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Review

Mapping the Global Knowledge Landscape of Urban Green Walkability: A Bibliometric Analysis

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Abstract

Urban green walking systems have emerged as a pivotal strategy to alleviate urban challenges, enhance public health, and promote sustainable urban development, garnering increasing attention across multiple disciplines. This study presents a comprehensive bibliometric review of literature published in the Web of Science Core Collection between 1998 and 2023, employing the R-based tool Bibliometrix (version 4.5.0) to analyze research output, scholarly contributions, and thematic evolution. Findings reveal an overall growth in publications, with the field progressing through nascent (1998–2016), rapid growth (2017–2020), and stable maturity (2021–2023) phases. Urban Forestry & Urban Greening recorded the highest number of publications, while Landscape and Urban Planning exhibited strong academic influence. China and the United States are leading contributors, though international collaboration rates suggest opportunities for broader global engagement. Core research themes center on health promotion, spatial planning, and social equity, reflecting interdisciplinary integration across environmental science, urban planning, and public health. Despite the formation of an emerging theoretical framework, gaps persist regarding research trajectory clarity, interdisciplinary depth, thematic synthesis, and methodological diversity. Future research should expand multilingual and multi-source datasets, integrate field-based investigations with quantitative modeling, and advance understanding of the mechanisms underpinning urban green walking systems, thereby informing evidence-based urban planning and the development of livable cities.

Keywords: urban green walking systems; sustainable cities; bibliometric analysis; research trends; interdisciplinary integration

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1. Introduction

As global urbanization accelerates, urban spatial structures are undergoing continuous evolution, while environmental pollution, traffic congestion, and public health challenges have become widespread urban issues, significantly affecting residents' quality of life and the sustainability of cities. Walking, as the most basic and low-carbon mode of mobility, not only offers substantial health benefits for individuals but also plays a critical role in alleviating urban ecological pressures and improving environmental quality [1]. The World Health Organization emphasized as early as 1992 that walking should be the preferred form of physical activity for urban residents, a stance widely acknowledged as essential for promoting sustainable urban development [2,3].

In recent years, the concept of "human-centered" urban planning has gained increasing global prominence, fostering the widespread implementation of pedestrian-priority policies and the development of green walking systems. Numerous countries and regions have introduced initiatives such as "Car-Free Day" (a public environmental campaign that originated in France in 1995 and was later promoted globally by the European Union, typically restricting private vehicle access within designated areas on specific dates to raise public awareness of environmental pollution and traffic congestion while encouraging low-carbon mobility), "Walkable Cities" (an urban planning and assessment framework that prioritizes pedestrian needs by systematically optimizing walking infrastructure, enhancing environmental comfort and safety, and thereby improving the attractiveness and continuity of walking trips, often evaluated through international certification systems) [4], and "Green Transportation Networks" (comprehensive urban transport systems integrating low-energy and low-emission modes such as walking, cycling, and public transit, designed to minimize dependence on private vehicles and support sustainable urban mobility) [5,6].

These initiatives have collectively driven the redesign of urban public spaces and the optimization of pedestrian environments. Green walking systems, as essential infrastructure for enhancing urban livability and sustainability, have attracted considerable attention from scholars across environmental science, urban planning, and public health disciplines [7]. International research on green walking systems has explored multiple dimensions, with the existing literature primarily focusing on three core themes: health promotion, spatial planning, and social equity, reflecting the key interests of environmental science and ecology, public health, urban planning, and social behavior studies. Some researchers have concentrated on developing scientifically robust frameworks for evaluating pedestrian-friendly green spaces, aiming to enhance accessibility and comfort [8,9]; others have emphasized quantitative indicators for walking space design, promoting the integration of theoretical and practical perspectives [10,11]; additional studies have investigated the dynamic interactions between pedestrians and the environment based on social behavior and spatial interaction theories [12].

However, despite the abundance of existing qualitative and case studies, the field of green pedestrian systems still lacks systematic quantitative analysis and large-scale data support overall. Most current research methodologies rely on small-sample surveys and case-specific analyses and lack a systematic overview of global research progress as well as an assessment of trends—this limits the comprehensive understanding of its functional effects and influence mechanisms. Against this backdrop, adopting bibliometric methods to conduct systematic integration and visual analysis of existing studies helps address the aforementioned research gaps and provides objective, comprehensive data support for the development of the field.

Bibliometric analysis has emerged as a powerful tool to uncover the development trajectory, research hotspots, and evolving trends of a discipline, and it has been increasingly applied in urban studies, environmental science, and public health. The R-based Bibliometrix software (version 4.5.0) integrates multidimensional statistical and visualization functions [13], enabling systematic mapping of the knowledge structure and research frontiers in green walking systems [14,15]. Systematic bibliometric assessment of global literature provides insights into international research dynamics [16] and supports interdisciplinary integration and theoretical innovation [17,18].

In this study, we systematically analyzed literature on green walking systems published in the Web of Science Core Collection from 1998 to 2023 using Bibliometrix, combining bibliometric methods with visual analytics. The study aims to map the global research landscape, identify development patterns, uncover thematic hotspots and emerging trends, and provide theoretical and practical insights to guide evidence-based planning and policy

formulation for green walking systems. Specifically, three research questions are addressed: (1) What are the global research status and developmental characteristics of green walking systems? (2) Which themes and topics dominate current international research? (3) What are the future research directions and potential breakthrough areas? Research on urban green walking systems is of critical importance for addressing urbanization challenges, promoting sustainable city development, and enhancing public health. Bibliometric analysis, with its objectivity, reproducibility, and visualization capabilities, enables a systematic understanding of the knowledge structure, highlights research trends, and offers reliable guidance for both theoretical advancement and practical application in this field.

2. Literature Review

This review is organized around the concepts of the "urban walking system" and the "green walking system," reflecting their inherent theoretical and developmental interconnections. The urban walking system conceptualizes walking as a fundamental urban function and a key driver of spatial structure, embodying the shift in urban planning paradigms from "car-oriented" to "human-centered" design. Building on this foundation, the green walking system incorporates principles of ecological civilization and sustainable development, highlighting the integration of walking networks with green infrastructure, ecological spaces, and healthy lifestyle promotion, and signaling a transition in research focus from transportation functionality to ecological sustainability. Structuring the review along this framework allows for a systematic mapping of the knowledge evolution in walking system research and provides a solid theoretical basis for understanding its contribution to urban livability and ecological resilience.

2.1. Urban Walking Systems

Urban walking systems are conceptualized differently across academic disciplines. In the context of urban planning and design, they encompass diverse spatial typologies such as pedestrian streets, plazas, courtyards, underground passages, and elevated walkways, complemented by connective infrastructures including overpasses, underpasses, traffic signals, and landscaping features [19]. Within urban transportation planning, walking systems primarily serve commuting and daily mobility functions, with an emphasis on accessibility and operational efficiency [20,21]. From the perspective of urban landscape design, walking systems are conceived as linear sequences integrating open spaces, parks, squares, fountains, and tree-lined avenues, promoting landscape continuity and spatial permeability, effectively linking commercial hubs with adjacent areas and facilitating the organic integration of urban functions [22–24]. Collectively, urban walking systems constitute a complex assemblage of physical forms and connectivity mechanisms, synergistically supporting mobility, leisure, and social interaction [25].

Historically, the genesis of urban walking systems can be traced to the earliest city streets. Between the late 19th and early 20th centuries, rapid industrialization and urban expansion highlighted the importance of walking infrastructures as urban spaces diversified and transportation modes evolved. In 1909, Park introduced the concept of "urban ecology," recognizing pedestrian spaces as fundamental components of urban activity [26]. By the mid-20th century, the rapid proliferation of automobiles resulted in congestion and environmental degradation, prompting Jacobs to advocate for the enhancement of sidewalks and street-crossing facilities, emphasizing pedestrian-centered urban design [27]. In 1987, the World Commission on Environment and Development (WCED) published Our Common Future, promoting sustainable development and integrating walking systems with ecological and social equity objectives [28]. Entering the 21st century, smart city

paradigms have elevated intelligent walking systems as a prominent research focus, with information technologies increasingly applied to optimize pedestrian experiences [29–31].

Although research on urban walking systems has progressively expanded, with emerging interdisciplinary theoretical frameworks, the majority of studies remain primarily situated within the domain of transportation engineering, focusing on infrastructure enhancement and travel efficiency. In contrast, the exploration of walking systems in relation to urban cultural heritage, community development, and mental well-being remains comparatively scarce [32–34]. This research bias can be attributed to several factors: technical metrics (e.g., traffic flow efficiency, facility density) are more easily quantified and standardized, facilitating policy implementation and engineering practices; conversely, "soft" dimensions—encompassing cultural, psychological, and social behavioral aspects—are inherently subjective, context-dependent, methodologically complex, and time-intensive, often limiting their generalizability and marginalizing them in resource allocation and academic evaluation frameworks. As a result, the deeper values of walking systems—such as cultural identity, sense of place, and social cohesion—have yet to be fully examined. Within the context of high-quality urban development, urban walking systems, as integrative multidisciplinary platforms, necessitate the expansion of both theoretical constructs and practical applications to meaningfully enhance residents' quality of life and advance sustainable urban growth.

2.2. Green Walking Systems

Under the growing influence of green development principles, traditional pedestrian systems have increasingly merged with ecological spaces, giving rise to the concept of green pedestrian systems. The origins of this idea can be traced back to Whyte's introduction of the "greenway" concept [35]. During the early 1990s, the greenway movement gained momentum across Europe and North America. Although research at that stage largely emphasized peripheral greenways, while intra-urban pedestrian green spaces remained relatively underexplored, this period nevertheless provided an essential theoretical and practical foundation for the evolution of green pedestrian systems [36].

From the perspective of spatial design, the development of green pedestrian systems has been significantly informed by pattern language theory. In A Pattern Language (1977), Alexander outlined key patterns such as "Green Streets" (Pattern 51), "Accessible Green" (Pattern 60), and "Tree Places" (Pattern 171). These patterns underscored the importance of human-scale environments, the integration of natural elements, and spatial accessibility, thereby offering fundamental guidance for creating pedestrian-friendly spaces [37]. More recently, Mehaffy expanded this framework in A New Pattern Language (2020), introducing principles such as "Walkable Multi-Modal Streets" (Pattern 2.1), "Urban Greenways" (Pattern 3.1), and "Street Trees" (Pattern 8.3). These newer patterns highlight the integration of ecological and transport functions, while emphasizing the role of pedestrian systems in fostering social interaction and promoting healthier lifestyles [38]. Collectively, these design approaches provide a solid theoretical basis for shaping both the spatial configuration and functional orientation of green pedestrian systems.

At the international practice level, the "New Means to Promote Pedestrian Traffic in Cities" project, conducted across six European countries, developed a systematic framework for evaluating pedestrian conditions along four key dimensions: safety, comfort, attractiveness, and intermodal connectivity. The initiative sought to expand walking as a mainstream travel mode, reduce environmental impacts, and enhance public health. With the deepening of related research, green pedestrian systems are increasingly regarded as a distinct subtype of greenway systems. In addition to offering nature-oriented pathways,

they serve as crucial linkages between urban and rural landscapes, with their functional scope and spatial attributes becoming progressively more defined [39–41].

Contemporary scholarship on green walking systems primarily follows two trajectories: one examines walking environment design, spatial structure, and morphological characteristics [42,43]; the other emphasizes greenway construction experience, theoretical development, and emerging trends [44,45]. Nevertheless, as a hybrid of walking and green space networks, green walking systems lack systematic reviews, particularly regarding policy frameworks, spatial optimization, and infrastructure enhancement. These gaps constrain the strategic development and planning of green walking systems.

Overall, green walking systems constitute a complex interdisciplinary domain encompassing environmental science, public health, urban design, and ecological planning. With rising living standards and health awareness, they hold strategic significance in enhancing residents' quality of life, advancing urban sustainability, and reinforcing ecological and cultural values, warranting further theoretical elaboration and practical expansion.

2.3. Research Gaps

Despite notable advances in urban and green walking system research, significant deficiencies persist in the areas of systematic framework development, depth of analysis, and thematic synthesis, as outlined below:

2.3.1. Ambiguous Research Trajectory

Existing studies lack a coherent mapping of the developmental trajectory of walking systems. While some literature references historical evolution, there is limited consolidation of key scholars, foundational theories, and core contributions. Specifically, details regarding the timing of theoretical proposals, the scholars involved, and the subsequent influence on research remain unclear, obscuring the field's developmental pathway and hindering a comprehensive understanding of its evolution.

2.3.2. Limited Analytical Depth

Current research predominantly focuses on single perspectives, such as urban planning or transportation design, with insufficient interdisciplinary integration and systemic inquiry. Many studies emphasize spatial optimization or infrastructure enhancement while neglecting soft dimensions, including social psychology, cultural identity, and health and well-being. This lack of interdisciplinary collaboration restricts the investigation to surface-level phenomena, limiting insights into the operational mechanisms and complex interactions within urban walking systems, and constraining innovation and systemic understanding.

2.3.3. Insufficient Hotspot Consolidation

Although emerging topics such as "green low-carbon mobility" and "smart technology-enabled pedestrian spaces" are occasionally addressed, they lack systematic synthesis and rigorous analysis. Research on these topics is often fragmented, failing to form a coherent knowledge framework. Furthermore, the logical interconnections among hotspots and their influence on research paradigms remain underexplored. This limits the field's capacity to respond to practical challenges and hinders the development of informed policy and forward-looking urban planning strategies.

3. Data Sources and Research Methods

3.1. Data Acquisition and Cleaning

To systematically map the development and knowledge structure of global research on green walking systems, the Web of Science (WoS) Core Collection was selected as the

primary data source. The WoS Core Collection indexes rigorously curated, high-impact journal publications, offering broad disciplinary coverage, comprehensive citation data, and standardized metadata, making it highly representative for fields such as urban planning, environmental science, and transportation studies, and ensuring the reliability of both data quality and subsequent analyses.

Following iterative testing and extensive consultation with domain experts, the search formula was defined as TS = ("Urban green walking system") OR ("Urban green walking space"). To maintain literature quality, the search was limited to the "Topic" field, spanning from 1998—the year of the earliest relevant publication—to the end of 2023. Only "Articles," "Review Articles," and "Conference Papers" were included, while book chapters, editorial materials, and other publication types were excluded; no language restrictions were applied. The initial search retrieved 1719 records, which, after screening and deduplication, resulted in a final dataset of 869 publications. All data were exported in plain text format for subsequent analysis.

Based on this rigorously curated dataset, a systematic bibliometric analysis was conducted to reveal the evolution and structure of research in the field (Figure 1).

3.2. Research Methods and Analytical Framework

This study adopts a bibliometric approach, leveraging the bibliometrix package (version 4.5.0) and its interactive graphical interface biblioshiny within the R (version 4.5.0) environment to systematically analyze and visualize the sample of publications retrieved from the WoS Core Collection [14,16,17]. The analytical workflow follows a structured sequence: "data retrieval → data preprocessing → bibliometric analysis → results visualization," comprising three key stages.

First is data acquisition and preprocessing. Centered on the theme of "urban green walking systems," a comprehensive search strategy incorporating synonyms and related expressions was developed to ensure exhaustive keyword coverage. After importing the raw data into R, preprocessing involved the following: (1) deduplication, identifying and removing duplicate records; (2) field standardization, harmonizing author and institution names by correcting case, removing extraneous spaces and special characters, and consolidating synonymous entries caused by spelling variations to improve analytical accuracy; (3) data completeness verification, ensuring critical fields such as title, authors, year, journal, abstract, and keywords were fully available and consistent.

Second is calculation of core metrics and network analysis. Using the cleaned dataset, descriptive statistics were computed in bibliometrix, including annual publication trends, geographic distribution of outputs, prolific authors and institutions, and core journals. Collaboration networks among countries/regions and institutions were constructed to identify key cooperative clusters. Keyword co-occurrence analysis was conducted with a minimum-frequency threshold to exclude low-frequency terms, followed by clustering based on co-occurrence strength to reveal principal research themes and their interrelationships.

Third is results visualization. Utilizing the biblioshiny interface, a range of visual outputs was generated, including annual publication trend charts, country/region collaboration networks (with node size representing publication volume and edge thickness indicating collaboration intensity), keyword co-occurrence networks and strategic diagrams, keyword cloud maps based on normalized term frequency (with font size reflecting research prominence), and distribution charts for prolific authors, institutions, and core journals. These visualizations provide an intuitive and comprehensive representation of research dynamics and knowledge structure within the field of green walking systems.

It is noteworthy that, while bibliometrix offers powerful tools for keyword frequency analysis and co-occurrence network construction, the methodology primarily relies on

author-assigned keywords and indexed database fields, which may not fully capture implicit or semantically related topics embedded in the literature. Nevertheless, this approach effectively identifies and visualizes the core research hotspots and structural knowledge of the field, providing robust support for understanding the overall landscape of urban green walking systems research.

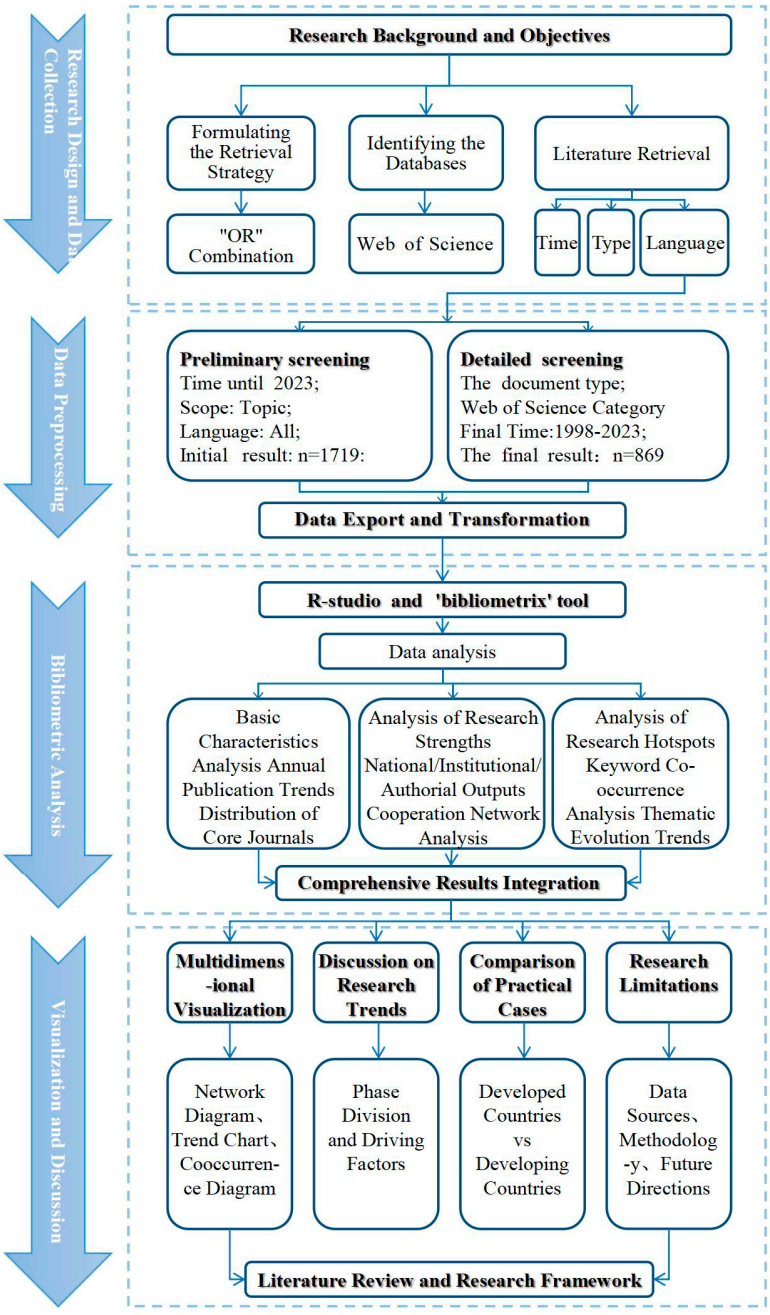

Figure 1. Data Acquisition and Cleaning Workflow for Global Research on Urban Green Walking Systems.

4. Research Results

4.1. Basic Characteristics

4.1.1. Trends in Annual Publication Volume

The number of publications and their year-to-year fluctuations provide insights into the pace and developmental stages of research on urban green pedestrian systems. Between 1998 and 2023, a total of 869 relevant papers were published, exhibiting an overall

fluctuating upward trend (Figure 2). Based on annual publication counts, the research progression can be divided into three stages: Nascent stage (1998–2016): During this period, fewer than 10 papers were published annually, accounting for 20.48% of the total output. Research was in its early phase, and results were relatively scattered. Rapid development stage (2017–2020): Approximately 75 papers were published per year, comprising 34.64% of the total. This stage saw a marked increase in research activity and academic output. High growth stage (2021–2023): Annual publications exceeded 110 papers, representing 44.88% of the total, indicating sustained and rapid growth in the field. In summary, the three-stage evolution model of publication volume reveals that research on urban green walking systems has progressed from a slow initial phase, through accelerated accumulation, to a stage of stable and mature development.

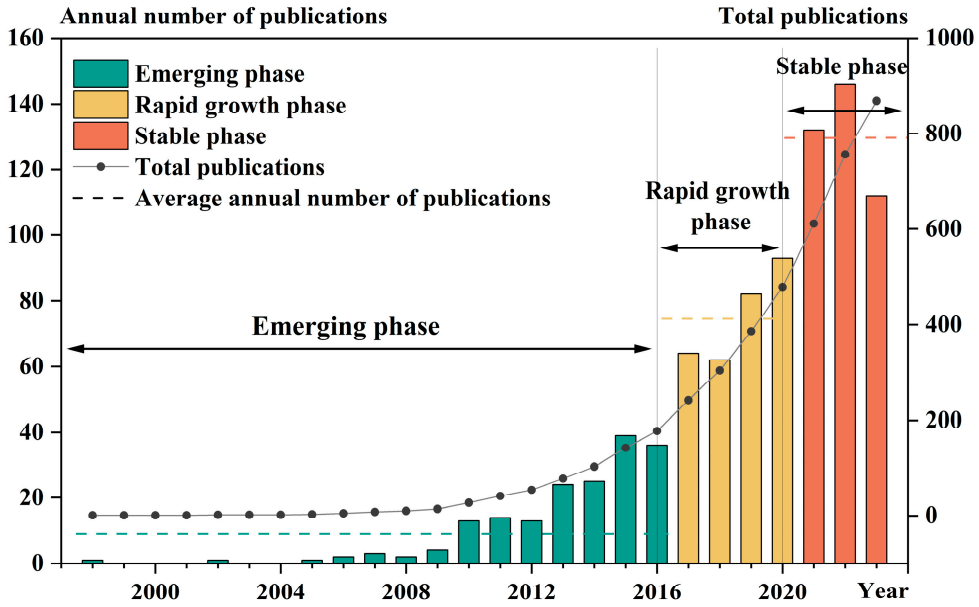

Figure 2. Number of articles published in the field of urban green pedestrian systems and their annual publication trend from 1998 to 2023.

4.1.2. Major Journals

The core journals and primary communication platforms in the field of urban green pedestrian systems can be identified through analysis of publication volumes. Between 1998 and 2023, a total of 274 journals published relevant research. The top ten journals are listed in Table 1. Among them, Urban Forestry & Urban Greening leads in publication volume, with 91 papers and 3677 citations, highlighting its significant influence in the field. Other prominent journals include the International Journal of Environmental Research and Public Health (85 articles), Sustainability (58 articles), Landscape and Urban Planning (51 articles), and Cities (24 articles). Notably, although Landscape and Urban Planning ranks fourth in terms of article count, it amassed 3624 citations (averaging 71.06 citations per article), substantially surpassing other journals and reflecting its considerable academic recognition and impact. Additionally, both the International Journal of Environmental Research and Public Health and Urban Forestry & Urban Greening began publishing related literature relatively recently in 2009 and 2010, respectively. Despite this late start, each has averaged approximately 6.07 articles annually since then, demonstrating rapid growth and establishing themselves as important academic platforms in this research area.

Table 1. Top 10 journals by publication volume in the field of urban green walking systems (1998–2023).

Journal Name	NP	TC	PY_Start	Country of Publication
Urban Forestry & Urban Greening	91	3677	2010	Germany
International Journal of Environmental Research and Public Health	85	2431	2009	Switzerland
Sustainability	58	991	2012	Switzerland
Landscape and Urban Planning	51	3624	2010	Netherlands
Cities	24	1174	2014	Britain
Health & Place	21	1476	2010	USA
Land	15	100	2018	Switzerland
Sustainable Cities and Society	15	225	2016	Netherlands
Frontiers in Public Health	14	143	2016	Switzerland
International Journal of Behavioral Nutrition and Physical Activity	14	617	2008	Britain

Note: NP = Number of publications; TC = Total citations; PY_start = First year of publication in this field.

4.2. Leading Entities Driving Research

4.2.1. Major Countries

The number of publications serves as an indicator of a country's research capacity and academic influence in the field of urban green pedestrian systems. Between 1998 and 2023, China, the United States, the United Kingdom, Australia, the Netherlands, Spain, Germany, Finland, Canada, and South Korea (Figure 3) ranked as the top ten countries by publication volume. Among these, China and the United States stand out with 585 and 318 papers, respectively, reflecting the strong academic attention devoted to this topic in both countries. In terms of total citations, China (5292) and the United Kingdom (4569) are in the lead, underscoring their prominent roles in global scholarly communication. However, China's average citations per paper (9.05) are slightly below the average of the top ten countries (9.46), indicating that while the country's research output is rapidly expanding, there remains room to enhance the international impact and academic quality of its publications. Notably, Australia, despite producing a comparatively smaller number of papers (203), has accumulated 3355 total citations and an average of 16.53 citations per paper, the highest among the top ten countries, demonstrating its strength in generating high-quality research.

The international cooperation network graph (Figure 4) reveals that research in urban green pedestrian systems is characterized by substantial international collaboration, with well-structured cooperative relationships among countries. China has established partnerships with 28 countries, totaling 110 collaborative links. The United States and the United Kingdom reported 119 and 105 collaborations, respectively, demonstrating that these three countries hold a clear advantage in the volume of international cooperation. To better assess cooperation intensity relative to output, the "number of collaborations/total publications" metric was used to standardize cooperation frequency. According to this measure, Spain (0.48) and Finland (0.47) exhibit significantly higher international cooperation rates compared to China (0.19) and the United States (0.37). This indicates that although China and the United States lead in absolute collaboration numbers, Spain and Finland are more active in international cooperation on a per-publication basis.

4.2.2. Major Institutions

Between 1998 and 2023, the top ten research institutions in terms of publication volume in the field of urban green pedestrian systems were Wuhan University, the University of Hong Kong, Deakin University, the University of Exeter, the University of London, the Chinese Academy of Sciences, the University of Melbourne, the University of Western

Australia, Utrecht University, and the University of Edinburgh, with a combined total of 243 publications (Figure 5). Wuhan University led with 33 papers, underscoring its central role and leadership in the field. The University of Hong Kong ranked second with 28 papers, highlighting its substantial influence in the global research community. Overall, while Chinese institutions dominate the list, contributions from Australia, the United Kingdom, and the Netherlands demonstrate the field's broad international engagement and strong potential for cross-border collaboration.

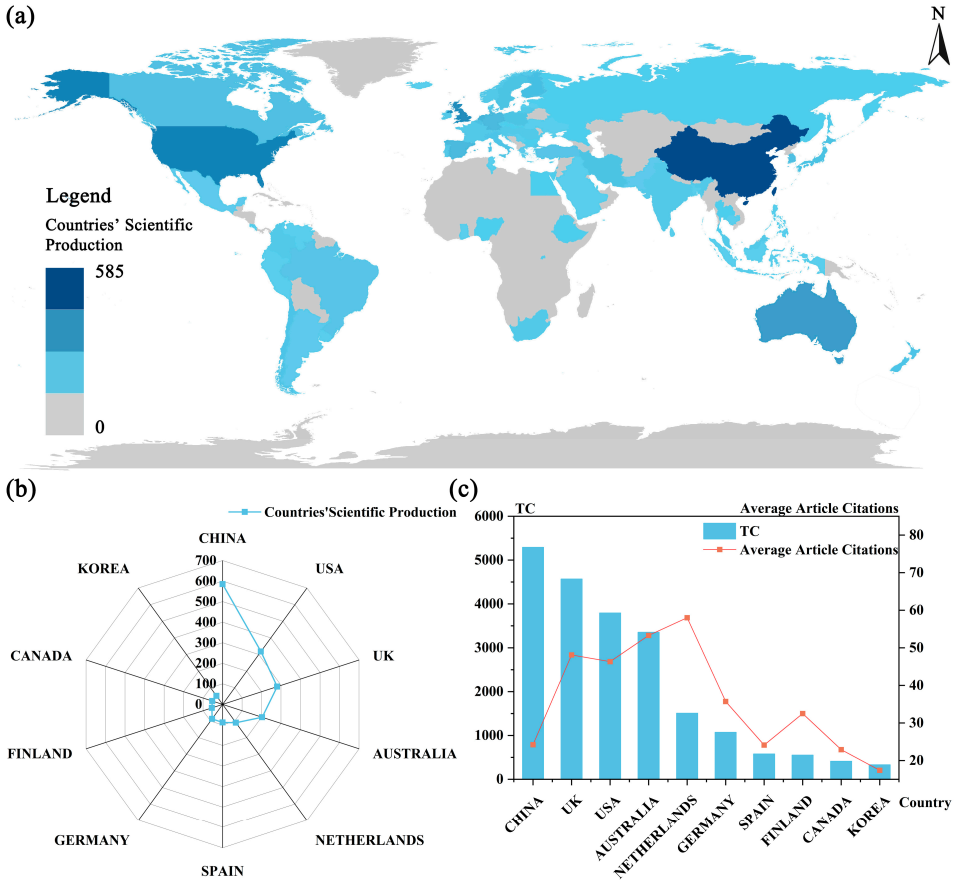

Figure 3. Top 10 countries by publication volume in the field of urban green pedestrian systems (1998–2023). Note: TC = total citations. Panel (**a**) illustrates the global distribution of publication volume by country; panel (**b**) lists the top ten countries by publication volume; panel (**c**) compares total citations and average citations per paper among these countries.

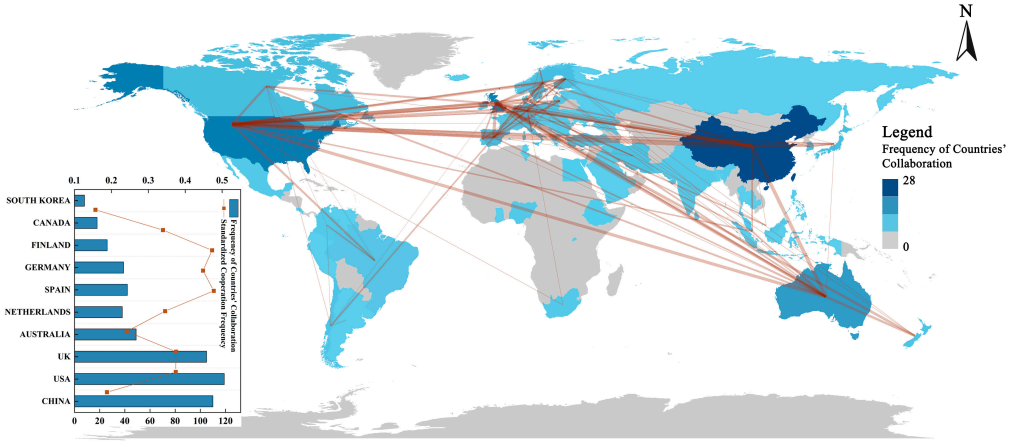

Figure 4. Research cooperation among countries in the field of urban green pedestrian systems from 1998 to 2023.

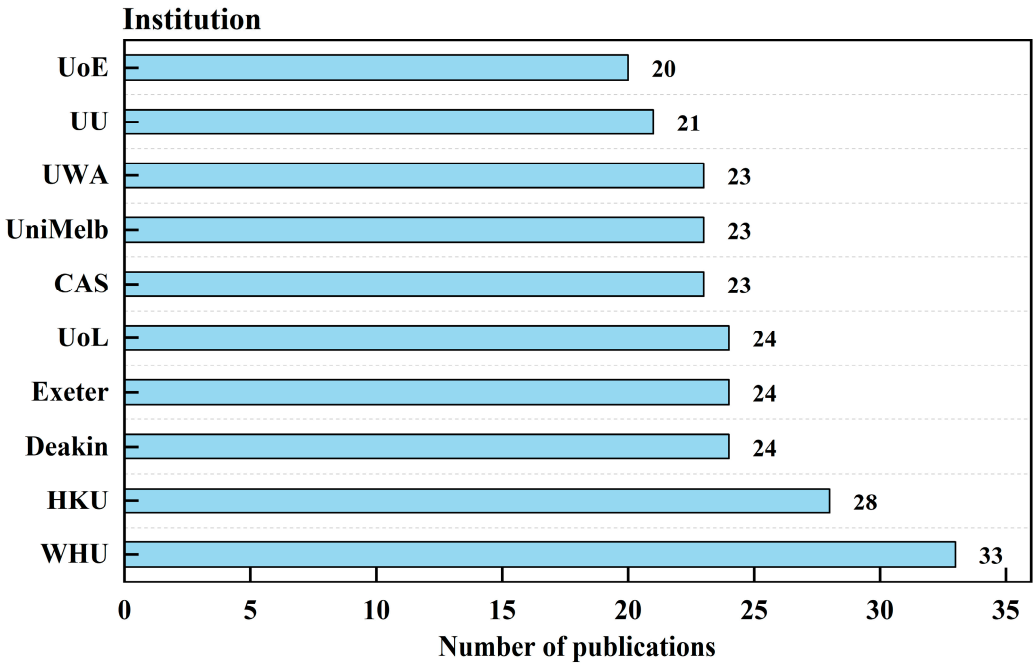

Figure 5. Top 10 research institutions by publication volume in the field of urban green pedestrian systems from 1998 to 2023. Note: WHU = Wuhan University; HKU = University of Hong Kong; Deakin = Deakin University; Exeter = University of Exeter; UoL = University of London; CAS = Chinese Academy of Sciences; UniMelb = University of Melbourne; UWA = University of Western Australia; UU = Utrecht University; UoE = University of Edinburgh.

In the institutional partnership network (Figure 6), the top ten institutions by publication volume are primarily organized into four collaboration clusters: (1) a green cluster centered on the University of Melbourne, Deakin University, and the University of Western Australia; (2) a blue cluster comprising the University of Hong Kong and Wuhan University; (3) a red cluster including the University of Exeter, the Chinese Academy of Sciences, and the University of London; (4) a purple cluster formed solely by Utrecht University. Betweenness centrality analysis shows that the University of Exeter (156.814), the University of Hong Kong (94.127), and Deakin University (87.793) occupy core positions in the network, acting as key connectors that facilitate information flow and interdisciplinary collaboration. Closeness centrality results revealed that the University of Western Australia (0.008), the University of Melbourne (0.009), the University of London (0.009), and Wuhan University (0.009) maintain shorter path distances to other nodes, enabling faster resource access and more efficient information exchange. In terms of PageRank scores, the University of Exeter (0.038) and the University of Hong Kong (0.035) rank highest, reflecting both frequent collaborations and strong structural influence in the global academic landscape. Overall, the network reveals a dual-core collaboration pattern between Chinese and Western institutions, with the University of Hong Kong being an increasingly prominent leader in global academic exchange. This highlights the growing trend toward multi-center, multi-country cooperation in the field.

4.2.3. Lead Authors

The number of papers and citations an author has accumulated in the field of urban green pedestrian systems serves as a key indicator of their academic influence. Between 1998 and 2023, a total of 2858 authors contributed to research in this area. The top ten scholars by publication volume form the core research cohort in the field (Table 2). Notably, Chinese scholars hold a dominant position, reflecting strong research coordination and output capacity. As of 2023, Veitch J leads with 12 publications, 288 citations, and an H-index

of 9, underscoring substantial academic influence. Following closely, Liu Y and Lu Y have published 12 and 10 papers, respectively, each with an H-index of 7, indicating consistent research productivity. Giles-Corti B also stands out with an H-index of 9, comparable to Veitch J. In summary, scholars from multiple countries have established a relatively stable research echelon, playing an increasingly prominent role in international academic collaboration and knowledge production in this field.

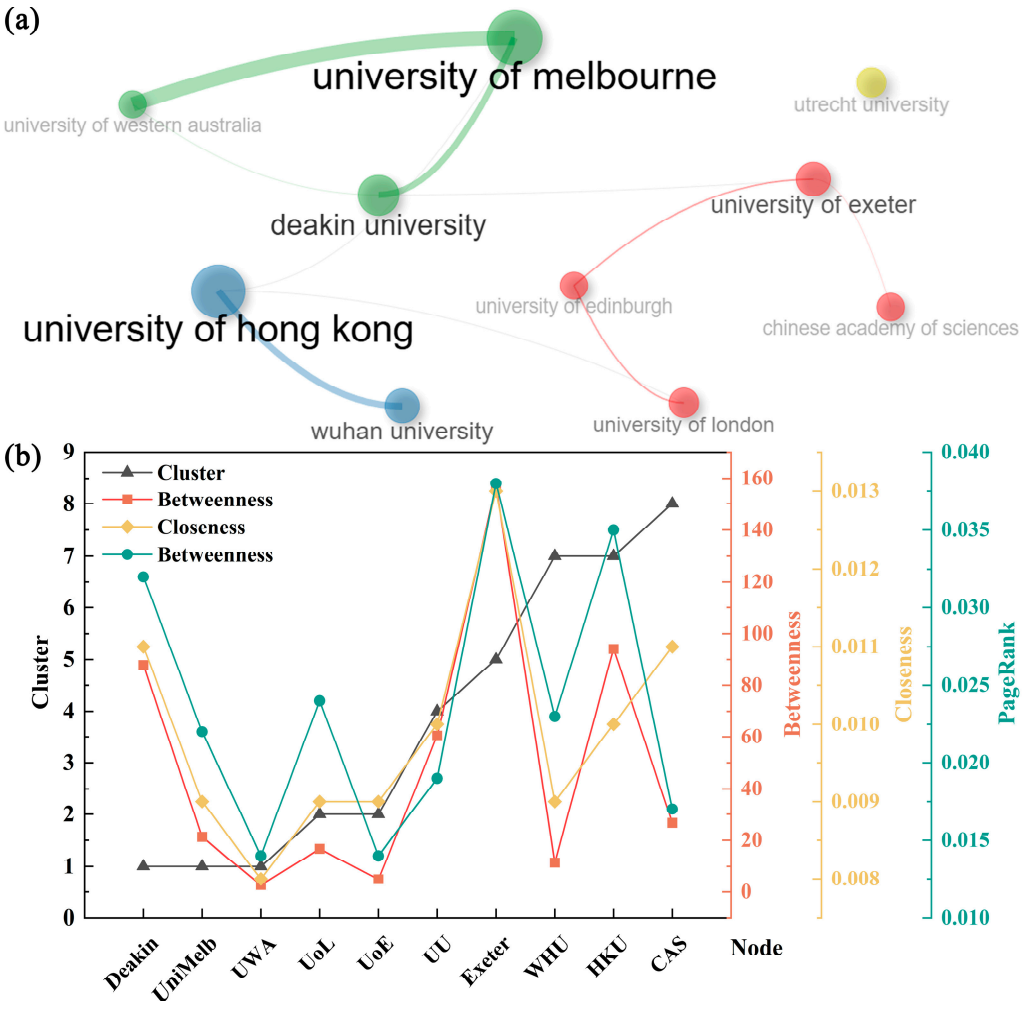

Figure 6. Top ten institutions in terms of publication volume in the field of urban green pedestrian systems from 1998 to 2023. Note: Panel (**a**) shows the institutional cooperation network among the top ten institutions, One color corresponds to one cluster (theme); Panel (**b**) compares their centrality and influence indicators.

In the author collaboration network for the field of urban green pedestrian systems, notable differences were observed among countries in both the frequency of collaboration and the degree of international engagement. Overall, China, the United Kingdom, and the United States maintain substantially higher numbers of collaborative publications than other countries, positioning them at the core of the global research network (Figure 7). China ranks first, with 219 collaborative publications, of which 58 are transnational collaborations (accounting for 26.5%), indicating a strong dominance of domestic collaboration. The United Kingdom and the United States follow with 95 and 82 collaborative publications, respectively. The United Kingdom's 29 international collaborative papers represent 30.5% of its total, exceeding the United States' 22 papers (26.8%), which reflects a relatively stronger inclination toward international cooperation. Although Spain (24 papers) and

Japan (20 papers) have comparatively fewer collaborative outputs, over 50% of their publications are the result of international collaboration. This proportion is far higher than that of high-output countries such as China, the United States, and India, suggesting that Spain (a European country) and Japan (an Asian country) place greater emphasis on cross-border cooperation and global knowledge exchange in this research area.

Table 2. Top 10 scholars by publication volume in the field of urban green pedestrian systems (1998–2023) and their academic influence.

Author	h_Index	TC	NP	PY_Start	Affiliated Institutions	Country of Affiliation
Veitch J	9	288	12	2017	Deakin University	Australia
Liu Y	7	547	12	2015	University of Copenhagen	Denmark
Lu Y	7	756	10	2018	City University of Hong Kong	Hong Kong
Giles-Corti B	9	850	9	2013	Royal Melbourne Institute for Technology University	Australia
Grazuleviciene R	7	460	9	2014	Vytauto Didziojo Universitetas (Vilnius University)	Lithuania
White MP	8	664	8	2013	University of Exeter	UK
Hooper P	7	532	8	2015	University of Western Australia	Australia
Timperio A	6	412	8	2013	Deakin University	Australia
de Vries S	7	1020	7	2012	Wageningen UR (University of Wageningen)	Netherlands
Gaston KJ	7	1027	7	2013	University of Exeter	UK

Note: The H-index reflects the combined measure of an author's productivity and citation impact. TC = Total citations; NP = Number of publications; PY_start = First year of publication in this field.

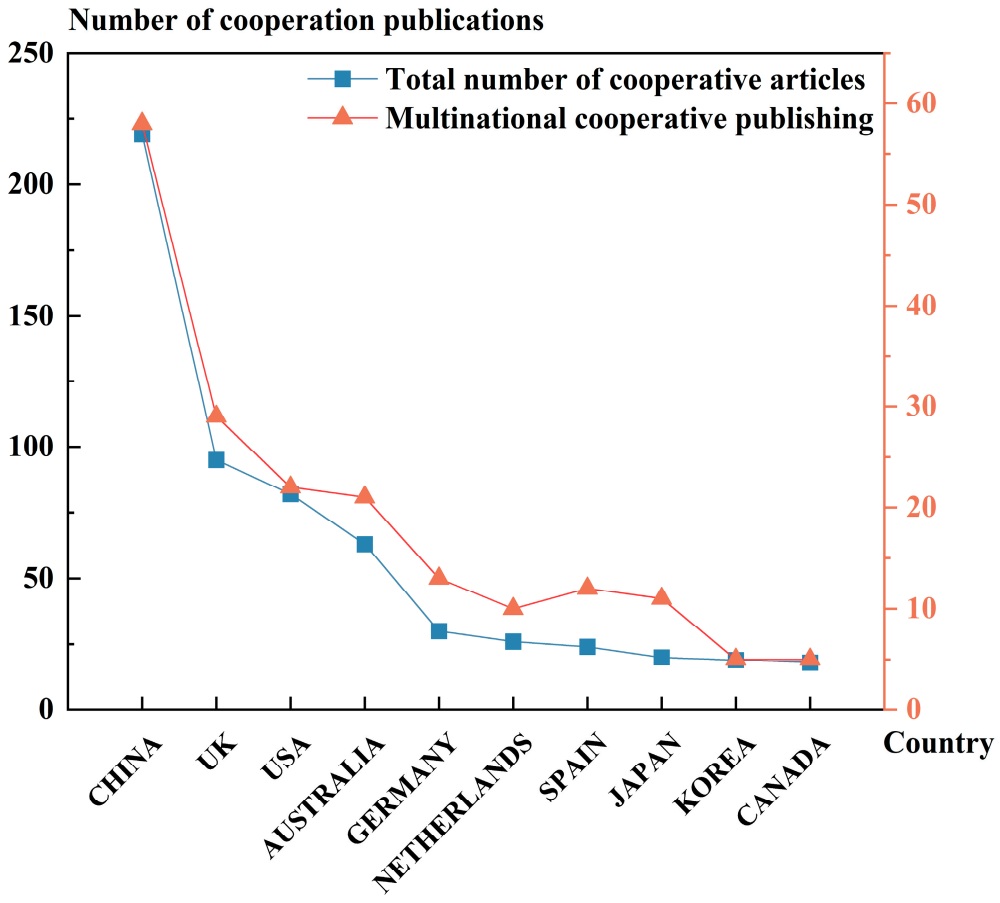

Figure 7. Total publications and cross-national collaborative publications by corresponding authors of different nationalities in the field of urban green pedestrian systems from 1998 to 2023.

4.3. Research Hotspots

4.3.1. Health Promotion Perspective: Emphasizing the Health Benefits of Walking

The high-frequency keyword analysis (Figure 7) elucidates the core thematic structure of research from a health promotion perspective. It is important to note that this analysis reflects the co-occurrence frequency of terms within the literature, representing the strength of associations between topics rather than direct causal relationships. Within this context, "Walking" (351 occurrences), "Physical activity" (286 occurrences), and "Health" (269 occurrences) constitute a central research triangle, indicating that contemporary scholarship is predominantly focused on the relationship between walking behaviors and health outcomes. The strong linkage between "Obesity" and "Physical activity" further confirms the efficacy of walking systems as interventions for obesity [46], particularly highlighting the critical role of the built environment in regulating residents' daily energy expenditure [47,48]. However, the keywords "Mental health" and "Well-being" together account for less than 8% of occurrences, while "Obesity" also appears relatively infrequently, suggesting that research attention to psychological health and specific health issues remains limited. Current studies on mental health are largely theoretical, lacking interdisciplinary empirical evidence addressing neurophysiological mechanisms, such as stress hormone regulation and emotional modulation. Accordingly, the field urgently requires systematic investigation into the multidimensional health benefits of walking systems, particularly through integrating existing empirical findings to clarify the specific pathways and intervention effects of green walking environments on mental health and targeted outcomes, including obesity.

4.3.2. Spatial Planning Perspective: Green Space Accessibility Dominates Design Logic

Optimization of built environment elements constitutes the technical foundation for implementing green walking systems. High-frequency keyword analysis (Figure 8) reveals that "Green space" (206 occurrences, 32.91%) occupies a central position, and its strong co-occurrence with "Accessibility" (127 occurrences, 20.29%) not only highlights the close conceptual interconnection between these terms but also underscores a core consensus in current research and planning practice: the spatial equity of green space provision—i.e., accessibility—is a critical prerequisite and guiding principle for achieving walkability. Accordingly, the results indicate that green space accessibility predominantly governs the spatial planning and design logic of green walking systems. Secondary hotspots, including "Built environment" (143 occurrences) and "Park" (122 occurrences), further refine the design dimensions, emphasizing macro-level factors such as street network density, park entrance placement, and continuity of pedestrian pathways.

The prominence of keywords such as "Green space" and "Accessibility" closely aligns with design models proposed by Alexander and Mehaffy, including "green streets," accessible green spaces, and urban greenways, reflecting strong coherence between theoretical frameworks and empirical research [37,38]. This consistency not only demonstrates the applicability of pattern language theory in guiding green walking system design but also reveals the intrinsic linkage between macro-scale spatial patterns and walkability.

Nevertheless, the relatively low frequency of "Urban design" (28 occurrences, 4.47%) highlights a current research limitation: most studies remain heavily dependent on GIS-based spatial analysis, lacking quantitative investigations of ergonomic parameters such as pavement materials, shading coverage, and visual permeability. This limitation is partly due to the availability constraints of existing datasets, as conventional GIS sources rarely provide street-level, multi-temporal, and attribute-rich microenvironmental data. To address this gap, future research should focus on developing metadata repositories specifically tailored for urban environments, integrating multi-source data including street-view imagery, remote

sensing, IoT sensors, and participatory geographic information. Such repositories should enable semantic description, standardized coding, and spatially explicit management of microenvironmental elements, thereby supporting fine-grained analysis and optimization of green walking systems across material, ecological, and sensory dimensions.

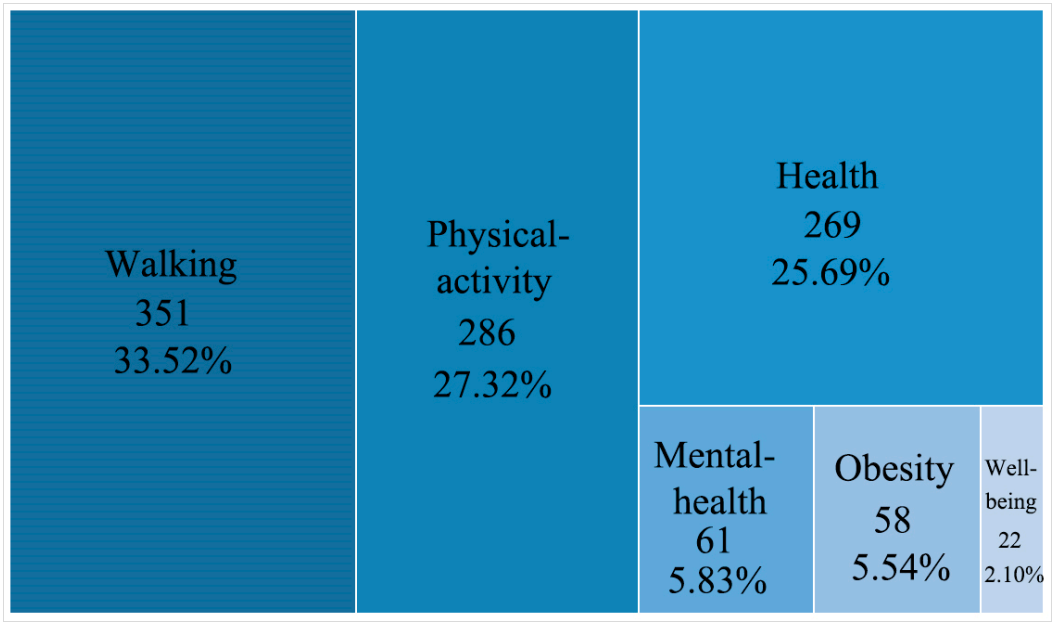

Figure 8. Distribution of high-frequency keywords related to health promotion in the field of urban green pedestrian systems. Note: The rectangular areas represent the frequency and proportion of different keywords in the relevant literature.

In conclusion, the field urgently requires more systematic investigation of micro-level design indicators to advance the planning and implementation of green walking systems.

4.3.3. Social Equity Perspective: Environmental Justice and Group Differences

The distribution of social-dimension hotspots (Figure 9) demonstrates a marked polarization: "Equity" (47 occurrences, 28.83%) and "Environmental justice" (44 occurrences, 26.99%) together account for over 55%, underscoring the scholarly focus on resource allocation inequalities, particularly the potential health disparities resulting from insufficient walking resources in low-income communities. Nevertheless, research targeting specific population groups remains limited: the combined occurrences of "Children" (25) and "Older adults" (20) represent less than 25% of the total sample, with most studies confined to theoretical advocacy.

In addition, the keyword "Perceived safety," which reflects critical determinants of walking behavior, appears only 14 times, revealing a notable gap in empirical investigations of nighttime safety perceptions among women, individuals with disabilities, and other vulnerable populations. The co-occurrence patterns of these keywords indicate that, despite widespread acknowledgment of social equity and justice principles, in-depth empirical analyses of diverse social groups' actual experiences, perceived barriers, and differentiated needs within green walking systems remain scarce. Therefore, the field urgently requires more nuanced research focused on heterogeneous user groups and comprehensive, perception-driven analyses to inform the equitable design and planning of green walking environments.

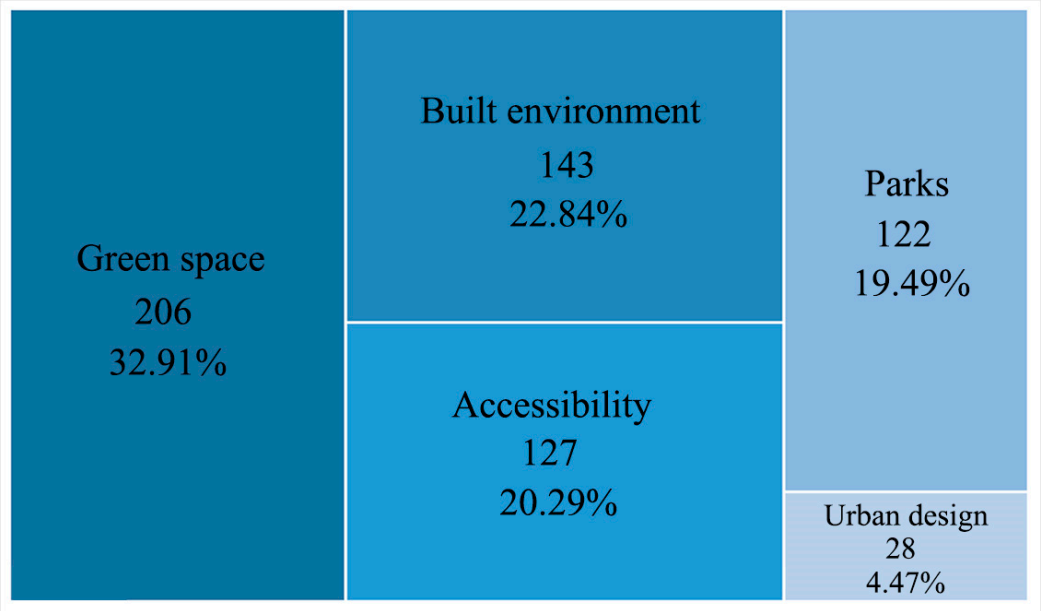

Figure 9. Distribution of high-frequency keywords from the spatial planning perspective in the field of urban green pedestrian systems. Note: The rectangular areas represent the frequency and proportion of different driving factors in the relevant literature.

4.4. Evolutionary Trajectory of Research Themes

4.4.1. Drivers of Evolution

(1) Policy Shifts

Between 1998 and 2016, national development strategies prioritized rapid infrastructure expansion and urban sprawl, with policies emphasizing the establishment of foundational walking networks. Consequently, research on the "built environment" and "accessibility" gradually emerged, providing institutional support for the initial development of urban walking systems [49]. From 2017 onward, strengthened global environmental governance prompted a policy shift toward greener and more ecological urban development [50,51], elevating "green space" as a critical component of urban spatial governance and drawing attention to its functional value within walking systems [52]. Between 2021 and 2023, policy emphasis on sustainable development further intensified, highlighting the role of walking systems in promoting public health and urban sustainability, which accelerated research on "health" and "physical activity" [53]. Simultaneously, more refined urban design requirements stimulated scholarly investigation into micro-level environmental factors such as paving materials and shading coverage [54].

(2) Societal Context Shifts

Socioeconomic development has significantly transformed residents' lifestyles. Early research focused on basic commuting needs, relying predominantly on macro-level descriptive analyses. In recent years, escalating traffic congestion, environmental pollution, and heightened public health awareness have driven research on physical activity and obesity prevention [55], alongside growing attention to "mental health" [56] and "well-being" [57], shifting studies from theoretical speculation toward empirical validation. The differentiated needs of specific populations, such as children and older adults, have stimulated research on "perceived safety" [58] and "equity" [59]. Concurrently, rising demand for recreational use of parks and other green spaces [60] has reinforced studies exploring the interrelationship between "green space" and "accessibility."

(3) Technological Advancements

Recent advances in big data and IoT technologies have provided novel data sources and methodological support for studying urban green walking systems. Integration of GIS and remote sensing has enabled high-precision identification and quantification of spatial patterns in "green space" and the "built environment," transforming "accessibility" research from conceptual discussions to fine-grained spatial metrics and improving the accuracy of built environment characterizations. This technological progress underpinned the rapid development of accessibility-focused research on green spaces between 2017 and 2020 [61]. The widespread adoption of wearable devices and mobile technologies has facilitated large-scale collection of walking behavior data, supporting empirical studies on the relationship between physical activity and walking environments. Moreover, emerging data sources such as street-view imagery and participatory geographic information have allowed more detailed characterization of micro-level walking environment quality across diverse communities, extending "environmental justice" analyses from macro-scale spatial equity to perceptual experience and actual usage equity [62]. At the micro-design scale, IoT sensors and remote-sensing-based microclimate simulations enable objective quantification of parameters affecting human comfort, such as pavement thermal performance, shading, and visual permeability, providing critical technical pathways to overcome traditional GIS limitations and achieve refined, human-centered urban design.

4.4.2. Evolutionary Trends

Combining annual publication trends with temporal keyword co-occurrence analysis, the evolution of research on urban green walking systems can be divided into three distinct stages, each characterized by core keyword clusters that reflect shifting research paradigms and focal areas.

(1) 1998–2016: Exploration and Foundational Construction

Research during this period was diverse, centering on the "built environment" and emphasizing foundational elements of "accessibility," including connectivity of walking networks and facility integration [63]. Studies on "walking" were largely descriptive at the macro level, with limited exploration of micro-level mechanisms [64]. Social equity considerations emerged, primarily focusing on spatial disparities in "equity" [65]. The "perception" theme began to appear, emphasizing residents' subjective experiences of walking environments, including satisfaction, safety, and convenience [66]. Built environment studies concentrated on physical elements such as building density and street morphology, while broader topics like "environments" and "walking" lacked systematic theoretical frameworks. "Green space" and "health" had yet to become central research themes. This stage can be characterized as "function-oriented foundational exploration."

(2) 2017–2020: Focused Deepening

During this stage, "green space" became the central research theme, with increasing focus on its functional integration with walking systems [67]. Parks, as key spatial carriers, were investigated in terms of their configuration and interaction with walking activities [68]. Walking research became more nuanced, addressing diverse forms such as recreational, commuting, and fitness-related walking and their interaction with green spaces. Accessibility studies, supported by GIS and related technologies, became more precise, emphasizing spatial distribution characteristics from a green space perspective [69]. Health-focused research highlighted the role of green space in promoting "physical activity" [70]. Social equity considerations incorporated the concept of "environmental justice," examining the spatial fairness of green space distribution and associated facilities [71]. This stage can be defined as "ecology-health-focused deepening."

(3) 2021–2023: Integrated Expansion

Research in this stage progressively established a comprehensive framework centered on "green space," with dual axes of "health" and "equity" [72]. Health research expanded to multidimensional assessments encompassing "physical activity" [73], "mental health" [74], and "obesity" [75]. Micro-level urban design studies emerged, integrating ecological functions of green space into built environment analyses and emphasizing their contribution to urban environmental sustainability [76]. At the macro-city scale, research explored synergies between walking systems and urban transport, land use, and ecological protection. Social equity research became more granular, addressing fair access for specific populations such as "children" and "older adults" [77]. "Perceived safety" emerged as a key determinant of walking willingness, with research increasingly focused on balancing comprehensive benefits and urban sustainability objectives [78]. This stage is characterized by a "human-centered, multi-objective integrated expansion."

5. Discussion

5.1. Knowledge Evolution and Paradigm Shift in Urban Walking System Research: From Functional Construction to Ecological Integration

Firstly, regarding the developmental characteristics of urban green walking system research, this study identifies a clear three-stage evolution model: "emergence–growth–stabilization." Notably, by employing the standardized metric of "collaboration intensity per publication," we reveal a misalignment between the volume and density of scientific collaboration. While China and the United States are in the lead in absolute publication counts and total collaboration, countries such as Spain and Finland demonstrate higher international collaboration activity relative to output. This finding highlights that evaluating a nation's research influence should extend beyond output scale to consider integration and efficiency within global knowledge networks. High-output countries should therefore not only sustain academic productivity but also cultivate deeper and broader international research collaborations.

Secondly, concerning the structure of research themes, keyword co-occurrence analysis indicates that the knowledge framework of this field is highly concentrated around three interrelated dimensions: "health promotion," "spatial planning," and "social equity" (Figures 8–10). However, significant imbalances persist among these hotspots. Core health-related topics such as "walking" and "physical activity" are extensively explored, whereas deeper outcomes, including "mental health" and "well-being," remain underexamined. Macro-level planning concepts like "green space" and "accessibility" dominate, while micro-level urban design parameters—such as paving materials and shading coverage—receive limited attention (Table A1). Principles of "equity" and "environmental justice" are widely discussed, yet empirical studies addressing perceived safety and the differentiated needs of vulnerable groups—children, older adults, and women—remain scarce. These imbalances suggest that future research should transition from broad exploration to in-depth investigation, targeting underdeveloped areas to construct a more balanced and comprehensive knowledge system.

Finally, with respect to research trends and paradigm shifts, thematic evolution analysis delineates a trajectory from "functional construction" to "ecological integration" and ultimately toward "comprehensive benefits." The field is progressively shifting from early attention on the basic functions of physical space to an integrated consideration of ecological elements within walking systems, and finally toward a focus on their broader contributions to human health, social equity, and urban sustainability. This paradigm shift underscores that future advances will depend on genuine interdisciplinary integration, particularly by incorporating perspectives and methodologies from environmental psychology, public

health, and data science into conventional urban planning and design research to address increasingly complex urban challenges.

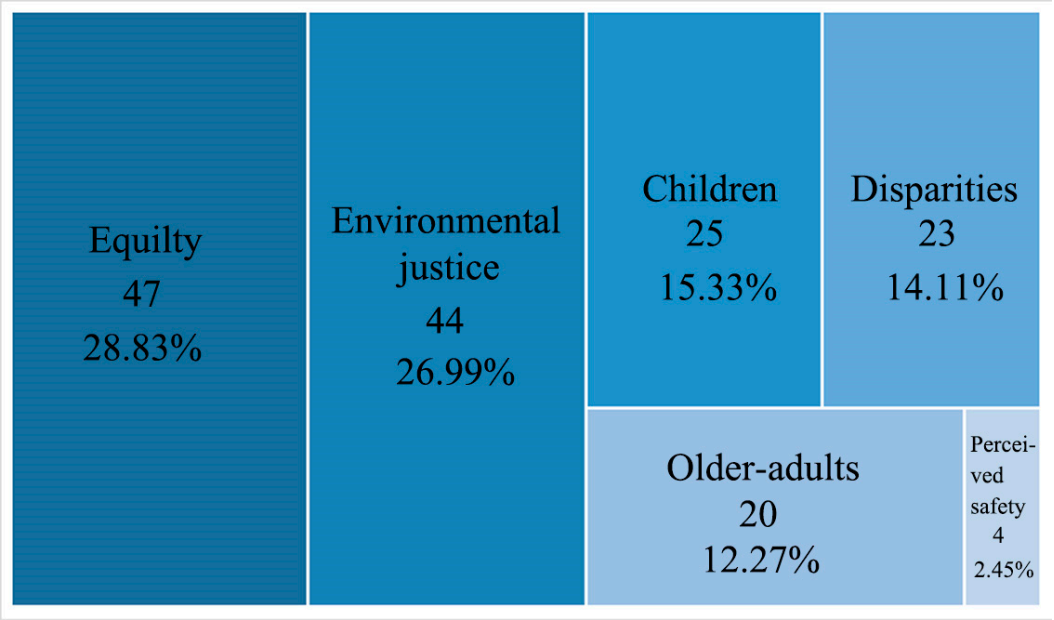

Figure 10. High-Frequency Keyword Distribution from the Social Equity Perspective in the Field of Urban Green Walking Systems. Note: The rectangular areas represent the frequency and proportion of different drivers in the relevant literature.

5.2. Research Limitations

This study has several inherent limitations regarding data sources, analytical approaches, and research design, which should be considered when interpreting the findings and extrapolating their applicability. First, the analysis is solely based on the Web of Science (WoS) database. While WoS is widely recognized for its authority and representativeness, its coverage is inherently selective. It predominantly indexes English-language mainstream journals, offering limited representation of regional publications, niche topics, interdisciplinary studies, and non-English literature. Additionally, the database updates with a time lag, constraining its ability to fully capture the most recent research developments. Despite extensive testing and expert consultation to construct a robust composite search query, keyword-based retrieval remains susceptible to terminological variations and indexing rules, potentially omitting semantically relevant studies expressed using alternative terms and thereby affecting the dataset's comprehensiveness and representativeness.

Second, bibliometric analysis using Bibliometrix relies primarily on conventional quantitative indicators, including publication counts, citation frequencies, and author or journal distributions. While these metrics effectively illustrate research structures and developmental trends, they are insufficient to fully capture research innovation and broader scholarly influence. In interdisciplinary fields such as urban green walking systems, the significance of novel methodological approaches or pioneering contributions may not be reflected in early citation counts, resulting in potential underestimation of their academic impact. Moreover, co-occurrence and co-citation analyses primarily reveal patterns of knowledge association but lack the capacity to model or test causal mechanisms among multidimensional factors, limiting insights into the intrinsic logic and evolution of research themes.

Finally, the study design focuses on bibliometric methods without fully integrating gray literature, policy documents, or field-based survey data, restricting the scope of knowledge acquisition. Insufficient consideration of regional cultural contexts and socioeconomic heterogeneity further constrains the applicability and generalizability of some

conclusions. The lack of comprehensive assessment of methodological innovation, problem relevance, and practical effectiveness also diminishes the ability of bibliometric findings to inform emerging research and policy practices. Future research could address these limitations by employing multi-database retrieval strategies (e.g., Scopus, Google Scholar, and leading Chinese databases), incorporating gray literature and policy texts, combining qualitative approaches with quantitative modeling, and systematically integrating regional heterogeneity and practice-based feedback, thereby enhancing the comprehensiveness, rigor, and practical relevance of the insights.

5.3. Practical Implications

The development of urban green walking systems is strongly influenced by local socio-economic conditions, natural endowments, and cultural context. To elucidate the diverse pathways through which these systems contribute to urban sustainability, this study classifies global case studies into developed and developing country contexts. This distinction enables a comparative assessment of priorities, core strategies, and sustainability dimensions under different resource conditions and development stages, providing context-sensitive insights for localized urban implementation.

5.3.1. Developed Countries: System Integration and Quality Optimization

In developed countries, where infrastructure is relatively advanced and public participation is high, green walking system practices prioritize network integration, ecological function enhancement, and cultural quality improvement, aiming to achieve the synergistic objectives of sustainable urban development.

Copenhagen, Denmark, represents a benchmark for green mobility systems. Its dense, coherent pedestrian network efficiently connects urban functional zones and integrates seamlessly with public transport, substantially improving accessibility and convenience. This approach aligns with Michael Mehaffy's Mode 2.1, demonstrating the value of multimodal integration through coordinated walking, cycling, and transit networks, 300-m walking-priority zones, and traffic-calmed streets [38]. The synergy of pedestrian and cycling infrastructure fosters a safe, comfortable slow-mobility environment and promotes green travel. This case underscores the importance of integrating multiple transport modes to optimize pedestrian networks, reduce traffic congestion, and lower carbon emissions [79,80].

Amsterdam, the Netherlands, highlights the integration of historical preservation with modern pedestrian systems. While retaining traditional street layouts and building textures, planners designed pathways to enable immersive cultural experiences. The integration of street trees and green spaces follows Christopher Alexander's Mode 51 "Green Streets," enhancing comfort and ecological function [37]. Parks, green spaces, and pedestrian paths form a composite green system, improving accessibility and urban attractiveness. This example demonstrates that green walking systems serve as both transportation infrastructure and cultural carriers, strengthening place identity and historical continuity [81,82].

Singapore, as a "Garden City," embeds green walking systems into the urban fabric. Linear park networks connect functional zones, with pedestrian pathways serving as ecological corridors, supplemented by shaded rest areas to ensure environmental comfort. This approach aligns with Mehaffy's Mode 3.1, where elevated greenways traverse traffic arteries to ensure citywide pedestrian connectivity [38]. Integration with transit, commercial centers, and residential areas promotes seamless "door-to-door" green mobility. Large-scale vegetation and seasonal flowers enhance esthetic experience, illustrating that pedestrian systems should balance ecological function, landscape quality, and daily mobility to improve urban livability [83].

5.3.2. Developing Countries: Adaptive Innovation Under Resource Constraints

In developing countries, green walking system initiatives emphasize adaptive innovation, prioritizing efficient resource use, integration with major infrastructure, and leveraging local cultural assets under constraints.

In Chengdu, China, river and lake greenway networks connect parks, wetlands, and cultural landmarks, forming multifunctional systems for recreation, fitness, and cultural engagement. Community coverage radii of 400–500 m follow Christopher Alexander's Mode 60 "Accessible Green Space" principle, ensuring daily accessibility for residents [37]. Chengdu's experience demonstrates how ecological and cultural resource integration can enhance urban connectivity, improve residents' quality of life, and advance ecological city concepts [84].

Curitiba, Brazil, exemplifies coordination between bus rapid transit (BRT) and pedestrian networks, creating a synergistic model of public transport and green mobility. This approach aligns with Mehaffy's Mode 2.1, and street tree spacing of 5–6 m reflects Mode 8.3, strengthening the integration of greenery with transport infrastructure [38]. Vegetative corridors and ecological restoration improved microclimates and air quality. Curitiba illustrates that in developing contexts, pedestrian systems should advance alongside public transport to enhance mobility efficiency and ecosystem services [85].

In Kuala Lumpur, Malaysia, land scarcity prompted vertical pedestrian systems, connecting commercial areas, public facilities, and transport nodes via elevated walkways and underground passages. Shaded tree zones align with Christopher Alexander's Mode 171 "Under-Tree Spaces," mitigating hardscape intensity and encouraging pedestrian linger [37]. Integration of traditional Malay architectural elements and artistic patterns enhanced cultural identity and esthetic experience. This case demonstrates that even under resource limitations, spatial innovation and cultural adaptation can expand system functionality and urban identity [86].

Overall, developed countries focus on quality enhancement through system integration and fine-scale design on established infrastructure, while developing countries emphasize strategic integration and adaptive design to address sustainability gaps and equity challenges. These diverse practices highlight that successful green walking system implementation is context-dependent, requiring dynamic, localized balancing across ecological, social, and economic dimensions. Collectively, they provide valuable theoretical and practical guidance for urban implementation across varied contexts.

6. Conclusions

This study systematically reviewed literature on urban green walking systems published in the Web of Science Core Collection from 1998 to 2023 using Bibliometrix, revealing the evolution of research trends and thematic foci. Publication outputs show a sustained growth pattern, progressing through three stages: emergence, rapid expansion, and stable development, indicating increasing scholarly attention. Globally, 67 countries (or regions) contributed to this field. China leads in publication volume, Australia demonstrates notable academic influence, and countries such as Japan and Spain play important roles in fostering international collaboration and knowledge integration.

Thematic evolution demonstrates a clear shift from exploratory studies to in-depth, focused research. Early studies primarily examined the relationship between walking behavior and the built environment. During the intermediate stage, GIS and other technological tools enabled detailed analyses of green space and accessibility. More recently, research has expanded to investigate the integrated impacts of green walking systems on health, equity, and urban sustainability. High-frequency keyword analysis further highlights three interrelated knowledge dimensions: (i) a health-promoting perspective

centered on "walking," "physical activity," and "health"; (ii) a spatial planning perspective dominated by "green space," "accessibility," and "built environment"; (iii) a social equity perspective emphasizing "equity," "environmental justice," and vulnerable population groups, including children and older adults.

These thematic hotspots are not merely theoretical but are reflected in urban practice. For instance, Copenhagen's multimodal transport integration aligns with the co-occurrence of "health" and "accessibility," while Singapore's linear park networks correspond to "green space" and "urban design." Similarly, Chengdu's greenway system and Curitiba's BRT-integrated pedestrian network illustrate how green spaces can simultaneously support recreational, commuting, and equity objectives. Case studies confirm that successful green walking systems systematically implement these core research themes, enhancing urban livability and resilience across diverse contexts.

From an academic perspective, urban green walking systems are essential for three reasons: (i) they promote sustainable urban development by linking ecological functions with urban structures, mitigating heat islands, and reducing transport-related carbon emissions; (ii) they provide effective public health interventions, encouraging physical activity and preventing chronic diseases; (iii) they advance social equity by ensuring fair access to walking infrastructure and mitigating health disparities. Thus, green walking systems transcend basic mobility functions, emerging as integrated urban infrastructure that simultaneously addresses ecological, health, and equity goals, directly contributing to urban sustainability and residents' quality of life.

Despite these insights, limitations remain regarding data sources, methodological approaches, and geographic representation. Future research should expand multi-source datasets, develop multidimensional evaluation frameworks, advance interdisciplinary methodologies, and conduct comparative analyses across regions. In practice, policymakers should integrate green walking systems into core urban strategies, emphasizing fine-scale environmental design, inclusive access for vulnerable groups, and smart management enabled by digital technologies. The integration of research and practice will support the development of higher-quality, more applicable, and impactful green walking systems worldwide.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author. The bibliometric data were self-extracted from the Web of Science Core Collection database.

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

Appendix A

Table A1. Keyword clustering and core metric indicators.

	Cluster	Betweenness	Closeness	PageRank	Frequency
walking	1	52.745	0.02	0.077	351
physical activity	1	38.02	0.02	0.066	286
health	1	31.46	0.02	0.059	269
mental health	1	1.201	0.018	0.017	61
obesity	1	0.729	0.016	0.016	58
well-being					22
green space	1	20.178	0.02	0.047	206
built environment	1	5.261	0.019	0.033	143
accessibility	2	5.957	0.019	0.031	127
parks	3	7.719	0.02	0.031	122
urban design					28
equity	2	0.638	0.016	0.013	47
environmental justice	2	0.403	0.015	0.012	44
children					25
disparities					23
older adults					20
perceived safety					4

References

1. Blacklock, R.E.; Rhodes, R.E.; Brown, S.G. Relationship Between Regular Walking, Physical Activity, and Health-Related Quality of Life. *J. Phys. Act. Health* **2007**, *4*, 138–152. [CrossRef] [PubMed]
2. Tan, R.; Wu, Y.; Zhang, S. Walking in Tandem with the City: Exploring the Influence of Public Art on Encouraging Urban Pedestrianism within the 15-Minute Community Living Circle in Shanghai. *Sustainability* **2024**, *16*, 3839. [CrossRef]
3. Willberg, E.; Fink, C.; Klein, R.; Heinonen, R.; Toivonen, T. 'Green or short: Choose one'—A comparison of walking accessibility and greenery in 43 European cities. *Comput. Environ. Urban Syst.* **2024**, *113*, 102168. [CrossRef]
4. Cobbinah, P.B.; Finn, B.M. On Pedestrian Accessibility: Spatial Justice and Progressive Planning in African Cities. *J. Plan. Lit.* **2025**, *40*, 170–184. [CrossRef]
5. Ou, Y.; Zheng, J.; Liang, Y.; Bao, Z. When green transportation backfires: High-speed rail's impact on transport-sector carbon emissions from 315 Chinese cities. *Sustain. Cities Soc.* **2024**, *114*, 105770. [CrossRef]
6. Fan, Z.; Zhan, Q.; Liu, H.; Wu, Y.; Xia, Y. Investigating the interactive and heterogeneous effects of green and blue space on urban PM2.5 concentration, a case study of Wuhan. *J. Clean. Prod.* **2022**, *378*, 134389. [CrossRef]
7. Li, M.; Liu, H. Enhancing the cooling effect of urban green infrastructure: An empirical analysis of interactive impacts and optimizing pathways over 310 Chinese cities. *Landsc. Urban Plan.* **2025**, *259*, 105344. [CrossRef]
8. Lwin, K.K.; Murayama, Y. Modelling of urban green space walkability: Eco-friendly walk score calculator—ScienceDirect. *Comput. Environ. Urban Syst.* **2011**, *35*, 408–420. [CrossRef]
9. Wu, Y.; Zhan, Q.; Quan, S.J. Improving local pedestrian-level wind environment based on probabilistic assessment using Gaussian process regression. *Build. Environ.* **2021**, *205*, 108172. [CrossRef]
10. Zhang, S.; Adam, M.; Ghafar, N.A. How Satisfaction Research Contributes to the Optimization of Urban Green Space Design—A Global Perspective Bibliometric Analysis from 2001 to 2024. *Land* **2024**, *13*, 1912. [CrossRef]
11. Huang, Z.; Jia, Q.; Luo, S.; Tu, Z.; Zhao, L.; Li, S.; Lu, Z. Static and dynamic assessments of park accessibility and equity across different living circles in shenzhen's core area. *Environ. Res. Commun.* **2025**, *7*, 025011. [CrossRef]
12. Pan, H.; Luo, Y.; Zeng, L.; Shi, Y.; Hang, J.; Zhang, X.; Hua, J.; Zhao, B.; Gu, Z.; Buccolieri, R. Outdoor Thermal Environment Regulation of Urban Green and Blue Infrastructure on Various Types of Pedestrian Walkways. *Atmosphere* **2023**, *14*, 1037. [CrossRef]
13. Janik, A.; Ryszko, A.; Szafraniec, M. Scientific Landscape of Smart and Sustainable Cities Literature: A Bibliometric Analysis. *Sustainability* **2020**, *12*, 779. [CrossRef]
14. Aria, M.; Cuccurullo, C. bibliometrix: An R-Tool for Comprehensive Science Mapping Analysis. *J. Informetr.* **2018**, *11*, 959–975. [CrossRef]
15. Godin, B. On the origins of bibliometrics. *Scientometrics* **2006**, *68*, 109–133. [CrossRef]

16. Guo, Y.M.; Huang, Z.L.; Guo, J.; Li, H.; Guo, X.R.; Nkeli, M.J. Bibliometric Analysis on Smart Cities Research. *Sustainability* **2019**, *11*, 3606. [CrossRef]
17. Ding, Y.; Chowdhury, G.G.; Foo, S. Bibliometric cartography of information retrieval research by using co-word analysis. *Inf. Process. Manag.* **2001**, *37*, 817–842. [CrossRef]
18. Rodríguez, M.S.; Alvarez, A.M.O.; Arango-Vasquez, L. Worldwide trends in the scientific production on soccer players market value, a bibliometric analysis using bibliometrix R-tool. *Team Perform. Manag. Int. J.* **2022**, *28*, 415–440. [CrossRef]
19. Wang, X.; Yin, Z. Coupling Vitality Simulation of Pedestrian System in Subway-Transit Area Based on Walkability. In Proceedings of the 18th Conference of the Associated research Centers for the Urban Underground Space, Singapore, 1–4 November 2024.
20. Ma, L.; Brandt, S.A.; Seipel, S.; Ma, D. Evaluating neighborhood roads through agent-based modelling: A step towards the optimal pedestrian desire path system. *Expert Syst. Appl.* **2025**, *266*, 125782. [CrossRef]
21. Zagorskas, J.; Turskis, Z. Enhancing Sustainable Mobility: Evaluating New Bicycle and Pedestrian Links to Car-Oriented Industrial Parks with ARAS-G MCDM Approach. *Sustainability* **2024**, *16*, 2994. [CrossRef]
22. Wang, A.; Fu, N.; Ren, C. City for people or vehicles? Urgent need for safe and healthy walking system in high-density cities under climate change. *Indoor Built Environ.* **2025**, *34*, 687–691. [CrossRef]
23. Dushkova, D.; Taherkhani, M.; Konstantinova, A.; Vasenev, V.I.; Dovletyarova, E.A. Understanding Factors Affecting the Use of Urban Parks Through the Lens of Ecosystem Services and Blue–Green Infrastructure: The Case of Gorky Park, Moscow, Russia. *Land* **2025**, *14*, 237. [CrossRef]
24. Tang, L.; Zhan, Q.; Liu, H.; Fan, Y. Impact of Internal and External Landscape Patterns on Urban Greenspace Cooling Effects: Analysis from Maximum and Accumulative Perspectives. *Buildings* **2025**, *15*, 573. [CrossRef]
25. Xu, R.; Chen, Y.; Chen, Z.; Guo, D.; Zhao, Z. Constructing underground pedestrian networks: A model based on the source-sink theory and a case study of Xinjiekou in Nanjing City, China. *Tunn. Undergr. Space Technol.* **2024**, *154*, 12. [CrossRef]
26. Park, R.E. The City: Suggestions for the Investigation of Human Behavior in the Urban Environment. *Am. J. Sociol.* **1915**, *20*, 577–612. [CrossRef]
27. Jacobs, J. *The Death and Life of Great American Cities*; Vintage Books: New York, NY, USA, 2012.
28. Francis, G. Mapping our common future. *Lancet* **2021**, *397*, 871. [CrossRef]
29. Zhang, Z.; Lu, C.; Cui, G.; Meng, X.; Gong, C.; Gong, J. Prediction of Pedestrian Spatial-Temporal Risk Levels for Intelligent Vehicles: A Data- Driven Approach. *IEEE Trans. Veh. Technol.* **2024**, *73*, 7708–7721. [CrossRef]
30. Pazzini, M.; Cameli, L.; Vignali, V.; Simone, A.; Lantieri, C. Video-Based Analysis of a Smart Lighting Warning System for Pedestrian Safety at Crosswalks. *Smart Cities* **2024**, *7*, 2925–2939. [CrossRef]
31. Yang, X.; Zhang, H.; Zhuang, Y.; Wang, Y.; Shi, M.; Xu, Y. uLiDR: An inertial-assisted unmodulated visible light positioning system for smartphone-based pedestrian navigation. *Inf. Fusion* **2025**, *113*, 102579. [CrossRef]
32. Guite, H.F.; Clark, C.; Ackrill, G. The impact of the physical and urban environment on mental well-being. *Public Health* **2006**, *120*, 1117–1126. [CrossRef]
33. Chan, H.Y.; Mansoor, U.; Su, J.; Chen, A. Walking in the city of footbridges: Sense of community, subjective walkability and walking habits in a layered neighborhood. *Travel Behav. Soc.* **2025**, *40*, 101049. [CrossRef]
34. Learnihan, V.; VAN Niel, K.; Giles-Corti, B.; Knuiman, M. Effect of Scale on the Links between Walking and Urban Design. *Geogr. Res.* **2011**, *49*, 183–191. [CrossRef]
35. Davidoff, P. *Securing Open Space for Urban America—Conservation Easements—Whyte, Wh*; Urban Land Institute: New York, NY, USA, 1960.
36. Xing, Z.N.; Jian, Y.K.; Fang, H.Z. Perspectives on greenway development. *Acta Ecol. Sin.* **2006**, *2006*, 3108–3116.
37. Alexander, C.; Ishikawa, S.; Silverstein, M. *A Pattern Language: Towns, Buildings, Construction (Center for Environmental Structure Series)*; Oxford University Press: Oxford, UK, 1977.
38. Mehaffy, M.W.; Kryazheva, Y.; Rudd, A.; Salingaros, N.A.; Gren, A.; Mehaffy, L.; Mouzon, S.; Petrella, L.; Porta, S.; Qamar, L.; et al. *A New Pattern Language for Growing Regions: Places, Networks, Processes*; Mijnbestseller.nl: Oxford, UK, 2020.
39. Searns, R.M. The evolution of greenways as an adaptive urban landscape form. *Landsc. Urban Plan.* **1995**, *33*, 65–80. [CrossRef]
40. Xu, B.; Shi, Q.; Zhang, Y. Evaluation of the Health Promotion Capabilities of Greenway Trails: A Case Study in Hangzhou, China. *Land* **2022**, *11*, 547. [CrossRef]
41. Gobster, P.H. Perception and use of a metropolitan greenway system for recreation. *Landsc. Urban Plan.* **1995**, *33*, 401–413. [CrossRef]
42. Ros-Mcdonnell, D.; de-la-Fuente-Aragón, M.V.; Ros-Mcdonnell, L.; Cardós, M. Toward Resilient Urban Design: Pedestrians as an Important Element of City Design. *Urban Sci.* **2024**, *8*, 65. [CrossRef]
43. Taher, H.; Elsharkawy, H.; Rashed, H.F. Urban Green Systems for Improving Pedestrian Thermal Comfort and Walkability in Future Climate Scenarios in London. *Buildings* **2024**, *14*, 651. [CrossRef]
44. Tan, K.W. A greenway network for singapore. *Landsc. Urban Plan.* **2006**, *76*, 45–66. [CrossRef]

45. Liu, L.; Cai, Y.; Jin, L.; Zhu, Y.; Gao, Y.; Ding, Y.; Xia, J.; Zhang, K. Landscape pattern optimization strategy of coastal mountainside greenway from a microclimatic comfort view in hot and humid areas. *Urban Clim.* **2022**, *46*, 101297. [CrossRef]
46. Herman, K.M.; Craig, C.L.; Gauvin, L.; Katzmarzyk, P.T. Tracking of obesity and physical activity from childhood to adulthood: The Physical Activity Longitudinal Study. *Int. J. Pediatr. Obes.* **2011**, *4*, 281–288. [CrossRef]
47. Roberts, M.J.; Johnson, W.; Qooja, S.; Moorthy, A.; Bishop, N.C. Combined associations of obesity and physical activity with pain, fatigue, stiffness and anxiety in adults with spondyloarthropathies: UK Biobank study. *Rheumatol. Adv. Pract.* **2024**, *4*, rkae109. [CrossRef]
48. Topping, K.J. Obesity and Physical Activity. In *Peer Interventions for Health and Wellbeing*; CRC Press: Boca Raton, FL, USA, 2025; pp. 132–142. [CrossRef]
49. Renne, J.L.; Hamidi, S.; Ewing, R. Transit commuting, the network accessibility effect, and the built environment in station areas across the United States. *Res. Transp. Econ.* **2016**, *60*, 35–43. [CrossRef]
50. Mell, I.C.; Allin, S.; Reimer, M.; Wilker, J. Strategic green infrastructure planning in Germany and the UK: A transnational evaluation of the evolution of urban greening policy and practice. *Int. Plan. Stud.* **2017**, *22*, 333–349. [CrossRef]
51. Dotsenko, E.; Ezdina, N.; Mudrova, S. Ecologization of Regional Industrial Complex in the Transition to Sustainable Development. *E3s Web Conf.* **2018**, *41*, 04050. [CrossRef]
52. Kondo, M.C.; Fluehr, J.M.; Mckeon, T.; Branas, C.C. Urban Green Space and Its Impact on Human Health. *Int. J. Environ. Res. Public Health* **2018**, *15*, 445. [CrossRef]
53. Mahindru, A.; Patil, P.; Agrawal, V. Role of Physical Activity on Mental Health and Well-Being: A Review. *Cureus* **2023**, *15*, e33475. [CrossRef]
54. Mccormack, G.R.; Koohsari, M.J.; Turley, L.; Nakaya, T.; Shibata, A.; Ishii, K.; Yasunaga, A.; Oka, K. Evidence for urban design and public health policy and practice: Space syntax metrics and neighborhood walking. *Health Place* **2021**, *67*, 102277. [CrossRef]
55. Renna, F.; Thakur, N. Direct and indirect effects of obesity on U.S. labor market outcomes of older working age adults. *Soc. Sci. Med.* **2010**, *71*, 405–413. [CrossRef]
56. Lee, Y.H.; Hwang, J. Walking for Mental Health: Effects of Mobile-Based Walking on Stress and Affectivity in College Students. *Int. J. Ment. Health Promot.* **2025**, *27*, 060685. [CrossRef]
57. Gatrell, A.C. Therapeutic mobilities: Walking and 'steps' to wellbeing and health. *Health Place* **2013**, *22*, 98–106. [CrossRef]
58. Boarnet, M.G.; Day, K.; Anderson, C.; Mcmillan, T.; Alfonzo, M. California's Safe Routes to School Program: Impacts on Walking, Bicycling, and Pedestrian Safety. *J. Am. Plan. Assoc.* **2005**, *71*, 301–317. [CrossRef]
59. Martinez-Gomez, D.; León-Muñoz, L.M.; Guallar-Castillon, P.; López-García, E.; Aguilera, M.T.; Banegas, J.R.; Rodríguez-Artalejo, F. Reach and equity of primary care-based counseling to promote walking among the adult population of Spain. *J. Sci. Med. Sport* **2013**, *16*, 532–538. [CrossRef]
60. Iamtrakul, P.; Teknomo, K.; Hokao, K. Walking and Cycling Behavior Within the Service Area of Public Parks. *J. East. Asia Soc. Transp. Stud.* **2008**, *6*, 225–240.
61. Zhou, X.; Kim, J. Social disparities in tree canopy and park accessibility: A case study of six cities in Illinois using GIS and remote sensing. *Urban For. Urban Green.* **2013**, *12*, 88–97. [CrossRef]
62. Kato-Huerta, J.; Geneletti, D. A distributive environmental justice index to support green space planning in cities. *Landsc. Urban Plan.* **2023**, *229*, 104592. [CrossRef]
63. Zielstra, D.; Hochmair, H. Comparative Study of Pedestrian Accessibility to Transit Stations Using Free and Proprietary Network Data. *Transp. Res. Rec. J. Transp. Res. Board* **2011**, *2217*, 145–152. [CrossRef]
64. Wagner, A.; Simon, C.; Ducimetière, P.; Montaye, M.; Bongard, V.; Yarnell, J.; Bingham, A.; Hedelin, G.; Amouyel, P.; Ferrières, J.; et al. Leisure-time physical activity and regular walking or cycling to work are associated with adiposity and 5 y weight gain in middle-aged men: The PRIME Study. *Int. J. Obes.* **2001**, *25*, 940–948. [CrossRef]
65. Porter, G. Living in a Walking World: Rural Mobility and Social Equity Issues in Sub-Saharan Africa. *World Dev.* **2002**, *30*, 285–300. [CrossRef]
66. Vinson, D.W.; Jordan, J.S.; Hund, A.M. Perceptually walking in another's shoes: Goals and memories constrain spatial perception. *Psychol. Res.* **2015**, *81*, 66–74. [CrossRef] [PubMed]
67. Xing, L.; Liu, Y.; Liu, X.; Wei, X.; Mao, Y. Spatio-temporal disparity between demand and supply of park green space service in urban area of Wuhan from 2000 to 2014. *Habitat Int.* **2018**, *71*, 49–59. [CrossRef]
68. Aliyas, Z.; Ujang, N.; Zandieh, M. Park Characteristics in Relation to Exercise and Recreational Walking. *Environ. Justice* **2019**, *12*, 218–225. [CrossRef]
69. Zannat, K.E.; Adnan, M.S.G.; Dewan, A. A GIS-based approach to evaluating environmental influences on active and public transport accessibility of university students. *J. Urban Manag.* **2020**, *9*, 331–346. [CrossRef]
70. Hooper, P.; Boruff, B.; Beesley, B.; Badland, H.; Giles-Corti, B. Testing spatial measures of public open space planning standards with walking and physical activity health outcomes: Findings from the Australian national liveability study. *Landsc. Urban Plan.* **2018**, *171*, 57–67. [CrossRef]

71. Ma, X.; Longley, I.; Gao, J.; Salmond, J. Evaluating the Effect of Ambient Concentrations, Route Choices, and Environmental (in)Justice on Students' Dose of Ambient NO_2 While Walking to School at Population Scales. *Environ. Sci. Technol.* **2020**, *54*, 12908–12919. [CrossRef]
72. Hansmann, K.; Grabow, M.; Mcandrews, C. Health Equity and Active Transportation: A Scoping Review of Active Transportation Interventions' Impact on Health Equity. *Ann. Fam. Med.* **2023**, *21*, 3657. [CrossRef]
73. Yu, J.; Yang, C.; Zhao, X.; Zhou, Z.; Zhang, S.; Zhai, D.; Li, J. The Associations of Built Environment with Older People Recreational Walking and Physical Activity in a Chinese Small-Scale City of Yiwu. *Int. J. Environ. Res. Public Health* **2021**, *18*, 2699. [CrossRef] [PubMed]
74. Wang, M.; Jiang, C.; Huang, Y.; He, X.; Deng, L. The Association of Outdoor Walking Per Week with Mental Health and Costs of Psychotropic Drugs in Adults. *J. Community Health* **2023**, *48*, 136–140. [CrossRef]
75. Gao, H.; Xu, Z.; Chen, Y.; Lu, Y.; Lin, J. Walking Environment and Obesity: A Gender-Specific Association Study in Shanghai. *Int. J. Environ. Res. Public Health* **2022**, *19*, 2056. [CrossRef]
76. Nabipour, M.; Nasseri, S.H.; Saber, E.T. Comparison and Evaluation of Built Environment Factors for Developing Pedestrian Urban Travels. *Fuzzy Inf. Eng.* **2021**, *13*, 505–521. [CrossRef]
77. Encho, H.; Uchida, K.; Horibe, K.; Nakatsuka, K.; Ono, R. Walking and perception of green space among older adults in Japan: Subgroup analysis based self-efficacy. *Health Promot. Int.* **2023**, *38*, daac175. [CrossRef] [PubMed]
78. Bao, Y.; Gao, M.; Luo, D.; Zhou, X. Urban Parks—A Catalyst for Activities! The Effect of the Perceived Characteristics of the Urban Park Environment on Children's Physical Activity Levels. *Forests* **2023**, *14*, 423. [CrossRef]
79. Andersen, C.W.; Kristensen, M.T. Danish Version of 10 Meter Walking Test Manual and Score Sheet. 2019. Available online: https://www.researchgate.net/publication/338095579_Danish_version_of_10_meter_walking_test_manual_and_score_sheetpdf?channel=doi&linkId=5dfdbc9792851c83648ddd3b&showFulltext=true (accessed on 11 September 2025).
80. Joergensen, C.H.; Krawack, S.; Soerensen, M.M.; Therkelsen, H. *Transport Planning and Policy: The Danish Experience*; United Nations: New York, NY, USA, 1993.
81. Ton, D.; Duives, D.C.; Cats, O.; Hoogendoorn-Lanser, S.; Hoogendoorn, S.P. Cycling or walking? Determinants of mode choice in the Netherlands. *Transp. Res. Part A Policy Pract.* **2018**, *123*, 7–23. [CrossRef]
82. Welleman, T. Chapter 13: The Dutch Bicycle Master Plan 1990–1996. In *the Greening of Urban Transport*, 2nd ed.; Wiley (John) & Sons: Hoboken, NJ, USA, 1997.
83. Kim, Y.; Sim, T.E.; Chua, Y.S.; Bakytuly, N.; Satyanaga, A.; Pu, J.H. Harnessing Green Cover Systems for Effective Slope Stabilization in Singapore. *Land* **2025**, *14*, 436. [CrossRef]
84. Wu, Q.; Dai, Y. Ecological Security Patterns Research Based on Ecosystem Services and Circuit Theory in Southwest China. *Sustainability* **2024**, *16*, 2835. [CrossRef]
85. Martins, R.D.A. Curitiba, Brazil. In *Green Cities: An A-to-Z Guide*; Sage Knowledge: Thousand Oaks, CA, USA, 2003. [CrossRef]
86. Karuppannan, S.; Baharuddin, Z.M.; Sivam, A.; Daniels, C.B. Urban Green Space and Urban Biodiversity: Kuala Lumpur, Malaysia. *J. Sustain. Dev.* **2013**, *7*, 1. [CrossRef]

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