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Review

Connecting Urban Green Spaces with Children: A Scientometric Analysis Using CiteSpace

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Abstract: In recent years, the interaction between urban green spaces (UGS) and children has been a popular direction in research on child-friendly cities. Keeping up with emerging trends and key turning points in the development of collective knowledge is crucial. In this study, a quantitative analysis of publications related to UGS and children published in the Web of Science (WoS) core collection between 1980 and February 2022 was conducted by means of scientometric methods. Then, it using CiteSpace (5. 8. R3, Chaomei Chen, Philadelphia, the U.S.) to visualize collaborative networks, co-citation networks, document clustering, and bursts of keywords in the database literature. The study results show a rapid increase in the number of publications in this field in recent years. The main driving forces in these studies were from the United States (262 publications), China (68), and Australia (65). A scientometric analysis of the literature on UGS and children's studies provides a unique and exciting snapshot of this field of knowledge. The findings offer the readers a general preliminary grasp of the research in the field. Research findings suggest that collaboration and analysis involving multiple disciplines, specialties, and perspectives will become a mainstream trend in the field. Our results may help researchers further identify potential views on collaborators, research frontiers, and topical issues.

Keywords: urban green space (UGS); children; CiteSpace; scientometric; visualization

Citation: Niu, Y.; Adam, M.; Hussein, H. Connecting Urban Green Spaces with Children: A Scientometric Analysis Using CiteSpace. *Land* **2022**, *11*, 1259. https://doi.org/10.3390/land11081259

Academic Editor: Zhonghua Gou

Received: 13 June 2022
Accepted: 3 August 2022
Published: 6 August 2022

1. Introduction

By 2018, 548 cities in the world had a population of more than 1 million. By 2030, it is estimated that there will be 706 cities with populations of more than 1 million [1]. The world's population will be highly concentrated in cities [2]. The phenomenon of urbanization has brought many benefits to modern societies that cannot be ignored, such as an increase in people's standard of living [3], healthcare [3,4], education [5], and life expectancy [4]. However, the rapid transition to urbanization is accompanied by many hazards to the urban environment. For example, the expansion of buildings leads to a reduction in urban ecological diversity and intensifies the heat island effect [6,7]. The lack of urban green space (UGS) leads to a sense of alienation from nature [8]. Lastly, the increase in traffic, congestion, and epidemics has led to a series of environmental problems related to unsustainable development [9,10]. In one way or another, the process of urban change affects all people integrated into the city, with children being one of the important stakeholders. This accelerated "urbanization" of the planet poses significant health and well-being challenges for children, including reduced physical activity [11,12] and increased exposure to air pollution, excessive noise, and hot climates [13–15].

UGS is the most accessible play space for children and is especially appealing to them. McKendrick [16] says the area shapes children's well-being and the environment in which they live: their immediate environment and the broader social sphere. The UGS dominated by nature creates spaces for everyone to share. The benefits of exposure to nature for the health and well-being of children are increasingly being demonstrated [17,18]. Some studies claim that children prefer natural environments more than adults [17,19]. Children's

nature-based experiences have great potential to reduce stress and promote better mental health [17,20].

UGS is formed through planning and design, and after that, the content and quality of the green space is shaped by its management and maintenance and the further development of the landscape [21]. Adequate open and green space and well-planned and designed urban areas are highly correlated with public perception [22]. UGS can significantly impact children's personal growth, social interaction, physical health, and well-being [23]. A specific basis for the right of children to connect with nature is contained in the Convention on the Rights of the Child issued by the United Nations in 1989: Article 29(1e), on developing respect for the natural environment as an aim of children's education [24]. Resolution 4.105 Communication, adopted at the Fourth IUCN World Conservation Congress (Barcelona, Spain, 2008), acknowledges the importance of connecting children to nature and states that "connecting children to nature as part of their everyday lives in meaningful ways tends to be a precursor to their growing up as adults with a passion and commitment to work actively in support of conservation of the environment and natural resources [25]". Since the concept of "child-friendly cities" was introduced by the United Nations Conference on Human Settlements: Habitat II in 1996 [24], the study of the relationship between UGS and children has received increased attention from researchers, and the results have been continuously developed and updated.

In academia, the review and examination of previous research work is valuable because advances in knowledge and theory at the frontiers of academic disciplines depend on the theoretical and empirical contributions of individual research efforts [26,27]. Therefore, as knowledge accumulates, regular analysis of the literature is necessary. However, searches of the Scopus and Web of Science (WoS) databases showed few review articles related to UGS and children's studies. McCormick [28] reviewed 12 publications on green space and children's mental health, which were cited 226 times. Vanaken and Danckaerts [29] reviewed 21 publications based on the psychological impact of UGS on children or adolescents. The articles summarized access to green space and improved children's mental health, overall health, and cognitive health development. The advantage of such literature review articles is that they allow for a fine-grained interpretation and analysis of the literature on the same topic. However, this review approach may also ignore the fundamental issues of a subject area [30,31]. Therefore, as a relatively young field of study, it is imperative to comprehensively review and analyze the evolution of the field of UGS and children's studies. With the current rapid growth in the field, it has become essential to identify and analyze the overall state of research related to UGS and children.

With the rapid development of computational and information visualization technologies, the combination of quantification and visualization can help us further our knowledge in specific fields. Scholars can discover hidden relationships and trends in the relevant literature. CiteSpace is a diverse, time-phased, and dynamic software for literature analysis. It can not only show the overall situation of a research field but also highlight some important literature in the development of the field [30,32]. It can effectively help readers to better understand the field of research they are working in. CiteSpace has been used in at least 50 countries and is constantly upgraded and updated with high reliability [30,33]. This study uses bibliometric citation and contribution analysis as a theoretical basis and CiteSpace as a visualization tool to analyze the scientific literature captured by WoS. The quantitative analysis and review of the existing literature allows for a macroscopic conception of the overall developmental characteristics and trends in UGS and children's research and allows for better access to a complete picture of the research field. The use of CiteSpace can outline the structure and dynamics of UGS and children's research.

Therefore, this study attempts to conduct a scientometric analysis of the literature related to the study of UGS and children through CiteSpace in order to accomplish the following research objectives:

1. Analyze the dominant authors, articles, institutions, and countries in the field of UGS and children's research.

2. Locate the major knowledge bases and research clusters in UGS and children's studies, explain the major studies' essential elements, and discern trending research topics.
3. Analyze changes in the field's focus since 1980 through co-citation clustering and keyword bursts to analyze the current evolving themes and areas of greater focus in the future.

2. Methods, Tools, and Materials

2.1. Scientometrics

Scientometrics is a branch of information science that allows for quantitative analysis of patterns in the scientific literature to understand emerging trends and knowledge structures in a field of study [34]. The concept of scientific knowledge mapping originated from a symposium organized by the National Academy of Sciences in 2003, which introduced the concept of mapping, mining, analyzing, ranking, navigating, and presenting knowledge [35]. Chaomei Chen then used this concept to develop CiteSpace, which uses scientific publications as inputs to describe the structure of knowledge in a network of co-cited references, and then presents the connections between research content in an interactive visual format. The visual images obtained by this method are called "scientific knowledge maps", which reveal the sources and level of knowledge development in a research field [36].

2.2. CiteSpace

CiteSpace is an information visualization software developed in the Java language. It is mainly based on the theory of communal factor analysis and pathfinder network scaling to measure domain-specific literature to explore the critical paths of scientific domain evolution and its intellectual turning points. As a scientific literature data mining and visualization software, it combines various clustering and social network analysis methods. Its novelty lies in analyzing the potential motives of scientific evolution and detecting the frontiers of scientific development through the betweenness centrality between the critical points of scientific literature.

Nodes and links are the most important components of the CiteSpace visualization graph. The node types include "Author, Institution, Country, Term, Keyword, Source, Category, Reference, etc." When using the software, we can select any specific time span, then select the node types for the input database, and finally, click "Go" to analyze the node and establish a "link" (Figure 1). Compared to earlier visualization tools, CiteSpace's visual analysis capabilities improve the clarity and interpretability of visualizations [30]. Professor Chen [30] particularly emphasized that the most important thing about using CiteSpace is that it allows users to map, generate, and interpret knowledge maps, which he believes will change the way people view the scientific world. In addition, Carrot2 developed by Audilio Gonzales, was used in this study to assist CiteSpace in visualizing the overall knowledge groups.

Co-citation analysis is an essential analysis function provided in CiteSpace to precisely find the important publications in a research field. When two (or more) papers are cited by one or more later papers simultaneously, the two papers are said to constitute a co-citation relationship. Second, from the co-citation knowledge graph, we can also visualize the connections between the literature. The more closely linked nodes in the co-citation mapping indicate that they are often cited in the same literature, appearing together in multiple later publications. Since the literature appears together, it conveys an important message that these co-cited articles must be similar in content. Therefore, the intensity of the co-citation of articles appearing in the references becomes greater. The higher the co-citation value, the greater the similarity in content between the two, and the stronger the connection between them [30,34,35].

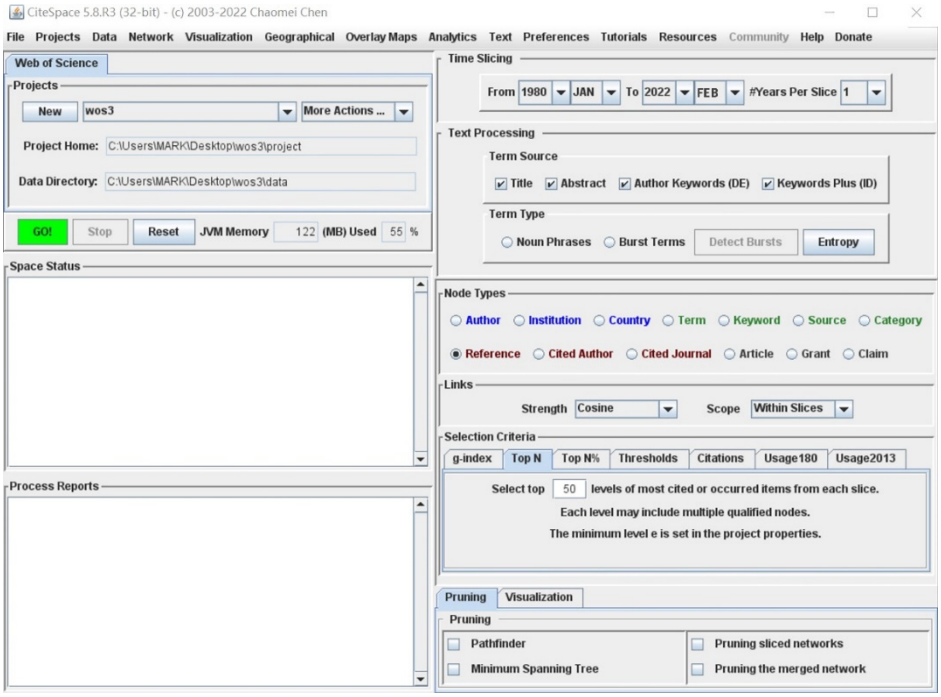

Figure 1. The operating interface of CiteSpace.

CiteSpace provides two metrics, Modularity (Q) and Silhouette (S), based on the clarity of network structures and clustering, which can be used as a basis for us to judge the effectiveness of mapping. Modularity (Q) is a value from 0 to 1. $Q \geq 0.3$ indicates a high degree of modularity in the network, and those closer to 1 show closer relationships and connections within the cluster. Silhouette (S) is used to measure the homogeneity of the network, and the clustering is generally considered reasonable when $S > 0.5$. If at $S > 0.7$, the clustering effect is considered convincing [30,35].

2.3. Citespace Settings and Analysis Paths

We first set the period for the analysis, with time slices ranging over 42 years, from 1980 to 2022. We chose to use one year as the time slice, which helps to provide a more detailed overview of studies and themes from the database. Threshold interpolation sets the value of (C, CC, CCV) to (2, 2, 20). C (Citation) refers to the minimum citation frequency, and only documents that meet this condition can participate in the following operations. CC (Co-citation) is the number of co-citations, and CCV (Co-citation Cosine Co-efficient) refers to the ratio of co-citations between data [30]. The other metrics use default values based on Chen & Song's [37] work. This study will visualize and analyze the literature data in the field of UGS and children's studies through the following analysis paths:

1. Publication network analysis: This allowed us to determine the general status of publications in UGS and children's studies, including the number of publications, countries, disciplinary distribution, and collaborative networks of organizations and authors.
2. Co-citation cluster analysis: The research front consists of a cluster of co-cited core papers and the group of current source papers that cite one or more of these core papers [37]. The content of the clusters allows for analysis of the thematic division and research frontiers of UGS and children's research.
3. Keyword analysis: keywords are the condensation and distillation of the core ideas and contents of the literature and can reflect the core content of the literature [32,38]. By counting the high-frequency keywords in the publications in UGS and children, we can quickly grasp the research hotspots in the field.
4. Analysis of keywords with the strongest burst. Keywords with the strongest burst can reflect the change in research topics and hotspots in a field, and emphasize the sudden

change, burst, or sharp increase in the research field within a period. Keywords with the strongest burst can reflect the clear research directions in a period and represent the research hotspots and scientific trends in a specific timeframe.

2.4. Data Sources and Screening

The publication data used in this study were obtained from the Web of Science Core Collection (WoS) produced by Thomson Reuters. The WoS Core Collection is the most commonly used and authoritative search engine for research literature, providing comprehensive coverage of major research results worldwide, including articles, meeting abstracts, books, and published projects. WoS includes SCI-Expanded (Science Citation Index Expanded, 1970-present), SSCI (Social Sciences Citation Index, 1970-present), A & HCI (Arts & Humanities Citation Index, 1975-present), and ESCI (Emerging Sources Citation Index, 2015-present). The WoS Core Collection database covers over 12,000 journals and 150,000 conference proceedings in 250 disciplines worldwide [39]. WoS provides powerful access to publications and citation information related to published research papers and contains more than 90 million records and 1 billion cited references [39]. Many studies have demonstrated that WoS is an ideal data source for scientometric analysis of the literature [38,40,41].

In this study, we searched the scientific literature based on the WoS Core Collection database that is consistent with research on UGS and children. The first publication related to it was recorded in 1980. Because this study aims to analyze the bibliography of the related field through scientometrics quantitatively, this study's data extraction period was set from 1980 to 27 February 2022 to minimize the omission of important studies from earlier years. The concepts and definitions included in the study of UGS concerning children are gradually expanding, and multiple names and themes are associated with them. After several search tests, the researchers identified search topics (including titles, abstracts, author keywords, and keywords plus): the combinations of ("green spaces" or "open spaces" or "green area" or parks) and (urban or city) and (child or children or kid or kids) were used for the advanced search, which found a total of 1270 publications. The researchers reviewed the titles and abstracts of all articles individually to eliminate "noise" in the database and ensure the accuracy of the data, and 795 publications were selected (Data retrieved at 14:15 on 27 February 2022). The publication data are then stored as a "full record and cited references" using a "plain text file" format.

3. Research Results

3.1. Overview of UGS and Children's Study

As of February 2022, 795 publications related to UGS and children were counted in the WoS Core Collection database (Figure 2). The earliest one was "Urban open space for children in the Bangkok metropolis" by Chalermchai Honark in 1980 in the journal Ekistics. Honark's [42] study analyzed the use of and demand for urban public space among children (up to 14 years old) under different economic conditions in the city of Bangkok. Honark's findings effectively demonstrate that children's demand patterns for open space are overwhelmingly dependent on their socioeconomic environment. Figure 2 shows the progress of the number of publications in the UGS and children's research literature from 1980 to 2021. Specifically, the UGS and children's research experience can be divided into the following developmental stages:

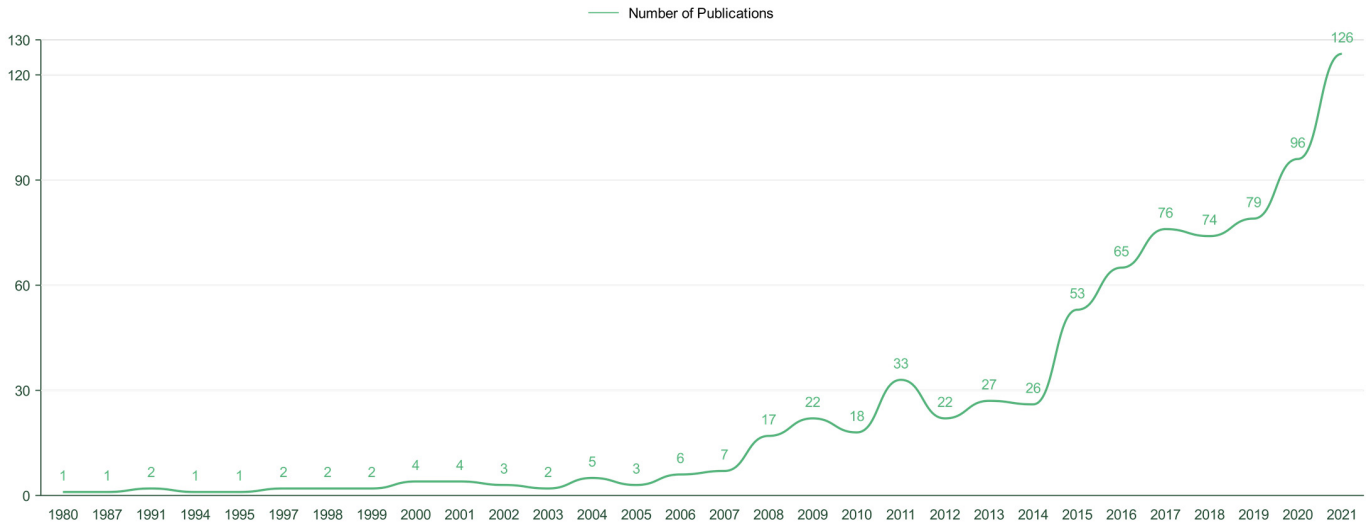

Figure 2. An annual number of publications indexed in the WoS and published from 1980 to 2022.

1. Budding stage (1980–2007). During these 27 years, the number of published articles was less than 10 per year, indication that this is the embryonic research stage. Researchers were already beginning to notice the link between UGS and children. Only ten papers were published in the 16 years from 1980 to 1995, and they were cited very infrequently and had little impact. In 1995, the United Nations International Children's Emergency Fund (UNICEF) and The United Nations Human Settlements Programme (UN-Habitat) convened the Habitat II Conference in Istanbul. At the conference, UNICEF and UN-Habitat jointly developed the "ChiId Friendly City Initiatives (CFCI)" [43]. Since then, research papers and conference literature on UGS and children have slowly begun to grow.
2. Development stage (2008–2016). During these nine years, international conferences related to the environment, health, and medicine have begun to discuss topics related to UGS and children [3,44,45]. There has been an increase in basic and empirical research on UGS/urban public open space and children's studies during this period.
3. Rapid development stage (2016-present). The number of articles has maintained a rapid growth since 2016. In 2018, UNICEF officially issued the Handbook on Child-Friendly Cities and Communities. This handbook defined the framework for CFCI action more clearly and further increased the attention to research in this field. The number of published articles has continued to grow in the past five years, reaching more than 490. This shows that research related to UGS and children has entered a stage of steady growth, a trend that may be closely related to the international focus on children.

3.2. Research Disciplinary Categories' Distribution

We selected the node type as "Category" in CiteSpace and obtained the visualization map of the disciplinary category distribution of UGS and children's research. After simplifying and merging data from the same disciplinary category, 237 nodes and 412 lines were extracted and analyzed for betweenness centrality (Figure 3). Of these 237 disciplines, the disciplines with the highest number of publications were Environmental Science & Ecology, Public, Environmental & Occupational Health, Urban Studies, Environmental Studies & Science, Geography, and Urban Studies. The map distribution shows that the study of UGS and children is a multidisciplinary research field that integrates environmental, geographic, ecological, economic, medical, and other multidisciplinary features. According to the thickness of the linked lines, disciplines in similar fields such as environmental science, architecture, urban planning, and geology have strong links. In addition, although some disciplines have published a small number of papers (such as Education

& Educational Research and Humanities), their relatively high betweenness centrality values may reflect the fact that these disciplines play a pivotal role in the construction of interdisciplinary cooperation and research systems, which provides a good foundation for the further comprehensive development of this field in the future.

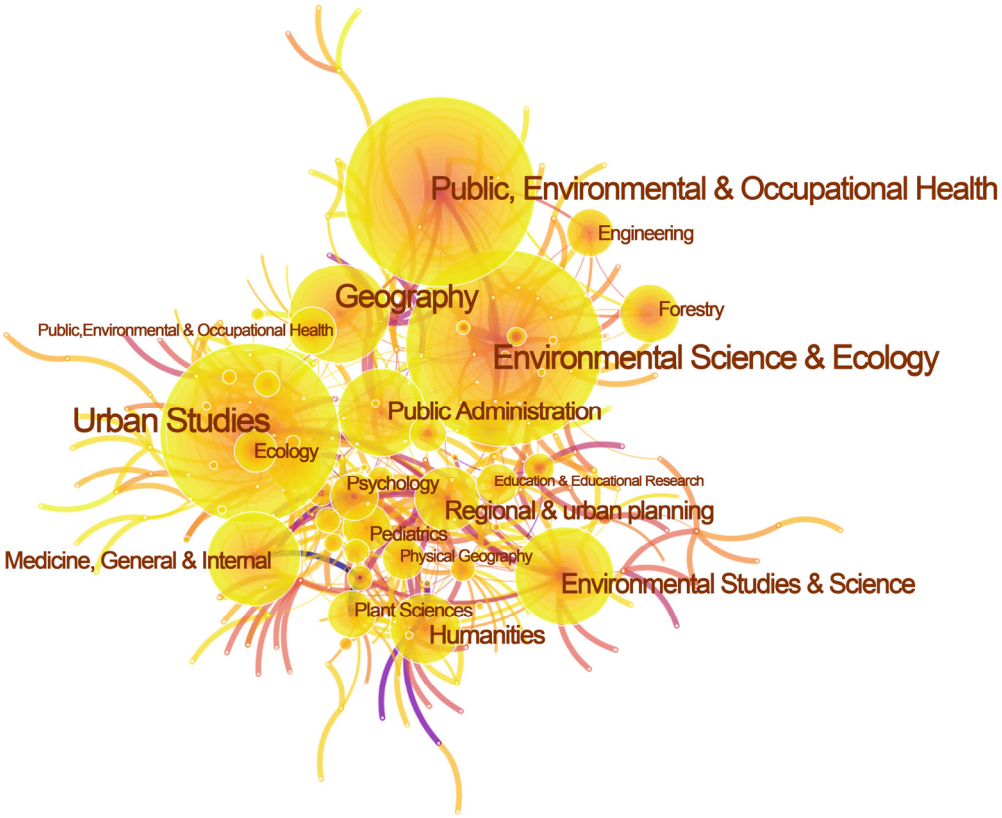

Figure 3. Network of links between research disciplines.

3.3. Researcher Network Distribution

Researcher networks are used to analyze the collaborative relationships of researchers in a particular field of study. The development and improvement of an academic research discipline depend largely on collaboration between researchers [46]. The author mapping in CiteSpace consists of 604 nodes and 637 collaboration links (Figure 4). Figure 4 shows that the number of authors studying UGS and children is high, but the collaborative network of researchers is loose. The overall state of researcher collaboration shows an extensive dispersion with localized concentrations, with some authors forming academic communities. Figure 4 also reflects the core researchers and their research teams in the research area, with ten publishing more than five articles. There have been collaborative relationships between the researchers Cohen, D.A., Veitch, J., Timperio, A., Williamson, S., and Han, B. (Figure 4 shows the collaboration network of some top authors). Although there are some collaborative relationships among researchers in various fields, the intensity of collaboration is not strong and has not yet formed a widespread collaborative dynamic. The main reason for this pattern may be the differences in policy support and demand for children's use of UGS in different countries or regions [47–49]. Also, this reason is responsible for the current lack of a universal standard for measuring the child-friendliness of UGS in current academia.

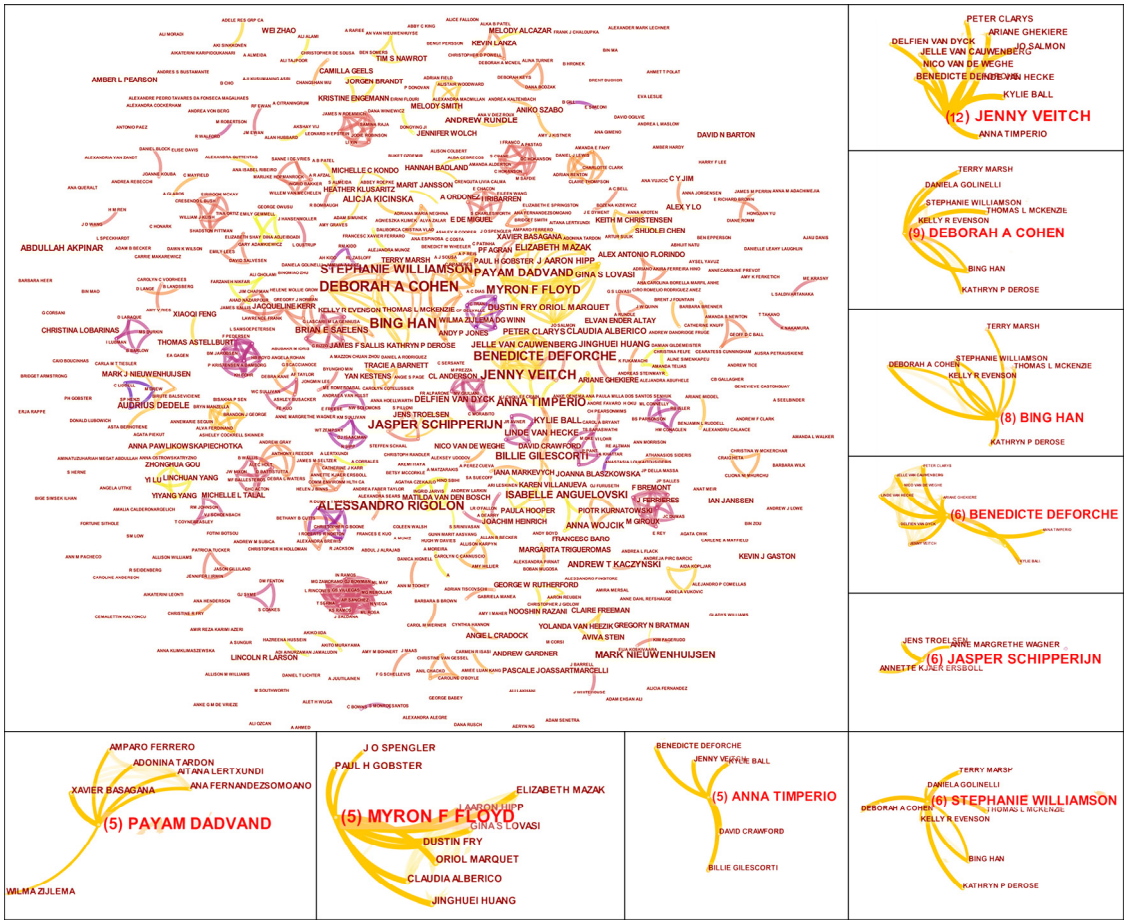

Figure 4. Collaboration network of researchers, and collaboration network of some top researchers.

The most-published researcher in the field of UGS and children is Veitch J from Deakin University. Veitch Jenny is a Member of the World Urban Parks, Children play, and nature committees. She has a particular research focus on how features and designs of places such as public open spaces may promote opportunities for physical activity. Veitch has 12 related articles in the WoS database. The most frequently cited article is "Where do children usually play? A qualitative study of parents' perceptions of influences on children's active free-play". Veitch et al. [50] suggest that further understanding of the impacts on children's active free-play outdoors will require the inclusion of children in future studies of outdoor environments and the use of objective measures of children's physical activity.

There is a strong academic link between Veitch and Deforche. Their study examined the incentives that can promote children to visit and actively socialize in UGS by gaining insight into the latter's characteristics. Their findings highlight which UGS features should be prioritized by UGS planners and designers to support the access of children and youth to social interaction and physical activity [51–54]. There is also a strong academic collaboration between Cohen and Han, whose research focuses on the relationship between UGS and children's physical activity. They identified activity in UGS as a potential opportunity to prevent childhood obesity, and that UGS as an intervention site can provide environments that promote the health and well-being of children and adolescents [14,55–58]. Schipperij's research on UGS focuses on the Finnish region. He collected site-specific information on the value of experiences by gathering people's general attitudes towards UGS and the benefits they perceive that can be derived from UGS. A simple method was thus developed to describe the experiential qualities of UGS for use in strategic UGS planning [59,60]. Jasper Schipperij also studied the use of UGS by primary school teachers and students, and their

research found that most primary school students prefer forested areas and prefer a natural environment with easy access [59,61].

3.4. Research Institutions' Network Distribution

In terms of the distribution of institutions, between 1980 and 2022, CiteSpace shows 437 nodes and 491 collaborative links for institutions conducting research, as shown in Figure 5. Deakin University, The University of Melbourne, and The University of British Columbia contributed the most to UGS and children's research with 16, 13, and 12 publications. In general, the number of research outputs was related to the amount of research funding provided by the research institutions and the proportion of those that included urban environments and children as a research priority [62]. The distribution of research institutions can help in understand academic support for and recognition of the topic [62,63]. A total of 437 institutions are involved in this area of research, indicating that this research direction has been taken seriously by the academic community and has been extensively researched. The overall density of institutional cooperation mapping is only 0.00052, indicating that the international connection between research institutions is not strong and reflects the apparent differentiation of research on UGS and children worldwide. In terms of node connection strength, two institutions with a strong connection strength tend to be in the same or neighboring countries. In addition, we can clearly see from Figure 5 that most of the more authoritative institutions that have studied UGS and children are concentrated in the United States, Australia, the United Kingdom, France, New Zealand, and other countries whose economies are more developed.

Figure 5. Collaboration network of institutions.

3.5. Country Cooperation Network Distribution

UGS-related studies have specific geographical attributes. Most researchers adopt the principle of proximity in the sample selected for their studies [48,64,65], so the geographical distribution among countries can reflect the depth and breadth of research on relevant aspects of this study area in different world regions. There are 41 nodes and 127 linked lines in the country collaboration mapping from CiteSpace (Figure 6). The United States published 262 articles, China 68 articles, and Australia 65 articles. China ranks second in research output, a notable change in recent years. This change in research trends confirms previous researchers' conclusions about the growing importance of the Asia-

Pacific region [64]. Strong economic growth and a stable political environment in the Asia-Pacific region have ensured greater urban attention to children (UNWTO, 2010), driving research and development on UGS and children [66–68].

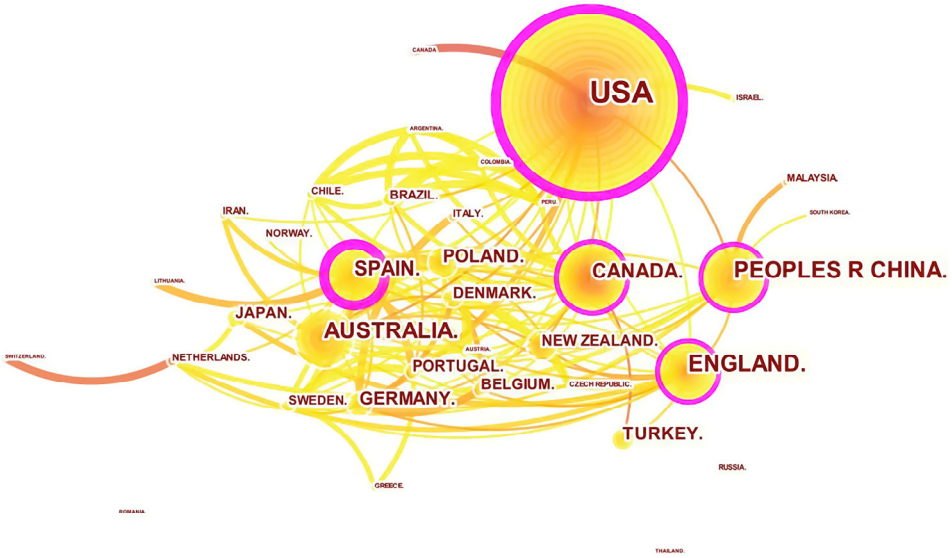

Figure 6. Collaboration network of the country.

From the betweenness centrality of nodes, we can see that European and American countries have played a vital role in this area of research. The highest centrality value was 0.39 for the United States. France, New Zealand, Switzerland, the United States, the United Kingdom, Germany, and Belgium all had betweenness centrality values above 0.1 (Figure 6). This may be due to European countries' similar physical and geographical environments. The fact that European countries develop and promulgate conventions and policies among themselves promotes strong international collaborative research relationships among European countries. (e.g., The Europe Landscape Convention and The New EU Green Deal).

4. Research Hotspots and Trends

4.1. Knowledge Group Analysis

Analyzing knowledge groups in a scientific field effectively outlines their basic knowledge, research areas, and research directions. In this study, 795 documents were analyzed and clustered by converting data to Carrot2 through CiteSpace. Carrot2 is predominantly a Java programming library with public APIs for managing language-specific resources, algorithm configurations, and executions. The knowledge clusters appearing in Figure 7 are the results of the clustering of the imported 795 pieces of literature by Carrot2 using the STC algorithm. The key data structure in the STC algorithm is the Generalized Suffix Tree (GST) built for all input documents. The algorithm traverses the GST to identify words and phrases that frequently occurred in the input documents and merges sub-groups of documents with high overlap.

The clusters calculated by Carrot2 are shown in the FoamTree (Figure 7). More giant bubbles represent a more significant number of publications in the cluster. Notably, the topics that received the most scholarly attention were "Exposure and Health, Nature Space, Children to Park Playgrounds, Urban Natural Environment, Children's Parents, Association between Urban Green Space, Children as Users, and Levels of Green Space", etc. The clustering results clearly show that children's activity status in urban natural areas is still the mainstream of research. "Green Space was Measured, Neighborhood Physical Activity, Access to Green, and Importance of Green Space" have also attracted scholars' attention. It is worth noting that "Children Prefer, Behaviours in Children, Wellbeing,

and Effects of Green Space" has also become an essential direction in the study of UGS and children.

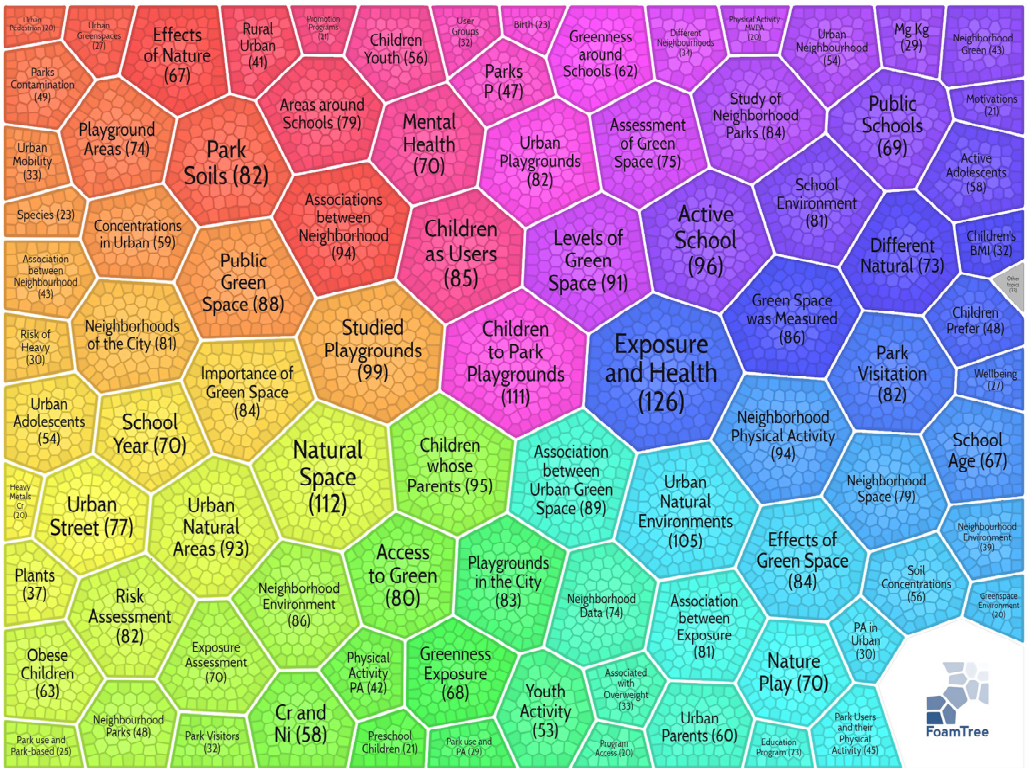

Figure 7. Visualization of the publication cluster foam tree.

4.2. Literature Co-Citation Analysis

Co-citation analysis is an essential analysis function provided in CiteSpace to find precisely the important publications in a research field. When two (or more) papers are cited by one or more later papers simultaneously, the two papers are said to constitute a co-citation relationship. Table 1 shows the top ten articles in terms of the number of co-citations. The most frequently co-cited article was published by Hartig in 2014, in which Hartig describes the benefits of nature for human health. He claims that urbanization, resource exploitation, and lifestyle changes have reduced the potential for human contact with nature [8]. Hartig claims that Children were the most commonly considered subgroup. Restorative contact with nature in childhood can cumulatively provide far-reaching developmental benefits [8]. The second-most co-cited paper is Wolch et al., 2014, on Urban green space, public health, and environmental justice [69]. The paper reviews the British and American literature on urban green space, particularly parks, and compares efforts to green American and Chinese cities. They find that China's UGS supply is relatively inadequate. They also suggested that children with more access to parks and recreation facilities were more active than those with less access, and most results for adults were similar [69]. The third-most-co-cited article was by Gordon-Larsen et al. Their study assessed the additional effect of differences in recreational facilities in urban public settings on overweight through adolescents, with a sample of 20,000 US adolescents [70]. They found that low social status and high minority block groups were less likely to have facilities, which in turn was associated with a decrease in PA and an increase in obesity [70].

Table 1. The top-10 references with the most Co-citation counts.

No.	Co-Citation Counts	Authors	Title	Journal	Year
1	42	Hartig, T.; Mitchell, R.; Vries, S.D.; et al.	Nature and Health	Annual Review of Public Health	2014
2	41	Wolch, J.R.; Byrne, J.; Newell, J.P.	Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'	Landscape and Urban Planning	2014
3	39	Gordon-Larsen, P.; Nelson, M.C.; Page, P.; et al.	Inequality in the built environment underlies key health disparities in physical activity and obesity	Pediatrics	2006
4	31	Cohen, D.A.; McKenzie, T.L.; Sehgal, A.; et al.	Contribution of public parks to physical activity	American Journal of Public Health.	2007
5	29	Markevych, I.; Schoierer, J.; Hartig, T.; et al.	Exploring pathways linking greenspace to health: Theoretical and methodological guidance.	Environmental Research	2017
6	29	Dadvand, P.; Nieuwenhuijsen, M.J.; Esnaola, M.; et al.	Green spaces and cognitive development in primary schoolchildren	Proceedings of the National Academy of Sciences	2015
7	28	Cohen, D.A.; Ashwood, J.S.; Scott, M.M.; et al.	Public parks and physical activity among adolescent girls	Pediatrics	2006
8	23	Chawla, L.	Benefits of nature contact for children	Journal of Planning Literature	2015
9	23	Amoly, E.; Dadvand, P.; Forns, J.; et al.	Green and blue spaces and behavioral development in Barcelona schoolchildren: the BREATHE project	Environmental Health Perspectives	2014
10	42	Markevych, I.; Tiesler, C.M.T.; Tiesler, E.; et al.	Access to urban green spaces and behavioural problems in children: Results from the GINIplus and LISAplus studies	Environmental Health Perspectives	2014

4.3. Co-Citation Clustering Analysis

The network's modularity is maximized during clustering using an intelligent local moving algorithm for community detection to identify clusters in the network of cited references [71]. The clustering values generated by CiteSpace show that the degree of modularity $Q = 0.7087 > 0.3$, and the effect of clustering the network is significant. $S = 0.852 > 0.7$ represents a very high homogeneity of the network and convincing clustering results. The silhouette values for each cluster are greater than 0.6, indicating that the results are robust and meaningful (Table 2). The analysis identified 10 major clusters within the co-citation mapping, as shown in Figure 8.

Table 2. Summary of the largest 10 clusters.

Cluster ID	Size	Silhouette	Label (LLR)	Mean (Year)
0	173	0.863	Physical Activity	2015
1	167	0.965	Children	2010
2	129	0.888	Urban Park	2008
3	114	0.94	Child-friendly Environment	2013
4	110	0.825	Green Space Use	2012
5	65	0.719	Mental Healthy	2002
6	43	0.897	Environment Justice	2015
7	37	0.987	Covid-19 Pandemic	2019
8	12	0.994	Nature	2003
9	8	0.908	Soparc	2018

LLR: Top terms (log-likelihood ratio, p-level). **Size:** The number of references that a cluster contains.

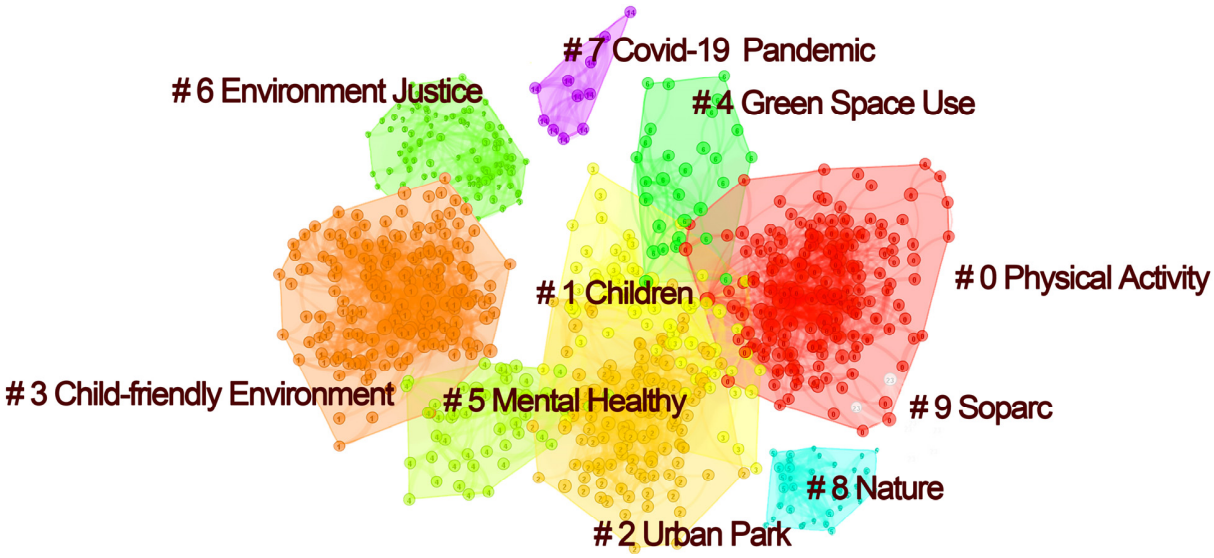

Figure 8. Clustering of co-citation references.

Figure 9 shows the overlap between the clusters, and the clusters are partially related and extended to each other. For example, cluster #0, physical activity, contains 173 articles with a homogeneity of 0.863, which is not the highest among all, but close to 1, indicating that the similarity of the cluster members is already relatively high. Cluster #0's average year is 2015, which means that most of the publications that explicitly include "physical activity" in their keywords were published around 2015. The researcher summarized three paths for studying UGS and children based on an in-depth understanding of the specific contents contained under each cluster name: (1) Identification of the connotation of UGS and children research. (2) Research and concrete planning at the micro-level of UGS and children. (3) The impact of changes in the general social environment on children's use of UGS.

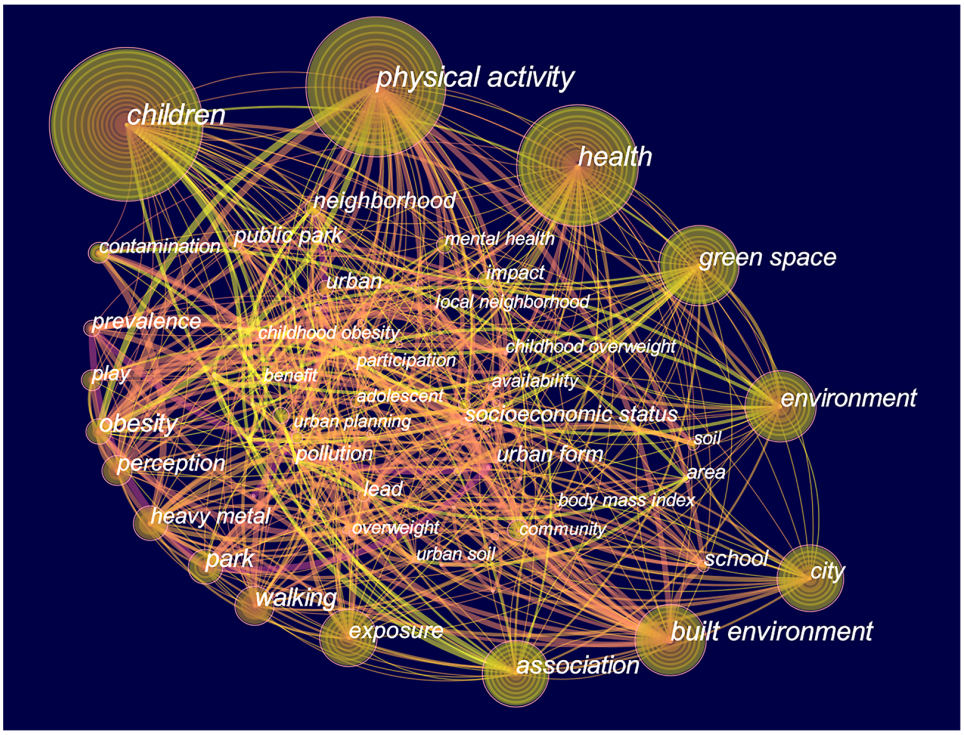

Figure 9. Keyword co-occurrence network.

1. Identification of the connotation of UGS and children's research. This includes the clusters "Urban Park, Children, and Child-friendly environment". Urban park is the most widely used form of UGS. It is a UGS open to the public in the city, with the primary function of recreation [72,73]. Urban park also serves as a comprehensive function of ecology [74], landscape beautification [75], science education [76], and emergency shelters [77]. Urban parks are an essential part of the UGS system and urban green infrastructure and are an important indicator for the overall environmental level of a city and the quality of life of its residents [78–80]. The 'Children' cluster can be interpreted as the urgent need of children for UGS, which leads to the study of child-friendly UGS. This research has become a new hot direction for UGS research with the continuous optimization of physical conditions globally. "Child-friendly Environment" is specifically related to children's rights, children's participation, social security, growth environment, and live interaction [81–83]. The above three clusters discuss the connotation, specific requirements, and relevant indicator systems of UGS and children's research. These clusters form the basic framework related to UGS and children's research.

2. Research and concrete planning at the micro-level of UGS and children. This aspect includes the clustering of "Physical Activity, Mental Healthy, Soparc, and Green Space Use". Research on children in UGS must be put into practice. In other words, the study of UGS and children should be based on supporting children's physical and mental growth, meeting their real needs, and promoting the communication of their will [29,84,85]. Furthermore, expect that each child has opportunities to explore, shape, and change according to the child's background, experiences, and character [84,86]. The System for Observing Play and Recreation in Communities (SOPARC) tool can be applied to a variety of environments. SOPARC is able to obtain information on children and their physical activity in UGS and use momentary time sampling to record observations [87,88]. The presence of SOPARC in the clusters indicates that SOPARC has been widely used in recent years in studies of UGS and children [89–93]. Therefore, research workers should revisit the planning and design of UGS from the perspective of children to provide more comprehensive urban public spaces for the future growth needs of children. Overall, the above clustering is a microscopic addition to the main framework.

3. The impact of changes in the general social environment on children's use of UGS. This aspect includes clustering "Environment Justice" and "Covid-19 Pandemic". An excellent social environment allows children to develop positively in health and education [89,94]. It is not constrained by having a low socioeconomic status or conditions of poverty (e.g., low family income and poor housing). The current study results show that we still need to make sustained efforts in this area [86,95]. Making UGS child-friendly is part of building child-friendly cities. We should give children equal access to resources and opportunities in urban public settings.

4.4. Keyword Frequency Analysis

Keywords are a condensation of the content of the full text and can reflect the core content of the literature. The high-frequency keywords represent the research hotspots in a period. In this study, keyword co-occurrences and keywords with the strongest burst are mapped through CiteSpace, and the mapping language is interpreted. 372 keywords and 805 linked lines were extracted from CiteSpace from 1980 to 2022 (Figure 9). The number of linked lines was greater than the number of nodes and intricate links between keywords, indicating an extensive range of UGS and children's studies. Table 3 lists the 30 most frequently used keywords and their mediated centrality, reflecting this research area's focus. "Physical activity, Neighborhood, Impact, Adolescence, Overweight, and Obesity" emerged earlier. "Green space, Mental health, Urban green space, Public health, Urban park, Environmental justice, Exposure, and Air pollution" emerged later and are the hotspots of research on UGS and children in the last decade.

Table 3. Top 30 most frequently used keywords during 1980–2022.

No.	Keyword	Year	Freq.	Centrality
1	Children	1999	250	0.03
2	Physical Activity	2003	196	0.10
3	Health	2006	154	0.05
4	Green Space	2012	124	0.01
5	Environment	2002	99	0.07
6	City	2001	96	0.10
7	Built Environment	2007	85	0.05
8	Association	2007	68	0.07
9	Exposure	2013	62	0.07
10	Walking	2006	56	0.03
11	Park	2008	55	0.07
12	Heavy Metal	2007	54	0.10
13	Perception	2008	54	0.10
14	Obesity	2006	53	0.10
15	Play	2009	46	0.07
16	Prevalence	2001	45	0.05
17	Mental Health	2012	44	0.04
18	Neighborhood	1999	42	0.07
19	Urban	2010	39	0.02
20	Urban Green Space	2012	38	0.03
21	Impact	1999	37	0.03
22	Adolescent	2007	36	0.02
23	Air Pollution	2014	36	0.02
24	Space	2010	35	0.09
25	Public Health	2010	35	0.20
26	Benefit	2001	35	0.04
27	Access	2009	31	0.05
28	Overweight	2006	31	0.03
29	Environmental justice	2011	30	0.03
30	Urban Park	2016	30	0.01

4.5. Keywords with the Strongest Bursts

The burst of keywords concerns those that have increased significantly in their frequency of use in a short period and are used further to explore the cutting-edge dynamics of the research field, reflecting the sudden impact on the research field of new concepts formed by policies or public events from a particular moment onward [30,33]. The burst of keywords can reflect the changes in research topics and hotspots in a field, reflecting the persuasive research topics in a period and representing the research hotspots and scientific trends in a specific time.

In Figure 10, 'Terms' represents the burst noun terms; 'Year' represents the starting time of the analysis (i.e., 1980, means the time span 1980–2022); 'Strength' represents the intensity of the burst; 'Begin' represents the starting year of the burst of noun terms; 'End' represents the end year of the burst, and the red line represents the duration of the burst. Figure 10 shows that CiteSpace calculates that the keywords started to burst from 2006 onwards. The earliest burst keyword was 'overweigh' (starting in 2006 and ending in 2009). Researchers in this period focused on the relationship between childhood obesity and UGS because childhood obesity contributed to the increased incidence of chronic childhood diseases [96,97]. For this reason, researchers have begun to explore the link between children's health and UGS. The keyword burst in recent times has been 'environmental justice'. Many researchers have begun to examine children's access to the benefits of UGS during the last two years. Some researchers argue that a lack of knowledge about the allocation and status of UGS can hinder the appropriateness and rationality of subsequent UGS planning, which may ultimately undermine the livability and sustainability of cities [64,65,98]. The keyword with the longest sustained burst was 'public

park' (start in 2008 and end in 2016), while the keywords with the shortest sustained burst were 'play', 'community', 'park use', and 'pattern'. The top-five most bursting keywords are 'walking', 'urban green space', 'urban form', 'socioeconomic status', and 'obesity'. From the keywords' strongest burst, we can see that although the research topics related to UGS and children are updated rapidly, many research branches still show continuous development.

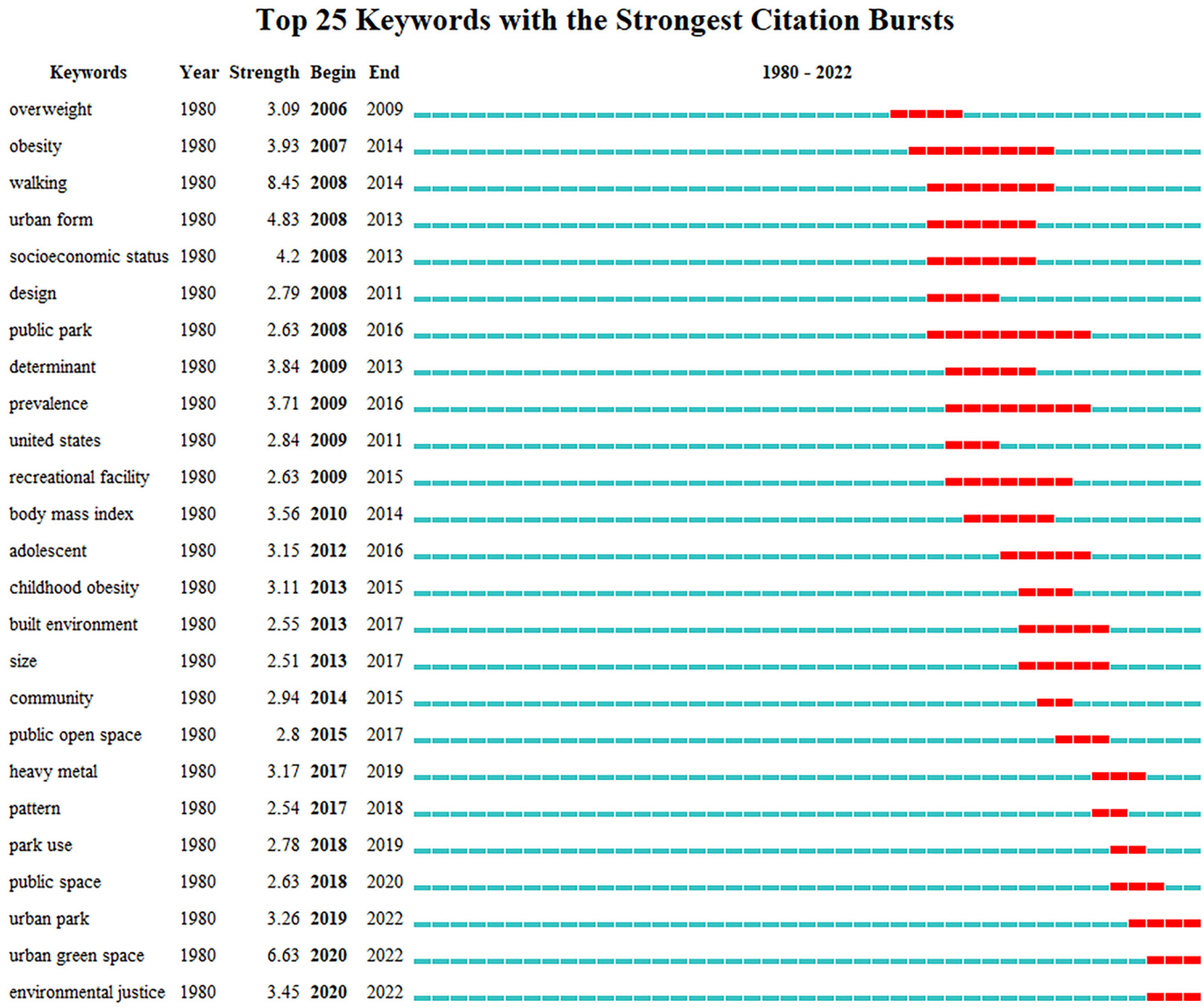

Figure 10. Top 25 keywords with the strongest bursts.

5. Discussion and Conclusions

5.1. Advantages of Scientometric Analysis with CiteSpace

The greatest strength of scientometrics lies in analyzing massive amounts of data and visually and clearly illustrating the evolutionary path of the discipline [34,35,37]. CiteSpace, on the other hand, provides a scientific, simple, and cost-effective visual presentation. This literature review approach can reduce scholars' subjectivity and irreproducible manipulation regarding literature database selection. It helps researchers to sort out complex collaborations and citations, extract classic and cutting-edge literature, and obtain a visual and straightforward overview of the development and evolution of a subject area [30,32,99]. In this way, many existing publications can be analyzed using WOS or other identifiable databases, and the number of published articles, disciplines, author networks, countries, and the distribution of research institutions can be obtained.

However, scientometrics is not infallible. Scientometrics relies on the support of database structures and different analysis algorithms and is relatively mechanistic in its literature analysis. As a result, there may be a gap between the results of a CiteSpace analysis and those of an empirical analysis [30,37]. Despite the weaknesses and shortcomings of the citation analysis in CiteSpace, the information of the study is difficult to replace, and the study's results are relatively certifiable (i.e., verifiable and able to be evaluated) [30].

5.2. Research on UGS and Children

This study was conducted with the assistance of CiteSpace software to comb the literature related to the field of UGS and children in the WOS database from 1980–2022. In terms of the literature, the research on UGS and children has grown significantly from 2016 to the present. As of February 2022, the number of related articles increased to a total of 795. This indicates that more researchers are concerned or interested in this area. From this literature, we find that the naturalness, ecology, atmosphere, quality, and other characteristics of UGS positively affect children's social and emotional well-being, developing resilience, health, perception, and freedom of action. However, some effects show stronger evidence than others. Physical activities make up the largest proportion of research on children and UGS. This is because children's physical and mental health benefit when they engage in physical activities in UGS. In this study, we found a growing interest in studying the interaction between the characteristics of UGS and child-friendliness. A large part of the research on the relationship between UGS and child-friendliness has focused on the United States, China, and the United Kingdom. Research has focused on promoting children's access to urban areas by enhancing accessibility, environmental equity, and biodiversity in UGS. Our review also shows that research on children in developing countries is beginning to gain traction. This contributes both to the protection of children themselves and to global research findings in this area.

We used CiteSpace to obtain 10 major research clusters and 25 outbreak keywords in this research area, which represent what the broader scientific community considers to be key research directions in the relationship between UGS and children. The CiteSpace analysis of the literature revealed that the direction of research has evolved from health topics (e.g., obesity, being overweight, physical activity, mental health) to those related to sociology (e.g., environmental justice, child-friendliness, and the impact of the COVID-19 pandemic on children's use of UGS). Current and trending publications expand their investigations into more complex areas such as the role of UGS in children's emotional and behavioral resilience [100–102], the fact that contact with UGS can reduce the incidence of autism in children [103,104], and the relationship of UGS to children's sensory dimensions and stress restoration [105–108]. These studies show that research collaborations across different disciplinary areas are taking place and that research on UGS and children is becoming more rational, complex, and comprehensive.

The global response to the COVID-19 pandemic has brought about significant changes in child mobility patterns and living environments. Future research will focus on UGS and planning practices in the context of health crises, as some of the articles in this review have done. For children, UGS near low-density housing and high-density neighborhoods increased the chances that children were outdoors during the pandemic [85,109]. These studies shed new light on the value of UGS as a means of enhancing children's resilience to stressors such as the COVID-19 pandemic. The research on UGS and children during COVID-19 highlights the need to provide additional outdoor recreational opportunities for children in times of crisis and also reveals some of the important green justice dilemmas that may be faced on the road to future sustainable urban planning.

More than 117 studies point to the key role of UGS in developing pro-environmental behaviors in children, particularly in fostering emotional connections with nature in urban settings. Contact with the natural environment has a potential protective effect against adverse symptoms of children's mental health. UGS has been beneficially linked to mental health and depressive symptoms in young adults, adolescents, and children [110–113]. For

most urban children, spending time in UGS may be an affordable and widely available way to promote mental health and provide a buffer for developing poor mental health [114]. Students can also improve their concentration and social skills through contact with UGS, balancing stress levels and thus indirectly contributing to their learning [57,84,115]. It is time to take nature seriously as a learning resource, especially for students who are not effectively exposed to nature through traditional instruction. This information reinforces the rationale for including UGS in scientific planning. While UGS provides a wide range of ecosystem services for children, promoting their health and well-being, numerous studies have shown that many municipal government norms and policies do not have very clear quantitative norms and standards regarding UGS. UGS lacks physical, cognitive, perceptual, emotional, and social dimensions regarding the quality of child-friendly environments. The quality dimensions of UGS for planning child-friendly environments are weakly addressed. Starting from the precautionary principle, most researchers agree that in the context of rapid global urbanization, cities should over-provide sufficient UGS to protect the mental health of children and adolescents. Next, research in this area could focus on norms and standards for measuring the child-friendliness of UGS in cities with different cultures, lifestyles, social contexts, and climates to meet the cultural, recreational, and accessibility needs of urban children in order to provide maximum public health benefits. In the future, this information may provide decision makers in urban planning with tools to improve the quality of UGS friendliness.

In this study, we also found that UGS is often under-provided. This has led to unequal access to UGS, which has become an environmental justice issue. Related evidence suggests that adequate high-quality UGS around homes can lead to better early neurodevelopment in children [116]. UGS is more beneficial to people living in more deprived areas because it is an affordable and widely available recreational site. This is despite the fact that the total area of UGS provided has not increased proportionally, and even that UGS has a greater potential for crowding [117]. Some studies have suggested that informal UGS can reduce distributional inequalities in UGS availability, especially among the most vulnerable groups of citizens, such as older and child residents.

5.3. Limitations of This Study

Some limitations should be noted from our study, which is important. First, literature not recorded in the WoS core repository was not included. Secondly, using the number of citations as an indicator of the importance of works may lead to the omission of highly relevant publications of a particular subfield that had not gained wider popularity. Therefore, our findings may not be comprehensive. Third, the search terms selected in this paper will have different alternatives, and the results generated may be biased if other search terms are used. Further research can refine the study's scope to provide a more detailed division and more thorough analysis of the search terms, or can expand the scope of the study to include more research areas (e.g., green spaces outside of cities). Fourth, this study only reflects the general and basic state of research on UGS and children. Considering the prevalence and complexity of this research area, future review studies on this research area can further screen the database to identify literature that requires close reading. While scientometric citation analysis provides quantitative evidence about the importance and linkage of papers in the field of study, qualitative analysis remains irreplaceable to the subjective judgment of the researcher and to exploratory approaches to interpreting results. These two research methods can complement each other to provide a more objective evaluation of the literature in a field of study.

5.4. Conclusions

This study is a literature analysis and citation-based extension of the study of UGS and children that outlines the trajectory of collective knowledge evolution from 1980 to the present, providing a unique and interesting snapshot of this field of knowledge. Research on UGS and children is undergoing a period of rapid development. Our study mines the

content of literature databases through CiteSpace to identify patterns and trends in this research area through cited and co-cited references. The emerging trends and patterns identified in the analysis of this study are based on computational attributes selected by CiteSpace, with the aim of facilitating the task of perceiving scientific frontiers based on the literature of the field in question.

Author Contributions: Y.N., wrote the manuscript under the supervision of H.H. and M.A.; Methodology, Y.N.; Data curation, Y.N.; Writing—original draft preparation, Y.N., H.H. and M.A.; Writing—review and editing, Y.N., H.H. and M.A.; Supervision, H.H. and M.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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

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