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Healing Architecture and Lighting Optimization in Children's Mental Health Clinics: A Systematic Literature Review

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Abstract

Children's mental health facilities are increasingly expected to provide environments that support psychological recovery in addition to clinical treatment. However, existing healthcare design standards remain largely focused on functional and technical requirements, with limited guidance on child-centred healing environments. This study aimed to synthesize recent evidence on healing architecture for school-age children (5–11 years), identify measurable lighting design parameters applicable to architectural simulation, and evaluate their relevance within the Indonesian regulatory context. A systematic literature review following the PRISMA 2020 guideline was conducted using the Scopus database, resulting in 40 eligible peer-reviewed studies published between 2021 and 2026. Evidence was narratively synthesized across five themes: child-specific healthcare design, lighting and daylighting, color, acoustics, and integrated indoor environmental quality. The findings indicate that lighting is the most consistently supported environmental factor, followed by color, acoustics, biophilic design, and indoor environmental quality, all of which contribute to emotional regulation, stress reduction, and restorative experiences, particularly among children with autism spectrum disorder and attention-deficit/hyperactivity disorder. Based on this evidence, child-centred recommendations for illuminance, correlated color temperature, color rendering index, and window-to-wall ratio were synthesized and aligned with Indonesian technical standards.

Keywords

Children's Mental Health Clinic, Evidence-Based Design, Healing Architecture, Lighting, Salutogenic Design, Window-to-Wall Ratio.

1. Introduction

Mental health conditions among children represent an increasing global public health concern. Although healthcare facilities have been developed to address these conditions, many care environments continue to adopt institutional clinical models primarily focused on medical functions, which may unintentionally increase anxiety and psychological discomfort among pediatric patients. This highlights that the physical environment of healthcare facilities is not merely a setting for clinical activities but also an active factor influencing psychological and physiological recovery (Jagkson & Prayuti, 2025). In this context, healing architecture has emerged as an evidence-based design approach that intentionally applies physical environmental elements, including lighting, color, materials, acoustics, and connections with nature, to support users' recovery processes (Jablonska & Furmanczyk, 2024; Simonsen et al., 2024). This approach aligns with salutogenic design, which considers the built environment as an active determinant of health rather than a passive container for healthcare services (Younis, 2021).

Children have distinct environmental needs compared with adults due to differences in cognitive development, sensory sensitivity, and behavioral responses to environmental stimuli. Therefore, design evidence derived from adult healthcare settings cannot be directly transferred to pediatric facilities (Babbu & Haque, 2023). This issue is particularly relevant for children with additional vulnerabilities, such as Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD), who demonstrate greater sensitivity to light intensity, color contrast, and noise exposure compared with typically developing children (Nair et al., 2022; Alizadeh et al., 2024; Saavedra-Torres et al., 2026).

Among the elements of healing architecture, lighting plays a critical role because it influences both visual and non-visual aspects of human experience. Visually, lighting affects comfort and clinical task performance, while non-visual effects include regulation of circadian rhythms, mood, and emotional responses (Wu et al., 2023; Meng & Wang, 2025). However, existing healthcare lighting guidelines, including ANSI/IES RP-29-22 in 2022 and Indonesia's SNI 6197 in 2020, remain largely generic and do not specifically address the psychological needs of children with mental health vulnerabilities. Furthermore, existing studies on healing architecture in pediatric healthcare have often focused on general populations, adult healthcare environments, or broad age categories, resulting in limited evidence regarding specific design parameters for school-age children with psychological needs. The lack of integration between scientific evidence and local regulatory frameworks further limits the development of contextually applicable design recommendations in Indonesia.

To address these gaps, this study introduces a novel contribution by synthesizing recent scientific evidence on the application of healing architecture elements in facilities serving school-age children, with particular emphasis on identifying measurable lighting design parameters that can be directly applied in design simulations. This study further bridges scientific findings with Indonesian technical standards and regulations to develop recommendations that are not only evidence-based but also contextually appropriate. This review specifically focuses on children aged 5–11 years. Although the Law of the Republic of Indonesia Number 35 of 2014 on Child Protection defines children as individuals under 18 years of age, this study limits its scope based on developmental differences and environmental requirements across childhood stages. Indonesian public health classifications distinguish toddlers (0–5 years), school-age children (5–11 years), and adolescents (approximately 10–19 years), each with different developmental and environmental needs (Departemen Kesehatan RI, 2009). Therefore, studies focusing on toddlers/neonates or adolescents were excluded to ensure that the synthesized evidence could be translated more precisely into design parameters for school-age children's mental health clinics.

This study aims to map recent scientific evidence from 2021–2026 regarding the application of healing architecture elements, including lighting, color, acoustics, air quality/thermal comfort, and biophilic features, in facilities serving school-age children, including mental health facilities, identify measurable lighting design parameters, such as illuminance, Correlated Color Temperature (CCT), Color Rendering Index (CRI), Window-To-Wall Ratio (WWR), and glare index, from scientific literature and technical standards as direct inputs for simulation processes and evaluate these findings within the framework of Indonesian regulations and standards to develop evidence-based design recommendations that apply to local contexts.

2. Literature Review

2.1. Theoretical Foundations

Healing architecture originates from Evidence-Based Design (EBD), an approach that integrates the best available scientific evidence into architectural decision-making to understand how physical environments influence health outcomes. Within this framework, the built environment is considered an active component of healing rather than merely a passive container for healthcare activities. Younis (2021) proposes that healing environments operate through three interconnected design strategies, namely sensory, spatial, and symbolic dimensions, which collectively determine restorative effectiveness. This perspective reflects the principles of salutogenic design, which positions the physical environment as an active determinant of health and wellbeing.

The relevance of healing architecture has increased alongside the growing demand for more supportive mental healthcare environments. Jablonska and Furmanczyk (2024) argue that psychiatric facilities require a holistic and humanistic design approach to respond to increasing mental health service demands. Similarly, Simonsen et al. (2024) emphasize the role of nature and vitality in inpatient psychiatric spaces, highlighting their contribution to the development of healing environments. From a professional perspective, Cho (2023) found that therapeutic environmental criteria, including lighting and privacy, are recognized as important considerations among architectural designers; however, their implementation remains frequently constrained by budget limitations and regulatory requirements.

Within the framework of healing architecture, lighting is consistently identified as a critical environmental variable because of its dual visual and non-visual effects on human wellbeing. Wu et al. (2023) demonstrate that spatial luminance distribution, rather than average illuminance alone, influences the restorative potential of living environments. In addition, Meng and Wang (2025), through a synthesis of 121 studies, reveal that visual access to nature through windows is consistently associated with positive health outcomes, further supporting the importance of environmental design elements in healthcare settings.

2.2. Developmental Considerations and Age Classification of Pediatric Users

Children represent a heterogeneous population with distinct developmental characteristics and environmental requirements. According to Law Number 35 of 2014 on the Amendment of Law Number 23 of 2002 on Child Protection, a child is defined as an individual under 18 years of age. However, this broad legal definition encompasses multiple developmental stages with substantially different cognitive, sensory, and behavioral needs. Therefore, this review adopts an operational age classification based on the public health categorization used by the Ministry of Health of the Republic of Indonesia and Regulation of the Minister of Health Number 25 of 2014 on Child Health Efforts.

Table 1. Operational age classification adopted in this review

Source	Category	Age Range	Role in This Review
Law Number 35 of 2014 on the Amendment of Law Number 23 of 2002 on Child Protection	Child	0–<18 years	General legal umbrella; not used as the sole operational boundary because it is too broad for specific design needs.
Departemen Kesehatan RI (2009)	Childhood	5–11 years	Core target population of this review (school age).
Regulation of the Minister of Health Number 25 of 2014 on Child Health Efforts	School-age child / Adolescent	>6–<18 years / 10–18 years	Complementary regulatory framework; "school-age child" overlaps with the core 5–11 group.
Ministry of Health adolescent health programme (World Health Organization, 2026)	Early adolescent	10–19 years (early phase 12–16)	Secondary group, excluded from synthesis unless findings are general/age-generalisable.
Departemen Kesehatan RI (2009)	Toddler	0–5 years	Excluded; typically associated with separate early-childhood development services.

Table 1 summarises the age categorisation adopted in this review and establishes school-age children aged 5–11 years as the primary target population because this developmental stage exhibits distinct cognitive, sensory, and environmental characteristics relevant to healthcare design. As healthcare architecture studies rarely provide precise age stratification, many use broad terms such as *child*, *paediatric*, or *children's hospital* that encompass populations from infancy to adolescence (Departemen Kesehatan RI, 2009). Therefore, studies explicitly focusing on toddlers/neonates and adolescents or youth-justice settings were excluded, whereas studies involving general child populations were retained as the closest approximation to the target group. Figure 2 illustrates the adopted age classification.

2.3. Environmental Design Elements in Healing Architecture

Healing architecture integrates multiple environmental elements that influence children's experiences and responses within healthcare facilities, including lighting, color, acoustics, indoor air quality, thermal comfort, and biophilic features. These elements are particularly important in pediatric and mental healthcare environments because children exhibit distinct cognitive, sensory, and emotional responses to environmental stimuli compared with adults. As an evidence-based design approach, according to Younis (2021), Jablonska and Furmanczyk (2024), and Simonsen et al. (2024), healing architecture seeks to create supportive environments that promote psychological well-being, reduce stress, and enhance healthcare experiences through the deliberate integration of therapeutic environmental features.

Among these environmental elements, according to Meng and Wang (2025), lighting is recognized as one of the most influential design variables because it affects both visual and non-visual aspects of health and well-being. From a visual perspective, appropriate lighting improves comfort and supports functional performance, whereas its non-visual effects include regulating circadian rhythms, mood, and emotional responses. However, current healthcare lighting standards, including ANSI/IES RP-29-22 and Indonesia's SNI 6197:2020, provide general technical requirements without specifically addressing the psychological and sensory needs of children with mental health conditions. Therefore, this review focuses on measurable environmental parameters, including illuminance, CCT, CRI, WWR, glare index, acoustic conditions, and indoor environmental quality indicators, to support evidence-based lighting simulations and the development of child-centered healthcare environments (Wu et al., 2023).

2.4. Review Framework: PICOC

The PICOC framework (Population, Intervention, Comparison, Outcome, and Context) was applied to structure the review questions and guide the systematic search strategy. This framework ensured that the literature search remained aligned with the research objectives and supported a systematic evidence synthesis. The population comprised school-age children aged 5–11 years as patients or users of healthcare facilities, including mental health facilities, outpatient clinics, and children's hospitals. Studies explicitly focusing on toddlers or neonates (0–5 years) and adolescents (≥12 years), including youth-justice settings, were excluded to maintain consistency with the targeted developmental stage. The intervention included healing architecture and evidence-based design elements, namely natural and artificial lighting, color, acoustics, indoor air quality, thermal comfort, and biophilic features.

The comparison considered conventional or institutional healthcare environments and those designed according to healing, therapeutic, or salutogenic design principles. The outcomes included psychological wellbeing indicators, such as anxiety, stress, emotional regulation, restorative perception, and patient and staff satisfaction, together with measurable environmental parameters, including illuminance (lux), CCT, CRI, WWR, sound level (dBA), and carbon dioxide concentration (ppm CO_2). The context encompassed healthcare environments, including clinics, hospitals, wards, and waiting rooms, while school classrooms were included as comparative settings representing the everyday environments of school-age children. The review primarily focused on studies involving the 5–11-year population and/or mental health contexts, with toddler, neonatal, and adolescent/youth-justice facilities excluded from the evidence synthesis.

3. Methods

This systematic literature review followed the PRISMA 2020 reporting guideline to ensure transparency and reproducibility throughout the identification, screening, eligibility assessment, and evidence synthesis processes (Page et al., 2021). A systematic search was conducted in the Scopus database on July 2, 2026. The search strategy combined four groups of keywords: (1) healing architecture concepts ("healing architecture," "therapeutic design," "evidence-based design," "salutogenic design," "supportive design," "DIALux," and "DIALux Evo simulation"); (2) healthcare settings ("patient well-being," "ambulatory care," "outpatient," "mental health," "anxiety," "depression," "stress," "hospital," "healthcare facilities," "medical center," and "clinic"); (3) population ("child"); and (4) measurable environmental design elements ("lighting," "daylighting," "color," "colour," "visual art," "acoustic," "biophilic," "Window-To-Wall Ratio (WWR)," "glare," "color rendering index (CRI)," "Correlated Color Temperature (CCT)," "lux," "MEL-EDI," "natural light," "noise reduction," "indoor air quality," and "thermal comfort"). The search was limited to English-language journal articles published between 2021 and 2026, indexed as final publications, and available through open-access sources, resulting in 184 records.

Studies were eligible if they investigated at least one healing architecture, therapeutic design, evidence-based design, or salutogenic design element within healthcare settings and reported one or more measurable physical environmental parameters, including lighting, color, acoustics, biophilic elements, indoor air quality, thermal comfort, or WWR. The review focused on school-age children (5–11 years) or healthcare and educational settings whose findings could reasonably be generalized to support technical design recommendations for this population.

Conference proceedings, books, review articles without explicit synthesis or primary data, non-English publications, studies published before 2021, inaccessible full-text articles, studies unrelated to the built environment, purely clinical or medical studies without architectural relevance, and studies explicitly involving toddlers or neonates (0–5 years), adolescents (≥12 years), or youth-justice settings were excluded.

To complement the systematic search, Indonesian and international technical standards and regulations, including SNI, Regulation of the Minister of Health, Indonesian laws, and ANSI/IES standards, were retrieved directly from their official publishers to provide normative technical parameters. Study selection involved title and abstract screening followed by full-text eligibility assessment to confirm the reporting of measurable design parameters and population relevance.

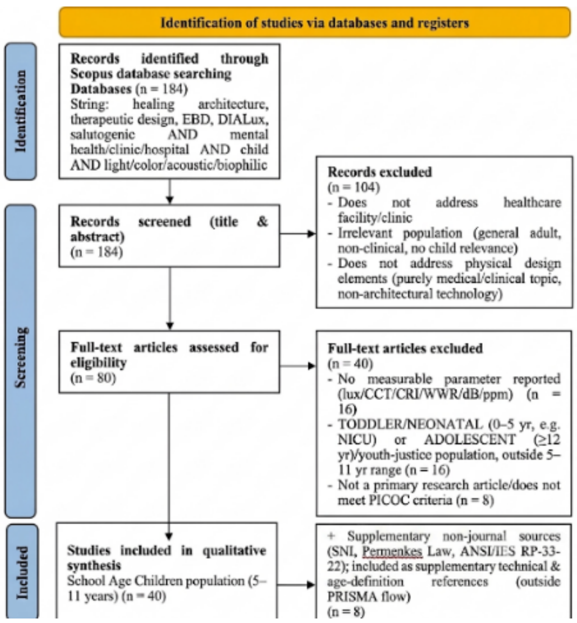

Figure 1. PRISMA Diagram

A total of 40 studies met the eligibility criteria and were included in the qualitative synthesis in Figure 1. Data extracted from each study included the authors, publication year, journal, study design, study population, healing architecture elements examined, and key findings related to lighting, color, acoustics, indoor environmental quality, and spatial characteristics. The evidence was synthesized narratively using five themes: lighting and daylighting, color, acoustics, indoor air quality and thermal comfort, and design considerations for school-age children with mental health vulnerabilities. Given the methodological heterogeneity of the included studies, a quantitative meta-analysis was not performed. Instead, methodological quality was evaluated narratively based on methodological clarity and reporting transparency.

4. Results

4.1. Overview of the Included Studies

Table 2 presents the distribution of included studies by publication year. The findings indicate an increasing trend in research interest, with the highest number of studies published in 2025 (13 studies), followed by 2024 (8 studies). Although fewer studies were identified in 2026 due to the limited publication period, the overall pattern shows growing attention toward the investigated topic in recent years.

Table 2. Distribution of Included Studies by Publication Year

Year	Number of Studies
2021	7
2022	1
2023	7
2024	8
2025	13
2026	4

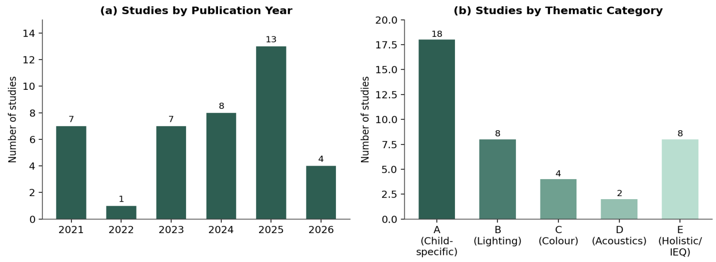

Figure 2. Distribution of the 40 included Studies by (a) Publication Year and (b) Thematic Category

Figure 2 presents the distribution of studies based on publication year and thematic category. This distribution illustrates the evolution in the number of studies and the dominance of child-specific design themes within the reviewed literature. Figure 3 further depicts the thematic scope through a visualization of keyword frequencies, based on the author-provided keywords reported in the 40 included studies.

Figure 3. Keywords Frequency

4.2. Mapping Healing Architecture Elements

The included studies were grouped into five thematic categories based on their main focus. These themes cover child-specific healthcare design, lighting, color, acoustics, and holistic environmental design. The categorization highlights key environmental factors that support children's comfort and wellbeing. Table 3 summarizes the included studies and their key findings.

Table 3. Summary of Included Studies by Thematic Category

Theme	Citation	Study Focus	Key Relevant Finding
Theme A: Design specific to children's healthcare facilities	Qi et al. (2021)	Pediatric waiting spaces	Reduced visual density improves satisfaction.
	Abulawi (2023)	Hospital artwork	Figurative art reduces anxiety.
	Pattabi et al. (2024)	Child-friendly wards	Color and privacy improve comfort.
	Babbu and Haque (2023)	Pediatric design framework	Children require distinct design parameters.
	Alhsainat and Günçe (2024)	Positive distractions	Nature and art support recovery.

Theme	Citation	Study Focus	Key Relevant Finding
	Alizadeh et al. (2024)	ADHD environmental quality	Sensory-sensitive children require stricter environmental control.
	Mangili et al. (2025)	Staff satisfaction	Healing environments benefit staff and patients.
	Russo and Andreucci (2023)	Biophilic open spaces	Purpose-designed green spaces support child development.
	Wang and Zheng (2026)	Art interventions	Participatory art reduces negative emotions.
	Nair et al. (2022)	Lighting and color (ASD)	Warm, low-intensity lighting minimizes sensory overload.
	Sathyanarayanan and Caldas (2025)	Pediatric healthcare design	Physical environment remains the design priority.
	Sathyanarayanan et al. (2025)	VR pediatric rooms	Windows and wall colors improve visual comfort.
	Park (2026)	Color preferences	Children's preferences differ from designers' assumptions.
	Patra and Wu (2025)	Hospitalization experience	Environmental quality influences treatment experience.
	Saavedra-Torres et al. (2026)	Multisensory architecture	Spatial design supports cognitive development in ASD.
	Vollmer and Koppen (2021)	Parent–child rooms	Family-centered layouts reduce parental distress.
	Rucitra et al. (2024)	Visual stimuli	Balanced stimulation prevents sensory overload.
	Sholanke and Adebisi (2026)	Biophilic hospitals	Natural elements improve user satisfaction.
Theme B: Lighting and Daylighting	Wu et al. (2023)	Spatial luminance distribution optimisation	Optimised luminance patterns enhance indoor restorative potential.
	Al-Dmour (2025)	IAQ, daylight, and vegetation integration in cancer-care environments	Natural light, materials, and air quality jointly improve patient wellbeing.
	Meng and Wang (2025)	Health impacts of window views	Window access to nature is consistently linked to better health outcomes.
	Meenu et al. (2025)	Daylighting performance and window-to-wall ratio	Moderate WWR improves daylight distribution while reducing glare risks.
	Suess and Maddock (2025)	Virtual green views in acute-care wards	Simulated nature views support physiological stress recovery.
	Elnaklah and AlWaer (2025)	Window views and cognitive comfort in healthcare facilities	Natural views improve cognitive performance and perceived comfort.
	Kapoor et al. (2021)	Indoor environmental quality in school classrooms	Poor air, lighting, and acoustics negatively affect children's comfort and cognition.
	Aghajari and Chen (2025)	Classroom lighting optimisation	Integrating daylight and artificial lighting improves visual comfort.

Theme	Citation	Study Focus	Key Relevant Finding
Theme C: Color	Edwards (2023)	Biophilic colors in clinical settings	Nature-inspired colors increase patient hope compared with institutional colors.
	Oh et al. (2021)	Color properties and physiological stress responses	Bright and low-saturation colors reduce stress indicators.
	Panahi et al. (2025)	Color therapy for chemotherapy patients' anxiety	Color interventions significantly reduce patient anxiety.
	Song et al. (2021)	Color perception and preference in healthcare spaces	Calming colors receive greater visual attention and preference.
Theme D: Acoustics	Tziovara et al. (2024)	Sound perception in dental-clinic environments	Background music reduces anxiety, while equipment noise increases patient stress.
	Deng et al. (2023)	Acoustic treatment in hospital wards	Acoustic improvements reduce reverberation and enhance sound environments.
Theme E: Holistic design, indoor environmental quality, and theoretical frameworks	Younis (2021)	Healing-environment design framework	Sensory, spatial, and symbolic strategies support effective healing environments.
	Nunayon and Zhong (2025)	IEQ research integration	Light, thermal, acoustic, and air-quality factors should be assessed holistically.
	Ackley et al. (2024)	IEQ in healthcare facilities	Daylight, comfort, acoustics, and IAQ influence patient and staff outcomes.
	Yan et al. (2025)	Healing-space design and emotional regulation	Light, nature, and color affect emotional regulation through perceptual pathways.
	Jablonska and Furmanczyk (2024)	Healing architecture in psychiatric hospitals	Human-centred design approaches are essential for supportive healthcare spaces.
	Simonsen et al. (2024)	Nature integration in psychiatric inpatient spaces	Nature connection supports wellbeing but requires practical implementation strategies.
	Cho (2023)	Therapeutic environmental criteria in healthcare design	Light, privacy, and nature are valued but limited by budget and regulations.
	Verderber et al. (2021)	ICU built-environment review	Healthcare design requires integrated evaluation of safety, function, and user needs

Based on Table 3, children with mental-health conditions require environmental approaches distinct from adult healthcare settings. Babbu and Haque (2023), Alizadeh et al. (2024), and Saavedra-Torres et al. (2026) highlight heightened sensory sensitivity among children with ADHD and ASD, requiring careful control of light, color, and acoustics. Russo and Andreucci (2023) emphasize that therapeutic green environments should be designed according to children's scale and developmental needs rather than simply adapting adult spaces. Cho (2023) notes that although architects value therapeutic elements such as lighting and privacy, implementation is often constrained by budget and regulation. Yan et al. (2025) further establish that architectural features influence emotional regulation through perceptual-affective pathways. Studies focusing on adolescents or adolescent-specific facilities were excluded to maintain recommendations specific to school-age children (5–11 years).

Lighting is one of the most consistently supported factors in healing-environment research. Wu et al. (2023) show that spatial luminance distribution, rather than average illuminance alone, influences restorative potential. Similarly, Meng and Wang (2025), based on 121 studies, find that access to natural views through windows is consistently associated with positive health outcomes. This is supported by Elnaklah and AlWaer (2025) and Suess and Maddock (2025), who report that green views from windows can promote stress recovery. At the design level, Meenu et al. (2025) demonstrate that window-to-wall ratio significantly affects daylight distribution, with moderate ratios optimizing daylight while limiting glare. In schools, inadequate lighting can reduce children's visual comfort, whereas integrated daylight and artificial lighting can improve comfort without increasing energy use (Kapoor et al., 2021; Aghajari & Chen, 2025). For children with autism, Nair et al. (2022) emphasize that excessive light and strong contrasts may cause sensory overload, while dim, warm lighting can create a calmer environment.

Color, acoustics, and other Indoor Environmental Quality (IEQ) factors collectively shape psychological and physiological responses in healing environments. Oh et al. (2021) show that brighter, less saturated colors can reduce physiological stress, while Panahi et al. (2025) confirm that color interventions significantly reduce patient anxiety. Edwards (2023) further finds that nature-inspired palettes, including green, pale blue, and warm brown, are associated with greater patient hope. However, Park (2026) emphasizes that children's preferences may differ from adult assumptions. Acoustic quality is similarly important, with sound-absorbing ceilings and insulated openings reducing reverberation time by 13-53% in hospital wards (Deng et al., 2023). Meanwhile, background music may reduce anxiety but equipment noise remains a stressor (Tziovara et al., 2024). Recent research therefore supports an integrated approach to IEQ, considering interactions among lighting, thermal comfort, acoustics, and air quality (Nunayon & Zhong, 2025; Ackley et al., 2024). Al-Dmour (2025) and Verderber et al. (2021) further emphasize natural materials, ventilation, infection control, family involvement, and functional requirements in promoting wellbeing.

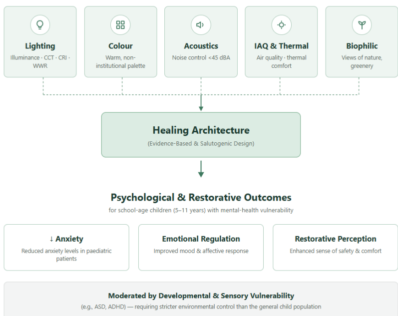

Figure 4. Conceptual Framework Linking Healing Architecture Variables to Children's Psychological Outcomes

Figure 4 visualizes the five design elements, namely lighting, color, acoustics, indoor air quality/thermal comfort, and biophilic design, are drawn from variable-specific evidence. These elements converge into the Healing Architecture construct, whose effects are moderated by developmental and sensory vulnerability, as demonstrated in children with ADHD and ASD by Alizadeh et al. (2024) and Saavedra-Torres et al. (2026), to produce the child-focused psychological and restorative outcomes examined in this review.

4.3. Lighting Design Parameters for Simulation

Tables 4 and 5 present the synthesized lighting design parameters developed as baseline inputs for schematic-stage simulation in pediatric healthcare environments.

Table 4 summarizes the core photometric parameters, including illuminance, minimum CRI, and recommended CCT. Illuminance and CRI values are primarily derived from SNI 6197:2020 (Badan Standardisasi Nasional, 2020), specifically the "Hospital/Health Clinic" category. Where specific requirements for children's mental-health facilities are unavailable, such as examination/consultation and play-therapy rooms, values are adapted through functional interpolation from the nearest healthcare categories. This limitation reflects the absence of dedicated lighting standards for pediatric mental-health clinics and highlights the need for further evidence-based development of child-specific environmental criteria.

Table 4. Core Photometric Parameters

Space	**Illuminance (lux)**[1]	**Min. CRI (Ra)**[1]	**Recommended CCT**[2]
Waiting room	200	80	3000–3500 K (warm white)
Examination/consultation room	300–350[4]	80	3500–4000 K
Children's inpatient room	350	80	3000 K (night: <2700 K)
Play-therapy room	250	80–90	3000–3500 K, adjustable
Corridor (daytime)	150–200	80	3000–3500 K
Corridor (night-time)	50	80	≤2700 K
Laboratory/support room	500	90	4000 K
Recreation/rehabilitation room	250	80	3000–3500 K
Staff/office room	350	80	4000 K

The CCT recommendations in Table 4 represent an interpretive synthesis rather than direct normative requirements. These recommendations are informed by sensory considerations identified in previous studies, particularly the need to reduce overstimulation and support emotional regulation among children with sensory sensitivities (Nair et al., 2022; Alizadeh et al., 2024; Saavedra-Torres et al., 2026). Lower and adjustable CCT values are therefore recommended in therapeutic and rest-oriented spaces, while higher CCT values are maintained in task-oriented areas requiring visual accuracy.

Table 5. Recommended Window-to-Wall Ratio (WWR) and Child-Centred Mental Health Design Considerations

Space Type	**Recommended WWR**[3]	**Child- and Mental Health-Oriented Design Considerations**
Waiting room	30–40%	Minimize direct glare and integrate views of natural elements or greenery to support stress reduction and wellbeing (Meng & Wang, 2025; Suess & Maddock, 2025).
Examination/consultation room	25–35%	Separate task lighting from ambient lighting to allow dimming during therapeutic interactions and patient consultations (Nair et al., 2022).
Children's inpatient room	30–40%	Provide adjustable lighting systems and avoid sharp light–shadow contrasts that may increase sensory discomfort (Nair et al., 2022).
Play therapy room	35–45%	Prioritize indirect natural lighting with glare control; avoid cool CCT values (>4500 K) that may contribute to sensory overstimulation among children with ASD/ADHD (Alizadeh et al., 2024; Saavedra-Torres et al., 2026).

Space Type	Recommended WWR[3]	Child- and Mental Health-Oriented Design Considerations
Corridor (daytime)	15–25% (side openings)	Avoid abrupt transitions between bright and dark areas to maintain visual comfort and reduce sensory stress.
Corridor (nighttime)	Not applicable	Use low-level orientation lighting to support safety while preserving circadian rhythms.
Laboratory/support room	20–30%	Follow SNI 6197:2020 requirements; this space type is not directly associated with child-patient therapeutic interaction.
Recreation/rehabilitation room	35–45%	Integrate biophilic elements and figurative artwork to enhance emotional engagement and therapeutic experience (Abulawi, 2023; Wang & Zheng, 2026).
Staff/office room	25–35%	Apply general workplace lighting recommendations based on SNI 6197:2020.

Based on Table 5, the WWR parameters and design notes for children serve as design guidelines to balance natural light access with visual and sensory comfort. Spaces requiring therapeutic effects such as waiting areas and recreation rooms are recommended to have access to natural elements to support well-being and stress recovery (Meng & Wang, 2025; Suess & Maddock, 2025). Conversely, therapy and clinical spaces require control over glare and light contrast, as well as lighting flexibility, to accommodate children's sensory sensitivities (Nair et al., 2022). The two tables translate research findings into practical design parameters that link lighting performance with the psychological and sensory needs of children in mental health facilities.

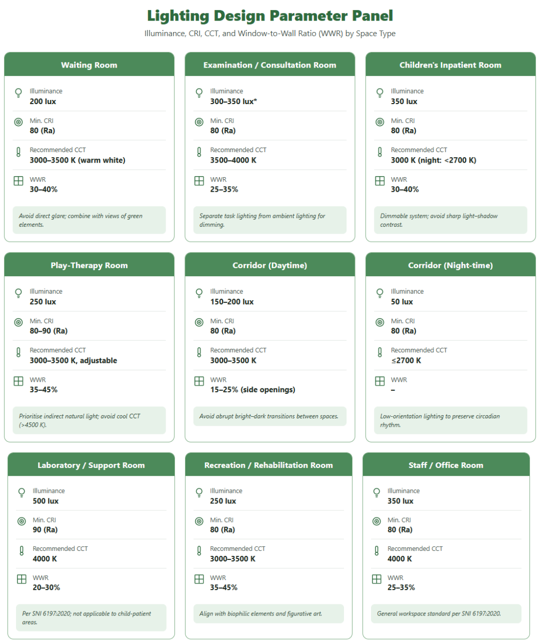

Figure 5. Visual Lighting Design Parameters Panel

This panel visualises the tabulated illuminance, CRI, CCT, and WWR parameters in Figure 5, translating them into a schematic-stage reference for each pediatric healthcare space type. Important methodological note. SNI 6197:2020 and ANSI/IES RP-29-22 provide illuminance and CRI values that are normative and ready for direct use. However, the CCT and WWR values in this table are the authors' interpretive synthesis drawn from qualitative findings across multiple studies, not a single normative figure from one source, and therefore require further verification through lighting simulation and, ideally, field validation in subsequent design or empirical research.

4.4. Comparison with Indonesian Standards and Design Recommendations

Beyond the 40 systematically reviewed journal articles, this review incorporates eight supplementary technical standards and regulatory documents obtained through non-systematic retrieval outside the PRISMA search process. These documents are used as normative and legal references to contextualize the design recommendations within the Indonesian healthcare environment.

The technical foundation for lighting and building-envelope recommendations is primarily derived from SNI 6197:2020 Energy Conservation in Lighting Systems (Badan Standardisasi Nasional, 2020a) and SNI 6389:2020 Energy Conservation of Building Envelopes (Badan Standardisasi Nasional, 2020b). SNI 6197:2020 provides the normative basis for minimum illuminance (lux) and CRI requirements in hospital and clinic spaces, which informs the photometric parameters. Meanwhile, SNI 6389:2020 guides envelope-related considerations, including OTTV requirements associated with window openings and WWR, ensuring that daylight recommendations remain consistent with energy-efficiency principles.

Healthcare-specific requirements are further supported by Regulation of the Minister of Health Number 40/2022 on Technical Requirements for Hospital Buildings, Infrastructure, and Health Equipment, which provides technical guidance for hospital spaces, including child-oriented provisions such as stimulation-themed wall finishes and safe materials. In addition, Law Number 18/2014 on Mental Health establishes the legal basis for mental-health facility planning by requiring appropriate separation of spaces for children, women, and elderly users. Internationally, ANSI/IES RP-29-22 Recommended Practice: Lighting Hospital and Healthcare Facilities is used as a comparative reference for CCT recommendations, lighting controls, and psychological considerations in healthcare lighting design.

Child-related regulations support the definition and age boundary of the target population. Law Number 35/2014 on Child Protection provides the general legal definition of children (0–<18 years), while Departemen Kesehatan RI (2009) age categorization supports the adoption of childhood classification (5–11 years) as the operational population of this review. Furthermore, Regulation of the Minister of Health Number 25/2014 on Child Health Efforts defines school-age children and adolescent categories, complementing the age boundary applied in this study.

5. Discussion

This review demonstrates that healing architecture for school-age children with mental health conditions should be understood as an integrated environmental approach rather than a collection of isolated design features. The synthesis indicates that lighting, color, acoustics, biophilic design, and indoor environmental quality interact to influence children's psychological comfort, emotional regulation, and restorative experiences. These findings reinforce the evidence-based design perspective, which argues that healthcare environments should be developed using empirical evidence to improve health outcomes instead of relying solely on architectural intuition.

The predominance of lighting-related studies suggests that visual environmental quality remains the most mature area of healing architecture research. This finding is consistent with previous reviews by Verderber et al. (2021) and Nunayon and Zhong (2025), which identify lighting as one of the principal determinants of patient wellbeing within healthcare environments. Unlike earlier studies that primarily examined lighting from the perspectives of visual performance or energy efficiency, the present review indicates that lighting also plays an important role in emotional regulation among children with sensory vulnerabilities. The convergence of findings from Nair et al. (2022), Wu et al. (2023), and Meng and Wang (2025) suggests that daylight quality, luminance distribution, and appropriate correlated color temperature should be considered simultaneously to minimize sensory overload while promoting restorative experiences.

The findings also confirm that child-centred design cannot be achieved by directly adapting environmental strategies developed for adult healthcare facilities. Previous studies by Alizadeh et al. (2024) and Saavedra-Torres et al. (2026) have consistently reported that children with autism spectrum disorder and attention-deficit/hyperactivity disorder demonstrate greater sensitivity to environmental stimuli than adult users. This review extends those findings by showing that sensory-responsive architectural design should become a fundamental design principle throughout pediatric mental-health facilities rather than an intervention applied only within specialized therapy rooms. Consequently, environmental parameters such as adjustable lighting, reduced visual complexity, and controlled acoustic conditions should be incorporated from the earliest stages of architectural planning.

Another important finding concerns the increasing recognition of multisensory healing environments. While previous research frequently investigated lighting, color, or acoustics independently, recent studies emphasize the interaction among multiple environmental variables. This pattern aligns with Ackley et al. (2024), Yan et al. (2025), and Nunayon and Zhong (2025), who argue that IEQ components collectively influence occupants' physical and psychological wellbeing. Accordingly, the conceptual framework proposed in this review integrates lighting, color, acoustics, thermal comfort, indoor air quality, and biophilic design into a unified healing architecture construct, providing a broader perspective than studies focusing on individual environmental attributes.

The review also highlights a significant evidence gap of translating empirical findings into practical design standards for pediatric mental-health facilities. Although numerous studies recommend therapeutic environmental characteristics, relatively few provide measurable architectural parameters that can directly support design decision-making. The synthesized recommendations for illuminance, correlated color temperature, color rendering index, and window-to-wall ratio therefore contribute by bridging scientific evidence with schematic-stage architectural practice. This approach complements the normative requirements established in SNI 6197:2020 while incorporating psychological evidence that is not explicitly addressed in existing technical standards.

The comparison with Indonesian regulations demonstrates that current national standards primarily emphasize safety, functionality, and energy efficiency, whereas child-specific psychological needs receive comparatively limited attention. This observation is consistent with Cho (2023), who reported that healthcare architects often recognize the importance of therapeutic environmental features but face constraints imposed by regulations and project resources. Consequently, future revisions of healthcare design standards may benefit from integrating evidence-based recommendations that explicitly address children's developmental characteristics, sensory regulation, and emotional wellbeing. Such integration would strengthen the alignment between architectural regulations and contemporary evidence on healing environments, thereby supporting the development of pediatric mental-health facilities that are both technically compliant and psychologically responsive.

6. Conclusion

This systematic literature review synthesizes evidence from 40 peer-reviewed studies to identify the healing architecture elements most relevant to mental health facilities for school-age children. The findings indicate that lighting is the most consistently supported environmental factor, followed by color, acoustics, biophilic design, and integrated indoor environmental quality. These elements contribute to psychological comfort, emotional regulation, stress reduction, and restorative experiences, particularly for children with sensory vulnerabilities such as autism spectrum disorder and attention-deficit/hyperactivity disorder. Based on these findings, this review proposes child-centred lighting design parameters, including illuminance, correlated color temperature, color rendering index, and window-to-wall ratio, synthesized from empirical evidence and interpreted alongside Indonesian technical standards. These recommendations provide a practical reference for the schematic design stage while demonstrating how evidence-based design principles can be translated into architectural decision-making.

This review has several limitations. Only English-language journal articles published between 2021 and 2026 were included, while technical standards and regulations were incorporated through a non-systematic search. They therefore were not part of the PRISMA process. In addition, several proposed design parameters, particularly CCT and WWR, represent interpretive syntheses rather than universally accepted normative values. Future research should validate these recommendations through lighting simulation, post-occupancy evaluation, and empirical studies conducted in pediatric mental health facilities. Further investigations are also needed to establish child-specific environmental standards and to examine the combined effects of multiple healing architecture variables on children's psychological outcomes across different cultural and healthcare contexts.

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Data Disclosure Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.