Healing architecture
A review of the impact of biophilic design on users

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ABSTRACT: This paper presents a systematic review conducted to identify, compare and synthesize published qualitative and quantitative data related to biophilic design parameters and their impact on human health and well-being within therapeutic environments, from the user's perspective. This work is part of a broader research study whose ultimate goal is the redefinition of a holistic and scientifically underpinned biophilic design framework for therapeutic environments. This study aims to specifically collect, identify, analyse and hierarchise those biophilic design parameters critical for clinical environments, in a way that can more efficiently guide designers. This paper focuses on explaining our research methodology and presenting the resulting key biophilic parameters for each type of user and space.
KEYWORDS: Therapeutic Environment, Biophilic Design, Systematic Review

1. INTRODUCTION

The biophilic design discipline refers to the innate human connection to nature and natural processes to promote health and well-being in the spaces we inhabit (E. Wilson, 1984; E. O. Wilson, 1979). The principles that define biophilic design can be examined from three different perspectives: as established in building regulations and standards, as used in design practice and as investigated in research practice. When examining each of these areas, we can find several issues and disconnections. In practice and regulatory frameworks, we can observe the use of an unbounded design framework that is not underpinned by scientific facts and do not prioritise principles or parameters. In scientific academic environments, there is abundant research on many of the different aspects of biophilic design, but all of this in-depth research providing scientific facts about the importance of nature on humans has happened separately or for a specific design parameter, and not in a holistic way. Thus, the ultimate goal of this research project is the redefinition of a holistic and scientifically underpinned biophilic design framework, with a focus on therapeutic environments. This research also aims to hierarchise the biophilic design parameters included in the new framework in a way that can more efficiently guide designers. Our thesis believes that an efficient biophilic design framework should be specific to building function and context, where only specific parameters from the established general frameworks are relevant. There are three established general frameworks of biophilic design parameters (Browning et al., 2014; Kellert et al., 2011; Kellert & Calabrese, 2015).These parameters relate not only to the physical environment (e.g., Fresh Air, Daylight, Thermal Comfort, Multisensory Environment, Spaciousness, View, Natural Colour, Greenery-Plants, Natural Material Seasonal Changes, Water) but also to emotional and psychological wellbeing (e.g., Refuge-Privacy, Prospect, Sense of Belonging, Curiosity, Welcoming and Relaxing Feelings, Mastery and Control).

The provision of healthcare has evolved to what has been termed 'Factory Hospitals', where the design focuses on the efficient delivery of medical mass treatment, regardless of the mental and sensory well-being of human-beings (Jencks, 2017). Patients receiving a chronic disease diagnosis and undergoing treatment might be subjected to high levels of psychological distress, with many reporting symptoms of fatigue, anxiety or depression (Zabora et al., 1997). As there is evidence of growing research interest in nature's role in physically and psychologically supporting patients, this research aimed to provide an account of generated knowledge from users' experiences, to better inform human-centred policy and design. This paper specifically discusses a systematic review conducted to identify, compare and synthesize the published scholarly literature on biophilic design parameters and their impact on human health and well-being within clinical therapeutic environments, from the user's perspective.

	Inclusion Criteria	Exclusion Criteria
Population	Those who use therapeutic places regularly	Those who are not related to therapeutic environments
Nature of the Intervention	Therapeutic environment, Clinical settings Healing environment, Hospitals or healthcare	Retail or shopping, Residential buildings, Neighbourhoods or urban districts, Universities or schools, Workspace or Office setting
Comparators	Biophilic design parameters, Biophilic variables of the biophilic design patterns	Non-biophilic elements
Outcomes	Studies that give strong insights or scientific facts to compare or rank a cluster of biophilic patterns	Studies that examine only one or an inadequate number of patterns.
Cultural / Linguistic	English	Non-English
Period	1973 to current	Pre-1973
Study Design	Empirical research, Qualitative or Quantitative Any primary comparative study	News, reports and reviews
Types of Documents	Academic Journals	Editorials commentaries, News reports, Magazines, Books, Reports, Proceedings (published or unpublished) Thesis or Dissertation

Table 1:
Inclusion and exclusion criteria

2. METHODOLOGY

The systematic review methodology follows a review question, a systematic search strategy, screening and selection of literature, data extraction and quality assessment. The general review question decided for this research is:

a) Which biophilic criteria are most critical in a clinical therapeutic environment
b) and in which way they inform design?

This paper presents the first part (a) of the review question.

The search strategy consisted of searching keywords, searching syntaxes based on the databases used, and a set of inclusion and exclusion criteria (Table 1). The search was conducted on six selected databases. The language was limited only to English, and the searching period goes from 1973, when Fromm coined the term biophilia, up to September 2020. The type of document was restricted to peer-reviewed academic journal articles, in order to compile less biased data. A total of 1,095 publications were exported to Rayyan QCRI, a software that supports systematic review processes by expediting the initial screening of abstracts and titles using a semi-automated system (Ouzzani et al., 2016). After removing 193 duplicates, the initial screening was done by reading abstracts and checking full texts in some particular cases. The initial screening was repeated five times and peer-reviewed, to ensure that all requirements had been met rigorously. Eventually, 16 studies were employed for the full-text reading stage, while 879 papers were excluded. Meanwhile, five more publications were also included externally for full-text reading in this stage.

The selected 21 full-text papers were read and reviewed by two researchers separately to reduce the risk of bias. Lastly, seven studies (Abdelaal & Soebarto, 2019; Blaschke et al., 2017, 2018; Nejati et al., 2016; Peditto et al., 2020; Tanja-Dijkstra & Andrade, 2018; Tinner et al., 2018) were included in the synthesis. An updating search was conducted on 26.09.2021. A total of 106 new publications were exported to Rayyan QCRI. In the end, two more studies were included in the synthesis (Putrino et al., 2020; Wiltshire et al., 2020), reaching nine studies in total (Fig. 1). All nine studies were published between 2016 and 2020. Four studies were from the USA, three studies were from Australia, one study was from the UK, and one study was jointly carried out between the UK and the Netherlands.

The analysis of the decided final papers and the data extraction for this systematic review followed individual methods for each study, as all studies used divergent methodological approaches. Another reason for this was that the extracted data (biophilic design parameters) were referred to in a wide range of definitions since there is no standard framework.

Figure 1:
Identification of the included articles in the systematic review

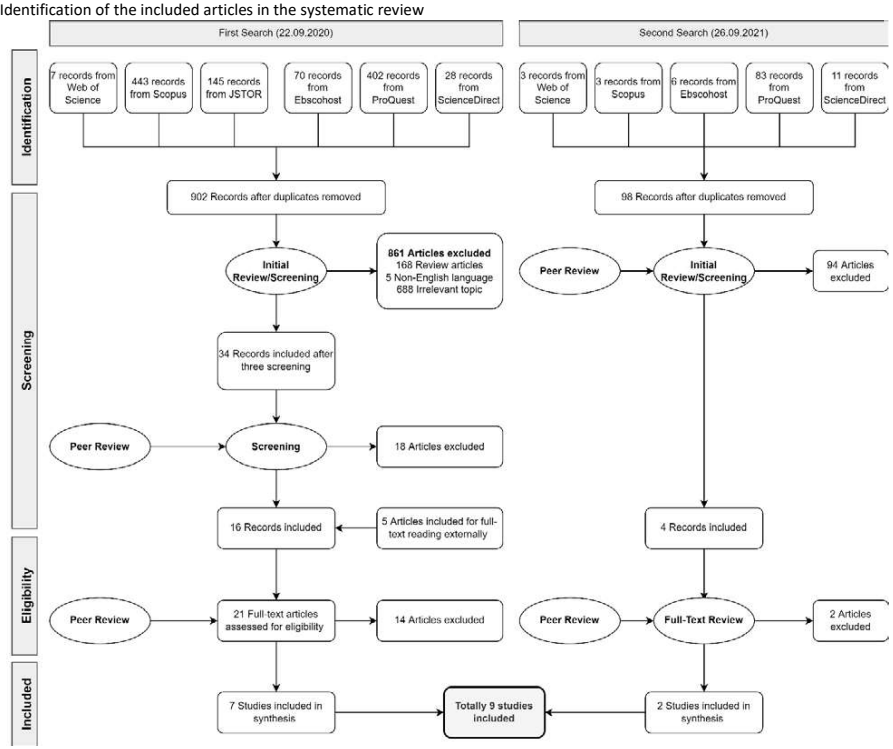

Table 2 summarises the general overview of the selected studies. Study 1 and Study 2 were qualitative researches, the data extraction followed a second analysis of the statements and facts reported in these studies by using NVivo 12 software, a tool to support qualitative analysis by organising and visualising unstructured or semi-structured data through a system of codes (NVIVO, 2012).

Study 3, Study 4, Study 5 and Study 6 represented quantitative data from different groups of the population. Finally Study 7, Study 8, and Study 9 employed mixed-method research. All studies contributed to the goal of the systematic review from both patients' and staff's perspectives.

The quality assessment tool in this systematic review was adopted from the study developed by Holloway Cripps (Holloway Cripps, 2016) and modified in accordance with the systematic review guideline from Boland et al. (2017) in which the reliability of the studies is assessed through 13 questions forming a checklist. According to this checklist, Study 3, Study 5, and Study 7 were considered High-Quality studies (high reliability). Study 1, Study 2, Study 4, and Study 6 could not satisfactorily respond to one, three, one, and two questions respectively. Accordingly, these four studies were classified as Good Quality. Lastly, Study 8 and 9 were rated as Poor Quality, but they were nonetheless kept as a control group for assessing the results obtained from the other seven studies.

3. RESULTS

The analysis of the selected studies proved that clinical settings cannot be examined as one whole environment in terms of the users' requirements and the importance of biophilic design parameters. The clinical spaces assessed in the studies were places where patients received treatment as well as working environments for the staff. Therefore, this systematic review study examined biophilic design parameters in clinical environments from two different perspectives: patient-based perspective and staff-based perspective. Within this classification, further differentiation was determined to be needed, as the analysis revealed some differences in environmental perception between the inpatient users and outpatient users. Thus, the synthesis was also carried out separately considering inpatients' and outpatients' needs for a biophilic environment.

Table 2:
General overview of the selected studies

Study	Reference	Method	Participant number	Population /Context	Contribution to the Systematic Review
1	(Blaschke et al., 2018)	Qualitative	20	Patient/Oncology	Inpatient / Clinical
2	(Wiltshire et al., 2020)	Qualitative	18	Cancer Patients	Outpatient/ Clinical
3	(Blaschke et al., 2017)	Quantitative	38	Experts/Oncology	Inpatient/ Clinical
4	(Peditto et al., 2020)	Quantitative	104	Young Cancer Patient Facilities	Inpatient/ Clinical
5	(Tinner et al., 2018)	Quantitative	72 Staff, 62 Patient	Staff and Patient/ Cancer Centre	Staff, Outpatient/ Clinical
6	(Putrino et al., 2020)	Quantitative	496	Frontline Healthcare Workers/ COVID-19	Staff/ Clinical
7	(Nejati et al., 2016)	Mixed	10 Interviews, 993 Surveys	Professional Nurses and Healthcare Workers	Staff / Clinical
8	(Abdelaal & Soebarto, 2019)	Mixed method review	NA	Patients	Inpatient and Outpatient/ Clinical
9	(K. Tanja-Dijkstra & Andrade, 2018)	Review-Mixed	Case 1: 62 Survey	Cancer Patients	Outpatient and Inpatient / Clinical

3.1. The prominent biophilic design parameters in clinics for patient-based perspective

In terms of the patient-based perspective, the studies focused on the most commonly used spaces by cancer patients in clinical environments: chemotherapy units, waiting rooms, wards/rooms, outdoor areas accompanying hospitals or clinics, break areas, and doctor/diagnosis rooms. The studies that recruited outpatient participants (Abdelaal & Soebarto, 2019; Tanja-Dijkstra & Andrade, 2018; Tinner et al., 2018; Wiltshire et al., 2020) mainly focused on chemotherapy units and waiting rooms as well as doctor rooms. In the inpatient-based studies, the main focus was ward or hospital room environments and, in some cases, outdoor areas for patients who can go out for refreshment (Abdelaal & Soebarto, 2019; Blaschke et al., 2017, 2018; Peditto et al., 2020; Tanja-Dijkstra & Andrade, 2018).

The data in relation to the outpatients' perspective was collected from four studies. While Study 8 and Study 9 employed both inpatient and outpatient participants, Study 2 reported data for only outpatients and Study 5 had both outpatient and staff perspectives. The results showed variations depending on the studies because of the directed questions, different approaches and existing environment of the population, and scope of the studies. Although these differences in the results made the progress more complicated in terms of extracting general conclusions and obtaining a clear ranking of biophilic design parameters, they contributed to making the study more extensive and less biased.

The synthesised groups of the biophilic design parameters for a clinical environment for outpatient users are summarised in Table 3. All these parameters were explicitly commented by outpatient participants as required biophilic design parameters, but some of them were emphasised and reported as more critical. Therefore, three different groups were created in order to hierarchise these biophilic design parameters. The parameters within the groups were listed alphabetically regardless of any ranking since there was no exact comparison of parameters in the examined studies. These specified biophilic design parameters should be taken into account to create stress-reducing, relaxing and comfortable environments for outpatients in cancer clinics.

Table 3:
Biophilic design parameters for outpatients in clinical settings based on synthesis results in order of importance

Importance Level	Biophilic Design Parameters
1st Group	Fresh Air Light-Daylight Thermal Comfort Welcoming and Relaxing
2nd Group	Multisensory Environment and Quietness Refuge-Privacy Spaciousness View-Prospect
3rd Group	Bringing Outside to Inside Colour Greenery-Plants

	Natural Material
	Seasonal Changes
	Water

Five of the examined studies reported data about the environmental needs of inpatients, particularly in oncology settings. Study 1, Study 3 and Study 4 focused only on inpatients' environments. While Study 1 and Study 4 collected data directly from cancer patients, Study 3 used professional experts' views. Furthermore, Study 8 and Study 9 employed data about both inpatient and outpatient groups.

Even though the important parameters for inpatient-based environments were not much different from outpatient-based environments, the detected priority differences may impact the environmental quality since the function of the spaces and patients' physical conditions are different. The synthesised groups of the most prominent biophilic design parameters for a clinical environment for inpatient users are summarised in Table 4.

For patients who are usually spending their time in wards or hospital rooms on their beds, the most important parameters were View, Prospect, and Daylight through windows. Therefore, the beds' position and connection with windows were important to apply these biophilic features efficiently.

Another outstanding parameter in the first group was Refuge, Security and Protection showing the patients need to feel safer because of their health conditions, fear of death, and desperate neediness on unfamiliar people (healthcare workers).

However, it should be considered that these parameters were usually mentioned in the studies with their visual impact, not for physical contact as these patients' movement is quite restricted, but the studies also sought access to outdoor settings where it is compatible with the patients' health condition.

Table 4:
Biophilic design parameters for inpatients in clinical settings based on synthesis results in order of importance

Importance Level	Biophilic Design Parameters
1st Group	Feeling Relaxed and Comfortable
	Prospect
	Refuge, Security and Protection
	Light-Daylight
	View
2nd Group	Fresh Air
	Greenery
	Mastery and Control
	Multisensory Environment
	Thermal Comfort
3rd Group	Bringing Outside to Inside
	Colour
	Natural Material
	Seasonal Changes
	Water

3.2. The prominent biophilic design parameters in clinics for staff-based perspective

The studies in relation to staff (Nejati et al., 2016; Putrino et al., 2020; Tinner et al., 2018) mainly examined the restoring characteristics of spaces. Study 6 and Study 7 collected data about staff break areas, while Study 5 assessed the clinical environment from both patient and staff points of view.

The synthesised groups of the biophilic design parameters for a clinical environment for staff are summarised in Table 5.

Like in previous users, all these parameters were stipulated as required biophilic design parameters by staff participants, some of them were emphasised and reported as more critical by the participants. In this case, four different groups were created in order to hierarchise the most relevant biophilic design parameters, listed following the same procedure as before.

The most outstanding demand was for Privacy and Refuge, with the need for Quietness also frequently emphasised. The studies indicated the importance of physical access to the outdoor environment. Interestingly, Greenery – Plants was ranked very low, two main reasons for this, the chore of having to water them and the presence of pathogenic fungi that pose a threat of infection to patients. However, the visual impact of Greenery, particularly in the outdoor break areas, was praised in the same studies.

Table 5:
Biophilic design parameters for staff in clinical settings based on synthesis results in order of importance

Importance Level	Biophilic Design Parameters
1st Group	Privacy-Refuge
	Quietness
2nd Group	Fresh Air
	Natural Light
	Prospect
	Thermal Comfort
	View
3rd Group	Multisensory Environment
4th Group	Greenery - Plants
	Water

4. CONCLUSION

The systematically selected data helped to qualitatively reveal the biophilic design parameters that are the most critical for promoting and supporting human health and wellbeing in clinical therapeutic environments, from the user's perspective. This strand of research provides crucial knowledge on how the impact of nature-based design features on human wellbeing best informs our design decisions for this specific building typology. The available case studies are limited and highly localised in developed countries, thus based on specific building typologies. The perception and relationship humans establish with nature is climate and culture dependant, therefore, these are aspects that need to be factored in. As more studies develop in different regions, in different climates and in diverse cultures more data will help to shape reliable design frameworks. A more detailed analysis of the biophilic parameters and recommendations for implementation in practice will follow in a subsequent publication. Research focused on non-clinical therapeutic environments in the UK, developed by the authors (Tekin et al., 2021, 2022), revealed the importance of other biophilic parameters for the patient experience, such as Curiosity or Sense of Belonging, expected in this study but not even mentioned. Likewise, a holistic design framework also needs to be supplemented by the analysis of objective scientific facts on the impact of nature on humans, which is currently undergoing work.

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