ISSN: 2753-7919
British Journal of Healthcare and Medical Research; Vol. 13 No. 02 (2026) (44-57)
https://doi.org/10.14738/bjhr.1302.20133

Biophilic Design in Hospitals: A Narrative Review of Its Impact on Users' Well-being and Healing Environments

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Abstract: The design of healthcare facilities can influence patients' emotional state, comfort, and overall hospital experience. In recent years, growing attention has been directed toward architectural strategies that incorporate natural elements to create more supportive clinical environments. Among these approaches, biophilic design has been increasingly explored as a way to reconnect built spaces with nature and promote healthier indoor environments. This narrative review discusses current evidence on the application of biophilic design principles in hospital settings. The literature indicates that integrating elements such as natural light, vegetation, nature-inspired materials, and improved environmental conditions may contribute to the development of more supportive and restorative healthcare environments. These features have been linked to lower stress levels, improved psychological well-being, and more positive patient experiences during hospitalization. Nature-oriented design strategies appear, therefore, to offer valuable opportunities for improving the quality of healthcare spaces and supporting both patient recovery and staff well-being.

Keywords: Biophilic design, Healthcare architecture, Hospital environment, Healing environments, Well-being.

INTRODUCTION

Healthcare environments play an important role in shaping patients' experiences, psychological well-being, and recovery processes, as well as the working conditions of healthcare professionals. Traditionally, hospitals have been designed primarily to meet clinical and technological requirements. However, increasing attention has been directed toward the influence of the physical environment on health outcomes and patient experiences. Environmental characteristics such as lighting, spatial organization, noise levels, and visual aesthetics can significantly affect patients' emotional responses, stress levels, and overall perception of healthcare quality.

Early research in environmental psychology highlighted the importance of environmental conditions in supporting recovery processes. In a landmark study, Ulrich [1] demonstrated that surgical patients with views of natural landscapes experienced shorter postoperative stays and required fewer analgesics compared with patients whose windows faced brick walls. Since then, a growing body of research has emphasized the importance of designing healthcare environments that support both physiological and psychological aspects of healing.

Within this context, the concept of healing environments has become increasingly relevant in healthcare architecture. Healing environments refer to healthcare spaces intentionally designed to promote patient recovery and well-being through the optimization of environmental conditions. Several environmental factors have been associated with improved patient outcomes, including access to natural light, enhanced indoor environmental quality, reduced noise levels, and visual connections to nature [2; 3]. These environmental characteristics may help reduce stress and anxiety, promote relaxation, and improve patients' overall healthcare experiences.

Among the different design approaches proposed to improve healthcare environments, biophilic design has gained growing attention. This approach seeks to strengthen the relationship between humans and nature by integrating natural elements and nature-inspired features into the built environment. In healthcare settings, the incorporation of natural elements has been associated with several potential benefits, including reduced stress levels, improved psychological comfort, and enhanced patient satisfaction [4].

Despite the increasing interest in nature-based design strategies in healthcare architecture, the existing literature remains fragmented across different disciplines, including architecture, environmental psychology, and healthcare design. While numerous studies have examined individual environmental factors such as daylighting, natural views, or indoor environmental quality, there remains a need to synthesize current evidence on the broader impact of biophilic design strategies in hospital environments.

Therefore, this narrative review aims to examine the existing literature on the application of biophilic design in healthcare settings, with particular attention to hospital environments. By analyzing recent research findings, this review seeks to identify the main environmental design strategies associated with biophilic principles and to explore their potential influence on user well-being, psychological comfort, and healing processes in healthcare facilities. To better contextualize these issues, the following section outlines the main theoretical perspectives that explain the relationship between nature, the built environment, and human well-being.

THEORETICAL BACKGROUND

The theoretical foundations of biophilic design are rooted in the concept of biophilia, which describes the innate human tendency to seek connections with nature and other living systems. The term was initially introduced by Fromm [5] and later expanded by Wilson [6], who proposed that humans have evolved in close interaction with natural environments. According to the biophilia hypothesis, this evolutionary relationship continues to shape human psychological and physiological responses to environmental stimuli.

Exposure to natural elements has been associated with a range of psychological and physiological benefits, including improved emotional well-being, reduced stress levels, and enhanced cognitive functioning. Conversely, environments that lack natural features, such as highly artificial or enclosed indoor spaces, may contribute to psychological discomfort and mental fatigue. Over time, this theoretical perspective has influenced both environmental psychology and architectural research, encouraging the integration of natural elements into the design of built environments.

Building upon the concept of biophilia, biophilic design represents an architectural approach that aims to reconnect people with nature within the built environment. Kellert et al. [7] defined biophilic design as the deliberate incorporation of natural elements and processes into architectural design to support human health and well-being. This approach involves creating environments that provide both direct experiences of nature, such as daylight and vegetation, and indirect experiences of nature, including natural materials, organic forms, and patterns inspired by natural systems.

More recent frameworks have further systematized these design strategies. For example, Browning et al. [8] proposed fourteen patterns of biophilic design that provide practical guidance for incorporating nature-based elements into architectural projects. These patterns include visual connections with nature, dynamic lighting conditions, the presence of water, and the use of natural materials, all of which may contribute to creating environments that evoke natural settings and promote psychological comfort.

Another important theoretical perspective relevant to healthcare environments is the concept of healing environments. In healthcare architecture, healing environments refer to spaces intentionally designed to support physical and psychological recovery through the optimization of environmental conditions. Research in evidence-based healthcare design has demonstrated that environmental characteristics can significantly influence patient experiences, stress levels, and recovery processes.

Ulrich [1] provided one of the earliest empirical demonstrations of this relationship by showing that patients recovering from surgery experienced faster recovery when they had views of natural landscapes. Subsequent studies have reinforced the importance of environmental factors in healthcare facilities. For example, Ulrich et al. [3] highlighted that environmental design interventions, such as access to natural light, reduced noise levels, and improved indoor environmental quality, can contribute to more supportive healthcare environments. Similarly, Huisman et al. [2] emphasized that physical environmental factors, including lighting conditions and access to natural elements, may influence patients' comfort, satisfaction, and psychological well-being.

Environmental psychology also offers theoretical explanations for the benefits of natural environments. One of the most influential frameworks is the Attention Restoration Theory, proposed by Kaplan and Kaplan [9]. According to this theory, natural environments possess restorative properties that help individuals recover from mental fatigue and cognitive overload. Natural settings provide opportunities for effortless attention, allowing cognitive resources to recover, whereas highly artificial environments often require sustained directed attention, which can lead to mental fatigue. A related perspective is stress reduction theory, which suggests that exposure to natural environments can trigger immediate physiological and psychological relaxation responses [10]. Natural elements such as vegetation, water, and natural light may therefore play an important role in reducing stress and supporting emotional recovery within healthcare environments.

Building upon these theoretical perspectives, the present study adopts a narrative review approach to examine how biophilic design principles have been applied in healthcare environments and to synthesize current evidence regarding their potential impact on well-being and healing processes.

METHODS

This study adopted a narrative review approach [11] to synthesize the existing literature on the impact of biophilic design in healthcare environments, with particular attention to its effects on patient well-being and recovery in hospital settings.

A literature search was conducted in the Scopus database to identify relevant peer-reviewed articles. The search was performed using the following query: «TITLE-ABS (“biophilic” OR “biophilia” AND “design” AND “healthcare” AND “well-being”)». To focus on recent contributions to the topic, the search was limited to publications published between 2020 and 2026. Additionally, only journal articles (DOCTYPE = “ar”) were included in the search results.

The search initially identified 14 articles. Titles and abstracts were screened to determine their relevance to the research topic. Studies were excluded if they did not directly address biophilic design in healthcare environments, if they did not examine aspects related to well-being, healing environments, or environmental design, or if the full text was not available. On the contrary, studies were included if they:

- investigated biophilic design or nature-based design principles in healthcare environments,
- focused on healthcare or hospital environments,
- explored the relationship between environmental design and well-being, patient recovery, or user experience,
- were published as peer-reviewed journal articles.

Following the screening process, six studies were excluded, resulting in eight articles that were considered relevant and included in this narrative review.

For each selected study, relevant information was extracted and summarized, including the aim of the study, methodology, sample characteristics, and key findings. The extracted data were then qualitatively analyzed to identify recurring themes related to the implementation of biophilic design principles in healthcare settings.

Although narrative reviews do not follow a fully systematic protocol, the literature selection and synthesis were conducted in a structured manner to ensure transparency and relevance of the included studies.

RESULTS

Characteristics of Included Studies

A total of eight studies published between 2022 and 2025 were included in this narrative review, as shown in Table 1. The selected studies explored different aspects of biophilic design in healthcare environments, including environmental design strategies, hospital architecture, and the relationship between natural elements and patient well-being.

The included studies employed a variety of research methodologies. Several studies adopted qualitative approaches, including expert interviews, conceptual analyses, and design frameworks for healthcare environments [12; 13]. Other studies utilized quantitative

methods, such as questionnaire-based surveys conducted among patients and healthcare staff to assess perceptions of environmental conditions in hospital wards [14]. In addition, some studies used case study approaches to analyze the implementation of biophilic design principles within specific healthcare facilities [15].

The geographical distribution of the studies reflects the global relevance of biophilic design in healthcare architecture, with research conducted in different regions including Europe, Asia, and the Middle East [14; 15; 16]. This diversity indicates a growing international interest in integrating nature-based strategies into healthcare design.

Across the selected studies, several key biophilic design elements were consistently identified. These included access to natural daylight, integration of greenery and natural views, the use of natural materials, and improvements in indoor environmental quality, such as air quality and ventilation [15; 16; 17]. These environmental features were frequently associated with improved patient comfort, reduced psychological stress, enhanced emotional well-being, and potential improvements in recovery outcomes.

Overall, the reviewed literature emphasizes the increasing recognition of biophilic design as an important strategy in healthcare architecture, supporting both patient-centered care and improved healthcare environments [16; 18].

Table 1: Synthesis of included studies

Study	Aim of the study	Methodology	Sample	Key findings	Potential biases
Untaru et al. [18]	The study aimed to explore biophilic design attributes in a hospice care center and to investigate how healthcare professionals' attitudes toward these features influence their emotional well-being, satisfaction with green elements, and workplace attachment.	Mixed-method research design combining qualitative and quantitative approaches. Semi-structured interviews were conducted to identify biophilic design elements, followed by a web-based survey analyzed using Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM)	188 healthcare professionals (including physicians, nurses, volunteers, and social workers) working in a hospice care center in Romania participated in the survey.	The study identified several biophilic design features within the hospice environment, including natural lighting, views of nature through windows, wooden furniture, nature-inspired decorative elements, and warm natural colors. Results showed that positive attitudes toward biophilic design significantly improved healthcare professionals' emotional well-being. Emotional well-being also positively influenced satisfaction with green features and workplace attachment.	The study was conducted in a single hospice facility, which may limit the generalizability of the findings. In addition, the use of self-reported survey data may introduce response bias, and the cross-sectional design prevents establishing causal relationships between variables.

Sathyanarayanan & Caldas [12]	The study aimed to explore current trends, barriers, and future directions in pediatric healthcare design, with a focus on patient-centered care, adaptability, participatory design strategies, and the role of environmental and technological factors in supporting patient well-being.	Qualitative study based on semi-structured interviews with healthcare design experts. The data were analyzed using thematic analysis following Braun and Clarke's six-phase framework.	15 experts in pediatric healthcare design, including architects, pediatric nurses, psychologists, healthcare administrators, child life specialists, and researchers.	The study highlighted the growing importance of patient-centered and family-centered design in pediatric healthcare environments. Experts emphasized the role of sustainable and biophilic design elements, such as natural materials, daylighting, and access to green spaces, in promoting psychological and physiological well-being. Emerging technologies such as virtual reality and artificial intelligence were also identified as promising tools for improving patient engagement and healthcare operations.	The study included experts primarily from the United States, which may limit the generalizability of the findings. The qualitative design and reliance on expert opinions may introduce subjectivity, and the absence of direct patient or family perspectives limits insight into user experiences.
Xie et al. [19]	The study aimed to investigate the effects of multisensory nature-based stimulation, including visual, tactile, and olfactory interaction with plants, on anxiety reduction and physiological relaxation in a dental clinic environment.	Experimental within-subject study conducted in a dental clinic setting. Participants were exposed to five experimental conditions (control, visual, tactile, olfactory, and combined tactile–olfactory plant stimulation). Psychological anxiety levels were assessed using the State-Trait Anxiety Inventory (STAI-S), while physiological responses were measured through heart rate, heart rate variability (HRV indices such as LF/HF, RMSSD,	40 participants (20 males and 20 females) with a mean age of 24.32 ± 4.00 years participated in the experiment.	Results showed that exposure to plant-based sensory stimuli significantly reduced anxiety and physiological stress compared to the control condition. The combined tactile-olfactory stimulation produced the strongest effects, including substantial reductions in anxiety scores and improvements in physiological indicators such as heart rate variability and skin conductance. These findings highlight the effectiveness of multisensory biophilic	The study involved a relatively small sample of young adults, which may limit the generalizability of the results to broader patient populations. Additionally, although conducted in a real dental clinic, participants were not undergoing invasive procedures, which may reduce ecological validity. The study also focused on short-term responses and excluded additional sensory modalities such as auditory stimuli.

		SDNN), and skin conductance.		interventions in promoting relaxation and psychological well-being in healthcare environments.	
Kindervaag et al. [13]	The study aimed to explore key insights for the development and implementation of biophilic design innovations in public healthcare environments using the "Outdoor Care Retreat" project as a case study. The research sought to understand how innovative healthcare environments integrating nature can be developed within public hospital systems.	Qualitative case study based on semi-structured interviews and document analysis. Data were analyzed using reflexive thematic analysis following Braun and Clarke's methodological framework.	Eight stakeholders involved in the development and implementation of the Outdoor Care Retreat project, including healthcare professionals, architects, project managers, sponsors, and members of the project foundation.	The study found that biophilic healthcare environments can improve the hospitalization experience for patients and families by providing access to natural surroundings and spaces that differ from conventional hospital environments. The Outdoor Care Retreat, a small wooden cabin located in natural surroundings near hospital buildings, allowed patients, particularly children, to engage with nature, experience emotional relief, and interact with family members in a less clinical setting. The study also highlighted that successful implementation of biophilic design requires collaboration between healthcare professionals, architects, and stakeholders, as well as supportive organizational cultures that encourage innovation.	The study focused on a single case study, which limits generalizability to other healthcare settings. Additionally, participants were directly involved in the project and may have provided favorable perspectives regarding its success. The researchers also acknowledged their familiarity with environmental psychology and biophilic design research, which may have influenced interpretation of the findings.
Edwards [17]	The study aimed to investigate the relationship between biophilic colors and the psychological construct of hope,	Experimental study composed of three experiments. Participants were exposed to colored test cards	154 healthy adult participants recruited from a university population. Different subsets of participants	The results showed that yellow, particularly at maximal color depth, was the color most	Participants were healthy volunteers rather than healthcare patients, which limits the applicability of

	in order to understand how specific color cues may contribute to well-being and inform design strategies for healthcare environments.	representing biophilic colors (red, yellow, green, and blue). The experiments assessed which colors and color depths most strongly evoked feelings of hope, using controlled laboratory conditions and statistical analyses including chi-square tests.	took part in the three experimental phases.	strongly associated with feelings of hope among participants. Yellow evoked significantly stronger emotional responses compared to other biophilic colors such as red, green, and blue. The study suggests that color cues in built environments can influence psychological states and that specific colors may enhance well-being in healthcare settings.	findings to clinical populations. Additionally, the study focused on isolated color stimuli rather than full architectural environments, and cultural or contextual factors influencing color perception may not have been fully captured.
Zhao et al. [16]	The study aimed to investigate the application of biophilic design principles in healthcare environments and to explore how integrating natural elements into hospital spaces can improve environmental quality, promote human health, and support sustainable healthcare design.	Mixed-method research combining literature review, field investigation, structured interviews, and case study analysis. The study examined biophilic design applications in hospital environments and proposed design strategies using architectural modeling and visualization tools such as SketchUp, Lumion, and AutoCAD.	Case study analysis of **12 hospitals in China**, combined with a survey of **240 respondents** including patients, hospital staff, and other users of healthcare facilities.	The results showed that integrating natural elements such as plants, natural light, water features, natural materials, and healing gardens can significantly enhance the quality of healthcare environments and promote psychological and physiological well-being among patients and staff. Biophilic design elements were found to reduce stress, improve emotional states, enhance patient recovery, and create more restorative healthcare spaces.	The study focused on healthcare facilities located in China, which may limit the generalizability of the findings to other cultural and healthcare contexts. Additionally, the research relied partly on subjective survey responses and design evaluations rather than controlled experimental measurements of health outcomes.
Al-Dmour [15]	The study aimed to investigate how the integration of biophilic design (BD) and evidence-based design (EBD) principles, particularly	Multi-method research approach combining literature review, case study observation, and semi-structured interviews. The	Case study conducted at the King Hussein Cancer Center (Jordan), including 12 interview participants (5 architects, 4	The study found that integrating biophilic design elements, such as improved indoor air quality systems, access to daylight, visual exposure to	The research was based on a single case study, which may limit the generalizability of the findings to other healthcare contexts. Additionally,

	indoor air quality, natural daylight, greenery, and material selection, can improve patient well-being and therapeutic outcomes in cancer healthcare environments.	study evaluated environmental design elements within a cancer treatment facility and analyzed how biophilic design strategies influence patient well-being and healthcare environments.	oncology healthcare providers, and 3 hospital designers) and observational analysis of hospital facilities.	greenery, and carefully selected materials, can significantly enhance psychological comfort and patient recovery in cancer treatment environments. The findings also highlighted that environmental needs may vary depending on cancer type and disease stage, suggesting the importance of adaptable and patient-centered design strategies.	interviews were conducted only with healthcare professionals and designers, without direct participation of patients, which may limit insights into patient experiences.
Muhamad et al. [14]	The study aimed to investigate the impact of daylighting in inpatient hospital wards and to examine how natural light exposure influences patients' recovery, well-being, and users' experiences within healthcare environments.	Quantitative research using questionnaire surveys administered to patients and healthcare staff in an inpatient ward. The collected data were analysed using statistical analysis (SPSS) to evaluate users' perceptions of daylighting conditions and their effects on health and recovery.	50 respondents (patients and healthcare staff) from the inpatient ward at Seri Manjung Hospital in Malaysia. The sample included 30 patients and 20 healthcare professionals aged 18 and above.	The findings indicated that natural daylighting improves users' psychological comfort, increases productivity and satisfaction, and contributes positively to patient recovery. Most respondents reported that adequate daylight exposure enhances well-being and accelerates the healing process in hospital wards.	The study relied on self-reported perceptions from a relatively small sample size within a single hospital ward, which may limit the generalizability of the findings to other healthcare settings.

Results of the Review

The analysis of the included studies identified several recurring themes regarding the role of biophilic design in healthcare environments. The findings suggest that integrating natural elements into hospital design can positively influence patient well-being, psychological comfort, and recovery processes [16; 18]. Four main categories of biophilic design elements emerged from the literature: 1) daylighting, 2) greenery and natural views, 3) natural materials, and 4) indoor environmental quality.

Daylighting and Exposure to Natural Light

One of the most frequently discussed biophilic design elements across the reviewed studies was access to natural daylight. Exposure to daylight in healthcare environments has been associated with improvements in both psychological and physiological outcomes for

patients. Natural light contributes to enhanced mood, reduced stress levels, and improved circadian rhythm regulation [14].

Studies conducted in inpatient hospital wards reported that adequate daylight exposure contributes to a more comfortable and restorative healthcare environment. For example, Muhamad et al. [14] found that the majority of patients and healthcare staff perceived natural daylight as beneficial for their daily activities and overall well-being. Furthermore, respondents indicated that natural lighting conditions could contribute to improved satisfaction and comfort within hospital wards.

In addition, access to daylight through windows not only improves illumination but also provides visual connections with the outdoor environment, which may further enhance psychological comfort for patients [17].

Greenery and Views of Nature

Another important theme identified in the literature was the presence of greenery and natural landscapes within or around healthcare facilities. Exposure to natural elements such as gardens, vegetation, or outdoor landscapes has been associated with reduced psychological stress and improved emotional well-being [18].

Several studies emphasized that even indirect contact with nature, such as views of green spaces through windows or nature-inspired interior design elements, may contribute to positive patient experiences during hospital stays [13]. Access to natural environments can provide restorative benefits, helping patients cope with the stress and uncertainty commonly associated with healthcare settings.

Healing gardens and outdoor spaces were also highlighted as valuable design strategies, allowing patients to engage in light physical activity and relaxation, which may support both mental and physical recovery [15].

Natural Materials and Sensory Experience

The use of natural materials in healthcare environments also emerged as a significant design consideration. Materials such as wood, stone, and other natural textures can contribute to creating warmer and more welcoming interior environments compared to conventional clinical spaces [17].

Research suggests that incorporating natural materials, along with tactile and olfactory stimulation, into hospital interiors may help reduce stress levels and improve emotional comfort among patients and healthcare staff [16; 19]. In addition, the use of low-emission or antimicrobial materials may improve both hygiene and indoor environmental quality in healthcare settings [15]. These findings indicate that careful selection of materials can play an important role in shaping both the sensory experience and health-related outcomes within healthcare environments.

Indoor Environmental Quality

Another key theme identified in the reviewed literature was the importance of indoor environmental quality, including air quality, ventilation, and lighting conditions. Biophilic

design strategies often aim to improve indoor environmental conditions by integrating natural ventilation, optimizing natural light, and using materials that minimize indoor pollutants [16]. Improved indoor environmental conditions were frequently associated with increased comfort and reduced stress for both patients and healthcare professionals. In particular, maintaining high indoor air quality is especially important in healthcare settings where patients may have compromised immune systems or chronic illnesses [15; 19].

Therefore, healthcare environments designed according to biophilic principles may contribute to more supportive and therapeutic hospital spaces. Although the extent of the impact may vary depending on the design strategies implemented, the literature consistently highlights the potential of biophilic design to enhance patient well-being and promote healing environments in healthcare facilities [16; 18].

DISCUSSION

The findings of this narrative review highlight the increasing relevance of biophilic design in healthcare environments, particularly in relation to patient well-being, psychological comfort, and recovery processes. Across the studies included in this review, the integration of natural elements into hospital environments was consistently associated with improved user experiences and more supportive healthcare spaces. These findings reinforce the growing recognition that the physical environment of healthcare facilities can significantly influence both patient outcomes and staff well-being.

The positive effects associated with nature-based elements in healthcare environments can be interpreted through the biophilia hypothesis, which proposes that humans possess an innate tendency to seek connections with nature and natural systems [6]. According to this perspective, exposure to natural elements such as daylight, vegetation, and natural materials may support psychological restoration and reduce stress levels in built environments. In healthcare settings, where patients frequently experience anxiety, discomfort, and emotional distress, the incorporation of natural elements may therefore contribute to more supportive and restorative environments.

One of the most frequently discussed environmental factors identified in this review is natural daylight. Adequate exposure to daylight in hospital environments has been associated with improved mood, enhanced circadian rhythm regulation, and reduced stress levels among patients. Previous research has demonstrated that patients exposed to natural views and daylight during hospitalization may experience improved recovery outcomes compared to those in environments lacking natural elements [1]. These findings support the importance of incorporating daylighting strategies into healthcare architecture, such as large windows, appropriate building orientation, and spatial layouts that maximize access to natural light.

The restorative benefits of natural environments may also be explained through the Attention Restoration Theory, which suggests that exposure to natural settings can help restore cognitive resources that become depleted during periods of mental fatigue [9]. In hospital environments, patients often experience prolonged stress and cognitive overload due to medical treatments and unfamiliar surroundings. Access to natural elements, including daylight and views of nature, may therefore provide restorative experiences that support emotional regulation and psychological well-being.

Another important element identified in the reviewed studies is the presence of greenery and natural views in healthcare environments. Access to vegetation, healing gardens, or outdoor landscapes has been widely associated with reduced psychological stress and improved emotional comfort. Natural environments can provide patients with opportunities for relaxation, distraction from medical procedures, and emotional relief during hospitalization. In addition, visual connections with nature through windows or indoor plants may provide similar restorative benefits even when direct outdoor access is limited.

These findings are consistent with the broader concept of healing environments, which emphasizes the role of environmental design in supporting patient recovery and well-being. Research in evidence-based healthcare design suggests that environmental interventions such as access to natural views, reduced noise levels, and improved lighting conditions may contribute to improved healthcare experiences and potentially better health outcomes [3]. The integration of nature into healthcare environments is therefore increasingly recognized as an important component of patient-centered healthcare design.

In addition to daylight and greenery, the use of natural materials also emerged as a relevant component of biophilic design strategies in healthcare environments. Traditional hospital interiors are often characterized by sterile and highly clinical aesthetics, which may contribute to feelings of anxiety or discomfort among patients. The incorporation of natural materials such as wood or stone can help create warmer and more welcoming interior environments, potentially improving patients' emotional comfort and overall perception of healthcare spaces.

Biophilic design provides a structured framework for integrating these natural elements into architectural practice. According to Kellert et al. [7], biophilic design strategies can include both direct experiences of nature, such as daylight and vegetation, and indirect experiences of nature, including natural materials, organic forms, and nature-inspired design patterns. More recent frameworks have also identified specific design patterns that facilitate the implementation of biophilic principles in built environments, such as visual connections with nature, dynamic lighting conditions, and spatial configurations that evoke natural environments [8].

Another key theme emerging from this review concerns the importance of indoor environmental quality in healthcare settings. Hospitals are complex environments where environmental conditions such as air quality, lighting, and ventilation can directly influence patient comfort and safety. Biophilic design strategies often aim to improve these conditions by integrating natural ventilation systems, optimizing daylight penetration, and selecting materials that minimize indoor pollutants.

Previous research examining environmental factors in healthcare facilities has highlighted that improvements in indoor environmental quality can contribute to reduced stress levels, improved patient satisfaction, and better workplace conditions for healthcare staff [2]. Similarly, environmental design interventions that incorporate natural elements have been associated with improved well-being in clinical settings [4]. These findings suggest that biophilic design may contribute not only to improved aesthetic qualities of healthcare environments but also to healthier indoor conditions.

Despite the promising findings identified in the literature, several limitations and challenges remain. One limitation concerns the methodological diversity of existing studies. The studies included in this review employed different research designs, including surveys,

experimental studies, and qualitative analyses. This variability makes it difficult to directly compare results across studies and limits the ability to establish causal relationships between biophilic design interventions and health outcomes.

Another limitation is that many studies focus primarily on perceived well-being and subjective experiences, rather than measurable clinical outcomes. While user perceptions provide valuable insights into environmental quality, further research is needed to examine how biophilic design interventions may influence objective health indicators such as recovery time, stress biomarkers, or patient length of stay.

Finally, the implementation of biophilic design strategies may be influenced by contextual factors such as climate conditions, cultural preferences, and healthcare infrastructure. As a result, design solutions that are effective in one healthcare setting may not necessarily produce identical outcomes in different contexts. Future research should therefore explore the application of biophilic design principles across diverse healthcare environments and geographical regions.

Overall, the findings of this review suggest that integrating natural elements into hospital architecture may represent a promising strategy for improving healthcare environments. By incorporating features such as natural daylight, vegetation, natural materials, and improved environmental conditions, healthcare facilities may create more supportive environments that enhance patient well-being and contribute to more positive healthcare experiences.

CONCLUSION

This narrative review examined the role of biophilic design in healthcare environments, with particular attention to hospital settings and their potential influence on patient well-being and healing processes. The reviewed literature suggests that the integration of nature-related elements into healthcare architecture may contribute to more supportive and restorative environments for both patients and healthcare professionals. Key biophilic design components identified in the literature include natural daylight, access to vegetation and natural views, the use of natural materials, and improved indoor environmental conditions. These elements have been associated with reduced psychological stress, enhanced emotional comfort, and improved overall patient experiences during hospitalization. By fostering a stronger connection between indoor spaces and natural environments, biophilic design strategies may help create healthcare facilities that support both physical and psychological aspects of healing. Despite the growing interest in nature-based design strategies in healthcare architecture, further research is needed to better understand the long-term effects of biophilic design interventions on clinical outcomes. Integrating nature-based design principles into healthcare architecture may therefore represent an important strategy for improving the quality of hospital environments and promoting patient-centered care.

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