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" Enhancing Healthcare Environments: The Role of Biophilia in Interior Architecture of Hospitals and Medical Centers "

" تعزيز البيئات الصحية: دور البيوفيليا في العمارة الداخلية للمستشفيات والمراكز الطبية "

ABSTRACT

In recent years, the concept of biophilic design has gained significant momentum in the field of healthcare architecture, particularly within hospitals and medical centers. It points out the current deficiency in integrating natural elements into these environments, which significantly affects the health and well-being of patients and healthcare workers who spend extensive time in therapeutic settings. This lack of integration hinders sustainability in design and results in insufficiently comprehensive models.

The manuscript aims to explore how biophilic principles can be effectively incorporated into interior architecture, emphasizing their potential to enhance patient healing, improve staff well-being, and create supportive environments. It will present into the tangible benefits of biophilic design, noting that elements like natural light, greenery, and water features can lead to lower stress levels, shorter hospital stays, and greater patient satisfaction. Moreover, the paper will present international case studies showcasing successful implementations of biophilic strategies in healthcare facilities. It will also address the challenges faced when integrating these designs into hospital interiors and provide practical recommendations for architects and healthcare managers aiming to foster healing environments through nature. Ultimately, the manuscript argues that biophilic design is not merely a trend but an essential aspect of effective healthcare architecture. By enhancing the connection between patients and nature within hospital settings, it seeks to improve healing processes and elevate the overall quality of care provided in medical environments.

1. Introduction

Biophilic design, the integration of nature into Architecture and Interior Architecture, has emerged as a foundation for improving healthcare environments. This was evident in early architectural practices where humans

connected to nature (Figure 1). Before the Industrial Revolution, people lived in agricultural settings and were in clear contact with nature. As challenges increased in the 19th century due to increasing population density and deteriorating health conditions due to inadequate sanitation, expanding green spaces such as public parks became increasingly important as a means of promoting health and reducing the stresses of city life(figure 2)[1]

The psychologist Erich Fromm originally used the term "biophilia" in 1964, and American biologist Edward O. Wilson popularized it in 1984. He characterizes biophilia in his book as the joy that comes from being surrounded by living things and as humanity's intrinsic attraction for the natural environment. The advantages of people interacting with nature are noted by biophilia. The natural world appeals to us. Since we have developed alongside nature, humans continue to find ways to rejuvenate themselves by engaging with the natural world and stimulating their senses. This holds particular significance in healthcare settings.[2]

figure (1) The Hanging Gardens of Babylon and the integration with nature

Figure (2)[3] Central Park, Manhattan , New York City

The "healing powers of nature" were stated in the Lexicon Medicum in 1839. It made the case that many illnesses might be healed without the use of medications by just paying attention to the air, diet, rest, physical exercise, and mental condition. As a result, the environment was already thought to be therapeutic and able to influence people's health and aid in their recuperationz[4]. An account of hospital gardens in England from 1800 to 2013. Even if the strategy has altered and developed over time, this knowledge has persisted since then.[5]

The aim of biophilic architecture is to design structures and environments that foster a sense of connection between humans and the natural world, bridging the gap between them. Preserving natural light, greenery, and natural features in buildings improves the productivity and well-being of their occupants as well as the sustainability of the built environment. Biophilic design is based on the idea that people are by nature. Exposure to nature can reduce stress levels, decrease pain perception, and speed up recovery times for patients. Despite growing awareness of the benefits of biophilic design, many healthcare facilities lack adequate integration of natural elements. This manuscript aims to explore effective strategies for incorporating biophilic principles into the interiors of hospitals and health centers. By presenting international case studies that illustrate successful applications of biophilic design, it highlights the tangible benefits and challenges associated with these approaches. Finally, this paper argues that biophilic design is not just a trend but a key component of effective health architecture—one that can transform medical environments into supportive spaces helpful to healing.[6]

The Importance of biophilic design in medical treatment:

Connected to nature and that we may enhance our general quality of life, happiness, and health by incorporating aspects of the natural world into our constructed environment.[7]

More and more scientific research shows that people's physical and mental health, performance, and well-being are still significantly impacted by the majority of our innate desires to connect with nature. Even though there is a lack of data and the research is frequently methodologically flawed, the findings from a variety of fields, including employment, education, health, recreation, housing, and community, lend credence to the idea that human fitness and quality of life are still significantly impacted by contact with nature. In the healthcare industry, for instance, numerous studies have shown that being in nature can lower blood pressure, reduce stress, relieve pain, aid the recovery from disease, speed up healing, increase staff morale and performance, and reduce conflicts.[891011]

Despite the fact that nature perception is multisensory and includes reactions to both visual and auditory stimuli, research has so far mostly focused on the effects of nature viewing.

From the oldest great cities, like ancient Rome, the intuitively grounded concept that visual exposure to trees, water, and other nature tends to generate repair or recovery from stress has existed[12]. In the United States throughout the 19th century, the establishment of urban pastoral parks, like Central Park in New York, and the subsequent preservation of wilderness for public use were influenced by intuitively based arguments regarding the beneficial and stress-reducing effects of observing nature[13]. Historically, a recurring motif in these beliefs is the idea that when people are under stress, opinions of views of urban or constructed environments tend to hinder recovery, particularly if they lack natural elements like

flora and water, most natural settings will have stress-reducing effects. More recently, my colleagues and I have proposed that humans had significant evolutionary advantages in terms of survival if they were able to develop the ability to respond in a restorative or stress-reducing manner to specific natural content and configurations (such as water or savannah-like surroundings)[14] . Hence, modern humans may be biologically ready to swiftly and easily develop calming, stress-relieving reactions to unthreatening natural environments or content, but they lack this preparation for the majority of urban or constructed content.[15]

The Therapeutic Power of Nature:

Figure (3) The main advantages of biophilic design for interior spaces are illustrated in this graphic[16].

brief visual encounters with nature may help people recuperate from stressThis was also discovered in a study when patients in medical facilities were exposed to nature views for very brief periods of time, like ten minutes. In Heerwagen and Orians' (1990) study on patient anxiety in a dental fears clinic, for example, questionnaire data indicated that patients experienced less stress on days when a large mural of a natural scene was displayed on a waiting room wall as opposed to days when the wall was blank. Similarly, heart rate readings showed that people felt less anxious or tense while the nature mural was in view. [17]

In a study of patients slated for dental surgery, Katcher and his colleagues discovered that thinking about an aquarium with fish as an alternative configuration of nature content significantly decreased anxiety and discomfort while also improving patient compliance scores during the procedure. In a presurgical holding room, Coss (1990) investigated the effects of showing several kinds of ceiling-mounted photographs to critically ill patients who were on gurneys. His results indicate "While short-term exposures to nature can foster impressive stress recovery, it seems possible that wellness benefits may tend to be greatest in certain situations involving long duration exposures to nature.[18]

According to the results of a few studies conducted in prisons and hospitals, extended exposure to natural window views can have significant positive health effects. In one study, hospital patients recuperating after gall bladder surgery had better postoperative outcomes if their room windows looked out over a small stand of trees instead of a brick building wall . [19]Individuals who had the natural window view tended to have lower scores for minor post-surgical complications like nausea or a persistent headache, had shorter hospital stays after surgery, and had significantly fewer negative evaluation remarks in nurses' notes (such as "patient is upset," "needs much encouragement"). Additionally, although nature view patients were more likely to receive moderate analgesics like acetaminophen, wall view patients required higher dosages of severe narcotic pain medications. Similarly, a survey of patients with severe disabilities from illness or accidents (and likely under stress) revealed that scenes of trees and other natural elements were a highly favored category of hospital window views[20]. These findings are supported by research on prisons, which shows that views of nature outside prison cell windows, as opposed to views of walls and buildings, are linked to higher levels of inmate wellness, as evidenced by fewer sick calls and lower rates of stress symptoms like headaches and digestive disorders[21].

Shinrin-yoku or forest therapy, has gained more attention and interest as a means of promoting health.[2223]

According to many studies, 95% of patients and visitors reported feeling happy and content, and the indoor environment of hospitals has been shown to promote patients' health. Additionally, having flora in rooms and on rooftops reduces pain and enhances patients' psychological reactions to therapy. Additionally, several studies have shown that using everyday items enhances patients' perceptions of environmental quality and aids

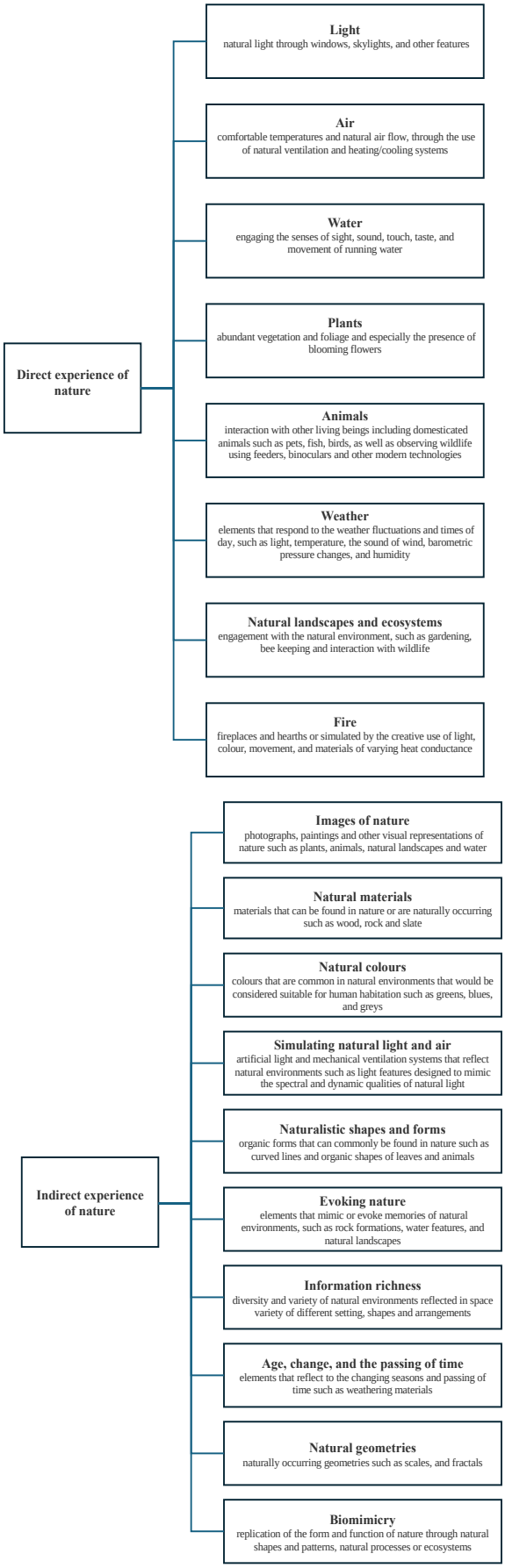
in their recovery from the illness (the difference between Figure 4 and Figure 5) . Additionally, people undergoing chemotherapy are impacted by routine light impacts , Therefore, it was believed that nature was therapeutic and had the power to affect people's health and aid in patients' recovery. Furthermore, studies backed up the advantages of what nature may offer a building through biophilic design, whether it be through interior spaces or architectural resolutions.[24]

Figure (4) The figure shows the integration with nature, patient's room featuring a variety of greenery and plants, with an open view through large windows[2526].

Figure (5) The figure depicts a traditional interior design for a patient room[27].

Principles Of Biophilic Design By Kellert [28]

Stephen Kellert, a pioneering figure in the field of biophilic design, identified several principles that serve as a framework for integrating natural elements into built environments. These principles not only emphasize the aesthetic and functional aspects of biophilia but also highlight its profound impact on human health and well-being. This section outlines Kellert's key principles of biophilic design, illustrating their relevance to healthcare architecture.[29]



The 1st Case Study Khoo Teck Puat Hospital | Singapore

Khoo Teck Puat Hospital is a 550-bed replacement hospital on a 3.5-hectare urban site in northern Singapore. The design recreates the charm and naturalistic ambiance of the pre-war hospital while enhancing staff efficiency in a patient-centered care environment. The energy-efficient design reduces energy costs by 50% and provides 40% of the floor area with the potential for natural ventilation (Figure 5, 6). [30]

Since its founding in 1938, Singapore's Alexandra Hospital has been regarded as one of the region's most advanced medical facilities. At the close of the 20th century, calls for modern architecture and modernization grew louder. The internationally active RMJM architectural firm granted their wishes. Through the assistance of CPG Consultants, they created a new "healing architecture" for this esteemed institution. The historical legacy of the Alexandra Hospital is honored at the new Khoo Teck Puat Hospital, which is energy and staff efficient and clearly focused on patient care.

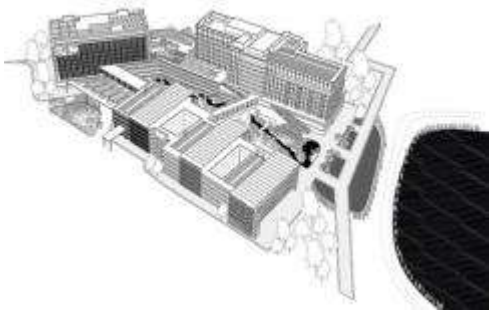


Figure (5) Green roofing enhances the ventilation[31].

Figure (6) Green roofing enhances the ventilation

The Khoo Teck Puat Hospital (KTPH), which has over 800 beds, offers general and emergency care to about 550,000 people living in Singapore's northern region. The KTPH prioritizes a healing atmosphere in addition to its preciseing medical requirements. This is founded on a biophilic design that capitalizes on and expands upon the region's inherent benefits. The concept was to establish a "garden hospital." This was made possible by terraces, vertical vegetation on the buildings, a peaceful aquatic landscape, and green garden scenery. The main feature of the gardens is the Yishun Pond, which has pathways and little pavilions lining its banks. Patients and staff experience relaxation and well-being because to the KTPH's green features. Meanwhile, They also guarantee better air quality for the entire region.[32]

This "green thread" continues into the KTPH's interior. It goes well with the light-filled, contemporary interior of this medical facility. The various wings are connected by passageways that are adorned with flora. The higher levels house the patient rooms, which are well-lit by natural light. Critical services including triage and surgery are located on the lowest floor. It is technically state-of-the-art and features explosion protection. In additionzhaving decontamination and quarantine sections, the ambulance and emergency areas are prepared for civil crises.

Green walls, rooftop gardens, courtyards, water features, and ponds are all incorporated into the hospital's design to create a healing environment (Figure 7). The healing atmosphere is improved by the windows that look out onto these green areas from patient rooms (Figure 8).

[33]The biophilic design is further supported by the interior materials and color schemes that were chosen from elements of nature. the use of natural materials like stone and wood. earthy colors like browns ,blues and greens that are used in interior design to create a sense of calm that promotes menta l and emotional health (Figure 9)

The hospital's landscaping incorporates green spaces, walking paths, and water features that encourage outdoor engagement and physical

activity. Patients, particularly those undergoing rehabilitation, benefit from having access to these natural settings as they speed up their recuperation and enhance their health.

KTPH's biophilic design features align with the objectives of environmental sustainability. The hospital lessens its reliance on artificial resources by integrating natural features. The hospital's carbon footprint is decreased through the use of natural ventilation systems, energy-efficient lighting, and green roofing (Figure 10 , Figure 11).

Figure (7) Green walls, Rooftop Gardens and Courtyards as a fundamental elements in the design[34].

Figure (8) Reception area using wood as a nature material

Figure (9) Interior Design of Patient's room.

Figure (10) Green roofing enhances the ventilation.

Figure (11) The hospital's landscaping, waterfalls, and ceiling openings enhance the ventilation.

The 2nd Case study Maggie's Centre (London, UK)

REHABILITATION CENTER, HEALTHCARE INTERIORS• OLDHAM, UNITED KINGDOM

- Architects: dRMM
- Area: 260 m²
- Year: 2017
- Manufacturers: Allgood, Aresi, Coexistence, IPIG,
- Mowat & Co
- Building Services Engineer: Atelier Ten
- Structural Engineer: Booth King Partnership
- Landscape Design: dRMM, Rupert Muldoon
- Main Contractor: F Parkinson
- Landscape Subcontractor: Hultons
- Structural Timber Subcontractor: Zublin Timber
- Funding: Stoller Charitable Trust
- Timber Advice: AHEC
- Cost Consultant: Robert Lombardelli Partnership
- Tulipwood Supplier: Middle Tenessee Lumber
- Machining Of Cladding: Morgan Timber
- Internal Joinery: Uncommon Projects
- Artist (Curtain): Inside Outside
- Film: AHEC
- Client: Maggie's
- City: Oldham
- Country: United Kingdom

Maggie's, Oldham was built in 2017. It started with co-founder Maggie who understood the impact environment and design can have on someone dealing with cancer.

Maggie talked about the need for "**thoughtful lighting, a view out to trees,**

birds and sky" and the opportunity "to relax and talk away from home cares".
It is the first engineered hardwood structure in the world.

- Its tulipwood exterior belies its equally inventive and exquisite inside.The center is a one-story structure with steel legs supporting it over its garden, designed by Alex de Rijke of dRMM (Figure 14).With its corrugated, thermally treated tulipwood exterior and cross-laminated timber construction for the main load-bearing structure.The kitchen has a huge walnut plank for a work surface (Figure 16) , and the door fixings are also made of timber.A set of curtains can be used to partition the interior space (Figure 15), and the tree that grows through the middle brings nature inside Oldham.[35]

Figure (12) Ground Floor Plan ,Rehabilitation Center ,Oldham, UK.

Figure (13) Green roofing enhances the

Figure (14) Tulipwood Structure with steel legs as supports .

Figure (15) The open Kitchen with walnut plank for a work surface

The garden at Oldham empties into a gated and private wooded retreat beneath the building. When designing the neighboring Pennines, garden designer Rupert Muldoon was inspired to create a complex, fleeting wilderness that is both ornamental and made up of fragrant flowers and bushes.
The greenhouse and potted herb garden provide a more communal space where guests can engage in some hands-on gardening.[36]

Figure (16) The integration of nature into the design creating a harmonious connection between the indoors and the natural environment.

Figure (17) Fire place brings the warmth and organic beauty of nature into the space.

Figure (18) Natural materials like wood and curved glass enhance the space, creating a harmonious connection with the environment.

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Figure (19) Curtains can be used to partition the interior space

Elements of Biophilic Design (By Kellert)	Strategy (By Kellert)	1st Case Study Khoo Teck Puat Hospital,Sinapore	2nd Case Study The Maggie's Centre (London, UK)
Light	Sun light , Moon light	 37	38 
Air	Ventilation from openings , Cross ventilation , wind.	 39	40 
Water	Water features such as Fountain , Waterfalls, Ponds, Streams and Brooks Water walls	 41	N.A.
Weather	Seasonal Transition		
Annimal	nteraction with other living beings including domesticated animals such as pets, fish, birds, as well as observing wildlife using feeders, binoculars and other modem technologies	N.A	N.A.
Natural Landscape and ecosystem	engagement with the natural environment ,such as gardening ,bee keeping and interaction with wildfield	 42	 43

Plants	Indoor Plants, Green Roof and walls ,Hanging plants and Courtyard	44 	45 
Fire	Fireplace	N.A.	
Imeges of Nature	Photographs ,Paintings of nature	 46	N.A.
Natural Materials	Wood ,Glass, Salt and Rock		47 
Natural Colours	Earth colors such as blues ,Greens and neutral colors also	 48	49 
Simulating Natural light and air	artificial light and mechanical ventilation systems that reflect natural environments such as light features designed to mimic the spectral and dynamic qualities of natural light.		N.A

Naturalistic shapes and form	organic forms that can commonly be found in nature such as curved lines and organic shapes of leaves and animals		50 
Evoking nature	elements that mimic or evoke memories of natural environments, such as rock formations, water features, and natural landscapes	 51	 52
Information richness	diversity and variety of natural environments reflected in space variety of different setting, shapes and arrangements	 53	 54
Age, Change , and the passing of time	elements that reflect to the changing seasons and passing of time such as weathering materials	 55	
Natural geometries	naturally occurring geometries such as scales, and fractals		
Biomimicry	replication of the form and function of nature through natural shapes and patterns, natural processes or ecosystems	 56	

previous analysis of the first and second case studies, it was found that the first case study achieved 16 out of 18 biophilic design elements, representing 89% of the identified elements. In contrast, the second case study achieved 14 out of 18 elements, representing 78%

- Use natural light when possible in your spaces, such as through glass doors, skylights, large windows or open floor plans , Adding natural light to indoor spaces is a fantastic approach to improve mood and health, as it is crucial for our overall well-being .
- Adding greenery and live plants to exterior and also to interior spaces to connect outdoor and indoor also improve the air quality and the ambiance of a space. In addition to removing carbon dioxide from the air and releasing oxygen, plants also provide a peaceful, organic atmosphere that ties the area to the natural world .
- Add water features, such as aquariums or water walls, that create soothing sounds and gentle motions that mimic light rain or flowing rivers, as these are known to have calming psychological effects.
- Use raw material from nature in interior architecture, because they are biodegradable, renewable, and sustainable, natural materials have a smaller environmental effect and less dependence on artificial resources. By giving areas timeless, organic traits and fostering a sense of connection to nature through their colors and textures, they raise the aesthetic value of spaces. Materials that enhance indoor air quality, support mental health, and lessen stress include stone and wood, all of which enhance general well-being.
- Nature-inspired color schemes can greatly improve the therapeutic setting by creating a serene and healing area for employees, patients, and guests. Feelings of calm, security, and wellbeing can be generated by earth tones in nature's color range. These emotions are crucial in medical settings.

Conclusion:

Enhancing staff welleing and patient outcome s requires that biophilic design ideas be includ ed into healthcare architecture,The significant effects of natural components on health and h ealing in medical settings, including natural li ght, vegetation, water features, and sustainabl e materials, have been examined in this public ation.

Healthcare facilities may greatly improve the therapeutic experience for patients and encour age a better work environment for employees by designing areas that encourage a connectio n to nature.

The information provided emphasizes how cr ucial natural light is for regulating circadian r hythms, elevating mood, and speeding up hea ling.

In addition to purifying indoor air, adding real plants creates a peaceful environment that is resonant with development and energy.

water elements also provide calming noises th at replicate natural settings, which helps patie nts feel less stressed and anxious.

Using natural raw materials improves the aest hetics of healthcare facilities and lessens their negative effects on the environment while cre ating a timeless and organic beauty.

Color schemes inspired by nature can arouse f eelings of security and serenity, which are ess ential in medical environments where patients frequently suffer from anxiety.

Successful applications of biophilic design ha ve yielded observable advantages, such as inc reased staff morale, shortened recovery perio ds, and better patient satisfaction, as evidence d by global case studies like Khoo Teck Puat Hospital and Maggie's Centre.

These illustrations demonstrate how biophilic architecture can revolutionize the developmen t of supportive healthcare settings.

Biophilic design must be given top priority designers , healthcare administrators, and legislators as a crucial part of healthcare planning. Healthcare architecture can promote healing environments and improve the general standard of care given to patients by using biophilic design as a fundamental component.

In order to create therapeutic spaces that connect with nature's restorative qualities, biophilia plays a critical role in interior architecture. Since the built environment has a significant impact on health and well-being, it is imperative to acknowledge that incorporating nature into these areas is not only advantageous but also necessary.

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