International Journal of Entrepreneurship, Management and Social Sciences (IJEMSS)
Volume 3, Issue 1; ISSN: 3026-9881
email: ijemss@futminna.edu.ng

A Framework for Integrating Biophilic Design in Cancer Treatment Centers in Ilorin, Nigeria

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Abstract

The design of healthcare environments plays a crucial role in patient recovery and overall well-being, particularly in cancer treatment centers where emotional support is vital. However, many modern hospitals in Nigeria focus primarily on sterile, technology-driven care, inadvertently neglecting the psychological needs of patients. His oversight can hinder recovery, as the integration of biophilic design, incorporating natural elements into built environments, has been shown to enhance mental and emotional healing. This study aims to bridge this gap by exploring the effective integration of biophilic design in cancer treatment centers, where patients often face heightened stress. Utilizing a case study methodology, three healthcare facilities were assessed based on the 14 Patterns of Biophilic Design. The findings reveal a limited application of these principles, particularly in areas such as sensory diversity, water features, and healing gardens, which restrict opportunities for restorative experiences. This research offers practical implications, providing actionable recommendations for incorporating biophilic elements, such as therapeutic gardens and enhanced natural lighting, into healthcare design. By highlighting the essential role of biophilic design in improving patient outcomes, this study contributes to the broader discourse on healthcare innovation, emphasizing the need for a more holistic approach to cancer treatment in Nigeria.

Keywords: biophilia, biophilic design, healthcare facilities, nature, recovery

1.0 Introduction

Healthcare environments significantly impact patient recovery and well-being, particularly in cancer treatment centers. Modern hospitals often emphasize sterile, technology-driven care, inadvertently neglecting the psychological and emotional needs of patients (Davidson, 2013). Recent research, however, highlights the benefits of nature-based care, reintroducing biophilic design as a valuable component in healthcare settings (Downton, *et al.,* 2017). Biophilia, the innate human affinity for nature, has been shown to improve emotional, mental, and physical well-being (Tekin & Gutiérrez, 2023). Integrating natural elements into the built environment can reduce stress, enhance recovery, and promote positive mood changes. These effects are especially crucial for cancer patients, who face immense psychological and physical challenges.

Concrete Healthcare quality is one of the most frequently cited principles and is on top of the global agenda. One of the significant health issues in the Twenty-First Century is Cancer, the second primary cause of global mortality (Ferlay *et al.*, 2020). Cancer treatment in Nigeria faces a dual challenge: while medical advancements have improved survival rates, the psychological and emotional well-being of patients is often overlooked. Current cancer treatment centers in the country are designed with a focus on functionality and medical efficiency, neglecting the integration of nature-inspired elements that can promote mental and

emotional healing (Iyendo *et al*, 2016). Research has shown that biophilic design, incorporating natural elements into the built environment, can reduce stress and enhance overall well-being (Wichrowski et al., 2021). However, the application of biophilic design in Nigerian healthcare facilities, especially cancer treatment centers, remains largely unexplored. There is a critical need to develop healthcare environments that address not only the physical but also the emotional and psychological needs of cancer patients in Nigeria.

However, this study aims to develop a framework for integrating biophilic design into cancer treatment centers in Ilorin, Nigeria. The objective is to explore how nature-based design elements can improve the physical, emotional, and mental well-being of cancer patients. This research will examine the potential of biophilic design to create a more healing-oriented environment that supports patient recovery and enhances the overall healthcare experience.

2.0 Literature

2.1 The Concept of Biophilia

Biophilia, as introduced by (Wilson, 1984), refers to the inherent human desire to connect with nature and living systems. This concept, grounded in evolutionary biology, suggests that humans are biologically predisposed to find comfort and well-being in environments that include natural elements (Kellert, 2008). The theory argues that exposure to nature can have profound effects on mental and physical health, making it a crucial consideration in the design of built environments (Browning *et al.*, 2014, Gillis and Gatersleben, 2015).

2.2 Principles of Biophilic Design

Biophilic design, derived from biophilia theory, seeks to incorporate natural elements into the built environment to foster human well-being (Browning *et al.,* 2014). As identified by (Kellert and Calabrese, 2015), this design approach revolves around three core experiences: direct experience of nature (e.g., light, water, plants), indirect experiences (e.g., natural materials, representations of nature), and spatial experiences (e.g., refuge and prospect). These principles allow for the design of spaces that promote a restorative connection to nature, leading to improved health outcomes, particularly in settings where stress reduction and mental health are critical.

2.3 The Application of Biophilic Design in Healthcare Settings

A successful biophilic design integrates natural elements into spaces in a way that is both inspiring and therapeutic, without compromising functionality. The approach can vary depending on the users. For example, cancer patients in a study by (Ebaid, 2022) preferred natural features over artificial ones but avoided strongly scented materials and stimulating nature sounds due to health sensitivities. However, when it comes to stress reduction, even artificial nature elements are preferable to no visual connection to nature at all, which aligns with findings from (Huelat, 2008) and (Ebaid, 2022). In healthcare environments, biophilic design has been shown to significantly benefit patient health. Studies by (Ulrich, 1984) and (Van den Berg & Custers, 2011) reveal that exposure to nature reduces stress, improves mood, and accelerates recovery. Hospitals that incorporate natural light, green spaces, and water features promote emotional well-being and reduce the need for medications (Jackson et al.,

2013; Totaforti et al., 2018). For cancer patients, whose treatment is both emotionally and physically taxing, integrating biophilic elements into care settings can offer holistic support, enhancing healing beyond physical treatments.

2.4 Health Benefits of Biophilic Design for Cancer Patients

Cancer treatment is not only physically demanding but also emotionally overwhelming for both patients and their families. Research has consistently shown that exposure to nature has restorative effects, helping individuals manage stress, improve cognitive function, and foster a sense of well-being (Ratcliffe et al., 2013; Wichrowski et al., 2021). In particular, biophilic design, which integrates natural elements into the built environment, can alleviate the negative effects of stress, enhancing mental clarity and resilience during treatment. It has also been linked to faster recovery, improved patient mobility, and a reduced need for pain medication (Han, 2009; Interface, 2023). Figure 1 presents findings from a study by (Ebaid, 2022) that evaluated patient satisfaction before and after two phases of renovation. Prior to 2019, satisfaction was at 76%. The first phase of renovations, completed in 2021, introduced large windows to maximize natural light, views of outdoor greenery, and increased use of wood and stone materials, resulting in an 82% satisfaction rate. The second phase, which included the addition of indoor greenery, water features, and quiet, nature-themed relaxation areas, further improved satisfaction to 94%. Interviews in the study highlighted the profound impact of these changes, especially the indoor greenery added during the 2020 renovations. These results are particularly relevant in cancer treatment, where the integration of nature into healthcare environments promotes both mental and physical healing.

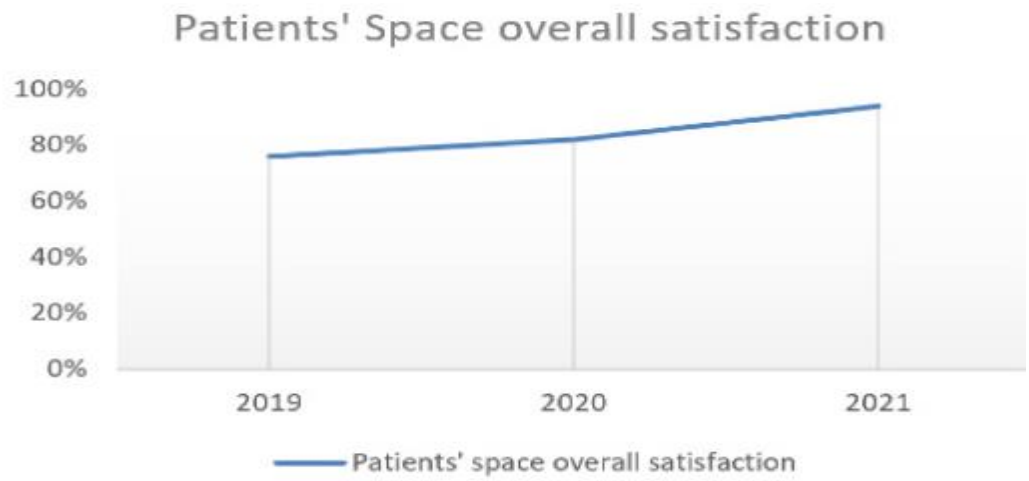

Figure 1: Users' satisfaction timeline improvement after the application of some biophilic design patterns in the hospital spaces, (Ebaid, 2022).

2.5 Relevance of Biophilic Design to Nigerian Cancer Treatment Centers

Cancer treatment in Nigeria presents unique challenges, including limited access to care and facilities that are not designed with the patient's holistic well-being in mind (Adejoro, 2023). Biophilic design offers an opportunity to rethink these spaces, providing not only physical

comfort but also addressing the psychological and emotional needs of patients. By introducing nature-inspired elements such as green spaces, natural light, and water features into Nigerian cancer centers, healthcare providers can enhance the patient experience, potentially improving both psychological resilience and physical outcomes.

2.5.1 General deductions

Despite the growing body of research supporting the benefits of biophilic design in healthcare, there is a clear gap in its application to cancer treatment centers, especially in low-resource settings like Nigeria. Most studies have focused on healthcare environments in high-income countries, where facilities are often equipped to incorporate biophilic elements. However, cancer treatment centers, which demand an even greater emphasis on psychological and emotional support for patients undergoing long-term treatment, are particularly suited to the application of biophilic principles. In Nigeria, the design of healthcare facilities tends to focus on functionality, often at the expense of holistic well-being. This presents an opportunity to explore how biophilic design can be integrated into the design of Nigerian cancer treatment centers to provide a more supportive healing environment.

3.0 Research methodology

This study employed a qualitative research approach to explore the integration of biophilic design principles in cancer treatment centers. The primary aim was to develop a framework for incorporating biophilic design into cancer treatment centers in Nigeria, enhancing both the psychological and physical well-being of patients. A case study design was utilized, involving the observation of three healthcare facilities in Nigeria: Ahmadu Bello University Teaching Hospital (ABUAD) in Shika, National Hospital Abuja, and University Teaching Hospital (UITH) in Ibadan. Three healthcare facilities were selected based on their relevance to the study's objectives and their varying degrees of biophilic design integration. The hospitals selected represent a mix of public and teaching hospitals, providing a comprehensive overview of the healthcare environment in Nigeria. The National Hospital in Abuja is one of Nigeria's foremost healthcare institutions, while ABUAD and UITH are prominent teaching hospitals with established cancer treatment departments. These hospitals were chosen for their significant role in cancer care and the varying degree of architectural features that potentially incorporate biophilic design elements.

Data collection was carried out through direct observation of the selected healthcare facilities, focusing on physical and environmental features that align with biophilic design principles. An observation guide was developed to structure the data collection process. The guide focused on observing specific biophilic design patterns and parameters that influence patient experiences and emotional well-being in cancer treatment centers. The following biophilic design parameters were observed across the three case study locations: Visual Connection with Nature, Non-Visual Connection with Nature, Non-Rhythmic Sensory Stimuli, Thermal Airflow & Variability, Presence of Water, Dynamic & Diffuse Light, Connection with Natural Systems, Biomorphic Forms & Patterns, Material Connection with Nature, Complexity & Order, Prospect & Refuge and Peril. An observation schedule/checklist was created to ensure a systematic and detailed approach to gathering data. The checklist was designed to assess the presence and quality of each of the 12 biophilic design parameters listed above. For each

parameter, specific criteria were included to guide observations and ensure consistency across the three case studies.

The observations were carried out over a period of two months, with on-site visits conducted at each of the three hospitals. Each hospital was visited twice to ensure comprehensive data collection, covering different times of day to observe how lighting, temperature, and patient activities varied. Field notes were taken to document the presence and quality of the observed biophilic design elements, and photographs were taken (with consent from hospital administrators) to visually record design features. The checklist was used to score each biophilic design element on a scale from 1 to 5, with 1 indicating no presence of the feature, and 5 indicating the excellent presence of the feature. The researcher noted any other observations that seemed relevant to the patient's emotional and psychological experience, including patterns in the behavior of patients or staff in relation to the biophilic elements. The study used a purposive sampling approach to select the three healthcare facilities, ensuring that each case study hospital was relevant to the study's focus on cancer treatment and biophilic design. The selection was based on the hospitals' role in cancer care, the diversity of their design approaches, and the presence of biophilic elements or the potential to integrate them. The purposive sampling method was chosen because it allows for targeted selection of relevant cases, ensuring that the findings are pertinent to the research objectives.

After data was collected, a thematic analysis approach was used to identify recurring themes and patterns related to the integration of biophilic design elements. The analysis focused on how these elements influenced the physical and emotional experiences of patients in the observed hospitals. Themes related to stress reduction, psychological comfort, and patient engagement with the environment were explored in relation to the presence or absence of biophilic design features. The findings from the three hospitals were compared to evaluate the diversity of biophilic applications and their effects on patient experiences. The analysis aimed to identify best practices for incorporating biophilic design into cancer treatment centers in Nigeria and provide insights for developing a framework for future healthcare facility designs.

4.0 Results and Discussion

This section presents the findings obtained from the case study observation guide, analyzed using Microsoft Excel, and displayed through tables. The results are discussed with a focus on how biophilic design patterns and attributes impact patient well-being, particularly within oncology departments. The analysis compares the extent of biophilic elements in three case studies: Ahmadu Bello University Teaching Hospital (ABUTH), National Hospital Abuja (NHA), and University College Hospital (UCH) Ibadan, offering insights into the practical implications of biophilic design for cancer treatment centers in Nigeria.

4.1 Case study 1: Ahmadu Bello Teaching Hospital (Oncology Department)

The Ahmadu Bello University Teaching Hospital incorporates several biophilic design elements within its oncology department, offering a strong visual connection to nature. The department is surrounded by carefully curated landscapes, allowing for uninterrupted outdoor views from many interior spaces. The longer axis of the building is oriented to optimize both solar alignment and natural ventilation, with windows positioned to enhance airflow and light diffusion. The hospital's architecture includes repeating symmetrical patterns and

interconnected walkways that create harmony within the built environment. However, despite the integration of greenery, the lack of a dedicated therapeutic garden diminishes opportunities for patient engagement with healing spaces. In terms of sensory stimuli, there is an absence of water features such as aquariums or fountains, which could enhance the multisensory experience and provide a calming effect for patients. The hospital's lighting strategy, with windows providing varied diffusion of light, enriches the patient experience by reducing glare and maintaining a dynamic interplay between natural light and shadow. Nonetheless, the facility would benefit from more interactive nature analogues and water elements to foster a more immersive healing environment.

Table 1: Analysis of biophilic design elements and attribute - Ahmadu Bello University Teaching hospital (oncology department)

S/N	Patterns of biophilic design	Attributes	Level			
			Ab	**low**	**Med**	**Hi**
1	**Visual Connection with Nature**	• The availability of a variety of plants and landscape			✓	✓
		• unhindered views of the natural world from the interior	✓			
		• presence of healing gardens				
2	**Non-Visual Connection with Nature**	• Availability of natural sounds over noises from cities	✓		✓	
		• Incorporating water and natural ventilation				
3	**Non-Rhythmic Sensory Stimuli**	• Warm colour schemes are used for sensory stimulation	✓		✓	
		• Clouds, Shadows, Water reflection.				
4	**Thermal Airflow & Variability**	• Design considering the direction of the sun and wind		✓		✓
		• windows positioned to provide natural ventilation				

5	**Presence Of Water**	• Presence of water features for landscape (aquarium/fountain)	✓		
6	**Dynamic & Diffuse Light**	• windows positioned to provide dynamic and diffuse light		✓	✓
		• Reflective surfaces are used to improve illumination and reduce glare.			
7	**Connection With Natural System**	• Visual access to the site's current natural system		✓	
	Nature Analogues				
8	**Biomorphic Forms & Patterns**	• Using indoor plant themes		✓	
		• Use of organic forms on the exterior of buildings	✓		
9	**Material Connection With Nature**	• Using eco-friendly construction materials		✓	
		• Using a natural colour scheme, such as green, inside of buildings	✓		
10	**Complexity & Order**	• Landscape design and intricate architectural expression		✓	
		• Integration of buildings parts into whole			✓
	Nature Of Space				
11	**Prospect**	• Arranging a structure, window, or hallway to maximise the view of exterior landscapes	✓		✓
		• Incorporating savannah-like ecosystems into planned or existing designs			
12	**Refuge**	• Variation in indoor light levels		✓	

13	**Mystery**	• A low-maintenance landscape with a meandering path • Curved edges preference over sharp corners in interior areas.	✓	✓
14	**Peril**	• Towering walls, floor to ceiling windows.	✓	

(Source: authors field work, 2024)

As shown in Table 1 above, the biophilic design elements are moderately implemented at Ahmadu Bello University Teaching Hospital, , creating a beneficial but limited impact on patient well-being. The Visual Connection with Nature is rated as medium, indicating the presence of plants and landscaping, though without dedicated healing gardens, the full therapeutic potential is not achieved. Visual connections to nature are essential for reducing stress, yet the hospital could enhance this with more open views of greenery. The Non-Visual Connection with Nature, such as natural sounds and ventilation, is also moderately present, suggesting that while patients experience some benefits from natural ventilation, additional sensory elements like water sounds could further reduce anxiety. The Thermal Airflow & Variability scores high, indicating well-planned natural ventilation, which significantly improves patient comfort and reduces reliance on artificial climate control. However, the Presence of Water is rated low, highlighting a missed opportunity to incorporate water features, which are known for their calming effects. Overall, while the hospital excels in terms of airflow, landscape design, and natural light, the absence of certain biophilic features, such as water elements and comprehensive healing gardens, limits its potential to fully maximize the positive impacts on patient recovery.

4.2 Case study 2: University college hospital, Ibadan (Oncology Department)

The oncology department at the National Hospital Abuja integrates some biophilic design features but demonstrates notable gaps in patient engagement with nature. While the facility is surrounded by landscaping, there is no therapeutic garden, limiting opportunities for patients to benefit from restorative outdoor environments. The design lacks a coherent visual connection to nature, especially in public areas like waiting rooms, where patients are unable to view exterior greenery. Additionally, the use of artificial colors such as green and white helps create a calming atmosphere but is not enough to offset the lack of direct outdoor engagement. The department also lacks water elements and auditory connections to nature, further reducing its capacity to stimulate a non-visual connection to natural environments. Despite adequate lighting through dynamic and diffuse windows, the facility could improve by incorporating more natural sounds, water features, and healing gardens to enhance the healing experience for patients. Moreover, the compartmentalization of outdoor areas hinders the creation of cohesive spaces that support well-being.

Table 2 below reveals that the National Hospital, Abuja, incorporates many of the same biophilic design elements as Ahmadu Bello University Hospital, with moderate application across key features. Visual Connection with Nature is rated medium, signifying that while there is access to landscaping, views of nature are obstructed in some areas, particularly in public spaces, reducing the potential calming effect. The Non-Visual Connection with Nature and

Non-Rhythmic Sensory Stimuli also receive medium scores, indicating that sensory elements like natural sounds or reflections are present but could be improved by incorporating more soundscapes and enhancing building layout for better cross-ventilation. Similar to Ahmadu Bello, the Presence of Water is low, showing a missed chance to introduce water features like fountains or aquariums that could enhance relaxation for patients. The hospital performs well in Thermal Airflow & Variability and Prospect, maximizing natural ventilation and providing expansive views of the landscape, but lacks dedicated therapeutic spaces and a rich sensory environment. These features, crucial for reducing stress and improving mental health, are underutilized, making the hospital's biophilic design less impactful than it could be.

Table 2: Analysis of biophilic design elements and attribute - University college hospital, Ibadan (Oncology Department)

S/N	Patterns of biophilic design	Attributes	Level			
			Ab	**low**	**Med**	**Hi**
1	**Visual Connection With Nature**	• The availability of a variety of plants and landscape				✓
		• unhindered views of the natural world from the interior			✓	
		• presence of healing gardens	✓			
2	**Non-Visual Connection With Nature**	• Availability of natural sounds over noises from cities	✓		✓	
		• Incorporating water and natural ventilation				
3	**Non-Rhythmic Sensory Stimuli**	• Warm colour schemes are used for sensory stimulation	✓		✓	
		• Clouds, Shadows, Water reflection.				
4	**Thermal Airflow & Variability**	• Design considering the direction of the sun and wind		✓		✓
		• windows positioned to provide natural ventilation				

5	**Presence Of Water**	• Presence of water features for landscape (aquarium/fountain)	✓		
6	**Dynamic & Diffuse Light**	• windows positioned to provide dynamic and diffuse light		✓	✓
		• Reflective surfaces are used to improve illumination and reduce glare.			
7	**Connection With Natural System**	• Visual access to the site's current natural system		✓	
	Nature Analogues				
8	**Biomorphic Forms & Patterns**	• Using indoor plant themes		✓	
		• Use of organic forms on the exterior of buildings	✓		
9	**Material Connection With Nature**	• Using eco-friendly construction materials		✓	
		• Using a natural colour scheme, such as green, inside of buildings	✓		
10	**Complexity & Order**	• Landscape design and intricate architectural expression		✓	
		• Integration of buildings parts into whole			✓
	Nature Of Space				
11	**Prospect**	• Arranging a structure, window, or hallway to maximise the view of exterior landscapes	✓		✓
		• Incorporating savannah-like ecosystems into planned or existing designs			

12	**Refuge**	• Variation in indoor light levels			✓
13	**Mystery**	• A low-maintenance landscape with a meandering path		✓	✓
		• Curved edges preference over sharp corners in interior areas.			
14	**Peril**	• Towering walls, floor to ceiling windows.		✓	

Source: authors field work, (2024)

4.3 Case study 3: National Hospital, Abuja (Oncology Department)

The University College Hospital Ibadan exhibits significant weaknesses in terms of biophilic design. Though public areas are well-ventilated and airy, private and chemotherapy wards are less connected to natural environments, with one-sided windows preventing cross-ventilation. Patients in certain wards have limited views of nature, with many overlooking sidewalks and parking lots, which undermines the restorative potential of the outdoor environment. The general color scheme of the hospital is also described as "drab and unwelcoming," and there is minimal greenery or façade greening, which could negatively affect patient recovery. Despite these shortcomings, the hospital does feature adequate provisions for circulation through verandas, balconies, and terraces. The atrium, however, provides insufficient lighting, especially for lower-level areas. Additionally, the hospital's rigid architectural design lacks organic forms and complexity, which could otherwise enhance the healing environment through a deeper connection to nature. To improve, the hospital could introduce more engaging natural elements such as therapeutic gardens, varied lighting schemes, and water features.

Table 3: Analysis of biophilic design elements and attribute – National hospital, Abuja (Oncology Department)

S/N	Patterns of biophilic design	Attributes	Level			
			Ab	**low**	**Med**	**Hi**
1	**Visual Connection with Nature**	• The availability of a variety of plants and landscape			✓	
		• unhindered views of the natural world from the interior			✓	
		• presence of healing gardens		✓		

2	**Non-Visual Connection with Nature**	• Availability of natural sounds over noises from cities • Incorporating water and natural ventilation	✓ ✓		
3	**Non-Rhythmic Sensory Stimuli**	• Warm colour schemes are used for sensory stimulation • Clouds, Shadows, Water reflection.	✓ ✓		
4	**Thermal Airflow & Variability**	• Design considering the direction of the sun and wind • windows positioned to provide natural ventilation			✓ ✓
5	**Presence Of Water**	• Presence of water features for landscape (aquarium/fountain)	✓		
6	**Dynamic & Diffuse Light**	• windows positioned to provide dynamic and diffuse light • Reflective surfaces are used to improve illumination and reduce glare.	✓		✓
7	**Connection With Natural System**	• Visual access to the site's current natural system	✓		
	Nature Analogues				
8	**Biomorphic Forms & Patterns**	• Using indoor plant themes • Use of organic forms on the exterior of buildings	✓ ✓		
9	**Material Connection With Nature**	• Using eco-friendly construction materials		✓ ✓	

		• Using a natural colour scheme, such as green, inside of buildings			
10	**Complexity & Order**	• Landscape design and intricate architectural expression	✓		✓
		• Integration of buildings parts into whole			
		Nature Of Space			
11	**Prospect**	• Arranging a structure, window, or hallway to maximise the view of exterior landscapes	✓		✓
		• Incorporating savannah-like ecosystems into planned or existing designs			
12	**Refuge**	• Variation in indoor light levels		✓	
13	**Mystery**	• A low-maintenance landscape with a meandering path	✓ ✓		
		• Curved edges preference over sharp corners in interior areas.			
14	**Peril**	• Towering walls, floor to ceiling windows.	✓		

(Source: authors field work, 2024)

The University College Hospital, Ibadan, shows a strong application of biophilic design elements, particularly in providing patients with beneficial connections to nature. Data presented in Tbale 3 below shows Visual Connection with Nature is rated high, meaning patients enjoy ample access to views of plants and natural landscapes from interior spaces, a feature known to significantly reduce stress and promote healing. The Connection with Natural Systems is also high, further enhancing the patient experience by offering visual access to the surrounding natural environment. The hospital excels in Dynamic & Diffuse Light, with windows and reflective surfaces allowing natural light to fill indoor spaces, supporting circadian rhythms and reducing the need for artificial lighting. However, Presence of Water is

rated low, indicating that despite the hospital's strengths, it lacks water features that could provide additional calming effects. Other sensory elements, such as Non-Visual Connections and Non-Rhythmic Sensory Stimuli, are moderately present, suggesting room for improvement in diversifying sensory inputs to create a richer healing environment. While the hospital has strong elements like light and natural views, it could further enhance patient well-being by incorporating more sensory features and water elements.

4.4 Comparative Analysis and Implications

Across the three case studies, the hospitals demonstrate a moderate application of biophilic design elements, which positively influence patient well-being but leave room for improvement. Common strengths include the presence of Visual Connections with Nature, natural ventilation through Thermal Airflow, and access to Dynamic & Diffuse Light, all of which contribute to reducing stress and promoting recovery. However, these hospitals also share common gaps in the Presence of Water and Non-Visual Sensory Stimuli, missing opportunities to incorporate water features and more diverse sensory experiences that could enhance relaxation and mental health. Among the three, Ahmadu Bello University Teaching Hospital demonstrates the strongest implementation of biophilic design principles, particularly in its thoughtful use of landscaping, window placement, and natural ventilation. In contrast, the National Hospital Abuja and University College Hospital Ibadan exhibit considerable weaknesses, particularly in terms of their Visual Connection to Nature and the lack of healing gardens or water features. The absence of key biophilic elements, such as water features and therapeutic gardens, in these facilities limits their ability to fully engage patients in restorative experiences. The use of nature in hospital design has been shown to significantly improve patient well-being by reducing stress, enhancing mood, and fostering a sense of calm. In the context of cancer treatment centers in Nigeria, where stress management and emotional well-being are critical for recovery, strengthening these biophilic features could significantly improve patient outcomes. The integration of more dynamic and interactive natural features is crucial for enhancing the healing environment. To strengthen biophilic design in these settings, hospitals should prioritize creating therapeutic gardens, improving natural ventilation, and incorporating multisensory elements such as water features and dynamic lighting. These interventions would contribute to better patient outcomes by aligning the built environment more closely with the principles of biophilic design, ultimately fostering spaces that promote both physical and emotional healing.y

4.5 Discussion of Findings

The findings of this study highlight the significant role of Nature in Space patterns in designing healthcare facilities that promote healing and reduce psychological stress. For instance, the case studies demonstrate these patterns through the presence of healing gardens, which offer patients a calming environment, as well as unrestricted views from interior spaces, allowing patients to visually connect with the outdoors. At Ahmadu Bello University Teaching Hospital, the thoughtful placement of windows ensures that patients can enjoy natural scenery, contributing to their emotional well-being. Similarly, the use of a variety of landscapes and plants across all three hospitals further strengthens this connection to nature, reinforcing the therapeutic potential of biophilic design.

Furthermore, warm hues are strategically used in interior spaces, such as the chemotherapy wards of the University College Hospital Ibadan, to stimulate the senses and create a soothing atmosphere. Additionally, buildings are carefully oriented to maximize exposure to natural sunlight and airflow, which not only enhances patient comfort but also fosters a healthier indoor environment. In terms of quantitative data, research has shown that patients exposed to natural elements and adequate lighting report lower stress levels and improved recovery times. Although specific patient surveys were not conducted in this study, the design features observed align with well-established principles of biophilic design, known to improve patient outcomes.

5.0 Conclusion and Recommendations

This study underscores the potential of biophilic design to significantly improve patient recovery and well-being in cancer treatment centers in Nigeria. The findings indicate that elements such as healing gardens, unrestricted views of nature, and natural ventilation are moderately incorporated in the healthcare facilities analyzed, contributing to reduced stress and enhanced patient outcomes. Despite these positive aspects, there remain notable gaps, especially in the lack of water features, non-visual sensory stimuli, and therapeutic gardens, which could further optimize the healing environment. The research objective of assessing the integration of biophilic design was largely achieved, providing insight into both the strengths and areas for improvement in the design practices of these centers. The findings emphasize the need for more comprehensive biophilic design strategies to maximize therapeutic benefits. Practically, this research offers valuable insights that can inform future healthcare facility designs in Nigeria. By integrating more diverse biophilic elements, such as sensory gardens, water features, and dynamic lighting systems, healthcare designers can create environments that foster not only physical recovery but also emotional well-being. Further research should focus on quantifying the impact of biophilic design on patient outcomes through patient surveys or clinical studies, to provide robust evidence for these design interventions.

The research recommended that hospitals should prioritize strengthening both visual and non-visual connections to nature by incorporating healing gardens, courtyards, and indoor plants to offer patients direct access to natural elements. Ahmadu Bello University Teaching Hospital serves as a model in this regard with its well-designed landscapes and window placement, a strategy that other hospitals should adopt to enhance visual connections with nature. Furthermore, hospitals should introduce water features, such as fountains or reflecting pools, which provide calming sensory stimuli currently absent in the case study hospitals. The inclusion of water elements could play a critical role in reducing patient stress and enhancing relaxation.

Moreover, the design of therapeutic spaces with improved natural ventilation should be a priority across all facilities, following the example of Ahmadu Bello University Teaching Hospital's effective use of natural breezes to optimize comfort. Hospitals should also incorporate dynamic lighting systems that mimic natural light cycles, which can help regulate circadian rhythms and improve overall patient well-being. Increased use of glass to allow for more natural light penetration would also enhance the indoor environment of healthcare spaces. Lastly, it is recommended that a comprehensive biophilic design framework be developed specifically for healthcare facilities in Nigeria. This framework should provide guidelines on spatial arrangements, material choices, and landscape design that cater to the therapeutic needs

of patients, particularly those undergoing cancer treatment. By adopting these recommendations, healthcare facilities in Nigeria can create environments that more effectively support both the psychological and physical recovery of patients.

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