



# Effects of the Physical Environment of Pediatric Healthcare Settings on Health Outcomes of Patient & Family and Staff

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Paper ID: 12A12I

Volume 12 Issue 12

Received 30 June 2021

Received in revised form 06 September 2021

Accepted 15 September 2021

Available online 24 September 2021

## Keywords:

Child-centred care;  
Hospital design;  
Health outcomes;  
Childcare  
environment; Patient  
safety; Pediatric  
patient; Healthcare  
environment; Access  
to garden; Hospital  
layout; Hospital  
rooms; Hospital  
orientation; Hospital  
light; Hospital  
ventilation; PICO;  
Paediatric  
healthcare; PRISMA.

## Abstract

**Aim:** This study identifies, evaluates, and synthesizes the recent literature related to the pediatric healing environment and presents the impact of physical environments on the health outcomes of pediatric patients, families, and staff. **Background:** Recent studies have shown that the physical environment has an increasing impact on health outcomes, however, the effects of the physical environment of the pediatric healthcare settings on health outcomes of patients, families, and staff have not been extensively investigated. **Methods:** A multi-phased approach was adopted to review literature, including a literature search, screening, and selection of literature, its appraisal, and discussion. Electronic databases: Scopus, PubMed, and Web of Science were searched to find peer-reviewed articles between 2000 to 2020. Finally, a total of 38 peer-reviewed articles were examined and discussed. **Results:** The findings suggest that design strategies, such as improved layout, proper rooms, orientation, adequate light & ventilation, positive distraction, and play can help patients achieve better outcomes. The result is grouped into seven research themes. (1) architectural features; (2) interior design features; (3) environmental attributes; (4) access to nature; (5) artwork & thematic design; (6) interactive technologies and positive distractions; (7) family and peer support. **Conclusion:** The result indicates that an appropriately designed pediatric healthcare environment has several positive effects, including lower levels of anxiety and fear among patients, improved family experience, and improved staff satisfaction with the work environment.

**Disciplinary:** Architecture Science & Engineering, Health Science

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## Cite This Article:

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), 12A12I, 1-12. <http://TUENGR.COM/V12/12A12I.pdf> DOI: 10.14456/ITJEMAST.2021.240

# 1 Introduction

## 1.1 Pediatric Healthcare Environment

A growing body of literature suggests that a healthcare-built environment has a considerable impact on patient health outcomes and the same is also true for pediatric healthcare environments (Akinluyi, 2019; Alvaro, 2015; Shepley, 2001; Ulrich et al., 2004). Healthcare built environment components i.e. hospital layouts, nature, exterior view, artwork (Nanda et al., 2009), lighting, color (Park & Park, 2013), and noise are the factors that can impact the health of children, families, and staff (Sherman et al., 2005; Varni et al., 2005). Pediatric healthcare facilities provide medical care and well-being to infants, children, and adolescents.

Children are not just little adults; they are more sensitive than adults, and their needs become much more distinct when they are ill. They cannot be effectively treated in a health facility designed for adults (Schubert et al., 1993). The impact of healthcare-built environments on the health outcomes of patients, especially for pediatric patients, is understudied and the data about the impact of architecture on sick children is scarce (Shepley, 2001).

The objective is to identify, evaluate and synthesize the recent literature and to present the impact of the physical environment of pediatric healthcare settings on the health outcomes of pediatric patients, families, and staff. The research questions outline the goal of this study:

- What features of pediatric-built environments have been deliberated?
- In what settings have the studies been conducted?
- What level of evidence do these studies have?
- What interventions are being used to examine the effect of the physical environment on health outcomes?
- What types of therapeutic goals & design strategies have been explored?

# 2 Research Methods

## 2.1 Search Strategy for Identification of Studies

Scopus, PubMed, and Web of Science were databases used to find research articles in peer-reviewed journals published between 2000 to 2020, in the English language using the keywords: pediatric; healthcare architecture; layout; evidence-based design; finish; child-centered care; healing spaces; patient safety; infection; stress; noise; light; ventilation; privacy; healing spaces; and positive distraction.

The PICO (Population, Intervention, Comparison, and Outcomes) framework was used to form the search strategy (Table 1). It is a well-established framework in the healthcare sector for defining and answering healthcare-related questions (Jamshidi et al., 2020). Keywords were categorized in four groups as per PICO framework: Population (P): - Pediatrics treated at healthcare facilities, families, and staff; Intervention (I): - articles that have analyzed the effect of the built environment on the wellbeing of children, families, and staff; Comparison (C):- not applicable; and

Outcomes (O):- studies that relate built-environments with patient safety, stress, and positive distraction.

The search terms were combined by using Boolean operations (i.e., AND, OR etc.) to extract specific results. By manually searching the reference list of previously retrieved publications, additional articles were also found. Articles were screened by their title and abstract before reviewing the full paper. The level of evidence for each article was judged according to Stichler (2010), (Table 2). It is a well-established approach for evaluating evidence in the healthcare sector (Bosch & Lorusso, 2019).

This study was performed according to the method proposed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1). PRISMA has a four-phased flow diagram and 27-item checklist, used in reporting the literature reviews for a wide variety of research (Anåker et al., 2016).

**Table 1:** PICO search framework adapted from Jamshidi et al. (2020)

Framework item	Description	Results
P	Patient Problem or Population	Pediatric, family, staff
I	Intervention	Built environment
C	Comparison or Control	N/A
O	Outcome	Patient outcome, family & staff

## 2.2 Inclusion Criteria

All included articles in this study met the following criteria.

- Articles published in the English language.
- Studies published in peer-reviewed journals between 2000 to 2020.
- Studies addressed the relationship of the built environment with health outcomes.
- Articles fall between 1 to 3 levels of evidence (LOE), (Table 2).

**Table 2:** Level of Evidence (LOE) for Healthcare Design adapted from Stichler (2010)

Level	Description of Quality	Included
1	Systematic reviews of multiple randomized controlled trials or nonrandomized studies; meta-analysis of multiple experimental or quasi-experimental studies; meta-synthesis of multiple qualitative studies leading to an integrative interpretation	Y
2	Well-designed experimental and quasi-experimental studies with consistent results compared to other, similar studies	Y
3	Descriptive correlational studies, qualitative studies, integrative studies, or systematic reviews of correlational or qualitative studies, or RCT or quasi-experimental studies with inconsistent results compared to other, similar studies	Y
4	Peer-reviewed professional standards or guidelines with studies to support the recommendation	N
5	Opinion of recognized experts, multiple case studies	N
6	Recommendations from manufacturers or consultants who may have a financial interest or bias	N

## 2.3 Exclusion Criteria

All excluded articles in this study met the following criteria.

- Articles published in other than the English language and published before 2000.
- Articles investigated clinical/medical aspects.
- Articles not published in peer-reviewed journals.

- Articles that did not fall between 1 to 3 LOE.
- Review articles

## 3 Results

### 3.1 Articles Reviewed

The search for publication in three databases produced 3627 articles. A handheld scan of references yielded an additional 33 articles, bringing the total number of articles to 3660. A total of 1009 articles were screened, after the removal of duplicates. In total, 103 articles met the inclusion criteria. After reading the full text, 38 articles were found to be relevant to the theme and hence were included in this study (Figure 1).

### 3.2 Analysis of Included Articles

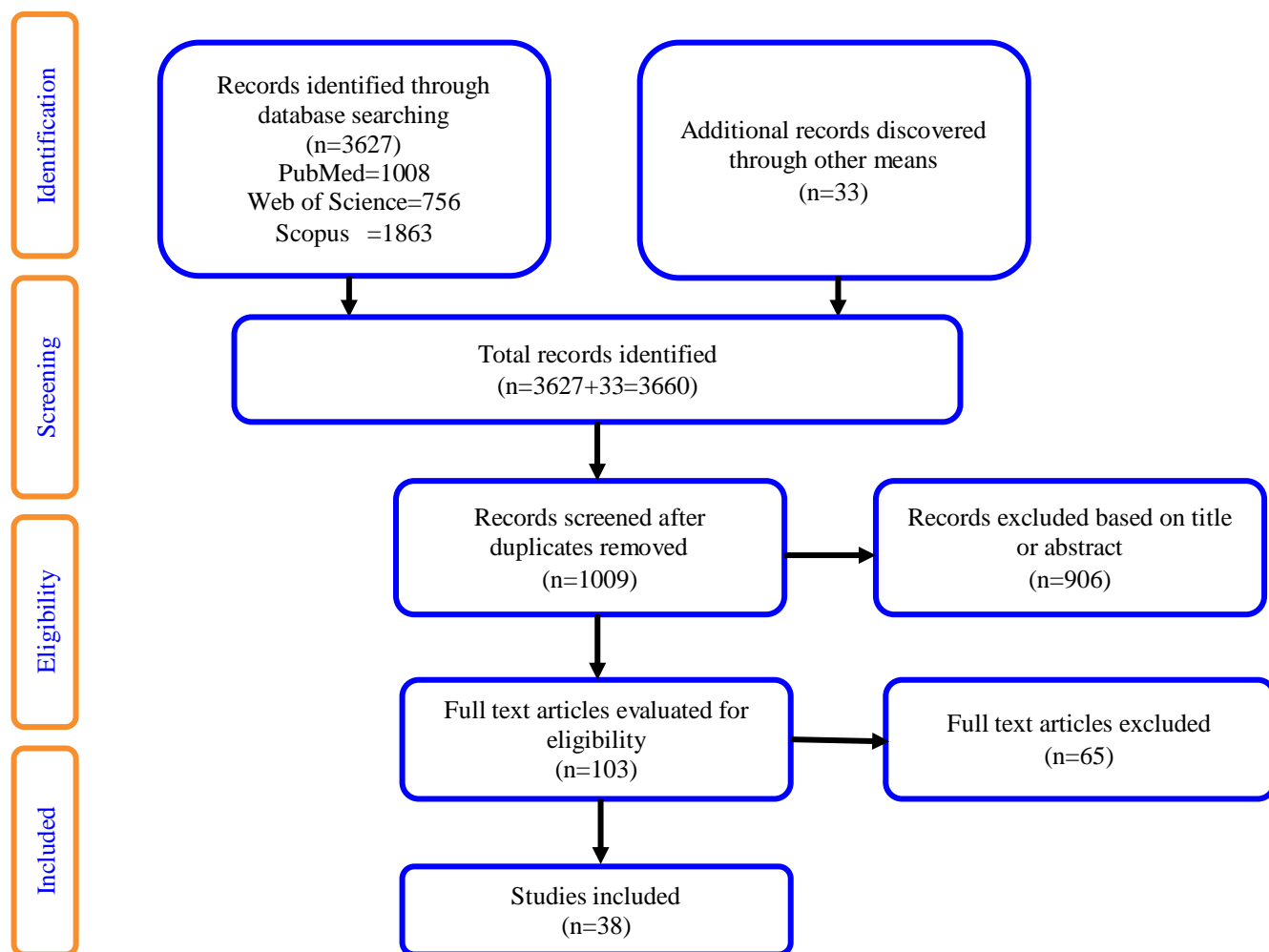
The included articles are grouped into seven design themes: (1) architectural features (2) interior design features (3) environmental attributes (4) access to nature (5) artwork & thematic design (6) interactive technologies and positive distractions (7) family and peer support. The design themes, environmental factors, and citations are presented in (Table 3).

**Table 3:** Categorised list of articles based on themes and environmental design factors

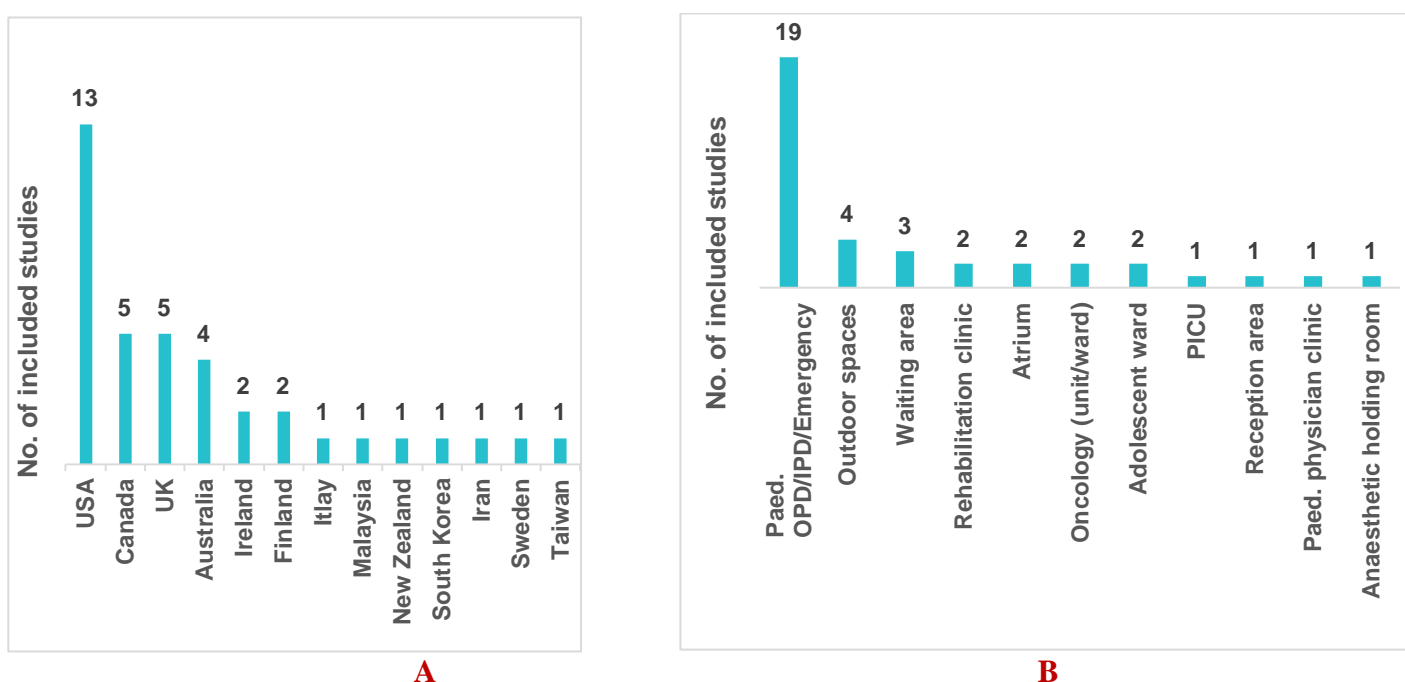
Design themes	Environmental factors	Citations
Architectural features	spatial layout, architectural scale, unit configuration, wayfinding, signages, accessibility, barrier-free spaces	(Adams et al., 2010; Birch et al., 2007; Coad & Coad, 2008; Ghazali et al., 2013; Gibson & Nelson, 2009; Hutton, 2005; Koller & McLaren, 2014; Lambert et al., 2014; Tivorsak et al., 2004)
Interior design features	décor, color, furnishing, flooring material,	(Coad & Coad, 2008; Corsano et al., 2015; Nasab et al., 2020; Park, 2009; Pasha & Shepley, 2013; Pelander et al., 2007; Tivorsak et al., 2004)
Environmental attributes	lighting, noise, temperature, overall environment	(Birch et al., 2007; Clift et al., 2007; Coad & Coad, 2008; Lambert et al., 2014; Robinson and Green, 2015)
Access to nature	healing garden, playful activities	(Pasha, 2013; Pasha & Shepley, 2013; Reeve et al., 2017; Whitehouse et al., 2001; Woo & Lin, 2016)
Artwork & thematic design	artwork, aesthetics, anxiety & stress	(Bishop, 2012; Clark et al., 2019; Coad & Coad, 2008; Eisen et al., 2008; Tivorsak et al., 2004)
Interactive technologies & positive distraction	interactive media, therapeutic play	(Biddiss et al., 2013, 2018; Chau et al., 2006; Lim et al., 2019; Wolitzky et al., 2005)
Family and peer support	comfort, privacy, security, dignity, music & internet access	(Birch et al., 2007; Clift et al., 2007; Eisen et al., 2008; Hutton, 2005; Lambert et al., 2014; Nasab et al., 2020; Peditto et al., 2020; Pelander et al., 2007)

The included studies had varied levels of evidence: Level#1 (n=1); Level#2 (n=4); and Level#3 (n=34). The majority of these studies were conducted in developed countries: United States (n=13); Canada & United Kingdom (n=5, each); Australia (n=4); Ireland & Finland (n=2, each); Italy; Malaysia; New Zealand; South Korea; Iran; Sweden and Taiwan (n=1, each); (Figure 2-A), in several pediatric healthcare environments, including the reception area, waiting room, physician's clinic, rehabilitation clinic, procedure room, pediatric and adolescent's ward (general, surgical, neurological, orthopedic), emergency department, anesthetic holding room, cancer unit, and PICU;(Figure 2-B), and into a variety of geographical, cultural, and socio-economic settings. The

number of included studies and their level of evidence against each design theme are listed in (Table 4).



**Figure 1:** Diagram showing the process of screening based on works of (Anåker et al., 2016; Jamshidi et al., 2020).



**Figure 2:** (A) Country-wise number of included studies; (B) No. of included studies in various settings.

**Table 4:** Included studies, their level of evidence, against each design theme.

Design themes	No. of included studies	Level of evidence (No of studies)
Architectural features	10	L3(n=10)
Interior design features	10	L2(n=1), L3(n=9)
Environmental attributes	5	L2(n=1), L3(n=4)
Access to nature	6	L3(n=6)
Artwork & thematic design	6	L1(n=1), L3(n=5)
Interactive technologies & positive distraction	6	L2(n=2), Le=3(n=4)
Family and peer support	11	L1(n=1).L3(n=10)

## 4 Discussion

The findings indicate that the physical setting of pediatric healthcare environments is important for the healing process and well-being. The following sections summarise the findings.

### 4.1 Theme 1: Architectural Features

Several studies reveal an association between the physical structure of the healthcare and patient outcomes (Adams et al., 2010; Birch et al., 2007; Lambert et al., 2014). Appropriate, and creative use of hospital spaces, and child-friendly hospital structures, can improve patient well-being and satisfaction (Ford et al., 2018).

In a level#3, Ghazali et al. (2013) evaluated a pediatric ward and suggested: “... *designers to improve on Character & Innovation, Use and Access*”. Lamber et al. (2014) suggest architects create spacious environments for children’s healthcare environments at all levels.

Two-level#3 studies investigated the same atrium in Toronto. The authors conclude that children perceived the atrium as an inviting space Adam et al.(2010), however, the children’s responses about the size of the atrium were varied; some associated it with comfort, while others find it scary Koller & McLaren (2014). Two-level 4 study, focused on accessibility and wayfinding. Hospital entrances, according to Coad & Coad (2008), should be inviting, clean & welcoming, and corridors should be simple with improved signposting such as colored arrows or footprints. Adam et al.(2010), conclude that wall maps, signages, landmarks, artwork are helpful in navigation. Lambert et al. (2014) highlight the hospital structures to be seamless and free-flowing.

Considering the varied and developing needs of children of different ages in terms of shapes, patterns, etc., there is a need to create healthcare environments as unstructured, flexible, and contemporary (Babbu, 2016; Lambert et al., 2014).

The importance of providing separate facilities for children has been highlighted in three-level#3 studies. Children prefer separation between private and common areas (Hutton, 2005), and dislike being placed in shared rooms with adults Gibson & Nelson (2009). Adolescents dislike having to wait and be seen in rooms designed for younger children (Tivorsak et al., 2004).

### 4.2 Theme 2: Interior Design Features

The important goal of the designer is to create psychologically supportive, appealing healthcare facilities, enhancing their hospital experience to promote wellness (Pelander et al.,

2007). According to Birch et al.(2007), age-associated characteristics of hospital spaces, finish and décor, are important design characteristics.

Several studies revealed that the appropriate color in hospitals can decrease stress and promote faster recovery. Park (2009) investigated the role of color on pediatric patients through a simulation model and finds that blue and green are the most common colors among pediatric patients, while white is the least popular; girls prefer purple and red, and outpatients and inpatients prefer yellow. In contradiction to the general belief that younger people might choose bright colors, young people prefer mild colors, with blue and green being the most popular (Coad & Coad, 2008).

Three-level 3 studies investigated texture as a design element. The hospital spaces for children need to be created based on the interest of children in terms of color, pattern, and texture (Lambert et al., 2014). Children have strong preferences for textures throughout all age groups, which includes shiny textures, metal glitters, nature, and animals (Corsano et al., 2015).

Two-level 3 studies (Pasha & Shepley, 2013; Tivorsak et al., 2004) discussed the preferences of children for furniture. Adolescents hate uncomfortable furniture in waiting rooms, and prefer comfortable, age-appropriate/ child-scale furniture in healthcare settings, according to authors. Different aspects of flooring: texture, color, number of joints need to be considered while selecting a specific type of flooring material (Tivorsak et al., 2004).

### **4.3 Theme 3: Environmental Attributes**

A growing body of literature suggests that the environmental design features: lighting, noise, temperature are directly related to the pediatric quality of life as it affects children, physiologically and psychologically (Coad & Coad, 2008; Lambert et al., 2014; Robinson and Green, 2015).

Natural and ambient lighting are important design characteristics that can impact the treatment of pediatric patients and are closely related to sleep-related patient outcomes. Though the lighting is an important aspect in creating a therapeutic environment, hospital lighting quality and lighting levels are influenced by clinical requirements (Birch et al., 2007). Children want to have control over lighting levels around their own bed spaces (Lambert et al., 2014).

The noise inside the hospital is primarily associated with babies crying, gurgling radiators, beeping machines, staff talking loudly at the nurses' station (Birch et al., 2007), and outside noise mainly due to traffic, particularly at night (Lambert et al., 2014). Segregation of baby wards from wards of older children is suggested by many children (Birch et al., 2007; Clift et al., 2007).

### **4.4 Theme 4: Access to Nature/Garden**

For hospitalized children, families, and staff; access to nature is particularly important. Outdoor environments with natural elements can provide a relaxing atmosphere and can boost the mood of the children (Pasha, 2013; Pasha & Shepley, 2013; Reeve et al., 2017). Playing outside has

a positive effect on children, children's feelings can be improved, discomforts can be relieved, and healing can occur when they are exposed to nature and the garden (Woo & Lin, 2016).

A garden with more facilities for children, such as play features, sculptures, and child-sized furniture, encourage more physical activity (Pasha & Shepley, 2013). Improper garden location, poor visibility, navigational difficulty, parents' preoccupation with their child, and their workload are all identified as barriers to garden visitation (Pasha, 2013). Insufficient greenery, shading, and seating are some of the factors that prevent people from visiting gardens in hospitals (Pasha, 2013).

Whitehouse et al. (2001), propose recommendations for overcoming the barrier to garden visitation as (1) staff members must be updated on the garden's intent, and how to integrate it into the patient and family care (2) colorful brochures with images that provide details about the garden and directions to get there (3) flyers about the garden could be put in lifts and other high activity areas to improve the visibility of garden details.

#### **4.5 Theme 5: Artwork and Thematic Design**

A growing body of literature supports the relationship of artwork in pediatric healthcare settings with health promotion and patient well-being. Drawings and artwork may be a powerful source of psychological and emotional support for hospitalized children (Bishop, 2012; Clark et al., 2019; Water et al., 2017). Brightly colored products and imaginative décor appeal to children, however, adolescents favor artwork that portrays realistic scenes (Tivorsak et al., 2004). In a level 1 study, (Eisen et al., 2008) find that adult patients prefer nature & representational art images over abstract images, with representational nature art being the most common among all age groups. Art is a crucial environmental characteristic that serves a variety of purposes in the hospital experience of children, including positive distraction, entertainment, and interaction that aid children's ability to maintain a positive attitude Bishop (2012). Coad & Coad (2008), conclude that children prefer artwork & simple thematic design, and an underwater/ sea environment.

#### **4.6 Theme 6: Interactive Technologies for Play and Distraction**

Interactive technologies have become an increasingly concerning tool for positive distraction. Toys, books, handheld games that were traditionally provided in pediatric healthcare waiting spaces pose a risk of infection (Aguero et al., 2004).

According to Bachmeier, "many physicians no longer provide toys in their waiting rooms because the resources needed to disinfect them are prohibitive" (as reported in Biddiss et al.; 2013, p.51). Biddiss et al. (2013), designed an interactive media display (ScreenPlay) in Toronto. The ScreenPlay is made up of one hundred, 300mm x300mm floor tiles, act as capacitive on/off switches. When a person walks across the floor sensor, it activates and generates animation that can be projected on the wall/screen. The authors find that ScreenPlay is a unique alternative to traditional toys. Children prefer Screenplay the most and they rank it at the top; aquarium, music, television, video games, and toys are ranked at 2 to 6 respectively, according to Biddiss et al. (2013).



In a level#2 study, Wolitzky et al. (2005), find that the children in virtual reality conditions feel substantially less discomfort during medical interventions. Chau et al. (2006), compared two augmented conditions: one for children with motor impairment and the other for teenagers who are relearning community mobility skills and found that augmented environments can help in specific community mobility tasks. Lim et al. (2019), in a level#3 study compared wall-murals, virtual-pond, and TV display installed in a reception area of a pediatrics hospital and find the virtual pond as a beneficial positive diversion for children of all age groups.

#### **4.7 Theme 7: Family and Peer Support**

The pediatric patient often feels lonely, scared in hospital settings which are a strange world filled with unfamiliar sights, and odors. Painful treatments and alienation from family members are the social and emotional difficulties, children experience in hospitals (Eisen et al., 2008). Adolescents express fear & anxiety in an unfamiliar environment, staying away from family, friends, etc. Clift et al (2007). Children experience depression, alienation, loneliness, and anxiety, being alone with limited family support (Clift et al., 2007). Access to friends and family provides children with a sense of protection and comfort (Peditto et al., 2020; Pelander et al., 2007). Children of all ages desire the hospital to be a nice place to visit and are concerned about age-associated characteristics of the hospital (Birch et al., 2007), want to play and share activity spaces with friends and peers (Hutton, 2005; Nasab et al., 2020), and desire to have their parents' beds nearby. Providing a safe environment for children to interact with their families, and peers have a positive effect on their behavior and are highly beneficial (Lambert et al., 2014). Adolescents can comfortably mingle and interact with each other if a barrier-free environment is created rather than a personal space (Nasab et al., 2020). Adolescents do not want to be isolated from their peers according to Clift et al (2007).

## **5 Conclusion**

Analyzing the effect of pediatric healthcare environments on the health outcomes of patients, families, and staff has become increasingly relevant. Included articles of this study support that the physical design of pediatric healthcare settings with specific design characteristics can affect health outcomes. Though architectural and interior design features are essential to architects and designers, their effect on well-being and health outcomes has not been thoroughly investigated in the current research.

Factors such as lighting, noise levels, artwork, access to nature, and views through windows have all been positively associated with health outcomes in recent literature and have been fairly studied. Access to nature has been shown to benefit patients, families, and staff in terms of improved hospital experience and staff satisfaction with the work environment.

Studies have suggested that interactive technologies, ScreenPlay can provide better play opportunities for differently-abled children and also a safer choice for play in terms of infection risk. Several studies have collectively suggested that aquariums, wall-murals, can positively impact

well-being and health outcomes, including lower levels of anxiety and fear among pediatric patients.

The findings also revealed that physical environment studies in developing countries are lacking; studies conducted in developed nations may recommend guidelines that are not feasible in low-income countries. Studies conducted in developed countries, for example, have advocated the use of single-family rooms to contain the infection and to have better control over environmental conditions; however, in low-income countries, where the focus is on meeting basic needs; these facilities may be perceived as a luxury. The recommendations of studies conducted in one country may not be suitable for another due to differences in geographical, cultural, and socioeconomic settings. The infrastructure of a country's healthcare environment is strongly affected by its economic status, necessitating further research into the design of healthcare settings in many parts of the world.

## 6 Availability of Data and Material

Data can be made available by contacting the corresponding author.

## 7 Acknowledgement

This paper is based on the ongoing Ph.D. work of Abdul Halim Babbu at the Department of Architecture, National Institute of Technology, Patna, India. The author is thankful to all the faculty members of the Department of Architecture, NIT Patna for their constructive suggestions.

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