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Evaluating design features to support inclusive, self-directed, and active healthy living behaviours

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Active healthy living design has typically focused on urban and community environments to support physical activity; this article looks at an expanded definition of active healthy living opportunities at building level design for various groups. We wanted to engage youth, adults, and diversely abled people through a form of inclusive design that encourages individuals to venture out of their private homes, workplaces, or other isolating conditions and explore areas of shared spaces or get outside of personal environments and buildings for self-directed, restorative activity. Incentives for people to venture outside of private spaces became even more important for maintaining healthy minds and bodies during the recent pandemic. The objectives of this discussion are to propose a multidisciplinary tool to facilitate decisions around creating shared spaces in different building typologies that promote active, self-directed behaviour by occupants to engage physically, socially, or psychologically with features that support health and wellbeing. We first examined a wide range of theories and design practices for potential applications to building-centred design that supports healthy behaviour, reduces environment stress, and employs space syntax and the Biophilic Healing Index to help encourage healthy behaviours by a wide range of occupant ages and abilities in and around buildings. A rating scale was then associated with criteria representing evidence-based guidelines, and capable of being fitted for use as a teaching-learning and discussion aid. An overview of data from demonstration of the tool is presented, along with feedback on proposed improvements and how these might impact professional practice.

KEYWORDS

active healthy living design, self-directed healthy behaviour, biophilia, biophilic healing index, inclusive design, Ratings Tool

1 Introduction

1.1 Current frameworks related to human health and wellbeing under discussion

Active healthy living has been gaining greater attention as physical activity becomes integrated into daily living environments (Adlakha, 2017). Design that increases opportunities for physical activity has become of interest for many planners, architects, public health professionals, researchers, and others. Much of this interest has focused on neighbourhood, community, urban, transportation or other exterior place design that includes design affordances and removal of obstacles (RWJ Active Living Research,

2012; Evenson et al., 2012; Wekerle and Whitzman, 1995). Less focus has been on building-centred design planning, research, and examples of applications that support occupant's active, self-directed behaviour. Self-directed behaviour has been examined in several disciplines, including learning and employee productivity, and has been measured and found to have some efficacy in studies on weight loss programs (Hwang, Ning, Trickey and Sciamanna, 2013; Gudzune, Doshi, Mehta, Chaudhry, Jacobs, Vakil, Lee, Bleich and Clark, 2015; Nikolaou and Lean, 2017).

A number of initiatives (US Department of Health and Human Service, 2020; US Environmental Protection Agency, 2022; US Housing and Urban Development, 2022) such as Health Impact Assessments, HUD Healthy Homes, EPA Healthy Buildings Healthy People, Well-Building Standard, Fitwell, and Building H have relied on evidence-based data and contextual analysis to advance objectives for healthy building environments, with some neighbourhood design initiatives overlapping with building-level design features. On the topic of building level health focus, US Department of Housing and Urban Development (US HUD, 2023) has been charged with overseeing federal policy for decent, safe, and sanitary housing (HUD Strategic Plan). Other certification systems, such as Fitwell (2002), created and supported by US CDC research, and WELL Building Standards (2020) offer extensive, robust criteria across multiple health-relevant sectors that incorporate specific directives and rely on multiple layers of administrative qualification, sometimes requiring substantial fees. The Building, (2021) platform offers an index ranking companies across 5-health related behaviors that balance design features for facilitating healthy private behaviors with outdoors social engagement.

In the United Kingdom, Building Regulations set the standards for all building work. The Legislation, 1984 allows the government to publish approved documents which give details on how to meet the legal requirements of the Building Regulations. But there are no guidelines to prevent damages to mental health. Town planning is regulated by the National Planning Policy Framework (NPPF), updated in 2021. NPPF attempts to promote "healthy and safe communities" by setting generic guidance to policy and decision makers to promote "active street frontages" (NPPF, 2021). NPPF directs policymakers and local communities to use tools proposed by experts, such as Building for a Healthy Life (Birkbeck et al., 2020). In this tool, the professionals highlight that "improving the health of local communities requires … a "whole systems" approach" (Birkbeck et al., 2020), and direct us in "Putting Health into Place" (National Health Service (NHS) England publications).

Research examining physical activity in the built environment is juxtaposed with an objective of discouraging sedentary activity. Our paper regards both values as separate but related concepts that might vary in forms of occupant engagement. An important role for built environment design is to strategically integrate building features that promote health-oriented, self-directed occupant behaviours that engage cognitive and emotional precursors of wellbeing through skeletal and fine motor muscles. Building features can provide contexts that support a health psychology approach to wellbeing (Matarazzo, 1980), engaging occupants in a whole person approach by creating opportunities to actively self-select affordances for their physical, psychological, and social impact; design should become more inclusive.

1.2 Literature and evidence-based support for inclusive, self-directed design

Studies on active living have typically been limited to design for elder residential environments (Gharaveis, 2020) or specific forms of activity, such as stair climbing or walking (Balsas, 2021). A review of the literature on qualities of buildings for allowing physical activity reveals features important to both building-level and neighbourhood level effects. Social science and design researchers have examined built environment features that promote engagement by occupants through natural movement, configuration, and attraction (Hillier et al., 1993); affordances for potential activities provided by the physical environment (Gibson, 1979); or create obstacles, or reduce the attraction of other features that promote physical movement (Zimring et al., 2005). Zimring's social ecologic model defines occupant physical activity engagement generally through three dimensions of intentionality: recreational (specifically for the desired activity as with entering an exercise room), instrumental (activity intrinsic to carrying out a task such as walking mail to the mailroom), and hybrid (both an intentional pursuit and intrinsic to the task, such as taking the long way around a donut circulation corridor) A range of opportunities for self-directed engagement within buildings becomes possible when design affordances are present. This approach is not inconsistent with Sommer's (1974) recommendations for avoiding "hard architecture" by incorporating generic principles for a continuity with surrounding environments, creating flexible setting choices for occupants, and decentralising opportunities for safety and security. Christopher Alexander's Pattern Language (Alexander, et al., 1977 can facilitate positive engagement with and in the built environment. Alexander's language of timeless patterns gives people means to improve their neighbourhood or town. Groupings of these patterns form a language made of codes/thoughts to solve a problem by adapting it to people's preferences (Alexander et al., 1977).

Many design researchers over the years have offered guidelines for creating physical environments that engage users. Kaplan (1979) laid early groundwork showing patterns of urban park use based on micro-behaviour settings: "Nooks" providing privacy through seating but not from passers-by, larger group enclosed seating areas, and areas easily accessible from corner nodes and high activity areas. Carstans (1985) proposed a compendium of site, plan, and ergonomic features and examples that support recreation, health and exercise, sensory stimulation, safety, security, comfort, ease of access, environmental negotiability, and other attractions believed essential for quality of life (QOL) in elder living environments. Carstans provides both examples of design with overviews of shared space plans as well as plans and layouts that are defined in terms of micro-behaviour settings. Hamedani Golshan et al. (2021) cites Allen Penn's posit that spatial configuration shapes and organises spatial cognition. Theoretical models of spatial configurations (space syntax) and human movements are considered helpful for anticipating patterns of walkability. The authors further combine Hillier et al. (1993) theory of natural movement with Barker's theory of behaviour settings, which require occupants to read the social cues and physical affordances inherent to the settings, to help guide behavioural design in urban settings. Wicker (2012) uses behaviour setting examples to suggest the importance of linking small-scale

behaviour settings with human experience, feelings, and emotions in the context of embedded socio-ecological systems.

1.3 The Biophilic Healing Index and restorative design-an applied advancement of Christopher Alexander's pattern language

Designing behaviour settings with inanimate features that connect with positive human experiences and emotions can support wellbeing and active pursuit of health interests. These objectives may be advanced in settings through a variety of mechanisms that include engaging gross motor physical activity, skeletal, and fine motor muscles, and cognitive processing of positive social and biological values through biophilic connections. Cognitive patterns of active internal connectivity, designed by manipulating specific biophilic patterns of free fractal flow, examine how integrated spaces may link harmoniously with their surroundings (Salingaros, 2012). According to Salingaros, human sensory systems evolved to respond to natural geometries of fractals, colours, scaling, symmetries. Fractal patterns reflect a sense of flowing harmonious movement on different scales of design made of symmetries that influence human health (Salingaros, 1999; Tracada, 2008).

The Biophilic Healing Index (BHI), which is the latest tool being proposed by Salingaros (Salingaros, 2019) and Tracada (2022), can be used as a professional guide to measure patterns of biophilia as a basis to understand where multidisciplinary professionals can intervene. The BHI can be used to assess the interiors of buildings and their immediate surroundings, including interconnecting spaces, such as courtyards, for example. In 2013, the workshops run by the International Society of Biourbanism focused on Artena town fractal structure. The Artena project used place-based nodes and paths, focal points and channels of mobility to uncover places of meaning and opportunity (Journal of Biourbanism, 2013; Tracada and Caperna, 2013).

The Biophilic Healing Index can provide interventions to improve not only indoors and outdoors spaces, but also heal by freeing people to engage with aspects of their building they find to be restorative. The inclusion of BHI in the Ratings Tool is invaluable to make recommendations for future improvements as well as showing weaknesses in the way we use our buildings by measuring the impact of biophilia before any proposed new design.

1.4 Developing evidence-based guidelines for everyday use

The study team proposes a framework of evidence-based design (EBD) guidelines derived from a collection of researchers for design affordances that support occupants' preferences for health-seeking behaviours. The design features advance building-centred inclusive, and active health-oriented behaviours for occupants with a wide range of typical and atypical physical and non-physical abilities. While evidence-based design originated in historic and recent medical fields, its application has expanded to design of other built environments, including schools (Lippman, 2010) and workplaces (Vischer and Zeisel, 2008). A forerunner of EBD, post-occupancy evaluation has evolved over the years as a joint effort of social scientists, designers, and engineers to better understand the success of building objectives as well as responses by stakeholders, including occupants (Preiser and Nasar, 2008; Becker, 2018; Scott-Webber et al., 2013). There has been a dearth of post-occupancy evaluations produced, however that advance Building Performance Evaluation and EBD generally, for reasons, such as budgeted costs, additional time commitments, difficulty in measuring less tangible effects, and hesitation about visibility of design imperfections (Marmot, 2002). Researchers who have studied building features for their contribution to healthy occupant behaviour can help inform design features and programming that support inclusive, self-directed healthy behaviours.

Elements such as stairs can promote active healthy climbing behaviour, locating printers centrally in offices encourage employees to move around and connect with occupants, and incorporating generous daylight, planting, walking pathways, and collaborative spaces can motivate occupants to step out of private spaces to improve the sense of wellbeing of occupants (Adlakha, 2017). Those occupants less able or inclined to participate in physical activity can still engage affordances that support a sense of wellbeing and connection.

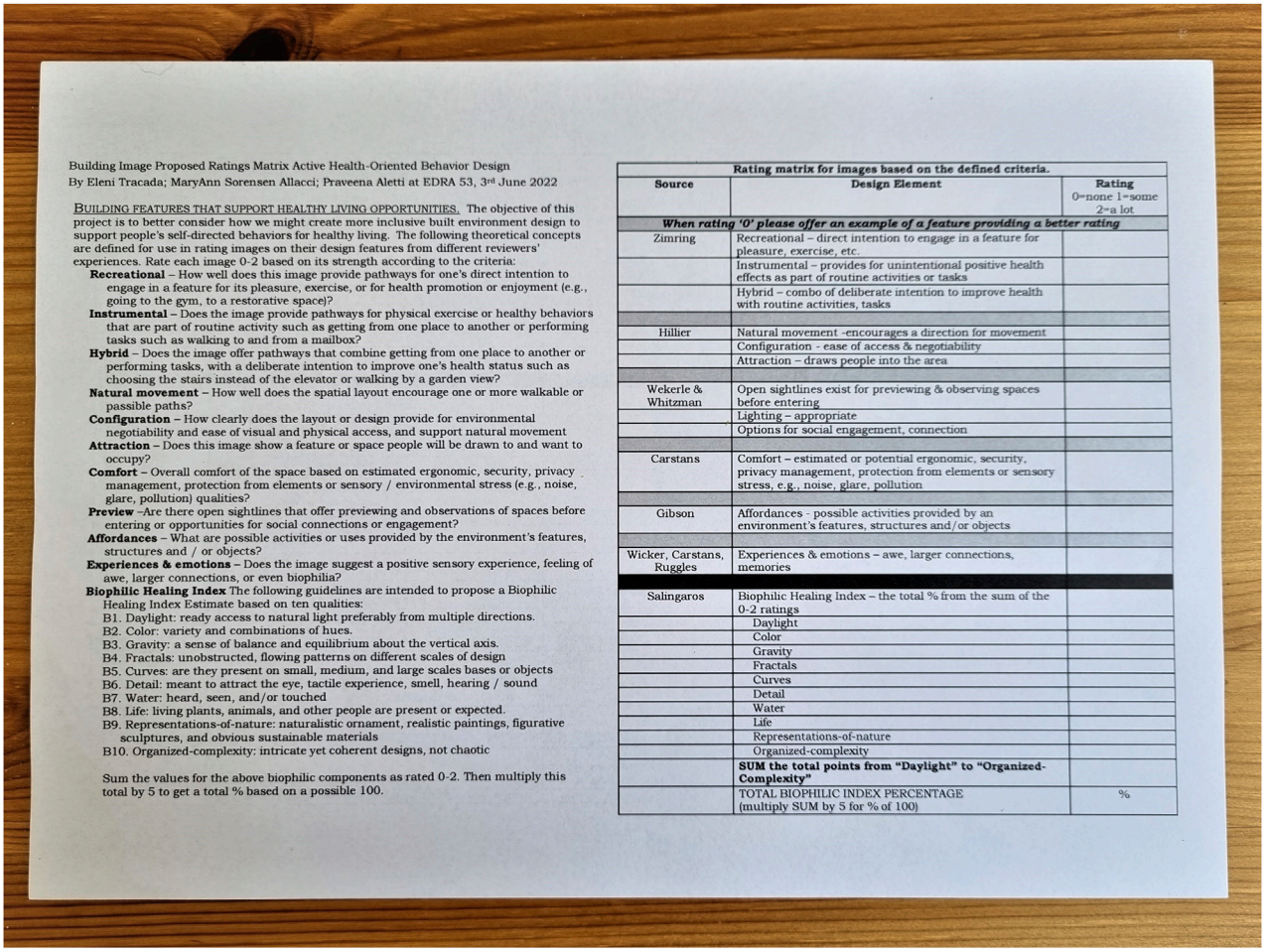
2 Methods

2.1 Tool development for EBD of inclusive, self-directed healthy behaviors

A compendious inclusive tool to assess building-related spaces for opportunities for healthy behaviours was envisioned for use by not only designers and planners, but also members of other sectors such as healthcare and public health professions, housing managers, human resources personnel, and occupants themselves. A user-friendly tool was developed to blend research-supported health-oriented design concepts and guide diverse stakeholders in an assessment process of building features that afford occupant self-directed healthy behaviours. The tool was intended to facilitate discussions of a building's existing and potential features to support inclusive healthy behaviours and help professionals consider a wide range of design solutions.

A Ratings Tool to Assess Inclusive Design for Self-Directed Healthy behaviours was created as a collaboration between an interior design graduate student, an architect, and a design researcher. On the heels of an isolating and anxiety-provoking experience of the 2020–2021 global pandemic that typically limited people's access to sources supporting physical, social, and psychological wellbeing, the research team focused on expanding building-centred design opportunities for inclusive, healthy activities linked to physical activity, social connectedness, and psychological restoration. The team recognised the contribution of various certification design and healthy building but sought to create a streamlined and simplified tool that could be used freely and across disciplines.

A matrix was created borrowing from urban planning, biophilia, active living, and social engagement design-applicable theories associated with several researchers working towards building design features that support wellbeing. A list of criteria was generated from the research, with some criteria further categorised by subtopics to create clear definitions and relevancy



Building Image Proposed Ratings Matrix Active Health-Oriented Behavior Design
By Eleni Tracada; MaryAnn Sorensen Allacci; Praveena Aletti at EDRA 53, 3rd June 2022

BUILDING FEATURES THAT SUPPORT HEALTHY LIVING OPPORTUNITIES. The objective of this project is to better consider how we might create more inclusive built environment design to support people's self-directed behaviors for healthy living. The following theoretical concepts are defined for use in rating images on their design features from different reviewers' experiences. Rate each image 0-2 based on its strength according to the criteria:

Recreational – How well does this image provide pathways for one's direct intention to engage in a feature for its pleasure, exercise, or for health promotion or enjoyment (e.g., going to the gym, to a restorative space)?
Instrumental – Does the image provide pathways for physical exercise or healthy behaviors that are part of routine activity such as getting from one place to another or performing tasks such as walking to and from a mailbox?
Hybrid – Does the image offer pathways that combine getting from one place to another or performing tasks, with a deliberate intention to improve one's health status such as choosing the stairs instead of the elevator or walking by a garden view?
Natural movement – How well does the spatial layout encourage one or more walkable or passible paths?
Configuration – How clearly does the layout or design provide for environmental negotiability and ease of visual and physical access, and support natural movement
Attraction – Does this image show a feature or space people will be drawn to and want to occupy?
Comfort – Overall comfort of the space based on estimated ergonomic, security, privacy management, protection from elements or sensory / environmental stress (e.g., noise, glare, pollution) qualities?
Preview –Are there open sightlines that offer previewing and observations of spaces before entering or opportunities for social connections or engagement?
Affordances – What are possible activities or uses provided by the environment's features, structures and / or objects?
Experiences & emotions – Does the image suggest a positive sensory experience, feeling of awe, larger connections, or even biophilia?
Biophilic Healing Index The following guidelines are intended to propose a Biophilic Healing Index Estimate based on ten qualities:
B1. Daylight: ready access to natural light preferably from multiple directions.
B2. Color: variety and combinations of hues.
B3. Gravity: a sense of balance and equilibrium about the vertical axis.
B4. Fractals: unobstructed, flowing patterns on different scales of design
B5. Curves: are they present on small, medium, and large scales bases or objects
B6. Detail: meant to attract the eye, tactile experience, smell, hearing / sound
B7. Water: heard, seen, and/or touched
B8. Life: living plants, animals, and other people are present or expected.
B9. Representations-of-nature: naturalistic ornament, realistic paintings, figurative sculptures, and obvious sustainable materials
B10. Organized-complexity: intricate yet coherent designs, not chaotic

Sum the values for the above biophilic components as rated 0-2. Then multiply this total by 5 to get a total % based on a possible 100.

Rating matrix for images based on the defined criteria.		
Source	**Design Element**	**Rating** 0=none 1=some 2=a lot
When rating '0' please offer an example of a feature providing a better rating		
Zimring	Recreational – direct intention to engage in a feature for pleasure, exercise, etc.	
	Instrumental – provides for unintentional positive health effects as part of routine activities or tasks	
	Hybrid – combo of deliberate intention to improve health with routine activities, tasks	
Hillier	Natural movement -encourages a direction for movement	
	Configuration - ease of access & negotiability	
	Attraction – draws people into the area	
Wekerle & Whitzman	Open sightlines exist for previewing & observing spaces before entering	
	Lighting – appropriate	
	Options for social engagement, connection	
Carstans	Comfort – estimated or potential ergonomic, security, privacy management, protection from elements or sensory stress, e.g., noise, glare, pollution	
Gibson	Affordances - possible activities provided by an environment's features, structures and/or objects	
Wicker, Carstans, Ruggles	Experiences & emotions – awe, larger connections, memories	
Salingaros	Biophilic Healing Index – the total % from the sum of the 0-2 ratings	
	Daylight	
	Color	
	Gravity	
	Fractals	
	Curves	
	Detail	
	Water	
	Life	
	Representations-of-nature	
	Organized-complexity	
	SUM the total points from "Daylight" to "Organized-Complexity"	
	TOTAL BIOPHILIC INDEX PERCENTAGE (multiply SUM by 5 for % of 100)	%

FIGURE 1
The Ratings Tool in original format used during workshops with professionals and introduced to and used by students during surveys on site and classroom work.

to individual buildings, using a rating system of 0–2, with 0 representing absence of a criterion, one indicating a small amount present of a criterion quality, and two representing a good amount of a criterion value in a behaviour setting (Barker, 1968) or pattern of features (Alexander, et al., 1977). The Biophilic Healing Index (Salingaros, 2019) was also incorporated. See Figure 1 showing the original template (adapted later for students).

2.2 Virtual and actual space assessment using the Ratings Tool

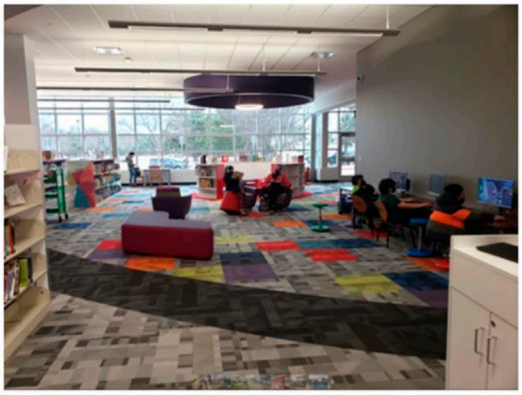
Version one of the Tool was adapted for use with images of interior and exterior building-centred shared spaces or for onsite actual space assessments. Images were considered useful as a teaching or training tool and could be used onsite or as a remote exercise. A bank of additional images was selected from both online and personal sources offering examples of Tool criteria (present or absent) in common or shared building-related spaces.

Five images and the ratings matrix Tool were introduced in a workshop at the 2022 annual conference of the Environmental Research and Design Association (EDRA), a multidisciplinary professional organisation attended by designers, public health practitioners and policy makers, community collaborators, educators, and others (Sorensen Allacci, et al., 2022). Methods for the workshop were guided in part using Zeisel's descriptions for participatory design methods (Zeisel, 2006) to interact with multidisciplinary practitioners.

2.3 Pilot testing the Tool

Instructions were provided to workshop attendees for using the Ratings Tool for image assessments. Participants were given 10 min to individually evaluate the images on thirteen criteria using the Tool. Participants reassembled into the full group and discussed their ratings on each criterion in a focus group format for 15 min. Attendees from various professional backgrounds were asked to

Rating matrix for images based on the defined criteria.		
Source	Design Element	Rating 0=none 1=some 2=a lot
WHEN RATING '0' PLEASE OFFER AN EXAMPLE OF A FEATURE PROVIDING A BETTER RATING		
Zimring	Recreational – direct intention to engage in a feature for pleasure, exercise, etc.	2 2 2
	Instrumental – provides for unintentional positive health effects as part of routine activities or tasks	1 1 1
	Hybrid – combo of deliberate intention to improve health with routine activities, tasks	1 2 1.5
Hillier	Natural movement -encourages a direction for movement	2 2 2
	Configuration - ease of access & negotiability	2 2 2
	Attraction – draws people into the area	2 1 1.5
Wekerle & Whitzman	Open sightlines exist for previewing & observing spaces before entering	2 2 2
	Lighting – appropriate	2 1 1.5
	Options for social engagement, connection	1 1 1
Carstans	Comfort – estimated or potential ergonomic, security, privacy management, protection from elements or sensory stress, e.g., noise, glare, pollution	2 1 1.5
Gibson	Affordances - possible activities provided by an environment's features, structures and/or objects	2 2 2
Wicker, Carstans, Ruggles	Experiences & emotions – awe, larger connections, memories	1 1 1
Salingaros	Biophilic Healing Index – the total % from the sum of the 0-2 ratings	
	Daylight	2 2 2
	Color	2 1 1.5
	Gravity	1 1 1
	Fractals	1 2 1.5
	Curves	1 1 1
	Detail	1 0 .5
	Water	0 0 0
	Life	0 1 .5
	Representations-of-nature	0 0 0
	Organized-complexity	2 1 1.5
	SUM the total points from "Daylight" to "Organized- Complexity"	
	TOTAL BIOPHILIC INDEX PERCENTAGE (multiply SUM by 5 for % of 100)	9.5 / 47.5%



Library

FIGURE 2
Excerpt from Ratings Tool used in remote instruction, with student assessments averaged across two group members.

return their matrices to workshop organisers upon leaving the session.

Workshop results and discussion were evaluated by the authors. As expected, there were wide variations in the ratings on criteria for each image as well on the ability for attendees to complete all image ratings. Active discussion took place among attendees about specific reasons for criteria selection, indicating an understanding of the tool's criteria and objectives. Most comments seemed grounded in macrolevel analysis, and typical or mainstream ability or accessibility needs. The Biophilic Health Index tool was particularly well received, with suggestions for enhancing its visibility in the Tool.

2.3.1 Remote application of the Tool

Two versions of the Ratings Tool were then developed for trials with teaching. The use of the Tool and 12 images from the image bank were tested with online class groups of undergraduate students. The sample images and the Tool became a midterm project for students working remotely in groups; they were instructed to first rate the images using the Tool individually, then propose solutions to improve ratings by design. Group members were asked to discuss their Tool assessments, and the groups proposed design solutions to improve ratings, with lowest ratings taking priority. See Figure 2 for an example of averaged ratings across group members.

2.3.2 Onsite application of the Tool in actual shared spaces

The Tool was also modified for onsite teaching and use as a post-occupancy tool. Students participating in onsite graduate design classes were asked to use the Ratings Tool as a group to evaluate a shared space that they identified and visited. Based on feedback from previous online student use, the Ratings Tool was streamlined to further detail the criteria. The same protocol was used for student groups to first rate each criterion individually, then average each criterion across group members selecting lowest scoring criteria to develop proposed design solutions.

2.3.3 Applications of the BHI to promote healthy living through project solutions

In 2021, Salingaros ran a workshop online with students in the module Urban Design, in an architectural design programme, in the United Kingdom. The students used the Biophilic Healing Index to measure percentages of ten patterns (Salingaros, 2019); they were able to generate appropriate survey questions for residents near the campus area.

The result of this investigation produced solutions which promoted blending the campus interiors with its surroundings to enable free flows (fractal expansions of indoors to blend with outdoors). Students learnt how architecture responds to human needs by encompassing hierarchy of scales similar to natural complex systems (Simon, 1969; Smith, 1969). The human brain easily perceives fractal self-similar shapes, forms and structures by clustering them at different sizes and scales; it distinguishes natural patterns and perceives fractal flows (Salingaros, 2010; Tracada, 2013).

2.3.4 Limitations of the method

Modifications to the Ratings Tool continue. Several of the criterion subtopics overlap or require refinement between researched guidelines. While distinctions between concepts and criterion are important for literature contributions, practical application of the EBD guidelines calls for a more seamless,

practical, and simple definition of criterion to best serve diverse stakeholder groups and potential design solutions in a relativistic relationship to a building space. The importance of clear instructions and examples is also relevant to the application of the Biophilic Healing Index. The process of discussion on design features is probably the most important step to support healthy human activity. The use of images matrix or onsite spaces with and Ratings Tool is particularly effective through dialogue between individuals, through which different experiences and attributes facilitate blending of knowledge for a holistic, inclusive approach to design critique. More generous time contribution for small working groups' process is needed to introduce and explore the criteria closely mainly with practitioners.

3 Conclusion

The research team sought to filter evidence-based guides from the literature to consolidate criteria with a focus on building-level design that affords active and self-directed behaviours for a wide range of occupant abilities and needs. The development of a matrix tool with these objectives necessarily needs to be simplified, streamlined, and accessible to be user-friendly for a range of potential multidisciplinary users. The Tool is not intended to serve as an objective, instrument generalizable across populations. A form of 'ecological validity' is a more appropriate lens for analysis (Wolf, 2005). Rather than a computed statistic (Andrade, 2018), ecological validity addresses the likelihood of a "relativistic" effect, in our case for the person-environment situation (Araujo, Davids and Passos, 2005). While designers might be the primary audience for purposes of the tool, we do believe other users including public health professionals, researchers, developers, and managers who understand the needs of building occupants can also use the tool toward a more inclusive approach for creating all-inclusive, common spaces to support self-directed healthy behaviours. The Ratings Tool is intended to motivate thoughtful discussions to explore enhanced design solutions and build knowledge between those engaged in the process. One important finding from implementing the Tool in various contexts is that its value increases with the skills of the user as we found during our interactions with practitioners. Implications for instructors and supervisors may be even greater to ensure development of students' skills around the core criteria.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

ET and MS co-developed the conception and design of the study. MS, ET, and PA (see acknowledgments) contributed to producing a literature review as well as developing initial methods. ET focused on Biophilic Healing Index development for the study, and both researchers (ET and MS) applied the Ratings Tools to classes in their academic programmes and prepared the manuscript for submission. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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