

Review

Scientific Production on Physical Activity, Physical Education, Global Warming and Climate Change: A Bibliometric Analysis

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Abstract: Physical activity allows people to obtain multidimensional benefits. Regular practice and following the recommendations can provide the benefits mentioned above. However, it has been evidenced that the variability in the environmental temperature is a determining factor to adhere to the regular practice of physical activity. From this point of view, it has become evident that researchers have joined criteria to explore the effects of climate change or global warming on physical activity or physical education. This study is the first bibliometric analysis of the scientific literature related to physical activity, physical education, global warming, and climate change. The objective of the present bibliometric review was to examine annual publication trends, identifying the categories, journals, and countries with the highest number of publications on this topic. In addition, the secondary objective was to identify the most productive and prominent authors, highlight the most cited articles, and determine the keywords most used by the authors. We analyzed 261 papers published in journals indexed in the Web of Science, examining the trend followed by annual publications, identifying prolific and prominent co-authors, leading countries and journals, most cited papers, and most used author keywords. The annual publications followed an exponential growth trend ($R^2 = 90\%$), which means that there is great interest in the scientific community for this object of study. The *Journal of Physical Activity & Health* was the journal with the most published papers. M.S. Tremblay and E.Y. Lee were the most prominent co-authors, and as reference authors on the subject, M. Nieuwenhuijsen and H. Khreis were the most prominent authors. The three countries with the highest productivity are the USA, the UK, and Canada. Although a total of 29 keywords were identified, only 25 of them were commonly recurrent, with the most used being climate change and physical activity.

Keywords: physical activity; physical education; global warming; climate change; public health



Academic Editor: David Brown

Received: 31 March 2025

Revised: 2 June 2025

Accepted: 4 June 2025

Published: 11 June 2025

Citation: Castillo-Paredes, A.; Denche-Zamorano, A.; Fuentes-Rubio, M.; Portela-Estinto, M.; Adsuar, J.C.; Salas-Gómez, D. Scientific Production on Physical Activity, Physical Education, Global Warming and Climate Change: A Bibliometric Analysis. *Societies* **2025**, *15*, 161. <https://doi.org/10.3390/soc15060161>

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1. Introduction

The regular practice of physical activity (PA) provides physical, biological, psychological, and social benefits for individuals [1–4]. These benefits are obtained by adhering to the current recommendations of non-governmental bodies such as the World Health Organization [5], the American College Sport Medicine [6–8], and others such as the American Heart Association [9] that work to improve people's quality of life.

In addition, it has been demonstrated that the regular practice of PA is conditioned by a socioecological context, which is related to the interaction between social and environmental influences, the latter referring to the availability of spaces for PA in rural or urban areas [10]. Thus, the willingness and availability of spaces for staying active and enhancing healthy behaviors are influenced by environmental quality, which affects the motivation to keep moving, such as for the use of parks or actively moving from one place to another [11]. From this point of view, safety, accessibility, and climate are factors that reinforce an active lifestyle [12].

Regarding the climate, it has been shown that there are negative effects on individuals depending on age, educational level, and race if the weather conditions are not suitable for outdoor PA, suggesting an accompaniment through an evaluation to estimate the suitability of the climate whether it is rainy, snowy, or sunny and the decision that the person has to make for the development of PA or exercise in adverse weather conditions [13]. In addition, it has been demonstrated that changes in environmental temperature or changes in the weather are factors or variables that allow the person to decide whether or not to perform PA [14,15], because changes in temperature of at least 10° F are a determining factor to adhere to the practice of PA [16].

In Chile, physical education (PE) is included in the school curriculum of educational institutions. This subject seeks the integral development of students through motor practice, to obtain biopsychosocial benefits, using available spaces, as well as the development of activities in the environment [17]. However, it is necessary to incorporate environmental education into curricular contents related to the fundamental objectives related to physical and motor activity in the natural environment [18]. It is for this reason that PE can contribute to the actions that must be taken to mitigate climate change, creating a cultural change on the part of students and teachers, in the integration of contextualized activities that contribute to the protection of the environment [19]. On the other hand, systematic reviews have demonstrated the potential effect of climate change on mental health, which may be associated with an increase in depression and post-traumatic stress disorder [20], global health implications related to climate change and cardiovascular disease [21], cancer and climate change [22], a review of climate change in human health related to allergies, autoimmunity, and the microbiome [23], systematic reviews on climate change, PA, and sport [24], and an umbrella review on the relationship between PA and climate change [25]. From this point of view, the connection between PA, PE, and climate change is crucial to promoting healthy lifestyle habits, encouraging the creation of healthy spaces for active travel that raise environmental awareness, and contributing to the formation of upright citizens who act responsibly regarding their health and the environment. This involves key elements such as the benefits of PA, the role of PE as a transformative space within the classroom, and the impact of unfavorable climate change due to its effects on cardiorespiratory diseases, food security, and water availability, among others [1–25].

However, to date, there is no evidence of a bibliometric review that has conducted an analysis of publications related to PA or PE and climate change or global warming. From this point of view, the development of bibliometric reviews makes it possible to evaluate and measure the information obtained in relation to a particular area of knowledge and

objectively verify the proliferation of the line of research, trends, researcher productivity, citations, keywords, countries, and more [26–31].

Following this logic, the development of a bibliometric review related to PA, PE, and climate change is necessary for the following reasons. First, this methodology would allow for mapping the state of knowledge on research related to these variables. Second, governmental and non-governmental organizations recognize the importance of PA and quality PE as a human right. Furthermore, when considering climate change or global warming, necessary actions can be taken to care for the environment. Therefore, PA and PE can be sustained over time; an example of this is Welch et al.'s study [16], where they indicated that temperature variability allows people to decide whether or not to engage in PA.

To our knowledge, this is the first bibliometric analysis, based on the traditional laws of bibliometrics, of documents published in journals indexed in the Web of Science (WoS) database specifically addressing the intersection between climate change and/or global change and physical activity and/or physical education. The general objective of this study was to conduct a comprehensive bibliometric analysis of the scientific production in this field, focusing on publication trends, the main researchers, and the main countries and journals interested in the subject, together with emerging topics of interest to researchers in this field. The specific objectives were as follows: (1) to examine annual publication trends in order to understand the evolution of scientific interest in the topic, its current status, and identifying the stage of development; (2) to identify the thematic categories, journals, and countries with the highest number of publications in this field, indicating in which disciplines knowledge of the subject is being developed, providing useful information to establish research divulgation strategies, as well as contributing a guide for potential future international research collaborations.

In addition, the secondary objective was to identify the most productive and prominent authors, helping to understand collaborative networks; establish strategic alliances between researchers or collaborative groups and/or to follow the most influential lines of research; highlight the most cited articles in the subject, providing documents that represent a substantial knowledge base and contributing information on which approaches have had the greatest impact among researchers; and determine the keywords most used by the authors, which can help to identify the most recurrent topics for researchers, emerging terms, or possible gaps in knowledge.

2. Materials and Methods

2.1. Design, Data Source, Procedures, and Analysis

A bibliometric analysis was developed based on the traditional laws of bibliometrics [32–50]. These include Bradford's law of dispersion, Zipf's law, and Lotka's law. These laws are based on well-established scientific formulae, and their scientific validity can be tested empirically [33–36,43].

The Web of Science Core Collection (WoSCC) was consulted and researched [51]; this is particularly beneficial for researchers interested in understanding the impact of their work. The Web of Science (WoS) is a valuable platform for researchers that provides access to numerous databases. It offers meta-analysis and citation trend tracking functions, ensuring high data integrity by excluding self-citations and duplicates. The WoS is widely used to identify high-impact articles, discover research areas, and perform bibliometric analysis [52]. The WoSCC includes more than 12,000 high-impact international journals. The WoSCC is one of the most prestigious databases for the scientific community [53]. WoS is a database with over 12,000 high-impact international publications across various fields. WoSCC users find high-impact articles, discover research areas, and identify trends. In

addition, the WoSCC provides a large amount of information on documents and is therefore one of the most widely used databases by researchers for bibliometric analysis [38].

2.2. Search Strategy

The search was performed on 2 January 2025 by searching three databases of the main collection of WoS: Citation Index Expanded (SCIE), Social Science Citation Index (SSCI), and Emerging Sources Citation Index (ESCI). To increase the accuracy and precision of the search, the tags TI (title), AB (abstract), and AK (Keywords) were used; in addition, quotation marks were used to perform exact searches, and two Boolean operators (AND/OR) were included to complete the search. The search strategy used was as follows: (TI = (("physical activit*" OR "physical education")) OR AB = (("physical activit*" OR "physical education")) OR AK = (("physical activit*" OR "physical education"))) AND (TI = (("global warning" OR "climate change")) OR AB = ("global warning" OR "climate change")) OR Ak = ("global warning" OR "climate change"))).

The inclusion criteria were defined as follows: articles indexed in the WoSCC within the three indicated databases identified through the search strategy. The exclusion criteria included articles that did not meet the search criteria and documents that were neither articles nor reviews. We did not limit the language or date of publication to "since" to ensure the inclusion of as many publications as possible, encompassing articles published in the WoSCC up to 2 January 2025.

To minimize bias in the filtering and selection process, we implemented strict control mechanisms, such as the PRISMA method [54].

Researchers A.D.-Z. and A.C.-P. conducted the search independently, ensuring that the same documents were obtained. The titles and abstracts of the publications were reviewed to verify that the inclusion criteria were met. Subsequently, data extraction was performed in plain text and .xls (Microsoft Excel 2016) format.

2.3. Data Process and Analysis

The Price/Dobrov law was applied to check the status of the scientific production on the topic according to the trend of annual publications [32,34,39]. The trend of annual publications was checked for an exponential growth rate based on the adjusted coefficient of determination (R^2) [28,39]. This law makes it possible to establish that a small group of researchers are responsible for a larger number of articles in that area of knowledge. These calculations were performed between the publication years (2008–2024). Previous years were excluded because there was no continuity. A graph was made to represent the current trend of publications, and R^2 was calculated using Microsoft Excel. Subsequently, a descriptive analysis was performed with the classification of the documents by WoS thematic categories.

To identify the journals with the highest number of publications on this topic, Bradford's Law of Concentration of Science was used [40–42]. Using this law, we identified the core journals that made up the top third of documents; the use of this law allows us to understand how scientific articles in this area of study are distributed in different journals. We then performed a descriptive analysis on these core journals, covering aspects such as journal name, publisher, number of documents, citations, normalized citations (citations per document), Journal Impact Factor (JIF), quartile, and the percentage of Gold Open Access.

To identify the most relevant documents, the Hirsch index (h-index) was used [33,43,55]. The h-index makes it possible to measure scientific performance, compare researchers, and compare the impact between journals, departments or institutions, and researchers. To make this determination, the documents were ordered in decreasing order according to the

number of WoS citations received, identifying as the most cited documents the h document with h or more citations. A graph of the distribution of documents and citations was made to establish the cut-off point with the h -index. In addition, measures of central tendency and dispersion (mean, median, interquartile range, and outliers) were calculated for the citations of the documents found [26,56]. These measures were presented graphically in a BoxPlot made with Microsoft Excel.

Subsequently, once the duplicate authors were eliminated and the names of the authors were standardized, Lotka's law was applied to determine the number of authors to be considered prolific. This law allows us to describe the distribution of the productivity of researchers in an area of study, considering that few of them publish many articles and most researchers publish a few or only one article. Lotka's law is calculated according to the following formula: the square root of the total number of authors. A graph with the distribution of papers by authors was generated to corroborate the correct application of Lotka's law. Co-authorship plots were performed in VOSviewer software (version 1.6.20) with the prolific authors [27,48].

To identify the prominent authors (prolific authors with articles among the most cited), the authors of the most relevant articles were crossed with the prolific authors [49]. This analysis allows us to discriminate the prolific authors with the highest relevance (prominent authors).

A descriptive analysis of the co-authoring countries was performed based on the number of articles per country. A graph was created in Microsoft Excel to show the relationship between co-authoring countries and their total citations.

An analysis of the frequency of the use of the author keywords was carried out, and a Word Cloud was created with the most frequently used words. Finally, to identify the author keywords [50] with the highest occurrence in the documents, Zipf's law was applied to the total author keywords [50]. This law describes the distribution of words according to their frequency. Co-occurrence graphs were made to find thematic clusters with VOSviewer and to analyze the temporal evolution of these concepts.

3. Results

A total of 281 documents were found. After applying the inclusion and exclusion criteria, 261 documents were analyzed. The documents eliminated were: 14 for being editorial manager, 5 Meeting Abstracts and one for being a correction.

Figure 1 shows the flow diagram up to the final set of documents. The document set consisted of 209 articles (80.1%) and 52 reviews (19.9%).

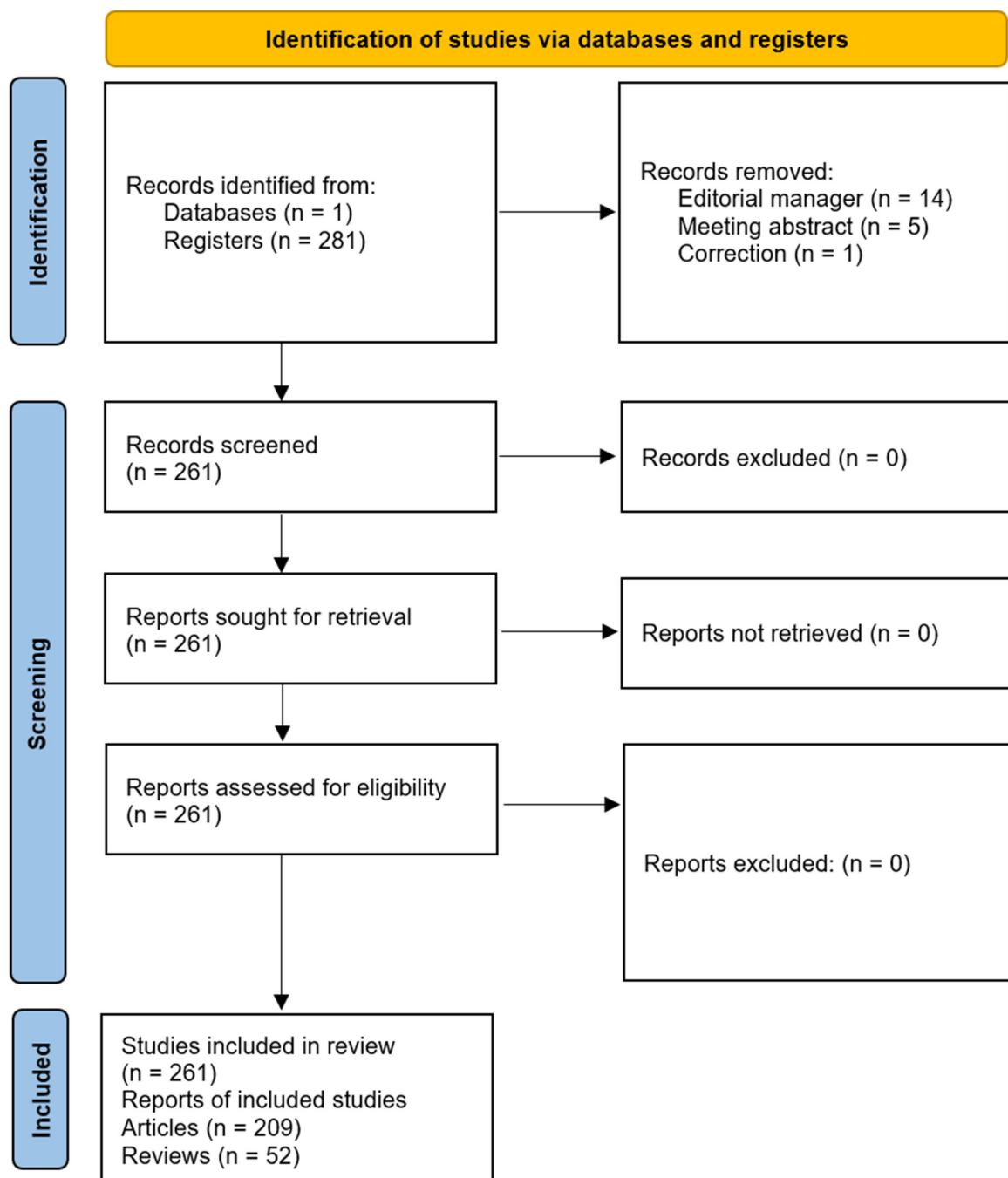


Figure 1. Flow diagram.

3.1. Annual Publication Trends

It was found that publications on the subject are in a phase of exponential growth ($R^2 = 90\%$). Over the last four years (2021–2024), total publications have tripled from 86 papers in 2020 to 261 at the time of analysis. The first paper on the subject was published in 2005 [57]. However, there was no continuity in annual publications until 2008; this continuity has not been interrupted to the present day. Figure 2 shows the frequency of publications according to years. Research related to global warming and/or climate change and physical activity (252 papers, 96.5%) predominated over research related to these topics and physical education (8 papers, 3.1%). In addition, a single paper was found that was simultaneously related to all terms (0.4%).

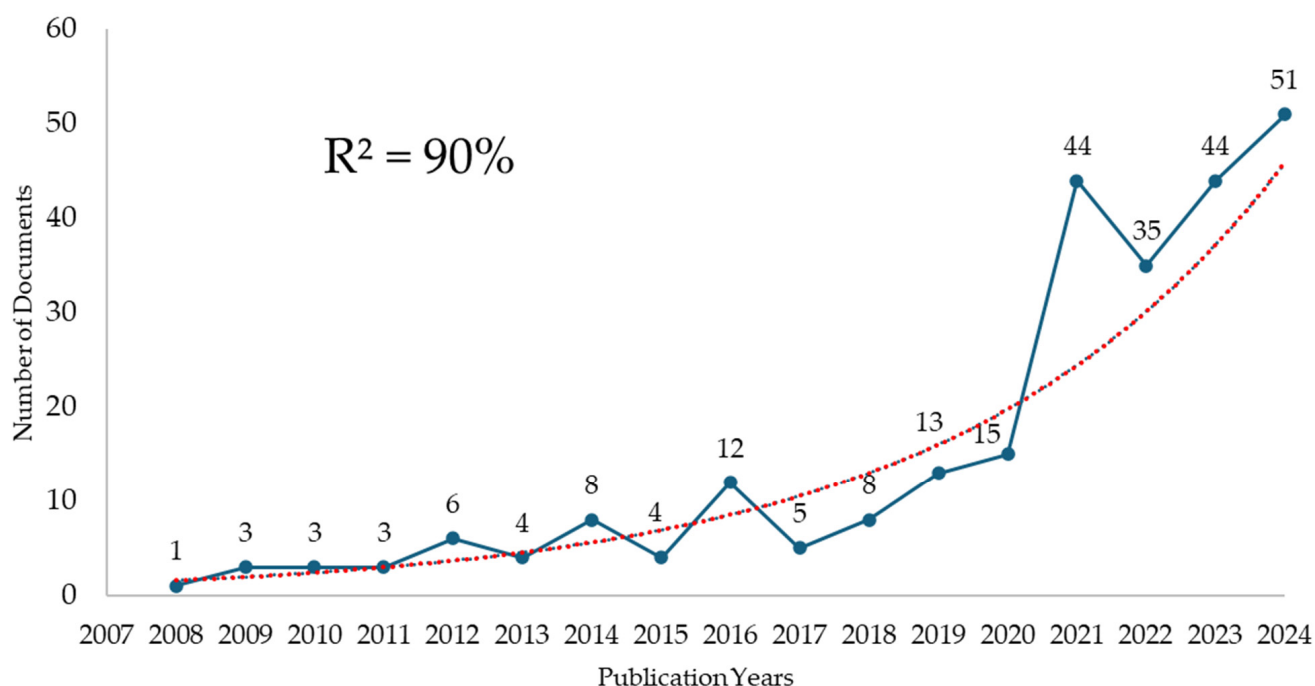


Figure 2. Annual publications trend. The blue points represent the frequency of publications in each year (x-axis). The red line is an exponential trend line.

3.2. WoS Categories

In these years, the object of study has been approached from numerous disciplines and areas of knowledge. Thus, the documents were related to 96 WoS thematic categories. The thematic categories related to the environment were the categories with the highest number of related documents: public environmental occupational health (91 documents), environmental sciences (68 documents), and environmental studies (24 documents). Other relevant thematic categories, according to the number of related documents, were sport sciences (17 documents), nutrition dietetics (14 documents), green sustainable science technology and medicine general internal (12 documents), meteorology atmospheric sciences (11 documents), and ecology and physiology (9 documents).

3.3. Most Cited Documents

The documents presented between 0 and 750 citations in the WoSCC. The median number of citations was seven (IQR = 20). Applying the h-index, 44 papers with 50 or more citations were highlighted, considering these as the most cited papers in the dataset. These results were reinforced after an analysis of the distribution of citations in the papers. Figure 3 shows a boxplot with the distribution followed by these citations. This boxplot shows that papers with more than 51 citations can be considered outliers. Among the rest of the most cited documents, five documents stood out with a range of citations between 244 and 750 [58–62]. The most cited papers can be consulted in the Supplementary Materials (Table S1. Most cited papers).

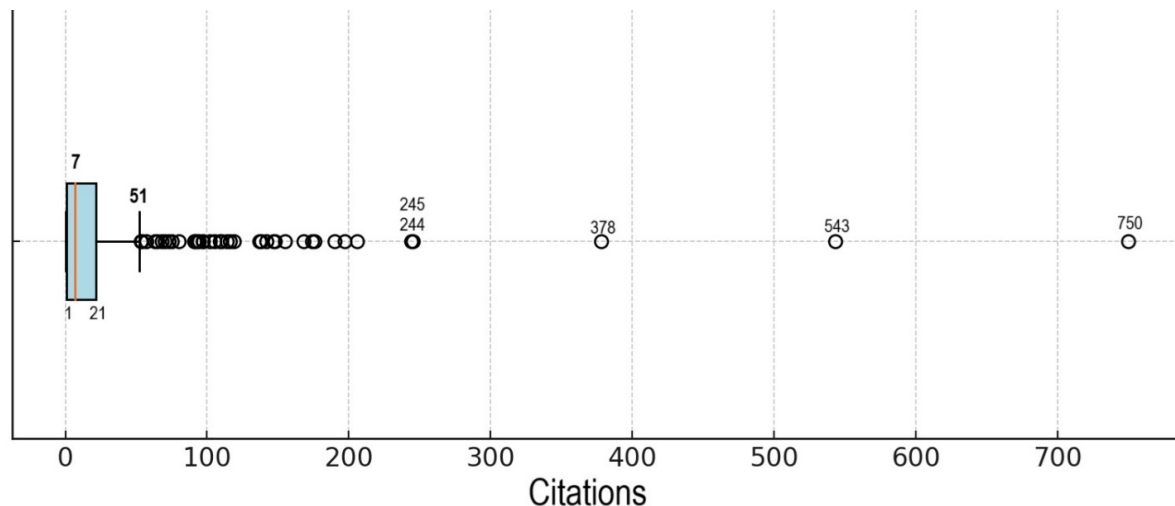


Figure 3. Boxplot with the distribution followed by the citations. The number 7 and the red line represent the median of citations per paper. The blue box represents 50% of the citations. Number 51 represents the upper limit.

3.4. Nucleus of Journals

The set of documents was distributed among 178 journals with a publication range between 1 and 13 documents. The core group of journals of the object of study consisted of 18 journals (10.1%); these journals accounted for 31.4% of the documents. These journals presented a publication range between 3 and 13 documents. The rest of the journals (160 journals, 89.9%) formed a wide Zone 1 with one (141 journals, 79.2%) or two (19 journals, 10.7%) documents, concentrating 68.6% of the documents. Given the wide peripheral dispersion of documents in journals with a low level of publication, it was not possible to segment the journals into Bradford's three classic zones, so the journals did not fit the theoretical distribution proposed in that author's law. Table 1 shows the core of journals, highlighting the *Journal of Physical Activity & Health* (Human Kinetics Journals) with 13 documents.

Table 1. Nucleus of journals.

Publication Titles	Doc.	Cit.	Norm. Cit.	JIF	Q.	% G.O.A.
<i>Journal of Physical Activity & Health</i>	13	303	23.3	2.9	Q2	5.1%
<i>BMC Public Health</i>	7	61	8.7	3.5	Q1	97.6%
<i>International Journal of Environmental Research and Public Health</i>	6	112	18.7	n.a.	n.a.	96.1%
<i>Environment International</i>	5	629	125.8	7.7	Q1	12.8%
<i>International Journal of Behavioral Nutrition and Physical Activity</i>	5	117	23.4	5.6	Q1	99.8%
<i>Sustainability</i>	5	67	13.4	3.3	Q2	99.6%
<i>Environmental Health Perspectives</i>	4	750	187.5	10.1	Q1	89.6%
<i>Environmental Research</i>	4	617	154.3	7.7	Q1	12.8%
<i>German Journal of Exercise and Sport Research</i>	4	26	6.5	1.6	Q3	83.6%
<i>Journal of Transport & Health</i>	4	95	23.8	3.2	Q2	26.4%
<i>Science of the Total Environment</i>	4	39	9.8	8.2	Q1	16.3%
<i>Environmental Science and Pollution Research</i>	3	16	5.3	n.a.	n.a.	7.2%
<i>Frontiers in Public Health</i>	3	10	3.3	3.0	Q2	99.6%
<i>Frontiers in Sustainable Cities</i>	3	24	8.0	2.4	Q2	91.1%
<i>Lancet Planetary Health</i>	3	109	36.3	24.2	Q1	76.3%
<i>Obesity Reviews</i>	3	71	23.7	8.0	Q1	40.2%
<i>PLOS One</i>	3	37	12.3	2.9	Q1	99.3%
<i>Urban Forestry & Urban Greening</i>	3	21	7.0	6.0	Q1	23.2%

Doc. (number of documents); Cit. (citations); Norm. Cit. (normalized citations: citations/documents); JIF (Journal Impact Factor); Q. (JIF quartile); % G.O.A. (percentage of Gold Open Access); n.a. (not applicable).

3.5. Prolific and Prominent Co-Authors

The entire production was the result of the work of 1398 authors. The publication range of these authors was between 1 and 10 papers. Figure 4 shows the distribution of authors according to the number of papers published.

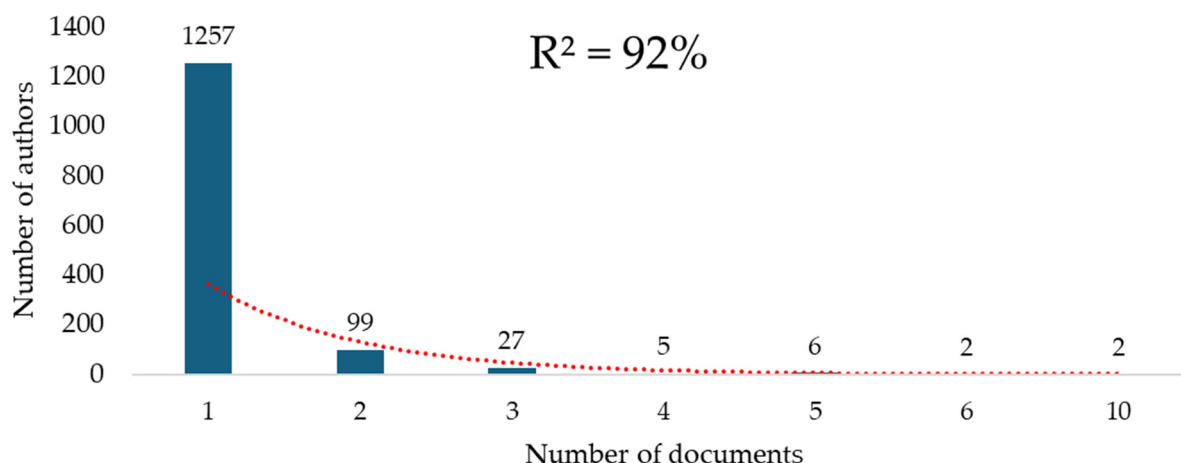


Figure 4. Distribution of authors by number of documents published. The bars represent the absolute frequency of the number of co-authors (y-axis) who have 1, 2, 3, etc., documents published (x-axis).

When Lotka's law was applied, it was estimated that the prolific authors would be the 37 with the highest number of published papers (square root of 1398). A total of 15 authors were found to have four or more papers, while 42 authors were found to have three or more papers, with the latter being considered the prolific authors. Among these authors, Eun-Young Lee and Mark S. Tremblay (10 papers) stood out as the authors with the highest number of published papers. The prolific authors and their collaboration networks are shown in Figure 5. In this graph, it can be seen how the prolific authors E.-Y. Lee and Mark S. Tremblay publish within a large collaborative network with other prolific authors (Cluster Network). Figure S1 shows this same network of authors according to the average year of publication of their papers.

Cross-referencing the prolific authors with the authors of the most cited papers identified 24 prominent authors, all of them with three or more published papers and at least one of them among the most cited papers. Prominent authors included M. Nieuwenhuijsen (five papers, five most cited papers), H. Khreis (four papers, four most cited papers), A. Woodward (four papers, three most cited papers), J. Woodcock, and J.D. Rojas-Rueda (three papers, three most cited papers). As shown in Figure 5, these prominent authors published in different collaborative networks (blue and yellow cluster). The prominent authors are shown in Table 2.

Table 2. Prominent co-authors.

Publication Titles	Cluster	Doc.	Cit.	Most Cited Papers
Nieuwenhuijsen, M.	Blue	5	741	5
Khreis, H.	Blue	4	564	4
Woodward, A.	Yellow	4	1088	3
Rojas-Rueda, D.	Blue	3	346	2
Woodcock, J.	Yellow	3	852	2
Lee, E.-Y.	Red	10	210	1
Tremblay, M.	Red	10	198	1
Bhawra, J.	Purple	6	167	1
Katapally, T.	Purple	6	167	1
Vanderloo, L.	Red	5	162	1

Table 2. Cont.

Publication Titles	Cluster	Doc.	Cit.	Most Cited Papers
Bernard, P.	n.a.	4	139	1
Morrison, S.	Red	4	172	1
Anenberg, S.	n.a.	3	72	1
Aubert, S.	Red	3	183	1
Cagas, J.	Red	3	179	1
De Nazelle, A.	Blue	3	96	1
Hallal, P.	Sky	3	113	1
Huang, W.	Red	3	171	1
Jeon, J.	Red	3	171	1
Kim, Y-S.	Red	3	171	1
Milner, J.	Yellow	3	150	1
Nader, P.	Red	3	171	1
Schipperijn, J.	Sky	3	110	1
Shaw, C.	Yellow	3	75	1

Doc. (number of documents); Cit. (citations); n.a. (not applicable).

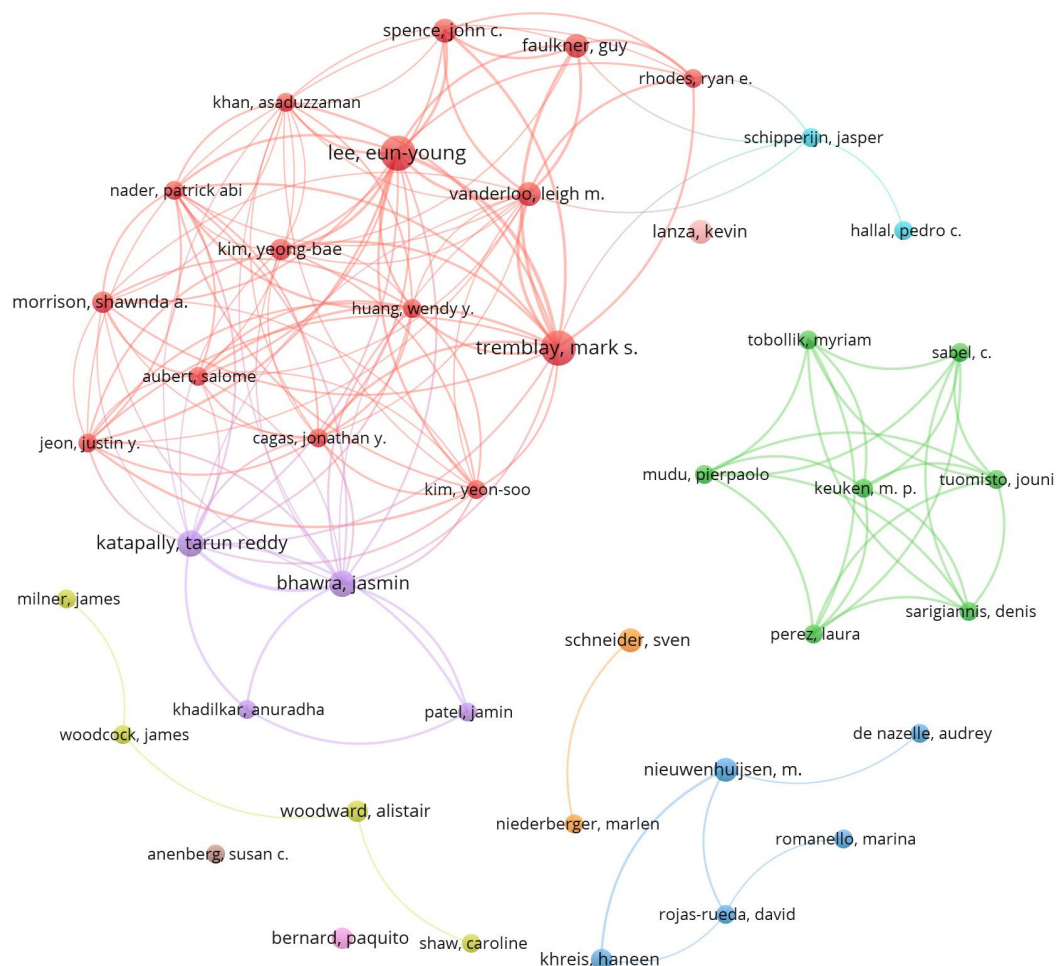


Figure 5. Prolific authors. Node size: occurrences (number of publications). Color cluster: cluster membership based on collaboration patterns. Line thickness: association strength based on number of co-authored documents.

3.6. Countries

There is a global interest in the subject, with researchers being from up to 70 countries around the world. The USA (89 papers) was the leading country in the world in terms of the production of research on this topic, followed by countries such as the United Kingdom (58 papers), Canada (41 papers), Australia and Germany (36 papers), China (28 papers), as

well as other European countries such as Spain (19 papers), France (16 papers), Sweden (15 papers), and Italy and the Netherlands (12 papers). Figure 6 shows a global map highlighting the countries involved in the development of the object of study.

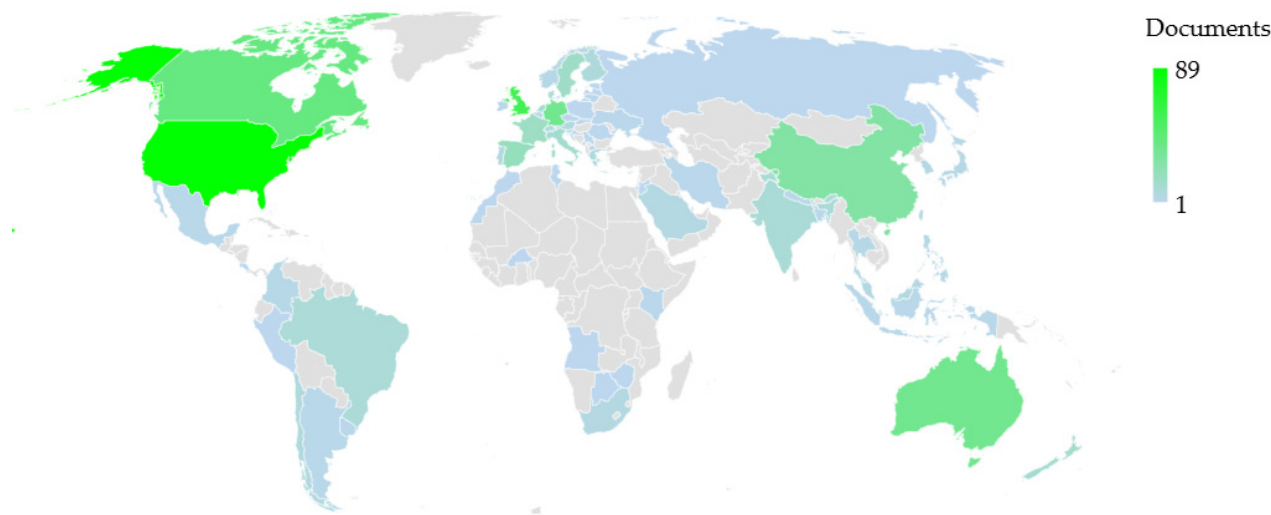


Figure 6. Global production map of publications of documents.

3.7. Author Keywords

By applying Zipf's law to the 821 author keywords used in the 261 documents, it was estimated that the most relevant keywords should be the 29 with the highest frequency of use (square root of 821). In total, 94.5% of the keywords (776) had a low frequency of use, between 1 and 3, with 680 of them (82.8%) only being used once. On the other hand, there were also keywords with a high frequency of use. There were 45 keywords used in four or more documents (Figure 7), 35 keywords used in five or more documents, and 25 used in six or more documents. Figure S2 shows the distribution of keywords according to frequency of use.

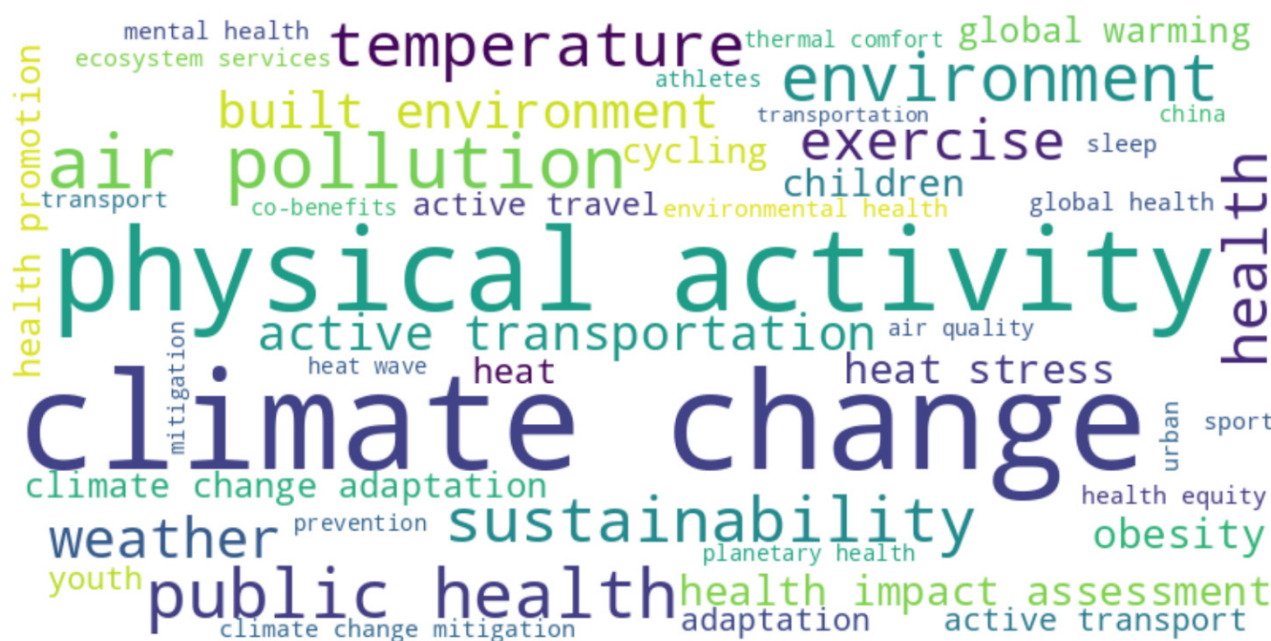


Figure 7. Word Cloud with 45 most used author keywords. Larger word size indicates higher concurrency.

Since Zipf's law estimated 29 keywords, the 25 keywords with six or more documents were considered the most relevant concepts for the authors. Figure 8 shows the 25 most used keywords. Among these keywords, climate change (81 occurrences), physical activity (58 occurrences), air pollution (18 occurrences), public health (15 occurrences), environment (14 occurrences), sustainability and temperature (13 occurrences), health (12 occurrences), and exercise and weather (10 occurrences) stood out. Among others, two large thematic clusters were found: one around the concept of climate change (red cluster), together with terms related to health, heat, or global warming, and the other around the physical activity concept (green cluster), together with terms related to active transportation and pollution. Exercise, health promotion, and active travel were the terms with the most current average year of publication (Figure S3).

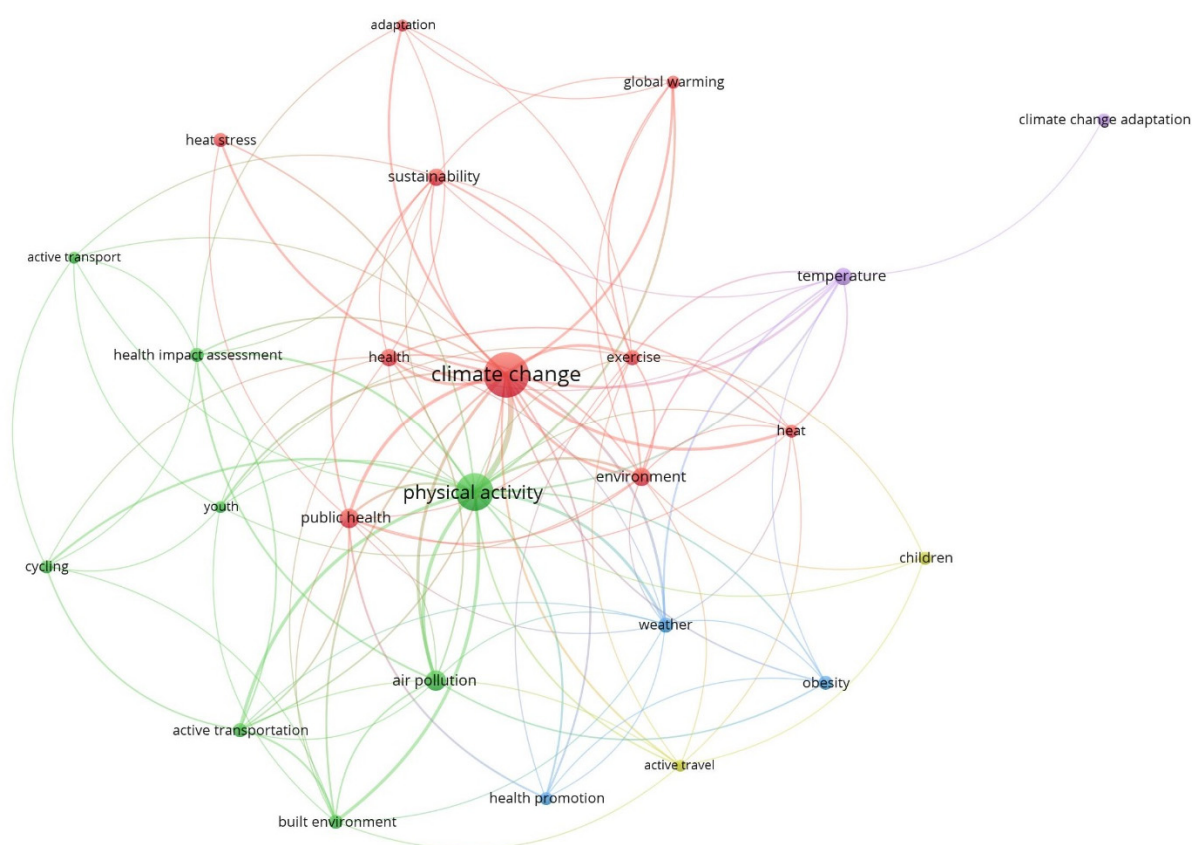


Figure 8. Most used author keywords graph. Node size: occurrences. Color cluster: thematic cluster based on author keyword co-occurrences. Line thickness: association strength based on number of co-authored documents.

4. Discussion

This research is the first to perform a bibliometric analysis of physical activity or physical education and global warming or climate change in papers indexed in Web of Science (WoS). It was found that this object of study is in a phase of exponential growth, which demonstrates the high level of interest from the scientific community. In addition, this study shows the annual publication trends, the WoS categories with the highest number of related papers, the most cited papers, the core journals of this topic, as well as the prolific and prominent co-authors, countries with the highest number of papers, and the keywords most used by the authors.

4.1. Annual Publication Trends, WoS Categories, and Nucleus of Journals

Regarding the exponential growth of research, there was a strong increase between 2021 and 2024. This could be related to international commitments or agreements, such as the renewed focus of the Paris Agreement in 2021 [63] or COP 26, COP 27, and COP 28 [64], which aim to contribute to and encourage the development of research for the design and implementation of climate change mitigation and adaptation strategies.

Regarding the interest in and global approach to the subject of study, there are numerous disciplines or areas of knowledge concentrated in the largest number of papers: first, public environmental occupational health; second, environmental sciences; and third, environmental studies. However, disciplines or areas related to sports science, nutrition and dietetics, general internal medicine, atmospheric meteorology, and ecology and physiology have also been found in smaller quantities. However, the main thematic categories did not include those specifically related to education. Only education educational research and education special appeared with three papers and one paper. This was due to the low current production of research related to climate change and/or global warming and physical education, as only eight specific papers were found, while one paper was found including PA and PE. This paper [65] was a bibliometric review based on research on PA in the natural environment within the context of physical education and cited that in the current context, with advancing climate change, it is necessary to educate new generations about sustainable practices in the natural environment.

In addition, a total of 178 journals have published at least one document and at most thirteen related to the subject of study, with a total of 18 journals forming the main core of the object of study. More than 50% of the core journals are journals that publish mostly in Gold Open Access. However, the journal with the highest number of publications, the *Journal of Physical Activity & Health* (Human Kinetics Journals), is a hybrid journal with a high percentage of articles published as subscription and free to read (Bronze Open Access). This journal aims to inspire significant change in the way the world views the relationship between physical activity and health by publishing in Occupational Environmental Public Health and presenting some of the most highly cited articles in the dataset [66,67].

4.2. Most Cited Documents, Prolific and Prominent Co-Authors, Prolific Authors, and Countries

As for the most cited articles, a total of 44 documents with 50 or more citations are highlighted. Among them, five papers stood out with a range between 244 and 750 citations [58–62], which point out the importance of the use of active travel or active commuting, car-free cities and the construction of environments based on green areas to combat climate change, obtain health benefits through these actions, and promote PAAs for the authors. E.-Y. Lee and Mark S. Tremblay were outstanding for their great production, appearing at the center of the main group of collaboration with researchers from all over the world. It was M. Nieuwenhuijsen and H. Khreis who were identified as the main prominent authors, forming a collaborative group with up to six papers among the most cited related to CO₂ emission-free cities, urban design for health, and personal or shared bicycle use for health improvements, air quality, and urban redesign [62,68–72]. Authors and countries are linked. If a country presents many papers, it may be because there are many researchers publishing something about it and/or a few publishing a lot. Canada appears in third place among the countries that produce the most, but only two of the authors belong to that country. The countries with the highest number of documents published are the USA, followed by the United Kingdom, both with more than 50 published documents. On the other hand, Spain, France, Sweden, Italy, and the Netherlands have less than 20 documents published. The United States and the United Kingdom were the countries with the highest number of publications, followed by Canada. The Canadian origin of the prolific authors

Lee and Tremblay makes it not surprising that this country is among the world leaders in production. In the case of the USA, this may be related to interests in the areas of research for the development of new knowledge and the economic investment required in these areas applicable to public health [73]. The addition of the other countries can be linked to the commitment made in the Paris 21 Agreement to reduce global emissions and build climate resilience through increased investment and financing to achieve climate goals [74].

4.3. Author Keywords

As far as keywords are concerned, a total of 821 keywords were used, of which only 29 were the most used, estimated according to Zipf's law of 25 keywords in six documents. It is important to note that 3% of the keywords were the most used; this confirms the importance of the use of keywords available in repositories or thesauri related to the research areas, thus promoting the visibility of the research and improving the impact, recovering the relevance in the use of the correct words in the titles, abstracts, and keywords of a research article [75–79].

The most used keywords were climate change and PA. At the same time, there were keywords that could be associated with these two most used keywords. Within these keywords associated with climate change and PA we found temperature, air, public health, air quality, health, transportation, and active transportation, among others. However, the latter term active transport, from physiology, may be associated with active transport as it is a cellular process that moves molecules across the cell membrane [80], but in terms of PA or sustainable transport, it is related to moving from one place to another either by walking or cycling, among other travel modes [81]. However, for this definition of commuting modes, there is the definition of active commuting or passive commuting [82,83]. This suggests a review of the use of the keywords related to active commuting, active travel, and active transport.

4.4. Limitations and Strengths

As for the limitations of the review, they are related to the use of and dependence on the databases indexed in the WoS main collection. This ensures the quality of the documents, the standardization of publication processes, and quality indicators, although it limits access to documents indexed in other databases. Another limitation is related to the analysis of documents developed mostly in English over other languages. Although we did not limit the search by language, the search vector only included English terms, which may have limited access to documents written in other languages. And finally, due to the type of analysis and the software available, it is not possible to dive deeper into the content, validity of the research, or conclusions provided by the identified documents.

As for the strengths, this study allowed us to analyze patterns, metrics, number of citations, authors, and keywords among the documents, which meant we could identify where the research topic is heading. Another strength is related to the identification of authors, collaboration networks, and the number of articles published per year, which shows the growth of the research topic and the years in which it grows exponentially. And as a last strength, it is related to the analysis of information and its growth; in this way, new topics, areas, or available gaps that can be addressed can be identified.

The development of this bibliometric review could have an impact on the development of public policies because it implies the review of research related to the implications of policies in research, which could generate a constant feedback loop of them, which are carried out by the researcher [84,85]. For this case of climate change and PA or PE, it is possible to verify the status of research related to climate change and education, since PE is a discipline of pedagogy that seeks through the practice of PA the integral development

of people, contributing to the ultimate goal of education, which is the creation of integral human beings for the society in which they participate [86].

4.5. Practical Implications, Health Impacts of Physical Activity, and the Consequences of Climate Change

For the development of future research related to the field of study, the use of keywords already available in repositories or thesauri of words available for the type of research and study variables is recommended. In addition, this review provided valuable content on a topic of governmental and non-governmental relevance, which could allow for the construction of educational or health policies to raise awareness among the population about the effects of global warming or climate change on the body during PA practice or in the PE class.

Physical activity not only reduces the risk of chronic diseases but also eases the burden on health systems by preventing these conditions. Therefore, it should be integrated with government and community initiatives that promote green spaces, reduce pollution, and foster healthy communities. Combining PA promotion with climate change policies can have a positive impact on public health and the environment [85,87].

In addition, a small number of studies addressing PE and climate change or global warming have been evidenced in this research, which could be an emerging research niche, which could be in line with the national and international agreements of the SDGs.

4.6. Future Lines of Research

Based on the findings of this bibliometric analysis, several key lines of research have been identified to strengthen the current knowledge on the relation between PA, PE, and climate change.

First, there is a need to investigate how education systems are or are not integrating environmental sustainability into PE programs. Future research could focus on teacher training and pedagogical models that promote climate change literacy through PA.

Another future line with great social impact is to explore the relationship between active school transportation and environmental conditions. In this sense, it is necessary to study how climatic variables, such as air quality, temperature, and others, influence the mobility decisions of children and adolescents, and how school and urban policies can support active travel in the face of certain climatic risks.

On the other hand, natural and built environments should be analyzed as either facilitators or barriers to PA in the context of climate adaptation. This includes examining access to green space and urban planning in relation to public health and sustainability objectives.

In addition, technological innovations can contribute to measuring, promoting, and adapting PA in areas affected by climate change, especially in vulnerable communities.

Moreover, interdisciplinary approaches are needed to assess how public and educational policies integrate PA promotion with environmental sustainability. Comparative and mixed-methods studies can provide effective strategies to help communities better adapt to the effects of climate change while promoting health and PA.

Finally, future research could use innovative methodologies, such as ethnographic or longitudinal designs, to understand the experiences of people engaging in physical activity under changing climatic conditions. Such research can help estimate the long-term impact of climate change on PA patterns and health.

These lines of research can help improve current knowledge and support policies, educational reforms, and community interventions aligned with the Sustainable Development Goals.

5. Conclusions

This bibliometric analysis found that research on physical activity and education, climate change, and global warming has experienced exponential growth in recent years, demonstrating the existence of a growing interest in this field.

The thematic categories with the highest volume of papers that contributed to the topic were environmental studies and sciences, as well as studies related to environmental and occupational public health.

A core of 18 journals was identified, highlighting the *Journal of Physical Activity & Health* as the journal with the highest number of papers. However, the journals did not follow Bradford's distribution, and there was a large peripheral dispersion with a large number of journals with a low publication volume in the subject.

In terms of production, authors such as M.S. Tremblay and E.Y. Lee led a large global collaborative group, with Lee leading a large group of global collaboration. In this sense, the USA, the UK, and Canada were the countries with the most documents. However, by quantity and relevance of their publications, M. Nieuwenhuijsen and H. Khreis were the prominent authors.

Strategies to reduce greenhouse gas emissions and urban natural environments to improve public health were the topics of the most cited articles. The themes of these articles were in line with the most used keywords by researchers, which were climate change and PA mainly; however, a total of six or more papers were identified as using the 25 most relevant keywords considered by the authors according to Zipf's law. Although the keywords used are related to physical education, they were not evident in the analysis obtained in the results, so it is suggested that a more detailed analysis of research related to physical education and climate change should be carried out.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/soc15060161/s1>, Table S1. Most cited papers; Figure S1. Prolific authors. Score: average publication years; Figure S2. Distribution of author keywords by number of occurrences; Figure S3. Author keywords graph. Score: average publication years.

Author Contributions: Conceptualization, A.C.-P. and J.C.A.; methodology, A.C.-P. and J.C.A.; software, D.S.-G.; formal analysis, A.D.-Z. and D.S.-G.; investigation, A.C.-P., A.D.-Z., M.F.-R., M.P.-E. and J.C.A.; data curation, A.D.-Z. and A.C.-P.; writing—original draft preparation, A.C.-P., D.S.-G., A.D.-Z., M.F.-R., M.P.-E. and J.C.A.; writing—review and editing, A.C.-P., D.S.-G., A.D.-Z., M.F.-R., M.P.-E. and J.C.A. All authors have read and agreed to the published version of the manuscript.

Funding: The author Angel Denche-Zamorano was supported by the Spanish Ministry of Education, Culture and Sport, grant number FPU20/04201, funded by the Spanish Ministry of Science, Innovation and Universities, grant number MCIN/AEI/10.13039/501100011033, and funded, as appropriate, by the "European Social Fund Investing in your future" and the "European Union NextGenerationEU/PRTR".

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

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

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