

Review

The Impact of the Physical Environment on Staff in Healthcare Facilities: A Systematic Literature Review

Roshan S. Shetty ¹, Giridhar B. Kamath ^{2,*} , Lewlyn L. R. Rodrigues ² , Rama Devi Nandineni ¹ and Sham Ranjan Shetty ³ 

¹ Manipal School of Architecture and Planning, Manipal Academy of Higher Education, Manipal 576104, Karnataka, India; roshan.shetty@manipal.edu (R.S.S.); nandineni.rd@manipal.edu (R.D.N.)

² Department of Humanities and Management, Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal 576104, Karnataka, India; l.rodrigues@manipal.edu

³ T A Pai Management Institute, Manipal Academy of Higher Education, Manipal 576104, Karnataka, India; shamranjan.shetty@manipal.edu

* Correspondence: giridhar.kamath@manipal.edu

Abstract: This article investigates the staff outcomes that are influenced by physical environment features in a healthcare facility. Over the past few decades, research on the physical environment and its effects on hospital staff has advanced steadily. Focusing on the physical environment has become a research area with great potential because it is crucial to provide a favorable work environment for health professionals, which directly impacts the quality of care. A systematic literature review was conducted to identify research articles from two scientific databases and a healthcare journal. Articles that fulfilled the inclusion and exclusion criteria for relevant articles were included in this review. Relevant data were derived from the final shortlisted articles. The features identified in the articles were divided into three dimensions of the physical environment. The results demonstrate different outcomes for staff. This review shows the need to develop a comprehensive study involving the most important features of the three dimensions of the physical setting and its effects on staff. This study contributes invaluable insights for hospital administrators, architects, and designers by informing them about the critical factors shaping the healthcare workplace environment.

Keywords: healthcare facility; staff outcomes; physical environment



Citation: Shetty, R.S.; Kamath, G.B.; Rodrigues, L.L.R.; Nandineni, R.D.; Shetty, S.R. The Impact of the Physical Environment on Staff in Healthcare Facilities: A Systematic Literature Review. *Buildings* **2024**, *14*, 2773. <https://doi.org/10.3390/buildings14092773>

Academic Editors: Oleg Kapliński, Agata Bonenberg, Jan Słyk and Wojciech Bonenberg

Received: 22 June 2024

Revised: 22 July 2024

Accepted: 25 July 2024

Published: 3 September 2024



Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The healthcare industry has more dynamic and complicated environments than other service industries [1]. It is a complex environment with continually functioning organizational systems, technological infrastructure, and users, including patients, families, and staff [2]. These interactions are dynamic since patient needs, service care, and technology are unpredictable over time and are likely to change, which places a heavy burden on how the built environment is designed. The physical environment is critical for enhancing patient well-being and providing a supportive workplace for healthcare workers [3]. Every aspect of the physical environment influences staff outcomes in a healthcare environment [4]. The physical environment is the physical features of the environment where users carry out tasks [5]. According to [6,7], the physical environment encompasses architectural elements, interior design, and ambient features. Within healthcare settings, staff outcomes are influenced by these physical factors and include a range of indicators, such as well-being, satisfaction, performance, productivity, stress and burnout, commitment, turnover, and other impacts on healthcare professionals in their workplace. The healthcare setting can create a stressful environment, as physical environmental factors act as environmental stressors [8]. In addition to providing treatment, healthcare settings face new challenges, including protecting users from infectious diseases [9]. According to [10], healthcare settings need to be designed to be resilient for continual development by

integrating additional information about the influence of various design strategies on the users and other outcomes related to the organizations.

Studies have shown that variables like long work hours, variable schedules, patient distress, high patient volumes, workplace violence, and illness risk can lead to stressful work circumstances [11,12]. According to reports from Mental Health America (2020), 93% of healthcare personnel are stressed, 82% have mental and physical fatigue, 45% of nurses claim that they do not receive appropriate emotional care, and 22% of health professionals experience depression and post-traumatic stress [13]. In addition, 69% of doctors reported depression, 13% had suicidal thoughts, 64% of female doctors reported burnout [14], and frontline staff, nurses, and young staff had major psychological indications other than depression [15].

Many scientific studies [12,16–25] have gathered evidence demonstrating relationships between the physical healthcare environment and outcomes for patients, families, staff, and organizational outcomes. Consequently, there is an increasing consensus that an effectively designed environment can improve patient outcomes, promote a supportive work environment for users, and meet organizational and business goals. Although research on the effects of the work environment on healthcare workers has significantly increased, with more than 1.1 million hits in Google Scholar and 50,000 articles in the last five years [26], these studies have focused mainly on the task context, social context, organizational culture context, and physical context.

The healthcare environment has immense opportunities to be an effective intervention for reducing and preventing mental exhaustion [27] and can lessen stress and provide restorative conditions [28] for healthcare professionals. Research has also demonstrated the significance of physical environmental design on performance and efficiency among staff in healthcare facilities [5].

The majority of studies have proven that the physical environment in healthcare facilities has an impact on patient and staff outcomes. Healthcare professionals are increasingly conscious of the need for a well-designed physical workplace environment, as this environment is crucial for fostering positive and supportive work environments, and improved designs can make the jobs of staff much easier [12,16,20,26,29]. A great deal of potential exists for healthcare physical environment design to be an efficient approach for minimizing and eliminating negative impacts on staff [27]. Additionally, understanding the complex interplay between the physical environment and staff outcomes is essential for healthcare administrators, architects, designers, and policymakers. A supportive and conducive workplace environment enhances staff well-being and improves patient care quality, safety, and satisfaction.

Although the previously published research provides relevant information, those studies dealt with specific factors, as opposed to a more comprehensive assessment of physical environmental factors. It is vital to understand the extent to which physical environmental factors are studied and their impact on staff in healthcare settings. This article provides a systematic review of peer-reviewed articles to comprehensively understand the physical environmental factors that impact staff in healthcare facilities. This study aimed to address the following questions. Research question (RQ) 1: Which physical environmental factors contribute to staff outcomes in healthcare settings? RQ 2: What staff outcomes concerning the physical environment in healthcare settings have been studied? RQ 3: Which theories pertaining to the physical environment have been discussed in the literature?

2. Review Methods

A systematic review must employ an established method, as outlined by [30] for searching, filtering, reviewing, interpreting, synthesizing, and reporting findings obtained from various publications. We selected relevant studies for review in six steps: (i) identifying the concepts to be included in this study; (ii) selecting relevant databases; (iii) identifying keywords and search strategies; (iv) selecting the inclusion and exclusion criteria; (v) screening the data; and (vi) obtaining the search results.

In step (i), we identified the following concepts of interest: the population, setting(s), and outcome of the study. The population of interest was healthcare staff, the setting(s) of interest was the physical healthcare environment, and the outcome was the staff outcome. In step (ii), we selected two databases: PubMed and Scopus. In addition, manual searching was performed in the *Health Environments Research and Design (HERD) Journal*. PubMed was chosen because it is a healthcare-based database, and Scopus is one of the largest databases of peer-reviewed literature. The search included articles published between January 2010 and September 2022 to capture a decade of research given the surge in healthcare environment research starting from 2010 onward. In step (iii), we identified keywords and the search strategy. Using Boolean operators, the literature was searched for “physical environment”, “staff outcomes”, and “hospital” and their related terms. Table 1 lists the keywords used. The searches used standard search filters. The titles and abstracts were examined for relevant information. The approach involved search terms related to the hospital, physical environment, and staff outcomes and included several search strings for every database. Repeated searches were carried out using various terms and search string combinations.

Table 1. Keywords used in the search.

All Words Related to the Hospital	All the Words Related to The Physical Environment	All Words Related to Staff Outcomes
Healthcare Hospital Healthcare building Healthcare facility Healthcare setting Healthcare sector	Physical environment Healthcare design Built environment Building design Hospital environment Hospital design Environmental factors Healthcare environment	Employee outcomes Staff safety Staff stress Staff satisfaction Staff efficiency Staff performance Staff burnout Turnover intent Job satisfaction Workplace satisfaction perception

In step (iv), the inclusion and exclusion criteria were defined, and the criteria for selecting articles are given in Table 2.

Table 2. Inclusion and exclusion criteria.

Inclusion Criteria	Rationale
Only peer-reviewed journal publications	Ensuring that articles are peer-reviewed maintains a high standard of research quality and credibility.
Available in electronic databases	Limiting the search to electronic databases ensures the accessibility and verifiability of the sources, facilitating the replication of the review process and ensuring that the articles are easily retrievable.
Limited to the healthcare context only	Focusing on the healthcare context ensures that the findings are directly relevant to healthcare environments, where the impact of design features on staff outcomes is critically important.
All healthcare professionals at any level working in a healthcare facility	Including all healthcare professionals ensures a comprehensive understanding of how design features impact various roles within healthcare settings, providing a holistic view of staff outcomes across different professional levels.
Articles published in the English language only	Limiting the review to English-language publications ensures that the reviewers can accurately interpret and analyze the content, maintaining the integrity of the review process.
Full-text articles	Including only full-text articles ensures that all relevant details of the studies can be thoroughly examined and assessed, allowing for a complete understanding of the research findings and methodologies.
Studies employing robust research methodologies, including quantitative, qualitative, or mixed-method approaches	Including methodologically rigorous studies ensures that the findings are based on sound research practices, enhancing the validity and reliability of the review.

Table 2. Cont.

Exclusion Criteria	Rationale
Book chapters, conference proceedings, reports, and review papers	Excluding these articles ensures that the review focuses on original research studies that provide direct evidence of the impact of design features on staff outcomes.
Sectors other than healthcare	Excluding articles from other sectors ensures that the findings are specific to healthcare environments, where the specific challenges and dynamics may differ significantly from other settings.
Articles with only abstracts	Excluding articles that provide only abstracts ensures that the review is based on comprehensive data and detailed methodologies, which are necessary for a thorough analysis and accurate interpretation of the study results.

In step (v), data screening, this review was conducted using article titles within the database to screen out irrelevant articles, and duplicates were removed. The abstract of each article was screened for relevance. The full articles were critically reviewed, and all relevant information required for this review was documented.

In step (vi), for the search results, a total of 4869 articles were initially retrieved and subsequently checked. Based on the analysis of the titles and abstracts, 4172 articles (books, conference proceedings, dissertations, editorial commentaries, and review articles) were excluded. By employing the full-text inclusion and exclusion criteria, 439 articles were excluded. Consequently, 258 articles were assessed for eligibility. A total of 191 articles failed quality checks and were removed. Finally, 67 articles were selected for this review. These articles were thoroughly reviewed and verified by the authors. Figure 1 shows the flowchart of the article selection process.

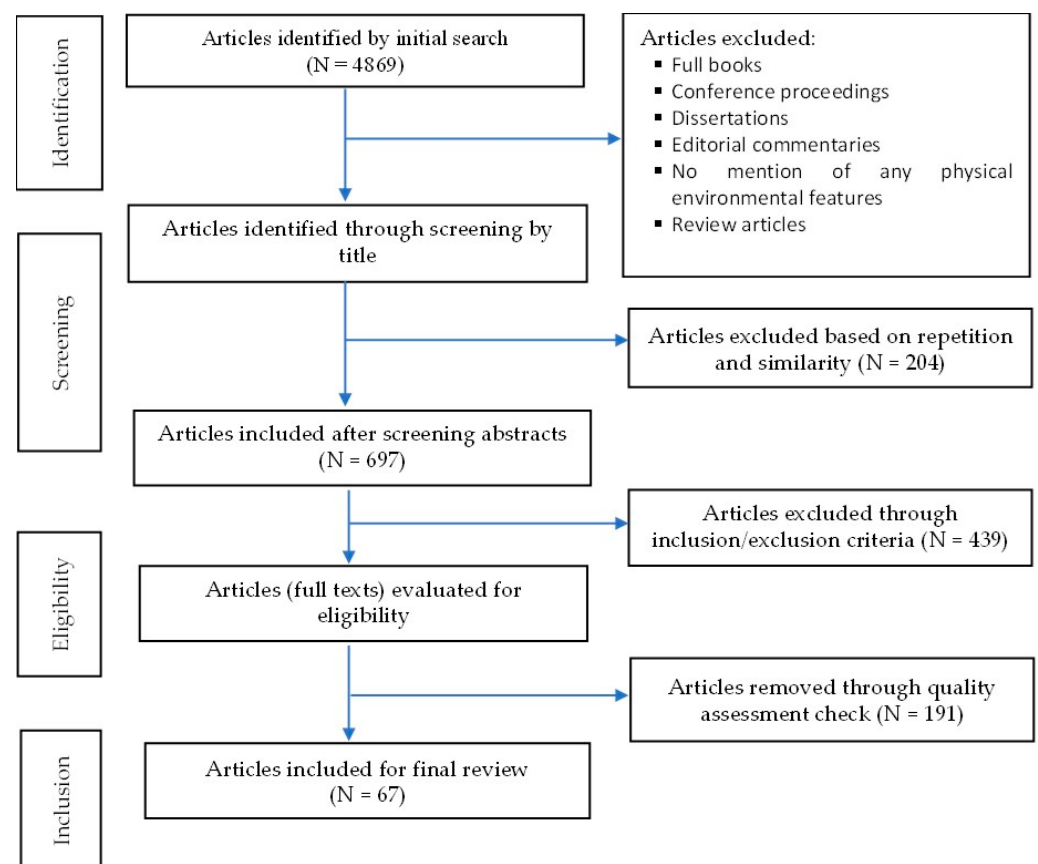


Figure 1. Flowchart of the study selection process for review.

3. Data Extraction and Synthesis

After the quality assessment, 67 articles were selected for this review. These articles were thoroughly reviewed and verified by the two authors. All 67 articles were analyzed and summarized. The first author gathered information from the included studies.

3.1. Analysis of the Included Articles

This section addresses RQ 1 and RQ 2. The information obtained included information such as (i) the articles published per year, (ii) the countries in which the studies were performed, (iii) the research techniques, (iv) the sampling types, (v) the sampling frames, (vi) the study settings, and (vii) the methods of data collection.

3.2. Identification of Variables

This section provides insights into the physical environmental variables considered to study the impacts on various staff outcomes. The physical environment was classified into three dimensions based on the study by [6,7,31]. The three dimensions included architectural design features, which represent relatively permanent aspects; interior design features, which include less-permanent elements of the environment; and ambient features, which encompass environmental conditions and sensory stimuli. Clusters were formed based on these three dimensions of the physical environment. Similarly, the staff outcome measures were also assessed for this study. This was crucial because it mapped the independent and dependent variables.

3.3. Theories Identified

Several theories have been established in the domains of environmental psychology, the environment and behavior, and organizational behavior. These theories provide valuable frameworks for analyzing the interaction between the environment and human behavior in an organizational context. Environmental psychology theories focus on how individuals perceive and interact with their immediate physical surroundings, while environment and behavior theory investigates how environmental factors influence individuals' behavior. Organizational behavior theory investigates individuals' behavior in organizations and how it influences organizational success. These theories provide support for the research undertaken to better understand the complex interplay between the environment and its impact on the individual. This understanding can guide the design of more supportive and conducive environments. This section presents the answer to RQ 3 by identifying the theories used in the review articles in the fields of environmental psychology, the environment and behavior, and organizational behavior.

3.4. Keyword Analysis

Figure 2 depicts a weighted cloud theme generated by Jason Davies's word cloud generator. It is a comprehensible technique for visualizing text data. The commonly used keywords in the articles were design, environment, satisfaction, and nurse. It can be concluded that most articles discussed environmental design and its impact on staff satisfaction.



Figure 2. Weighted focus cloud generated by a word cloud generator developed by Jason Davies.

4. Results and Discussions

4.1. General Characteristics

An analysis of the published articles led us to the conclusion that more articles were published in PubMed than in the Scopus database. Regarding the distribution of articles reported in the systematic review between 2010 and 2022 (Figure 3), there was a peak in the related research area during 2015, with twelve studies, and in 2018, with nine studies.

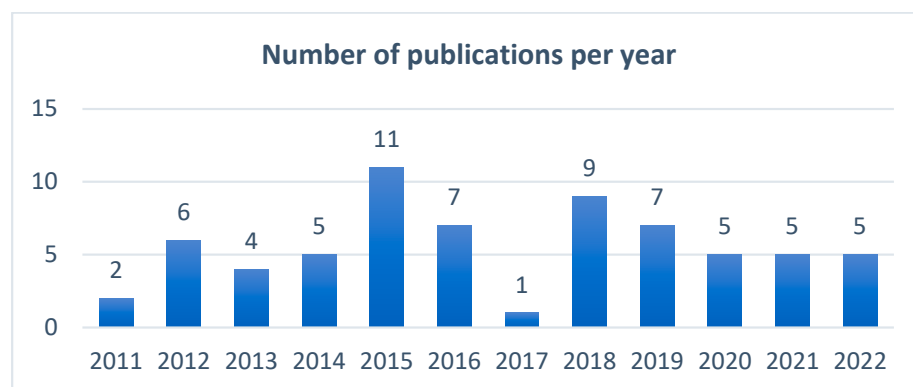


Figure 3. Number of publications per year.

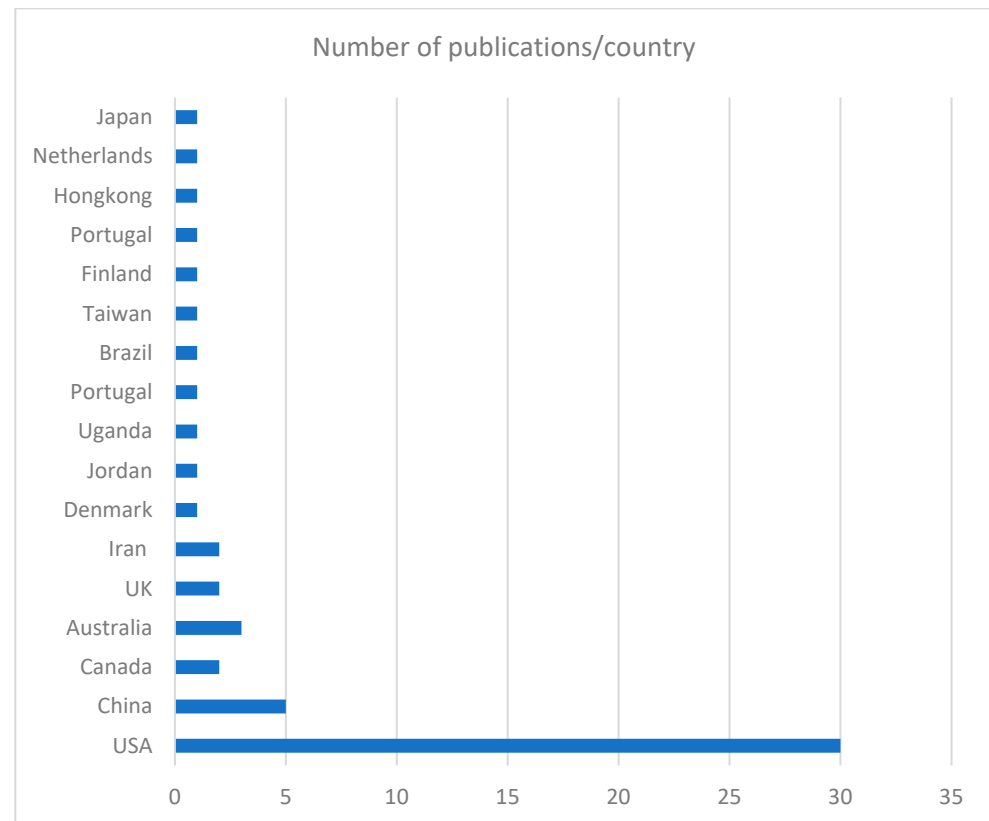
Relevant research originated from multiple countries, including 30 (n = 30) from the USA; 5 from China; 3 from Australia; 2 each from Canada, the UK, and Iran; and 1 each from Denmark, Jordan, Uganda, Portugal, Brazil, Taiwan, Finland, Hong Kong, the Netherlands, and Japan (Figure 4).

4.2. Research Technique

Of the total articles reported for this review (Table 3), 45% used mixed methods, followed by quantitative methods (40%) and qualitative methods (15%). The quantitative methods used questionnaire survey methods for data collection, and the qualitative methods included focus group discussions, structured or semi-structured interviews, and observational studies. Both qualitative and quantitative mixed methods were used.

Table 3. Research methods reported in this review.

Sl. No.	Research Methods	Number of Articles Reported in this Review (n = 67)
1	Quantitative methods	27 [17,22,23,31–54]
2	Qualitative methods	10 [55–63]
3	Mixed methods	30 [8,18,19,56,64–89]

**Figure 4.** Number of publications per country.

4.3. Sampling Technique

Nonprobability sampling was adopted by 31 articles; 7 articles used the probability-sampling technique, and the remaining articles did not report the sampling technique adopted. The sampling techniques adopted in this review are reported in Table 4.

Table 4. Sampling techniques reported in this review.

Sampling Techniques	Types of Sampling Techniques	Number of Articles Reported in this Review (n = 67)
Probability sampling	- A random sample (n = 4) [23,71,85] - Cluster random sample (n = 1) [33]	7
Nonprobability sampling	- Convenience sample (n = 19) [5,8,34,37,38,40,48,49,51,56,60,64,70,76,77,85–87,89] - Volunteer/self-selected sample (n = 5) [59,72,78,83,88] - Purposive sample (n = 3) [57,58,74] - Sequential sample (n = 1) [18] - Convenience and snowball sample (n = 2) [67,81] - Convenience and purposive sample (n = 1) [55] - Non-random sample (n = 1) [45]	31
Not mentioned	[17,19,22,31,32,35,36,39,41–44,46,47,50,52,53,61,62,65,66,68,69,73,75,79,80,82,90]	29

4.4. Sampling Frame

There was a wide variety of participants in the studies. Nurses and doctors were the respondents in most of the studies. The studies on nurses were considered the highest sampling frame. The nurses included registered nurses, senior nurses, charge nurses, associate chief nurses, chief nurses, critical care nurses, circulating nurses, intensive care nurses, and nurse managers. The second most studied healthcare professionals were the care team staff members, comprising physicians, therapists, advanced practice specialists, physician supporters, and nurse practitioners. The clinical and non-clinical staff sample frame was the third most investigated sample frame. A detailed summary of the health professionals (study participants) included in this review is given in Table 5.

Table 5. Study participants included in this systematic review.

Healthcare Professionals (Study Participants)	Number of Articles Reported in this Review
Nurses	[8,17,19,22,39,40,42,47,55,56,61,64,65,70,75,78,79,82,84,89]
Care team staff members	[23,32,36,51,71]
Clinical and non-clinical Staff	[38,53,57–59,77,80]
Staff members	[63,66,67]
Physicians/medical doctors, nurses, and therapists	[5,18,31,33,37,41,44,46,67,71,73,81,86,91]
Nurses and technicians	[41]
Diagnostic, pharmacy, sterilization, rehabilitation, and health science department staff	[43]
Midwives and supporters	[60]
Medical directors	[49]
Nursing, social work, and therapy staff	[54]
Healthcare providers/employees	[50,62,88]
Technicians	[52]

4.5. Study Settings

Although the context of the studies varied, most of the studies were performed at general hospitals (n = 15), followed by acute care hospitals (n = 7). The detailed settings of the included studies in this review are provided in Table 6. The designs of the listed studies varied. The sample sizes varied considerably, from as low as 9 to 1561 staff participants.

Table 6. Settings of the selected studies.

Study Setting	Selected Studies Carried Out in This Setting
Hospital	15 [34,47,49,50,52,53,58,67,69,72–74,76,80,85]
Public nonprofit hospital	2 [64,81]
Somatic hospital	1 [55]
University teaching hospital/academic medical center	6 [17,35,43,51,61,87]
Maternity facility	2 [60,65]
Primary care facility	2 [32,77]
General hospital	2 [46,66]
Ambulatory care	1 [18]
Community hospital	3 [5,44,56]

Table 6. *Cont.*

Study Setting	Selected Studies Carried Out in This Setting
Acute care hospital	7 [22,31,39,57,77,78,89]
Mental healthcare facility	1 [77]
Tertiary care facility	3 [38,54]
Medical care center	1 [40]
Care and rehabilitation facility	1 [42]
Veterans' affairs healthcare facility	1 [62,63]
Children's hospital	1 [90]
No contextual information	18 [8,19,23,33,36,37,41,45,48,59,70,75,79,82–84,86,88]

4.6. Methods of Data Collection

Eleven studies used experimental and quasi-experimental designs [22,42,43,54,65,75,78,81,83,90], thirteen studies used interview methods [55–57,64,72,73,83], and six studies used focus group discussions [8,59,61,74,79,86]. One ethnographic study [60] and two thematic content analyses were used [18,59]. The remaining 53 studies [17,19,23,31–36,39,40,44–50,52,53,65–68,70,71,77,80,82,84,85,87–89,92] used survey questionnaire methods along with other methods. Few other studies used methods such as behavior mapping [48], participatory guided tours [62], visual assessment, simulation, and observational studies [41,51].

This review identified a wide range of research methods employed to investigate the impact of the physical environment on staff, which significantly helped us to understand the topic in depth. These studies investigated various aspects of environmental factors while gaining insights from various perspectives by employing a variety of research methods. The quantitative methods employed in the review articles included experimental and quasi-experimental research designs and survey research to acquire quantifiable data on staff outcome measures. The articles that employed experimental research allowed the researchers to manipulate specific environmental variables and observe their impacts on staff. These methods also provided useful information about the prevalence and extent of the impact of the environment on staff. The qualitative research methods, such as observational studies, interviews, and focus group discussions, enabled the researchers to delve deeper into the subjective experiences and perceptions of the physical environment. Furthermore, the mixed-method approach integrates both qualitative and quantitative methods, providing a more comprehensive understanding of complex phenomena. Overall, the diversity of the research methods allowed a more holistic approach to investigating various factors of the relationship between the physical environment and staff outcomes.

4.7. Identification of Physical Environmental Variables and Their Impacts on Staff Outcomes

4.7.1. Architectural Design Features and Their Impacts

Architectural design features were grouped into restorative elements, spatial layout and connections, design characteristics, workspace elements, and room and spatial dimensions. Table 7 shows the staff outcomes for architectural design features studied by various authors, and Figure 5 shows the number of articles on the effects of architectural design features on staff outcomes.

Table 7. Architectural design features and their impacts on staff outcomes.

Architectural Design Features	Staff Outcomes																		
	Satisfaction	Performance	Productivity	Burnout	Perception	Behavior	Communication	Experience	Efficiency	Collaborations	Teamwork	Privacy	Stress	Mood	Security/Safety	Work Pattern and Flow Disruption	Wellness	Activity	Well-Being
Restorative elements	7	2	1	1	3		1		1			1	4	2			1		1
Author/year	[8,23,34,42,43,50,53,56,64,66,78,80,85,93]																		
Spatial layout and connections	16	5	1	1	10	1	9	2	7	1	1	2	5			1		1	1
Author/year	[17,18,31–33,35,36,38,39,41,43,47,48,50,53,54,59,61,67,69–76,78,82–85,90]																		
Design characteristics	6	1			8		3	1	10		4	3							
Author/year	[5,37,41,57,59,67,69,73,78,82,86]																		
Workspace elements	4	3			3		1		3			1	1						
Author/year	[41,54,57,70,72,82,86,90]																		
Room and spatial dimensions	4	1			2		1	1	2			1	2		2				
Author/year	[43,49,53,57,58,73,74,78,82,89]																		

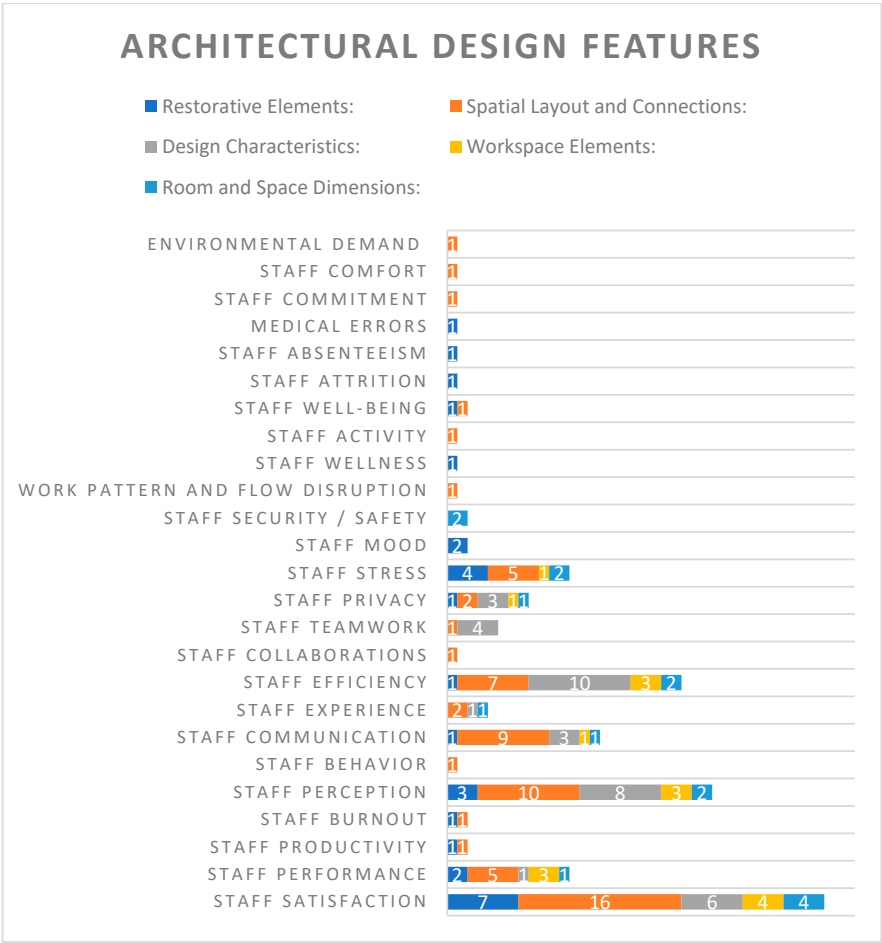


Figure 5. Total number of articles on impacts of architectural design features on staff outcomes.

Restorative Elements

Restorative elements in healthcare settings are designed to provide staff with environments that support relaxation, reduce stress, and promote overall well-being. The key restorative elements identified in the literature included break spaces [8,64], windows with views [23,34,42,50,53,80,85], balconies [64], and outdoor spaces [66]. Restorative break spaces are designated areas where staff can relax and recharge, often featuring comfortable seating and calming décor, significantly improving staff satisfaction [8,64], performance [64], and productivity [64] and reducing staff stress [8,64]. Windows that offer views of nature significantly enhance staff satisfaction [50,56,85], performance [22], communication [22], efficiency [56], and mood [5,22] and reduce stress [50,56]. Balconies, as outdoor extensions of interior spaces, provide fresh air, natural light, and views, offering a retreat from the high-pressure working environment. Outdoor spaces, such as gardens, are designed for relaxation and social interaction, allowing staff to connect with nature and take breaks, which are important for maintaining both mental and physical health.

Spatial Layout and Connections

Spatial layout refers to the organization and arrangement of various spaces within a healthcare facility. An effective layout ensures efficient workflows [48], easy access to essential areas, and minimal unnecessary movement, thereby enhancing staff satisfaction [17,18,37,41,43,47,50,54,71,73,75,78,84,85], efficiency [41,67,69,70,73,75,83], performance [36,37,43,70,91], productivity [83], behavior [17], communication [18,32,39,48,69,71,74], experience [71,73], privacy [69,85], collaboration [33], and teamwork [83]; improving perception [33,38,48,50,53,67,69,70,94], staff activity [38], well-being [83], commitment [43], and comfort [47]; and reducing burnout [35] and stress [35,50,61,83]. Visual connection, or the ability of staff to see and visually connect different areas within the facility, supports supervision, enhances communication [32], and improves the sense of safety and community among staff. The effective arrangement of spaces considers the need for privacy, ease of movement, and proximity to related functions, further enhancing workflow and reducing stress.

Design Characteristics

In healthcare settings, the design configuration plays a crucial role in determining how efficiently staff can perform their tasks, access necessary equipment, and interact with patients and coworkers. Flexibility refers to the ability of a space to adapt to different uses and needs over time. Flexible designs in healthcare can accommodate changing medical practices, emergencies, and evolving staff requirements without significant alteration and can help to improve staff perceptions [67,82], efficiency, and teamwork [67]. Accessibility ensures that all areas are easily accessible to staff by incorporating features such as wide doorways, ramps, and clear signage, which facilitate efficient and safe movement throughout the facility. Improving accessibility in healthcare settings enhances staff perceptions [57,67], efficiency [67], and privacy [57]. Good visibility supports patient supervision and enhances staff satisfaction [37,41,73], performance [71], communication [5,69], experience [73], efficiency [41,67,69,73], teamwork [5,67], and privacy [69] and promotes a collaborative environment among staff. Proximity is essential in healthcare settings for maintaining efficient workflows, ensuring quick response times, reducing physical strain on staff, and improving satisfaction [78], perception [67,82], communication [69], efficiency [67,69], teamwork [67], and efficiency.

Workspace Elements

An adequate workspace is essential for staff to perform their duties effectively and comfortably. Well-designed functional spaces promote staff performance [91]. Additionally, effective storage solutions are vital for organizations, reducing clutter, and ensuring that necessary items are easily accessible, all of which enhance staff satisfaction [41,43,54,63,86], performance [43,70,91], and efficiency [41,70].

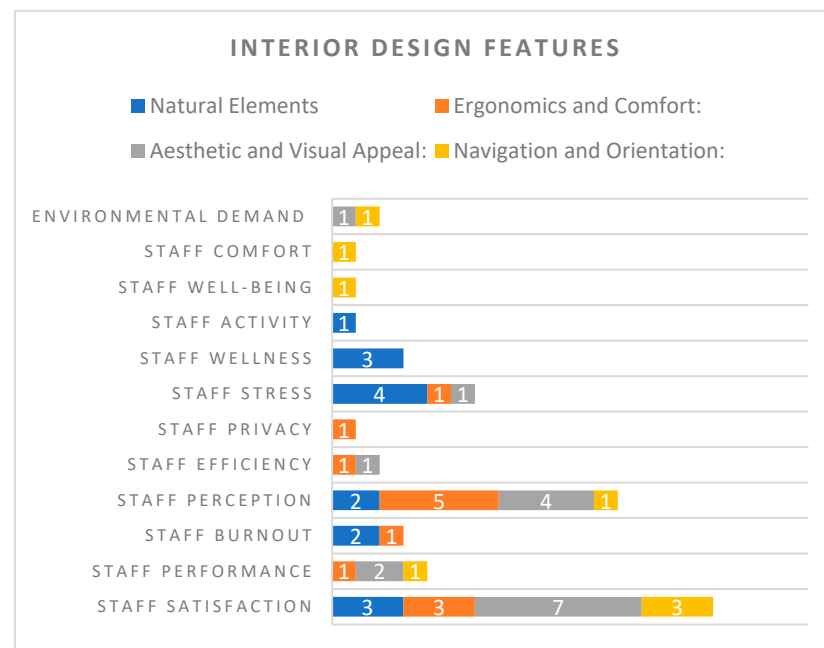


Figure 6. Total number of articles on the effects of interior design features on staff outcomes.

Natural Elements

In the healthcare context, incorporating natural elements such as gardens and landscaping can significantly impact staff well-being by reducing stress and providing a calming environment. Features such as aquariums also contribute to a soothing atmosphere, promoting staff wellness [80] and helping to alleviate anxiety and stress levels among staff [49]. Additionally, integrating artwork into healthcare spaces can boost morale and create a positive and inspiring atmosphere, ultimately reducing stress [49] and burnout [34] and improving satisfaction [64], wellness [80], activity [81], and perception [53] among staff. Furthermore, the projection of nature scenes (animations) on walls and ceilings improves staff satisfaction [52], and the presence of water features reduces stress [49].

Ergonomics and Comfort

In healthcare settings, prioritizing ergonomics and comfort for staff is essential for creating conducive work environments. Designing workspaces with ergonomic principles, such as adjustable desks and chairs, can significantly improve performance, efficiency, and perception [70] and reduce burnout [34] among staff members. Additionally, selecting comfortable and adjustable furniture supports good posture, reduces the risk of physical discomfort or injuries during long shifts, and improves satisfaction [84] and perception [31,53]. The incorporation of soft furnishings such as cushions and curtains further increases comfort levels, creating a warm and inviting atmosphere in staff areas and improving staff satisfaction [86] and perception [31,82].

Aesthetic and Visual Appeal

The aesthetic and visual appeal of healthcare settings are significantly influenced by elements such as flooring, carpeting, color schemes, and overall aesthetics. Comfortable and supportive flooring materials help reduce fatigue and minimize the risk of slips and falls, ensuring a safer environment for staff and improving satisfaction [44,78]. The use of calming colors and appealing design elements creates a welcoming and soothing atmosphere, which can positively impact staff satisfaction [78,84] and perception [53,82]. A visually appealing environment enhances the overall experience, making the workspace more enjoyable and uplifting for healthcare staff by improving satisfaction [54,84], performance [70,91], perception [62,70], and efficiency [70].

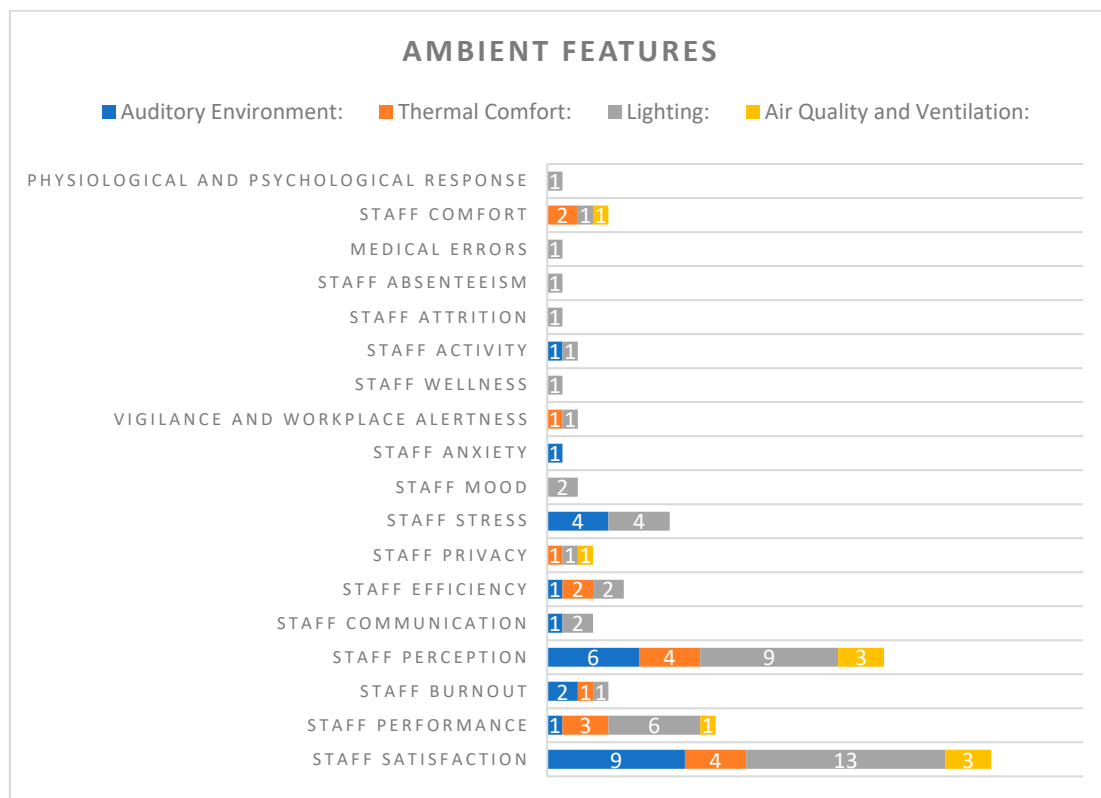


Figure 7. Total number of articles on the effects of ambient features on staff outcomes.

Auditory Environment

Ambient features are essential for creating a comfortable and efficient work environment. Integrating nature sounds or calming music into the auditory environment can help improve satisfaction [64], reduce stress, and improve focus, creating a more serene atmosphere for staff. Effective acoustic design in the healthcare setting impacts satisfaction [19,47,50,51,78,87,90], performance [70], perception [31,38,53,62,70,90], communication [90], efficiency [70], activity [38], comfort [47], burnout [19,34], stress [50,87,90], and anxiety [19].

Thermal Comfort

Thermal comfort is crucial for maintaining a comfortable work environment. Ensuring an optimal temperature is essential, as it prevents discomfort from excessive heat or cold, thereby enhancing staff satisfaction [47,53,84,85], performance [17,70], perception [31,53,70], efficiency [70], privacy [85], alertness [77], burnout [34], comfort [47], and productivity. Additionally, maintaining proper humidity levels is important for creating a comfortable atmosphere [47,70] as it reduces the risk of respiratory issues, contributes to a pleasant working environment, and improves efficiency and comfort.

Lighting

Lighting plays a pivotal role in creating an effective and pleasant work environment [96]. Access to natural daylight can significantly boost mood, energy levels, and overall well-being, which, in turn, leads to improved staff satisfaction [56,65,85,88], performance [17,22,70,88], communication [22], efficiency [56,70], privacy [85], mood [22,56], alertness [77], wellness [80], and activity [38] and reduced burnout [34], stress [56], attrition [23], absenteeism [23], and medical errors [23]. Additionally, adequate artificial lighting is essential for tasks that require precision, ensuring that staff can work efficiently even in areas with limited natural light, which can have an impact on satisfaction [45,47,50,52,65,68,79,84,90],

performance [79,95], stress [50,52,90], and comfort [47]. Together, these lighting elements significantly contribute to making the workplace more satisfying.

Air Quality and Ventilation

In the healthcare context, air quality and ventilation are vital for maintaining a healthy and comfortable work environment. Good ventilation systems ensure a constant supply of fresh air, which reduces the risk of airborne infections and helps maintain the overall health of users. Additionally, maintaining high air quality is essential for creating a pleasant working atmosphere, which significantly contributes to staff satisfaction, performance [43,47,84,85], and comfort [47]. Together, these elements ensure a safe, healthy, and comfortable environment for healthcare staff.

While examining the impacts of ambient features on staff experiences, the research articles revealed a strong focus on various outcomes. Staff satisfaction was a major theme, representing 29% of the research, with a significant emphasis on lighting (45%) and the auditory environment (31%). Staff perceptions were addressed in 22% of the articles, with lighting, again, being a primary focus (41%), followed by the auditory environment (27%). Staff performance, although less extensive, at 11%, highlights the critical role of lighting (55%) and thermal comfort (27%). Overall, the ambient feature studies indicated that lighting was the most frequently explored aspect, accounting for 48% of the research, followed by the auditory environment (26%) and thermal comfort (18%). These findings underscore the paramount importance of lighting in shaping staff satisfaction, perceptions, and performance while also highlighting the significant roles of auditory and thermal environments in creating optimal working conditions.

4.8. Overall Impact of the Physical Environment on Staff Outcomes

The findings of research articles shortlisted for this study highlight the varying emphasis placed on various physical environmental features concerning staff outcomes. Architectural design features received the most attention, with 52% of studies focusing on how these features impact staff experiences and outcomes. Ambient features, accounting for 32% of the research, highlight the importance of elements such as lighting, the auditory environment, and thermal comfort in shaping staff satisfaction, perceptions, and performance. Interior design features were the least studied in this context, comprising 16% of the research, indicating a smaller but still significant interest in aspects such as aesthetics, visual appeal, and ergonomics. These proportions reflect the critical role of spatial and environmental design in influencing staff well-being and efficiency, highlighting areas of greater research concentration and potential gaps for future exploration.

4.9. Theories, Models, and Frameworks

There were a few requirements that needed to be met to qualify the use of relevant theories. Theories used to emphasize the findings of a study have to be supported by appropriate references. Seven existing theories (attention restoration theory, stress reduction theory, space syntax theory, systems theory, person–environment fit theory, emotional congruence theory, and organizational theory), two new theories through inductive analysis (grounded theories), and three conceptual frameworks (organizational ecology, the environmental comfort model, the Donabedian model, the naturalistic model, and the new care model) were relevant and were used in the review articles. Most of the theories used are from the domain of environmental psychology and examine the relationship between humans and their environment. The studies also included multidisciplinary approaches to examine individual behavioral responses as well as motives. Only a few of the review studies focused on developing theoretical propositions by inductive analysis of participant data, as opposed to using pre-existing theoretical frameworks. Using “structure”, “process”, and “outcomes”, the conceptual Donabedian model offered a framework for reviewing health facilities and assessing the quality of healthcare. Table 10 lists the authors of the review articles and the theories or models they employed for the studies.

Table 10. Theories identified in this review.

Authors	Theory/Model
[64]	Attention restoration theory (ART)
[34]	Attention restoration theory and stress reduction theory
[74]	Becker and Parsons's (2007) organizational ecology Vischer's (2007, 2008) environmental comfort model of workspace quality
[39]	Space syntax theory
[75]	Systems theory
[57]	Grounded theory
[59,89]	Person–environment fit theory (Person–environment (P-E) congruence model)
[61,83]	New care model
[81]	Emotional congruence theory
[82]	Organization theory

5. Study Implications

This article consolidated findings from diverse geographical locations encompassing a wide range of physical environment factors, staff outcomes, theoretical applications, data collection techniques, etc. Although the researchers shared a common goal, i.e., to investigate the impact of physical environmental features on staff, most studies failed to identify the important features and levels at which these features have favorable and unfavorable effects on staff.

The majority of studies focused exclusively on outcomes among nurses (26 studies) in hospitals. The sample sizes ranged from 12 to 1561 staff. Few studies with multisite cross-sectional designs included large sample sizes. However, some studies with good study designs had relatively small sample sizes, limiting their generalizability. Most of the studies adopted non-random sampling ($n = 31$), while 29 did not report the sampling techniques adopted.

Our study revealed that only a few theories and conceptual frameworks ($n = 10$) were explicitly used in the review articles. The identified theories were from the field of environmental psychology and organizational behavior. Most of the studies did not mention or use any of the theories. It is crucial to employ theories when formulating research questions because they might affect the environmental characteristics that are analyzed and the connections between these characteristics and behavioral responses that are investigated. Theories are frequently employed to formulate research questions, devise research methodologies, and/or attempt to interpret results.

This review revealed the need to develop a comprehensive study involving the most important features of the three dimensions of the physical setting and to study the effects of these features on staff. The use of theories that explain the relationships between various constructs is of paramount importance in research. Table 11 shows the shortages in the reviewed articles and the possible directions for future research.

Table 11. Research gaps and directions for future research.

Shortages in Reviewed Articles	Research Gap Characteristics	Future Directions
The studies having a complex relationship between the environment and humans lacked empirical testing. Few studies used a dichotomous scale (yes versus no) while investigating the impacts of physical environmental features.	Evaluation gap	More empirical investigations by combining different techniques are needed. Multidimensional scaling techniques to understand the complex relationship between environmental variables and their impacts must be included in the research.

Table 11. Cont.

Shortages in Reviewed Articles	Research Gap Characteristics	Future Directions
The studies conducted to date provided no holistic solution for how the healthcare physical environment favorably affects staff. There were fewer studies from developing countries, as the majority of the previous studies were conducted in the United States. Generalizability was lacking. The majority of the studies also lacked how much the physical environmental features affected the various outcomes in healthcare professionals (efficiency, satisfaction, performance, productivity, etc.) The existing studies failed to include social, cultural, and behavioral considerations while studying the impact of the healthcare environment on its employees.	Knowledge void	Rigorous studies need to be conducted to identify the most important environmental features in the healthcare setting that have positive and negative outcomes among staff. This will help to strengthen evaluation methods by developing measurement instruments that describe different features of the physical environment. Social, cultural, and demographic variables should be included while investigating the impact of the environment on staff.
Theoretical application was absent in the majority of the studies. Most of the researchers did not show concern in applying environmental psychology theories, such as social learning theory (which promotes awareness of ingrained society standards); control theory (which discusses behavioral restrictions and how much control a person feels they have over their actions and behaviors); the theory of affordances (which provides an instantly recognizable function of environmental features); the preference model (positing that humans prefer engaging scenes to boring scenes); the pleasure–arousal–dominance hypothesis (positing that these three emotional responses translate into positive feelings); the behavior setting theory (positing that settings evoke particular patterns of behavior); and the biophilia hypothesis (positing that humans prefer being surrounded by nature).	Theoretical application void	The application of theories in studies about the healthcare environment has to be given more attention. It is crucial to use theories when posing research questions because theories can influence which environmental variables are addressed and which relationships between these elements and the behavioral responses of humans are examined. Researchers should describe theoretical constructs or conceptual structures and the relationships between physical environmental features based on these constructs or structures and link them to staff outcomes.
Even though there were a large number of mixed-method studies, the quantitative studies were equally large in number, and there were fewer qualitative studies. This implies that most studies did not consider both qualitative and quantitative methods, as the mixed method is a good approach to fully explore the research question. Most studies utilized only one research technique to study the effects.	Methodological void	Research problems and complicated phenomena can be better understood by combining qualitative and quantitative methodologies than by using just one of them. Future researchers should focus on utilizing both qualitative and quantitative tools.
The majority of earlier studies had study participants as nurses, implying a lack of studies on other healthcare professionals like physicians, technicians, and non-clinical staff.	Population void	A study on all healthcare professionals is required as they are exposed to a similar environment in healthcare settings.

6. Conclusions

To obtain insights into the impact of the physical environment on staff in healthcare settings, the research questions were defined, gaps were identified in the literature, and systematic directions were provided for prospective researchers. The results also suggest the need to include the social, cultural, and demographic information of staff while examining the impact of the physical setting on staff. The authors believe that this article offers helpful information about the state of the current literature on healthcare staff outcomes, which is critical because healthcare professionals are crucial in the healthcare service industry, as satisfied employees are more loyal to organizations and experience greater patient satisfaction. This review contributes to the literature by identifying the physical environmental variables in a healthcare setting. These variables were categorized based on the three dimensions of the physical environment, i.e., architectural design, interior design, and ambient elements. This study highlights that a comprehensive model needs to be developed to include important physical and environmental features to study their impacts on staff. The study also revealed important outcomes among staff in healthcare

settings. These included a wide range of outcomes among staff. Among all the outcomes, staff satisfaction was the most investigated.

Future research should focus on several key areas to gain comprehensive insights into their impacts on staff outcomes. In architectural design, the effects of biophilic elements, flexible spaces, and integrating design characteristics into spatial layouts and connections need further exploration to better understand their impacts on staff and the interactions with patients and coworkers. Longitudinal studies should assess the long-term benefits of natural integration, while simulation models can be used to replicate and analyze real-world systems to understand the behavior and predict outcomes. In interior design, the influence of ergonomic furniture, color schemes, and material choices requires more investigation. Ergonomic assessments using tools like posture analysis and user feedback; experimental designs on color psychology to explore how various color schemes and psychometric testing determine beneficial colors; and comparative studies on materials to guide material selection will provide valuable insights into enhancing the physical environment. Ambient design research should examine the effects of lighting, acoustics, and thermal comfort. Controlled experiments on lighting systems can explore the effects of various lighting conditions, such as natural versus artificial light. Sound mapping, which involves creating acoustic profiles of different environments, should be conducted to help understand the impact of noise levels. Cross-sectional studies in different climatic conditions can provide insights into how temperature, humidity, and airflow affect occupant comfort. By addressing these areas with clear and actionable recommendations, future research can enhance evidence-based design practices and optimize built environments for improved staff outcomes.

The findings presented encourage the development of future investigations that can aid healthcare designers, hospital administrators, and designers in providing better design recommendations for healthcare settings. Furthermore, this study provides insights into the administrative aspects of healthcare facilities, with an emphasis on the well-being of workplace staff. It examined factors influencing satisfaction, productivity, performance, etc., and offers avenues for improvement in healthcare facility administration. The results serve as a basis for establishing policies and procedures to increase stakeholder satisfaction, optimize operational efficiency, and improve overall care.

This study investigated the theoretical implications of the review articles by providing insights into theoretical frameworks that strengthen the understanding of how the physical environment influences staff outcomes. Only a few articles used theories when presenting the rationale for research on the physical environment in healthcare. This review emphasizes that future researchers should explicitly use theories as they can powerfully influence how evidence is collected, analyzed, understood, and used.

This research focused on addressing specific research questions. Despite our best efforts, the sheer volume of articles may have prevented the literature search from capturing all pertinent studies. Nevertheless, this review contributes new insights to the knowledge on healthcare design. The gaps identified in this study will permit future researchers to undertake additional studies and provide design recommendations for staff workplaces in healthcare settings for overall well-being.

A few limitations of this study are that this review did not report contextual factors, such as organizational culture and management practices, which could significantly influence staff outcomes. Another limitation of this study is the lack of quantitative synthesis. While qualitative synthesis provides valuable insights, it does not offer the same level of statistical rigor that a meta-analysis would.

Author Contributions: This manuscript is a result of collaboration among all the authors. Conceptualization, R.S.S. and G.B.K.; methodology, R.S.S. and G.B.K.; validation, R.S.S., G.B.K. and L.L.R.R.; formal analysis, R.S.S. and G.B.K.; writing—original draft preparation, R.S.S., G.B.K. and S.R.S.; writing—review and editing, R.S.S. and S.R.S.; supervision, G.B.K. and R.D.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Plsek, P.E.; Greenhalgh, T. The Challenge of Complexity in Health Care. *Bmj* **2001**, *323*, 625–628. [\[CrossRef\]](#) [\[PubMed\]](#)
2. Dash, S.; Shakyawar, S.K.; Sharma, M.; Kaushik, S. Big Data in Healthcare: Management, Analysis and Future Prospects. *J. Big Data* **2019**, *6*, 54. [\[CrossRef\]](#)
3. Huisman, E.R.C.M.; Morales, E.; van Hoof, J.; Kort, H.S.M. Healing Environment: A Review of the Impact of Physical Environmental Factors on Users. *Build. Environ.* **2012**, *58*, 70–80. [\[CrossRef\]](#)
4. Joseph, A. *The Role of the Physical and Social Environment in Promoting Health, Safety, and Effectiveness in the Healthcare Workplace*; Center for Health Design: Concord, CA, USA, 2006.
5. Gharaveis, A.; Hamilton, D.K.; Pati, D. The Impact of Environmental Design on Teamwork and Communication in Healthcare Facilities: A Systematic Literature Review. *Health Environ. Res. Des. J.* **2018**, *11*, 119–137. [\[CrossRef\]](#) [\[PubMed\]](#)
6. Harris, P.B.; McBride, G.; Ross, C.; Curtis, L. A Place to Heal: Environmental Sources of Satisfaction among Hospital Patients. *J. Appl. Soc. Psychol.* **2002**, *32*, 1276–1299. [\[CrossRef\]](#)
7. Dijkstra, K.; Pieterse, M.; Pruyn, A. Physical Environmental Stimuli That Turn Healthcare Facilities into Healing Environments through Psychologically Mediated Effects: Systematic Review. *J. Adv. Nurs.* **2006**, *56*, 166–181. [\[CrossRef\]](#) [\[PubMed\]](#)
8. Nejati, A.; Shepley, M.; Rodiek, S.; Lee, C.; Varni, J. Restorative Design Features for Hospital Staff Break Areas: A Multi-Method Study. *Health Environ. Res. Des. J.* **2016**, *9*, 16–35. [\[CrossRef\]](#) [\[PubMed\]](#)
9. Mustafa, F.A.; Ahmed, S.S. The Role of Waiting Area Typology in Limiting the Spread of COVID-19: Outpatient Clinics of Erbil Hospitals as a Case Study. *Indoor Built Environ.* **2023**, *32*, 1914–1928. [\[CrossRef\]](#)
10. Brambilla, A.; Rebecchi, A.; Capolongo, S. Evidence Based Hospital Design. A Literature Review of the Recent Publications about the EBD Impact of Built Environment on Hospital Occupants' and Organizational Outcomes. *Ann. Ig.* **2019**, *31*, 165–180. [\[CrossRef\]](#)
11. Schooley, B.L.; Tarcan, M. Comparing Burnout Across Emergency Physicians, Nurses, Technicians, and Health Information Technicians Working for the Same Organization. *Medicine* **2016**, *95*, e2856. [\[CrossRef\]](#)
12. Joseph, A.; Choi, Y.S.; Quan, X. Impact of the Physical Environment of Residential Health, Care, and Support Facilities (RHCSF) on Staff and Residents: A Systematic Review of the Literature. *Environ. Behav.* **2016**, *48*, 1203–1241. [\[CrossRef\]](#)
13. Li, Y.; Scherer, N.; Felix, L.; Kuper, H. Prevalence of Depression, Anxiety and Posttraumatic Stress Disorder in Health Care Workers during the COVID-19 Pandemic: A Systematic Review and Meta-Analysis. *PLoS ONE* **2021**, *16*, e0246454. [\[CrossRef\]](#)
14. Lacy, B.E.; Chan, J.L. Physician Burnout: The Hidden Health Care Crisis. *Clin. Gastroenterol. Hepatol.* **2018**, *16*, 311–317. [\[CrossRef\]](#) [\[PubMed\]](#)
15. Vizheh, M.; Qorbani, M.; Arzaghi, S.M.; Muhidin, S.; Javanmard, Z.; Esmaeili, M. The Mental Health of Healthcare Workers in the COVID-19 Pandemic: A Systematic Review. *J. Diabetes Metab. Disord.* **2020**, *19*, 1967–1978. [\[CrossRef\]](#) [\[PubMed\]](#)
16. Ulrich, R.S.; Zimring, C.; Quan, X.; Joseph, A.; Choudhary, R. *The Role of the Physical Environment in the Hospital of the 21st Century: A Once-in-a-Lifetime Opportunity* By; Center for Health Design: Concord, CA, USA, 2004; pp. 1–69.
17. Obeidat, B.; Bani, M.; Al-shloul, E. Heliyon Investigations into the Impact of Nursing Unit Layout on Critical Care Nurses. *Heliyon* **2022**, *8*, e08929. [\[CrossRef\]](#) [\[PubMed\]](#)
18. Fauer, A.; Wright, N.; Lafferty, M.; Harrod, M.; Manojlovich, M.; Friese, C.R. Influences of Physical Layout and Space on Patient Safety and Communication in Ambulatory Oncology Practices: A Multisite, Mixed Method Investigation. *Health Environ. Res. Des. J.* **2021**, *14*, 270–286. [\[CrossRef\]](#) [\[PubMed\]](#)
19. Terzi, B.; Azizoglu, F.; Polat, S.; Kaya, N.; İşsever, H. The Effects of Noise Levels on Nurses in Intensive Care Units. *Nurs. Crit. Care* **2019**, *24*, 299–305. [\[CrossRef\]](#) [\[PubMed\]](#)
20. Ulrich, R.S.; Zimring, C.; Zhu, X.; DuBose, J.; Seo, H.-B.; Choi, Y.-S.; Quan, X.; Joseph, A. A Review of the Research Literature on Evidence-Based Healthcare Design (Part I) Abstract Introduction Background. *Health Environ. Res. Des.* **2008**, *1*, 61–125.
21. Laursen, J.; Danielsen, A.; Rosenberg, J. Effects of Environmental Design on Patient Outcome: A Systematic Review. *HERD Health Environ. Res. Des. J.* **2014**, *7*, 108–119. [\[CrossRef\]](#)
22. Zadeh, R.S.; Shepley, M.M.; Ba, D.; Williams, G.; Sung, S.; Chung, E. The Impact of Windows and Daylight on Acute-Care Nurses' Physiological, Psychological, and Behavioral Health. *HERD Health Environ. Res. Des. J.* **2014**, *7*, 35–61. [\[CrossRef\]](#)
23. Shepley, M.M.; Gerbi, R.P.; Watson, A.E.; Imgrund, S.; Sagah-Zadeh, R. The Impact of Daylight and Views on ICU Patients and Staff. *Health Environ. Res. Des. J.* **2011**, *5*, 46–60. [\[CrossRef\]](#) [\[PubMed\]](#)
24. Rafeeq, D.A.; Mustafa, F.A. Evidence-Based Design: The Role of Inpatient Typology in Creating Healing Environment, Hospitals in Erbil City as a Case Study. *Ain Shams Eng. J.* **2021**, *12*, 1073–1087. [\[CrossRef\]](#)
25. Mustafa, F.A.; Ali, J.S. Active Design: Architectural Interventions for Improving Occupational Health Through Reducing Sedentary Behavior—A Systematic Review. *Am. J. Health Promot.* **2023**, *37*, 93–102. [\[CrossRef\]](#) [\[PubMed\]](#)
26. Maassen, S.M.; Van Oostveen, C.; Vermeulen, H.; Weggelaar, A.M. Defining a Positive Work Environment for Hospital Healthcare Professionals: A Delphi Study. *PLoS ONE* **2021**, *16*, e0247530. [\[CrossRef\]](#)

27. Jin, H.; Gold, C.; Cho, J.; Marzban, F.; Lim, L. The Role of Healthcare Facility Design on the Mental Health of Healthcare Professionals: A Literature Review. *HERD Health Environ. Res. Des. J.* **2023**, *16*, 270–286. [[CrossRef](#)] [[PubMed](#)]
28. Valipoor, S. In the Moment: Fostering Mindfulness and Reducing Stressors in the Healthcare Workplace. *HERD Health Environ. Res. Des. J.* **2021**, *14*, 386–398. [[CrossRef](#)] [[PubMed](#)]
29. Nordin, S.; Swall, A.; Anåker, A.; Koch, L. Von Does the Physical Environment Matter ?—A Qualitative Study of Healthcare Professionals’ Experiences of Newly Built Stroke Units. *Int. J. Qual. Stud. Health Well-Being* **2021**, *16*, 1917880. [[CrossRef](#)] [[PubMed](#)]
30. Pati, D.; Lorusso, L.N. How to Write a Systematic Review of the Literature. *Health Environ. Res. Des. J.* **2018**, *11*, 15–30. [[CrossRef](#)]
31. Sadatsafavi, H.; Walewski, J.; Shepley, M.M. Factors Influencing Evaluation of Patient Areas, Work Spaces, and Staff Areas by Healthcare Professionals. *Indoor Built Environ.* **2015**, *24*, 439–456. [[CrossRef](#)]
32. Lim, L.; Kanfer, R.; Stroebel, R.J.; Zimring, C.M. Beyond Co-Location: Visual Connections of Staff Workstations and Staff Communication in Primary Care Clinics. *Environ. Behav.* **2020**, *54*, 3–35. [[CrossRef](#)]
33. Joshi, R.; Joseph, A.; Ossmann, M.; Taaffe, K.; Pirrallo, R.; Allison, D.; Perino, L.C. Emergency Physicians’ Workstation Design: An Observational Study of Interruptions and Perception of Collaboration During Shift-End Handoffs. *Health Environ. Res. Des. J.* **2021**, *14*, 174–193. [[CrossRef](#)] [[PubMed](#)]
34. Mihandoust, S.; Pati, D.; Lee, J.; Roney, J. Exploring the Relationship Between Perceived Visual Access to Nature and Nurse Burnout. *Health Environ. Res. Des. J.* **2021**, *14*, 258–273. [[CrossRef](#)] [[PubMed](#)]
35. de Matos, L.B.N.; Fumis, R.R.L.; Nassar Junior, A.P.; Lacerda, F.H.; Caruso, P. Single-Bed or Multibed Room Designs Influence ICU Staff Stress and Family Satisfaction, But Do Not Influence ICU Staff Burnout. *Health Environ. Res. Des. J.* **2020**, *13*, 234–242. [[CrossRef](#)] [[PubMed](#)]
36. Valipoor, S.; Hakimjavadi, H.; De Portu, G. Design Strategies to Improve Emergency Departments’ Performance During Mass Casualty Incidents: A Survey of Caregivers. *Health Environ. Res. Des. J.* **2020**, *13*, 206–220. [[CrossRef](#)] [[PubMed](#)]
37. Zamani, Z. Effects of Emergency Department Physical Design Elements on Security, Wayfinding, Visibility, Privacy, and Efficiency and Its Implications on Staff Satisfaction and Performance. *Health Environ. Res. Des. J.* **2019**, *12*, 72–88. [[CrossRef](#)] [[PubMed](#)]
38. Broom, M.; Kecskes, Z.; Kildea, S.; Gardner, A. Exploring the Impact of a Dual Occupancy Neonatal Intensive Care Unit on Staff Workflow, Activity, and Their Perceptions. *Health Environ. Res. Des. J.* **2019**, *12*, 44–54. [[CrossRef](#)] [[PubMed](#)]
39. Brewer, B.B.; Carley, K.M.; Benham-Hutchins, M.; Effken, J.A.; Reminga, J. Nursing Unit Design, Nursing Staff Communication Networks, and Patient Falls: Are They Related? *Health Environ. Res. Des. J.* **2018**, *11*, 82–94. [[CrossRef](#)] [[PubMed](#)]
40. Cordoza, M.; Ulrich, R.S.; Manulik, B.J.; Gardiner, S.K.; Fitzpatrick, P.S.; Hazen, T.M.; Mirka, A.; Perkins, R.S. Impact of Nurses Taking Daily Work Breaks in a Hospital Garden on Burnout. *Am. J. Crit. Care* **2018**, *27*, 508–512. [[CrossRef](#)] [[PubMed](#)]
41. Fay, L.; Carll-White, A.; Real, K. Emergency Nurses’ Perceptions of Efficiency and Design: Examining ED Structure, Process, and Outcomes. *J. Emerg. Nurs.* **2018**, *44*, 274–279. [[CrossRef](#)]
42. Alvaro, C.; Wilkinson, A.J.; Gallant, S.N.; Kostovski, D.; Gardner, P. Evaluating Intention and Effect: The Impact of Healthcare Facility Design on Patient and Staff Well-Being. *Health Environ. Res. Des. J.* **2016**, *9*, 82–104. [[CrossRef](#)]
43. Schreuder, E.; van Heel, L.; Goedhart, R.; Dusseldorp, E.; Schraagen, J.M.; Burdorf, A. Effects of Newly Designed Hospital Buildings on Staff Perceptions: A Pre-Post Study to Validate Design Decisions. *Health Environ. Res. Des. J.* **2015**, *8*, 77–97. [[CrossRef](#)] [[PubMed](#)]
44. Harris, D.D. The Influence of Flooring on Environmental Stressors: A Study of Three Flooring Materials in a Hospital. *Health Environ. Res. Des. J.* **2015**, *8*, 9–29. [[CrossRef](#)] [[PubMed](#)]
45. Robinson, P.S.; Green, J. Ambient versus Traditional Environment in Pediatric Emergency Department. *Health Environ. Res. Des. J.* **2015**, *8*, 71–80. [[CrossRef](#)] [[PubMed](#)]
46. Horiguchi, M.; Shudo, E.; Sato, K.; Nakamura, M.; Sai, W.; Ohinata, T. Nurse Odor Perception in Various Japanese Hospital Settings. *Int. J. Nurs. Sci.* **2015**, *2*, 355–360. [[CrossRef](#)]
47. Kim, S.K.; Hwang, Y.; Lee, Y.S.; Corser, W. Occupant Comfort and Satisfaction in Green Healthcare Environments: A Survey Study Focusing on Healthcare Staff. *J. Sustain. Dev.* **2015**, *8*, 156–173. [[CrossRef](#)]
48. Bayramzadeh, S.; Associate, G.; Alkazemi, M.F. Centralized vs. Decentralized Nursing Stations: An Evaluation of the Implications of Communication Technologies in Healthcare. *HERD Health Environ. Res. Des. J.* **2014**, *7*, 62–80. [[CrossRef](#)] [[PubMed](#)]
49. Yen-Ju Lin, B.; Lin, Y.-K.; Wen Juan, C.; Lee, S.; Lin, C.-C. Moderating Role of Interior Amenities on Hospital Medical Directors’ Patient-Related Work Stresses. *HERD Health Environ. Res. Des. J.* **2013**, *91*, 77–92.
50. Campos-Andrade, C.; Hernándezfernaud, E.; Lima, M.L. A Better Physical Environment in the Workplace Means Higher Well-Being A Study with Healthcare Professionals. *Psychology* **2013**, *4*, 89–110. [[CrossRef](#)]
51. Trickey, A.W.; Arnold, C.C.; Parmar, A.; Lasky, R.E. Sound Levels, Staff Perceptions, and Patient Outcomes During Renovation Near the Neonatal Intensive Care Unit. *HERD Health Environ. Res. Des. J.* **2012**, *5*, 76–87. [[CrossRef](#)]
52. Quan, X.; Joseph, A.; Ensign, J.C. Impact of Imaging Room Environment: Staff Job Stress and Satisfaction, Patient Satisfaction, and Willingness to Recommend. *HERD Health Environ. Res. Des. J.* **2012**, *5*, 61–79. [[CrossRef](#)]
53. Mourshed, M.; Zhao, Y. Healthcare Providers’ Perception of Design Factors Related to Physical Environments in Hospitals. *J. Environ. Psychol.* **2012**, *32*, 362–370. [[CrossRef](#)]

54. Marie Kotzer, A.; Koch Zacharakis, S.; Raynolds, M.; Aia, A.; Buening, F. Evaluation of the Built Environment: Staff and Family Satisfaction Pre-and Post-Occupancy of the Children's Hospital. *HERD Health Environ. Res. Des. J.* **2011**, *4*, 60–78. [[CrossRef](#)] [[PubMed](#)]
55. Hjørhøy, L.G.; Thomsen, T.G.; Beck, M. Physical Environment as a Tool in Caring for the Hospitalized Patient: A Qualitative Study of Nurses' Experiences in Hospitals. *Health Environ. Res. Des. J.* **2022**, *15*, 143–153. [[CrossRef](#)] [[PubMed](#)]
56. Gharaveis, A.; Yekita, H.; Shamloo, G. The Perceptions of Nurses About the Behavioral Needs for Daylighting and View to the Outside in Inpatient Facilities. *Health Environ. Res. Des. J.* **2020**, *13*, 191–205. [[CrossRef](#)]
57. Haywood, A.; Barnes, S.; Marsh, H.; Parker, S.G. Does the Design of Settings Where Acute Care Is Delivered Meet the Needs of Older People? Perspectives of Patients, Family Carers, and Staff. *Health Environ. Res. Des. J.* **2018**, *11*, 177–188. [[CrossRef](#)] [[PubMed](#)]
58. Pati, D.; Pati, S.; Harvey, T.E. Security Implications of Physical Design Attributes in the Emergency Department. *Health Environ. Res. Des. J.* **2016**, *9*, 50–63. [[CrossRef](#)] [[PubMed](#)]
59. Durosaiye, I.O.; Hadjri, K.; Liyanage, C.L. Identifying Challenging Job and Environmental Demands of Older Nurses Within the National Health Service. *Health Environ. Res. Des. J.* **2016**, *9*, 82–105. [[CrossRef](#)] [[PubMed](#)]
60. Harte, J.D.; Sheehan, A.; Stewart, S.C.; Foureur, M. Childbirth Supporters' Experiences in a Built Hospital Birth Environment: Exploring Inhibiting and Facilitating Factors in Negotiating the Supporter Role. *Health Environ. Res. Des. J.* **2016**, *9*, 135–161. [[CrossRef](#)] [[PubMed](#)]
61. Rippin, A.S.; Zimring, C.; Samuels, O.; Denham, M.E. Finding a Middle Ground: Exploring the Impact of Patient- and Family-Centered Design on Nurse–Family Interactions in the Neuro ICU. *Health Environ. Res. Des. J.* **2015**, *9*, 80–98. [[CrossRef](#)]
62. Locatelli, S.M.; Turcios, S.; LaVela, S.L. Optimizing the Patient-Centered Environment Results of Guided Tours with Health Care Providers and Employees. *Health Environ. Res. Des. J.* **2015**, *8*, 18–30. [[CrossRef](#)]
63. Bosch, S.J.; Lorusso, L.N. Promoting Patient and Family Engagement through Healthcare Facility Design: A Systematic Literature Review. *J. Environ. Psychol.* **2019**, *62*, 74–83. [[CrossRef](#)]
64. Zhu, X. Assessing Preferences and Perceived Restorative Qualities of Break Spaces for Nurses in China. *HERD Health Environ. Res. Des. J.* **2022**, *15*, 126–142. [[CrossRef](#)] [[PubMed](#)]
65. Chang, W.; Cohen, J.; Mwesigwa, B.; Waiswa, P.; Rokicki, S. Impact of Reliable Light and Electricity on Job Satisfaction among Maternity Health Workers in Uganda: A Cluster Randomized Trial. *Hum. Resour. Health* **2022**, *20*, 30. [[CrossRef](#)] [[PubMed](#)]
66. Ma, M.; Adeney, M.; Long, H. Functional Settings of Hospital Outdoor Spaces and the Perceptions from Public and Hospital Occupant during COVID-19. *Healthcare* **2021**, *9*, 1534. [[CrossRef](#)] [[PubMed](#)]
67. Ahmadpour, S.; Bayramzadeh, S.; Aghaei, P. Efficiency and Teamwork in Emergency Departments: Perception of Staff on Design Interventions. *Health Environ. Res. Des. J.* **2021**, *14*, 310–323. [[CrossRef](#)] [[PubMed](#)]
68. Davis, R.G.; McCunn, L.J.; Wilkerson, A.; Safranek, S. Nurses' Satisfaction with Patient Room Lighting Conditions: A Study of Nurses in Four Hospitals with Differences in the Environment of Care. *Health Environ. Res. Des. J.* **2020**, *13*, 110–124. [[CrossRef](#)] [[PubMed](#)]
69. Xuan, X.; Chen, X.; Li, Z. Impacts of Nursing Unit Design on Visibility and Proximity and Its Influences on Communication, Privacy, and Efficiency. *Health Environ. Res. Des. J.* **2020**, *13*, 200–217. [[CrossRef](#)]
70. Freihoefer, K.; Lindval, S.; Bayramzadeh, S.; Hanson, L. Implications of a Decentralized Postpartum Unit Design and Clinical Operations. *Health Environ. Res. Des. J.* **2019**, *12*, 39–52. [[CrossRef](#)]
71. Zamani, Z.; Harper, E.C. Exploring the Effects of Clinical Exam Room Design on Communication, Technology Interaction, and Satisfaction. *Health Environ. Res. Des. J.* **2019**, *12*, 99–115. [[CrossRef](#)]
72. Wingler, D.; Machry, H.; Bayramzadeh, S.; Joseph, A.; Allison, D. Comparing the Effectiveness of Four Different Design Media in Communicating Desired Performance Outcomes with Clinical End Users. *Health Environ. Res. Des. J.* **2019**, *12*, 87–99. [[CrossRef](#)]
73. Xuan, X.; Li, Z.; Chen, X. An Empirical Examination of Nursing Units in China Based on Nurse Experience. *Health Environ. Res. Des. J.* **2019**, *12*, 108–123. [[CrossRef](#)] [[PubMed](#)]
74. Naccarella, L.; Raggatt, M.; Redley, B. The Influence of Spatial Design on Team Communication in Hospital Emergency Departments. *Health Environ. Res. Des. J.* **2019**, *12*, 100–115. [[CrossRef](#)] [[PubMed](#)]
75. Real, K.; Fay, L.; Isaacs, K.; Carll-White, A.; Schadler, A. Using Systems Theory to Examine Patient and Nurse Structures, Processes, and Outcomes in Centralized and Decentralized Units. *Health Environ. Res. Des. J.* **2018**, *11*, 22–37. [[CrossRef](#)]
76. Bayramzadeh, S.; Joseph, A.; San, D.; Khoshkenar, A.; Taaffe, K.; Jafarifiroozabadi, R.; Neyens, D.M. The Impact of Operating Room Layout on Circulating Nurse's Work Patterns and Flow Disruptions: A Behavioral Mapping Study. *Health Environ. Res. Des. J.* **2018**, *11*, 124–138. [[CrossRef](#)] [[PubMed](#)]
77. Sagah Zadeh, R.; Shepley, M.; Sadatsafavi, H.; Owora, A.H.; Krieger, A.C. Alert Workplace from Healthcare Workers' Perspective: Behavioral and Environmental Strategies to Improve Vigilance and Alertness in Healthcare Settings. *Health Environ. Res. Des. J.* **2018**, *11*, 72–88. [[CrossRef](#)] [[PubMed](#)]
78. Copeland, D.; Chambers, M. Effects of Unit Design on Acute Care Nurses' Walking Distances, Energy Expenditure, and Job Satisfaction: A Pre–Post Relocation Study. *Health Environ. Res. Des. J.* **2017**, *10*, 22–36. [[CrossRef](#)]
79. Hadi, K.; DuBose, J.R.; Ryherd, E. Lighting and Nurses at Medical–Surgical Units: Impact of Lighting Conditions on Nurses' Performance and Satisfaction. *Health Environ. Res. Des. J.* **2016**, *9*, 17–30. [[CrossRef](#)] [[PubMed](#)]

80. Trau, D.; Keenan, K.A.; Goforth, M.; Large, V. Nature Contacts: Employee Wellness in Healthcare. *Health Environ. Res. Des. J.* **2016**, *9*, 47–62. [[CrossRef](#)]
81. Ho, R.T.H.; Potash, J.S.; Fang, F.; Rollins, J. Art Viewing Directives in Hospital Settings Effect on Mood. *Health Environ. Res. Des. J.* **2015**, *8*, 30–43. [[CrossRef](#)]
82. Steinke, C. Assessing the Physical Service Setting: A Look at Emergency Departments. *Health Environ. Res. Des. J.* **2015**, *8*, 31–42. [[CrossRef](#)]
83. Pati, D.; Harvey, T.E.; Redden, P.; Summers, B.; Pati, S. An Empirical Examination of the Impacts of Decentralized Nursing Unit Design. *Health Environ. Res. Des. J.* **2015**, *8*, 56–70. [[CrossRef](#)] [[PubMed](#)]
84. Djukic, M.; Kovner, C.T.; Brewer, C.S.; Fatehi, F.; Greene, W.H. Exploring Direct and Indirect Influences of Physical Work Environment on Job Satisfaction for Early-Career Registered Nurses Employed in Hospitals. *Res. Nurs. Health* **2014**, *37*, 312–325. [[CrossRef](#)] [[PubMed](#)]
85. Rashid, M.; Boyle, D.K.; Crosser, M. Developing Nurse and Physician Questionnaires to Assess Primary Work Areas in Intensive Care Units. *Crit. Care Nurs. Q.* **2014**, *37*, 317–335. [[CrossRef](#)] [[PubMed](#)]
86. Guinther, L.; Carll-White, A.; Real, K.; Zephyr, D.; Bathke, A.; Smith, T.; Glass, B. One Size Does Not Fit All: A Diagnostic Post-Occupancy Evaluation Model for an Emergency Department. *HERD Health Environ. Res. Des. J.* **2014**, *7*, 15–37. [[CrossRef](#)] [[PubMed](#)]
87. Wang, Z. Role of a Service Corridor in ICU Noise Control, Staff Stress, and Staff Satisfaction: Environmental Research of an Academic Medical Center. *HERD Health Environ. Res. Des. J.* **2013**, *6*, 80–94. [[CrossRef](#)]
88. Dianat, I.; Sedghi, A.; Bagherzade, J.; Jafarabadi, M.A.; Stedmon, A.W. Objective and Subjective Assessments of Lighting in a Hospital Setting: Implications for Health, Safety and Performance. *Ergonomics* **2013**, *56*, 1535–1545. [[CrossRef](#)]
89. Dendaas, N. Environmental Congruence and Work-Related Stress in Acute Care Hospital Medical/Surgical Units: A Descriptive, Correlational Study. *HERD Health Environ. Res. Des. J.* **2011**, *5*, 23–42. [[CrossRef](#)] [[PubMed](#)]
90. Bosch, S.; Bledsoe, T.; Arnp-Bc, N.; Jenzarli, A.; Sykes, J.H. Staff Perceptions Before and After Adding Single-Family Rooms in the NICU. *HERD Health Environ. Res. Des. J.* **2012**, *5*, 64–75. [[CrossRef](#)] [[PubMed](#)]
91. Winger, D.; Hector, R. Demonstrating the Effect of the Built Environment on Staff Health-Related Quality of Life in Ambulatory Care Environments. *Health Environ. Res. Des. J.* **2015**, *8*, 25–40. [[CrossRef](#)]
92. Gharaveis, A.; Hamilton, D.K.; Pati, D.; Shepley, M. The Impact of Visibility on Teamwork, Collaborative Communication, and Security in Emergency Departments: An Exploratory Study. *Health Environ. Res. Des. J.* **2018**, *11*, 37–49. [[CrossRef](#)]
93. Zadeh, R.S.; Shepley, M.M.; Waggner, L.T.; Sagha Zadeh, R. Rethinking Efficiency in Acute Care Nursing Units: Analyzing Nursing Unit Layouts for Improved Spatial Flow. *HERD Health Environ. Res. Des. J.* **2012**, *6*, 39–65. [[CrossRef](#)] [[PubMed](#)]
94. Sadatsafavi, H.; Walewski, J. Corporate Sustainability: The Environmental Design and Human Resource Management Interface in Healthcare Settings. *HERD Health Environ. Res. Des. J.* **2013**, *6*, 98–118. [[CrossRef](#)] [[PubMed](#)]
95. Davis, B.E. Rooftop Hospital Gardens for Physical Therapy: A Post-Occupancy Evaluation. *HERD Health Environ. Res. Des. J.* **2011**, *4*, 14–43. [[CrossRef](#)] [[PubMed](#)]
96. Joseph, A. *The Impact of Light on Outcomes in Healthcare Settings*; Center for Health Design: Concord, CA, USA, 2006.

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.