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Design Characteristics for Sustainable Pediatric Healthcare Environments: Stakeholder's Perception

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Abstract
Background: The therapeutic environments of children and adolescents differ from those of adults, and are complex entities. Though studies have been conducted on the built environments of adult healthcare facilities, the impact of therapeutic environments on the health outcomes of pediatric patients is yet to be explored. Objective: The purpose of this study is to investigate design characteristics for creating a pleasant, comfortable, and child-friendly physical environment in children's healthcare settings. Method: After extracting features that influence pediatric healthcare design from the relevant literature, a survey questionnaire, consisting of 45 items from 14 domains, was conducted. Principal component analysis (PCA) using varimax rotation was used to explore the intrinsic concept in an Indian sample (N= 224). Results: PCA with varimax rotation yielded 4- factors: (1) child-centred design characteristics; (2) indoor ambient environmental quality; (3) positive distraction strategies; and (4) sense of autonomy and control, accounting for 78.14% of the explained variance. A factor loading range of 0.41 to 0.93 was found across the four variables, indicating construct validity, and all the factors were found to be significantly related to each other. Conclusions: This study concludes that the built environment of pediatric healthcare settings impacts patients' health outcomes and behaviour, with decreased patient stress & anxiety, and better family experience. The findings suggest the need of providing comfort to the children through several rejuvenating elements such as positive distraction strategies, play opportunities, family and peer interaction, child-friendly design, age-associated characteristics, etc. It also suggests various design characteristics that help contribute the positive patient health outcomes.

Keywords: pediatric therapeutic environment, healthcare design, child-friendly design, therapeutic play, family-centred care

1. Introduction

Children's healing spaces are more than just a "place" where they can receive medical treatment (Eisen et al., 2008). Pediatric healthcare facilities are diverse and complex environments in which technologies and a variety of users, including patients, families, and staff, interact regularly. Such involvement is remarkable in the sense that care and technologies, as well as patients' requirements, vary over time but are prone to change, putting a strain on the built environment (Elf et al., 2020). Children might experience anxiety, and stress, as a result of their interaction with the environments where they get care, which may leave a lasting impression on them (Eisen et al., 2008). Young children experience significant concerns and anxiety during their hospitalisation. Separation from family and friends, staying in an unpleasant and unfamiliar medical environment, and losing their autonomy can all have short- and long-term effects on a child's life (Babbu &

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Haque, 2022; Downing et al., 2014; Sherman et al., 2005b). For children and their families, adjusting to a new environment is a vital component of visiting a hospital. While the aspect of a hospital's environment may not be the direct cause of an individual's anxiety, it may amplify or lessen the harmful effects of psychological strain (Lim et al., 2019).

Pediatric healthcare facilities must put considerable thought than ordinary hospitals to address the unique requirements of hospitalised children (Lim et al., 2019; Nourmusavi Nasab et al., 2020). Because of the difficulty of keeping children's attentiveness for a long time, positive distraction is crucial to take into account in pediatric healthcare facilities (Bishop, 2012). Colour and lighting are ways to make a space look more appealing. Certain colours, such as mid-blue tones, can have a relaxing impact on children (Park, 2009). Wide areas of red, on the other hand, can overexcite worried patients when utilised as a wall or floor covering.

When it comes to creating healthcare facilities, healthcare providers, environmental psychologists, consultants, and architects face numerous obstacles (V. Lambert et al., 2014). They must not only examine difficult clinical strategies but also provide a compassionate, therapeutic environment in which patients can heal. The challenge for architects and interior designers is to create a built environment that can help patients feel less anxious. It is critical for architects planning healthcare facilities to address the experiences of sick children and their families while in the hospital, as well as how architecture may influence this experience.

A large body of literature has identified a link between hospital-built environment attributes and the well-being of patients (Babbu & Haque, 2021; Gaminiesfahani et al., 2020; Marquardt et al., 2014). Healthcare facilities have tried to alleviate patient anxiety by making the environment more clean, comfortable, and accessible. Well-designed healthcare environments can aid rehabilitation and reduce hospital stays. Healthcare environments must be adaptive to the evolution of the healthcare system; this necessitates the ability to consistently contribute the latest understanding regarding the impact of specific design solutions on health outcomes (Brambilla et al., 2019; Seyedahmadi, 2019). It has been claimed that a nice physical environment can improve a person's mental state health by diverting their attention away from their anxiety. Hospitals, as Ulrich et al. (2001) point out, frequently build functionally effective but psychologically harsh facilities. It's also been argued that the more appealing the built environment is, the more likely individuals are to respond emphatically to it (Lim et al., 2019).

Though the number of empirical research demonstrating the effects of healing space design on users is increasing, it lacks methodological rigour. The challenge of thoroughly analysing the impact of layout on health experience is one of the major reasons for this limitation. Moreover, the majority of these studies have been conducted in adult healthcare facilities in developed countries. Studies on the impact of the built environment on paediatric healthcare settings are rare, and only a few have been undertaken in developing nations such as India. The goal of this study is to offer a thorough grasp of surrounding factors that influence children's healing. The key findings from the literature are presented in (Table 1).

Table 1: Summary of findings from relevant literature

Attributes	Key findings	Author
Barrier-free environment	Children prefer a barrier-free environment with plenty of natural light. The ramp should be so gradual that its slope should be barely noticeable.	Nourmusavi et al. (2020)
Drawing & artwork	Art is a key attribute, which entertains, distracts, and engages young people. Augmented environments are helpful in pediatric rehabilitation.	Bishop (2012); Chau et al. (2006)
	Children prefer artwork, thematic design, wall murals and interactive ponds.	Eisen et al. (2008); Pearson et al. (2019)
	Artwork, plants, and trees are more appealing to children.	Tivorsak et al. (2004)
Spatial layout	**The large atrium is perceived as an inviting space**	**Adams et al. (2010)**
	Hospital entrances should be beautiful and welcoming.	**Coad & Coad (2008)**
	Emotional well-being and development are aided by good physical and aesthetic design.	Koller & McLaren (2014)
	Children prefer hospital settings as bright, joyful, and spacious.	Lambert et al. (2014)
Light & ventilation	Children prefer plenty of natural light in patient rooms. Light levels are essential for human function and can be incredibly useful to both patients and healthcare workers.	Coad & Coad (2008); Kotzer et al. (2011)
	Patient perceptions of discomfort and anxiety can be influenced by illumination.	Robinson & Green (2015)
Family support	children want parents to be near their beds. It's critical to create environments where patients and their families can be fully integrated into the healthcare team.	Nourmusavi et al. (2020); Kotzer et al. (2011)
Wayfinding	Signages and landmarks are helpful in navigation	Adams et al. (2010)
	Virtual reality is a popular wayfinding tool, while mobile applications are more useful as navigational aids.	Wolitzky et al. (2005)
	Complex floor plans, inadequate lighting and inappropriate colour contribute to poor wayfinding.	(Huisman et al., 2012)
Nature & outdoors	Barriers to garden visitation include a lack of knowledge of the garden, poor quality of seats and poor shades.	Pasha (2013), Jiang (2020)
	Gardens with facilities for children, such as child-size chairs, play areas, and sculptors, witnessed higher levels of physical activity and longer visits to the garden.	Pasha & Shepley (2013); Reeve et al. (2017); Sherman et al. (2005a)
	Garden helps calm down and deal with stressful working conditions.	Whitehouse et al. (2001)
Play opportunities	Interactive media & aquariums provide play opportunities and controlled the infection.	(Biddiss et al., 2013, 2019)
	DVD players, photographs, movies, games, and music are all popular among kids.	Lambert et al. (2014)
Anxiety and discomfort	Children experience anxiety in an unfamiliar hospital environment.	Clift et al. (2007)
	Anxiety and discomfort are substantially reduced when children are offered to watch animated cartoons.	Lee et al. (2012)

Caregivers' satisfaction	Caregivers of children with special health needs require assistance to improve self-efficacy.	(Ronan et al., 2020)
	Staff amenities, such as a staff lounge with comfortable chairs and TVs, and access to outdoor landscaped areas, can give great relief from the normal routine.	Kotzer et al. (2011)
Colour	Children prefer blue and green colours. Textures with metal glitters, patterns, stars, and striped material are popular options.	Coad & Coad (2008); Corsano et al. (2015)
	Children prefer a bright environment	Gibson & Nelson (2009)
	Blue and green are preferred colours among children. Girls prefer purple and red.	Park (2009)
Noise	Youth prefer to keep the baby ward away from older children due to noise.	Birch et al. (2007)
	Noise is a major source of concern in children's hospitals. Noise reduction has been proven to lower heart rates, increase time spent in normal sleep, and boost oxygen saturation.	Kotzer et al. (2011)
Patient Safety	Patient falls can be avoided by enhancing the design and availability of assistive devices.	Koller & McLaren (2014)
Privacy	Children hate to be treated in shared rooms.	Gibson & Nelson (2009)
	They prefer attached bathrooms with a curtain separating the toilet. Children's hospitals must be designed not just child-friendly, but also to protect their privacy and dignity.	Hutton (2005); Lambert et al. (2014)

2. Methods

This research used an empirical methodology because it was exploratory. According to Tortorella et al. (2022), empirical research is a good technique to learn things through direct or indirect experience or observation. The survey method is a popular choice among the available data collection technique for empirical research because of its many benefits, including its high level of representativeness, low cost, possible statistical significance, and uniform stimulation for all respondents (Chinelo Igwenagu, 2016).

2.1 Sample

A total of 231 participants, including doctors (n=48), nurses (n=57), healthcare architects (n=63), professors at architectural institutes (n=35), Research fellows (n=2), and PhD scholars working in healthcare (n=26), completed the questionnaire. The participants were selected at random from stand-alone pediatric hospitals, general hospitals with pediatric departments, private clinics of paediatricians, and academics from institutes imparting healthcare architecture courses in India.

2.2 Healthcare Questionnaire

The questionnaire items were created in two steps. From a review of the literature, we first determined the most important aspects of a pediatric healthcare-built environment. There were 45 elements found, which were divided into fourteen categories: (1) Barrier-free environment promoting better interaction with peers (2) Use of drawings and artwork for psychological and emotional support (3) Clear spatial layout, the network of corridors and clearly defined zones for the patient, family, and staff (4) Natural light and outside view through window (5) Adequate family support in family rooms (6) Wayfinding, signages and visual maps (7) Access to nature and outdoors (8) Adequate play opportunities and activity areas for children (9) Anxiety and discomfort (10) Caregivers' effectiveness and efficiency (11) Colour, texture, finish, and décor based on evolving needs of children (12) Inside and outside noise (13) Safety in rooms (14) Privacy and right to dignity (Table 2).

The scaling of items was done in the second phase. In this study, the questionnaires were scored on a five-point Likert scale. Strongly disagree (1), disagree (2), neutral (3), agree (4) and strongly agree (5).

The questionnaire was reviewed by a group of six experts, including professors (n=2), doctors (n=2), and healthcare professionals (n=2), to ensure the questionnaire's relevance, clarity, and coverage of items. Based on the feedback of the experts, the questionnaire was modified.

3. Analysis

An exploratory factor analysis was conducted using Principal Component Analysis in pediatric healthcare facilities in National Capital Region (NCR), India. Principal Component Analysis (PCA), is a dimensionality reduction technique, frequently used to reduce the dimensionality of big data sets by condensing a large collection of variables into a smaller set that still retains most of the data in the larger set. It is a data-reduction approach that does not make any assumptions about the underlying construct (Knekta et al., 2019). PCA condenses many observed variables into a smaller number of components that explain the most variance. The number of factors in the PCA solution is determined using several rules: (a) the items having eigenvalue of one or more are employed and the cumulative variance is determined, according to Kaiser's criteria (Tapia, 2001); (b) factors over the point where the scree plot becomes flat are retained (Weis & Schank, 2009); and (c) the result makes theoretical sense (Newton et al., 2010; Recio-Saucedo et al., 2018). For each maintained item, a factor loading of 0.40 is considered as a criterion.

The Statistical Package for the Social Science (SPSS; version 22) was used for all analyses. On the healthcare questionnaire, missing data were not imputed and the scale creators 'recommendation to eliminate scores for missing data was followed. PCA with varimax rotation was chosen for exploratory factor analysis.

3.1 Construct Validity and reliability

Cronbach's alpha and mean inter-item correlations were used to assess the internal consistency reliability of each scale. Internal consistency dependability refers to how well all of the items on a (sub)scale measure the same idea, and it's usually measured using

Cronbach's coefficient (ranging from 0 to 1) (Bijttebier et al., 2000; Rezaei et al., 2021). The Kaiser-Meyer-Oklin (KMO) index of sampling adequacy was used to determine whether the scale items had enough correlation to support factor analysis (Yip et al., 2003). The Bartlett test of sphericity was also used to see if the correlation matrix was an identity matrix, making factor analysis unfeasible (Carmassi et al., 2021).

Table 2: Design attributes for Pediatric healthcare, its mean & standard deviation

Item number	Description	Mean	SD	Cronbach α
1	Barrier-free environment promotes better interaction with peers	4.22	0.43	0.916
2	Use of drawings and artwork for psychological and emotional support	4.37	0.54	0.918
3	Clear spatial layout, a network of corridors and clearly defined zones for patient, family, and staff	4.08	0.61	0.915
4	Natural light and outside view through the window	4.18	0.62	0.916
5	Adequate family support in family rooms	4.11	0.70	0.916
6	Wayfinding, signages and visual maps	4.31	0.60	0.915
7	Access to nature and outdoors	4.50	0.55	0.921
8	Adequate play opportunities and activity areas for children	4.54	0.48	0.916
9	Anxiety and discomfort	3.80	0.84	0.916
10	Caregivers' effectiveness and efficiency	4.48	0.57	0.916
11	Colour, texture, finish, and décor based on evolving needs of children	4.48	0.56	0.916
12	Inside and outside noise	4.20	0.61	0.915
13	Safety in rooms	4.15	0.69	0.916
14	Privacy and right to dignity	4.36	0.56	0.916

4. Results

Out of 231 participants, 224 participants were eligible for inclusion in the factor analysis (i.e., they responded to all items of the questionnaire).

The KMO test confirmed sampling adequacy, KMO= 0.822, which is higher than the acceptable limit of 0.5 (Lum et al., 2020). The Bartlett's test of sphericity was significant, $\chi^2 = 4135.72$, $p < .001$, indicating that there was enough variance in the data to analyze. PCA was performed after Bartlett's test of sphericity and KMO measure both yielded significant results. Factors having an eigenvalue greater than one was used for the Varimax rotation. The internal consistency was satisfactory with Cronbach's alpha coefficient of 0.92.

The inter-item correlation coefficient of all fourteen attributes is presented in Table 3. The number of possible factors was not constrained in the PCA which yielded 4-factors with eigenvalues over one, explaining 78.14% of the cumulative data variance (Table 4). This is also supported by scree plot examination (See Figure 1). The rotated factor matrix revealed that all item loadings on one factor were higher than 0.4, which was considered acceptable for attributing an item to a specific factor (Yip et al., 2003). The factor

correlation matrix of the rotated pediatric healthcare design attributes is presented in Table 4.

Table 3: Inter-item correlation coefficient of pediatric healthcare design factors questionnaire

Attributes	Barrier-free environment	Drawing & artwork	Spatial layout	Light & ventilation	Family support	Wayfinding	Nature & outdoors	Play opportunities	Anxiety and discomfort	Caregivers' satisfaction	Colour	Noise	Safety in rooms	Privacy
Barrier-free environment	1.00	.45	.54	.53	.46	.38	.37	.50	.54	.62	.62	.54	.46	.38
Drawing & artwork		1.00	.38	.49	.47	.43	.31	.55	.39	.45	.46	.47	.44	.38
Spatial layout			1.00	.35	.56	.43	.47	.57	.58	.51	.52	.35	.56	.42
Light & ventilation				1.00	.42	.53	.35	.44	.53	.34	.34	.99	.387	.48
Family support					1.00	.49	.41	.36	.50	.32	.32	.42	.95	.45
Wayfinding						1.00	.32	.51	.50	.45	.45	.54	.46	.91
Nature & outdoors							1.00	.42	.28	.37	.37	.36	.40	.28
Play opportunities								1.00	.47	.72	.71	.45	.37	.47
Anxiety and discomfort									1.00	.48	.48	.54	.49	.46
Caregivers' satisfaction										1.00	1.00	.35	.33	.41
Colour											1.00	.35	.34	.41
Noise												1.00	.40	.45
Safety in rooms													1.00	.44
Privacy														1.00

Table 4: Varimax rotation loadings of pediatric healthcare design attributes (N=224)

Attribute number-Description	Loadings				
	Factor1	Factor2	Factor3	Facor4	Communality
3- Clear spatial layout, the network of corridors and clearly defined zones for patient, family, and staff	0.93	0.14	0.11	0.18	0.66
1- Barrier-free environment promoting better interaction with peers	0.93	0.14	0.24	0.18	0.46
6- Wayfinding, signages and visual maps	0.74	0.20	0.45	0.27	0.66
7- Access to nature and outdoors	0.57	0.36	0.45	0.01	0.97
11- Colour, texture, finish, and décor based on evolving needs of children	0.11	0.91	0.15	0.23	0.92
4 - Natural light and outside view through the window	0.09	0.90	0.19	0.25	0.94
12- Inside and outside noise	0.50	0.61	0.11	0.16	0.41

5- Adequate family support in family rooms	0.35	0.48	0.23	-0.02	0.72
8- Adequate play opportunities and activity areas for children	0.16	0.18	0.93	0.23	0.54
2- Use of drawings and artwork for psychological and emotional support	0.16	0.18	0.92	0.24	0.93
10- Caregivers' effectiveness and efficiency	0.38	0.41	0.41	0.26	0.93
13- Safety in patient rooms	0.40	0.32	0.41	0.17	0.96
14- Privacy and right to dignity	0.22	0.21	0.23	0.89	0.91
9- Anxiety and discomfort	0.25	0.24	0.27	0.87	0.93
Eigenvalue	7.04	1.51	1.43	1.16	
Cumulative variance explained in %	24.80	45.33	63.72	78.14	

The following inferences are drawn based on the various factor loadings received.

The eigenvalue of factor-1 was 7.04, accounting for 24.80% of the variance. It contained items related to the clear spatial layout and clearly defined zones for patients, family & staff (0.93), barrier-free environment (0.93), wayfinding, signage, and visual maps (0.74), and access to nature and outdoors (0.57). This factor is named "Child-centred design of hospital".

The eigenvalue of factor 2 was 1.51, accounting for 20.53% of the variance. It contained items related to the colour, texture, finish, and décor (0.91), natural light and outside view through window (0.90), Inside and outside view (0.61), and adequate family support in family rooms (0.48). This factor is termed "Indoor ambient environment quality".

The eigenvalue of factor 3 was 1.43, accounting for 18.39% of the variance. It contained items related to the play opportunities and activity areas for children (0.93), the use of drawings and artwork (0.92), caregivers' effectiveness and efficiency (0.41), and safety in patient rooms (0.41). This factor is termed "Positive distraction".

The eigenvalue of factor 4 was 1.16, accounting for 14.42% of the variance. It contained items related to safety in patient rooms (0.89), and anxiety and discomfort (0.87). This factor is named a "Sense of autonomy and control".

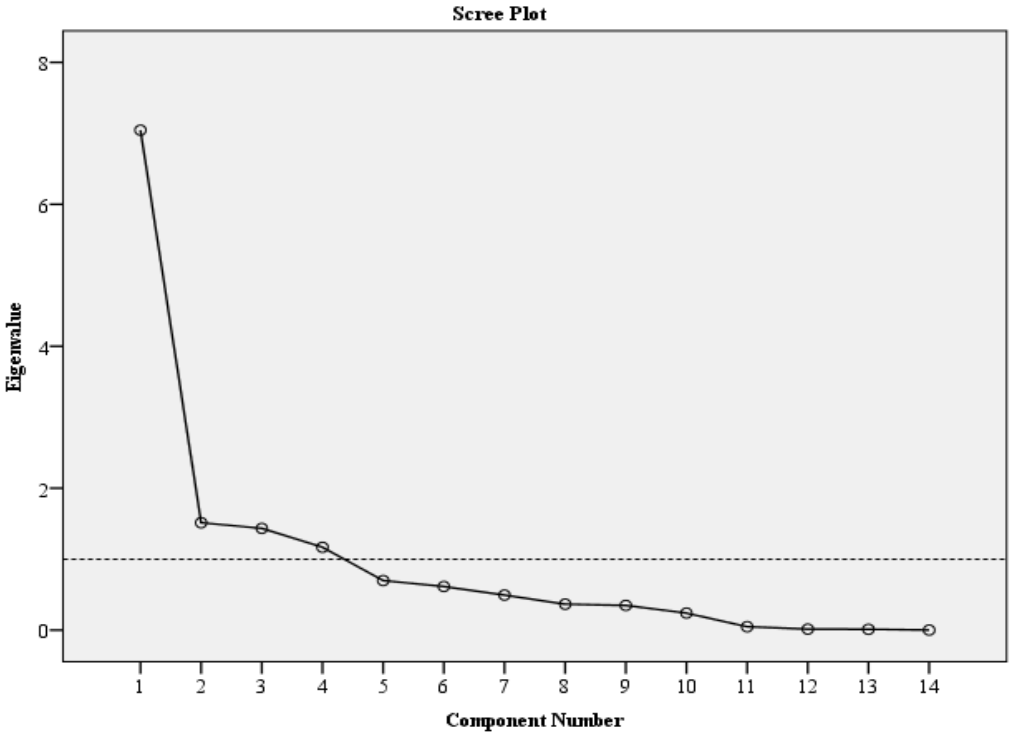
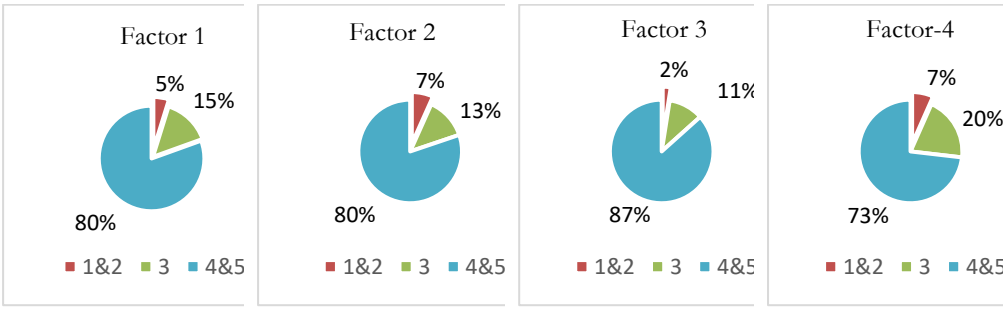


Figure 2: Pediatric healthcare design attributes items Scree Plot analysis.

The 5-point Likert scale used in this study has response options 1= strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree. The total disagreement is the sum of response 1&2, response # 3 remains neutral and the total agreement is the sum of response 4&5. The frequency of responses for all four factors is shown in Figure 3. It is evident that 5% of the respondents are not comfortable with factor 1: "Child-centred design of hospital"; 7% of the respondents are not comfortable with factor 2: "Indoor ambient environment quality"; 2% of the respondents are not comfortable with factor 3: "Positive distraction" and 7% of the respondents are not comfortable with factor 4: "Sense of autonomy and control" (Figure 3).



(A) (B) (C) (D)

Figure 3: Pie chart showing frequency of responses (in %) for factor 1, 2,3 & 4

5. Discussions

The features affecting the pediatric built environment were investigated using PCA. The items were empirically tested using PCA, and the components were developed as a result. The built-environment questionnaire revealed four reliable and correlated factors that influence pediatric healthcare design. The factor solutions were analysed and appropriate names for the factors were chosen for the factors and items that made empirical and theoretical sense. The amount of variance described by the whole solution and the factors, factor correlations, coefficients, communality values and the amount of variance explained by the whole solution and the factors are all useful sources of information.

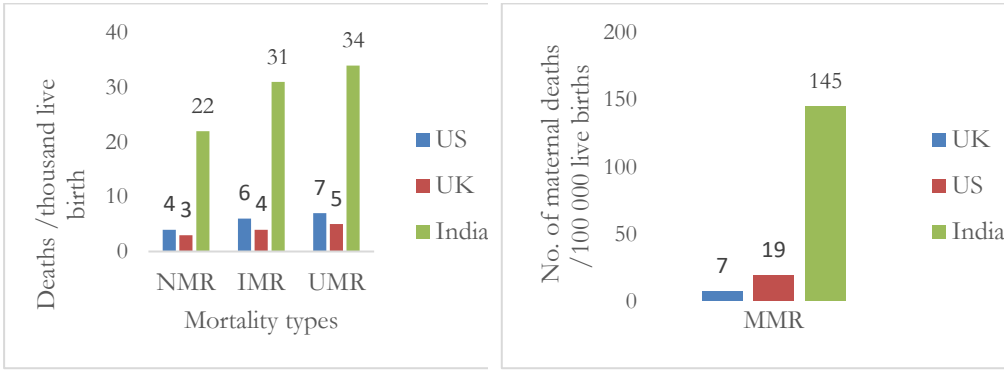
The optimum sample size for factor analysis is a complex issue. The large body of literature on factor analysis state that larger sample sizes are better in general since they improve the accuracy of all estimations and statistical power (Knekta et al., 2019). According to Budaev (2010), the minimum sample size is 100, although others typically require a much greater sample size. The minimum number of samples (n) for factor analysis with (y) number of variables, according to Banerji (2016), should be greater than 30+(y+3)/2. We had a sample size of 224 patients. The factors measure child-centred design characteristics; indoor ambient environmental quality; positive distraction strategies; and a sense of autonomy and control.

Four "child-centred design characteristics" items reflect the clear spatial layout, clearly defined zones, barrier-free environment, wayfinding and signages, and access to nature and outdoors. Four "indoor ambient environmental quality" items represent how participants feel relaxed by colour, texture, natural light, noise, and outside views from a window in a pediatric healthcare setting. Four "positive distraction strategies" items reflect how enhanced psychological and emotional support can be achieved by providing adequate play opportunities and activity areas, and the use of drawings and artwork in childcare facilities. Two "sense of autonomy and control items" reflect the frequency of negative emotions i.e., anxiety and discomfort faced by children in pediatric healthcare facilities. All the factors have good face validity and internal consistency.

The "Goal 3: Good health and well-being" of the Sustainable Development Goals (SDG), aims to ensure healthy lives and promote well-being at all ages. One of the targets of Goal 3 is to reduce the neonatal mortality rate (NMR) and under-5 mortality (UMR) by 12 and 25 per thousand live births respectively by 2030. The other target is to reduce the global maternal mortality ratio (MMR) to less than 70 per 100 000 live births by 2030. Figure 4, compares India's NMR, Infant mortality rate (IMR), UMR and MMR to those of the US and UK and demonstrates the disturbing trends. India has the greatest adolescent population in the world and 39% of the country's population is under the age of 18, India has a significant part to play in lowering the NMR, IMR, UMR and MMR because it has the highest death rate among these groups. The findings of this study, which were conducted in the Indian context, will aid policymakers in bolstering the country's infrastructure for pediatric healthcare, which would ultimately help achieve Sustainable Development Goals.

The findings demonstrate that all four factors derived in this study have a very high level of agreement among respondents. Factor 3 has the highest level of agreement (87%),

followed by factors 1 and 2 (each at 80%), and factor 4 (73%) (Figure 3). By incorporating "Positive distraction" strategies i.e., use of colourful drawings, artwork, audio & video distraction strategies like music, television, aquariums, virtual ponds etc.; "Child-centred design of hospital" i.e., child-sized furniture, clearly defined zones for children's, barrier-free environment etc; "Indoor ambient environment quality" i.e. colour, natural lighting, outside views; and "Sense of autonomy and control" i.e. providing opportunities to control immediate environments like window openings, air-conditioning control etc; the anxiety and stress of the pediatric patients can be greatly reduced which in turn would increase health outcomes and decrease the length of stay in hospital.



(A) (B)

Figure 4: (A)Comparison of mortality rates (2019); (B) comparison of MMR (2017). source: WHO

6. Conclusions

The goal of this study was to gain a better knowledge of the various built-environment characteristics that are associated with establishing a sense of confidence and faith in pediatric patients, as well as familiarising patients and their relatives with the hospital's working system and treatment process.

PCA revealed four new constructs: child-centred design characteristics; indoor ambient environmental quality; positive distraction strategies; a sense of autonomy and control. The four identified factors, showed high reliability and face validity, indicating that they reflect current concepts and theories. The generalizability of this study's findings will be enhanced if they are replicated with different ethnic groups. The following strategies should be implemented at the planning and design stages of pediatric healthcare facilities.

- To create physical settings in pediatric care that allow children and their families to feel at ease and involved while receiving care and socialising.
- To design children's healthcare facilities to be more spacious, flexible and child-friendly that look like non-institutional in character considering the developing needs of the children. For patients' navigation, smooth and free-flowing childcare spaces are quite effective.

- To design hospital entrances as inviting, clean & welcoming, and corridors should be simple with improved signposting such as coloured arrows or footprints. Wall maps, signages, landmarks and artwork are effective tools for navigation.
- Children care facility planners should consider the impact of designing pediatric healthcare facilities on patient outcomes as suggested by a large body of literature. Designers should involve and integrate children as major stakeholders in the design of pediatric healthcare environments.
- To provide colour, finishes and décor of childcare facilities based on age-associated characteristics to promote patient well-being by reducing stress and negative feelings. Textures with metal glitter, pattern, and stars are quite preferable.
- To use of blue and green colours in pediatric healthcare facilities is preferred by both inpatient and outpatient children of both gender groups.
- To provide music and illumination that might work well as fun activities and diversions. Plenty of natural light and a barrier-free environment in childcare areas are associated with reducing stress and discomfort among pediatric patients.
- To provide hospital gardens visible and easily accessible to all. Healing gardens are highly beneficial and have a positive impact on health outcomes. Providing windows in patient rooms with outside views of natural elements, landscaped gardens and greenery has restorative qualities and is an effective way of positive distraction.
- To promote garden use providing play features, sculptures, water fountains, child-sized comfortable furniture, greenery and adequate shading, socialisation space for parents is quite effective.
- To include thematic design containing views of water, beach, and undersea environment diverse range of natural and representational art images providing a rich source of aesthetic diversity to maintain a positive attitude in children.
- The design of the spaces should encourage children to play and hide scary medical equipment & supplies.
- To provide shared resources of play in waiting and common areas i.e., interactive media, aquariums, nature videos, and play opportunities for children with disabilities as a positive distraction strategy.
- To minimise cross-transmission of infection through handheld toys, books, and traditional shared play options; the installation of interactive media/ virtual play systems in waiting rooms or common areas is an effective intervention.
- To provide spaces for social interaction for both children and adults so that children can interact with family and peers while maintaining privacy. In paediatric healthcare environments, designers can concentrate on creating shared activity spaces where patients can engage with their peers and friends.
- To provide childcare environments that support personalisation and customisation of patient areas in terms of control of lighting/daylighting level, music, and television.

Given the importance of pediatric built-environment elements in patient recovery and a positive patient health outcome, more research is needed to identify additional factors. Further study is required to replicate this factor analysis in different healthcare settings.

References

Adams, A. … McKeever, P. (2010). Kids in the atrium: Comparing architectural intentions and children's experiences in a pediatric hospital lobby. *Social Science & Medicine*, *70*(5), 658–667. https://doi.org/10.1016/j.socscimed.2009.10.049

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). https://doi.org/10.14456/ITJEMAST.2021.240

Babbu, A. H., & Haque, M. (2022). A framework for the design of pediatric healthcare environment using the Delphi technique. *Ain Shams Engineering Journal*, 101975. https://doi.org/10.1016/j.asej.2022.101975, URL: https://linkinghub.elsevier.com/retrieve/pii/S2090447922002866

Banerji, H. (2016). An attempt to explore components of empathic architecture in hospitals – a study of Indian hospitals. *Journal of Architecture and Urbanism*, *40*(1), 8–17. https://doi.org/10.3846/20297955.2016.1150220

Biddiss, E. … McPherson, A. (2019). Positive Distraction in Pediatric Healthcare Waiting Spaces: Sharing Play Not Germs through Inclusive, Hands-Free Interactive Media. *Developmental Neurorehabilitation*, *22*(7), 445–452. https://doi.org/10.1080/17518423.2018.1518351

Biddiss, E. … McKeever, P. (2013). The Design and Testing of Interactive Hospital Spaces to Meet the Needs of Waiting Children. *HERD: Health Environments Research & Design Journal*, *6*(3), 49–68. https://doi.org/10.1177/193758671300600305

Bijttebier, P. … Vertommen, H. (2000). Reliability and validity of the critical care family needs inventory in a Dutch-speaking Belgian sample. In *Heart and Lung: Journal of Acute and Critical Care* (Vol. 29, Issue 4, pp. 278–286). https://doi.org/10.1067/mhl.2000.107918

Birch, J. … James, A. (2007). Sense and Sensibilities: In Search of the Child-Friendly Hospital. *Built Environment*, *33*(4), 405–416. https://doi.org/10.2148/benv.33.4.405

Bishop, K. (2012). The Role of Art in a Paediatric Healthcare Environment from Children's and Young People's Perspectives. *Procedia - Social and Behavioral Sciences*, *38*, 81–88. https://doi.org/10.1016/j.sbspro.2012.03.327

Brambilla, A. … Capolongo, S. (2019). Evidence Based Hospital Design. A literature review of the recent publications about the EBD impact of built environment on hospital occupants' and organizational outcomes. In *Annali di Igiene Medicina Preventiva e di Comunita* (Vol. 31, Issue 2, pp. 165–180). https://doi.org/10.7416/ai.2019.2269

Budaev, S. V. (2010). Using Principal Components and Factor Analysis in Animal Behaviour Research: Caveats and Guidelines. *Ethology*, *116*(5), 472–480. https://doi.org/10.1111/j.1439-0310.2010.01758.x

Carmassi, C. … Buselli, R. (2021). Validation of the Italian version of the peritraumatic distress inventory: validity, reliability and factor analysis in a sample of healthcare workers. *European Journal of Psychotraumatology*, *12*(1). https://doi.org/10.1080/20008198.2021.1879552

Chau, T. … Tam, C. (2006). Augmented environments for pediatric rehabilitation. *Technology and Disability*, *18*(4), 167–171. https://doi.org/10.3233/TAD-2006-18402

Chinelo Igwenagu. (2016). Fundamentals of Research Methodology and Data Collection. *LAP Lambert Academic Publishing*, *May*, 4–5. https://www.researchgate.net/publication/303381524_Fundamentals_of_research_methodology_and_data_collection#:~:text=1.1 Methodology is the systematic,a branch of knowledge., URL: https://www.researchgate.net/publication/303381524_Fundamentals_of_research_methodology_and_data_collection#:~:text=1.1 Methodology is the systematic,a branch of knowledge.

Clift, L. … Timmons, S. (2007). Adolescents' experiences of emergency admission to children's wards. *Journal of Child Health Care*, *11*(3), 195–207. https://doi.org/10.1177/1367493507079561

Coad, J., & Coad, N. (2008). Children and young people's preference of thematic design and colour for their hospital environment. *Journal of Child Health Care*, *12*(1), 33–48. https://doi.org/10.1177/1367493507085617

Corsano, P. … Izzi, G. (2015). The waiting room as a relational space: young patients and their families' experience in a day hospital. *Child: Care, Health and Development*, *41*(6), 1066–1073. https://doi.org/10.1111/cch.12239

Downing, J. … Fleming, E. (2014). Children's palliative care: Considerations for a physical therapeutic environment. In *Journal of Palliative Care* (Vol. 30, Issue 2, pp. 116–124). https://doi.org/10.1177/082585971403000207

Eisen, S. L. … Sherman, S. (2008). The stress-reducing effects of art in pediatric health care: art preferences of healthy children and hospitalized children. *Journal of Child Health Care*, *12*(3), 173–190. https://doi.org/10.1177/1367493508092507

Elf, M. … Ulrich, R. S. (2020). The built environment and its impact on health outcomes and experiences of patients, significant others and staff—A protocol for a systematic review. *Nursing Open*, *7*(3), 895–899. https://doi.org/10.1002/nop2.452, URL: https://onlinelibrary.wiley.com/doi/10.1002/nop2.452

Gaminiesfahani, H. … Tucker, R. (2020). A Scoping Review of the Impact on Children of the Built Environment Design Characteristics of Healing Spaces. *HERD: Health Environments Research & Design Journal*, *13*(4), 98–114. https://doi.org/10.1177/1937586720903845

Gibson, C., & Nelson, K. (2009). Obtaining adolescents' views about inpatient facilities using conjoint analysis. *Paediatric Care*, *21*(2), 34–37.

Huisman, E. R. C. M. … Kort, H. S. M. (2012). Healing environment: A review of the impact of physical environmental factors on users. *Building and Environment*, *58*, 70–80. https://doi.org/10.1016/j.buildenv.2012.06.016

Hutton, A. (2005). Consumer perspectives in adolescent ward design. *Journal of Clinical Nursing*, *14*(5), 537–545. https://doi.org/10.1111/j.1365-2702.2004.01106.x

Jiang, S. (2020). Positive Distractions and Play in the Public Spaces of Pediatric Healthcare Environments: A Literature Review. *HERD: Health Environments Research & Design Journal*, *13*(3), 171–197. https://doi.org/10.1177/1937586720901707

Knekta, E. … Eddy, S. (2019). One size doesn't fit all: Using factor analysis to gather validity evidence when using surveys in your research. In *CBE Life Sciences Education* (Vol. 18, Issue 1). https://doi.org/10.1187/cbe.18-04-0064

Koller, D., & McLaren, C. (2014). Children's Emotional Responses to a Paediatric Hospital Atrium. *Children & Society*, *28*(6), 451–464. https://doi.org/10.1111/chso.12002

Kotzer, A. 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. https://doi.org/10.1177/193758671100400405

Lambert, V. … Glacken, M. (2014). Social spaces for young children in hospital. *Child: Care, Health and Development*, *40*(2), 195–204. https://doi.org/10.1111/cch.12016

Lambert, Veronica … Glacken, M. (2014). Young children's perspectives of ideal physical design features for hospital-built environments. *Journal of Child Health Care*, *18*(1), 57–71. https://doi.org/10.1177/1367493512473852

Lee, J. … Ko, S. (2012). Cartoon Distraction Alleviates Anxiety in Children During Induction of Anesthesia. *Anesthesia & Analgesia*, *115*(5), 1168–1173. https://doi.org/10.1213/ANE.0b013e31824fb469

Lim, B. … Sebire, N. (2019). Designing to Distract:Can Interactive Technologies Reduce Visitor Anxiety in a Children's Hospital Setting? *ACM Transactions on Computer-Human Interaction*, *26*(2), 1–19. https://doi.org/10.1145/3301427

Lum, M. … Meuter, R. (2020). Healthcare communication distress scale: Pilot factor analysis and validity. *Patient Education and Counseling*, *103*(7), 1302–1310. https://doi.org/10.1016/j.pec.2020.02.010

Marquardt, G. … Motzek, T. (2014). Impact of the Design of the Built Environment on People with Dementia: An Evidence-Based Review. *HERD: Health Environments Research & Design Journal*, *8*(1), 127–157. https://doi.org/10.1177/193758671400800111

Newton, J. M. … Cross, W. M. (2010). Clinical Learning Environment Inventory: factor analysis. *Journal of Advanced Nursing*, *66*(6), 1371–1381. https://doi.org/10.1111/j.1365-2648.2010.05303.x

Nourmusavi Nasab, S. … Mirbazel, S. (2020). Ideal physical features of environmental design in children's hospital. *Facilities*, *38*(5/6), 445–466. https://doi.org/10.1108/F-03-2019-0032

Park, J. G. (2009). Color Perception in Pediatric Patient Room Design: Healthy Children vs. Pediatric Patients. *HERD: Health Environments Research & Design Journal*, *2*(3), 6–28. https://doi.org/10.1177/193758670900200302, URL: http://journals.sagepub.com/doi/10.1177/193758670900200302

Pasha, S. (2013). Barriers to Garden Visitation in Children's Hospitals. *HERD: Health Environments Research & Design Journal*, *6*(4), 76–96. https://doi.org/10.1177/193758671300600405

Pasha, S., & Shepley, M. M. (2013). Research note: Physical activity in pediatric healing gardens. *Landscape and Urban Planning*, *118*, 53–58. https://doi.org/10.1016/j.landurbplan.2013.05.005

Pearson, M. … Adams, N. G. (2019). The Physiological Impact of Window Murals on Pediatric Patients. *HERD: Health Environments Research & Design Journal*, *12*(2), 116–129. https://doi.org/10.1177/1937586718800483

Recio-Saucedo, A. … Schmidt, P. (2018). Relationships between healthcare staff characteristics and the conduct of vital signs observations at night: Results of a survey and factor analysis. *Nursing Open*, *5*(4), 621–633. https://doi.org/10.1002/nop2.179

Reeve, A. … 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. https://doi.org/10.1016/j.ufug.2017.05.013

Rezaei, M. … Mahdiraji, H. A. (2021). Key indicators of ethical challenges in digital healthcare: A combined Delphi exploration and confirmative factor analysis approach with evidence from Khorasan province in Iran. *Technological Forecasting and Social Change*, *167*, 120724. https://doi.org/10.1016/j.techfore.2021.120724

Robinson, P. S., & Green, J. (2015). Ambient Versus Traditional Environment in Pediatric Emergency Department. *HERD: Health Environments Research & Design Journal*, *8*(2), 71–80. https://doi.org/10.1177/1937586714566412

Ronan, S. … Marsh, L. (2020). Parents' experiences of transition from hospital to home of a child with complex health needs: A systematic literature review. *Journal of Clinical Nursing*, *29*(17–18), 3222–3235. https://doi.org/10.1111/jocn.15396, URL: https://onlinelibrary.wiley.com/doi/10.1111/jocn.15396

Seyedahmadi, S. (2019). Role of Natural Elements in Provision of Healing Environment: Sustainable Healthcare Building. In *European Journal of Sustainable Development* (Vol. 8, Issue 1). https://doi.org/10.14207/ejsd.2019.v8n1p401

Sherman et al. (2005a). Children's Environments and Health-Related Quality of Life- Evidence Informimg Paediatric Healthcare Environmental Design. *Children, Youth and Environments*.

Sherman, S. A. … Malcarne, V. L. (2005b). Post-occupancy evaluation of healing gardens in a pediatric cancer center. *Landscape and Urban Planning*, *73*(2–3), 167–183. https://doi.org/10.1016/j.landurbplan.2004.11.013

Tapia, M. (2001). Measuring Emotional Intelligence. *Psychological Reports*, *88*(2), 353–364. https://doi.org/10.2466/pr0.2001.88.2.353

Tivorsak, T. L. … Slap, G. B. (2004). Are Pediatric Practice Settings Adolescent Friendly? An Exploration of Attitudes and Preferences. *Clinical Pediatrics*, *43*(1), 55–61. https://doi.org/10.1177/000992280404300107

Tortorella, G. L. … Narayanamurthy, G. (2022). Measuring the effect of Healthcare 4.0 implementation on hospitals' performance. *Production Planning & Control*, *33*(4), 386–401. https://doi.org/10.1080/09537287.2020.1824283

Ulrich, R. S. (2001). Effects of Healthcare Environmental Design on Medical Outcomes. In *Effects Healthcare Environmental Design Medical Outcomes* (pp. 49–59).

Weis, D., & Schank, M. J. (2009). Development and Psychometric Evaluation of the Nurses Professional Values Scale—Revised. *Journal of Nursing Measurement*, *17*(3), 221–231. https://doi.org/10.1891/1061-3749.17.3.221

Whitehouse, S. … Mehlenbeck, R. s. (2001). Evaluating a Children's Hospital Garden Environment : Utilization and Consumer Satisfaction. *Journal of Environmental Psychology*, *21*(3), 301–314. https://doi.org/10.1006/jevp.2001.0224

Wolitzky, K. … Rothbaum, B. O. (2005). Effectiveness of virtual reality distraction during a painful medical procedure in pediatric oncology patients. *Psychology & Health*, *20*(6), 817–824. https://doi.org/10.1080/14768320500143339

Yip, M. P. … MacKenzie, A. E. (2003). Development of the Telemedicine Satisfaction Questionnaire to evaluate patient satisfaction with telemedicine: a preliminary study. *Journal of Telemedicine and Telecare*, *9*(1), 46–50. https://doi.org/10.1258/135763303321159693