



Science Forum (Journal of Pure and Applied Sciences)

Journal Homepage: <https://atbu.edu.ng/science-forum/>



Assessing Influence of Built Environment on The Patients' Recovery Using Biodiversity Design Principles: A Case of Ahmadu Bello University Teaching Hospital Paediatric Centre

Mudashir Gafar Olaiya, Fahel Paul

Department of Architecture, Ahmadu Bello University, Zaria, Nigeria

ABSTRACT

Recent research has increasingly highlighted the significant influence of the built environment on patient recovery, particularly within the framework of biodiversity. This trend has been notably observed in pediatric healthcare settings, where the integration of natural elements is believed to foster healing and well-being. Despite the growing body of evidence supporting the benefits of biodiversity in healthcare design, its application in Nigeria's pediatric facilities remains largely underexplored. This article aims to bridge this gap by evaluating how the built environment of pediatric hospitals impacts patient recovery, specifically through the lens of biodiversity principles. The focus is on promoting healing and family-centered care as key components of patient well-being. The research employs a case study methodology, assessing the pediatric center at Ahmadu Bello University Teaching Hospital (ABUTH) using four core biodiversity principles: healing gardens, interior landscapes, natural lighting, and color schemes. The evaluation revealed that while the ABUTH Pediatric Center excels in natural lighting (70%) and effective color use (60%), it falls short in other critical areas. Healing gardens and interior landscapes, both essential for fostering a therapeutic environment, were minimally incorporated, with scores of only 10% for each. These elements are crucial for pediatric recovery as they enhance emotional comfort and support a more holistic healing process. This study's findings underscore the need for a more deliberate inclusion of biodiversity principles in the design of pediatric healthcare environments. The research strongly advocates for the integration of these principles to create therapeutic settings that not only improve emotional recovery but also strengthen the connection between patients, their families, and the natural world. By incorporating healing gardens, thoughtful interior landscaping, and other biodiversity elements, pediatric facilities can significantly enhance patient care and recovery outcomes.

ARTICLE INFO

Received 12 February 2024
 Received in Revised Form
 21 February 2024
 Accepted 24 February 2024
 Published 28 February 2024
 Available online 28 February 2024

KEYWORDS

Built environment,
 Biodiversity principles,
 Pediatric hospital design,
 Patients Recovery

1.0 Introduction

Healthcare environments play a crucial role in promoting healing, well-being, and recovery for patients of all ages. Marques, McIntosh, and Kershaw (2021) assert that medical advancements and technological innovations often overshadow the significance of the physical environment in healthcare settings. In addition, there has been a growing recognition of the potential impact of the built environment on patient outcomes, particularly in paediatric healthcare facilities. In a healthcare setting for children, creating healing environments that cater to their unique needs and support their physical, emotional, and psychological well-being is of utmost importance (Babbu & Haque, 2021). In fact, Abbas and Ghazali (2010) stated that the relationship between biodiversity and human health has gained more attention in recent years.

Sandifer et al. (2015) stated that biodiversity, the variety of life forms on Earth, plays a crucial role in human health and well-being, particularly in the context of healing. Numerous studies have demonstrated the positive impact of exposure to biodiversity principles on a variety of health outcomes. Ward Thompson and Aspinall (2011) reported that access to natural environments also tends to enhance outdoor physical activity, thereby improving physical health. In addition, the study emphasized the importance of long-term exposure to natural environments, such as residing in areas with high greenness or in diverse landscapes, which has been associated with reduced all-cause respiratory, cardiovascular, and cancer mortality and improved respiratory and mental health in children and adults. Ulrich (2018) reaffirmed that incorporating biodiversity healing settings can improve patients' cognitive performance and psychological health.

Consequently, the concept of healing environments has gained significant attention in healthcare design in recent years, as stated by Aripin (2006). Furthermore, creating environments that promote physical and mental well-being has become a key objective, especially in the context of paediatric hospitals. Nigeria, as a developing country, faces unique challenges in healthcare, design, and infrastructure, particularly concerning paediatric care (Akinluyi et al., 2021; Timothy, et al., 2022). According to Aripin (2006), designing a paediatric healthcare centre involves a complex process that considers both functional and psychological requirements. The goal is to maximize the functional area and accommodate the maximum number of patients. However, the architectural design of these facilities often overlooks the space's physical environment. Perasso et al. (2021) assert that hospitalization

exposes children to physical disorders and numerous psychological challenges, with the hospital's environmental design playing a significant role in their well-being. Additionally, Jones et al. (2017) provided support for the notion that the inappropriate design of hospitals could potentially exacerbate fear, anxiety, and behavioural disorders among the paediatric patients. For children, hospital environments provoke a wealth of emotions, such as sadness, fear, anger, anxiety, loneliness, and homesickness. Marques et al. (2021) observed several benefits of biodiversity in different building typologies. Nevertheless, Timothy et al. (2022) highlighted a substantial knowledge deficit regarding the optimal incorporation of biodiversity concepts into healthcare design, particularly within the Nigerian paediatric hospital setting. Akinluyi et al. (2021) also confirmed that despite the potential benefits of biodiversity principles in the built environment, paediatric hospital settings remain largely unexplored.

Given the aforementioned issues, the design of the Hospital for Children requires careful consideration at the design stage. The article aimed to evaluate the impact of the built environment on the recovery of paediatric patients, utilizing the concept of biodiversity to promote healing and family-centred care as agents of the patients' well-being. The primary objective is to assess the level of incorporation of biodiversity principles at Ahmadu Bello University Teaching Hospital Paediatric Centre in Nigeria. The research component of the study necessitates an evidence-based design, which serves as a crucial tool for improving the healing environment in Nigeria's paediatric hospital design.

2.0 Review of Literature

In recent years, a growing corpus of literature has supported the magnitude of the connection between biodiversity and human health. Biodiversity encompasses the variety and linkage of all living organisms in an ecosystem, including plants, animals, and microorganisms.

Moreover, a substantial body of literature acknowledges the pivotal significance of biodiversity in upholding ecological equilibrium, delivering indispensable ecosystem services, and promoting the health of humanity (Sandifer et al., 2015; Romanelli et al., 2015). In addition, Sandifer et al. (2015) demonstrated that incorporating biodiversity into the design of healing environments promotes relaxation, stress reduction, and improved health outcomes, and the provision of natural elements such as green spaces, gardens, and water bodies can create a positive human calmness and restorative

atmosphere for workers' productivity, leading to reduced stress levels and, most importantly, improved patients' well-being and recovery rates.

Ulrich (2018) further highlighted the abundance of advantages that come with integrating biodiversity concepts into healthcare design as a potential way to improve healing environments. He further enumerated the effects of gardens, natural light, colour, and indoor landscapes on patients' health recovery, whether adults or children. This same study encouraged built environment designers to use biodiversity principles to promote human well-being in the hospital environment. Dinu Roman Szabo et al. (2023) posited that adopting the biodiversity concept in healthcare facility

development can create a symbiotic relationship for a balanced and sustainable ecosystem through the use of a healing garden, natural light, colour, and indoor landscape.

Xue et al. (2019) made an emphatic statement that application of the biodiversity principles is inevitable in the design of contemporary hospitals, particularly to create environments that support patients' recovery and nature enhancers for the experience of families and staff in the health care centres. Beery and Jorgensen (2018) unequivocally asserted that biodiverse environments actively promote physical activity, social interaction, and sensory stimulation, all of which are indispensable for children's growth and development (see Figure 1).



Figure 1: Biodiversity and human health (Hartg et al., 2014; Bratman et al., 2012)

According to Brown and Grant (2005) concept of biodiversity in human health, the crucial role of biodiversity in humanity's health is enormous. In addition, Bawa et al. (2020) claimed that biodiversity is the cornerstone of human societies. Figure 1 illustrates why notable environmentalists have concerns that humans may lose access to clean water, healthy food, and natural resources if biodiversity disintegrates (Hartg et al., 2014; Ulrich, 2018). Individuals who are poor and economically disadvantaged, particularly children who are the most vulnerable, are likely to suffer more than others (Bratman et al., 2012). On this note, several scholars have reaffirmed that biodiversity inevitably supports a variety of human and social requirements, including the development of energy, freshwater security, pharmaceutical and medical research, and food and nutrition security. Together, these requirements promote and sustain the health of humanity (Ulrich et al., 2018; Xue et al., 2019). In addition, Ulrich's et al. (2018) study postulated the incorporation of the principles of biodiversity into

healthcare design as a driver of new order to promote and enhance healing environments. The study further reported the effects of healing gardens on patients' health and rate of recovery.

Subsequently, Zhong et al. (2022) posited that the integration of biodiversity principles in healthcare design can encompass elements such as biophilic design, which involves incorporating natural materials, patterns, and light to create a connection with nature. In light of this idea, looking into how to use biodiversity to improve healing in the design of paediatric hospitals could be based on strong evidence that nature has healing properties, the moral obligation to put patients' health first, and the chance to find cost-effective medical solutions for kids who are more at risk not only in Nigeria but globally. With this research, the outcome is believed to contribute to the growing body of knowledge on nature-based design approaches in healthcare settings and ultimately improve the quality of care for paediatric patients beyond the local content of Nigeria. The following sections covered the relationship of biodiversity

principles to the paediatric healthcare facilities to support patient recovery.

2.1 Healing gardens and healthcare

There is a large and growing body of literature that demonstrates that contact with nature (urban green space, parks, and landscape gardens) can lead to measurable psychological and physiological health benefits, as well as numerous other positive effects. In fact, Reeve et al. (2017) acknowledged healing gardens as one of the fundamental elements of biodiversity principles. Din's et al.'s (2018) study delved into the impact of healing gardens on patient treatment, socialization, fostering a sense of control, promoting physical movement, and fostering access to and bonding with nature, all of which serve as pleasant distractions for patients' recovery. Xue et al. (2019) asserted that ancient civilizations, understanding the mental and physical healing benefits of interacting with the natural world, overlooked the importance of patients' exposure to well-landscaped green spaces in achieving comprehensive wellbeing. Aripin (2006) reported that ancient Egyptian physicians used nature as a

healing tool, known as horticulture therapy, and prescribed therapeutic walks through healing gardens as an alternative form of medication to aid patients suffering from mental disturbances.

According to Lee and Maheswaran (2011), concept of urban green spaces offers a wide range of physiological and psychological health benefits. They propose that incorporating well-lit landscape gardens visible to patients from their rooms could have positive effects, such as promoting calmness, faster healing, fostering positive mindsets about their diagnosis, and enhancing overall mental well-being. Although a few studies, such as Hofmann et al. (2018) and Shanahan et al. (2016), reported no significant positive effects of nature exposure, the evidence supporting positive mental and physiological health measures and general feelings of well-being outweighs these findings. Numerous studies have confirmed the therapeutic effects of providing hospital patients with access to gardens, plants, and natural light (See Plate I). This suggests that architects designing healthcare facilities could consider incorporating these elements to promote positive health outcomes.



Plate I: Concept of healing garden. (Demirkan, 2015)

Demirkan (2019), and Marcus and Barnes (1999) provided design guidelines that suggest that users of healing gardens require a good view, a peaceful environment where they can see and hear the sounds of birds, wind, or water sources, and a landscape where they prefer not to be surrounded by inappropriate mechanical sounds such as those emitted by air conditioners or traffic in the streets. Additionally, planting trees with leaves that effortlessly move and produce sounds, even in light winds, to generate patterns of colour, shade, light, and movement is essential for the design of a healing garden. Good landscaping, with strategically planted trees, fosters the thermal comfort, tranquillity, refreshment, and meditative environment required for patients' recovery. It also

provides a natural, child-friendly environment and increases happiness, as well as reducing noise from the auxiliary facilities in the healthcare centres.

2.2 Natural lighting and healthcare

Numerous studies have shown that exposure to natural light has positive impacts on patients' well-being and recovery. According to Ulrich et al. (2018), natural lighting helps regulate the body's daily rhythm, which plays a crucial role in sleep-wake cycles, hormone secretion, and overall physiological balance. Furthermore, it has been associated with reduced pain perception, decreased length of hospital stays, and improved mood and satisfaction among patients. Access to

light has been recognized as an essential element in architectural design, particularly in healing environments (see Plate 2a and 2b). Natural light

has numerous physiological and emotional benefits that can contribute to the well-being and healing of patients (Van den Berg, 2005).



Plate 2a and 2b: Access to nature and natural lighting (Ulrich et al., 2018)

According to design considerations by Joarder (2011) for maximizing natural lighting, First, the selection of appropriate fenestration and glazing systems is crucial for controlling daylight entry. High-performance glazing options, such as low e-coating and specifically selective coatings, can help balance natural light transmission while reducing heat gain and glare, and the use of clerestory windows and light shelves can also facilitate deeper light penetration into interior spaces. Secondly, it's crucial to carefully select interior design elements that will improve the distribution and diffusion of natural light. Light-coloured surfaces, reflective materials, and the strategic placement of mirrors can help bounce light deeper into rooms and corridors. Open floor plans and the use of interior glazing can promote light flow and visual connectivity between children and playground spaces for their recovery. It also has the potential to reduce the incidence of infectious diseases in the hospital environment, and above all, it has the potential to increase children's psychological enthusiasm for recovery (See Plate 3).

Consequently, Joarder (2011) and Kotzer et al. (2011) stated that orientation and building layout are strong determinants for optimizing the natural daylighting in healthcare facilities. They reaffirmed the need for architects to consider building orientation and layout to optimize access to natural light. The strategic placement of windows, skylights, and lightwells can ensure that healing spaces

receive ample daylight while minimizing glare and excessive heat gain. The study concluded that windows facing north or south are the most effective means of optimizing daylight exposure while minimizing direct sunlight infiltration.

2.3 Indoor plants and healthcare

Recently, the incorporation of indoor plants into healthcare environments has gained significant attention as architects, designers, and healthcare professionals have recognized the therapeutic benefits of nature and green spaces for promoting patients' recovery. In fact, studies conducted by Aydogan and Cerone (2021) and Ulrich et al. (2018) have demonstrated the positive effects of indoor plants on the social health of children, the cognitive ability of health workers, workplace performance, human health, and general health. Also, the presence of indoor plants in healthcare environments has proven to help workers reduce stress, anxiety, and blood pressure, as well as improve patients' mood, acoustic quality, and satisfaction. Aydogan and Cerone (2021) opined that indoor plants also have the ability to increase indoor air quality by removing harmful toxins and increasing oxygen levels, contributing to a healthier and more comfortable environment for patients, staff, and visitors. Lastly, he added that it enhanced spiritual well-being, increased recreation satisfaction, and contributed to biomedical advancement for patients' health (see Plate 3).



Plate 3a and 3b: Indoor plants in the children's ward (Wolverton, 2019)

The architectural design considerations for the integration of indoor plants in healthcare are plant selection, placement and accessibility, lighting, and water availability for maintaining the plants (Zhong et al., 2024). He emphasized that plant selection should be based on its ability to grow indoors, withstand varying lighting conditions, and require minimal maintenance. Most importantly, the healthcare environment should prioritize plants with non-toxic properties to ensure patients' safety from allergies or sensitivities. Plant placement and accessibility should be based on their visual appeal and accessibility to enhance staff and patients' connections to nature. Ultimately, adequate lighting is critical for indoor plants' growth and well-being, which must be considered to achieve the optimum health benefit of indoor plants.

2.4 Colour and healthcare

The study of color is a field of research that investigates the impact of varying shades of colour on human emotions, moods, and behaviors. Colors has the capacity to stimulate mental, emotional and physiological responses in individuals, and their appropriate application in healthcare environments, may exert a substantial influence on the mental, emotional and cognitive development and health of patients particularly children (Dijkstra, et al., 2006). When considering the healthcare environment, incorporating colour inspired by nature may provide a calming and caring ambiance, which aids in the entire

process of patients' recovery and healing (Dalke et al., 2006). In the case of the application of colour in healthcare, the fundamental architectural design considerations are: colour psychology, lighting and material selection, and integration with nature. Equally, from a medical perspective, Roshani (2014) stated that the concepts of colour therapy have a strong association with the direct healing of pediatric patients. We can safely conclude that understanding colour psychology is critical when selecting appropriate shades of colour for specific spaces in the healthcare environment (see Plates 4a and 4b).

In addition, several research studies have provided evidence for the positive impact of nature-inspired colors in healing environments (Dijkstra, et al., 2006; Dalke et al., 2006). Mulyati and Exposto (2023) provided evidence that pediatric patients' and health workers' stress levels decreased and their psychological well-being improved when they were in green spaces and surrounded by colors inspired by nature. The study further shows that environments with colors inspired by nature evoke good emotional reactions, improve attention restoration, and promote cognitive function. Wichrowski et al.'s (2021) study found that patients with access to natural views or nature-inspired artwork recovered more quickly, relied less on pain medication, and experienced fewer problems

than those without such visual stimuli (see Plate 4a and 4b).



Plate 4a and 4b: Use of colour in paediatric healthcare facilities (Dijkstra, et al., 2006; Dalke et al., 2006)

The critical literature review concluded that biodiversity has a profound impact on humanity's well-being, and Figure 2 presents the adapted assessment framework for this study. We recognised the belief that biodiversity could significantly contribute to patients' recovery and overall well-being. Despite the potential of biodiversity principles

in designing paediatric hospital environments, they remain largely unexplored in Nigeria. The research aims to fill this established gap by assessing the impact of the built environment on patients' recovery, using the concept of biodiversity to promote healing and family-centred care as agents of the patients' well-being.



Figure 2: Research assessment framework (Adapted from Ulrich et al., 2018)

3.0 Research Methods

The research employed a single-case study methodological approach to rigorously test the success of an intervention or treatment in a specific case. This approach aimed to assess the impact of the built environment on patients' recovery, utilizing the concept of biodiversity to promote patient recovery, with

a particular focus on pediatric health care facilities. Additionally, the method aims to demonstrate the overall effectiveness of four principles of biodiversity, namely healing gardens, natural lighting, indoor plant landscapes, and color application, in promoting the recovery of pediatric patients. The method is to provide a viable alternative to large group studies, such as randomized

clinical trials, which involve repeated measures and manipulation of an independent variable.

The study employed the purposive sampling method due to the nature of the research approach. The criteria used to select a single case study are as follows: The hospital must be

government-funded. The hospital has established a paediatric section for a minimum of ten years. The hospital must have a minimum of 100 beds. Finally, we considered convenience and financial considerations when selecting the final case study. We selected the Ahmadu Bello University Teaching Hospital Paediatric Section based on the set criteria. The study's tools were a physical survey and a checklist. The checklist clearly outlined all the research variables and architectural features, which were adapted

Plate 5: Facade of Ahmadu Bello University Teaching Hospital.

The teaching hospital complex houses several medical sections and departments. The hospital complex made a strategic decision to establish the pediatric department with the goal of providing specialized healthcare services tailored specifically for children. The pediatric department provides comprehensive healthcare, recovery, and overall well-being services to meet the unique needs of young patients with the highest standard of care. The physical inspection of the ABUTH's pediatrics section revealed its division into four subdivisions, specifically the Social Care Baby Unit (SCBU), Pediatric Medical Ward (PMW), Pediatric Surgical Ward (PSW), Emergency Pediatric Unit (EPU), and the administrative offices were not designated in the same building, and the spatial organization is poor for effective wayfinding.

from the research instrument of Ulrich et al. (2018).

4.0 RESEARCH FINDINGS AND DISCUSSION

4.1 Background Information

Ahmadu Bello University Teaching Hospital (ABUTH) is a teaching hospital that serves



Kaduna and neighboring states. The hospital was founded in 1962 as the foremost healthcare institution in northern Nigeria. In 1982, Ahmadu Bello University inaugurated the pre-clinical complex to accommodate the training of 150 medical students and 50 dental students. Subsequently, it has developed into a comprehensive teaching hospital with a wide array of medical specializations.

The hospital complex is well landscaped with green features and natural topographical features, despite, the pediatric department lack a functional and well landscape healing garden to facilitate patients' recreation activities and recovery (see Table 1). The four sections were design with deep planning concept that lack good view, and landscape gardens that could have positive effects on patients' calmness, faster recovery, fostering positive mindsets about their diagnosis, and enhancing overall mental well-being. This implies that consideration of incorporating healing garden and its elements is as low as 15 percent and the showed that the finding is contrary to planning concept recommended by Demirkan (2019), Marcus and Barnes (1999), and Xue et al. (2019). As presented in Table 1, the four sections of the ABUTH's

pediatric meet the technical requirement of the ventilation with the installation of large windows. Despite, the deep planning concept reduced the level of natural daylighting into some of the interior’s spaces that is SCBU and EPU (see Figure 3). The Northern and Southern position of windows enhance effective natural lighting with no glare. Finding revealed that ABUTH’s pediatric section fulfil

the biodiversity principles on natural daylighting by 75 percent therefore, satisfactory, acceptable and consistent with the Joarder (2011) and Kotzer et al. (2011) recommendation for maximizing natural lighting in the healthcare facilities.

Table 1: Level of application of biodiversity principles in ABUTH, Zaria.

Variable	Architectural Features	Level of availability					Scores and Remark
		0	25	50	75	100	
Healing garden	a. Well landscape seating areas b. Green landscape walkways c. Provision of accessible landscape garden d. Provision of landscape courtyards e. Available green spaces to help patients’ recovery	√	√				10% effort was made on the landscaping elements for the healing (therapeutic) garden, as observed.
Natural Lighting	a. Provision of large windows with clear glass b. Windows are orientated along north and south c. Provision of shading device to reduce glare d. Windows position aid natural lighting into the wards e. Windows sizes can advance indoor air quality/recovery				√	√	80% levels of incorporation in the provision of natural lighting for interior spaces were attained.
Indoor plant landscape	a. Natural plants skillfully landscape indoor spaces. b. Placement and accessibility to indoor plants are good. c. Plants are nurtured and positioned for optimal daylight. d. Plants enhance the visual appeal of indoor spaces. e. Plants are non-toxic and enhance the quality of the air.		√	√			10% levels of integration observed in the indoor plant landscape of the pediatric section.
Colour usage	a. The colour selection for the interior spaces is purposeful. b. Spaces were designed with children-friendly colour. c. Cartoons and artwork are used for wall decorations. d. Spaces were painted with colors inspired by nature. e. Biodiverse colour used in interior spaces can enhance patients’ recovery and well-being.			√	√	√	60% of the colour applied in the interior spaces of the pediatric section are nature-driven to inspire patients’ recovery.

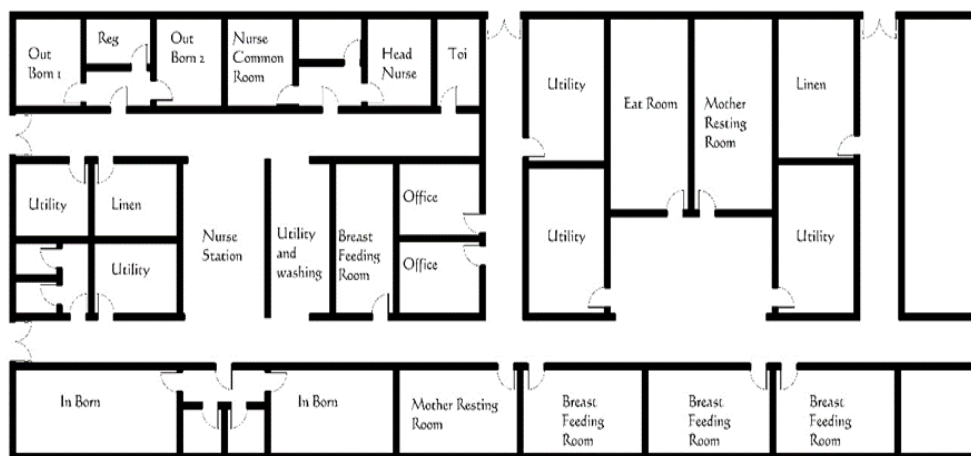


Figure 3: Floor plans of SCBU and EPU

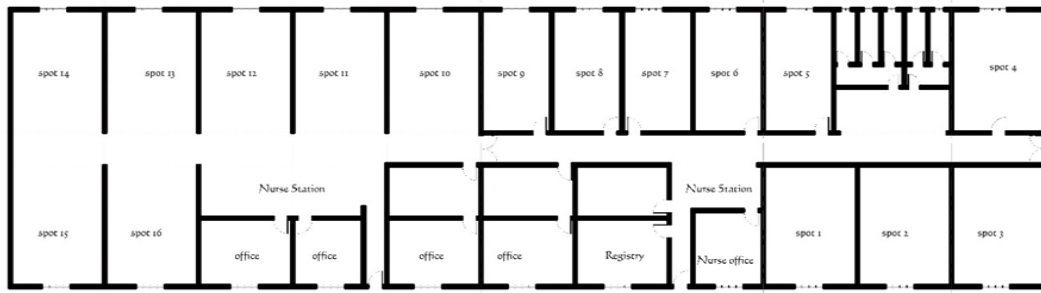


Figure 4: Floor plans of PWM and EPU

In addition, the physical survey on the level of provision of indoor plants landscape in the ABUTH's paediatric sections is low. No clear indication on the plant selection, placement and accessibility since indoor plants were practically absent except on the passage and most of them were not nurture and maintained (see Plate 6 and 7). In sum, patients' connections to nature are practically

given less consideration in the interior spaces in the paediatric section. This finding is against the advocacy of Zhong et al. (2024) and Ulrich et al. (2018) on the important of indoor plants on the social health of children, the cognitive ability of health workers, workplace performance, patients' well-being, and general health.



Plate 6: Children ward without indoor plants



Plate 7: Corridors without nature-inspired plants

Lastly, there is commendable application of nature inspired-colour combinations in the paediatric department, as presented in Table 1. The five items of measurements showed a substantial level of biodiverse application of colour observed in the paediatric section, which scored 65%. The respondents revealed that an appreciable effort was made during

the renovation of the four sections of the paediatric centre, which created the use of nature-inspired artwork and cartoon decoration on the walls to promote the young patients' recovery and contribute to the overall healing process as supported by the study conducted by Ulrich et al.'s (2018) and Wichrowski et al. (2021).



Plate 8: Ward painted with nature-inspired colour



Plate 9: Interior spaces painted in biodiverse colour

In summary, 80% of the facilities in the ABUTH pediatric center have efficient lighting, and 60% use nature-inspired color. However, the design of the four sections was based on a deep planning concept that did not provide a clear view of nature. The design notably omitted landscape gardens, which could potentially enhance patients' calmness, speed their recovery, foster positive mindsets about their diagnosis, and improve their overall mental health. Therefore, the design lacks the therapeutic benefits of the healing garden and indoor plant landscape in the wards, which are vital components that could enhance the recovery and well-being of pediatric patients.

Conclusion

The body of research demonstrating the benefits of green urban areas for human health and wellbeing is expanding. Despite the fact that there has been little scientific research on the quantitative worth by which nature and biodiversity can promote and advance human health and well-being, sustainability of the diverse natural habitats, as well as management and growing the green space and biodiversity in urban environments, are essential for the maintenance of human health and well-being in an urbanizing world.

The findings of this study clearly demonstrate that incorporating biodiversity principles can create a therapeutic environment that supports patients' emotional recovery and fosters a closer bond between patients, their families, and the natural world. By incorporating nature, hospitals can create healing environments that promote emotional well-being, aid in patient recovery, and foster a deeper connection between patients, their families, and the natural world. To achieve this, both architects in practice and training must focus on developing and implementing policies that

promote human interaction with biodiverse environments and strongly support biodiversity conservation and restoration.

We expect architects, who design built environments, to understand the profound health benefits of experiencing nature and biodiversity. Further research exploring these connections is crucial for improving ecosystems, communities, and human resilience. Nevertheless, given the limited scientific experimentation available in Nigeria to date, educational and political policymakers and scientists must intensify their efforts to comprehend the relationship between nature, biodiversity, ecosystem services, and health. They should incorporate more natural areas and biodiversity into the design and protection of our cities, not just health facilities, to enhance ecosystems, communities, and human resilience in general.

Reference

- Abbas, M. Y., & Ghazali, R. (2010). Healing environment of pediatric wards. *Procedia-Social and Behavioral Sciences*, 5, 948-957.
- Akinluyi Muyiwa, L., Fadamiro Joseph, A., Ayoola Hezekiah, A., & Alade Morakinyo, J. (2021). Theoretical Issues and Conceptual Framework for Physical Facilities Design in Hospital Buildings. *J. Archit. Environ. Struct. Eng. Res*, 4, 28-35.
- Aripin, S. (2006). Healing architecture: a study on the physical aspects of healing environment in hospital design. In *Proceedings of the 40th Annual Conference of the Architectural Science Association (ANZAScA)*, Adelaide, South Australia (pp. 22-25).
- Aydogan, A., & Cerone, R. (2021). Review of the effects of plants on indoor environments. *Indoor and Built Environment*, 30(4), 442-460.

- Babbu, A. H., & Haque, M. (2021). Effects of the physical environment of pediatric healthcare settings on health outcomes of patient & family and staff. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies*, 12(12), 1-12.
- Bawa, K. S., Nawn, N., Chellam, R., Krishnaswamy, J., Mathur, V., Olsson, S. B., ... & Quader, S. (2020). Envisioning a biodiversity science for sustaining human well-being. *Proceedings of the National Academy of Sciences*, 117(42), 25951-25955.
- Beery, T., & Jorgensen, K. A. (2018). Children in nature: sensory engagement and the experience of biodiversity. *Environmental Education Research*, 24(1), 13-25.
- Bratman, G. N., Hamilton, J. P., & Daily, G. C. (2012). The impacts of nature experience on human cognitive function and mental health. *Annals of the New York academy of sciences*, 1249(1), 118-136.
- Brown, C., & Grant, M. (2005). Biodiversity and human health: What role for nature in healthy urban planning? *Built Environment*, 31(4), 326-338.
- Dalke, H., Little, J., Niemann, E., Camgoz, N., Steadman, G., Hill, S., & Stott, L. (2006). Colour and lighting in hospital design. *Optics & Laser Technology*, 38(4-6), 343-365.
- Demirkan, G. Ç. (2019). Evaluation of healing gardens and design criteria. *Turkish Journal of Agriculture-Food Science and Technology*, 7(1), 148-151.
- Dijkstra, K., Pieterse, M., & Pruyn, A. (2006). Physical environmental stimuli that turn healthcare facilities into healing environments through psychologically mediated effects: systematic review. *Journal of advanced nursing*, 56(2), 166-181.
- Din, S. K. J., Russo, A., & Liversedge, J. (2023). Designing healing environments: a literature review on the benefits of healing gardens for children in healthcare facilities and the urgent need for policy implementation. *Land*, 12(5), 971.
- Dinu Roman Szabo, M., Dumitras, A., Mircea, D. M., Doroftei, D., Sestras, P., Boscaiu, M., ... & Sestras, A. F. (2023). Touch, feel, heal. The use of hospital green spaces and landscape as sensory-therapeutic gardens: a case study in a university clinic. *Frontiers in Psychology*, 14, 120-130.
- Hartig, T., Mitchell, R., De Vries, S., & Frumkin, H. (2014). Nature and health. *Annual review of public health*, 35, 207-228.
- Hofmann, M., Young, C., Binz, T. M., Baumgartner, M. R., & Bauer, N. (2018). Contact to nature benefits health: Mixed effectiveness of different mechanisms. *International journal of environmental research and public health*, 15(1), 31.
- Joarder, A. R. (2011). Incorporation of therapeutic effect of daylight in the architectural design of in-patient rooms to reduce patient length of stay (LoS) in hospitals.
- Jones, J., Nowacki, A. S., Greene, A., Traul, C., & Goldfarb, J. (2017). Investigating parent needs, participation, and psychological distress in the children's hospital. *Hospital pediatrics*, 7(7), 385-394.
- Kotzer, A. M., Zacharakis, S. K., Reynolds, M., & Buenning, F. (2011). Evaluation of the built environment: staff and family satisfaction pre-and post-occupancy of the Children's Hospital. *HERD: Health Environments Research & Design Journal*, 4(4), 60-78.
- Lee, A. C., & Maheswaran, R. (2011). The health benefits of urban green spaces: a review of the evidence. *Journal of public health*, 33(2), 212-222.
- Marcus, C. C., & Barnes, M. (Eds.). (1999). *Healing gardens: Therapeutic benefits and design recommendations* (Vol. 4). John Wiley & Sons.
- Marques, B., McIntosh, J., & Kershaw, C. (2021). Therapeutic environments as a catalyst for health, well-being and social equity. *Landscape Research*, 46(6), 766-781.
- Mulyati, M. I., & Exposto, L. A. S. (2023). Colour Selection Study of Children's Outpatient Clinic Interior Related to Patient Stress Level. *Asian Journal of Healthy and Science*, 2(5), 225-231.
- Perasso, G., Camurati, G., Morrin, E., Dill, C., Dolidze, K., Clegg, T. & Rippen, H. (2021). Five reasons why pediatric settings should integrate the play specialist and five issues in practice. *Frontiers in Psychology*, 12, 687292.
- Reeve, A., Nieberler-Walker, K., & Desha, C. (2017). Healing gardens in children's hospitals: Reflections on benefits, preferences and design from visitors' books. *Urban forestry & urban greening*, 26, 48-56.
- Romanelli, C., Cooper, D., Campbell-Lendrum, D., Maiero, M., Karesh, W. B., Hunter, D., & Golden, C. D. (2015). Connecting global priorities: biodiversity and human health: a state of knowledge review. World Health Organisation/Secretariat of the UN Convention on Biological Diversity.
- Roshani, A. (2014). Evaluation of the Perception Specifications of Colour in Interior Space by Colour Therapy Attitude: Patient Rooms in Healing Environments (Published Master's thesis, Eastern Mediterranean University (EMU)-Doğu Akdeniz University (DAÜ)). Available at: <http://i->

- rep.emu.edu.tr:8080/xmlui/handle/11129/3680.
- Sandifer, P. A., Sutton-Grier, A. E., & Ward, B. P. (2015). Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: Opportunities to enhance health and biodiversity conservation. *Ecosystem services*, 12, 1-15.
- Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Dean, J., Barber, E., & Fuller, R. A. (2016). Health benefits from nature experiences depend on dose. *Scientific reports*, 6(1), 28551.
- Thompson, R. (2023). The Utilization of Biophilic Arts Within Healthcare Settings: A Descriptive Case Study (Published Doctoral dissertation, The University of Arizona). Available at: <https://repository.arizona.edu/handle/10150/668410>.
- Timothy, I. O., Uwajeh, P. C., & Bamisaye, A. (2022). The Nigerian HealthCare Facilities: Need for Adopting Evidence-Based Design as an Innovative Approach for Improved Health and Wellbeing. In *International Conference on Innovations and Interdisciplinary Solutions for Underserved Areas* (pp. 49-65). Cham: Springer Nature Switzerland.
- Ulrich, R. S., Zimring, C., Zhu, X., DuBose, J., Seo, H. B., & Choi, Y. S. (2018). A Review of the Research Literature on Evidence Base Healthcare Design. *HERD: Health Environment Research and Design Journal*, 9-16.
- Van den Berg, A. E. (2005). Health impacts of healing environments; a review of evidence for benefits of nature, daylight, fresh air, and quiet in healthcare settings. UMCG.
- Ward Thompson, C., & Aspinall, P. A. (2011). Natural environments and their impact on activity, health, and quality of life. *Applied Psychology: Health and Well-Being*, 3(3), 230-260.
- Wichrowski, M. J., Corcoran, J. R., Haas, F., Sweeney, G., & Mcgee, A. (2021). Effects of biophilic nature imagery on indexes of satisfaction in medically complex physical rehabilitation patients: An exploratory study. *HERD: Health Environments Research & Design Journal*, 14(3), 288-304.
- Xeu, F., Lau, S. S., Gou, Z., Song, Y., & Jiang, B. (2019). Incorporating Biophilia into Green Building Rating Tools for Promoting Health and Wellbeing. *International Journal of Environmental Sciences*, 76-81.
- Zhong, W., Schroder, T., & Bekkering, J. (2022). Biophilic design in architecture and its contributions to health, well-being, and sustainability: A critical review. *Frontiers of Architectural Research*, 11(1), 114-141.
- Zhong, W., Schröder, T., & Bekkering, J. (2024). Implementing biophilic design in architecture through three-dimensional green spaces: Guidelines for building technologies, plant selection, and maintenance. *Journal of Building Engineering*, 109648.