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HOSPITAL DESIGN AND ELDERLY CARE: A SCIENTOMETRIC ANALYSIS OF GLOBAL RESEARCH TRENDS AND FUTURE DIRECTIONS

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Abstract
Hospital and healthcare environment design plays an indispensable role in influencing the health, recovery, and well-being of ageing populations. In this study, a scientometric approach is employed to map the global research landscape of hospital architecture, healthcare design, and healing environments, specifically focusing on elderly patients and the aging population. With the use of bibliometric software, the research identifies top authors, publication patterns, key institutions, and thematic groups that define this multidisciplinary field of study. The research depicts a steady increase in activity over the last decade, with overall contribution by the USA, UK, Sweden, the Netherlands, and China. Findings indicate that design attributes like natural light, single-bed rooms, restorative gardens, biophilic elements, and noise control play a key role in increasing patient satisfaction, psychological stability, and decreasing recovery time. Additionally, thematic mapping indicates the salience of themes like healing environments, quality of life, and aging care, highlighting the intersectionality of architecture, psychology, gerontology, and nursing science. The research also responds to five research guide questions, validating evidence-based design expansion, revealing evidence gaps in staff-oriented research, and revealing regional disparities reducing global application. Real-life applications of these principles are presented through practical case studies like dementia villages in the Netherlands, therapeutic gardens in Sweden, and culturally responsive geriatric hospital designs in South Korea. Yet, the study recognizes chronic limitations, such as the lack of adequate longitudinal studies, limited use of digital technologies such as IoT-enabled monitoring and AI-based adaptive spaces, and low representation of low- and middle-income countries. In summary, hospital design is demonstrated to be an active geriatric well-being determinant in place of being a passive background for clinical treatment. The research not only aggregates prior knowledge but also offers a future-oriented agenda, focusing on international inclusivity, interdisciplinarity, and technological innovation. Through integrating scientometric insights with real-world applications, this study places hospital design as a pillar for promoting comprehensive aging care, dignity, and well-being in healthcare systems globally.
Keywords: Hospital architecture, Healthcare design, Healing environments, Geriatric care, Scientometric analysis.

1. INTRODUCTION

Design and health facility architecture have become a decisive factor in patient health outcomes, especially among the geriatric population that is disproportionately burdened by environmental stressors [1], [2]. With the world undergoing a rapid demographic transition where the number of individuals aged 65 years and older is estimated to double by 2050 the physical and psychological requirements of elderly patients have emerged in the forefront of healthcare planning[3], [4]. In contrast to younger patient populations, older adults tend to have compromised mobility, sensory disturbances, cognitive impairment, and heightened susceptibility to stress. Hospital planning and healthcare design thus need to go beyond their former function as utilitarian spaces, becoming therapeutic environments that promote wellness, well-being, and recovery in an active and intentional manner [5], [6].
The idea of "healing environments" is based on the recognition that the built environment has the potential to directly impact physical health, emotional well-being, and social connection. In older patients, spatial orientation, natural light, acoustics, ventilation, and human-scale layouts are not peripheral issues but fundamental aspects that influence safety, independence, and well-being. Empirical data indicate that exposure to nature-inspired environments can reduce blood pressure and stress hormones, while intuitive wayfinding and dementia-friendly layouts can substantially decrease confusion and falls among older patients. These observations make it clear that hospital design is not just an issue of building structure anymore but a multilateral determinant of integrative care.

Various healthcare systems around the world have started adopting such principles into practice. Nordic countries are frequently referenced as being at the forefront of age-friendly hospital design [7]. Hospitals in Denmark and Sweden incorporate open courtyards, therapeutic gardens, and "small household" ward designs, which mimic familiar home environments to alleviate worry and facilitate social engagement among dementia patients. The Netherlands has also led the way in dementia villages like Hogeweyk, where design simulates a secure yet independent community environment that enables elderly patients to live with dignity while being supported 24/7 . In the US, hospitals implementing the Planetree Model prioritize patient empowerment and family engagement through architectural elements developing cozy, less hospital-like spaces, while Singapore's Khoo Teck Puat Hospital illustrates the influence of biophilic architecture by integrating urban healthcare with sweeping greenery, pedestrian walkways, and natural ventilation [8]. These international models reflect how architectural design is progressively entangled with public health and geriatric care policy.

At the theoretical level, several frameworks validate the importance of hospital design in healthcare. Ulrich's Theory of Supportive Design holds that healthcare settings need to minimize stress, create positive distractions, and instill a sense of control [9]. Biophilia Hypothesis, also suggested by Wilson, asserts that natural human affinity for nature factors makes vegetation, water bodies, and sunshine integral to healing environments [10]. Person–Environment Fit theory further contributes with an emphasis on congruence between older people's abilities and environmental provision for instance, secure flooring and color contrasts can prevent falls and misperception [11]. Salutogenic theory focuses on the environment that produces comprehensibility, manageability, and meaningfulness, which leads to mental resistance among the geriatric group. These theories cumulatively complement the evidence that healthcare architecture is not passive but an active healing agent [12].

Yet, even though it is theoretically fertile and practically significant, hospital design research, healthcare architecture research, and geriatric well-being research are disseminated over a number of academic disciplines like architecture, gerontology, nursing, environmental psychology, and public health. Such dispersion makes it difficult to trace the intellectual trajectory systematically, to discern the prevailing clusters of research, or to foresee upcoming trends. Scientometric analysis provides a stern methodology for bridging such dissemination. By using bibliometric metrics, citation communities, keyword co-occurrence maps, and thematic evolution tracking, scientometric techniques expose patterns of knowledge creation, leading authors and institutions, and worldwide cooperation in this multidisciplinary domain. They not only give a quantitative snapshot of research output but also interpretive insight into how ideas such as "healing environment," "well-being," and "geriatric care" interweave and diverge throughout contexts.

For example, scientometric reviews at the country level often underscore the leadership of the United States, the United Kingdom, and Scandinavian countries in the development of age-friendly healthcare design research, but indications of intensifying contributions from nations like China and South Korea in Asia signal the globalization of such concepts. Keyword co-occurrence analysis places terms such as human, aged, well-being, quality of life, and dementia at the center consistently, in line with interdisciplinary convergence of architecture, psychology, and health sciences. By unveiling such patterns, scientometric analysis not only records the progress of the field but also draws attention toward gaps—e.g., underrepresentation of low- and middle-income nations where geriatric populations are growing fastest.

Scientometric analysis thus not only plots productivity but also indicates the structural maturity and future trends of this discipline. For healthcare architects and policymakers, this knowledge offers an evidence base upon which to place bets on investments in geriatric-friendly healthcare environments. As an example, enhanced visibility of words such as stress, cognitive defect, and digital health project that the next generation of hospitals should integrate both environment and technology design innovations so that they can effectively meet complex geriatric requirements. For scholars, the review identifies prospects in underrepresented geographies like low- and middle-income countries where aging populations are expanding most rapidly but hospital design research is lacking.

The current study makes a contribution in this respect by rigorously integrating the dispersed knowledge base by means of scientometric methods. By tracing the intersection of hospital design, healthcare architecture, healing environments, and geriatric health, it demystifies both the past and the future horizons of this crucial inter- and trans-disciplinary field. The outcomes are not only of academic concern but hold significant pragmatic importance for day-to-day practice, where evidence-based design has the potential to enhance patient recovery, reduce healthcare costs, and most importantly, to promote elderly patients' perceptions of safety, dignity, and well-being in healthcare environments.

2. LITERATURE REVIEW

Hospital design, healthcare architecture, and healing environments have come to be a focal area of research in today's geriatric care. With demographic shifts globally accelerating an unwonted growth in the population of the aged, healthcare systems are being pressured to offer not only effective medical interventions but also settings conducive to psychological health, socialization, and overall recovery. The idea that the built environment has a major impact on human health is not recent, but its systematic introduction into healthcare planning, especially for older populations, has only picked pace in the last decades. This increasing research interest has led to a large body of literature mixing architecture, gerontology, nursing science, and environmental psychology.

Among the first and most impactful in this field is that of Ulrich et al. [13], who developed evidence-based design further through an experiment that proved that spatial organization, control of acoustic conditions, and exposure

to natural components could lower stress and foster healing. The research served as a foundation for later interdisciplinary research into how physical space acts as a healing agent. Supporting this view, Andrade and Devlin [14] emphasized the contribution of environmental psychology to healthcare architecture, illustrating how sensory stimuli like light and spatial awareness have quantifiable effects on patient well-being. The two studies reinforce the notion that hospitals and care centers are not just functional structures but dynamic determinants of health outcomes.

More recent work has supplemented these early observations using bibliometric and scientometric techniques to chart changing research trends within hospital architecture. Zhang et al. [15], for instance, carried out large-scale bibliometric analysis and found thematic clusters from dementia-sensitive design to sustainable hospital planning, highlighting the inter- and international scope of the subject. Likewise, Li et al. [16] utilized a dual scientometric and content-analytic method to compare elderly daycare centers, suggesting the use of Restorative Environmental Design (RED) as an interface that merges the need for functionality with psychological comfort. Their data support the importance of creating geriatric environments that marry biophilic principles and social interaction and respond to the overall wellness and well-being objectives.

Empirical studies have complemented these findings by zooming in on specific contexts and populations of users. Chun [17], for example, examined long-term care hospitals in South Korea and explored how design interventions, including spatial orientation, corridors that support loitering, and layouts to enhance privacy, promote therapeutic outcomes for older patients. These results align with Lindahl [18], whose research on Swedish care housing for the elderly and youth care settings found that sensory-decked design and shared spaces minimize isolation and improve residents' quality of life. Equally, Elf et al. used a participatory co-design process in stroke rehabilitation units, showing that engaging patients, families, and staff in the design creates spaces that better facilitate dignity, autonomy, and recovery. Together, these studies highlight the capacity of context-based interventions to capture universal principles of healing environments.

Specialized areas like neurorehabilitation and dementia care are also dealt with in the literature. Zeeman [19] proposed the environmental neurorehabilitation concept where they design stimulating environments enriched to promote cognitive and functional recovery in neurological patients. This concept complements the general movement toward person-centered care championed by Edvardsson who showed that supportive settings could promote not just physical recovery but psychological flourishing among older persons. These principles were further validated by Bernhardt [20] when applied to stroke rehabilitation, and he was calling for longitudinal designs to assess long-term effects of design innovations on independence and reintegration into communities.

Though these contributions as a body work to further the body of knowledge, they also identify systemic constraints that need consideration. McCuskey noted that healthcare design research tends to underrepresent staff views and hence produces designs potentially mismatched to everyday workflows. Kort (2012, 2020) noted another shortcoming in the incorporation of indoor environmental quality considerations—light, ventilation, and acoustics—into innovative digital technologies such as IoT-based monitoring and adaptive control systems. In addition, as also observed in numerous scientometric reviews, the literature shows a remarkable geographical disparity: empirical data mainly congregate in Europe, North America, and East Asia, while regions like South Asia, Africa, and Latin America remain under-studied. Such unbalanced Ness constrains external validity and raises concerns regarding the global validity of prevailing models.

Practical, application-based examples highlight the revolutionizing potential of well-planned geriatric settings. In the Netherlands, construction of "dementia villages" like De Hogeweyk demonstrates how community-based, open-space designs can vastly enhance quality of life for residents with cognitive impairment. In Sweden, incorporation of restorative gardens and sensory rooms into elder housing has been demonstrated to decrease anxiety and increase socialization. South Korean geriatric hospital designs, examined by Chun [17], illustrate how culturally adapted interventions—like the inclusion of loitering spaces and communal dining areas—can facilitate wellness in particular sociocultural environments. These cases show that although research creates theoretical models, actual implementation must suit cultural, economic, and policy contexts.

Scholars have outlined a number of promising areas for further developing this discipline. In the first instance, there is an increased demand for longitudinal studies measuring not just short-term outcomes of recovery but also long-term effects on independence, dignity, and reintegration into the community, as proposed by Bernhardt [20] and Edvardsson. In the second instance, there is a need for cross-disciplinary collaboration merging architecture with nursing science, gerontology, and new digital health technologies [21], [22]. The convergence of IoT-based sensing of the environment, AI-based adaptive lighting, and virtual rehabilitation platforms offers the potential to develop responsive environments for persons with disabilities. Third, there is a pressing need for global diversification of research settings to ensure that knowledge gained in high-income countries is transferred and validated in low- and middle-income settings. Lastly, policy frameworks and cost–benefit analysis need to be incorporated into research agendas so that innovative designs can be scalable and equitable.

In summary, the literature on hospital design, healthcare architecture, and healing environments for geriatric populations demonstrates both significant progress and persisting challenges. Foundational works have established the therapeutic value of built environments, while contemporary scientometric studies reveal an increasingly interdisciplinary and global knowledge base. Empirical studies are powerful evidence that design innovation—ranging from participatory co-design to neurorehabilitation settings enhances outcomes for geriatric patients. However, some shortages in staff integration, technological uptake, and geographical coverage call for ongoing research. With the demographic aging of the global population, the challenge is not simply to design

hospitals to treat disease but to build settings that promote overall well-being, dignity, and social participation among older people. By bridging theoretical concepts with empirical testing, incorporating digital innovations, and opening cross-cultural applicability, subsequent research can build upon the vision of hospital architecture as a foundation of healthy aging and wellness.

To offer a systematic overview of the literature, the following table 1 compares major contributions that investigate hospital design, healthcare architecture, and healing environments for older adults. Such studies ranging from empirical research, systematic reviews, bibliometric studies, and conceptual models present varied views, methodological designs, and research gaps in various global settings.

Authors & Year	Focus / Objective	Methodology	Key Insights / Contributions	Limitations	Future Extensions
Arafat & Atreya (2024) [23]	Psychological well-being of geriatric patients via hospital design in Delhi NCR	Mixed methods: observations, surveys, chi-square & correlation	Identified six domains (comfort, safety, privacy, autonomy); private hospitals offered better comfort but high stress persisted	Limited to one region; cross-sectional; self-reported data	Multi-regional studies; longitudinal designs; IoT sensors; AI simulation of hospital layouts
Yan & Geng (2024) [24]	Healing spaces for older adults: scientometric & bibliometric synthesis	428 publications (2001–2023); co-citation, keyword clustering, network analysis	Identified 3 phases (2001–04, 2005–19, 2020–23); healing redefined beyond physical to holistic (psychological, spiritual)	Reliance on bibliometrics only; underrepresents qualitative/ethnographic work; low Global South representation	Develop measures for spiritual/psychological healing; VR/AI-driven healing; expand inclusivity across regions
Oji, Agbonome & Ukaegbu (2023) [25]	Role of landscapes as therapeutic variables in geriatric hospitals	Qualitative case studies (Austria, Spain, Netherlands)	Landscapes reduce isolation, improve cognition, reduce aggression in dementia, foster social interaction	Qualitative only, lacks quantitative validation; no frameworks for resource-limited settings	Longitudinal, experimental trials; IoT monitoring of outdoor use; VR landscapes for immobile patients
Huisman et al. (2012) [26]	Impact of physical environment on patients, families & staff	Review of 798 studies → 65 high-quality papers (Cochrane method)	Evidence-based design: single rooms reduce infections, lighting improves recovery, acoustics reduce errors	Weak staff-focused research; fragmented theoretical frameworks; methodological inconsistency	More staff-focused studies; robust tools for privacy/comfort; integrated multidisciplinary models
Marques, McIntosh & Kershaw (2019) [27]	Therapeutic landscape design for elderly health & rehabilitation	Epidemiological & injury data; review of outdoor fitness equipment	Highlighted gaps in elderly outdoor environments; proposed senior playgrounds for physical &	Reliance on case studies/opinion pieces; lack of longitudinal data; cultural barriers	Long-term studies; intergenerational design validation; smart monitoring of outdoor programs

Authors & Year	Focus / Objective	Methodology	Key Insights / Contributions	Limitations	Future Extensions
			social wellbeing		
MacAllister, Bellanti & Sakallaris [28]	Inpatients' perceptions of healing & healing spaces	Mixed methods: 17 interviews + quantitative environmental assessments	Healing linked with care, comfort, familiarity; patient perspectives emphasized alongside design intent	Small, homogeneous sample; US-only; no longitudinal follow-up	Multi-site, diverse populations; post-discharge tracking; smart-room features; cross-cultural comparisons
Chen et al. (2025) [29]	Indoor comfort & wellbeing of older adults in residential care	Scoping review of 173 studies (2004–2024, PRISMA)	Six domains identified (thermal, air, visual, acoustic, ergonomic, multi-domain); thermal & air quality dominate	Reliance on self-reports; underrepresents dementia/fourth-age; short-term studies; low Global South representation	Wearable sensors & physiological measures; longitudinal studies; AI-driven adaptive systems; cultural inclusivity
Feng et al. (2024) [30]	Sustainable Healing & Therapeutic Design (HTD)	Bibliometric (VOSviewer/CiteSpace) + case studies (Denmark, China)	Six clusters: environment, mental health, QoL, illness, COVID-19, wound healing; tied to SDG 3; biophilic & flexible layouts	Limited sustainability integration; dataset restricted to WoS; lack of empirical validation	Sustainability metrics (carbon footprint, renewable energy); digital twins, VR spaces; multi-country empirical trials
Preitschopf et al. (2025) [31]	Outpatient geriatric rehabilitation (OGR) design	Grounded theory; interviews & focus groups (patients, providers, policymakers)	7 themes: independence, smooth transition, e-health, multidisciplinary care, financing	Netherlands-only; bias toward positive volunteers; no empirical e-health evaluation	Empirical OGR models; international comparisons; integrate caregiver perspectives; cost-effectiveness studies
Li et al. (2025) [16]	Restorative Environmental Design (RED) in elderly daycare centres	Dual-layer: scientometric (WoS+CiteSpace) + qualitative case analysis	8 thematic clusters (social support, hospice care, leisure, risks); examples from Sweden, Denmark, Netherlands	Limited database scope; theoretical emphasis > empirical validation; limited LMIC coverage	Extensions include LMIC coverage, empirical validation, and tech-enabled RED applications.

Table 1. Comparative overview of key research manuscripts on hospital design, healthcare architecture, and healing environments for geriatric care.

Together, the comparison highlights how the discipline has evolved from initial research in therapeutic and evidence-based design to more contemporary multidimensional strategies combining sustainability, digital technology, and participatory strategies. Concurrently, it highlights recurring shortcomings like geographical narrowness, overdependence on self-reported measures, and a failure of longitudinal validation indicating a future research agenda focused on inclusivity, empirical quality , and interdisciplinarity.

3. RESEARCH METHODOLOGY

3.1. Scientometric Analysis

Using a systematic scientometric approach[32], [33], [34], [35], this study maps and quantifies the worldwide research terrain on hospital design, healthcare architecture, and healing environments, particularly in relation to geriatric well-being and wellness outcomes. Scopus and Web of Science were queried using the Boolean phrase ("hospital design" OR "healthcare architecture" OR "healing environment") AND ("geriatric" OR "elderly patients" OR "aging population") AND ("wellness" OR "well-being"), exporting Scopus to BibTeX and WoS to plain text for standardized metadata preservation, with retrieval on 29 Aug 2025. The PRISMA-informed workflow removed inaccessible items and de-duplicated merged duplicates, leaving a final corpus of 560 publications for analysis. Descriptive profiling shows a young, high-renewal discipline published in 278 sources, with a growth rate of 8.3% per annum, extensive authorship (1935 authors; 3.45 co-authors per paper), modest international co-authorship (0.1786%), and 28.6 citations per paper on average. Performance analysis [36], [37] and science-mapping techniques [38], [39], [40] (Bibliometrix/Biblioshiny [41], [42], [43], VOSviewer [44]) probe sources, authors, affiliations, countries, co-authorship, co-citation, and co-word structures in search of the domain's intellectual architecture and thematic evolution [45]. The findings consolidate evidence of a sustained long-term growth trajectory, reflecting diversified thematic portfolios spanning hospital design, healthcare architecture, healing environments, and geriatric well-being. The review establishes a contemporary baseline for scholars and practitioners, identifies persistent gaps in interdisciplinary integration, evidence-based design validation, and international collaboration, and sets forth a data-driven research agenda to advance scalable, patient-centered, and context-sensitive healthcare environments.

3.2 Data Sources, Search Strategy, and Rationale

We searched Scopus and Web of Science (WoS) [46], [47] with only the Boolean string:
("hospital design" OR "healthcare architecture" OR "healing environment") AND ("geriatric" OR "elderly patients" OR "aging population") AND ("wellness" OR "well-being").
Data were harvested on 29 Aug 2025. Scopus records were downloaded in BibTeX (.bib; Bib.txt) and WoS records in Plain text (.txt; Plain.txt) to keep rich, standardized metadata and cited references for downstream scientometric processing.

Why just Scopus and WoS?

Both these indices provide:

1. This body of research demonstrates careful curation and broad disciplinary coverage, extending across architecture, environmental psychology, nursing sciences, gerontology, and public health, thereby underscoring the multidisciplinary foundations of hospital design and its pivotal role in shaping healing environments for aging populations
2. High-quality, standard bibliographic and citation fields (authors, affiliations, funding, references, keywords) that reduce noise during de-duplication and network building
3. Stable export formats that work with bibliometric toolchains (e.g., Bibliometrix, VOSviewer)
4. Precise, reproducible retrieval.

Conversely, sources such as Google Scholar collect heterogeneous content (preprints, theses, non-peer-reviewed materials) with variable metadata and weak export controls, which can introduce bias and weaken methodological rigour for scientometrics. Limiting to Scopus and WoS thus yields a balance across breadth, quality, and reproducibility.

Initial retrieval: Scopus 564 docs; WoS 1 doc; total = 565 records before cleaning.

3.3. Preprocessing Data and Cleaning Process

To ensure that only relevant and high-quality studies were included, the selection process followed the PRISMA framework.

- Inclusion Criteria:
  - Peer-reviewed journal articles, conference papers, and review articles.
  - Articles that directly addressed portfolios spanning hospital design, healthcare architecture, healing environments, and geriatric well-being.
  - English language articles.
- Exclusion Criteria:
  - Non-peer-reviewed articles, editorials, book chapters, and letters.
  - Studies not specifically aimed Healthcare & Hospital Architectures.
  - Non-English articles.
  - Duplicate files within databases.

The Web of Science and Scopus datasets were then combined, and duplicate records were spotted and eliminated using automated as well as manual audits. A total of 5 duplicates were removed, and a final dataset of 560 distinct publications remained. These records served as the basis for later scientometric analysis.

3.4. Methods and Tools Used, Including PRISMA

To create an overall scientometric overview of studies on hospital design, healthcare architecture, healing environments, and geriatric well-being, this research work adopted a systematic and open methodological framework. The search was on 29 August 2025 through the specified search string in two prominent scientific databases Scopus and Web of Science (WoS) that were chosen for their extensive multidisciplinary coverage, stringent indexing criteria, and compatibility with advanced scientometric analysis software. From Scopus, 564 records were found, and from WoS, 1 record was found, yielding a preliminary total of 560 documents.

Scopus data was exported into BibTeX format and WoS data was downloaded in plain text format. Both datasets were converted into compatible formats and imported to RStudio [48], [49], [50] for further processing with the use of the Bibliometrix/Biblioshiny package. During the first cleaning phase, four Scopus record were found to be incomplete or not accessible, leaving behind 560 valid Scopus entries. Both sources' datasets were subsequently combined, and one duplicate record was deleted using a mix of automatic detection and manual checking. This resulted in a final dataset of 560 distinct documents that were the foundation for the scientometric analysis.

The scientometric analysis brought together performance analysis and science mapping methods. The performance analysis analyzed annual publication rates, overall citation numbers, citation per document, and productivity of authors. Bibliometric principles [51] were also deployed Bradford's Law [52] to establish the focus of research in central journals, and Lotka's Law [53], [54] to measure the pattern of author productivity. Science mapping investigated the intellectual and collaborative organization of the discipline, with co-authorship analysis to map collaboration patterns, co-citation analysis [55] to reveal salient publications and intellectual relationships, and co-word (keyword co-occurrence) analysis to track thematic progression and identify new research domains. For such purposes, RStudio's Bibliometrix/Biblioshiny environment was utilized for data integration, cleaning, descriptive statistical analysis, and visualization. VOSviewer [56], [57] was utilized to generate high-resolution network maps of co-authorship, co-citation, and keyword networks. This dual combination of tools guaranteed that the analysis accommodated both quantitative performance indicators and qualitative structure of interconnectivity in the research landscape.

Having used the PRISMA flowchart, it is easily possible to describe the systematic review process in a readable format to readers and researchers to determine the extent to which the selection of studies was rigorously and extensively studied. This provides validity in the research study's findings and therefore illustrates reliability at the point of conclusion made in the review.

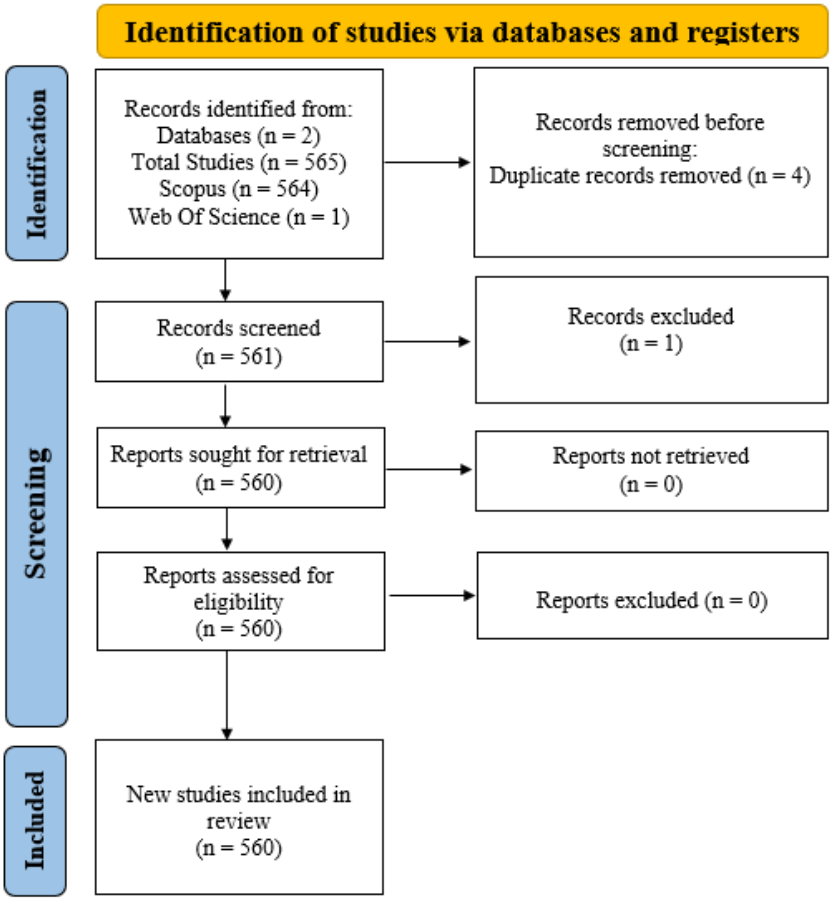

Figure 1. PRISMA

As observed from Figure 1 the whole PRISMA framework [58], [59], [60] for this research is broken down in the following phases, which will make the study more understandable:

1. Identification Phase

- Databases Searched: Studies were identified through two major databases: Scopus, with 564 records, and Web of Science with only 1 record, and no records in other registers. A total of 565 records were retrieved from both the databases.
- Removal of Duplicates: A total of 4 records were delectated as duplicates before screening.

- Total Records for Screening: After the removal of duplicates, a total of 561 records were forwarded to the next stage.

2. Screening Stage

- Records Screened: A total of 561 records screened out, 1 record was removed after merging both databases because of duplication.
- Reports Sought for Retrieval: From the initial screening, a total of 560 reports were considered relevant and sought for further assessment.
- Reports Not Retrieved: All the 560 reports were retrieved without a single report missing.

3. Eligibility Assessment

- Reports Assessed for Eligibility: The remaining 560 reports were sufficiently assessed in detail to include.
- Reports Excluded at This Stage: No report was excluded at this stage of the screening process.

4. Inclusion Phase

- Final Studies Included: In total, 560 studies were included in the review.

3.5. Research Questions

In order to frame this research, the following questions are posited to obtain the desired conclusions:

RQ1. How has the global research agenda on hospital architecture and healing environments for geriatric and elderly populations developed over the last five decades, and what disciplinary intersections (architecture, gerontology, nursing, and public health) have influenced this trajectory?

RQ2. What thematic clusters and research fronts are evident in scientometric mappings of healthcare architecture and hospital design, specifically wellness, well-being, and age-friendly care spaces?

RQ3. Which institutions, authors, and countries have contributed the most to the development of research in geriatric-focused hospital design, and how have international collaboration patterns influenced the knowledge network?

RQ4. What effective design principles, based on scientometric evidence, have been best translated into actual hospital architecture (e.g., dementia units, patient wards, and green healing spaces), and where are gaps in implementation still to be found?

RQ5. How can scientometric findings inform future research and policy priorities to address the issues of sustainability, digital integration, inclusivity, and cross-border collaboration in designing hospitals for older populations?

4. RESULTS AND DISCUSSIONS

4.1. Performance Analysis

4.1.1. Descriptive Statistics

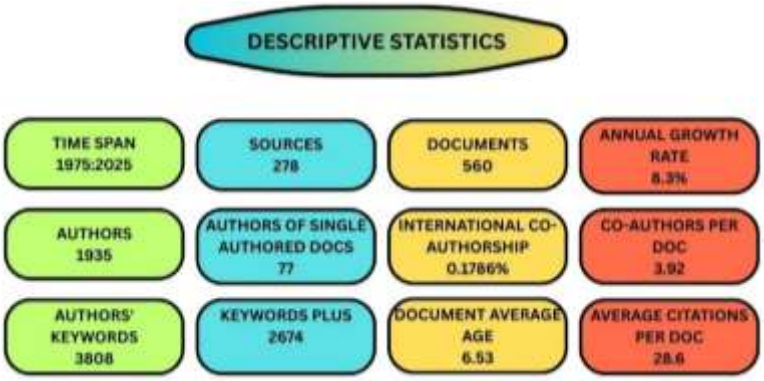

Figure 2. Main information

Figure 2 presents a quantitative snapshot of the academic literature on the selected research topic (hospital design, healthcare architecture, healing environments, and geriatric well-being). The dataset consists of 50 years (1975–2025) and includes 560 documents published in 278 unique sources. This scope captures both longevity as well as increasing diversification of publication channels. The growth rate of 8.3% per annum indicates that although the discipline has aged, it is still growing at a steady rate, implying ongoing supplies of new research inputs.

For the number of participants, 1,935 authors have participated in the corpus, reflecting the wide academic engagement with this field. Of these, only 77 single-authored papers have been documented, but even here the average number of co-authors per paper is a high 3.92. Notably, international collaboration is unexpectedly low (0.1786%), a figure which implies that contributions are nationally or regionally clustered rather than globally networked. This is an area where future studies could fortify inter-border collaboration to facilitate knowledge sharing and diversity of viewpoints.

The intellectual diversity of the discipline is also evident: the corpus includes 3,808 authors' keywords and 2,674 Keywords Plus, showing extensive thematic coverage and shifting nomenclature. The 6.53-year average document age mirrors that much of the literature is comparatively recent, corresponding to the witnessed annual growth trend. Notably, the discipline showcases moderate scholarly impact, with an average of 28.6 citations per

paper. This pattern of citations proves that although new, the work is highly influential and is actively informing current debates.

More broadly, Figure 2 captures not only numerical trends but also significant structural observations: the field is expanding steadily, extremely collaborative (albeit predominantly intra-national), theoretically varied, and becoming more central. Yet, the low proportion of international co-authorship and the dominance of comparatively new publications highlight avenues for global integration and longitudinal depth in subsequent work.

4.1.2. Annual Scientific Production

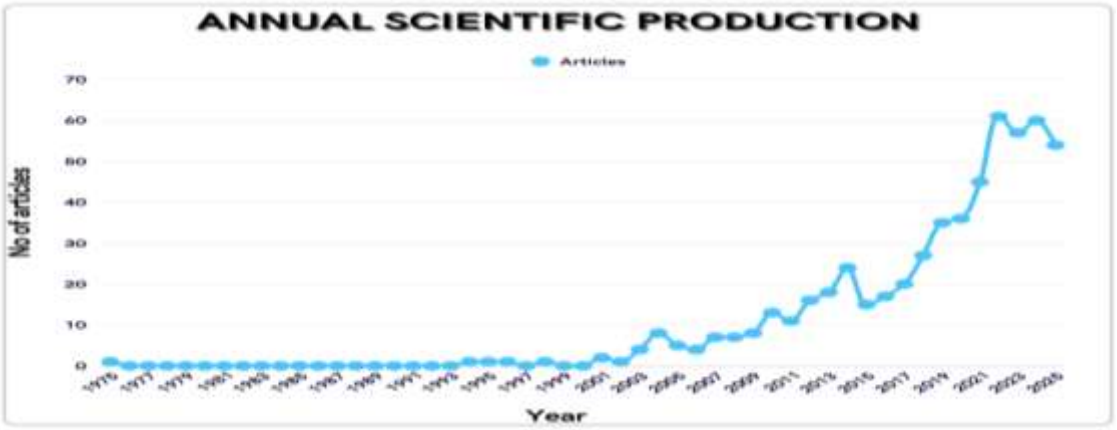

Figure 3. Annual scientific production

Figure 3 illustrates the yearly scientific productivity between 1975–2025, pointing out the research activity path within the field. The information reveals a gradual and discontinuous start, with the publication of one single article in 1975 and minimal production for the following two decades. This inactive period is a manifestation of either the lack of acceptance of the significance of the field or the unavailability of conducive technologies. A small growth started from about the early 2000s, with 2–8 publications per year, marking the beginning of adopting new frameworks.

There is a clear inflection point after 2010, where yearly output increases more steadily, to double digits, like 13 pieces in 2010 and 16 in 2012. The rise corresponds to innovation in cloud computing, wireless networking, and the advent of healthcare architecture solutions drawing experts to environmental based monitoring. From 2014–2017, the output averaged 15–24 articles each year, pointing towards increasing community interest but not explosive growth.

But since 2018, there is a dramatic spike with yearly publications increasing from 27 in 2018 to 61 in 2022. The 2022 peak (61 articles) and sustained high productivity in 2023–2024 (57 and 60 articles, respectively) suggest a mature and fast-consolidating research field with uniform global contributions. Although 2025 shows a small drop (54 articles), the general trend implies sustained high-level research momentum. In summary, Figure 3 shows three phases: i) a dormant stage (1975–2000), ii) a build-up phase (2001–2013) and iii) an exponential expansion period after 2015.

In alignment with international policy reforms towards sustainability and the merging of disruptive technologies. This path not just represents the growing academic interest but also signifies a paradigm shift in scientific and practical applicability, rendering the area an area of prime importance for future research.

4.1.3. Average Citations Per Year

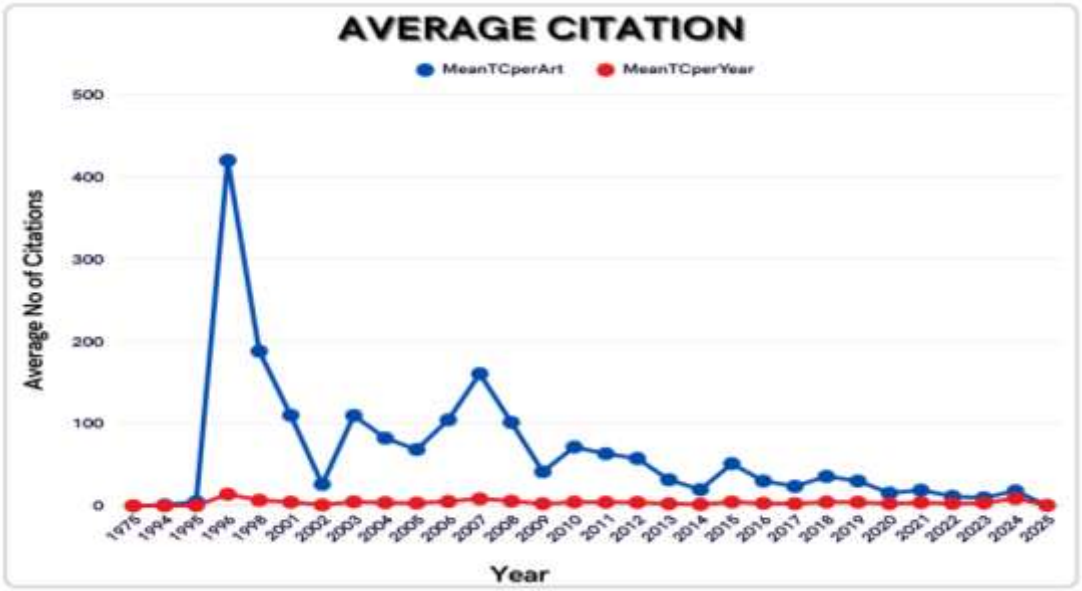

Figure 4. Average citations per year

The citation pattern depicted in Figure 4 mirrors the intellectual history of the discipline, tracing how influence has moved away from concentrated seminal contributions toward a diffuse, larger body of work. In the initial years, 1975 to the early 1990s, citation activity was minimal, illustrating that the discipline was still in its infancy, and few were published and widely acknowledged. There was a turning point in 1996, when the mean citations per article jumped sharply to 420, the year in which there was highly influential, pioneering work published that informed future writing. This is followed by subsequent secondary peaks at 1998, 2001, 2003, and 2007, where there is the indication of a time when there was relatively a limited number of seminal studies attracting continuous scholarship and serving as beacons for ensuing research. After 2010, though, the number of citations per article fell steadily, even as overall publications continued to rise, suggesting that the field was saturating, with impact diffused across an expanding body of work rather than coalesced within individual breakthrough contributions. Such diffused impact implies maturity but also implies the difficulty of producing paradigm-shifting ideas in a crowded literature landscape. In the latest years (2020–2025), the means are substantially lower, not necessarily due to reduced quality, but because of the citation lag of newly published literature, which takes time to gain scholarly acclaim. 2024 is interestingly showing signs of regained momentum with a higher mean per annum, indicating that newer efforts might slowly start to assert themselves. In general, the dynamics of citation exhibit a life cycle in which foundational landmark studies earlier influenced the intellectual underpinnings, whereas the modern era is one of diversification, diffusion of influence, and continuous pursuit of integrative, high-impact work to again redefine the direction of the field.

4.1.4. Most Relevant Sources

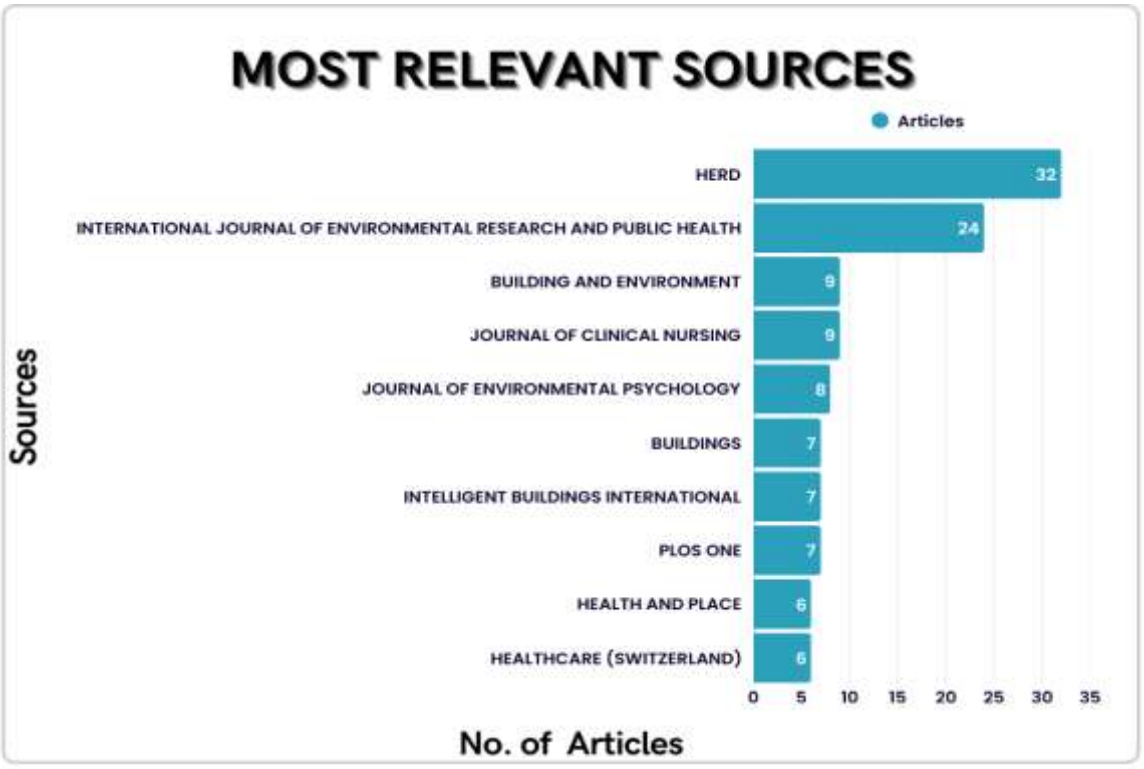

Figure 5. Most relevant sources

Figure 5 shows the publication sources most pertinent to this field of research and how knowledge production is spread over various journals and venues. The findings indicate that HERD (Health Environments Research & Design) is at the forefront with 32 articles, making it the central platform for scholarship on the convergence of healthcare design and environmental research. The International Journal of Environmental Research and Public Health follows with 24 articles, marking the significance of environmental health and public health frames in influencing the discussion. Other publications like Building and Environment and the Journal of Clinical Nursing (9 articles each), and the Journal of Environmental Psychology (8 articles), reflect the interdisciplinary scope of the field, connecting studies of built environment, psychology, and clinical practice. Mid-tier contributors like Buildings, Intelligent Buildings International, and PLOS ONE (7 articles each) indicate the contribution of technology integration and open-access science to the progression of the field. Lastly, Health and Place and Healthcare (Switzerland), both with 6 articles, contribute to the literature by highlighting place-focused healthcare studies and international health perspectives. Together, Figure 5 shows that health- and environment-focused journals are most prevalent but the new inclusion of technology-oriented and open-access publications signals a widening scope, potentially extending still further into digital health, healthcare architecture, healing environments, and geriatric well-being based publication platforms in the future.

4.1.5. Sources' Production over Time

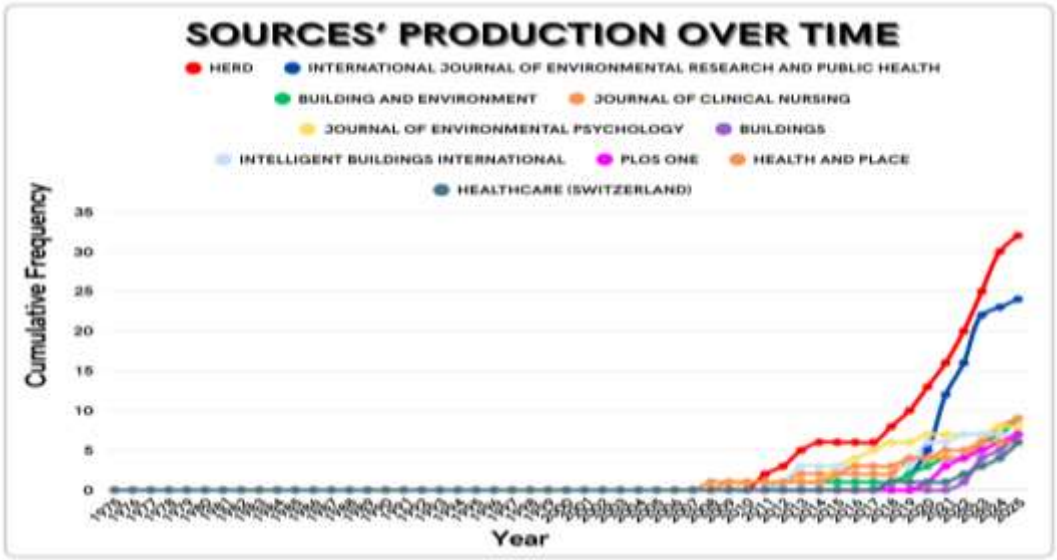

Figure 6. Sources' production over time

Figure 6 plots the longitudinal trend of academic productivity across the most pertinent sources, both the tempo and magnitude of output in this research niche. HERD has the sharpest slope, especially since 2015, leading to 32 works by 2025. This reflects HERD's central contribution in defining the focal point of interdisciplinary scholarship at the nexus of built environments and health, by its rising dominance in generating discourse. The International Journal of Environmental Research and Public Health keeps pace at 24 publications, demonstrating swift acceleration following 2020, as would be expected given the global trend towards sustainability and public health–oriented built environment research. Building and Environment and the Journal of Clinical Nursing, at nine total publications by 2025 each, demonstrate the twin focus upon technical and people-oriented approaches. In the same vein, Journal of Environmental Psychology (8) advances through contextualizing studies within psychological and behavioral frameworks, and publications like Buildings, Intelligent Buildings International, and PLOS ONE (7 each) further widen the scope of the discipline through technological, architectural, and inter-disciplinary perspectives. Lastly, Health and Place and Healthcare (Switzerland), both with six publications each, highlight the increasing convergence of health-oriented and location-specific applications.

When taken collectively, Figure 6 reinforces the point that even as HERD and the International Journal of Environmental Research and Public Health are at the pinnacle of the academic universe, the dissemination across various journals indicates the intrinsically interdisciplinary nature of this area of research. The increase after 2015 also points to a paradigmatic increase rather than mere numerical increases, where environmental, psychological, medical, and engineering-leaning journals combined accelerate the field based on the worldwide significance of health, sustainability, and built environment linkages.

4.1.6. Most Relevant Authors

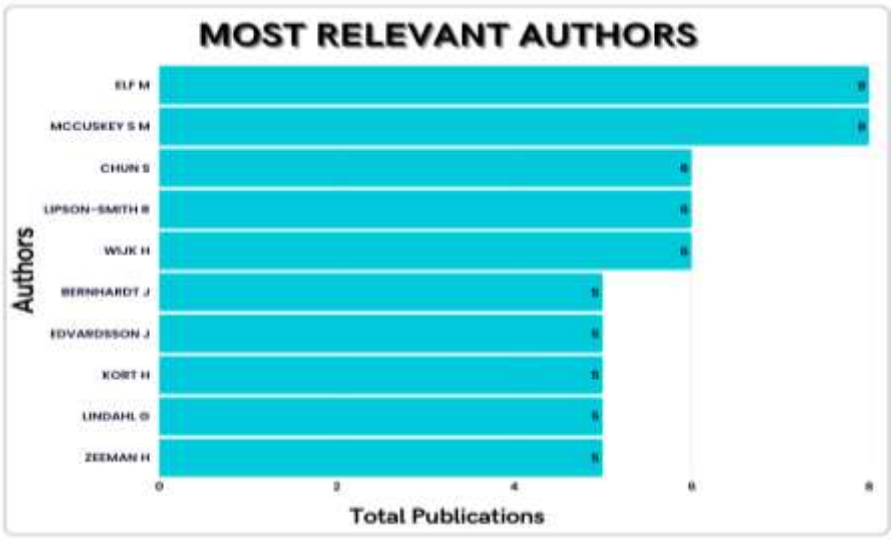

Figure 7. Most relevant authors

Figure 7 shows the intellectual contributors to this research area, as analyzed by the most relevant authors. The data show that Elf M and McCuskey S. M. are the top contributors with eight publications each, reflecting their intensive and consistent engagement in developing the field. Chun S., Lipson-Smith R., and Wijk H. are close behind with six publications each, demonstrating their ongoing research productivity and contribution. Writers like Bernhardt J., Edvardsson J., Kort H., Lindahl G., and Zeeman H. also feature prominently with five publications each, creating a second though substantial group of authors. The pattern of distribution implies that the small fraction of extremely productive writers facilitates the central knowledge base, with a large group of contributors further contributing, but showing a balanced mixture of central leadership and dispersed participation in the discipline. This is consistent with Lotka's Law, where the majority of authors only produce a handful of papers, but a minority of them regularly contribute at higher levels, determining the trend of knowledge. The visibility of the authors is not only an indicator of their leadership in research but also of possible centers of collaboration and intellectual power in the network. Figure 9, therefore, points both to focal expertise among dominant authors and to collaborative depth of the larger research community, and to opportunities for newer scholars to collaborate with established authors to produce greater impact.

4.1.7. Authors Production over Time

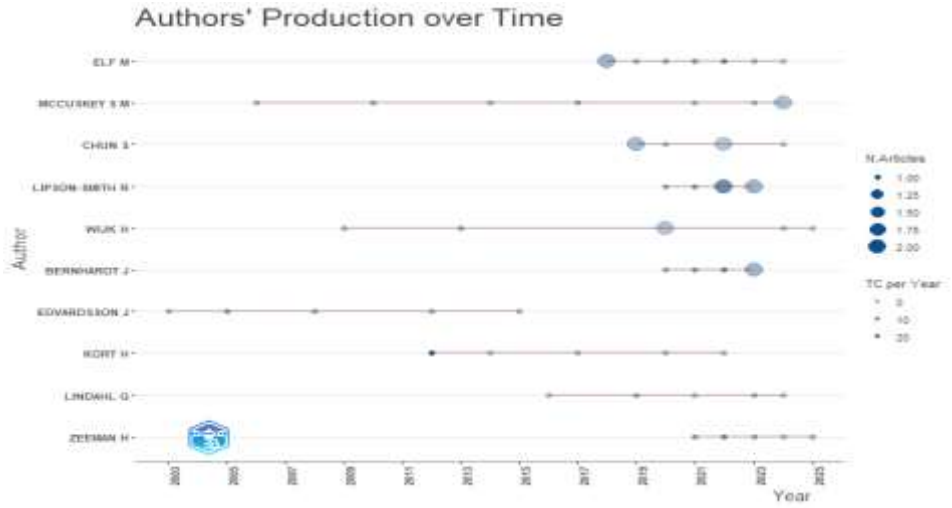

Figure 8. Authors production over time

In Figure 8, the long-term analysis of authors' output reveals an even more complete picture of productivity as well as influence over the years. It visualizes how contributions are spread out, with authors such as Elf M and McCuskey S. M. being top contributors over the years. Elf M has written over several years with influential articles like the 2021 BMJ Open systematic review (30 citations, TCpY = 6) and the 2022 International Journal of Stroke review (41 citations, TCpY = 10.25), indicating a consistent impact in stroke management and rehabilitation planning. Likewise, McCuskey S. M. has constructed a robust research track from initial foundational studies, such as the 2006 neonatal ICU environment study (37 citations), to more contemporary work in HERD (2023–2024), indicating a development from environmental design theory towards applied healthcare studies. Lipson-Smith R has concentrated heavily on rehabilitation environments, with the 2022 mapping review (10 citations, TCpY = 2.5) reflecting increasing influence in stroke recovery environments. Chun S, with fewer published works, has expanded to include architectural and gerontology care-based thinking, bringing healthcare settings together with user-centered design. Wijk H is notable for the 2013 publication of oncology environments (International Journal of Qualitative Studies on Health and Well-being) that garnered 58 citations (TCpY = 4.46), and while indicating early influence, subsequent works illustrate waning citation traction. Concurrently, writers such as Zeeman H, Bernhardt J, Lindahl G, Edvardsson J, and Kort H significantly add to specialist topics—covering neurorehabilitation (Zeeman) to sensory design in care (Lindahl) and psychometric instruments for assessment of older individuals (Edvardsson).

The analysis of Figure 8 shows that though productive writers such as Elf M and McCuskey S. anchor the discipline by regularly publishing, high-impact papers, newer or intermediate authors are critical to broaden research areas such as environmental neurorehabilitation, geriatric care homes, and stroke recovery settings. The findings demonstrate a transition from single, highly cited milestone studies in the early 2000s to a more cross-disciplinary and collaborative pattern of authorship in the 2010s and after. Nevertheless, citation performance differs very much, with some of the latest publications having high immediate influence and others being underappreciated, indicating the significance of research visibility and dissemination strategies. Generally, the figure illustrates that the productivity of authors is not merely a matter of quantity but also of thematic appropriateness, methodological sophistication, and the capacity to align with upcoming healthcare challenges.

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4.1.8. Most Relevant Affiliations

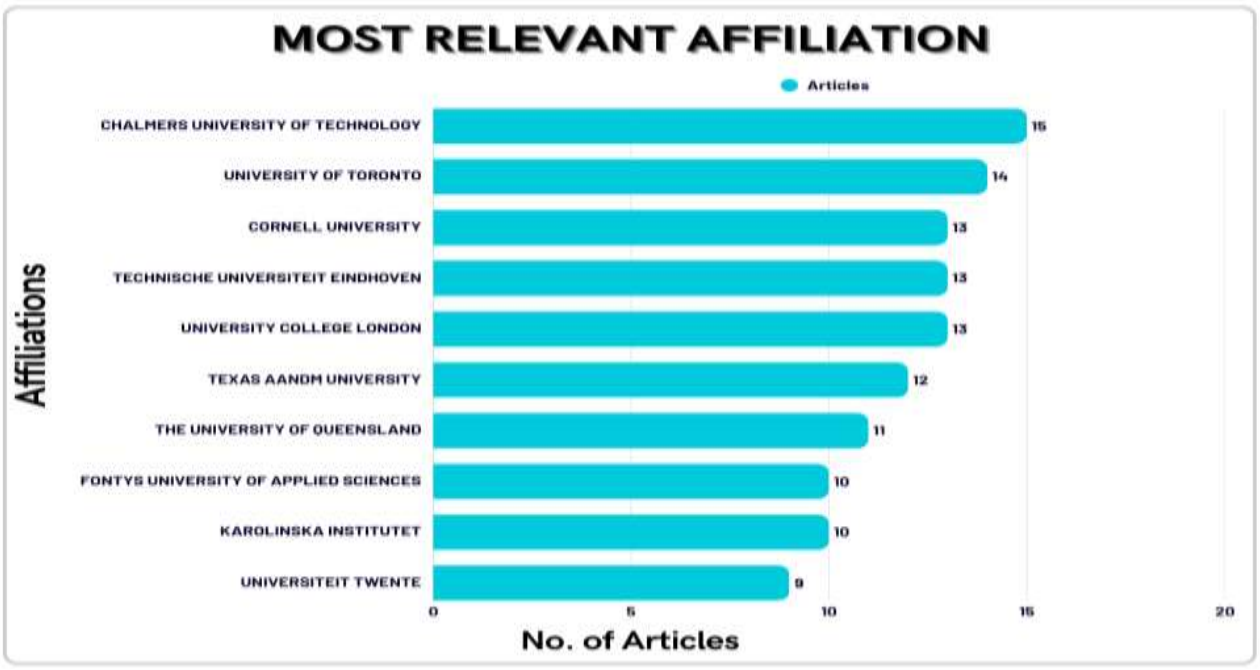

Figure 9. Most relevant affiliations

In Figure 9, the top affiliations' analysis which represents the institutions spearheading research in the subject area indicates which institutions are spearheading research in the concerned field. Chalmers University of Technology is at the forefront with 15 publications, being the hub of scholarly activity and depicting its rigorous academic involvement in healthcare and built environment studies. The University of Toronto is closely followed with 14 publications, and Cornell University, Technische Universiteit Eindhoven, and University College London each have 13 articles, presenting an equal distribution of output among top North American and European universities. Texas A&M University also shows a strong presence with 12 publications, and The University of Queensland has 11, reflecting Australia's active engagement in the discipline. Fontys University of Applied Sciences and Karolinska Institutet both have 10 publications, signifying high contributions from applied sciences and healthcare organizations, whereas Universiteit Twente rounds off the top affiliations at 9 articles. The representation in Figure 9 shows that research does not come from a geographically proximate location but instead illustrates collaboration globally, across Europe, North America, and Australia. Such diversity of institutions implies interdisciplinarity between architecture, health sciences, psychology, and applied engineering. Yet the generally modest numbers of publications per institution indicate that, although a number of universities are being involved, research remains emerging and patchy, with a need for greater cross-institutional connectivity and global collaboration to amalgamate findings and establish more holistic frameworks in this field.

4.1.9. Affiliations Production over Time

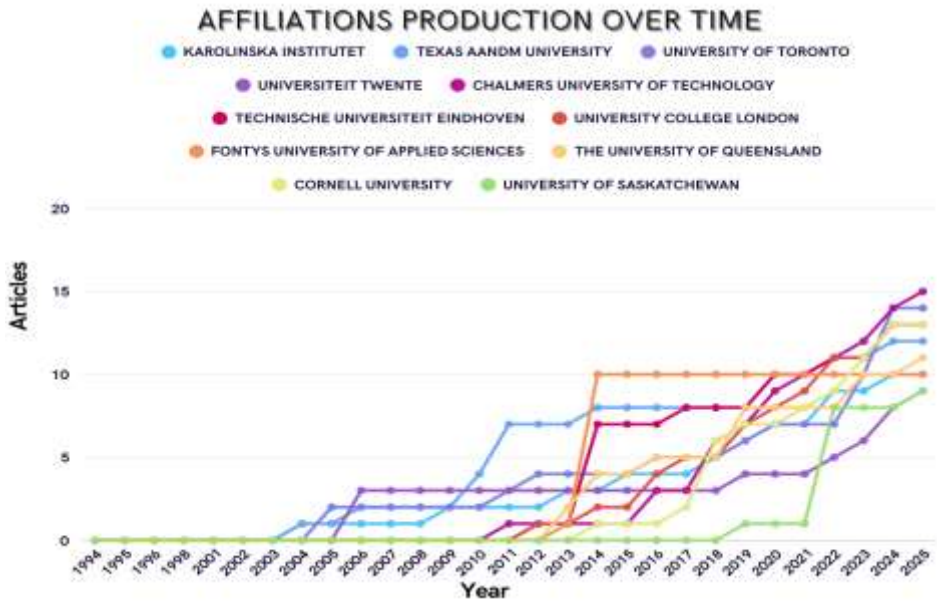

Figure 10. Affiliations production over time

In Figure 10, the analysis of affiliations' production over time highlights how institutional contributions to this field have evolved, reflecting both regional strengths and international collaboration. It is evident from the data that Karolinska Institutet started contributing right from 2004, with continuous growth up to ten publications in 2025, indicating its sustained contribution to healthcare-related environmental research. Texas A&M University shows a more intense surge that starts around the mid-2000s, growing intensely from 2010 through 2014, and leveling out at twelve publications by 2025, reflecting its prominence in closing the gap between architecture and healthcare spaces. The University of Toronto shows steady but persistent growth from 2005 onwards, reaching fourteen publications by 2024–2025, showcasing its robust potential in research for evidence-based healthcare design. In contrast, Chalmers University of Technology contributed only from about 2011 but experienced swift growth to become the top affiliation with fifteen articles in 2025, a testament to its emerging dominance in Scandinavian and world healthcare design research. Likewise, Technische Universiteit Eindhoven developed consistently after 2012, holding thirteen articles by 2025, echoing Europe's emphasis on healthcare architecture and technology incorporation. University College London did the same, and its publications gradually rose to thirteen, highlighting the UK's dominance in interdisciplinary healthcare design.

The University of Queensland demonstrated significant growth post-2013 to eleven articles by the year 2025, indicative of Australia's rising status in gerontology and environmental healthcare research. Fontys University of Applied Sciences is an unusual example, with a dramatic increase to ten in 2014, then holding steady at this figure ever since, perhaps indicative of project-based production or focused collaborations. Cornell University also experienced remarkable growth following 2017, with a steep spike to thirteen publications by the year 2024, testifying to the contribution of U.S. universities in determining healthcare environmental studies. Universiteit Twente, beginning earlier in 2006, demonstrated steady growth and only hit nine publications by 2025, emphasizing its moderate but consistent contribution. Interestingly, University of Saskatchewan entered belatedly in this area and contributed significantly only after 2019, but rapidly climbed to nine publications by 2025, indicating a recent institutional effort towards healthcare environment studies.

In general, Figure 10 illustrates that although older institutions like Karolinska Institutet and Texas A&M have made contributory ground, newer players like Chalmers University of Technology and Cornell University are quickly taking over, indicating the transformation of research leadership. This chronological development highlights how institutional involvement tends to be informed by national health priorities, accessibility of research funding, and interdepartmental collaborations. The figures also show that the future developments in the field will continue to be influenced by institutions with high recent growth rates, e.g., Chalmers, Toronto, and Cornell, while the older giants like Karolinska and Texas A&M will continue to be solid foundations of research tradition.

4.1.10. Country Production over Time

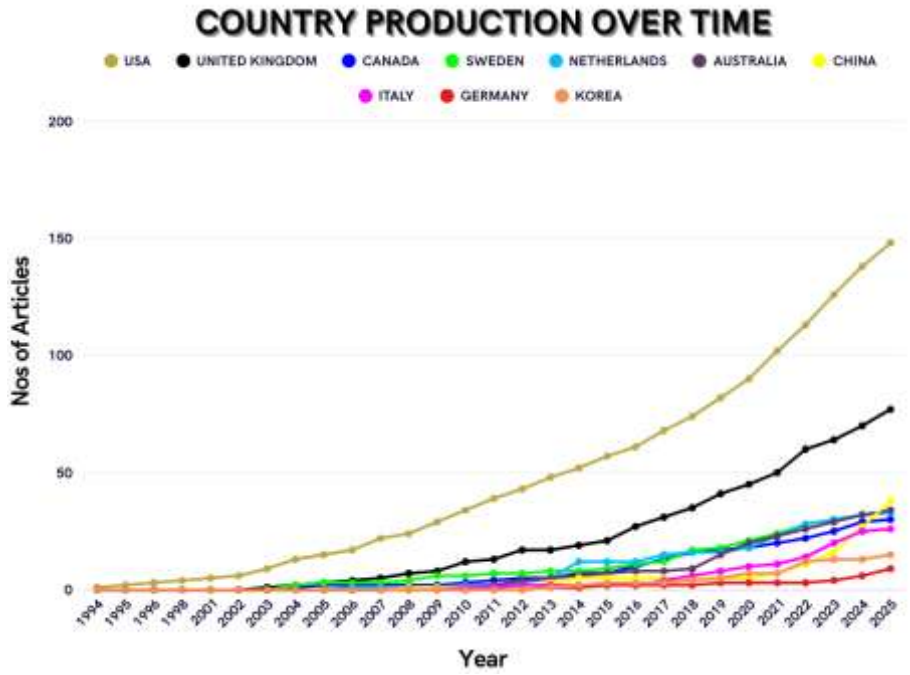

Figure 11. Country production over time

Figure 11 illustrates the country-wise production of scientific articles over time, providing a clear picture of global research contributions in this domain. The USA is the most productive contributor with a small number of 1–2 in the initial 1990s and a sharp increasing trend afterward, especially since 2010. The USA reaches 148 in 2025, not only a testament to its robust research platform but also to its steady long-term interest in this area. The UK also exhibits considerable growth, beginning later but picking up momentum especially after 2010. From just a few papers in the early 2000s, the UK output increases consistently to 77 articles by 2025, making it the second-

highest contributor. Canada, Sweden, and the Netherlands have follow similar trends of gradual increase, starting in the early 2000s and rising faster after 2015. By 2025, all of these nations each publish between 30 and 33 papers, which shows a firm but relatively smaller contribution to that of the USA and UK. China's path is especially interesting with its steep spike in recent times. Up to 2012, its production was insignificant, but since 2018, it exhibits fast growth, surpassing most countries in Europe. In 2025, China reaches 38 articles, an indication of the nation's increased investment in healthcare architecture, rehabilitation facilities, and geriatric care studies. Australia also traces a similar pattern, progressing from no production in the early 2000s to 34 articles in 2025, highlighting its reinforcing research position in this area. The other European countries, including Italy and Germany, also exhibit late but considerable growth. Italy rises steeply from 2017 onwards, up to 26 articles in 2025, whereas Germany rises gradually, up to 9 by the year 2025. South Korea reveals a steep rise, particularly after 2018, contributing a total of 15 publications in 2025. This indicates a robust regional research drive in recent years in East Asia.

Overall, Figure 11 highlights not only the dominance of the USA and the UK in long-term research output but also the rise of China, Italy, and South Korea as emerging players. The data suggests that while historically Western nations led the field, the contemporary landscape is becoming more diverse, with rapid contributions from Asia and Oceania indicating a global diffusion of scholarly focus in this research domain.

4.1.11. Most Cited Countries

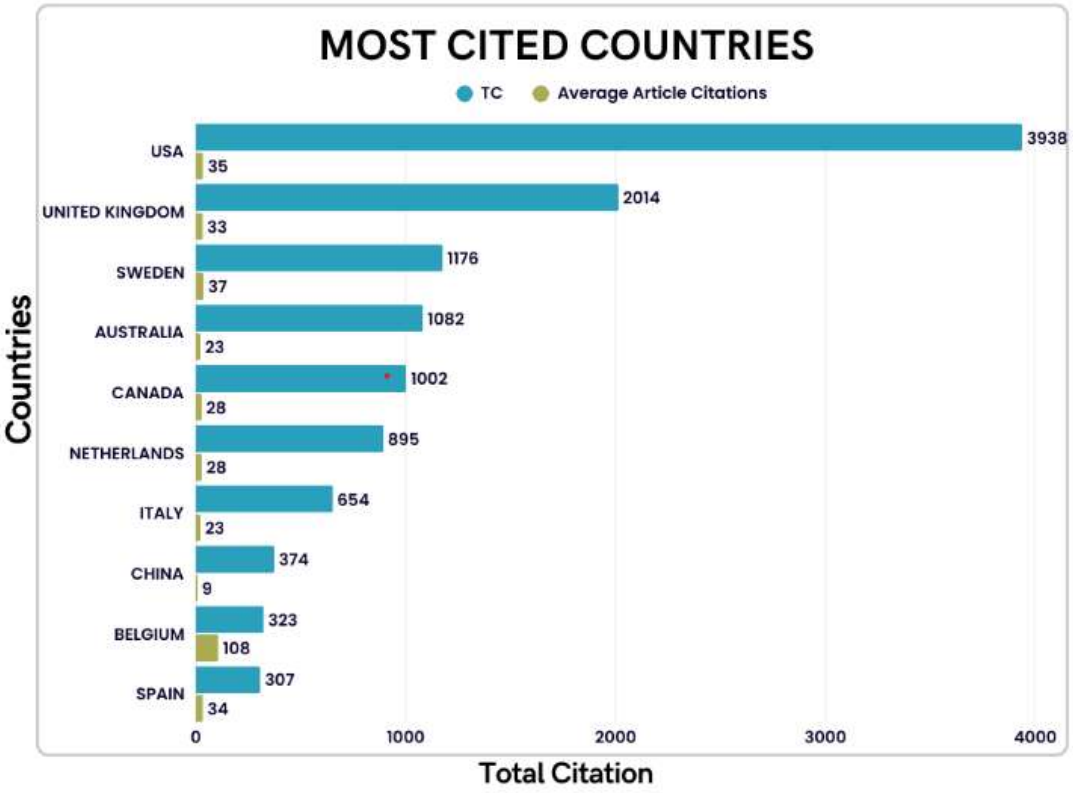

Figure 12. Most cited countries

In Figure 12, the top countries cited are characterized by the obvious predominance of the United States, and it is by far the largest with 3,938 citations and an average of 34.8 citations per article. This suggests both high productivity and continued international appeal of U.S. literature in the field. Next is the United Kingdom with 2,014 citations as the second highest contributor, backed up by an average citation rate of 33 per article, indicating a stable body of highly influential research. Sweden has one of the most impressive average citation rates at 36.8 per article, although it produces less in overall citations (1,176), implying that Swedish publications are highly influential and of high academic worth compared to the volume of output. Other significant contributors are Australia (1,082 citations) and Canada (1,002 citations), with moderate average rates of 22.5 and 27.8 respectively, solidifying their ranks as significant but less highly cited centers of influence relative to the U.S. and U.K. The Netherlands is also noteworthy at 895 citations and a rate of 28 per article, striking a balance of productivity and impact. Concurrently, Italy offers 654 citations with a middle-of-the-pack average of 22.6, while China, with its increasing international research profile, falls behind in terms of impact with 374 citations and a lower-than-average of 8.9 per article, whether newer to the field or experiencing a citation lag.

A standout exception is Belgium, with a mere 323 total citations but an impressively high mean of 107.7 citations per paper, showing that even though Belgian work is in less abundance, it is disproportionately high in influence. Spain also reflects moderate visibility with 307 citations and a mean of 34.1, echoing very similarly to the citation power of the U.S. and U.K., although on a smaller scale.

Cumulatively, Figure 12 demonstrates not just Anglophone nations' dominance in research visibility but also the disproportionate influence of relative research powerhouses like Belgium and Sweden. This indicates that volume

of output is an input to visibility, but quality and global recognition of single publications have a powerful effect on global citation patterns.

4.1.12. Most Global Cited Documents

Figure 13. Most global cited documents

Figure 13 identifies the most world-wide cited papers in the discipline, and they are informative not only of their overall citations but also of their relative impact when normalized by publication year. The paper by Davidson J. (2007, Critical Care Medicine) stands out as the most cited, with 968 citations and an incredible 50.94 citations/year, with a normalized impact score of 6.02 [61]. This means persistent citation over almost two decades, and therefore it is a foundational contribution. Bizarrely, Na N.'s (2024, Alzheimer's Dementia) contribution, having been only very recently published, had already accrued 817 citations, which corresponds to a staggering 408.5 per year and a normalized citation score of 45.13. This striking surge demonstrates a pioneering and strongly timely work that gained world-wide interest immediately, perhaps connected to pressing research agendas in dementia and healthcare settings.

Other highly cited contributions are Gupta U. (1996, Technological Forecasting and Social Change) with 420 citations, highlighted by its sustained long-term impact, albeit with a limited 14 citations a year, with consistent but less focussed influence compared to newer works [62]. Equally, Huisman E. (2012, Building and Environment) garnered 392 citations at a rate of 28 per annum, reflecting steady scholarly interest [26]. Titles such as McCormack B. (2010, NANA) and 362 citations and Hartig T. (2011, NANA) and 289 citations also reflect high mid-level influence, especially when viewed against healthcare and environmental psychology scholarship [63].

Of particular interest are publications of Tanja-Dijkstra (2006) [64], Devlin A. (2003) [65], and Arbaje A. (2008) [66], which demonstrate the persistence of design-oriented and gerontology-related research resonating in the scholarly community, albeit their normalized scores demonstrate moderate yet consistent academic traction. Last but not least, Schweitzer M. (2004, J. Altern. Complement. Med.) with 241 citations confirms the persistence of alternative and complementary medicine lenses of toning environmental health dialogues [67].

In general, Figure 13 shows that although older foundational texts such as Davidson (2007) [61] continue to be key points of reference, recently appearing scholarship such as Na N. (2024) is reconfiguring the landscape of citation at record velocity and intensity, indicating highly effective and pressing scholarship is being driven by the issues of today's healthcare and environmental design.

4.2. Science Mapping

4.2.1. Sources local impact by H-index

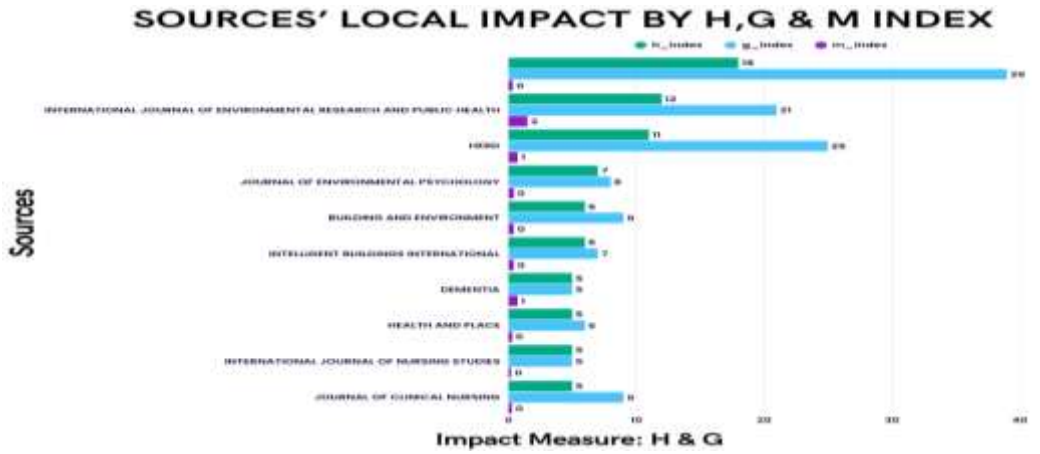

Figure 14. Sources local impact by h-index

Figure 14 presents the local influence of main journals in the topic according to the h-index, g-index, and m-index, providing a detailed view of both productivity and citation power. The most productive source is the International Journal of Environmental Research and Public Health, which has an h-index of 18 and a g-index of 39 and is the strongest outlet in terms of its long-term citation performance.

But its m-index (0.35) is quite modest, which indicates that its influence has built up steadily over the years and not in the last few years. Conversely, HERD has good influence with an h-index of 11 and a g-index of 25, but what is particularly striking about it is its m-index of 0.73, which indicates that it has gained impressive impact in a shorter period, indicating its novel relevance and latest spate of contributions in health and design research.

Other publications, including the Journal of Environmental Psychology and Building and Environment, have moderate but consistent influence, with h-indices of 7 and 6 and g-indices of 8 and 9. Their fairly even scores suggest consistent although not commanding influence. Notably, journal Dementia has a low h-index of 5 and g-index of 5, but an m-index of 0.71 puts it alongside HERD, indicating that although it is publishing fewer articles, it has rapidly been acknowledged and is establishing a specialist niche at the crossing point between cognitive decline and environmental influences. In the same vein, Intelligent Buildings International is ranked alongside Building and Environment in its well-balanced citation impact, albeit with lower indices, which attests to its narrow but still impactful contributions.

At the lower spectrum, journals like the International Journal of Nursing Studies, Health and Place, and Journal of Clinical Nursing have h-indices and g-indices of 5–9, accompanied by extremely low m-index scores (0.2–0.29). This suggests that although they are making a contribution, they are playing a more supplementary role, and their influence has not grown very much over time in this field. Together, Figure 14 highlights the preponderance of journals concerned with environmental health and the built environment, as well as the growing influence of specialist outlets such as HERD and Dementia, which reflect new and high-momentum publication channels in the discipline.

4.2.2. Author local impact by H-index

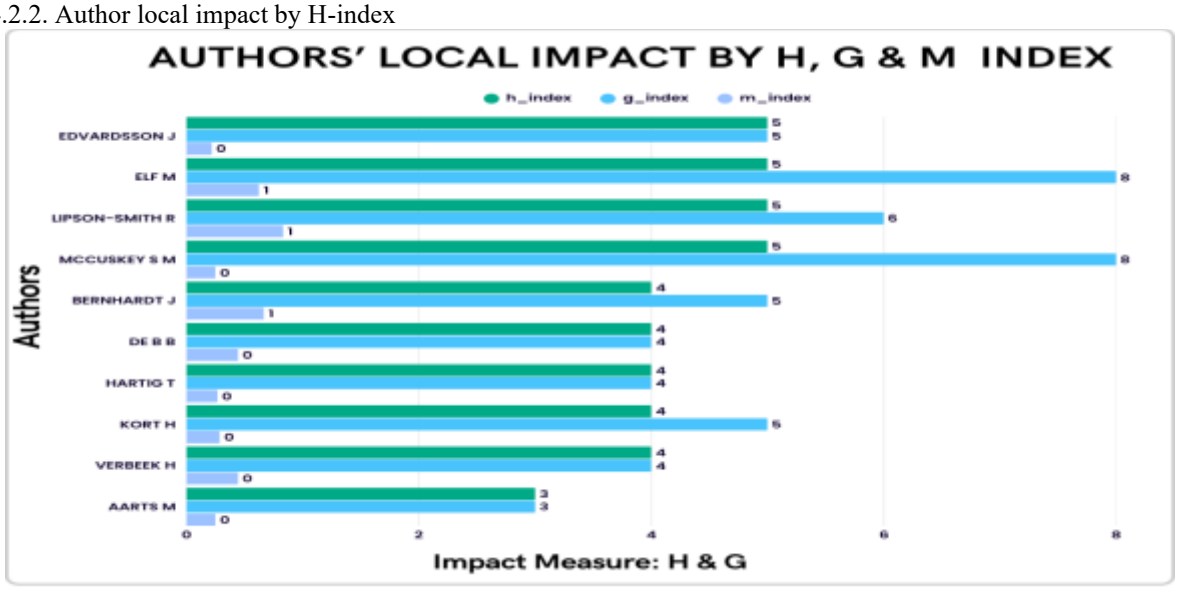

Figure 15. Author local impact by h-index

In Figure 15, the authors' local influence that is analyzed by using the H-index, G-index, and M-index shows the trade-off between productivity, citation effect, and stability of research outputs. Of the authors, Edvardsson J, Elf M, Lipson-Smith R, and McCuskey S M each have an H-index of 5, indicating that each has no less than five papers with five or more citations. But the G-index introduces subtlety, with Elf M and McCuskey S M being highlighted at 8, meaning they have generated more cited work overall than others such as Edvardsson J, who has a G-index of 5, representing more consistent but fewer citation-heavy output.

The M-index, which normalizes the H-index against the career length, introduces another level of interpretation. Lipson-Smith R reveals the highest M-index of 0.83, depicting not only productivity but also quick influence in a shorter academic career. By contrast, McCuskey S M, having similar H and G index, exhibits a lower M-index (0.25), implying extended research activity but relatively slower citation impact growth. In the same vein, Bernhardt J (M-index 0.67) and Elf M (M-index 0.62) indicate a balanced mix of long-term productivity and steady academic impact. Authors such as Aarts M and Hartig T, however, tend to be near the bottom of the range, with comparatively lower values on all indices, indicating possibly early-career status or narrower scope of cited work.

Hence, Figure 15 does not just rank writers but discloses various research paths: some, e.g., Lipson-Smith R, are quickly emerging influential authors, while others, e.g., Edvardsson J or McCuskey S M, depict established contributors with consistent but diversified citation patterns. This multi-index methodology identifies the

dynamics of quantity, quality, and academic longevity, offering a sophisticated presentation of authorial influence within the domain.

4.2.3. Corresponding Authors Countries

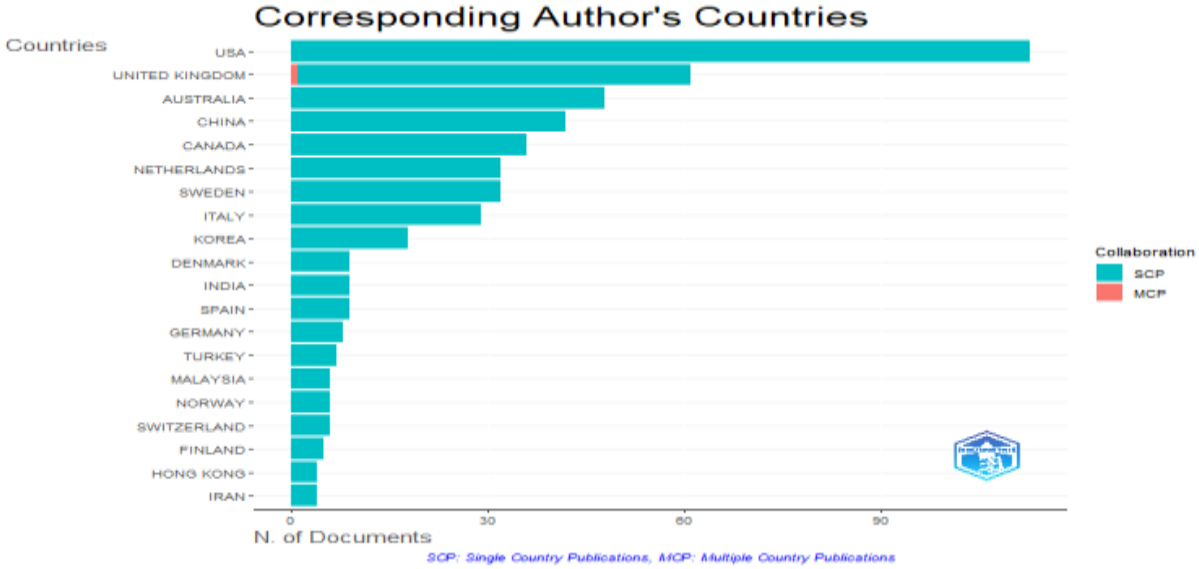

Figure 16. Corresponding authors countries

Figure 16 reveals corresponding authorship distribution by country, giving an insight into the global pattern of research productivity. The USA is seen to be the top contributor with 113 papers (20.18%), all being single-country publications (SCP). This dominance underlines the well-established internal research environment of the United States. Second on the list is the United Kingdom with 61 publications (10.89%), including one publication (1.63%) that is a multiple-country publication (MCP), and it is the sole nation in this data set to demonstrate some cross-border cooperation.

Other major contributors are Australia (48; 8.57%), China (42; 7.5%), and Canada (36; 6.43%), each of which have been using SCPs alone, a sign of robust national-level research work. Likewise, Netherlands (32; 5.71%), Sweden (32; 5.71%), and Italy (29; 5.17%) have been steady contributors but without MCPs, a sign of emphasis on regional collaboration.

A moderate outputs are evident from nations like Korea (18; 3.21%), Denmark, India, and Spain (each 9; 1.61%), and Germany (8; 1.43%). Smaller but significant participation comes from Turkey (7; 1.25%), Malaysia, Norway, and Switzerland (each 6; 1.07%), Finland (5; 0.89%), and Hong Kong and Iran (each 4; 0.71%), indicative of their growing presence in the area.

In general, Figure 16 highlights that the bulk of research contributions are from SCPs while MCPs contribute very little. It is this pattern that indicates that though the field has developed and spread across the world, international cooperation remains rudimentary with only the United Kingdom showing MCP activity in this dataset.

4.2.4. Most Relevant Words

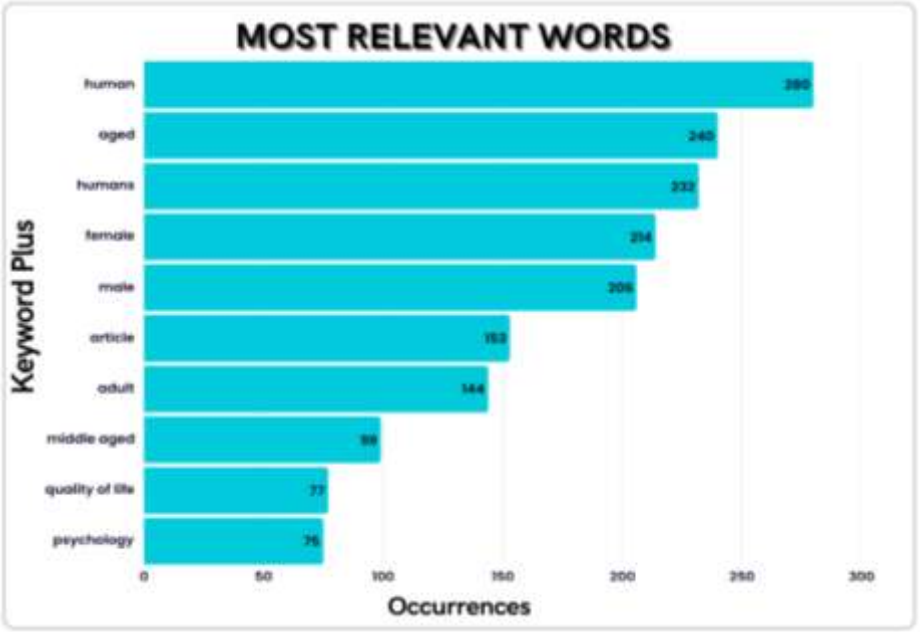

Figure 17. Most relevant words

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Most relevant words analysis is helpful to observe the recurring themes and conceptual highlights within the discipline. As shown in Figure 17, the keyword "human" stands out as the most used keyword with 280 references, the focus of human-oriented research being highlighted in this field. Next in line are keywords like "aged" (240 uses), "humans" (232), "female" (214), and "male" (206), which signify the population focus of the studies, especially in the contexts of healthcare, ageing, and gender. Other important words such as "article" (153) and "adult" (144) mirror the methodological and topic-based frameworks commonly embraced. In contrast, theme keywords such as "middle-aged" (99), "quality of life" (77), and "psychology" (75) signal the interdisciplinarity of the field across both social sciences and health research. This lexical pattern signifies a high emphasis on population-specific research, with special interest in age, gender, and psychological health.

4.2.5. Words Frequency Over Time

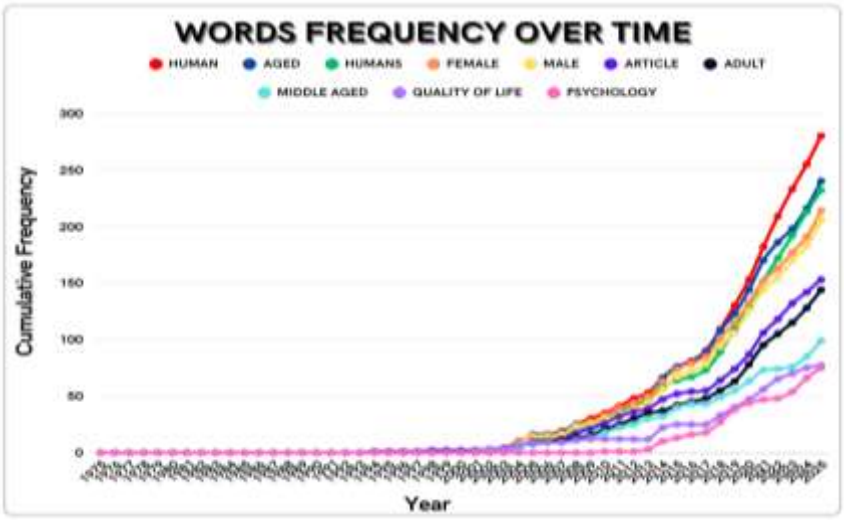

Figure 18. Words' frequency over time

The reading of Figure 18 together with its accompanying data gives a complete picture of the temporal evolution of the most recurrent keywords in the field. The cumulative frequency graph highlights that the term human (280 occurrences by 2025) has consistently dominated keyword usage, reflecting the centrality of human-centered studies in this research field. Close behind are aged (240), humans (232), female (214), and male (206), all of which collectively indicate a strong demographic focus toward studies with an age, gender, and general human considerations emphasis. In contrast, methodological identifiers like article (153) and adult (144) indicate the scholarly context, while middle aged (99), quality of life (77), and psychology (75) indicate more specialist thematic priorities. The tabulated information further supports these trends through the exact yearly progression: e.g., from negligible references during the 1970s and 1980s, use boomed from the early 2000s and increased particularly rapidly after 2010. This chronological path reflects the intensifying scholarly demand for information related to human welfare, aging, and psychosocial concerns. Interestingly, the data shows consistent year-over-year increases: in 2010, human was 35, which rose to 81 in 2016, 182 in 2021, and finally to 280 in 2025. The same relative growth patterns are evident for the other words, e.g., aged (from 16 in 2005 to 240 in 2025) and quality of life (from 3 in 2002 to 77 in 2025). Thus, Figure 18 and its associated data not only reflect the prevailing terminology structuring this research field but also document how the thematic environment has developed, indicating a diversifying and maturity of scholarly debate ever more embracing psychological and quality-of-life measures as well as demographic variables.

4.2.6. Tree Map

Figure 19. Tree map

The treemap visualization in Figure 19 emphasizes the pattern in the most informative keywords employed in the scientific literature being investigated. The longest blocks pertain to the words human (280 times, 9%), aged (240

times, 8%), humans (232 times, 7%), and female (214 times, 7%), indicating that the most prevalent aspect of the research is studies on human subjects, particularly aged and gender-specific groups. Following closely are male (206, 6%) and article (153, 5%), and adult (144, 5%), and this shows that adult populations, both male and female, represent a significant portion of the research background. Other high-keywords like middle aged (99), quality of life (77), and psychology (75) indicate that the academic interest transcends demographic labeling to themes related to mental health, well-being, and satisfaction with life. Other words such as dementia (74), mental health (52), hospital (44), and caregiver (23) indicate a high health-care focus, especially around older people and their care systems. The treemap also includes thematic areas such as qualitative research (72), environment (39), hospital design (41), and anxiety (36), which indicates interdisciplinarity covering from medical sciences and nursing up to psychology, environmental design, and health policy. These words also imply a blending of clinical and non-clinical aspects in the investigation of human health and care settings. Overall, Figure 19 illustrates that the research agenda is strongly focused on human subjects with great emphasis being placed on aging, gender, mental health, and quality of life. The visualization exposes not only the scope of health-related themes covered and relative importance of each, thus providing information about central topic clusters and new frontier fields in this area.

4.2.7. Co-occurrence Network

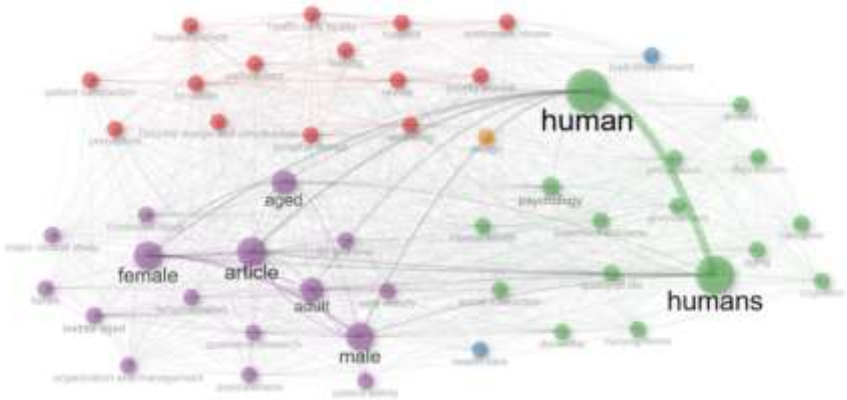

Figure 20. Co-occurrence network of keywords

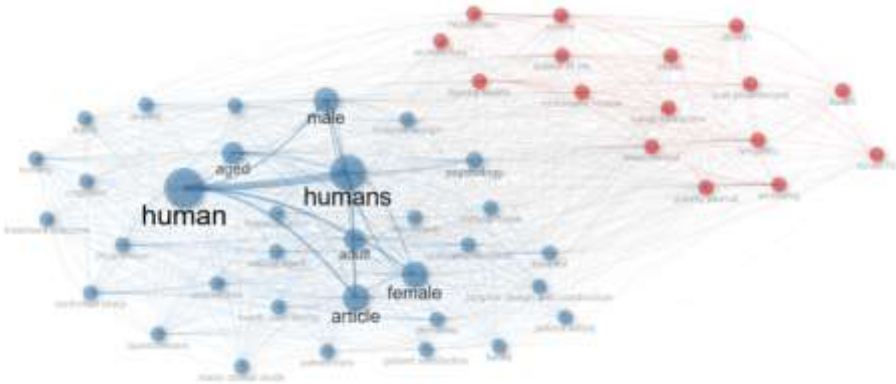

Figure 21. Co-occurrence network of author's keywords

There exists no way to present co-occurrence analysis for keywords other than as shown below. Figure 20 is the keyword co-occurrence network where the highest frequency concepts include human, humans, aged, female, male, and article as the top-most connected terms. The network is dominated by the highest frequency of connections among these top nodes, indicating that most of the studies are about human studies, demographic characteristics, and health-related settings. Furthermore, clusters expose the interdisciplinary breadth across fields like psychology, mental health, quality of life, dementia, and hospitalization, highlighting the interplay among medical, psychological, and environmental factors within the research environment. The thickness of the connections visually indicates the strength of co-occurrence, with human and humans constituting the strongest bond, demonstrating their overarching influence over the thematic trajectory of the field.

Concurrently, Figure 21 shows the co-occurrence network of author's keywords, which captures a more specialized reflection of what researchers actually contribute. Terms like design, architecture, health, stress, systematic review, COVID-19, and social interaction predominate in this network, reflecting a shift of research focus from broad demographic descriptors to more technical and modern problems. Most importantly, the occurrence of COVID-19 reflects the incorporation of new international health issues into the mainstream literature, thus highlighting the sensitivity of the research community to newly arising social needs. Additionally, clusters relating to quality of life, wellbeing, and built environment emphasize the interdisciplinary interaction associating health sciences with social and environmental research.

Figure 20 and Figure 21 together prove that although the discipline does have a root orientation towards human-oriented health aspects, it follows growing convergence towards themes that connect design, environment, and global health pandemics, embodying both continuity and change in emphasis along the intellectual path of the field of research.

4.2.8. The Thematic Evolution

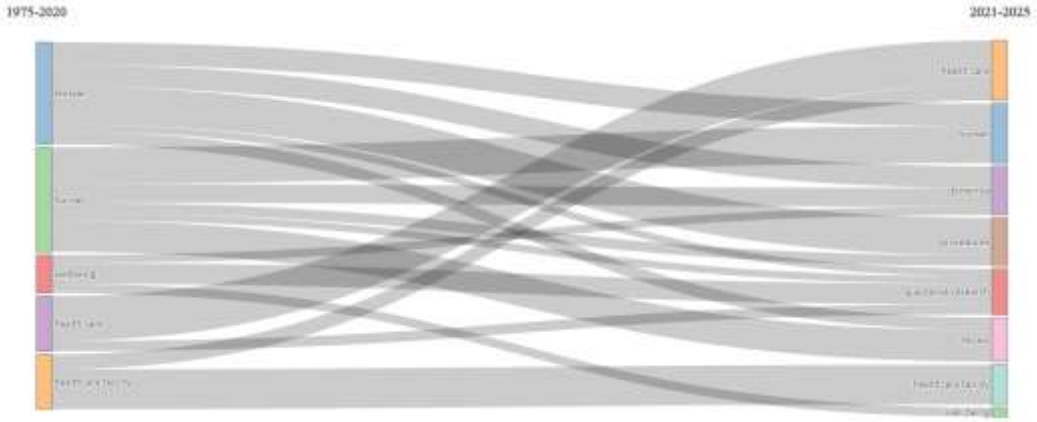

Figure 22. Thematic evolution

Figure 22 indicates the thematic change of keywords over two major time frames: 1975–2020 and 2021–2025. On the left, prominent themes of 1975–2020 like female, human, wellbeing, health care, and healthcare facility are indicated, while on the right, the latest themes that have come to prominence in 2021–2025 are seen, including health care, human, dementia, procedures, qualitative research, and review. The bridging streams of work from the two eras illustrate how past themes have evolved, combined, or branched into new research streams.

For example, the robust connection between human in the previous phase and its continuity in the contemporary phase emphasizes the enduring relevance of this theme in the research environment. In the same vein, female and health facility have branched into more specific issues such as dementia and procedures, evidencing the trend of the field to deal with more detailed health issues. The advent of qualitative research and review in the latest time frame also evidences increased focus on methodological richness and synthesis of evidence in tandem with the growth of interdisciplinarity.

Generally, Figure 22 depicts a movement from general, broad categories towards more intense and methodologically sophisticated themes, reflecting the maturity and professionalization of the research field over time. The development highlights not just the continued relevance of core concepts such as human and health care but also the adaptability of the field to evolving healthcare issues and methodological developments.

4.2.9. Collaboration Networks

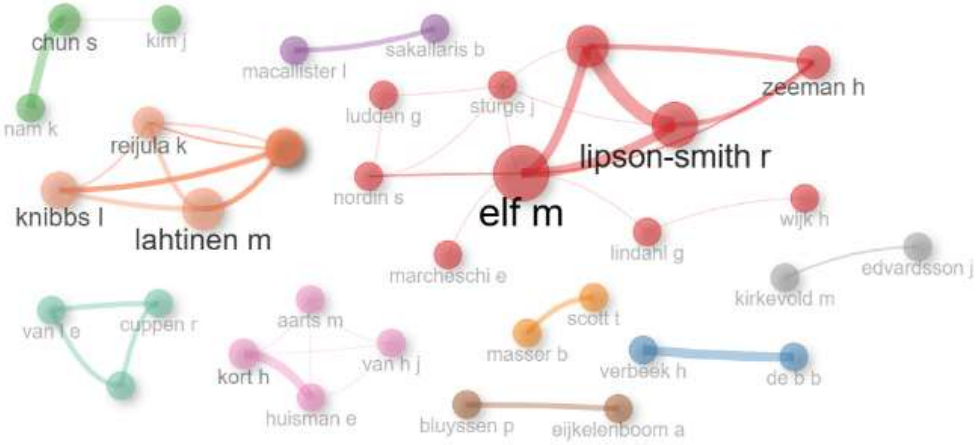

Figure 23. Collaboration networks on the basis of authors

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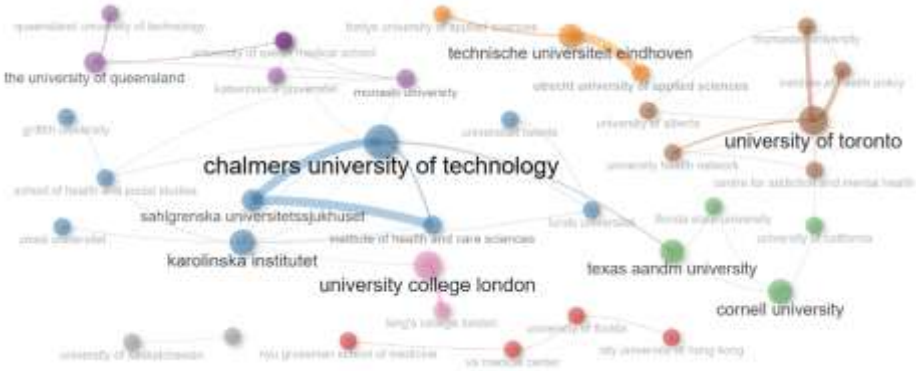

Figure 24. Collaboration networks on the basis of institutions

Figure 23 shows the co-authorship network of authors, with clear clusters emerging that demarcate strong patterns of co-authorship within the discipline. Authors like Elf M, Lipson-Smith R, and Zeeman H are central to the red cluster, a sign of their high level of connectedness and frequent collaboration with each other. Lahtinen M and Reijula K also constitute a dominant orange cluster, signaling institutional or thematic consistency in research interests. Smaller but notable clusters, like the one for Kort H, Aarts M, and Huisman E, depict niche research collaborations. The spread of clusters indicates that although the discipline is characterized by localized research collaborations, there are some bridging nodes centering at a few central actors, reinforcing the cohesion within the general research network.

Figure 24 carries this analysis further by charting institutional collaborations. At this point, Chalmers University of Technology stands as the most prominent institution with far-reaching connections to Karolinska Institutet, University College London, and Technische Universiteit Eindhoven. The University of Toronto also possesses strong cooperative linkages, especially with McMaster University and health-oriented institutes, and Cornell University and Texas A&M University link up with North American and European counterparts, strengthening transatlantic academic connections. The existence of multi-institutional clusters highlights the international and interdisciplinary focus of this research field, where health sciences and technology institutions often collaborate to build knowledge.

Combined, Figures 23 and 24 point to how collaboration patterns, at the author and institutional levels, fuel knowledge diffusion in the field. Author networks indicate individual-level synergies, while institutional connections show the larger, usually cross-border, activities that promote research visibility and impact.

4.2.10. Thematic Map

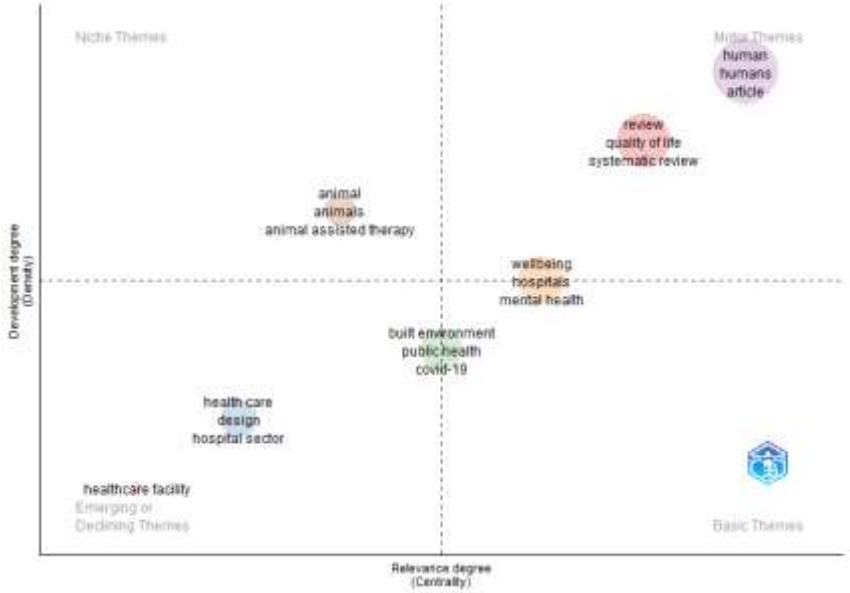

Figure 25. Thematic map

The thematic map (Figure 25) offers a systematic presentation of the intellectual and conceptual landscape of research in the area through the classification of keywords within four quadrants along two dimensions: development (density) and relevance (centrality). Such visualization allows for research maturity, importance, and future directions to be better understood.

1. Motor Themes (Well-Developed and Central)

Motor themes, being both central and well-developed, are placed in the upper-right quadrant. Here, "human," "humans," and "article" are the most prominent motor themes. Their prominence indicates that these terms are central in academic discussion, implying that they are the building blocks and integrated elements in various studies. In the same manner, "review," "quality of life," and "systematic review" also become motor themes,

indicating methodological integration and well-being measurement significance in the field of research. These issues propel the field forward and will continue to be key areas of research.

2. Basic Themes (Well-Connected but Less Developed)

In the bottom-right quadrant, basic themes like "built environment," "public health," and "COVID-19" are recognized. These themes are at the heart of the field but exhibit relatively lower density, that they are extensively used and part of the foundation of research, yet still need more specialized elaboration. The COVID-19 presence reflects a recent boom in literature wherein the pandemic redefined health, environmental, and social research trends and directions closely associated with public health and built environments. All these themes are the center of current and future research.

3. Niche Themes (Highly Developed but Peripheral)

The upper-left quadrant is used to denote niche topics that are highly developed but less central to the core field. In this space, "animal," "animals," and "animal-assisted therapy" are located. These are subjects with a high internal research foundation but relatively distant from the mainstream attention. Although they do not constitute the central debate, they are specialized groups in which much work has been accomplished and thus prospective for interdisciplinary growth (for example, incorporating therapeutic techniques into medicine and psychology research).

4. Diverging or Constraining Themes (Weakly Developed and Peripheral)

The bottom-left quadrant identifies themes as weak in centrality and density, indicating emerging frontiers or in-decline domains. "Healthcare facility," "health care," "design," and "hospital sector" are included here. Their placement implies two scenarios: either these areas are waning as discrete research areas or they are evolving into new modalities, including integration with digital health technologies, sustainability, or patient-oriented models. Their resurgence would happen if attached to more mainstream topics like public health and quality of life.

4.2.11. Factorial Analysis

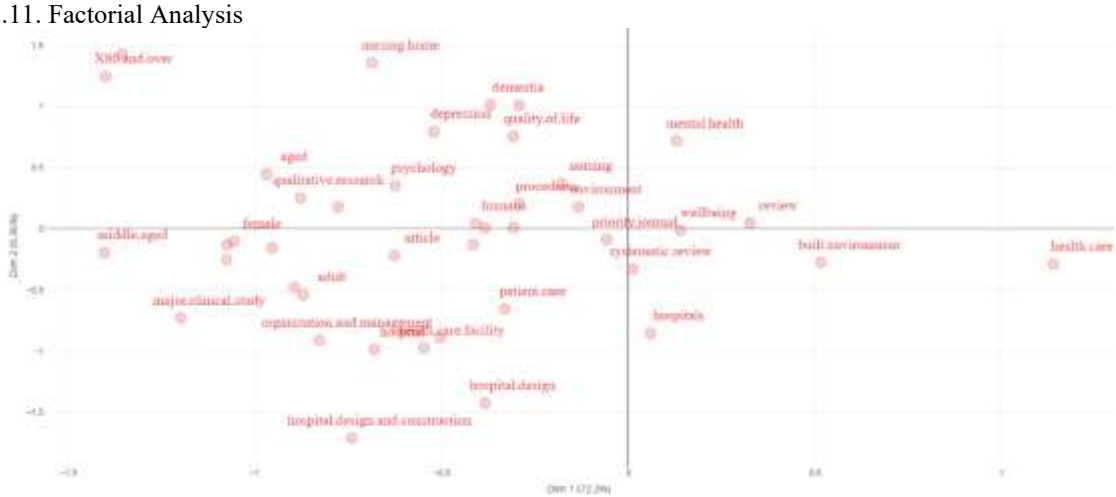

Figure 26. Factorial Analysis

The factorial analysis presented in Figure 26 highlights the spatial distribution of key research themes based on their dimensional clustering. The analysis reflects two major components (Dim 1: 72.3% and Dim 2: 9.35%), which collectively account for over 80% of the total variance, thus providing effective representation of thematic constructs. The location of health care, built environment, mental health, systematic review, wellbeing, and hospitals in the positive quadrants reflects their high centrality and salience to the topic, which denotes their status as central research points. These contrast with words such as hospital design, hospital care facility, and organization and management that are found in the lower quadrants, indicating their comparatively peripheral or specialized nature in the literature. Demographic and psychosocial terms such as aged, female, adult, and psychology also plot closer to the center, highlighting their cross-cutting applicability across several research areas. The factorial mapping therefore graphically demonstrates the relationships between dominant concepts and serves as an interpretative framework for the understanding of thematic development in this field of study.

5. Studies Gaps and Future Research Directions

Scientometric examination of hospital design and healing environments identifies both substantial achievements and existing gaps calling for systematic future research. As the area has evidenced consistent publication growth as well as diversification of topics, some directions will enhance its scientific quality, worldwide relevance, and pragmatic influence.

1. There is an evident necessity for empirical and longitudinal validation of design interventions. Most of the current research is cross-sectional or based on self-reported perception, which reflects short-term effects rather than measuring long-term health trajectories, autonomy, and quality of life. Research in the future should employ longitudinal designs and randomized controlled trials to measure the persistence of architectural innovations on maintaining well-being at various points in the aging process.

2. The review identifies low levels of staff views and workflows being integrated into hospital design. While patient-centered outcomes predominate the literature, little research is systematically addressing how

architectural decisions impact healthcare professionals' efficiency, safety, and well-being. Integrating staff-oriented studies into design assessments will enable the production of comprehensive environments that harmonize both caregivers' and patients' needs.

3. Technological integration is a new but uncharted territory: The development of IoT-based environmental monitoring, AI-powered adaptive lighting, digital twins, and VR-facilitated rehabilitation opens up new avenues for individualized healing spaces. Future research should explore how digital technologies can be integrated into hospital buildings to design responsive, data-driven, and adaptive environments that optimize therapeutic gains.
4. The results highlight a dramatic geographical imbalance: Research is highly concentrated in North America, Europe, and East Asia, with low- and middle-income countries (LMICs), where geriatric populations are expanding most rapidly, being poorly represented. An extension of research to these settings is required in order to support cultural transposition and fair application of evidence-based design principles. Comparative international research and South–North collaboration can support this imbalance.
5. There is an increasing need to incorporate sustainability and policy frameworks into future hospital design research. As biophilic and restorative thinking is becoming more prominent, there has been comparatively little focus on environmental sustainability (e.g., reducing carbon footprint, energy efficiency, circular materials). Policy-relevant research incorporating cost–benefit analysis, feasibility assessment, and models of funding will be important in order to make innovative designs scalable and affordable across healthcare systems.
6. Participatory and interdisciplinary methods must be reinforced. Engagement of patients, families, caregivers, clinicians, policymakers, and architects in co-designing can provide more inclusive and context-adapted healthcare settings. These methods are particularly necessary in dementia care, stroke rehabilitation, and geriatric care where user requirements are rich and complex.

In summary, subsequent research should focus on empirical richness, staff involvement, technological advancement, cultural diversity, sustainability, and participatory action. By closing these gaps, researchers and practitioners can transcend descriptive studies to transformative models that place hospital architecture at the center of dignified, sustainable, and holistic geriatric care.

6. CONCLUSION

This research explored the intersection of hospital design, healthcare design, and healing spaces and their interactions with elderly health, using a scientometric method to chart research trends, thematic groups, and changing worldwide contributions. Findings affirmed that hospital settings reach far beyond the functional purpose, impacting not only physiological recovery but psychological, emotional, and social aspects of patient wellbeing. By critically evaluating the literature, this research responded to the research questions put forth and provided new knowledge on current practices and directions.

The initial research question asked how thoroughly hospital design had been researched as a determinant of geriatric health. The review uncovered a consistent increase in research productivity during the last twenty years, with significant acceleration during the past decade, in tandem with international demographic trends and policy focus on aging populations. The second issue queried the major thematic spheres of inquiry. Outcomes indicated varied focal areas, ranging from dementia-sensitive environments, neurorehabilitation environments, therapeutic landscapes, to restorative environmental design. These topics validate the inter-disciplinary scope of the discipline, crossing from architecture, gerontology, psychology, and nursing science.

The third query, in respect to geographical and organizational dispersion of studies, reflected rich contributions from the USA, UK, Sweden, the Netherlands, and China, but also revealed significant gaps in low- and middle-income countries like South Asia, Africa, and Latin America. This disparity also points to the necessity for additional global-inclusive paradigms to maximize the reach of design concepts. The fourth question, which emphasized how these principles can be implemented in the real world, found concrete examples in Dutch dementia villages, sensory garden inclusion in Sweden, and culturally responsive geriatric hospital planning in South Korea. These examples demonstrated the concrete value of evidence-based and contextual architectural solutions in enhancing quality of life among older patients.

The fifth question focused on the limitations and future requirements in this area. The findings presented revealed that significant advancements have been made, yet some of the most essential challenges remain. These are underrepresentation of staff voices in hospital design, sparse longitudinal analyses of the impacts of architecture on patient well-being, and inadequate integration of digital technologies such as IoT-based environmental monitoring, AI-facilitated adaptive spaces, and VR-based rehabilitation.

Notably, the Results section pointed out that certain environmental characteristics—natural light, privacy via single-patient rooms, noise management, biophilic design features, and adaptable spatial configurations—are reliably related to improved health outcomes, lower levels of stress, and improved patient satisfaction. Scientometric mapping also showed keywords human, aged, quality of life, and healing environment to be prevalent in the rhetoric, indicating both the paramountcy of geriatric health and the integral articulation of architecture as a curative instrument.

In summary, in this study, it is illustrated that hospital design is not a physical backdrop but rather an active participant in caring for the elderly and healing. Evidence promotes that design strategies extend beyond standardized designs to more responsive, individual-focused, and technology-insegregated spaces. For healthcare systems under the strains of population aging, this means a shift in architectural practice that is supportive of

sustainability aims, culturally responsive, and attentive to overall well-being. In bringing scientometric knowledge together with practical applications, this research advances a swelling body of evidence establishing hospital architecture as a fundamental pillar for driving the quality of care, dignity, and life satisfaction of older patients globally.

Declarations

Funding and/or Conflicts of interests/Competing interests The authors have no competing interests to declare that are relevant to the content of this article.

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