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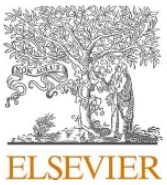
Publisher's version / Version de l'éditeur:

https://doi.org/10.1016/j.jenvp.2025.102621

Journal of Environmental Psychology, 105, pp. 1-15, 2025-05-10

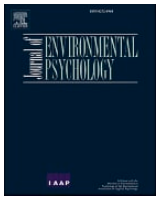
Journal of Environmental Psychology 105 (2025) 102621



Contents lists available at ScienceDirect

Journal of Environmental Psychology

journal homepage: www.elsevier.com/locate/jep



Home Boundary: A New concept in healthy and resilient housing

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ARTICLE INFO

Keywords:
Home boundary
Housing
Psychological health and well-being
Indoor-outdoor connectivity
Nature exposure
Social connection

ABSTRACT

This paper defines a new concept, *home boundary* (HB), to provide an integrated framework for understanding the effects of architectural features that influence residents' connections to nature, social life, and the outside world. The concept emerged from a narrative literature review of publications identified through a bibliographic search on *Scopus,* consolidating fragmented concerns and knowledge into identification of the primary research areas and relevant gaps and pointing to future research directions. In contrast to the current perspective, a comprehensive approach to the HB; treating it as a system for the facilitation of effective indoor-outdoor connectivity and considering all cultural and contextual factors, would mitigate residents' isolation at home and its adverse effects on their health and well-being, particularly in forms of housing where residents are largely disconnected from nature, social life, and the outside world. Interdisciplinary collaborations are essential to understand all these aspects and to identify strategies for addressing them. A communication network between researchers, designers, planners, and policymakers is required to translate research findings into innovative practical applications which are tailored to specific physical and cultural contexts. This approach can lead to meaningful changes in conventional housing practices and the development of planning guidance and regulations that will support health and well-being in both future and existing housing.

1. Introduction

The home is a prominent setting for living, learning, working, and socializing for various groups of people. As such, its potential to support the residents' health and well-being is crucial. Staying inside the home for prolonged periods of time can have negative health outcomes due, among other things, to the loss of connection with nature, social life, and the outside world. Recently, an extreme example of restriction to the home and separation from nature and social connections was experienced during the COVID-19 lockdown waves. The resultant isolation (Craig et al., 2022) was associated with emotional and behavioral alterations in children and adolescents (Pizarro-Ruiz & Ordóñez-Camblor, 2021) and among adults, including adverse effects on emotions and mood (Olszewska-Guizzo et al., 2021) and mental health (Pouso et al., 2021), with increases in the occurrence of depression and anxiety disorders (Amerio et al., 2020; Millán-Jiménez et al., 2021; Olszewska--Guizzo et al., 2021) and with increased perceived stress levels (Qiu et al., 2021).

One of the main coping strategies during the COVID lockdowns was to take refuge in the use of windows and balconies to connect with nature, people outside, and the world beyond the indoors, as was seen in photos that rapidly spread in the media (Fig. 1). This reveals the vital role of home boundaries in supporting residents' health and well-being.

The *home boundary* (HB) refers to the physical elements that define the border between home and its surrounding environment, such as openings and windows, private outdoor spaces, transitional and entrance spaces. They can provide residents with opportunities for exposure to nature and to people outside and to enable effective communication with a world different from indoors while staying in a safe, private home. Thus, the impact of home on residents' health and well-being extends beyond its indoor spaces, encompassing the quality of indoor-outdoor connectivity. However, this consideration is mostly overlooked in housing research, design, and policy. This is the starting point of the present paper which draws attention to the neglected role of HBs in creating health-promoting moments, the emergence of a new concept and approach in this area, and the potential within this domain for interdisciplinary research, leading to changes in housing design and regulations.

The experience of being restricted to the home during the COVID lockdowns brought HBs into sharper focus for all housing types, but

This article is part of a special issue entitled: Residential Psychology published in Journal of Environmental Psychology.

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https://doi.org/10.1016/j.jenvp.2025.102621
Received 30 December 2023; Received in revised form 3 May 2025; Accepted 9 May 2025
Available online 10 May 2025

especially so for apartment housing where dwellers are restricted within a small and limited space and are often separated from nature and the outside life, except for windows and balconies. Considering apartments as an inevitable type of future housing (Raynor, 2018), they deserve significant attention. This concept paper uses the special case of apartments to develop the HB framework for further study and application.

2. Theoretical background

2.1. Home boundary concept

Beyond being a mere wall, the HB can integrate porous elements and transitional spaces to create opportunities for connection and interaction with the outside world. Thus, rather than drawing a strict line between the interior and exterior of the home, the HB can serve as a dynamic interface that provides effective indoor-outdoor connectivity, while preserving the home's privacy, safety, and comfort.

As is typically seen in apartment housing configurations, HBs may include transparent components such as windows, in-between spaces like balconies, and transitional areas such as entrance spaces, entryways and corridors. Depending on the extent of porosity and the quality of indoor-outdoor connectivity provided by their components, HBs can be seen along a gradient from solid and impermeable to porous and permeable.

Permeable HBs consist of all possible opportunities at the home's edge for connectivity with the surrounding physical, natural, and social environments. This includes visual or passive connections, such as viewing natural elements and street life through windows and balconies, as well as physical or active connectivity through private outdoor areas such as getting fresh air, gardening, and socializing with neighbors. In contrast, impermeable HBs restrict residents to the indoors, leading to a loss of connection with the outside world, nature, and social life. Thus, HBs can play a critical role in either intensifying or alleviating the isolation issue while staying home, depending on their design and character.

The environment-behavior literature includes many articles about the perceptions, attitudes, preferences and effects of HB components, particularly concerning windows (Braçe et al., 2020; Honold et al., 2016; R. Kaplan, 2001), but these articles are fragmented across different disciplines and often fail to clarify how architectural elements contribute to the intended outcome. An integrated framework is essential to bring together all efforts and findings under an umbrella aiming to promote effective, health-promoting indoor-outdoor connectivity in the home.

The HB concept provides a comprehensive approach to the indoor-outdoor connectivity mechanism, leading fragmented concerns and studies towards more purposeful and practical paths for achieving healthy and resilient housing. This approach may lead to changes in the way we consider residential design, and influence housing design regulations.

2.2. Apartment housing and psychological health

The World Health Organization (WHO, 2016) recommends creating living environments that can support people's healthy lifestyles and contribute to their mental health. The association between particular aspects of housing design and residents' social and mental health and well-being is well established (Chatterjee, 2009, 2018; Davison et al., 2019; Evans, 2003; Odum, 2015).

Despite the growing world population living in apartments, broad research confirms the deleterious effects of some forms of apartment housing on residents' health and well-being compared to the general population living in other housing types (Evans, 2003; Kearns et al., 2012). Particularly, living in high-rise apartment housing, is linked to mental health problems and has been considered an unsuitable form of living for families with young children (Agha et al., 2019; Appold & Yuen, 2007; Kerr et al., 2021). Extensive reviews of the literature in this area (Chatterjee, 2009; Gifford, 2007) concluded that high-rise buildings caused many unpleasant consequences such as dissatisfaction, poor social relations, loneliness, stress, and anxiety. A major component of these adverse effects is caused by the lack of outdoor spaces, access to nature, and social interactions (Chatterjee et al., 2003). Indeed, people residing in this type of environment may suffer from dual challenges; living in detrimental conditions as well as lacking access to stress-reducing spaces or restorative resources to cope with these conditions.

2.2.1. Nature deprivation

A significant drawback in the conventional form of high-rise apartments is the lack of immediate connection to nature, even visually. As cities become more densely populated and experience vertical growth, the increased construction blocks residents' window views, reducing their visual connection to nature (Masoudinejad & Hartig, 2020). Noting the restorative potential of nature exposure, either actively or passively (Kaplan & Kaplan, 1989; S. Kaplan, 1995; Ulrich, 1983; Ulrich et al., 1991), apartment residents often are deprived of restorative opportunities in their everyday living environments. Such deprivation, in the long term, can lead to serious negative effects on residents' psychophysiological health (Hartig, 2007; Van Den Berg et al., 2007). Therefore, introducing natural elements to apartment housing can significantly improve living conditions and promote residents' well-being. For example, the adequacy of a nearby small piece of nature

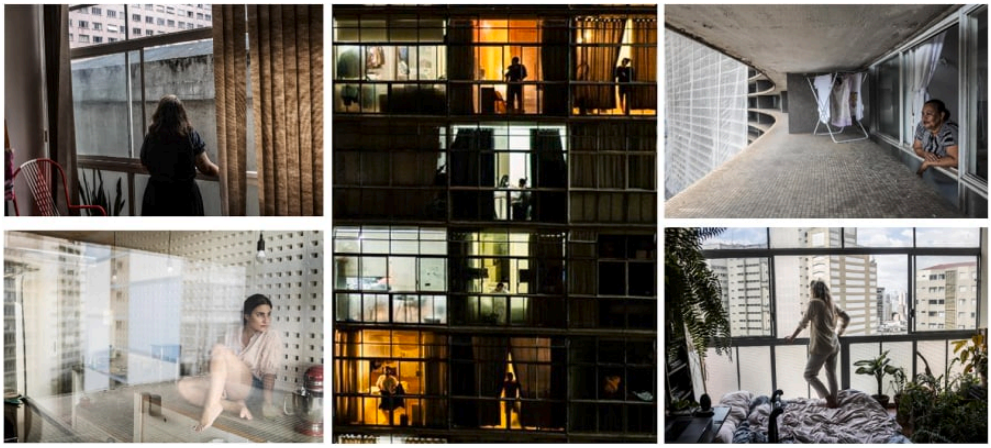

Fig. 1. How people interacted with their home boundaries in the COVID-19 quarantine- Copan Residential Building (by Oscar Niemeyer), Sao Paulo, Brazil (by courtesy of Joao Pina).

in apartment housing can increase residential satisfaction (R. Kaplan, 1985), moderate the effects of insufficiencies in the housing such as area deprivation (Mitchell & Popham, 2008) and improve behavioral and developmental outcomes among children (Aziz & Ahmad, 2017; Evans, 2006).

2.2.2. Social isolation

Social isolation and poor mental health are among the major challenges in apartment living, especially in high-rises (Gifford, 2007; Kalantari & Shepley, 2021). In general, residents of high-rise housing express greater feelings of social negativity and loneliness than those who live in non-high-rise housing, and children specifically report feeling more socially deprived while living in high-rises than their single-family-dwelling counterparts (Chatterjee, 2018). Regardless of the nature of apartment housing, some design factors may intensify the negative effects on social health. One common factor is the absence of suitable spaces for social interaction. Furthermore, shared spaces that lack territorial control may limit their use and lead to social withdrawal among residents (Evans, 2003), which is associated with psychological distress (Wells & Harris, 2007). Another factor is separating residents from the street life (Cappon, 1971), depriving them of the opportunity to interact, observe, and hear what happens in the street and public areas. This may exacerbate social isolation (Elsadek et al., 2020). Thus, encouraging design strategies that enable residents to connect with others outside the household, such as by incorporating visibility in border areas and creating effective semi-private outdoor spaces, should be considered to foster a sense of connection in apartments (Gibson et al., 2011; Huang, 2006; kaur & Narayan, 2017).

2.2.3. Specific populations

Even before the latest trend of home-based learning and work that encourages people to stay home for prolonged periods, the home has been the predominant setting for many demographic groups, such as older adults and people with disabilities. Noting that these people may experience limited mobility, we should not expect these individuals to use public, open or green areas when they are in need of psychological restoration and stress-reducing environments. Furthermore, some groups experience more profound effects from the immediate living environment, for instance children (Odum, 2015), particularly girls (Taylor et al., 2002). The mental well-being of both young children and their mothers is jeopardized when residing in high-rise, multi-unit housing, primarily due to the constrained play opportunities for children and social isolation experienced by mothers (Evans et al., 2003). Additionally, women appear to be more sensitive to their home living environments than men; suffering from higher distress (Pinault et al., 2020), having a greater desire to socially withdraw within the home, and having a higher chance of feeling unsafe outside during particular times of the day (Hartig et al., 1998). Therefore, access to a near-home area does not seem to compensate for inadequate restoration opportunities at home for women (Hartig et al., 1998). As such, the restorative potential of the home becomes more important for many demographic groups.

There are also notable differences between economic groups in the extent to which factors within the home environment impact people's general well-being. Low-income groups are more likely to face multiple environmental and psychological stressors (Evans & English, 2002), and they are more likely to be affected by home stressors like density and crowding (Rollings & Evans, 2019). As healthy parameters influence the housing price (Chan et al., 2009; Wing Chau et al., 2004), low-to moderate-income groups often cannot afford a healthy home and have to live in poor conditions (Chan et al., 2009; Kalantari & Shepley, 2021). Additionally, the association between high-rise living and experiencing health problems is stronger for people living in neighborhoods with poor conditions (Larcombe et al., 2019), while their home environment often cannot offer opportunities to resist stressful situations. On the other hand, despite the buffering effects of green spaces on the relationship between stressful life events and health (van den Berg et al., 2010), low-income groups are less likely to visit public natural environments (like parks) due to different factors including financial difficulty (Astell-Burt & Feng, 2021). Also, infrastructure-related factors such as traffic-related noise and air pollution, crowding, and hassles experienced while moving through busy city streets, may be perceived as stressful, further increasing the need for restoration, and consequently, discouraging people from leaving the home (Masoudinejad, 2013; Milgram, 1970). Overall, poor housing and the lack of access to restorative opportunities in everyday living environments can detrimentally affect mental and psychophysiological health (Hartig, 2007; Van Den Berg et al., 2007). Hence, the home environment itself must be a health-supportive and stress-reducing environment.

2.2.4. Specific circumstances

Extraordinary events necessitate the majority of the world population to stay home for a duration of time. An extreme case of home confinement was recently experienced during the COVID-19 pandemic. During the pandemic lockdowns, poor housing was associated with increased risk of experiencing moderate-to-severe depressive symptoms (Amerio et al., 2020), with nature deprivation and social isolation decreasing psychological well-being among residents (Clair et al., 2021; Ugolini et al., 2021). Conversely, having access to outdoor spaces, blue-green natural elements, and social relations were linked to experiencing positive emotions and having a higher quality of life (Pouso et al., 2021; Valizadeh & Iranmanesh, 2022). This widely lived global experience emphasized the importance of preparing housing environments for future crises, during which people are required to stay at home for an extended period. Not only might the recent pandemic not be the last one, but other crises, such as extreme weather events (e.g., wildfires and heatwaves) may also force people to stay home for considerable durations, highlighting the need for greater resilience in our homes.

Beyond global lockdowns, diverse groups of people experience home confinement in various life circumstances, such as illness and parental leave, during which they are consistently affected by their home features. The pandemic experience provided broadly observed conditions demonstrating that residents' health and well-being largely depend on the quality of indoor-outdoor connectivity at home.

Overall, the reasons mentioned above underscore the importance of well-designed HBs in supporting residents' psychological health and well-being by providing exposure to nature, social life, and the outside world, both generally and in extreme circumstances. It is particularly crucial to address the issue of isolation in certain forms of apartment housing and for specific demographic groups who experience home confinement or encounter living environment challenges more than others. Based on this reasoning, Fig. 2 illustrates a conceptual diagram of the possible relations between HBs and well-being. This framework informs the narrative literature review that follows.

3. Applying the HB framework

A narrative literature review was conducted to comprehend the primary research areas in this domain, explore findings, identify gaps, and envision future directions. To the best of our knowledge, the HB has not been studied as a concept or system thus far; however, certain benefits and features of its individual components have been investigated. As the main components of HBs in typical apartment housing include windows, private outdoor spaces (such as balconies and terraces), entrances and transitional spaces, this literature review was oriented toward studies regarding these components and their impact on residents' health and well-being via the exposure they provide to the outside world, nature, and social life.

3.1. Bibliographic search

The bibliographic search involved a combination of keyword searches and snowball searches in *Scopus*, encompassing various

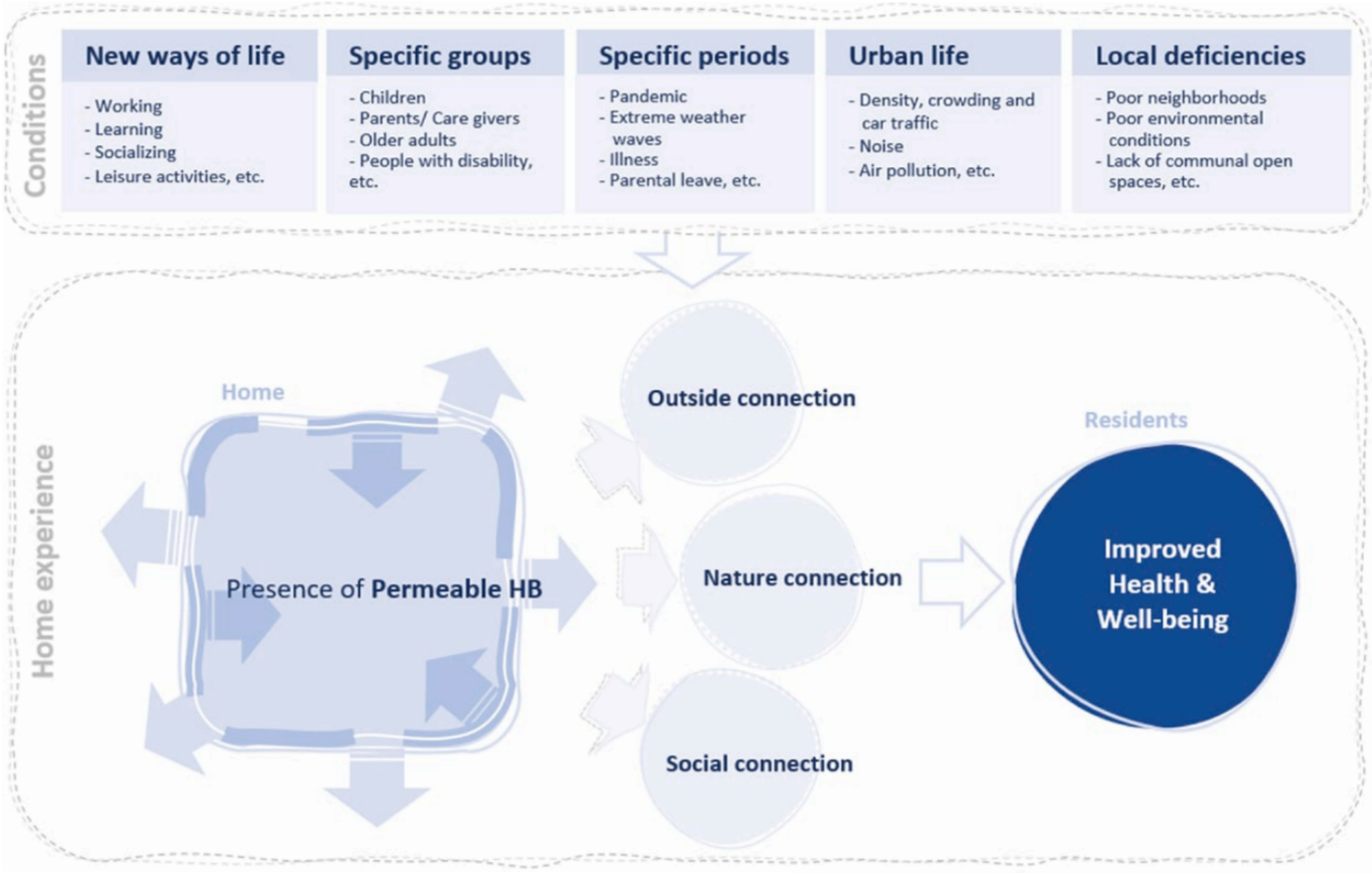

Fig. 2. *A conceptual diagram for the HB concept*. Based on the provided reasoning, HBs play a significant role in supporting health and well-being by connecting people to the outside world, nature, and social life, especially for specific populations and circumstances.

disciplines, including psychology, environmental psychology, architectural design, interior design, urban planning, and public health (see the search string in Supplementary Material).

The search was limited to only journal articles and reviews written in English, and in the context of residential buildings only. Type of residence (e.g., apartment, detached home, etc.) was not restricted in order to fully capture the important influences on well-being. The search primarily sought studies on how the HB and its components can affect residents' psychological health and well-being, by enhancing their connections to the outside, nature, and social life, either through measuring the effects or collecting people's insights, preferences, or lived experiences. Other aspects of a healthy home such as indoor environmental quality (IEQ), sick building syndrome, physical health, infection control, materials, accessibility, etc. were excluded from the search. It is noteworthy that, in addition to papers explicitly focusing on HB components, all studies indicating a connection to HB components in their results were included. There were no restrictions on the start date of the publications, and the resulting publications ranged from 1976 to November 2023 at the time of completing this paper.

3.2. *What we know about the benefits of HBs and what we need to know*

Reviewing the relevant literature showed that the HB, as a comprehensive concept, is unexplored, and the existing knowledge about its benefits is fragmented, focusing on their individual components rather than a unified system. This section summarizes the literature findings as they already exist, categorized into three components: windows, balconies, and entrance/transitional spaces. Based on the main scope of this paper, the findings in each category were sorted into three areas: connection to the outside, nature, and social life. Additionally, this section covers findings on people's preferences for the presence of HB components and their characteristics, examining what residents like, use, and are satisfied with in this regard. This is based on the theory that people's environmental preferences often indicate benefits for their health and well-being (e.g., Hartig & Staats, 2006; Purcell, 2001; Staats et al., 2003). This section also points out related gaps and open questions within each area. Fig. 3 illustrates the research topics in the reviewed literature (see the summary of the reviewed literature in Supplementary Material).

3.2.1. *Windows*

For decades, studies have highlighted the value of windows and their contribution to residents' health and well-being. However, there are several issues, particularly in the residential context, that have not yet been addressed in the literature or have received limited research to date. Relevant findings from the reviewed literature, along with notable gaps, are summarized in four areas as outlined below.

3.2.1.1. Window availability and characteristics. Research in workplace and healthcare settings provided strong evidence of people's preference for windowed rooms versus windowless ones and their strong desire for having a large window (Bringslimark et al., 2011; Butler & Steuerwald, 1991; Heerwagen & Orians, 1986). However, there is limited evidence regarding people's preference and satisfaction with windows in the residential context. Existing findings demonstrate that people have a strong preference towards having windows, particularly skylights, in home spaces (Butler & Biner, 1989), and spending time next to windows (Valizadeh & Iranmanesh, 2022), to the extent that they are willing to pay more for larger windows as a health-promoting feature in the home (Chan et al., 2009). The presence of windows indeed enhances residents'

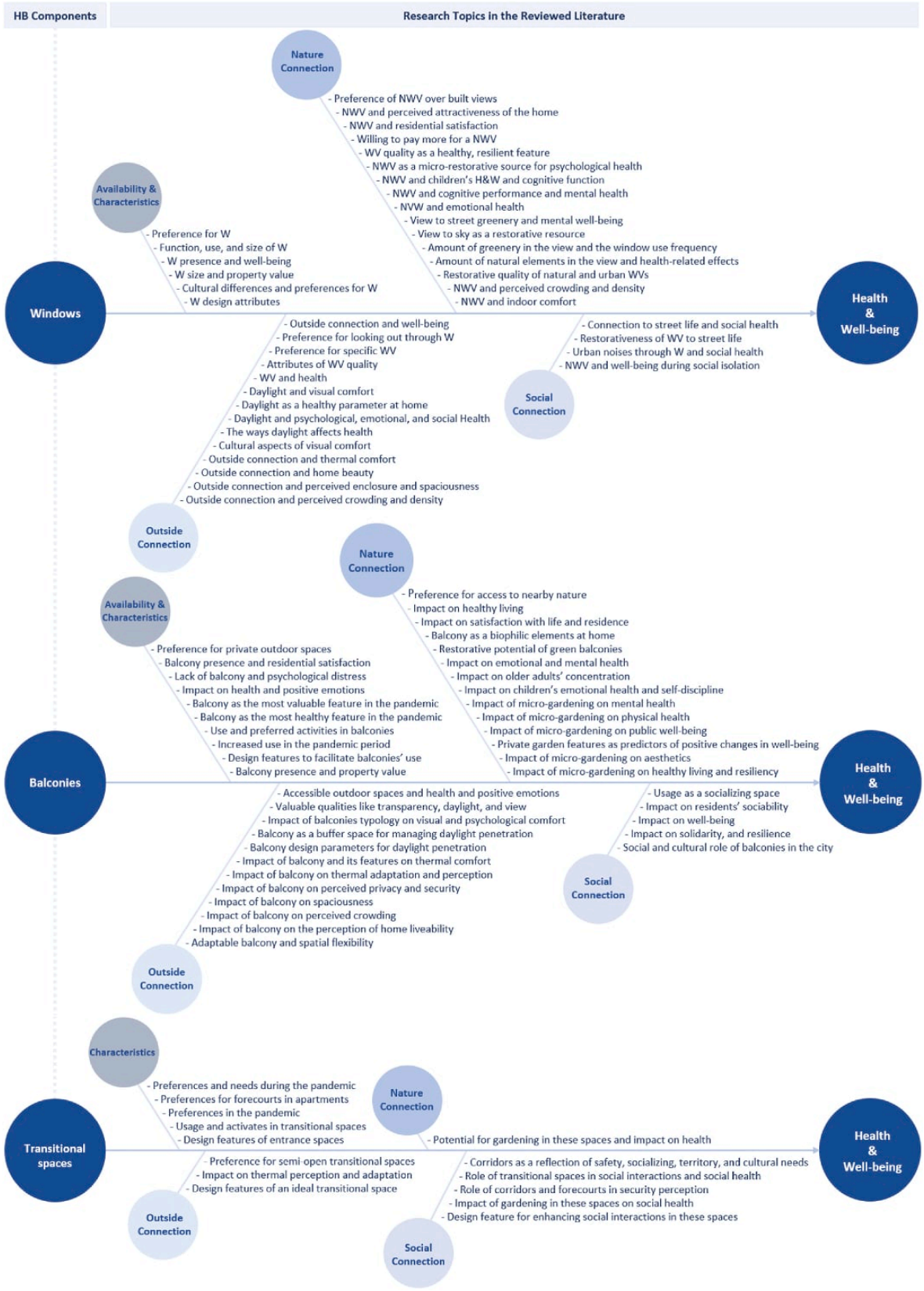

Fig. 3. Research topics related to HB components in the relevant literature. Acronyms: W = window, WV = window view, NWV = natural window view, H&W = health and well-being.

well-being (R. Kaplan, 2001). Further research is required to fully understand how preferences for windows vary according to different spaces, functions, cultural factors, and climate. The influence of desirable windows on satisfaction with the home is also an open question. Areas of further study include the preferred degree of opening, geometry, desirable orientations, and locations of windows on walls, particularly regarding what happens outside and how residents prefer to use the space next to the window.

3.2.1.2. Connection to the outside. Connection to the outside and a world different from the indoors is significant (R. Kaplan, 2001), especially for those who stay home for a long time. Key findings in this area relate to the different functions of windows and how the sensory stimuli they provide affect the indoor quality. They are sorted into four categories: 'view', 'visual comfort', 'thermal comfort', and 'spatial perception', as follows.

3.2.1.2.1. View. A key factor in the desirability of windows is their ability to provide an outside view and offer information about weather, time, and what is happening outside (Bishop et al., 2004; R. Kaplan, 2001). During the COVID-19 pandemic, people valued the view function of windows and their visual quality as the most important features in a healthy home (Alonso et al., 2021; Horne et al., 2020; Jaimes Torres et al., 2021; Zarrabi et al., 2021). Some studies have shown that certain attributes, such as expansive and unobstructed views, as well as a variety in viewing elements and their dynamic qualities, can enhance the view quality and increase preferences (Cho et al., 2023; Baxter, 2017; H. Lee, 2014).

3.2.1.2.2. Visual comfort. The presence and design of windows are crucial factors influencing residents' visual comfort (Xue, Mak, & Ai, 2016; Xue, Mak, Cheung, & Chao, 2016) due to daylight penetration. Daylight is central to a healthy home (Peters & Halleran, 2021) and contributes to psychophysiological health and well-being (Fernandez, 2022; Morales-Bravo & Navarrete-Hernandez, 2022; Shishegar & Boubekri, 2022; Veitch & Galasiu, 2012; Knoop et al., 2020; Veitch, 2012). Despite the strong hypothesis suggesting a link between home lighting and specific health outcomes, this relationship has not been thoroughly investigated (Osibona et al., 2021). Although research on visual comfort in residential settings predominantly centers on daylighting, there is a lack of daylighting metrics and design applications (J. Lee and Boubekri, 2022). Current guidance for daylighting in apartment housing is still scarce (Kesik et al., 2019), and is based primarily on research with young or middle-aged, healthy adult residents. Further research is needed concerning desirable light levels in a given room or for a given function as well as optimal light conditions throughout apartment homes (Peters & Halleran, 2021). This issue has become more critical as homes have come to accommodate more functions than before, and the need for rooms to be adaptable to different uses grows.

3.2.1.2.3. Thermal comfort. There is some evidence in research within residential contexts indicating that a connection with the outside (i.e., through openings and windows) can influence residents' comfort, enhance their satisfaction with IEQ, and improve their psychological well-being (Wågø et al., 2016). Based on the limited findings in this area, several mechanisms are evident. First, openings can provide passive means that support residents' natural adaptation to air temperature, humidity, and airspeed changes, unlike mechanical systems that create thermal monotony and reduce tolerance for indoor environmental fluctuations. Second, the ability to control comfort in the home encourages adaptive behaviors, such as opening windows, which improves satisfaction with thermal conditions and indoor air quality (de Dear & Brager, 2002). Indeed, the sense of control has emerged as a crucial factor in creating an atmosphere that promotes well-being (Wågø et al., 2016). Third, a connection to the outside can indirectly improve thermal perception by enhancing non-thermal comfort, such as improving spatial perception, as explained below. Overall, the behavioral and subjective factors linked to the effects of windows on residents' comfort are overlooked areas, warranting further research.

3.2.1.2.4. Spatial perception. Visual permeability of boundaries can affect perceived enclosure, spaciousness, and safety (Stamps, 2005, 2010). Positive effects of large windows and expanded views on spatial perception and aesthetics are well established in different settings (Butler & Steuerwald, 1991; Franz et al., 2005; Ozdemir, 2010; Vartanian et al., 2015). Yet, there is scarce evidence specifically in the residential context. Some studies have investigated how the presence of windows, along with their attributes (i.e., size, content and openness of the view, daylight penetration, and the air quality they provide), affect the perception of spaciousness, beauty, crowding, and density in home environments (Cuerdo-Vilches et al., 2021; Fisher-Gewirtzman, 2017a, 2017b; Kearney, 2006; Park et al., 2023; Pineault & Dubois, 2008).

Extensive research is warranted on the potential effects of the window attributes such as size, orientation, location, view content, tinting, and the quantity and quality of transmitted daylight on spatial perception, perceived density, crowding, and privacy, and especially on moderating deficiencies in the home, such as space shortage.

Overall, exploring the contribution that windows have on visual and psychological comfort requires multidisciplinary research, particularly when taking the IEQ, comfort, and cultural values into account. Balancing competing needs such as preventing glare and avoiding excess heat gain while providing daylighting and pleasant view through windows (e.g., Tuaycharoen & Tregenza, 2007) necessitates further studies. Moreover, cultural norms regarding privacy can influence the desired level of enclosure and permeability through openings, and may conflict with the desired level of daylight (Elgadra & Fotios, 2023) and view quality. Thus, cultural differences as well as climatic factors should be considered in these efforts.

3.2.1.3. Connection to nature. The effectiveness of windows largely depends on the view content and quality (R. Kaplan, 2001). People particularly enjoy seeing natural elements, such as tress, water, mountains, and the sky (Bishop et al., 2004; Masoudinejad & Hartig, 2020), to the extent that such views can increase property values (Crompton & Nicholls, 2022). People even compensate for the lack of a natural window view by bringing plants and pictures of nature indoors, as demonstrated in workplace studies (Bringslimark et al., 2011; Heerwagen & Orians, 1986). There is a longstanding interest in the health-promoting effects of natural view through windows, dating from the development of theories of stress reduction (Ulrich, 1983; Ulrich et al., 1991) and attention restoration (R. Kaplan & Kaplan, 1989; S. Kaplan, 1995). The preference for natural window views, as well as their positive influences on satisfaction with the residence (R. Kaplan, 1985, 2001; Kearney, 2006; Schmid & Säumel, 2021), emotional and mental health, and psychological restoration (e.g., Braçe et al., 2020; Honold et al., 2016; R. Kaplan, 2001; Soga et al., 2021) are well established in the literature. The adverse effects of poor views and built elements visible from windows on health and well-being are also documented (e.g., Amerio et al., 2020).

Although considerable research has been conducted in this area regarding window views, many outstanding questions still remain. The effects of various types of window views—regarding openness, vista, and the amount and type of nature depicted-have been studied in different settings, like healthcare (Ulrich, 2002) and educational environments (Li & Sullivan, 2016), but have received limited attention in residential context (Grinde & Patil, 2009; Velarde et al., 2007). Evaluation of preferences and the health-related effects of various components visible from windows in urban areas, and from different floor levels within buildings, as well as strategies to improve the quality of the view from those windows are topics of future research in this area (e.g., J. Kim et al., 2022; Koprivec et al., 2022; Masoudinejad & Hartig, 2020; Mirza & Byrd, 2023). Methods to provide natural views in dense residential areas are mainly understudied (e.g., Domjan et al., 2023; Li et al., 2022; Shentova et al., 2022). The relation between window view

quality and residents' comfort, such as thermal perception and tolerance as well as noise annoyance perception, is another area that has rarely been studied, with only a few pieces of evidence from workplace (Du et al., 2022; Ko et al., 2020) and residential context (Jiang et al., 2022; Nang Li et al., 2012), highlighting the need for further investigation. Another open question relates to the methods for preserving the view quality of neighboring buildings when constructing a new building, especially in dense areas. The influence of cultural considerations, such as privacy, on the perceived visual quality deserve attention in these studies. Beyond visual quality, other sensory aspects of windows that can connect residents with nature, such as natural soundscapes (Alvarsson et al., 2010; Qiu et al., 2021), should also be considered when evaluating the benefits of windows and their restorative potential.

3.2.1.4. Connection to social life. The significant potential of windows to connect residents to social life is almost overlooked in research. There is very limited evidence regarding the restorative potential of observing street life from apartment windows and the positive effects of hearing urban and neighborhood noises on well-being (e.g., Masoudinejad & Hartig, 2020; Torresin et al., 2021). Additionally, it has been shown that nature visibility from home can buffer against the adverse well-being outcomes of low social connectedness, highlighting its potential to help socially isolated individuals meet the need to feel connected (Cartwright et al., 2018). Considering that social isolation is a major concern in apartment housing, windows should be considered as factors of interest in future research in terms of their potential to support social well-being via connecting residents (passively or actively) with the outside, neighbors, and passers-by, as well as their role in providing a positive soundscape. Social exposure through windows on lower levels may raise some concerns such as privacy and street noise that must be addressed in research. How windows can provide residents of upper floors with social exposure, given their limited views of street life, also remains an open question. This research direction could lead to novel ideas for facilitating social interactions within HB components on various floor levels within apartment buildings.

3.2.2. Balconies

Despite being a defining feature of apartment housing, balconies and their health-related outcomes are rarely studied, particularly in pre-COVID-19 time. A summary of the findings from the reviewed literature and relevant gaps are provided in the following four areas.

3.2.2.1. Balcony availability and characteristics. Some architectural design recommendations highlight the importance of providing easily accessible outdoor spaces and nature at home, with an ideal private open space being both visually and functionally accessible from inside the dwelling (Marcus & Sarkissian, 2023). The role of balconies in fulfilling this need remains understudied.

Before the pandemic, balconies were rarely the center of attention in research, often viewed as artistic elements breaking up the building's facade massing rather than potential amenity spaces (Peters & Masoudinejad, 2022). During the pandemic, home confinement drew more attention to outdoor spaces: People came to value their balconies more and researchers focused further on this component, investigating the ways people and their homes respond to extreme circumstances. Regardless of culture and climate, during the pandemic, balconies were found to be used more frequently (e.g., Aydin & Sayar, 2021; Bassetti, 2020; Mesa-Pedrazas et al., 2023), recognized as some of the most valued spaces in the home (e.g., Adeeb Fahmy Hanna, 2023; Alonso et al., 2021), and were a strong factor in satisfaction with housing (Kleeman & Foster, 2023; Kley & Dovbishchuk, 2021). However, few studies have been conducted on why people desire for a balcony, how they use their balconies, or what activities they prefer to do there (e.g., Khalil & Eissa, 2022; Smektała & Baborska-Narożny, 2022), as well as the design attributes required to facilitate balcony functions that meet residents' needs in a specific region or culture (e.g., Molaei et al., 2022; Nam & Cho, 2021). To achieve effective balconies that contribute to residents' well-being, further investigation is required to identify people's preferences, activities, desires, and needs associated with balconies. Design strategies and features that create a functional and livable balcony, like its typology, optimal size, the desirable level of enclosure, and suitable connection to adjacent spaces within the dwelling, should also be studied. Cultural norms and lifestyle preferences, as well as desired levels of privacy and security can also affect how people use and benefit from balconies.

3.2.2.2. Connection to the outside. Access to outdoor spaces at home provides health benefits and promotes positive emotions for residents (Cheshmehzangi, 2021; Millán-Jiménez et al., 2021b; Pouso et al., 2021). This is due to advantages such as daylight, views, and sensory qualities provided by the connection to the outdoors. Existing findings in this area are sorted into three categories: 'visual comfort', 'thermal comfort', and 'spatial perception', as follows.

3.2.2.2.1. Visual comfort. Balconies are valued for qualities such as transparency, daylight, and a pleasant view (Wågø et al., 2016). Few studies have been conducted on the positive and negative effects of balconies on daylight penetration, luminous comfort (G. Kim & Kim, 2010; C. Ribeiro et al., 2020; Wilson et al., 2000; Xue, Mak, Cheung, & Chao, 2016), and the design parameters that contribute to them (Dolníková et al., 2021; Jakubiec et al., 2023; Yang Ouyang et al., 2023).

3.2.2.2.2. Thermal comfort. The presence of a balcony, its role in circulating fresh air, and its natural features can impact residents' comfort by indirectly influencing their feelings and behaviors (de Dear & Brager, 2002; Xue, Mak, Cheung, & Chao, 2016). As demonstrated for windows in the previous section, the presence of balconies can also enhance residents' well-being by providing sensory stimuli, increasing the sense of control over comfort, encouraging adaptive behaviors, and ultimately improving comfort and satisfaction with indoor conditions (Dahlan et al., 2009; Wågø et al., 2016). However, the number of studies in this area is limited, warranting further research efforts.

3.2.2.2.3. Spatial perception. By creating porous boundaries, balconies appear to affect the spatial appearance and how occupants perceive the room, just as windows do. Balconies may have a greater influence on spaciousness and density and crowding perception than windows, as they not only provide an outlook but also extend the floor area to the outside. Access to a balcony has been shown to increase satisfaction with room size, mitigate the feeling of crowding, and enhance residents' perception of liveability in compact cities, although the frequency of use may not be high (Kennedy et al., 2015; Park et al., 2023). Furthermore, balconies can influence actual and perceived privacy and sense of safety in the dwelling. Residents may perceive balconies as elements that reduce visual privacy and increase the risk of unauthorized access to low-floor apartments. Very few studies have addressed this topic, and some of them have resulted in contradictory findings (Wing Chau et al., 2004; Xue, Mak, Cheung, & Chao, 2016), highlighting the need for further research.

Overall, despite the potential positive effects of balconies via providing connection to the outside, there is a lack of research in these areas, and the design qualities of balconies in apartment housing are understudied (Kesik et al., 2019). Broad research is required on balcony typology, their enclosure style, and design parameters that contribute to visual and psychological comfort. Factors influencing comfort within the balcony itself (e.g., the orientation towards sun and wind, noise control, materials, enclosure, size, and privacy) are all subjects for future research. Although we excluded the growing area of research on the environmental performance of balconies and their contribution to IEQ (e.g., Bhikhoo et al., 2017; Omrani et al., 2017; C. Ribeiro et al., 2020), the findings from this area should also be considered when exploring psychological aspects. All of these issues are dependent on the contextual factors of balconies, which require broad research.

3.2.2.3. Connection to nature. People prefer to have access to nearby nature (R. Kaplan, 1985), which has positive effects on their health, well-being, and satisfaction with life and residence (Odum, 2015; Talbot & Kaplan, 1991; Taylor et al., 2002). A number of studies in different settings have provided strong evidence that having access to plants and natural features in close view causes beneficial psychological changes and supports restoration (Bringslimark et al., 2009). The role of balconies in meeting this need in apartment housing has been largely overlooked. Post-COVID-19 studies have placed greater emphasis on this topic and have demonstrated the biophilic potential of green balconies (Leon et al., 2020; Zwierzchowska et al., 2021), discovering their positive impact on emotional and mental well-being, and resilience in coping with stressful situations (Alhadedy & Gabr, 2022; Dzhambov et al., 2021; Kaplan Mintz et al., 2021; A. I. Ribeiro et al., 2021). Additionally, balconies can provide the opportunity for micro-gardening at home, which has been found to have some health-promoting effects (Soga et al., 2021) specifically in older adults (Yeo et al., 2020). Furthermore, the impact of green balconies on spatial appearance, particularly in terms of indoor aesthetics, has also been studied to a limited extent (Mladenović et al., 2017).

Extensive research is still required to identify the attributes of private outdoor spaces that meet residents' needs for proximity to nature, natural sensory stimuli, and facilitation of beneficial activities like micro-gardening. Moreover, the potential of green balconies offering a natural view from home, particularly in densely built or nature-deprived areas where apartments lack natural scenes from windows, deserves attention. The effects of green balconies on comfort as well as spatial perception remain open questions. These parameters are also influenced by culture, lifestyle, and climate, which should be considered in future research.

3.2.2.4. Connection to social life. People have a need to connect with people outside and street life while being in their home environment (Alexander et al., 1977). Certain features of houses, such as private outdoor spaces and gardens, have been shown to promote sociability and a sense of control, thereby enhancing residents' sense of well-being compared to apartment housing (Gibson et al., 2011; Kearns et al., 2000). In the context of apartment housing, balconies, positioned between private and public realms, can play a significant role as social spaces for communication (Aronis, 2022; Calvo & Bejarano, 2020) and contribute to the social and cultural life of the city (Aronis, 2009). The existing studies on this topic are mostly from the post-pandemic period, when people used their balconies more frequently for socializing (Aydin & Sayar, 2021; Bassetti, 2020; Beşir Ertaş et al., 2023; Elzein & Elsemary, 2022; Grigoriadou, 2021; Gür, 2022) and engaging in activities like playing music as a means for social solidarity (Calvo & Bejarano, 2020).

Investigating the possibilities of balconies for social connections in both active and passive forms is a subject of future research. Many balcony parameters, including floor level, height from the ground, proximity to neighboring balconies and windows, and features of streets and public spaces nearby or below, may influence the social role of balconies. In lower floors, balconies can create a strong connection with street life, as eye contact or verbal communication can be established (Gehl, 2011), and the social soundscape can be heard. This connectivity, however, becomes a challenge in upper-level apartments. One way to facilitate social interactions on higher-level balconies is by enhancing their accessibility from entryways and integrating them with transitional spaces, potentially providing opportunities for engaging with neighbors or hosting visitors while remaining outdoors. This, however, needs further research and reconsideration in terms of the current design paradigm of multi-family housing. Another open question concerns the impact of micro-gardening on social well-being. Despite some research suggesting that community gardening increases positive interaction among neighbors, social satisfaction, as well as social control over public and semi-private spaces (Home & Vieli, 2020; R. Kaplan, 1985; Lewis et al., 2018), the social outcomes of gardening on balconies are almost overlooked (see. Wang et al., 2023). Furthermore, exploring the potential of green balconies to moderate adverse effects of social isolation through exposure to natural elements is an important area for future research. Finally, cultural norms about social behaviors, privacy, and territoriality may dictate how different groups use balconies to socialize and therefore should be investigated in future research.

3.2.3. Entrance/transitional spaces

Entrance and transitional spaces are necessary in all buildings. Apartment buildings, where there is often both an interior public entry and a transition to the private apartment, are a special case with potential to influence many residents at once. The focus in this section is on this special case.

3.2.3.1. Characteristics. Beyond their function as circulation paths, entrance and transitional spaces undergo a process of change from one condition to another, acting as buffer spaces and serving as physical, psychological, and sensory links. These areas can be designed to be desirable spaces in apartment housing (Bay, 2000) and to foster healthy, resilient environments. Nevertheless, they are often understudied, with people's preferences, needs, and behavioral patterns in these spaces being largely overlooked. These spaces received greater attention in the post-COVID-19 literature primarily with a focus on hygiene and disinfection in transitory spaces, underscoring their crucial role as spaces in major need of change in future housing (Alati, 2020; Bahadursingh, 2020; Kang, 2020). Entrance spaces involve various behaviors with specific spatial requirements. Being a threshold space between inside and outside, the entrance area ideally should consist of two parts inside and outside (Alexander et al., 1977) to respond to the functional needs of both sides. Therefore, the design of entrance spaces and entryways should address the expectations for these areas while also enhancing the livability of residences, and should be given attention in both research and design. Many of the behaviors occurring in these spaces have a cultural basis, so cross-cultural perspectives and flexibility to accommodate cultural diversity should also be taken into account.

3.2.3.2. Connection to the outside. The potential for housing transitional areas (i.e., corridors and entrances) to serve as open or semi-open spaces that connect residents with the outdoors is mainly neglected, as these spaces are often designed to be enclosed. Limited relevant research exists, highlighting the importance of designing these spaces so that the transition between indoor and outdoor environments supports various activities, ensures privacy, improves thermal comfort, and enhances residents' well-being (Wågø et al., 2016). Given their ability to facilitate psychophysiological adaptation to thermal conditions, an ideal model for designing a transition space should incorporate a semi-open external corridor, with temperature and humidity gradually increasing or decreasing from the outdoor environments, through the transition space to the indoor environments (Jiao et al., 2023). Similar to balconies, further research is needed to explore how transitional spaces—ranging from public, to semi-private, to private areas—can offer sensory qualities, enhance visual and thermal comfort, and improve spatial perception, such as the feeling of spaciousness, safety, privacy, density, and crowding. Climatic and cultural differences should be carefully considered when examining this area.

3.2.3.3. Connection to nature. The potential of housing entryways and entrance spaces to incorporate natural elements and expose residents to them is largely overlooked, primarily due to the common belief and practice that these spaces are merely enclosed. Very few studies have been conducted on existing apartment buildings with semi-open corridors and forecourts aimed towards exploring their potential for gardening and their effects on residents' health (Bay, 2010; Bay et al., 2007). Extensive research is required to investigate effective ways to

harness this potential, whether through passive means, such as facing towards the outside and natural scenes, or actively, through the integration of natural elements and greenery fostered within these spaces. Outdoor corridors and semi-open entrances could be potential areas for creating green streets in the sky, providing each apartment dwelling with a small front yard. Such an entrance could serve as a small porch in which residents are exposed to fresh air, daylight and sunlight, views to outside, connection with the street and social life, and even enabling them to care for plants in the access-way. In fact, there is a triangular interrelationship between people, gardening, and the environment, where each element stimulates the others (Kong, 2005). For example, people who enjoy gardening use the spaces which facilitate this activity; the presence of plants improves the environmental quality of the space, thereby attracting more people and activities, leading to increased social interaction between neighbors and an enhanced sense of community, in turn encouraging more gardening. Despite this cyclical relationship, the benefits of green and gardened entryways on residents' health and well-being are unexplored in research. Moreover, this matter requires the implementation of flexible policies in residential buildings to facilitate personalizing home exteriors and semi-public spaces. Cultural norms and climate concerns should be considered in related studies as well.

3.2.3.4. Connection to social life. Despite the potential of entrance and transitional space design in regulating and improving social interactions, little scientific research is available on this matter in the context of housing. In this regard, several concepts and theories based on human spatial behaviors should be considered, such as privacy (Hall, 1959), territoriality, defined as a social-behavioral construct (Altman, 1975), and defensible space theory (Newman, 1972, 1996). Physical design strategies in residential buildings that reflect an understanding of privacy, territoriality, and defensible space provide residents with more control and supervision over spaces around the home. For instance, windows facing surrounding territories have good visibility of those areas and provide natural surveillance. Moreover, the subdivision of surrounding spaces into distinctive territories in terms of public, semi-private, and private zones can control movements in these areas. Accordingly, both crime rates and fear of crime in residences decrease (Reynald & Elffers, 2009).

Beyond crime, a clear spatial hierarchy in transitional spaces enables residents to control their interactions with others at home and manage boundaries to help regulate their social interactions. Some architectural design recommendations emphasize providing an intimacy gradient in entryways of the multi-family housing and a defined entrance space for each individual home, using physical or symbolic barriers (Alexander et al., 1977; Marcus & Sarkissian, 2023). In addition, the ease of personalization of these territories, as a territorial behavior, should be considered in apartment housing study, design, and policy (Marcus & Sarkissian, 2023). This need becomes more apparent when homes have a similar appearance in which case, residents tend to attach their unique identity to their homes through personalization.

These arguments align with the present study's purpose in the sense that safe and desirable spaces around the home (i.e., home boundaries) can decrease social conflicts and also encourage residents to spend time there and maintain them and in turn, facilitate the use of this threshold for socializing. Indeed, transitional zones that are neither private nor public can serve as connecting links, both physically and psychologically, fostering communication (Gehl, 2011). This way, entrance ways and spaces can accommodate activities that would occur on the street, front porch or path (Marcus & Sarkissian, 2023) such as sitting in front of the door, watching people passing by, and entertaining short visits with neighbors. Such livability sounds more attainable when apartment housing configurations stray from conventional forms. For example, incorporating entrance forecourts, semi-open corridors, and sky streets with the option of gardening can be effective strategies to foster a sense of community and security (Bay et al., 2007). Certain criteria have been identified for improving social interaction in semi-public transitional spaces of high-rise apartments, including visibility and openness, design attributes of nodes, opportunities for various activities and personalization (Huang, 2006; Siew Bee & Poh Im, 2016). Moreover, design strategies that connect transitional spaces with the surrounding street life can improve the psychological and social health of residents in high-rise housing (Kalantari & Shepley, 2021).

This topic deserves a great deal of attention in housing study and design, with the consideration of intervening factors like climate and culture. Cultural context strongly influences the social impact of home boundaries, as a review on high-rise post-occupancy studies reported that a majority of studies showing negative social relations in high-rise buildings were conducted in the U.S. and Europe while studies carried out in East or Southeast Asia presented opposite outcomes (Kalantari & Shepley, 2021). Notably, in research on the potentials of outdoor corridors or semi-open entrances, many concerns overlap with topics related to balconies.

4. Discussion, research directions, and implications

HB components have health-promoting effects via providing access and connection to the outside, nature and social life, yet the literature review revealed that the HB is a less-explored niche area in environment-behavior research, providing a context for a wide variety of studies. HB components have not received the attention they deserve, and there are still many unanswered questions that require further multidisciplinary research.

Among these components, windows were studied the most, particularly regarding the 'view', 'visual comfort', and 'connection to nature' topics. Balconies went largely unnoticed in pre-COVID-19 literature, but began attracting greater research attention during the COVID-19 pandemic. Indeed, the critical role of balconies and private outdoor spaces became apparent when people were confined at home and deprived of public outdoor spaces due to periods of lockdown when fear of catching the virus played an important role in interacting with the outside world. The least studied components of HBs, in relation to psychological health and well-being, are entrance and transitional spaces. Overall, there are various gaps and unknowns that should be investigated to reveal the effects of HBs on residents' psychological health and well-being, and to develop strategies to achieve improved outcomes.

4.1. Research directions

Fig. 4 illustrates some directions for future research on HB outcomes related to residents' emotional, mental, and social states. In addition to its direct effects on health and well-being, various subjects are recommended for study on indirect effects of HBs through people's preferences and satisfaction with home, as well as its influence on comfort and spatial perception at home. These are interrelated themes that have been overlooked or are not well-understood. To achieve or maximize the benefits of HBs, recommended research directions also include architectural aspects, design factors, and parameters that influence each effect within the suggested themes. Overall, the diagram proposes a systematic exploration of HBs in both psychological and architectural aspects.

Besides being understudied, HB components have mainly been perceived as discrete elements rather than as integral parts of a holistic mechanism connected to both the interior and exterior. A risk lurking here is the tendency to seek a one-size-fits-all solution for HB components in all housing scenarios. This may explain why incorporation of typical windows or balconies in many existing buildings does not necessarily result in effective HBs. To address this deficiency, the research directions in the figure below are not defined for individual components but for integrated components within the HB as a system.

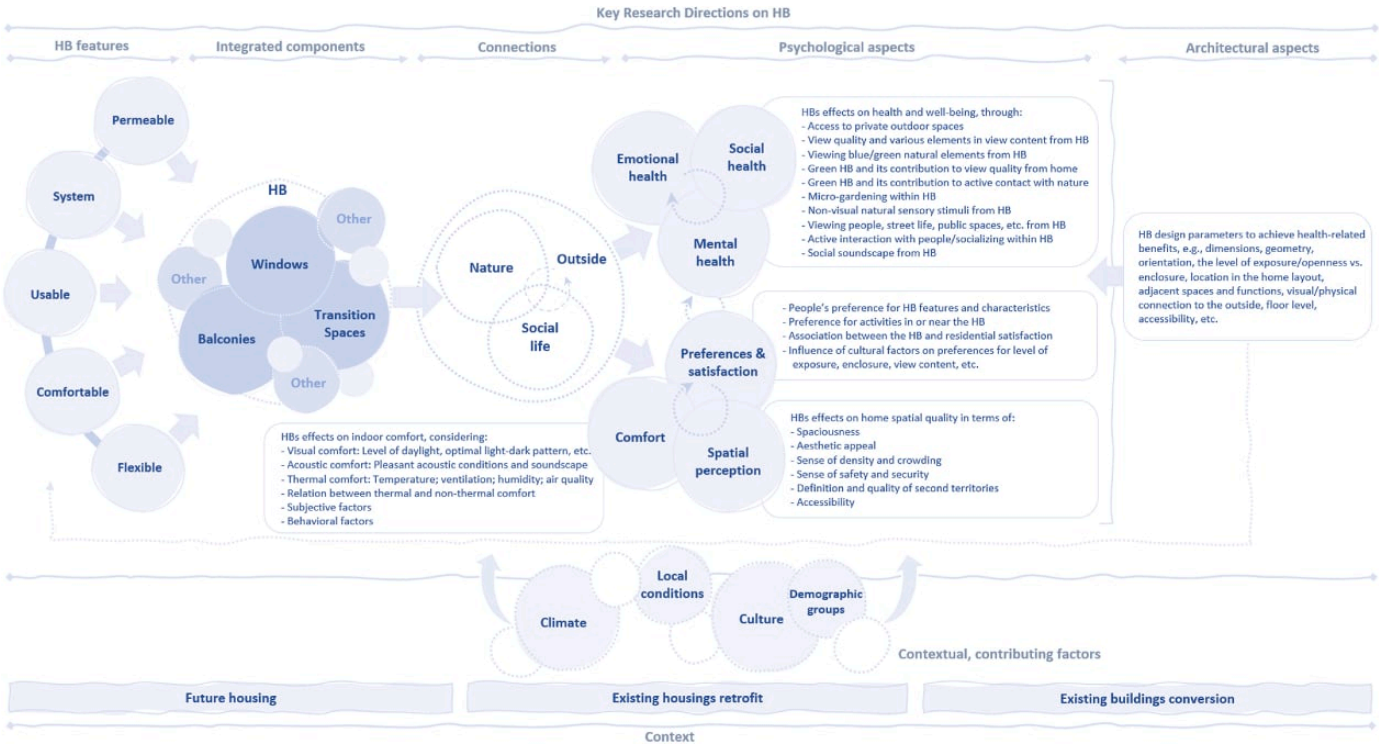

Fig. 4. Future Research Directions on the HB: Focus areas regarding its direct and indirect effects on residents' health and well-being (i.e., psychological aspects), along with architectural aspects facilitating achieving these effects, hypothesized features for creating effective HB, and contributing factors in the context of existing and future apartment housing.

Taking a comprehensive approach to the HB, recognizing it as a system, and considering contextual factors at play can lead us to explore opportunities to utilize and maximize the benefits of the HB that fits its context.

As we understand the effects of individual components, viewing the HB as a system allows us to create effective indoor-outdoor connectivity through the synthesis of all its potentials, which would be impossible with individual components alone in many contexts. For instance, integrating well-placed openings with private outdoor spaces and semi-private transitional areas creates unique and pleasant experiences that are often missed when windows, balconies, and corridors are treated as separate, conventional elements. Additionally, many effects are interrelated and can amplify each other, such as the triangular relationship between environmental quality, gardening, and social interaction in the HB, as discussed before. A comprehensive approach to the HB may lead to changes in residential design and create more resilient housing typologies.

The comprehensive approach to the HB requires knowing and acknowledging multiple contributing factors at play, such as contextual factors. Some of these factors are elaborated upon below.

Climate- Climate and local microclimate affect the comfort and functionality of the HB as a space as well as the indoor environment connected to it (Shamseldin, 2023). Therefore, each climate region requires specific design parameters and details to ensure the attainment of a comfortable and useable HB. Although it falls outside the scope of the themes studied in the present paper, the impact of the HB on IEQ is a broad area that should be considered alongside other relevant factors in HB-related research, in order to achieve optimal benefits. Particularly, in the face of climate change, there is an urgent need to develop strategies to enhance adaptation of housing against environmental threats and to ensure that residential buildings are designed and maintained to provide a safe and healthy indoor environment for their residents (Afolabi & Adedire, 2023). Given the sensitivity of the HB to these impacts, as they are mostly located on the building envelope, and their direct effect on IEQ and residents' comfort (Kisnarini et al., 2018; Ribeiro et al., 2020), HB-related studies should incorporate climatic concerns and explore strategies to address them.

Culture and lifestyle- Cultural norms and lifestyle can influence outcomes in HB-related research, such as the desirable level of privacy (Abdelwahab et al., 2023), being seen in private outdoor spaces, social interaction, and activities taking place in in-between spaces (Smektała & Baborska-Narożny, 2022), among others. Therefore, culture can alter the definition of preferable and effective HB across different contexts.

Specific populations and times- Future HB research should also address diversity among demographic groups and their particular needs, preferences, and activities. Furthermore, their experiences of being at home in specific times, events, or crises-when people undergo extreme conditions-should be taken into account. Indeed, the housing environment should be prepared for instances when people are forced to stay home, whether due to personal or global circumstances.

Nevertheless, these intervening factors should not weaken the HB but should lead to innovative strategies capable of adjusting to special conditions. Increasing permeability, embracing flexibility, and incorporating multi-layer boundaries, as opposed to adopting restrictive, fixed, and linear borders, are examples of design choices that can enhance adaptation in HBs. For instance, the "adaptable balcony" concept (Peters & Masoudinejad, 2022; Shamseldin, 2023) focuses on the idea of functional and comfortable balconies that are convertible according to residents' needs, changing weather, varying lifestyles, and insufficiency of unit space. Indeed, maximum continuity in the use of in-between spaces and addressing the conflicting functions and norms can be fulfilled by employing flexible strategies. This becomes more crucial in multicultural societies where housing should accommodate diverse cultural norms and needs. Moreover, regions with varying weather conditions can specifically benefit from these strategies. Such approaches are highly recommended over conventional forms of HBs that often disregard contextual differences and are ill-prepared for extreme conditions.

Local environment- Other contributing factors relate to ambient conditions such as neighborhood morphology, site planning, landscape design, and surrounding built and natural environments. For instance, providing a desirable view from the HB is influenced by local factors such as the built density in the neighborhood, the proximity, height, and façade design quality of nearby buildings, and the surrounding landscape design (Masoudinejad & Hartig, 2020). Likewise, functional, visual, and thermal comfort of private outdoor spaces is affected by factors related to the site and neighborhood planning and policies in addition to the local microclimate (Rodríguez-Algeciras et al., 2021). From another perspective, strategies to enhance the view quality from the HB should be carefully planned to prevent adverse impact on the quality of HBs in neighboring buildings. Therefore, strategies to attain effective HB within a specific area may significantly differ from those applicable in a zone with a different ambient condition. This emphasizes the necessity of considering the HB as a system within a specific context in research, design, and policy.

As argued thus far, a set of high-level features can be hypothesized for the HB to function effectively, as follows.

- *Permeable* – referring to sufficient porosity in the HB to facilitate indoor-outdoor connectivity.
- *System* – referring to the holistic mechanism of the HB, considering integrated components instead of discrete individual components.
- *Useable* – referring to the HB's ability to accommodate residents' activities, considering diverse cultures and lifestyles.
- *Comfortable* – referring to the comfort enabled by the HB in both physiological and psychological aspects, considering climate and culture, which in turn affects its usability.
- *Flexible/Adaptable* – referring to the ability of the HB to be adjusted to diverse needs in several ways: 1) By allowing residents to regulate the permeability of the HB to control their home environment exposure, 2) By offering spatial flexibility to adapt to diverse lifestyles and varying family needs, and 3) By providing environmental adaptability to adjust to varying weather conditions and offer comfort.

4.2. Implications

The HB is a dynamic concept that can open broader perspectives to novel and varied ways of connectivity in housing. This approach can lead to new research directions, different forms of home boundaries, and alter the design, configuration, and regulations of multi-family housing. This can not only enhance the quality of dwellings and housing areas but also that of neighborhoods on a larger scale.

The HB concept can support sustainable housing across social, economic, and environmental dimensions, particularly when addressing the needs of specific populations and communities. For instance, in the context of affordable housing, a thoughtfully designed HB could significantly contribute to creating healthy, resilient housing. This includes enhancing spatial perception such as space adequacy and sense of crowding, comfort, environmental and spatial adaptability, and overall satisfaction with the residence, while the housing configuration often aims to provide small, affordable units. Moreover, this can help address some psychological challenges in housing for older adults, contributing to the objectives of aging in place. As this group grows older, likely staying in their homes longer and facing a higher risk of isolation, an effective HB can support their comfort, health and well-being by maintaining their connection to nature, social life, and the outside world. Nevertheless, a poor understanding of HB benefits and a lack of innovative design solutions, have led many developers to oppose incorporating qualified HB components. For instance, many developers advocate for removing balconies from new housing, viewing them as unnecessary for small apartment units (Smektała & Baborska-Narożny, 2022) and as a waste of floor area and money (Campbell, 2023).

Besides being useful for seeking solutions and strategies for future housing, the HB can be applied to improving the quality of existing buildings through renovation and retrofitting. A majority of the world's population lives in existing residences that will last for decades, and their health and well-being should not be neglected. Hence, a part of HB-related efforts should be dedicated to improving the quality of existing buildings' HBs. In addition, the ongoing trend in energy-efficient and climate-adaptive retrofitting of existing buildings offers an opportunity to incorporate upgraded HBs while retrofitting building envelopes. This is an applicable and cost-effective strategy, with minimal disruption to residents, as evidenced by some successful cases (e.g., the project *Grand Parc*, Bordeaux, France. https://www.lacatonvassal.com). This offers an opportunity not only to enhance the climate adaptation in existing buildings but also to improve the quality of life and health-promoting moments within these buildings. Moreover, the trend of converting commercial buildings to residential use should consider this matter to provide healthy, resilient housing for future residents. Therefore, there is a need for research to identify existing restrictive HBs and to develop strategies for upgrading them. Here, taking a comprehensive approach to the HB system and considering contextual variations are necessary.

5. Conclusion

This paper emphasized that the influence of the home on residents' health and well-being extends beyond its indoor spaces, encompassing the quality of indoor-outdoor connectivity. This drew attention to the critical role of home boundaries in addressing the issue of residents' isolation, particularly in certain forms of apartment housing where residents' health and well-being are at risk due to disconnection from nature, social life, and the outside world. The concern intensifies when it comes to certain groups, particular lifestyles, and specific circumstances in which people endure extreme confinement. In response to this challenge, this paper defined the HB concept to guide fragmented concerns and studies in this area towards more purposeful and practical paths, offering a framework for rethinking ways to create effective HBs.

The HB, if designed thoughtfully, can support health and resilience in housing. To achieve this, the paper advocated for a comprehensive approach to the HB, treating it as a system to facilitate effective indoor-outdoor connectivity, and considering all contextual factors at play to realize opportunities for maximum benefits. Interdisciplinary collaborations, ranging from psychology and sociology to architecture, urban design and planning, to engineering, are required to understand all aspects influencing the quality of the HB as well as ways to address their implementation and improvement. Moreover, there is a need for a communication network between researchers, designers, planners, and policymakers to translate research findings into innovative practical applications that are tailored to specific physical and cultural contexts. These efforts can build a knowledge database to define strategies for housing design, retrofit, and conversion, and to pave the way for new housing policies. This can lead to meaningful changes in conventional housing practices and the development of planning guidance and regulations, supporting health and well-being in both future and existing housing.

Conflict of competing interest

None.

Acknowledgments

This article is a contribution from the NRC project A1-020175, 'Establishing Indoor Conditions for Healthful Aging in Place'. The author thanks Dr. Brad Gover and Dr. Liang (Grace) Zhou for their support, as well as Dr. Jennifer Veitch, Dr. Erhan Dikel, Alexander Hayes, and Julia Ignaszewski for their comments on the manuscript, and the reviewers for their valuable feedback.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2025.102621.

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