Space	Survey
Seok-Joo Hong, Hyae- Jin Bin (2015)	Study on Green Remodeling improvements of Senior Center - Focusing on Seoul Municipal K-Senior Center -	A Study on the Analysis of the Elderly Welfare Center and the Improvement of Green Remodeling in Deteriorated Facilities	Field Survey
Shin Yoon Jhin(2014)	A study on the elements of healing design of senior activity centers : with a focus on the effects of color and image of nature on a sense of comfort	A Study on the Application of Color and Natural Image for the Comfort in the Elderly Welfare Center	Survey
Kim Gil- Young, Choi Min- Seub(2013)	A study on the effects of the facility spaces and welfare services for the elderly user's satisfaction of the senior welfare center -Focused on Seoul city area	Analysis of Facility Space and Satisfaction in the Elderly Welfare Center	Survey
Rho Bang- Hwa(2013)	A Study of the Effects of Indoor and Outdoor Environmental Factors in Elderly Welfare on the User Satisfaction.	Verification of Quality of Service between the Effect of Indoor and Outdoor Environment on User Servicing and Satisfaction through Structural Discharge Model	Survey
Kim Sun- Kyung, Kim Mi- Hee(2009)	An Estimation of an Interior Environmental Affordance in Senior Center and User's Satisfaction about the Facilities - Focused on Gwang-ju city -	Analysis of User Facilities Satisfaction according to the Facility Satisfaction and Requirements of the Elderly Welfare Center Users and the Assessment of Indoor Environmental Support	Survey& Field Survey
Yeun Sook Lee et.(2007)	Research Papers : Environmental Affordance of a Well Recognized Senior Center of Japan	An Analysis of Environmental Support through Case Study and Analysis of the Successful Senior Center in Japan	Case analysis
Song-Hyun Lee (2014)	A Study on the User Satisfaction Factors of Leisure Facility Interior by Lifestyle in Senior Welfare Centers	A Case Study of Leisure Facilities in the Elderly Welfare Center and Analysis of Spatial Characteristics by Lifestyle Types	Case analysis& Survey
Kim Mi Young(2010)	A Study on Interior Color Design in Welfare Center for the Elderly	Analysis of Public Space of Senior Welfare Center in Daejeon Metropolitan City and The Color Design for Interior Design	Case analysis
Ryu Sook- Hee(2007)	Analysis of Interior Color Status in the Welfare Facility for the Elderly in Cheongju - Focused on the Application of Moon-Spencer's Theory of Color Harmony	Analysis on the Interior Color of Elderly Welfare Facilities in Cheongju	Case analysis
Soh Jun- Young(2006)	A Study on the Spatial Features by Types of Multipurpose Senior Centers in Seoul	Analysis on the Spatial Characteristics of the Multipurpose Senior Center in Seoul	Case analysis
Kim Yu- Ree(2004)	Interior coloring plan for space ability improvement of the general welfare institution for the aged	Analysis of Spatial Composition and Color in 5 Places with Elderly Welfare Center in Seoul	Field Survey
Lee Jong- Hyub, Kang Kun- Hee(2002)	A study on the architectural planning of senior welfare center	A Comparative Study on the Spatial Composition of the Multipurpose Senior Center in Seoul and the Rural Area and the Elderly Welfare Center Plan Reflecting the Needs of the Elderly	Survey
Soh Jun- Young(2001)	A Study on the Characteristics of Space Programs for Senior Center in Japan	A Case Study on the Spatial Composition of the Elderly Welfare Center in Japan	Case analysis

health, prevent disease, guarantee minimum income, provide social welfare service at home, and provide any necessary services for improving senior welfare under the Article 36 (1) of the Elderly Welfare Act. A senior welfare center is the base of local welfare service that implements the government welfare policies for the elderly therefore this study focuses on these centers.

3.1.3. Senior welfare center

Senior welfare centers were introduced in Korea when the Elderly Welfare Act was enacted in 1981, as similar facilities to the Senior Welfare Centers in Japan and the Multipurpose Senior Centers in the United States. In the beginning, it was used as an elderly university, a community center for the elderly, and an office for Senior Citizens Associations rather than providing various welfare services. However, in recent years the concept of the welfare of the elderly has expanded from providing services for the sick seniors of the low-income class to providing various services for the whole elderly community that includes healthy and economically competent seniors. It became necessary to have a senior welfare center that provides a wide range of services. In 1989, the Southern Senior Welfare Center was established in Jung-gu, Seoul. Under the Elderly Welfare Act, a senior welfare center is defined as a facility for elderly people to meet their welfare needs while residing in a community where their lives are maintained. It is defined as an elderly leisure welfare facility that functions as a comprehensive welfare center for the elderly to provide the necessary convenience for improving the elderly health and providing education, entertainment, and other welfare services of the elderly at a free or low rate.

3.1.4. Previous Study on the design of senior welfare centers

In order to review the previous studies on the design of senior welfare centers in Korea, I researched the dissertation and journal articles published since 2000 using the data of the homepage of the National Assembly Library. As a result of using 'senior welfare center indoor', 'senior welfare center design', 'senior welfare center environment', 'senior welfare center space' as a search term, 15 dissertations and articles were identified as previous studies and I did a literature review (see Table 1).

The previous studies on senior welfare centers were found to be inadequate compared to the studies of other spaces related to the elderly. There are five color-related papers(Son Hye-Yun(2015), Shin Yoon Jhin(2014), Kim Mi Young(2010), Ryu Sook-Hee(2007), Kim Yu-Ree(2004)) regarding the visual environment and the research on the light environment was not found.

When it comes to studies beyond the physical environment, the study on color is being actively conducted for the elderly. In order to improve the visual environment of senior welfare centers, it is necessary to study and analyze the indoor physical light environment.

3.2. Indoor Lighting Environment

The elderly welfare facility is the place where the elderly spend most of their time eating, resting, and having treatment one side of sleeping. The identification, distance, ventilation, and the management of furniture, floors and recreation facilities of such space is positively related to the quality of life of the elderly⁶. The physical environment factor of the elderly, which brings positive emotion, positively affects the physical and psychological health of the elderly and can be used as the countermeasure of the environmental factor that brings negative emotions⁷. Therefore, it is essential to manage the physical environment for the elderly welfare facility.

Among the factors that make up the physical environment of the space such as lighting, heat, sound and space conditions, the lighting quality or the light environment has the greatest influence on the people's visual comfort and satisfaction and it is one of the important factors affecting human health and work performance⁸.

3.2.1. Properties of Light

The visual preference is an aspect of pleasure. Understanding the meaning of the environment plays a very important role in human perception and reaction of the environment. Therefore, the visual element has a great influence on the comfort of the environment. Brightness of a setting plays a large role in determining the mood of a place. Vision plays the greatest role in recognizing objects and perceiving space and acquires the most information accurately among many sensory apparatus(Son Myoung hwan, 2012). The efficiency of work and the comfort of life are determined by sight. In particular, the light affects the definition of space as well as the character of the space itself because it makes people feel the space by limiting it, making it beautiful, and giving it a special character⁹. Further, the light environment in the building can have a great impact on the user's comfort, well-being, and health(Jeong Tai Kim etc, 2011).

3.2.2. Light Environment of the Elderly

In general, the visual function of the eye declines with age. As a result, the cornea of the eye, the pupil, the lens, and the retina are aged. As the cornea of the elderly over 65 years is thickened, the focal point of the light cannot meet at one point due to changes in the refractive index of the cornea and is accompanied by cloudy astigmatism. The amount of light

⁶ Mei-yung Leung, Jin gyu Yu, Ming L. A. Chong. Impact of facilities management on the quality of life for the elderly in care and attention homes – Cross-validation by quantitative and qualitative studies. *Indoor and Built Environment*, 26(8), 1070-1090, 2017.

⁷ Shin Yoon Jhin. A study on the elements of healing design of senior activity centers : with a focus on the effects of color and image of nature on a sense of comfort. doctoral thesis, Chonbuk National University, Korea, August 2014.

⁸ Joon-Ho Choi. Investigation of human eye pupil sizes as a measure of visual sensation in the workplace environment with a high lighting colour temperature. *Indoor and Built Environment*, 26(5),608-620, 2017.

⁹ John, K.,Garret, E. Interior architecture. New York:Van Nostrand Reinhold, 1992, p12.

Table 2. Previous Study of Light Environment and the Elderly

Researcher (Year)	Title	Contents of research	Research method
Lee Ye Sun (2017)	The effects of the stimulated program consist of bright light and tactile massage for elderly with cognitive impairment in long term care facilities	An understanding of the effects of stimulation programs on sleep disorders and depression in elderly care facilities by incorporating high levels of light and sensitive massage	Survey
Yoon Hong chu(2016)	Architecture design plan of a natural light nursing home	A Study on the Architectural Planning for the Elderly Care Facilities Using Natural Light	Previous Study
Moon Sun Young(2016)	A Study on Correlation of the Atmosphere and Physical Environment in the Space of the Building; Focused on the Light Atmosphere and Light Environment of Geriatric hospital Evaluation of Light	Moon SunYoung(2016) A Study on Correlation of the Atmosphere and Physical Environment in the Space of the Building; Focused on the Light Atmosphere and Light Environment of Geriatric hospital Evaluation of Light Environment Recommendation and Evaluation Image of the Elderly Care Hospital	Survey
Jee Soo In (2016)	A Study on the Therapeutic Effects of Light for Demented Elderly -focused on the visual and physiological therapeutic effects-	A Study on the Treatment Effect of Light and Light for the Elderly with Dementia	Previous Study
Kim Hyun-Jung(2016)	The effect of bright light therapy(BLT) on sleep in institutionalized elderly	A Study on the Effect of Light Treatment on the Sleep in the Elderly at the Hospital	Survey
Jo Sang Youl(2011)	The effect of the different levels of illumination while crossing obstacle in healthy older adults	Identification of Obstacle Pedestrian Patterns in the Elderly with Light Brightness	Field Survey

passing through the lens decreases as pupil diameter decreases, and the lens is hardened due to loss of elasticity and increase of turbidity, which causes presbyopia and cataracts. In addition, the efficiency of light sensation transfer is reduced as the retinal capillaries become thinner and the number of retinal rods and the type and quantity of neuron is decreased. In other words, the elderly have presbyopia, cataract, glaucoma, senile macular degeneration, decreased visual acuity, diminished spatial vision, reduced visual field and declined discrimination power of color as aging phenomena of visual function and diseases. They also have increased dazzle and decreased light and dark adaptation, leading to severe visual impairment¹⁰. The most common feature of presbyopia is the scattering of light from the lens, which also increases the dazzle. In addition, as the lens become cloudy and does not pass the light properly, the vision is unclear like standing in the middle of the cloud, the glare occurs, the yellowing of the lens causes the yellowing of the visual field and the dark adaptation is decreased¹¹. Light meets the visual, physiological and emotional needs of humans. Thus, light is a very effective element in meeting visual and physio

logical effects. Light is considered to be the most basic and important element to support physiological and emotional therapeutic effects, as well as therapeutic effects on a wide range of cognitive, behavioral and daily life impairments including

general aging characteristics¹². Light also primarily supports the visual function of the elderly, thereby satisfying the basic condition of clear vision environment with safety and comfort, and provides sufficient illumination to vision environment, thus reducing the cause of fall accident which often occurs to the elderly. Therefore, evaluation of the light environment is an essential factor in the environmental evaluation for the elderly, but it seems to be replaced by the color environment evaluation.

3.2.3. Previous Study of Light Environment for the Elderly

In order to grasp the previous research on the light environment for the elderly in Korea, I reviewed the dissertations and journal articles published since 2000 using the data of the homepage of the National Assembly Library. As a result of using 'elderly' and 'light' as a search word, 6 dissertation and articles were identified as previous studies. I did a literature review (see Table 2).

Measures of visual access and exposure between the two groups, with such a small sample, these differences cannot conclusively be attributed to the need by wanderers and non-wanderers for different amounts of information about their surroundings. However, this pilot study has suggested that by using the same methods on a larger sample it may yet be possible to confirm that wandering is not the aimless behavior it has long been believed to be. Instead, a more positive recognition of wandering as a goal seeking behavior may be established by

¹⁰ Jee Soo In. A Study on the Treatment Effect of Light and Light for the Elderly with Dementia. Korean Society of Basic Design & Art, Vol.17 No.2, 2016.

¹¹ Nomura Midori. Barrier Free Architectural Urban Planning Theory. Korea:Konkuk University Press,2009, p53.

¹² Jee Soo In. A Study on the Treatment Effect of Light and Light for the Elderly with Dementia. Korean Society of Basic Design & Art, Vol.17 No.2, 2016.

understanding the influence of the physical environment on wanderers.

Reviewing previous studies, I found that most of the previous studies on elderly people and light focused on nursing homes (Lee Ye Sun (2017), Yoon Hong chu (2016), Moon Sun Young (2016), Jee Soo In (2016), Kim Hyun-Jung (2016)) for the elderly and most of them were related to the light therapy for treatment. A senior welfare center, which is an elderly leisure facility, is a space where elderly people live according to various programs. And it is important that the indoor environment is designed without inconvenience for the elderly to live because problems that directly connect to the elderly's health can occur. Therefore, in this study, I would like to research the subjective satisfaction of light environment of senior welfare centers where the elderly spend a lot of time indoors and provide basic data for healthy and pleasant environment satisfying user's desire.

3.3. Biophilia

3.3.1. Theory of Therapeutic Design

In setting up the environment of senior welfare centers, it is important to consider the healing aspect which gives psychological comfort and stability to the elderly¹³. The healing aspect is based on the healing theory of nature and the healing effect of nature has been proved by various studies. According to the studies by Ulrich (1991), Lewy (1980), and Whitehouse (2001), natural factors, natural light, and gardens reduce stress and help restore from mental fatigue. The theory that explains the healing effects of nature includes Attention Restoration Theory (ART), which explains the physiological and psychological comfort of the forest environment, asserted by Kaplan (1989), Stress Recovery Theory (SRT), which explains how the natural environment reduces the response to stress, alleged by Ulrich (1991), Psycho-evolutionary Theory, which explains that the natural environment lowers the reaction to stress, and Biophilia, a theory that the human mind and genes have inherent attachment and regression instincts in nature. In this study, I would like to explain the current interest in the environment-friendly lifestyle and evaluate the light environment based on Biophilia theory which is closely related to human physical, psychological and cognitive well-being.

3.3.2. Biophilia

Biophilia is the theory that human minds and genes have inherent attachment and regressive instincts in nature. Edward O. Wilson (1979), a professor of zoology at Harvard University and founder of Sociobiology, created the term biophilia, a compound word of nature (bio) and love (philia), which means "creatures have the love for the natural environment."¹⁴

¹³ Shin Yoon Jhin. A study on the elements of healing design of senior activity centers : with a focus on the effects of color and image of nature on a sense of comfort. doctoral thesis, Chonbuk National University, Korea, August 2014.

¹⁴ Wilson, E. O. Biophilia: The human bond with other species. Cambridge: Harvard University Press, 1984, p7

Heerwagen focuses on the relationship between architecture and psychological well-being and defines it as the direction of the fundamental activity associated with avoiding human harm and finding, using, and enjoying natural resources that promote the reproduction of the body for health and survival¹⁵. Despite the material abundance and medical development in modern society, healing and well-being are required to live a comfortable life as diseases that have not been easily seen in the past (depression, attention deficit, hyperactivity disorder, etc.) appear. From this point of view, Biophilia is a concept of Healing and Well-being to find happiness at the center of our human being. It is related to physical and mental stability and can be explained by the concept of happiness, a state in which good psychological feelings are maintained¹⁶. Biophilia expression is beneficial to human activities in a way of emotional stability and stress reduction and is a human instinct but a positive element of the environment. Biophilia is the most valuable because it links humans and health and it is a factor for creating a healthy environment.

3.3.3. Biophilic Design and Light Environment

Biophilic Design, a compound word of Biophilia and design, is an intentional attempt based on this understanding of human instincts for nature¹⁷. Kellert & Wilson (1993) said that Biophilic design was attempted to express inherent human instincts that are attracted by nature or a thing having a process like nature in urban environmental design¹⁸. Kellert (2005) and Heerwagen (2001) explained 'Elements of Biophilic Design'¹⁹ classifying them by six elements. In this study, light environment will be evaluated with detailed design attributes of 'Light and Space' which has an important relation in human psychological and physical aspects and that can express the design in various ways. Other healing design theories have studied the effects of natural light only, while the 'light and space' element of biophilia explains the entire light environment, including natural and artificial light. And it has significance as an environmental assessment tool since it explains not only the functional aspects of light that have physical and psychological influences such as lighting, light color, glare, control of light, and proper illumination but also the spatial aspects of light that we can feel due to light.

4. METHODOLOGY

In this study, a literature review was conducted in addition to survey research (see Figure 1).

¹⁵ Kellert, S.R. Biophilic Design. New York: Wiley, 2011, p112

¹⁶ Yang So-Yeon, Lee Tae-Kyung. A Study on Lighting Environmental Evaluation Based on Biophilia. Journal of the Korean housing association, Vol.28 No.1, 2017.

¹⁷ Kellert, S.R. Biophilic Design. New York: Wiley, 2011, p354

¹⁸ Ibid.

¹⁹ Ibid.

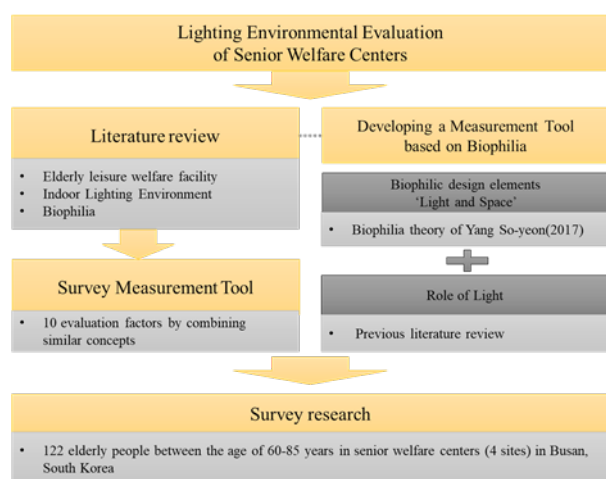


Figure 1. Flow Chart

In the literature review, literature and previous research on elderly leisure welfare facilities, the design of senior welfare centers, the characteristics of light, elderly people and light, biophilia theory and biophilic design was analyzed. Through this review, the framework of evaluation for analyzing the light environment of senior welfare centers was determined. Elderly who use the senior welfare center in Busan were surveyed and researched then evaluated senior welfare centers' light environment. To evaluate the indoor lighting environment, the Elements of Among the six elements of Biophilic Design, 'Light and Space' through Previous study and literature review was composed by comparing and analyzing the roles of light that has been summarized.

In the research study, in order to conduct a questionnaire for the elderly who use elderly welfare centers in Busan, survey was conducted directly with the elderly in consideration of the time period of use of the elderly welfare center after selecting the subject of the survey considering the environmental characteristics and regionality of the elderly welfare center. The light environment of the elderly welfare centers was investigated and evaluated





4.1. Research subjects

The subjects of this study was 122 elderly people between the age of 60-85 years in senior welfare centers (4 sites) in Busan, South Korea. Based on the current status of welfare facilities for the elderly in 2016 (Ministry of Health and Welfare, Dec. 31, 2015), among 24 senior welfare centers in Busan Metropolitan City, there are 12 sites that were established since 2000 and whose floor area is more than 1,000 square meters and that are composed of a certain number of rooms (computer room, auditorium, physical therapy room, restaurant, lounge, counseling room, lobby etc.). The subjects of this study were elderly people who use this 4 senior welfare centers (Table 3), whose identification and visual perception has no problem and that want to participate in this survey.

The area and facility's room composition, year of establishment, and the year of establishment, were selected

as the senior welfare centers representing each ward, but in consideration of locality, four senior welfare centers were divided into separate senior welfare centers so as not to overlap each other, and four senior welfare centers that responded favorably to the study were selected. As it is a survey targeting the elderly, there is no difficulty in identification and visual perception, and the survey was conducted by selecting the elderly who wished to participate in the survey as a survey target.

Table 3. Research Subjects

Site	Lot area Architectural area	Number of floors	Establish-ment year	Image
A Busan Gangseo- gu	2,975 m ² 2,319.6 m ² (Including annex restau- rant)	2F	2005 (Remodeling 2017)	
B Busan Dong-gu	705 m ² 1,502.8 m ²	5F	2000	
C Busan Sasang- gu	6,520 m ² 1,622.10 m ²	5F	2012	
D Busan Saha-gu	6,520 m ² 1,622.10 m ²	6F	2011	

4.2. Survey and Analysis Method

This research was carried out from June 10 to June 23, 2017 by a researcher and a surveyor.

Due to the nature of the light environment, a questionnaire was conducted based on sunny days, and a questionnaire was conducted by setting a time from around 10 am to around 3 pm, the time zone when the elderly use the welfare center most often. The survey place was limited to the lobby, which is the public space of four senior welfare centers. The researcher and surveyor distributed and collected the questionnaires in a one-on-one way considering that they were over 65 years old after receiving questions after reading the questionnaire in consideration of the visually impaired and helping people understand the content of the survey. The collected data were analyzed by a statistical program called SPSS Statistics 21.

4.3. Developing a Measurement Tool based on Biophilia

In the literature review, I reviewed the design principles based on Biophilia through the analysis of literature and previous studies on Biophilia theory and light and space. And I summarized them according to the evaluation tool of the light

Table 4. Survey Tool

Expressive Factors of 'Light and Space'		Role of Light	Detail Evaluation Items	
Categories	Contents		Contents	N
Natural light	The effects of daylighting	Daylight	Daylight	1
	The full color spectrum	Color temperature of light	Color of light	
Reflected light	Light reflecting / Mitigation of glare	Glare	Glare / Identification	1
	Penetration of light	Light control	Reflection/ depth of light	
Spatial harmony	Mass, and scale of light	Appropriate illuminance	Appropriate illuminance	1
	A sense of harmony / A sense of security	Harmony	Harmony	
Warm light	The feeling of a nested and secure / The perception of warmly lit areas	Stability	Stability / Warm	1
Light and shadow	The creative manipulation of light and shadow /The ability to discern objects	Recognition	Shadows / Recognition	1
Light pools	Assistance of movement and way-finding	Direction	Wayfinding	2
	Feelings of security and protection		Stability	
Filtered and diffused light	Providing a variable and mediated connection between spaces particularly inside and outside areas	Expandability	Continuity	2
Spaciousness	Feeling of openness / Spacious setting in close alliance with smaller spaces	Definiteness	Openness / Community	1
Spatial variability	Fosters emotional and intellectual stimulation	Symbolism	Experientiality/ Placeness	1
Light as shape and form	Creatively manipulated	Aesthetics	Curiosity	1
	Interest, curiosity, exploration, and discovery		visual pleasure	
10			12	

environment based on Biophilia theory of Yang So-yeon(2017) and made the evaluation tool of light environment. Among the six elements of biophilic design elements, I compared and analyzed 12 factors of 'Light and Space' with 'Role of Light' and formed 10 evaluation factors by combining similar concepts.

The detailed evaluation items for the 10 evaluation factors were constructed by analyzing the relationship between 'Light and Space' on biophilia and the role of light.

I analyzed previous studies on the light environment, the role of light is largely divided into functionality and spatiality. Functionality is divided into Daylight, Color temperature of light, Glare, Light control, Appropriate illuminance, Harmony, Stability. Spatiality is divided into Recognition, Direction, Expandability, Definiteness, Symbolism, Aesthetics in detail. I constructed by analyzing the correlation between the detailed role of light functionality and biophilia; (1) Natural light factor: light, the role of light color, (2) reflected light: glare, the role of light control, (3) spatial harmony: the role of illuminance and harmony, (4) Warm Light: The role of psychological stability.

In addition, I constructed detailed survey items by investigating and analyzing the relationship between the detailed role of spatiality and biophilia; (1) Light and Shadow: The role

of identification and shadow, (2) Light Pool: Wayfinding, role of directionality, (3) Filtered and Diffused Light: Role of continuity, (4) Spaciousness: Openness, the role of a sense of space, (5) Spatial Variability: The role of place, experience, (6) Light as Shape and Form: The role of visual enjoyment.

Considering survey subjects are the elderly, I simplified the survey questions and explained the contents in detail when I made the evaluation and research tool of the light environment (see table 4)

5. THE RESULT OF LIGHTING ENVIRONMENTAL EVALUATION

5.1. General Characteristics of the Elderly surveyed

A total of 122 subjects were surveyed in well distributed: 31 subjects form A welfare center (25.4%), 30 subjects form B welfare center (24.6%), 30 subjects form C welfare center (24.6%) and 31 subjects form D welfare center (25.4%). Subjects consisted of 41 men (33.6%) and 81 women (66.4%) in terms of gender.

5.2. The Result of Lighting Environmental Evaluation

5.2.1. The reliability coefficient α value

In order to examine the validity and consistency of each item of questionnaire collected through the survey, I calculated Cronbach's α value and verified the reliability of the measurement tools for each of 10 factors.

The reliability coefficient α value for 10 factors of light environmental evaluation is shown in Table 5. Results were shown from .649 to .944 reliability values. In general, the reliability coefficient α value of more than .6 is considered to have no problem in the reliability of the measurement index and all of the reliability coefficient α value of each factor in this study is over .6 so we can say that those factors meet the reliability levels.

Table 5. The reliability coefficient α value

Evaluation factors of light	Cronbach's α	M(SD)
1 Natural light	.649	3.69(0.62)
2 Reflected light	.736	3.61(0.55)
3 Spatial harmony	.717	3.51(0.55)
4 Warm light	.918	3.61(0.84)
5 Light and shadow	.758	3.71(0.65)
6 Light pools	.686	3.16(0.67)
7 Filtered and diffused light	.742	3.69(0.75)
8 Spaciousness	.686	3.52(0.73)
9 Spatial variability	.840	3.55(0.71)
10 Light as shape and form	.944	3.52(0.82)

5.2.2. The Result of Lighting Environmental Evaluation at elderly welfare centers

By using the light environment evaluation tool based on the biophilic theory, the light environment evaluation at elderly welfare centers were above average (3 points)

on senior welfare centers, the items that correspond to the natural light show the highest grade, and the items corresponding to the continuity of light, 'I feel that interior spaces are consecutive due to light' and 'I feel that indoor and outdoor spaces are connected due to light', show low grade. In addition, the items corresponding to the functionality of the light were rated high, while those corresponding to the spatiality of the light were rated low (see Table 6).

Survey Tools of Light Environmental Evaluation's 12 Factors blow :

1. There is plenty of natural light from outside.
2. My eyes are dazzled by the light indoors.
3. The brightness of the indoor light is appropriate.
4. The interior space is warm due to the light.
5. I feel uncomfortable because of shadow.
6. Light helps distinguish things and persons in a distance.
7. There is an exceptionally bright spot.
8. I feel that the interior space is consecutive due to light.
9. I feel that indoor and outdoor spaces are connected due to

light.

10. Indoor space looks wide due to light.

11. I feel a different light in each space of the welfare center.

12. Light makes the space of the welfare center beautiful.

Table 6. Result of Light Environmental Evaluation

Factors	M(SD)				
	A	B	C	D	Total
1	4.19 (0.91)	4.23 (0.86)	3.80 (1.13)	3.77 (0.88)	4.00 (0.96)
2	3.94 (1.18)	4.07 (0.94)	3.80 (1.00)	3.42 (0.77)	3.80 (1.00)
3	4.06 (0.77)	3.83 (0.99)	3.63 (1.00)	3.61 (0.84)	3.79 (0.91)
4	3.48 (1.21)	3.90 (0.96)	3.40 (1.35)	3.29 (1.10)	3.52 (1.18)
5	4.39 (1.02)	4.13 (0.94)	3.83 (1.29)	3.39 (1.12)	3.93 (1.15)
6	3.84 (1.21)	3.93 (0.87)	3.50 (1.20)	3.65 (0.76)	3.73 (1.03)
7	2.90 (1.30)	3.23 (1.10)	3.00 (1.26)	3.39 (0.96)	3.13 (1.16)
8	2.48 (0.96)	3.20 (1.40)	2.57 (1.31)	2.74 (0.86)	2.75 (1.17)
9	2.77 (1.20)	3.13 (1.43)	2.60 (1.30)	2.68 (0.95)	2.80 (1.25)
10	3.77 (1.20)	3.47 (1.17)	3.00 (1.26)	2.87 (1.02)	3.28 (1.21)
11	3.39 (1.28)	2.73 (1.31)	2.97 (1.33)	2.87 (0.92)	2.99 (1.23)
12	4.03 (0.95)	3.50 (1.31)	3.17 (1.32)	3.32 (0.95)	3.51 (1.17)

* p<.05, ** p<.01, *** p<.001

In particular, natural light was the highest evaluation.

Continuity of light, 'I feel that the indoor spaces are connected by light' and 'I feel that the indoor and outdoor spaces are connected by light', received low evaluation.

The lighting plan, which is the most satisfactory light environment for occupants, but which can cause inconvenience to occupants, should be carefully planned so as not to cause inconvenience to occupants by setting the uniformity system for the direction of lighting and the depth of the indoor space. Although natural light has a positive psychological effect on the occupants, the unconditional introduction of light can adversely affect occupants.

And as the light providing the characteristics of space has a lower result value for spatiality, I analyzed the consideration of light environment planning is lower than that of other architectural planning elements when planning space. I pointed out which is a problem of architectural planning that only meets the level of illumination. Light can provide not only functional elements, but also the atmosphere and visual enjoyment of the space.

A healthy light environment plan should be made for the elderly who are visually weak by planning the shape of lighting

and windows suitable for each space in consideration of the lighting environment when planning an architectural plan, away from the uniform indoor lighting type and the shape of windows.

In other words, among 10 factors of light environmental evaluation, the grade of 'light and shadow, natural light, diffusion light' which is an evaluation item of object identification and natural light was relatively high, and the grade of 'openness, shape and form of light, spatial harmony, light puddle' which is an evaluation item of harmony of light, aesthetics, limitation, directivity was low.

6. DISCUSSION & CONCLUSION

6.1. Discussion

A facility's environment has meaningful attributes that are intended and perceived representing the human being in relation to the environment as well as the attribute as the physical environment. Therefore, the environment should be planned as a space that reflects human needs.

The purpose of this study is to evaluate the physical environment of senior welfare centers which support the healthy leisure life of the elderly. Eyes get the information the fastest among the various sensory organs. I want to evaluate the light environment which has a great effect on the efficiency of work and the comfort of living. In particular, among the behavior elements of environmental psychology, light is a physical element for the visual environment, perception, and cognitive comfort as well as a psychological element for proper anxiety, stress, dependency, and privacy. It is also an important physical environmental factor which is included in the physical environment elements of the healing environment.

Elderly people spend a long time staying in indoor environments and they are very sensitive to the environment. Because their physical abilities have declined due to aging. So indoor environment plan in which the elderly live is closely related to the elderly's health. Environment for the elderly should be created as a pleasant and healthy environment to improve the quality of life of the elderly. Therefore, the building is planned with eco-friendly design. However, eco-friendly buildings tend to focus on energy rather than people living indoor. We needed a new research factor to create a healthy indoor environment, not an architectural eco-friendly factor. Since the 1990s, research on the relationship between the natural environment and health has been conducted in various fields with an ecological approach. Among them, the concept that stress is reduced and concentration is improved in an environment with surrounded by nature is the Biophilia Effect. Satisfaction with biophilia can be explained as being closely related to human physical, psychological, and cognitive well-being. There are various natural elements as design elements for the indoor biophilic effect. Among them, light creates a space that gives a sense of psychological stability by making a lively, bright. In addition, the elderly have vision problems such as decreased light intensity control ability and focus control ability.

Therefore, when creating an indoor environment for the elderly, the light environment must be considered. In particular, natural light makes the indoor environment hygienic by sterilizing ultraviolet rays from sunlight. In addition, it is known to affect osteoporosis, hypertension, rheumatism, arthritis, depression, and colon cancer that may appear in the elderly.

Therefore, to evaluate the light environment of the elderly welfare center I made the environmental evaluation tool and conducted an empirical evaluation based on biophilia theory that benefits human activities in a way of the emotional stability and stress reduction etc. among the healing design theories. Through this, I aimed to provide basic data on planning healthy indoor light environment. First, Biophilia theory explains the entire light environment including natural light and artificial light, unlike the existing healing design theory. It also describes the spatial aspect of light, what you can feel due to light as well as the functional aspect of light which is physical and psychological effects such as lighting, a color of light, dazzle, control of light, proper illumination. Thus it has significance as an evaluation tool of the indoor light environment. By performing a subjective evaluation on the elderly who are real users, this study is also different from existing studies on light environment evaluation which were conducted by the viewpoint of architecture and equipment.

6.2. Conclusion

Based on the research results of this study, the conclusions are as follows.

First, the overall grade of the light environmental evaluation seems to be high because the target facility is a large-scale elderly welfare center built recently since 2000 and it has excellent facility standards.

Second, most of the healing design elements focus on the introduction of natural light and its psychological influence. Of course, the use of natural light is important and it potentially saves energy use. However, uncomfortable reflections caused by natural light coming from windows are the most common problem in buildings and they are a potential problem for the user to actively use natural light. Indeed, the satisfaction with natural light was evaluated to be high, but the grade for the reflection and shadows was low. In terms of identification and perception, shadows and reflections are very important for senior welfare centers that are used by the elderly whose visual perception was degenerated. Considering education programs are provided the most in senior welfare centers, they also play an important role in the utilization of indoor programs. Therefore, when planning the light environment, the introduction of natural light is important, but it is necessary to plan the light environment considering the various factors that natural light causes.

Third, overall the items that correspond to the functionality of the light got a high grade, while the items that correspond to the spatiality of the light got a low grade. It is found that there are not enough plans to utilize the light to have users experience space in various ways or to show a rich sense of space.

Since the senior welfare center provides various programs to support the leisure life of the elderly and the elderly stay in the senior welfare center for a long time, the positive physical environment may support the pleasant and healthy leisure life and positively affect the physical and psychological health of the elderly. Therefore, the environmental plan for the elderly should be considered important and the plan that gets a low grade in the diversity of light and space should be reconsidered. In fact, site investigation found that even a space with various functions was planned as uniform windows and lighting. Upon planning the light environment of senior welfare centers, it is necessary not only to improve lighting by introducing natural light but also to improve the light environment by considering various architectural elements. Consideration should be given to light planning to provide the appropriate level of natural light and visual enjoyment.

This study explored how to plan indoor light environment to support the healthy leisure life of the elderly who are experiencing many changes physically and mentally. This study has significance since the evaluation data of indoor light environment is established based on the theory of 'Biophilia' which is a big concept of health in order to provide basic data of light environment in planning senior welfare centers in the future.

Since this study was conducted for certain senior welfare centers in Busan, there is a limitation to generalize its result and apply it to all centers. Research on the light environment of senior welfare centers is also inactive, making it difficult to obtain objective results using the accumulated data. As the scope of future research is widened, discussions about the application and utilization of evaluation tools should be continued.

REFERENCES

- Cho, SH., Lee, TK., & Kim, JT. (2011). "Residents' Satisfaction of Indoor Environmental Quality in Their Old Apartment Homes." *Indoor and Built Environment*, 20:16-25.
- Choi, JH. (2016). "Investigation of human eye pupil sizes as a measure of visual sensation in the workplace environment with a high lighting colour temperature." *Indoor and Built Environment*, 26(5):608-620.
- Ha, MK., & Lim, BL. (2005). Characteristics of health-concerning interior design under well-being trends. *Korean institute of interior design journal*, 14(3)
- In, JS. (2016). "A Study on the Treatment Effect of Light and Light for the Elderly with Dementia." *Korean Society of Basic Design & Art*, 17(2).
- Jeon, GH. (2009). *Study on Leisure Activation for the Elderly : Focusing on old-age leisure facilities*. Master's thesis. University of Seoul, Korea.
- John, K., & Garret, E. (1992). *Interior architecture*. New York:Van Nostrand Reinhold, p12.
- Kang, NN., Lee, TK., & Kim, JT. (2012). "Characteristics of the Quality of Korean High-rise Apartments Using the Health Performance Indicator." *Indoor and Built Environment*, 000:1-11.
- Kang, NN., Lee, TK., Kim, JT., & Kim, CG. (2014). "Residents' and experts' perspectives for evaluation of importance of Health Performance Indicators in social housings." *Indoor and Built Environment*, 23(1):150-160.
- Kellert, SR. (2011). *Biophilic Design*. New York: Wiley
- Lee, JE. (2004). *Development and application of health lighting plan for quality of life in residential areas*. Master's thesis. Sejong University, Korea.
- Lee, TK., & Kim, JT. (2015). "Residents' responses on indoor environment quality and energy use in apartments." *Energy and Buildings*, 98: 34-38.
- Lee, IS. (2001). *The theory of senior welfare*. Korea:Yang Seo Won, p247.
- Leung, MY., Yu, JG., & Ming, LA. (2017). Chong. "Impact of facilities management on the quality of life for the elderly in care and attention homes – Cross-validation by quantitative and qualitative studies." *Indoor and Built Environment*, 26(8):1070-1090.
- Nam, CS. (1989). *Modern society and welfare for the elderly*. Korea: Hong Ik Je, p203.
- Nomura, M. (2009). *Barrier free architecture·urban planning*. Korea:Konkuk University Press, p53.
- Shin, YJ. (2016). "A Study on Application of the Elements of Healing Design according to Functional Space of Senior Activity Centers - With a Focus on the Effects of Color and Image of Nature on a Sense of Comfort." *Journal of Digital Interaction Design*, 15(2): 123-136.
- Shin, YJ. (2014). *A study on the elements of healing design of senior activity centers : with a focus on the effects of color and image of nature on a sense of comfort*. Doctoral Thesis. Chonbuk National University, Korea.
- Son, MH. (2012). *A Study on Lighting Design For eating and drinking Space with the Application of Light's Characteristics of Architects*. Master's Thesis. Sangmyung University, Korea.
- Wilson, EO. (1984). *Biophilia: The human bond with other species*. Cambridge:Harvard University Press, p7
- Yang, SY., & Lee, TK. (2017). "A Study on Lighting Environmental Evaluation Based on Biophilia." *Journal of the Korean housing association*, 28(1).
- Yoo, SH., & Choi, SH. (2009). "A Study on the Environment Evaluation and Suggestion of Nursing Homes in the aspects of the Environmental Psychology and Behavior - Focused on the Elderly Dementia Patients." *Korean institute of interior design journal*, 11(2).

(Received Jul. 20, 2020/ Revised Nov. 16, 2020/ Accepted Dec. 17, 2020/)