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REVİEW ARTICLE

Scientific Production on Para Athletics: A Bibliometric Review

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Abstract

The aim of this bibliometric review was to perform a quantitative and qualitative bibliometric analysis using science mapping techniques, to investigate publication trends, author network clusters, and keyword occurrence linked to the scientific production in the sport of Para Athletics (PA). Studies related to PA were identified throughout a search across the databases PubMed, Scopus, and Web of Science (Core Collection). From an initial pool of 2,350 documents, 149 were deemed eligible and incorporated into the study. Most studies were published in the last 10 years, mainly in journals related to the fields of sport sciences and rehabilitation. The keyword analysis revealed 364 unique keywords, 8 distinct clusters, 287 connections. Bibliometric examination unveiled 21 authorship network clusters, comprising 260 links. Countries that contributed with most research (75.7% of all published articles) includes United States, Canada, Brazil, United Kingdom, Germany, Netherlands, Spain, South Africa, Japan, and Australia. Research related to PA has increased exponentially in recent years, particularly in the fields of sport sciences and rehabilitation. Collaborative research (authorship network clusters) seems prevalent, and all continents demonstrated participation in published studies, albeit with different relative contributions.

Keywords
Bibliometrics, Para-Athletes, Paralympic Athletes, Adaptive Sports, Para Sport

INTRODUCTION

In recent years, the undeniable growth of Paralympic sports has become increasingly apparent, reflecting a surge in participation, expanded sports offerings, and heightened global recognition (Dehghansai et al., 2020). Despite this increasing field of study, there is a deficiency in progress and a significant knowledge gap regarding the development of Paralympic athlete programs, particularly at the long-term (Patatas et al., 2018). This gap is particularly evident in Para Athletics (PA), the adapted version of athletics and the most widely practised Paralympic sport (Kim & Hong, 2022). Specifically designed for athletes with visual, intellectual, or physical impairments (IPC, 2022), PA includes various athletic events modified to meet these athletes' unique needs and capabilities (Holdback et al., 2024).

PA made its debut as a Paralympic sport in Rome in 1960 featuring 25 medal events and 31 para athletes in total. The sport has been featured in every subsequent edition and is currently under consideration for inclusion in the Games of Paris 2024 (IPC, 2024), where PA will award 164 medal events involving ~1069 athletes (IPC, 2024). The evolution and continuous development of PA has evidenced the need to conduct collaborative research to optimize sport classification, health, performance, and rehabilitation of paraathletes (Thompson & Vanlandewijck, 2021; Tweedy et al., 2018).

With the upcoming Games of Paris 2024 on the horizon, a bibliometric analysis of PA can help to obtain a comprehensive overview of the available

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research by mapping the cumulative scientific knowledge and thus providing valuable guidance for future investigations in the field (Andrade et al., 2013; Donthu et al., 2021). Therefore, this study aims to perform a quantitative and qualitative bibliometric analysis using science mapping techniques to investigate publication trends, author network clusters, and keyword occurrence linked to the scientific production in the sport of PA.

MATERIALS AND METHODS

Registration

The bibliometric study protocol was registered on the Open Science Framework (OSF) platform on January 22, 2024 (https://dx.doi.org/10.17605/OSF.IO/Y9284).

Search Engines

The bibliographic search was conducted on January 23, 2024, in the PubMed, Scopus, and Web of Science (Core Collection) databases.

Search Strategy

The following keywords were selected in English: “Paralympic,” “Paralympian,” “disabled athlete,” “para-athletics,” “para-athlete,” “para athletics,” “para athlete,” “adapted athletics,” “adaptive athletics,” “adapted athlete,” and “adaptive athlete”. Keywords in Spanish included: “para atletismo,” “para-atletismo,” “atletismo adaptado,” “atleta adaptado,” and “paraatletismo”. These keywords were combined using AND/OR boolean markers with no date restrictions up to January 23, 2024. The detailed search strategy is provided in Table 1.

Eligibility Criteria

As inclusion criteria, all articles published in peer-reviewed journals focusing on PA were selected. Exclusion criteria involve documents i) not directly relevant to the field of PA (e.g., those only mentioning PA but not addressing topics related to this specific area), ii) centred on other Paralympic sports, iii) that provided non-specific information regarding PA (e.g., studies that mixed PA participants with other sports presenting data in a way that impeded the extraction of specific information regarding PA), iv) published as notes, letters to the editor, conference proceedings, books, and editorials. Review articles were not included in the final selection, although they were examined to identify potential eligible articles. Documents in English and Spanish were included.

Table 1. Full search strategy for each database.

Database	Search Strategy	Results retrieved
PubMed	((((("paralymp*" OR "disabled athlete*"[Title/Abstract]) OR ("para-athlet*"[Title/Abstract]) OR ("para athlet*"[Title/Abstract]) OR ("adaptive athlet*"[Title/Abstract]) OR ("adapted athlet*"[Title/Abstract]) OR ("para-atlet*"[Title/Abstract]) OR ("para atlet*"[Title/Abstract]) OR ("atletismo adaptado"[Title/Abstract]) OR ("paraatletismo"[Title/Abstract])) AND ("track and field" OR "track & field" OR "paralymp*" OR "paralimpic*")))	1,536
Scopus	(TITLE-ABS-KEY ("disabled athlete*" OR "para-athlet*" OR "para athlet*" OR "adaptive athlet*" OR "adapted athlet*" OR "para-atlet*" OR "para atlet*" OR "atletismo adaptado" OR "paraatletismo")) AND ("track and field" OR "track & field" OR "paralymp*" OR "paralimpic*")	598
Web of Science	(((TS=("paralymp*" OR "disabled athlete*" OR "para-athlet*" OR "para athlet*" OR "adaptive athlet*" OR "adapted athlet*" OR "para-atlet*" OR "para atlet*" OR "atletismo adaptado" OR "paraatletismo"))) AND ALL=("track and field" OR "track & field" OR "paralympi*" OR "paralimpic*"))	216

Bibliometric Analysis

Utilizing bibliometric techniques (Donthu et al., 2021) we navigated through databases to reveal patterns, trends, key insights, authors, and keywords associated with PA. Advanced science mapping was used to explore networks and clusters within publications, authors, and keywords, visually representing the scientific scenario in PA. Performance analysis was utilized to examine total publications, top ten journals, and foremost contributing countries. The findings of the bibliometric analysis were interpreted to discern emerging trends, highlight prolific authors, and identify critical thematic clusters following the

BIBLIO guidelines (Montazeri et al., 2023). The bibliometric analysis was conducted using the VOSviewer software 1.6.19 (Leiden University, Leiden, The Netherlands).

RESULTS

Study Identification And Selection

The preliminary search produced 2,350 titles and was imported into the EndNote™ reference manager software 20.6 (Clarivate Analytics, Philadelphia, PA, USA) for further processing. Duplicates (n = 435) were then manually reviewed and removed. The remaining 1,915 titles underwent screening for relevance, considering abstracts and titles. Out of these, 1,761 titles were excluded. Additionally, 18 records identified by inspecting the references of review articles identified during the database search were added. Figure 1 provides a summary of the final inclusion of 149 articles.

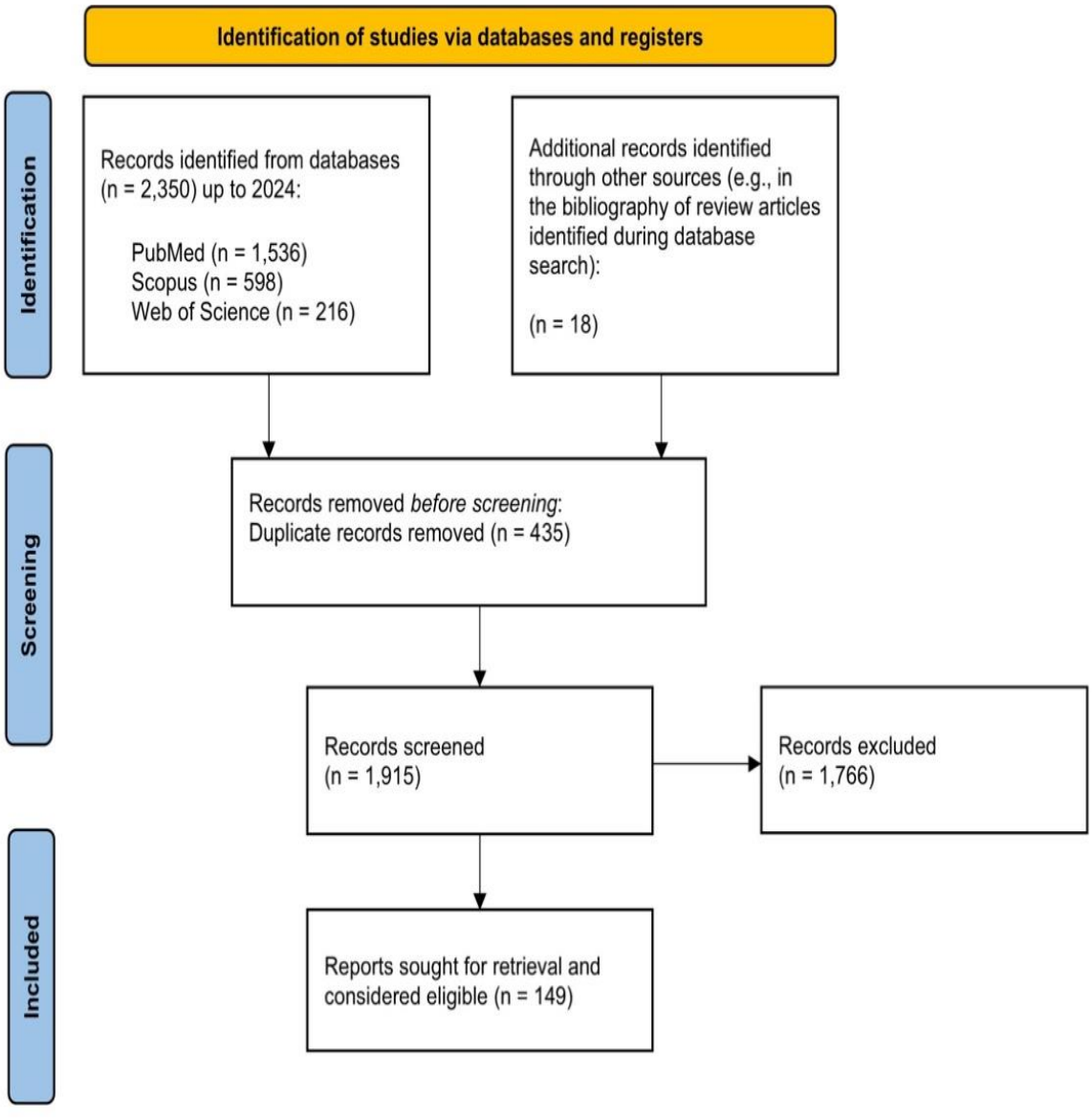

Figure 1. Flow chart of study selection in the review

Trends in Publication in Para Athletics

Figure 2 shows a graph of the scientific production related to PA over the years (i.e., from 1979 to early 2024). Additionally, it illustrates the cumulative count of publications over time. The top ten journals (by number of publications) where PA articles were published is shown in Table 2.

Keywords Analysis

The keyword analysis utilized the predetermined threshold, necessitating a minimum of two appearances for each keyword in the dataset (Figure 3). A total of 364 unique keywords were recognized, resulting in the creation of 8 distinct clusters. These clusters comprised 287 connections, contributing to a cumulative link strength of 365.

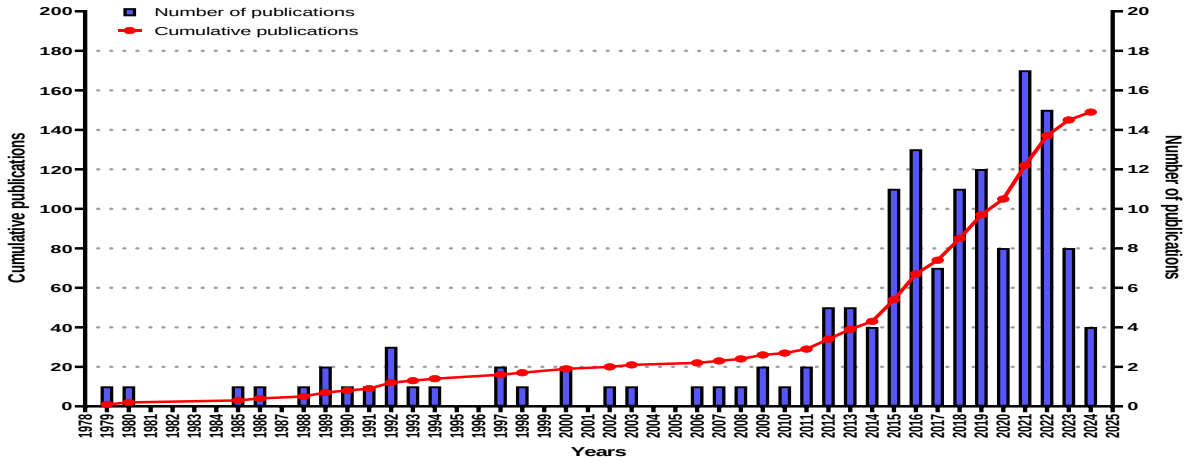

Figure 2. Yearly publication count and cumulative publications on Para Athletics over the years 1979-2024

Table 2. Ranking with the top 10 journals featuring publications on Para Athletics

Rank	Journal	Impact factor	Documents	Citations	Citations per document
1	Prosthetics and Orthotics International	0.8	12	107	8.9
2	Adapted Physical Activity Quarterly	1.7	10	136	13.6
3	Medicine & Science in Sports & Exercise	4.1	10	370	37.0
4	Paraplegia	2.1	6	119	19.8
5	British Journal of Sports Medicine	11.6	5	241	48.2
6	American Journal of Physical Medicine & Rehabilitation	2.2	5	128	25.6
7	Sports Biomechanics	2.0	5	20	4.0
8	PLoS ONE	2.9	4	41	10.3
9	International Journal of Sports Physiology and Performance	3.5	3	31	10.3
10	Journal of Sports Sciences	2.3	3	17	5.7

Note: data obtained from Scopus database.

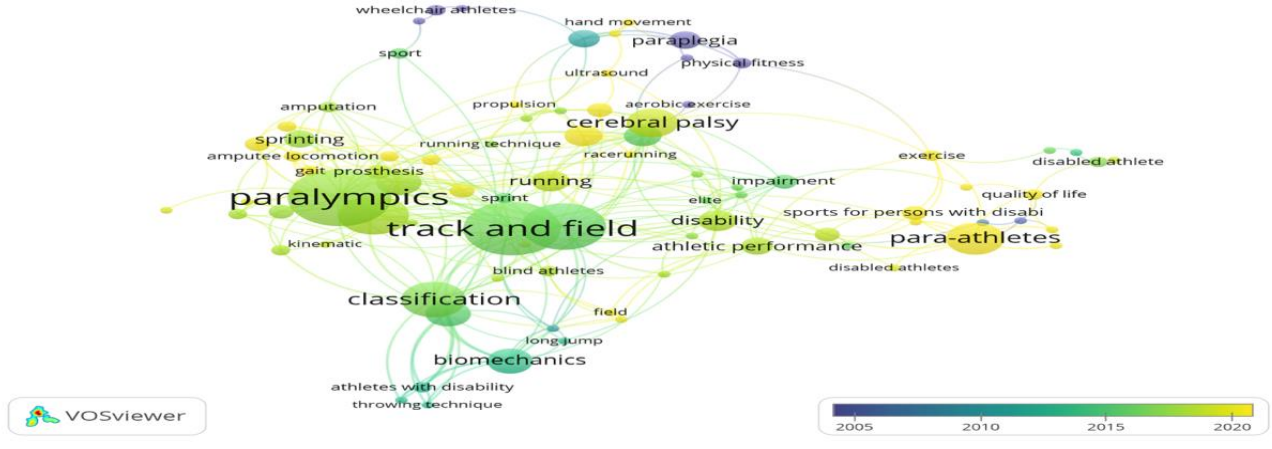

Figure 3. Keyword network visualization in Para Athletics research

Notes: the size of the bubbles denotes the number of times a keyword appears in published documents. Bubble colours represents the years of publication. Lines between bubbles denotes keyword co-occurrence in the same document.

Authorship

Applying the association strength method with a cluster resolution set at 1.00 and considering co-authorship connections involving a minimum of 2 documents per author (out of a total of 540 authors, 104 authors surpassed this threshold), our examination unveiled 21 clusters (taking into consideration the association strength method for normalization). These clusters comprised 260 links in total, contributing to a cumulative link strength of 576. Figure 4 provides a visual representation of the authorship network evolution over time. Connection weights are determined by document count. Details about the countries contributing to scientific articles related to PA can be found in Figure 5.

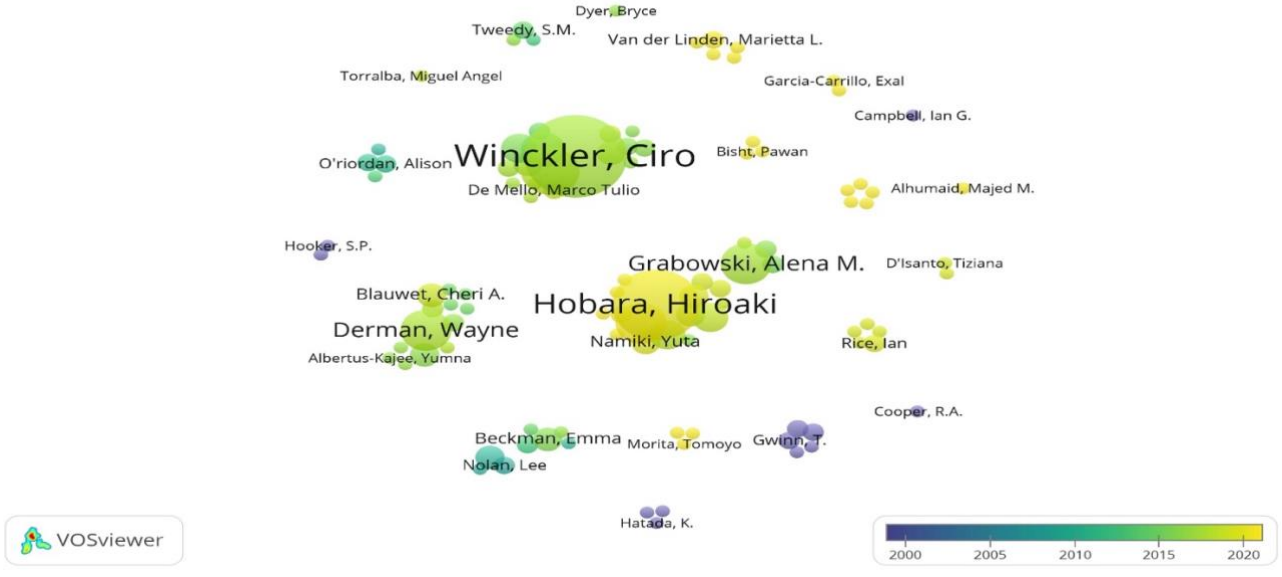

Figure 4. Visual representation overlaying authorship of publications on Para Athletics.
Notes: the size of the nodes indicates the publication output of authors.

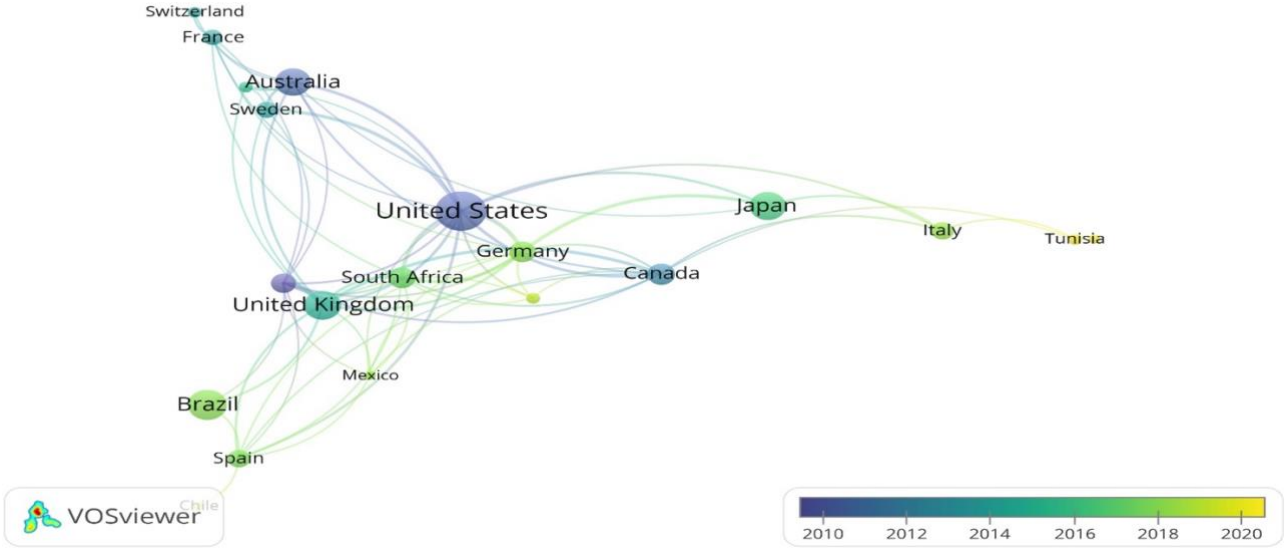

Figure 5. Image overlay representing countries contributing with publications related to Para Athletics
Notes: each color-coded country node indicates the volume of publications, indicating the international scope of research contributions. Connecting lines reveal collaborative efforts among different nations.

DISCUSSION

Growth in Paralympics is evident not only with the notable 10-fold rise in competitors from Roma in 1960 to London in 2012 (400–4237) (Leprêtre et al., 2016), but also in the scientific interest and the advancement in technology supporting para athletes (e.g., prostheses and wheelchairs) (Burkett, 2010). This development is also reflected in our examination of PA scientific publications over time, revealing a significant increase, particularly since 2010. Moreover, the quantity of PA articles is higher compared to other Paralympic sports, such as Para Cycling or Para Rowing (Puce et al., 2023; Umar et al., 2023). Specifically, between 1979 to 2010 it was observed a mean of 1.3 yearly publications related to PA, increasing to 9.1 yearly publications from 2011 to 2023. Remarkably, the publications in the top ten journals with the higher number of published studies (Table 2) received a mean of 19.2 citations per document (between 4.0 to 48.2 citations per document). A plausible explanation for this evolution could be linked to the Rio 2016 and Tokyo 2020 Paralympic cycles, given that two of the clusters of authors with the highest productivity are from the host countries of these games (Figure 4). The development of the evidence-based sports classification system, started in 2007 is a further important milestone for para sport. This process, led by the Australian research cluster, has been key in shaping best practice for Paralympic classification. It was essential to ensure that these classification systems have been developed and improved significantly in order to be a level playing field throughout all different types of impairments. In addition, these initiatives have helped to improve the knowledge of optimal performance indicators and functional abilities alongside impairments in athletes (Connick et al., 2018; Tweedy et al., 2014).

An exploration into the evolution of keyword patterns revealed characteristic trends. Leading up to 2023, there is a noticeable increase in the frequency of keywords associated with the terms “para-athletes” or “sports for persons with disabilities”. In contrast, during the earlier publication years, starting from 2014, common keywords included terms like “paraplegia” and “wheelchair athletes”. This shift observed in keyword patterns is in line with the observed social transformations among individuals with disabilities, evolving their identities from disabled to Paralympians (Le Clair, 2011). Notably, this transition can also be associated with the coined term of the “Paralympic paradox”, reflecting the ongoing dilemma in characterising Paralympians as impaired athletes or simply as athletes with a disability (Purdue & Howe, 2012). This analysis not only aids in recognizing the prevalent themes but also guides future research directions considering that keywords play a crucial role in transmitting academic concepts, ideas, and knowledge (Lu et al., 2020).

Our bibliometric analysis revealed the structure of 21 clusters of authorship networks. This remarks on the global and collaborative nature of PA research. Based on the top 10 countries with the higher number of published studies on PA, there is participation from North America (United States and Canada, 22.5%), South America (Brazil, 9.9%), Europe (United Kingdom, Germany, Netherlands, Spain, 21.6%), Africa (South Africa, 4.8%), Asia (Japan, 8.7%), and Oceania (Australia, 8.2%). However, the connections are largely closed to specific topics such as classification or local (i.e., region-based) aspects of athlete performance. Moreover, from the 21 clusters of research groups identified, most of these groups are isolated from each other, with no inter-group participation. The identified clusters and links offer a broad networking scenario. Such findings might urge researchers for future collaborative efforts in conducting PA research, and to understand the scientific progress, barriers, and collaborative dynamics within the PA community.

The substantial rise in publications, which has been especially noticeable since 2010, suggests an increased academic interest in PA. Not only do keyword patterns continue changing in tandem with society’s perceptions of athletes with impairments, but they also reveal complex stories inside the research domain. The collaborative and global character of authorship networks highlights the convergence of varied skills in PA research, and indicates a global-distributed contribution to the PA literature.

Although the current bibliometric review provides relevant and novel findings, its interpretation should consider some potential limitations. Firstly, although PubMed, Scopus, and Web of Science (Core Collection) databases were included in the search for documents, logistical restrictions precluded acces to SportDiscus, a potentially relevant source of additional documents.

Secondly, due to language restrictions, only documents in English and Spanish were included. Finally, the current bibliometric review was limited in the use of more robust strategies to mitigate the potential influence of publication bias (e.g., contact with relevant authors to discuss results). Considering the increased rate of publications in the field (see Figure 2), an update of the current bibliometric review is warranted, probably in the next 5 years. Additionally, researchers should aim to strengthen collaborative efforts (see Figure 4). Moreover, the potential limitations identified in this bibliometric review should be adressed in future investigations.

Conclusion

Research related to PA has increased exponentially in recent years, particularly in the fields of sport sciences and rehabilitation. Collaborative research (authorship network clusters) seems prevalent, and all continents demonstrated participation in published studies, albeit with different relative contributions. An interesting finding is the widespread continental collaboration research networks. This cooperation could potentially help to explain the global development of knowledge in PA. Mapping the evolution of research themes and key contributors, this study will serve as a basis for future studies while also guiding evidence-based practice within PA.

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Conflicts of interest

The authors declare that they do not have any conflicts of interest.

Author Contributions

Conceptualization and Methodology of the Study, EGC; Data Collection, EGC, RRC; Data Analysis and Interpretation, EGC and CW; Drafting the Article, EGC, RRC, CW. All authors have read and approved the final version of the manuscript.

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