

Architectural Interventions to Improve Daylight and Colour Impact for the Long-Term Sustainable Wellbeing of Paediatric Hospital Patients in Abuja, Nigeria

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Abstract

Daylight and colour are fundamental variables in the design of hospitals, daylight and colour helps to improve the positive response of patient's recovery in a hospital. This research work aims to evaluate architectural interventions to improve daylight and colour impact for the long-term sustainable wellbeing of paediatric hospital patients in Abuja, Nigeria. This study adopted a quantitative research approach, and a total of 300 questionnaires were distributed throughout the study population, with 269 questionnaires (90%) successfully recovered. The analysis of the data was carried out using descriptive statistics such as percentage and mean item score (MIS). While 52.8% of respondents agreed that the presence of a high-level window would improve daylight in the building, they also stated that they feel comfortable with the use of colour in the interiors. The findings reveal that 51.3% of the respondents agreed that they were comfortable with the application of colour in the treatment rooms. The findings reveal that 71.4% of the respondents agreed that bed arrangements should properly face window areas as a moderately important daylighting strategy in paediatric hospital design. According to the study's findings, having enough daylight in the paediatric wards is important since it speeds up patients' recuperation. The study recommends architectural changes to better the incorporation of daylighting and colour principles in the architecture of a paediatric hospital in Abuja, Nigeria. This would increase the impact it could have on young patients.

Keywords: colour, daylight, paediatric hospital buildings

INTRODUCTION

Paediatrics is the branch of medicine that deals with the development and care of infants and children and the treatment of their diseases (Silva, 2017; Terradas, 2020). Ensuring a child's health is critical not only for reducing child morbidity and mortality but also for increasing the likelihood of a healthier adult life, as in the popular saying, "Every adult is a survived child". The primary goal of child health care, however, is to prevent the major causes of death, difficulties, and disease during childhood: accidental injuries, infections, and educational and behavioral problems (Pelosi *et al.*, 2019). Children are the blessings and joy of society, the pride and strength of their parents and the nation. Their state of well-being, free from diseases, is very important to their parents and the nation as a whole (Brondani *et al.*, 2019). Colour and lighting can have an impact on people's perceptions and responses to the environment and also affect patient recovery rates, improving the quality and overall experience of patients, staff, and visitors. Colour and appropriate lighting are also powerful tools for coding, navigation, and wayfinding (Schloss *et al.*, 2017). Colour can also promote a sense of well-being and independence (Boyce, 2022).

The visual environment, including the quality of daylight and electric light, is a vital element influencing hospital staff morale and productivity; studies such as Samiou *et al.*, (2022) have even reported that an enhanced visual environment has improved recovery rates by as much as 10%. In fact, these improvements have been attributed to particular elements of the visual environment; they include the use of appropriate colour in interior design, the display of certain types of art work, and the provision of sunlight and attractive views out (Samiou *et al.*, 2022; Yokosawa, Schloss, Asano, & Palmer, 2015). There is also experimental evidence that people prefer certain types of light patterns for particular applications, which is likely to enhance performance (Strauss *et al.*, 2013; Schloss and Palmer, 2014). This level of benefit may not be sustainable for all areas, but realizing a proportion of the improvements would contribute significantly to hospital environments and staff and patient morale.

Several theoretical, clinical, and empirical studies such as Terradas *et al.*, (2020) and Schloss *et al.*, (2017) have demonstrated the importance of light and colour in children's hospitals for good psychosocial development. However, the chronic exposure of children to repeated experiences of hospitalization, maltreatment, sexual abuse, and neglect interferes with the development of their mental and physical abilities (Terradas *et al.*, 2020). According to EDGER (2016), having access to daylight can influence well-being by promoting healing and relieving patient pain and stress. It also reduces medical errors by hospital staff and is effective as an antidepressant. Daylight plays a major role in resource conservation and the occupant's level of productivity, health, and comfort. Furthermore, daylight hospitals have a great capacity for energy savings since their design integrates relevant

sustainable strategies in response to local climatic conditions. A hospital is a high-performance building that should attract, retain, and enhance the patient healing process and workers well-being.

The sun is the major source of daylight. It radiates electromagnetic waves with a balanced spectrum ranging from ultra-violet (100nm) to infrared radiation (10 nm), with a small part of this light visible to the human eye (Terradas *et al.*, 2020). Daylight is a combination of skylight and sunlight and constantly changes in character throughout the day and over different seasons of the year (Schloss *et al.*, 2017). This gradual change in colour, intensity, and direction helps control human behaviour in a way that artificial lighting cannot because of its static qualities of colour and intensity. With the advent of global warming, present and future architects are challenged to design paediatric hospitals that minimize greenhouse gas emissions, energy emissions, and energy consumption. Lack of careful lighting and colour in the design of healthcare environments can promote poor corporate 'sign-posting' of important areas such as reception desks and nursing stations.

This study therefore aims to evaluate architectural interventions to improve daylight and colour impact for the long-term sustainable wellbeing of paediatric hospital patients in Abuja, Nigeria. The objectives of this project include to (i) investigate the impact of daylighting and colour application on paediatrics hospital users (ii) determine the daylighting and colour performance of paediatric hospitals in Abuja, Nigeria.

LITERATURE REVIEW

Architecture in the Healing Process (Architecture and Healing process)

For better planning and designing of paediatric hospitals, architects and researchers have closely observed and tried to analyze the correlation between the physical parameters involved in creating a pediatric hospital and their effect on patients health-related outcomes such as patients comfort level, recovery, his length of stay, medication intake, stress levels, etc. Individually examining and studying these parameters on patients of different age groups can actually help in demonstrating how one can design healthy environments and spaces that can reduce stress and anxiety levels and address issues related to patients' comfort.

Daylight in Hospital

Healthcare centers are built aims to treat patients and improving human well-being. The interior design of the therapeutic space is an integral part of the design quality of the environment. Research shows that Therapeutic environments need high flexibility, security, intimacy, and relaxation as these spaces that lead to anxiety and panic in users, Lack of attention to physical design and interior design in therapeutic areas

causes users dissatisfaction (Ryan et al., 2014). Plate II, it is important to provide factors that needed for healthy hospital environments. Hospital lighting is an essential environmental factor in providing users with the right healing conditions (Kellert & Calabrese, 2015). It is essential to have the optimum amount of light in the design of therapeutic settings to identify important areas such as reception and nursing stations. The placement of windows in hospital rooms should be considered according to sun orientation to avoid direct exposure that leads to depression and eye pressure (Ulrich *et al.*, 2004)

Colour

Colors can have a significant impact on the psyche of patients; certain colors intend to encourage activities, while others promote passive behavior. According to color therapy, colors have the ability to influence many facets of our lives, including our emotions, mental state, mood, and energy level. Each color is considered to be in line with the seven energy centers or chakras. The concept of color therapy is based on the fact that our physiological behavior responds and functions in a predictable defined manner to colors.

Colour is an integral part of both the architectural design and structural concept, aspects of the healing environment, such as access to daylight, views, colour and orientation, were taken as the guiding principle for the architecture of the hospital and Research has shown that patients and staff react positively to colour, and that they are less likely to feel like they are in a hospital” (Molenaar, 2013). For the layout and furnishing of Martini Hospital, Arnold Burger and Bart Vos designed a complete modular-system concept including everything from walls to desks and cupboards.

The concept is called IFD, which stands for Industrial, Flexible, and Demountable. Demountable modular walls are used with a small module-size of 30 cm. The technical pipes and cables can be integrated into the walls so that any required combination and layout is possible, even in the arrangement with windows. The walls have different colours, so that it will always be possible to create rooms with different colour schemes, i.e. with a different atmosphere. The modular furniture system is similarly interchangeable. Purpose-made, standardised elements are assembled on site, always in a different way depending on the requirements. As the technical elements integrated into the basic modules are detachable, a change of functions can be realised without having to break anything away. It is possible, to build the desk at a certain stage, and later conveniently add to it, or disassemble the desk so as to use it in a different place or in a different form. The flexible modular furniture system too, has been designed in colour. Apart from the interior the double facades of the building “...allows the windows to open without suffering an increase of noise” (Burger *et al.*, 2006).

METHODOLOGY

This study was conducted at a selection of five hospitals located in Abuja, Nigeria. The method of purposive sampling was used for the purpose of selecting participants. In light of this, the data collected during this study was used to first define principles and methods pertaining to daylighting and colour in the design of paediatric hospitals. Additionally, it was used to evaluate the performance of daylighting and colour in paediatric hospitals located in Abuja, Nigeria. The information gathered from different sources was analyzed descriptively for the better assimilation and a proper elucidation. In order to carry out an in-depth finding about a subject matter under study, a descriptive analysis is used for a detail description. In order to ascertain the validity of the collected data, a reliability test was conducted on the variable items using Cronbach's alpha, and the test showed that the collected data are moderately reliable.

RESULTS AND DISCUSSION

General information for users and professionals

Table 1 reveals the analysed general information for users and professionals. With respect to the category of hospital users, the findings reveal that 49.1% of the respondents are patients, 39% are visitors, and 11.9% are other hospital users. The findings with respect to the gender of hospital users 55.8% of the respondents are female, while 44.2% are male. In respect of the professions of the respondents, 37.2% are doctors, 30.9% are nurses, 16.4% are midwives, and 15.6% are medical professionals. The findings on the built environment, professionals 46.1% of the respondents are architects, 24.5% are engineers, 15.2% are builders, and 14.1% are in other professions. The findings show educational attainment: 56.1% of the respondents are BSC holders or HND holders, 34.6% are MSC holders, and only 9.3% are NCE/OND holders.

Table 1: General Information for Users and Professionals

Variable	Frequency	Percentage
Category of hospital users		
Patient	132	49.1
Visitor	105	39
Others hospital users	32	11.9
Gender of hospital users		
Male	19	44.2
Female	150	55.8
Professions		
Medical Professional	42	15.6

Doctor	100	37.2
Nurse	83	30.9
Midwifery	44	16.4
Built environment professionals		
Architect	124	46.1
Engineer	66	24.5
Builders	41	15.2
Others	38	14.1
Educational attainments		
OND/NCE	25	9.3
HND/BSC	151	56.1
MSC	93	34.6
Years of experience of medical professionals		
0-5 years	55	20.4
6-10years	90	33.5
11-15 years	72	26.8
16-20 years	25	9.3
21-30 years	27	10.0

The findings revealed the years of experience of medical professionals, 33.5% have working experience between 6 and 10 years, 26.8% have working experience between 11 and 15 years, and only 9.3% have working experience between 16 and 20 years.

Perception of daylighting performance by the professionals

Table 2 shows the findings on the perception of daylighting performance by the professionals 66.9% of the respondents agreed that more windows need to be introduced to maximize the usable daylight as a moderately important aspect of daylighting strategies in paediatric hospital design; 8.9% agreed that it is extremely important; and 24.2% were neutral about it, with a mean value of 3.8, which implies that introducing more windows to maximize the usable daylight is a moderately important aspect of daylighting strategies in paediatric hospital design. These findings support the Urlich *et al.*, (2004) where it was revealed that More windows need to be introduced to maximize the usable daylighting and Window sizes where necessary should be increased to allow more daylighting.

Table 2: Perception of daylighting performance by the professionals

Statements	NI(1)	SI (2)	N (3)	MI (4)	EI (5)
More windows need to be introduced to maximize the usable daylighting	0	0	65 (24.2)	180 (66.9)	24 (8.9)
Window sizes where necessary should be increased to allow more daylighting	0	0	114 (42.4)	118 (43.9)	37 (13.8)
More daylighting sources should be introduced into the design such as screen walls, skylight	0	8 (3)	88 (32.7)	132 (49.1)	41 (15.2)
Skylight in courtyards should be introduced to allow daylight consumption?	0	0	45 (16.7)	175 (65.1)	49 (18.2)
The headroom of space should be increased to allow more daylight	0	0	37 (13.8)	205 (76.2)	27 (10.0)
Introduced slope ceiling to direct more light into space	0	0	14 (5.2)	129 (48.0)	126 (46.8)
Shelves properly positioned will benefit from different daylighting strategies	0	0	1 (0.4)	189 (70.3)	79 (29.4)
Building orientation and meticulous of the surrounding hospital environment	0	0	2 (0.7)	136 (50.6)	131 (48.7)
Beds arrangement should properly face window areas			27 (10.0)	192 (71.4)	50 (18.6)

As regards window sizes, 43.9% of the respondents agreed that window sizes where necessary should be increased to allow more daylighting as a moderately important daylighting strategy in paediatric hospital design; 13.8% agreed that it was extremely important; and 42.4% were neutral about it, with a mean value of 3.7, which implies that increasing the window sizes where necessary to allow for more daylighting is a moderately important daylighting strategy in paediatric hospital design.

Also 49.1% of the respondents agreed that more daylighting sources should be introduced into the design, such as screen walls, skylights, and fixed windows, as moderately important daylighting strategies in paediatric hospital design; 15.2% agreed that it is extremely important; 32.7% were neutral about it; and 3% agreed that it is slightly important, with a mean value of 3.8, which implies that introducing more daylighting sources into the design, such as screen walls, skylights, and fixed windows, is a moderately important daylighting strategy in paediatric hospital design. As regards skylights in courtyards 65.1% of the respondents agreed that skylights in courtyards should be introduced to allow daylight as a moderately important daylighting strategy in paediatric hospital design; 18.2% agreed that it is extremely

important; and 16.7% were neutral about it, with a mean value of 3.7, which implies that introducing skylights in courtyards to allow for more daylighting is a moderately important daylighting strategy in paediatric hospital design.

As regards the headroom, 76.2% of the respondents agreed that the headroom of space should be increased to allow more daylight as a moderately important daylighting strategy in paediatric hospital design; 10% agreed that it is extremely important; and 13.8% were neutral about it with a mean value of 4.0, which implies that increasing the headroom of space to allow for more daylighting is a moderately important daylighting strategy in paediatric hospital design.

In respect of the introduced slope ceiling to direct more light into space 48% of the respondents agreed that introducing slope ceilings to direct more light into space is a moderately important daylighting strategy in paediatric hospital design; 46.8% agreed that it is extremely important; and 5.2% were neutral about it, with a mean value of 4.4, which implies that introducing slope ceilings to direct more light into space is a moderately important daylighting strategy in paediatric hospital design. The findings revealed 70% of the respondents agreed that shelves properly positioned will benefit from different daylighting strategies as moderately important daylighting strategies in paediatric hospital design; 29.4% agreed that it is extremely important; and 0.4% were neutral about it with a mean value of 4.3, which implies that shelves properly positioned will benefit from different daylighting strategies as moderately important daylighting strategies in paediatric hospital design.

The findings shows the building orientation and meticulousness of the surrounding hospital environment 50.6% of the respondents agreed that building orientation and meticulousness of the surrounding hospital environment are moderately important daylighting strategies in paediatric hospital design; 48.7% agreed that they are extremely important; and 0.7% were neutral about it, with a mean value of 4.5, which implies that building orientation and meticulousness of the surrounding hospital environment are extremely important daylighting strategies in paediatric hospital design.

The results of the findings from the field survey revealed that bed arrangements, they should properly face window areas. 71.4% of the respondents agreed that bed arrangements should properly face window areas as moderately important daylighting strategies in paediatric hospital design; 18.6% agreed that it is extremely important; and 10% were neutral about it, with a mean value of 4.1, which implies that bed arrangements should properly face window areas are moderately important daylighting strategies in paediatric hospital design.

Daylighting performance of paediatric hospitals

Relative Importance Index was used to determine the daylighting performance of paediatric Hospitals and to rank each variable according to their important

The Relative Important index formular is given as:

$$RII = \frac{\sum W}{A * N}$$

Where W= Weight given to each statement by the respondent

A=Highest response integer which is 5

N= Total number of respondents for users=269 * 5 =1345

Table 3: Relative Important Index of Daylighting performance of paediatric hospitals

Relative Important Index	$\sum W$	RII	Rank
More windows need to be introduced to maximize the usable daylighting	1035	0.769	7
Window sizes where necessary should be increased to allow more daylighting	999	0.743	9
More daylighting sources should be introduced into the design such as screen walls, skylight, fixed windows	1013	0.753	8
Skylight in courtyards should be introduced to allow daylight	1080	0.803	5
The headroom of space should be increased to allow more daylight	1066	0.793	6
Introduced slope ceiling to direct more light into space	1188	0.883	2
Shelves properly positioned will benefit from different daylighting strategies	1154	0.858	3
Building orientation and meticulous of the surrounding hospital environment	1205	0.896	1
Beds arrangement should properly face window areas	1099	0.817	4

Among the daylighting performances, building orientation and meticulousness of the surrounding hospital environment were ranked first as the most important; the introduction of a slope ceiling to direct more light into space was ranked second; shelves properly positioned will benefit from different daylighting strategies were ranked third; bed arrangements should properly face window areas were ranked fourth; more windows need to be introduced to maximise usable daylighting; and window sizes, where necessary, should be increased to allow more daylighting were ranked 7th, 8th, and 9th, respectively.

CONCLUSION AND RECOMMENDATION

Daylight and colour these are fundamental variables in the design of hospitals and may, at times, prove the difference between life and death. The existence of sufficient

natural light in indoor spaces is preferred and more important than excessive or insufficient natural light. Sufficient daylighting achieved through architectural design reduces energy consumption and enhances the environmental quality of hospital spaces. This study intends to investigate the impact of daylighting and colour on paediatric hospital users in the design of paediatric hospitals in Abuja, Nigeria. The population in this study included paediatric hospitals within Nigeria and paediatric hospitals in other countries around the world. The case studies selected for this study were purposively sampled on these bases: As a paediatric hospital with adequate coverage in the scope of facilities required to operate as a standard children's facility. As a facility that possesses some paediatric design principles. Facilities in Nigeria with similar natural attributes to the intended proposed paediatric hospital as stated in the objectives of the study A sample size of five paediatric hospitals was drawn for this research. The study concluded that 77% of the respondents agreed that daylight within the wards helps patients recover faster. That the respondents were comfortable with the application of colour in the treatment rooms. The study proposed that propose the integration of daylighting and colour principles in the design of a paediatric hospital in Abuja, Nigeria. This research recommends: Because children dislike dull, dirty, disordered, and crowded spaces in a hospital but rather like clean, tidy, colorful, bright, comfortable, and well-maintained spaces, the walls should not just be plain but decorated with different colours and with very colourful wall hangings, pictures, paintings, or drawings. Such spaces take their minds off the clinical procedures and traumas that they go through and also make a visit to the doctor a much more pleasant experience.

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