Review

Exploring the Landscape of Digital Health in Sport Science: A Bibliometric Analysis of Global Research Trends and Future Directions (2010-2023)

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Review

Exploring the Landscape of Digital Health in Sport Science: A Bibliometric Analysis of Global Research Trends and Future Directions (2010-2023)

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Abstract: Digital health has gained widespread adoption across various disciplines. Within the field of sport science, there is growing interest in digital health, leading to a surge in research activities. The objective of this study is to conduct a comprehensive bibliometric and visualization analysis, tracing the evolutionary trajectory, identifying research hotspots, and uncovering emerging trends in digital health within the domain of sport science. By doing so, this research aims to offer scholars a systematic and comprehensive understanding of the dynamic landscape in this field. To achieve this, the Web of Science core collection was chosen as the primary database. A thorough literature search was performed, focusing on digital health and sport science, resulting in the screening of 1870 English-language documents. The findings revealed a consistent upward growth trend in the annual publication count from 2010 to 2023. Notably, the United States, specifically the Commonwealth of Pennsylvania System of Higher Education, and John B. Cronin, emerged as the most prolific contributors in terms of publications. Collaborative efforts among countries, institutions, and authors were also observed. The research hotspots identified encompassed several areas, including the evaluation of digital health technologies' effectiveness, exploration of the relationship between digital health technologies and physical activity/exercise performance, and the use of digital health technologies in assessing and rehabilitating sports injuries. Among the prominent digital health technologies employed in these studies were virtual reality, social media, and wearable devices. The predominant types of studies utilized meta-analysis, randomized controlled trials, and cross-sectional studies. Looking towards the future, the study identified several key research trends. These include the exploration of telemedicine, artificial intelligence-based machine learning, therapeutic interventions, and physical therapy within the realm of digital health. These emerging areas signify promising directions for future investigation and development in the field of digital health within sport science.

Keywords: digital health; sport science; global research; bibliometrics; Citespace

1. Introduction

In recent years, advanced emerging information technologies such as 5G communication, artificial intelligence, big data, and cloud computing have found extensive applications in the healthcare field [1–3]. These advancements have prompted the traditional healthcare industry to embark on a new development path, focusing on digital health [4,5]. This shift has created favourable conditions for the rapid growth of the digital health industry. Notably, in April 2019, the World Health Organization released evidence-based digital health guidelines, followed by the Global Strategy for Digital Health (2020-2024), which emphasized the priority of digital health development in healthcare systems worldwide. Digital health encompasses various digital technologies, including e-health, telehealth, and m-health [6], and presents new opportunities to enhance health outcomes by leveraging information technology to provide healthcare services that transcend time and space, with a focus on personalization. Going forward, utilizing digital technologies to improve physical and mental health and achieve universal health coverage is of utmost importance.

Digital health has gained significant traction across multiple disciplines and is currently a prominent research topic [7–9]. "Sport science," an interdisciplinary field rooted in the principles of

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kinesiology and influenced by natural and social sciences, stands to benefit immensely from the introduction of digital health [10]. In recent years, there has been a notable surge in interest from domestic and international experts and scholars regarding the application of digital health in sport science. Extensive research has been conducted, yielding substantial results. However, there is a lack of comprehensive and systematic bibliometric analysis and summarization of the scientific literature pertaining to digital health in the field of sport science. As a result, researchers struggle to discern the research dynamics, identify research hotspots, and stay up to date with the latest advancements in this domain.

The bibliometric analysis serves as a quantitative method for summarizing scientific literature and studying its popularity [11]. By employing techniques such as keyword co-occurrence analysis, clustering, and timeline plots, it enables the identification of research hotspots and trends within a specific field. Furthermore, bibliometric analysis facilitates an understanding of the contributions made by countries, institutions, and authors through knowledge graphs and collaboration networks. It enables citation analysis, journal analysis, and an assessment of publication impact, thereby assisting researchers in gaining insights into the past, present, and future of research in a given field. This, in turn, fosters high-quality development within relevant subject areas.

Therefore, the objective of this study is to conduct a comprehensive and systematic bibliometric and visual analysis of the intersection between sport science and digital health, based on an extensive corpus of scientific literature. By utilizing various analytical methods, the study aims to map global research networks, identify and summarize global research hotspots, and pinpoint key frontiers for future investigation. The ultimate goal is to provide experts and scholars with fresh perspectives and recommendations for conducting in-depth research in this evolving field.

2. Materials and Methods

2.1. Search Strategy and Data Collection

The development of a literature search strategy is a fundamental and crucial step in conducting a reliable bibliometric analysis, as it directly impacts the quality of the collected literature. In order to ensure a scientifically sound approach, we sought guidance from authoritative experts and esteemed scholars in the field, while also referring to previous studies. Through this collaborative effort, a comprehensive set of 92 keywords related to digital health was identified. To construct the search strategy for this study, Boolean operators (AND, OR) were employed to combine each keyword effectively. The search formulas for the primary keywords encompassed terms such as “digital health,” “telehealth,” “telemedicine,” “remote consultation,” “mobile health,” “electronic health,” and “electronic care,” among others. A visual representation of the literature search and screening process can be found in Figure 1, providing a clear overview of the filtered articles.

The Web of ScienceTM Core Collection (WoSCC, Clarivate Analytics, USA) is the most frequently used database in bibliometric research. With its vast coverage of nearly 9,000 high-impact journals and over 12,000 academic conferences worldwide, it offers a comprehensive collection of scholarly literature. Therefore, to ensure a robust analysis, the literature search for this study was exclusively conducted within the WoSCC database. To avoid any potential updates in the database literature, the search was completed on a single day, specifically on March 2, 2023. The search scope encompassed the period from January 1, 2010, to March 1, 2023.

During the search, a total of 3,427 documents in the field of sport science were identified within the specified timeframe. These documents consisted of various types (as in Figure 2), including articles (1,870; 53%), conference abstracts (824; 24%), review papers (471; 13%), conference proceedings papers (109; 3.1%), editorial material (96; 2.8%), online publications (66; 1.9%), revisions (35; 1%), letters (32; 0.93%), book reviews (5; 0.15%), and news articles (3; 0.09%).To ensure the focus on comprehensive research data, the document type was restricted to “article,” resulting in the removal of conference abstracts, review papers, conference proceedings papers, revisions, editorial materials, letters, and news articles. As a result, a total of 1,870 articles were selected for further analysis in this study.

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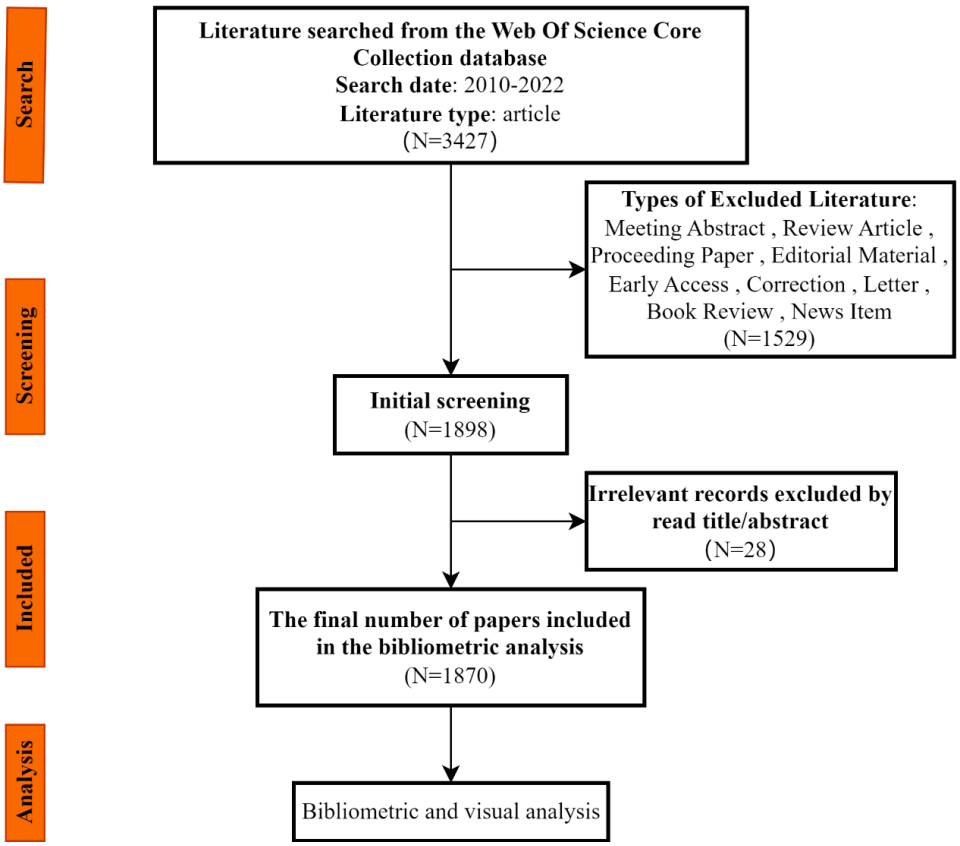

Figure 1. The flowchart for Article Screening.

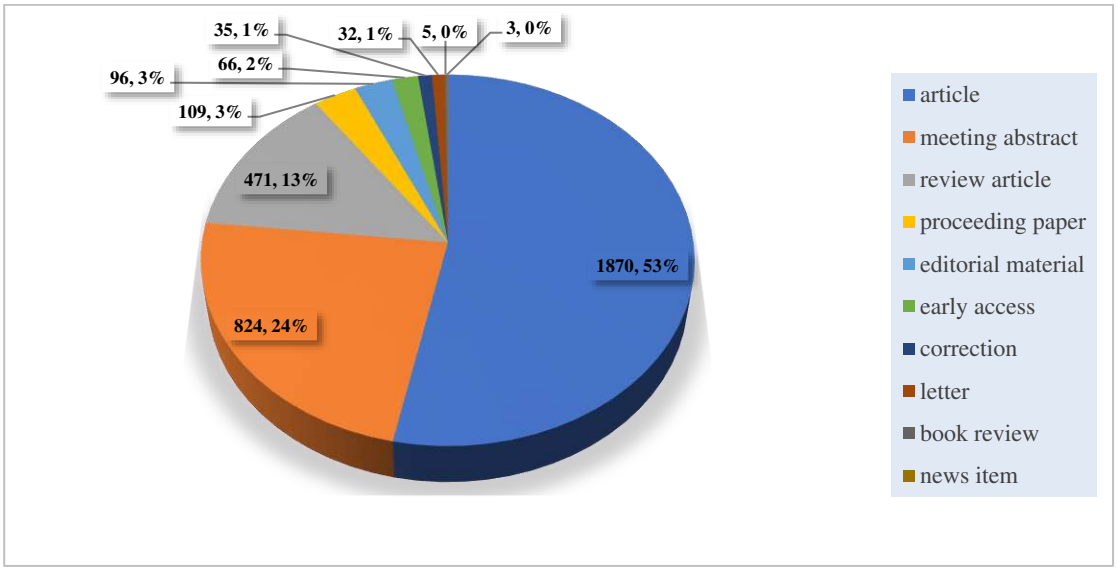

Figure 2. Visualization of the distribution of literature types.

2.2. Analysis Method

Bibliometrics, as an interdisciplinary field that incorporates mathematical, statistical, and bibliometric research methods, plays a vital role in analyzing the structural, temporal, and dynamic evolution of various disciplines or fields by quantitatively studying the literature system and bibliometric characteristics [12]. In comparison to traditional or systematic reviews, bibliometrics offers distinct advantages. Among these, Citespace software, developed by Prof. Chaomei Chen of Drexel University, leverages cocitation analysis theory and pathfinder network scaling to comprehensively and visually depict the research hotspots and future trends within specific fields.

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Therefore, this study employs bibliometric analysis in conjunction with the visualization capabilities of Citespace to analyze and visualize the domain of "digital health in sport science." The primary observation indicators encompass a number of articles, the citation relationships among journals, keywords, author collaborations and their networks, as well as collaborative networks among countries and institutions. By leveraging these analytical techniques, a comprehensive understanding of the research landscape in this field can be achieved.

2.3. Software Parameters Description

Within the knowledge graph generated by Citespace, the size of nodes reflects the frequency of keyword occurrences, thereby establishing a positive correlation. Furthermore, the thickness of connecting lines signifies the intensity of co-occurrence between keywords. Evaluating the importance of nodes within the network graph, intermediary centrality is utilized as an indicator, represented by the purple outer circle surrounding nodes (intermediary centrality > 0.1). A higher value indicates greater significance. To analyze keyword clustering, the LLR algorithm is employed, and the clustering module value Q and average profile value S are utilized to assess the rationality and homogeneity of the clustering effect within the knowledge graph. A larger Q value (>0.3) indicates a more favourable clustering effect, while a larger S value (>0.7) signifies increased homogeneity among nodes, enhancing the credibility of the clustering result. Keyword emergence refers to a period of the sudden increase in the frequency of specific keywords within a given time frame. A larger value signifies heightened keyword activity, offering insights into research trends and the latest research frontiers.

3. Results

3.1. Annual Trends of Publications

In general, there is a consistent upward growth trend in the annual number of publications within this field from 2010 to 2023. On average, there were 133 publications per year, with the highest number of publications observed in 2021, totaling 255. The research process within this field can be broadly summarized using Figure 3 as a reference. It can be divided into two distinct phases: the steady growth phase from 2010 to 2016, and the rapid growth phase from 2017 to 2022.

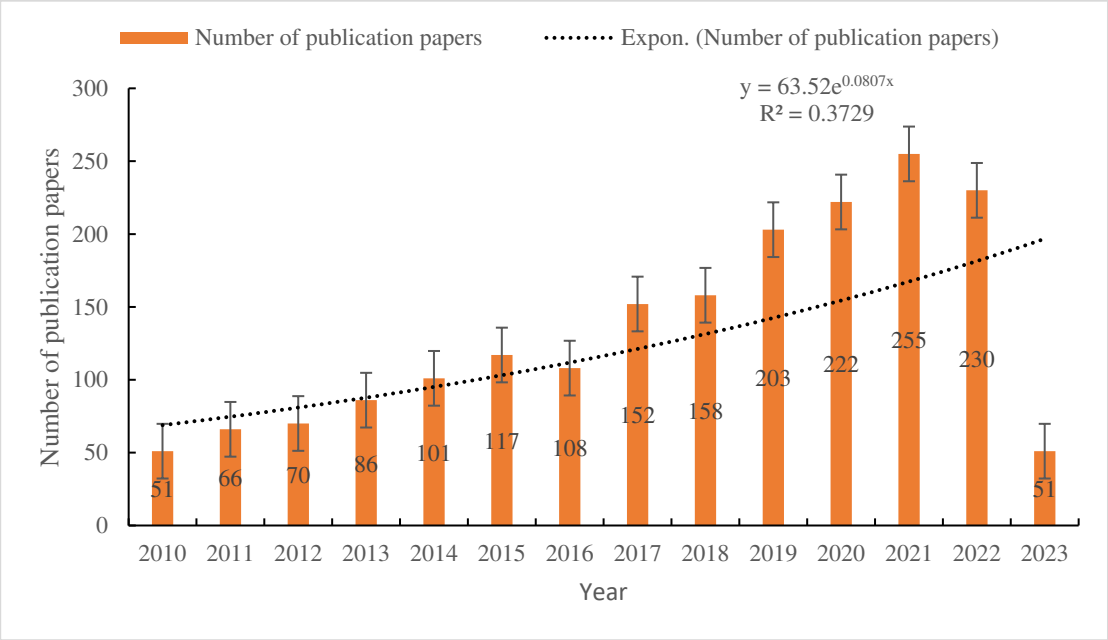

Figure 3. The annual publication of digital health in the field of sport science.

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During the steady growth phase (2010-2016), there was an average annual output of 85 articles, resulting in a total of 599 publications, accounting for approximately 32% of the overall publications within the studied period. The subsequent rapid growth phase (2017-2022) witnessed an average annual increase of 29 articles. In total, there were 1,271 articles published during this phase, constituting around 68% of the total publications. Notably, the number of publications from 2020 to 2022 nearly doubled compared to the output observed in 2016.

This analysis demonstrates a significant increase in research productivity within the field of study, indicating the growing interest and importance of digital health in sport science during the examined period.

3.2. Distribution of Published Journals

By analyzing the Citespace-generated biplot overlay, it becomes possible to ascertain the position of research on the topic relative to key disciplines and clarify the citation relationship between the citing journal (left) and the cited journal (right). The ellipses depicted on the map represent the number of publications and authors associated with each respective journal, with the length of the ellipse indicating the number of authors and the width representing the number of publications. The lines on the left and right of the map illustrate citation links, while the z-Scores function aids in providing a clearer and smoother trajectory for these citation links, with thicker lines indicating higher scores.

From Figure 4, it is evident that within the group of cited journals, the 1870 publications are predominantly distributed across journals in the fields of Neurology, Sports, and Ophthalmology. Additionally, the z-Scores function highlights that publications in the fields of Neurology, Sports, and Ophthalmology are primarily influenced by publications in the fields of Medical-Nursing-Medicine (z=3.85, f=5980), Sports Rehabilitation (z=3.68, f=5752), and Psychology, Education, and Sociology (z=2.27, f=3754).

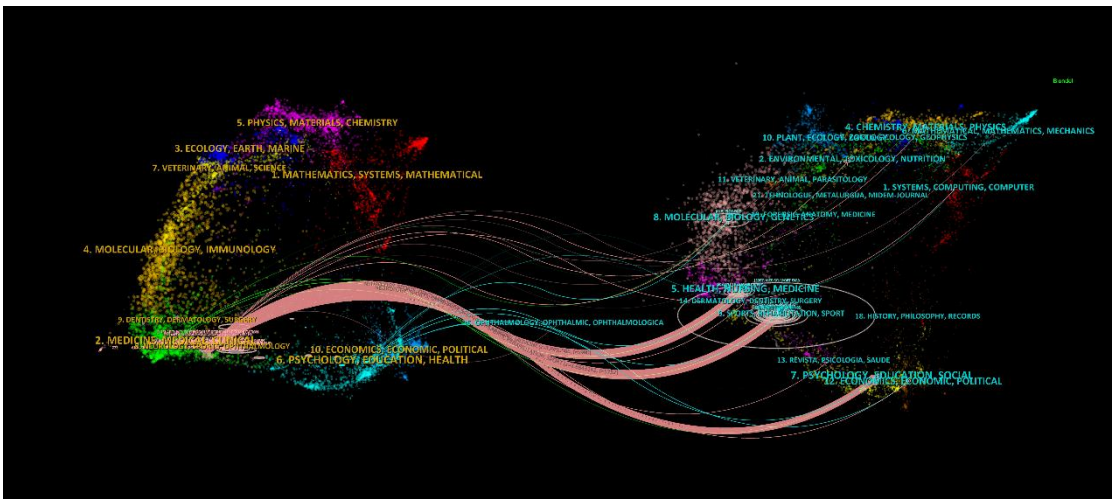

Figure 4. Biplot overlay of journal citation relationships.

3.3. Country Cooperation Network

The visual analysis of countries or regions resulted in a knowledge graph consisting of 74 nodes, 101 connected lines, and a density of 0.0374, as depicted in Figure 5a. Within the field of sport science for digital health, the United States emerged as the leading contributor with 822 articles, accounting for 43.96% of the total publications. Australia followed closely behind with 240 articles, while the United Kingdom contributed 191 articles (10.21%), and Canada produced 177 articles (9.47%). Notably, China accounted for only 52 articles, representing 2.78% of the total. The remaining countries or regions collectively contributed 20.74% of the articles. Analyzing centrality (Figure 5b), it was observed that Austria exhibited the highest centrality value of 0.67, followed by Belgium,

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Greece, and Portugal. Importantly, there exists a level of collaboration between most countries or regions in the field.

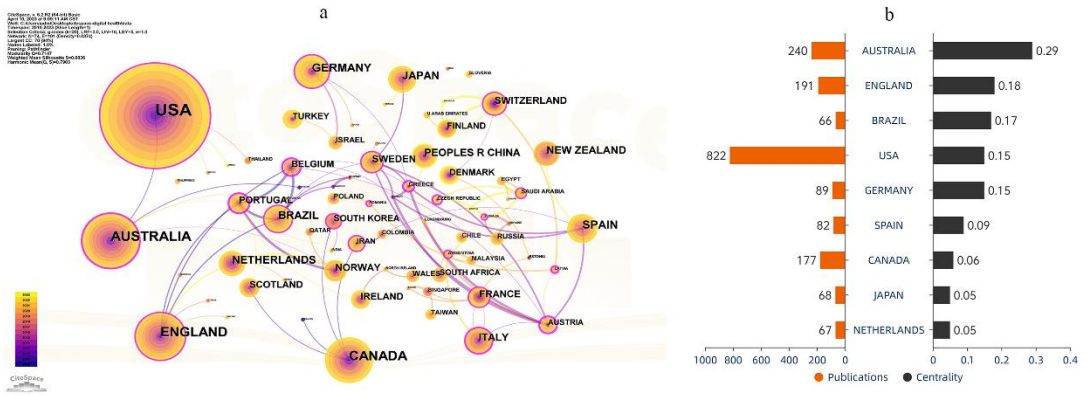

Figure 5. Knowledge mapping of country cooperation networks (a) and centrality ranking of countries (b).

3.4. Institutional Cooperation Network

The visual analysis of institutions resulted in a knowledge graph comprising 307 nodes, 472 connected lines, and a density of 0.01, as illustrated in Figure 6a. Notably, among the top 10 institutions based on the number of publications, all except for Oakland University of Technology (30 articles) were affiliated with institutions in the United States. The Commonwealth of Pennsylvania System of Higher Education (PCSHE) led with 47 articles, followed by Harvard University (44 articles), and the University of California system (34 articles), among others. Harvard University exhibited the highest centrality value of 0.25, indicating its prominent position within the network. Boston University followed closely with a centrality of 0.21, while PCSHE achieved a centrality of 0.2, and the University of Ohio System attained a centrality of 0.15 (Figure 6b). Upon observing the knowledge map, it becomes apparent that the co-occurrence connections between different institutions are intricate, indicating a close collaborative relationship among them.

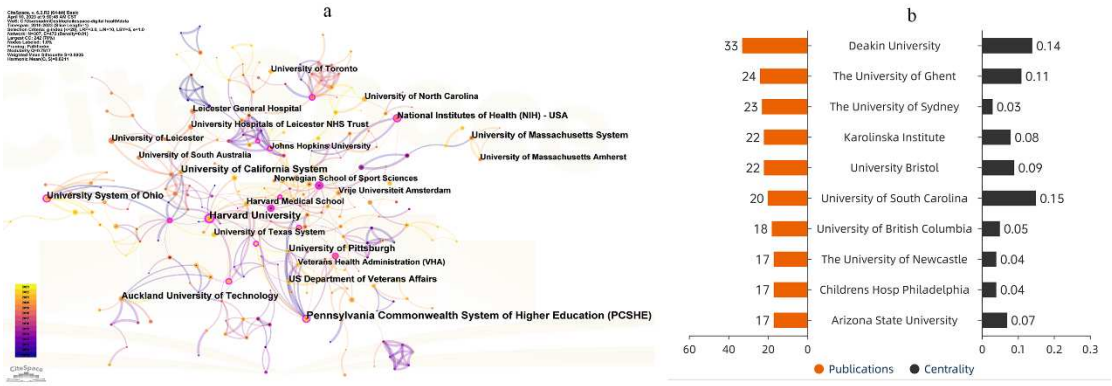

Figure 6. Knowledge map of institutional collaboration network (a) and centrality ranking of institutions (b).

3.5. Author Collaboration Network

The visual analysis of the author resulted in a knowledge graph comprising 444 nodes, 537 connected lines, and a density of 0.055, as illustrated in Figure 7. The colours of the lines and nodes indicate when the collaborations took place. Warmer colours represent more recent collaborations. Among the authors, Cronin, John B (17 articles) had the highest number of published articles,

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followed by Macadam, Paul (16 articles), Bassett, David R (14 articles), and Rowlands, Alex V (14 articles), as shown in Table 1. Notably, the field of study in digital health and sport science has been shaped by prominent researchers. John B. Cronin and Paul Macadam, along with their colleagues, have made significant contributions to the field. Other influential researchers include David R. Bassett and Patty S. Freedson, Alex V. Rowlands and Charlotte L. Edwardson, Alexander H. K. Montoye, Ulf Ekelund, Cailee E. Welch Bacon, and Sara L. Nottingham. These researchers have played a pivotal role in advancing knowledge and understanding in this area of research.

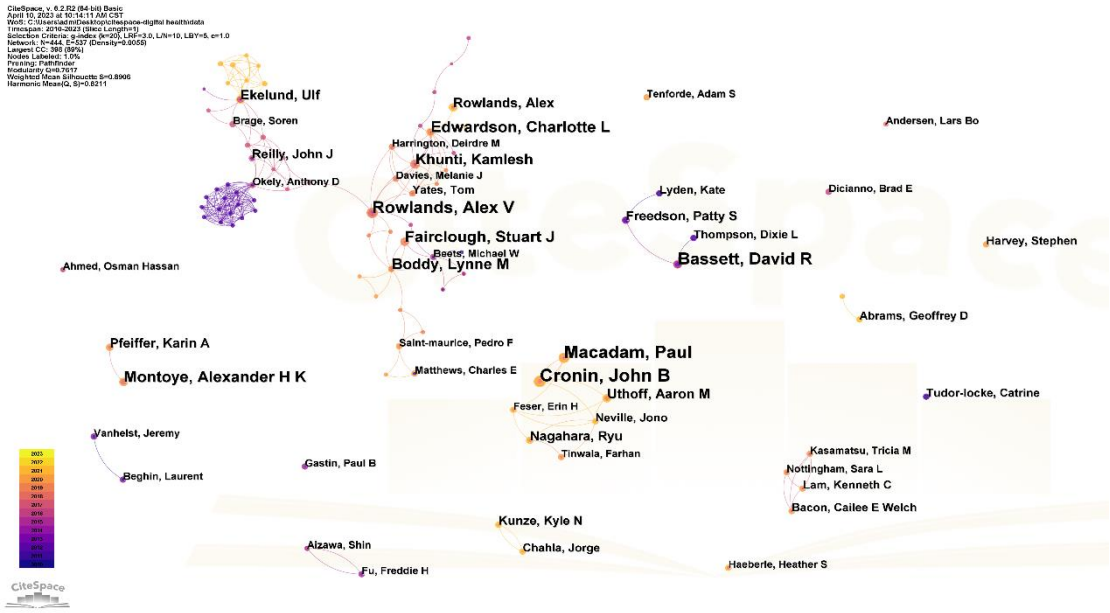

Figure 7. Author Collaboration Network Relationships.

Table 1. Publication ranking of authors.

Rank	Publication	Year	Author
1	17	2017	Cronin, John B
2	16	2017	Macadam, Paul
3	14	2010	Bassett, David R
4	14	2016	Rowlands, Alex V
5	12	2016	Edwardson, Charlotte L
6	11	2016	Fairclough, Stuart J
7	11	2017	Montoye, Alexander H K
8	10	2016	Boddy, Lynne M
9	9	2016	Khunti, Kamlesh
10	8	2018	Rowlands, Alex

3.6. Keyword co-occurrence and burst analysis

The visual analysis of keyword co-occurrence resulted in a knowledge graph comprising 410 nodes, 603 connected lines, and a density of 0.0072, as illustrated in Figure 8a. The most frequently occurring keywords in this field were physical activity (388), validity (329), reliability (209), and health (167). Notably, meta-analysis (0.39) emerged as the most central keyword, followed by sedentary behavior (0.3), public health (0.19), injury (0.18), and performance (0.17) (Figure 8b). For keyword burst analysis (Figure 9), the Citespace software was configured with a γ value of 1, and 25 keywords were selected. The results, shown in Figure 8, indicate that "standard" (calibration) had the highest burst intensity of 9.9, followed by energy expenditure (9.88), telemedicine (8.83), overweight (7.75), motion sensors (6.42), and pedometers (6.16). The keyword "randomized controlled trial" appeared over a longer period, spanning from 2011 to 2017. Additionally, the

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keywords telemedicine, therapy, machine learning, sports, and body therapy emerged as the latest research trends in the past four years, highlighting the evolving areas of study in this field.

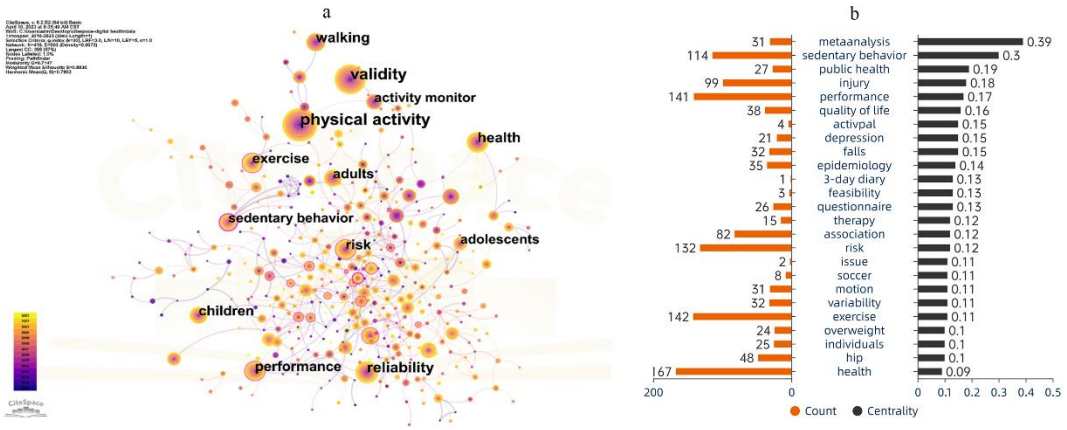

Figure 8. Keyword co-occurrence knowledge graph (a) and frequency (b).

Top 25 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2010 - 2023
energy expenditure	2010	9.88	2010	2015	
overweight	2010	7.75	2010	2015	
motion sensor	2010	6.42	2010	2013	
pedometers	2010	6.16	2010	2014	
computer science	2010	5.3	2010	2014	
activity monitor	2010	4.74	2010	2014	
calibration	2010	9.9	2011	2014	
randomized controlled trial	2011	4.71	2011	2017	
united states	2011	4.63	2011	2014	
objective measurement	2011	4.09	2011	2014	
motor activity	2013	4.7	2013	2015	
fitness	2011	4.39	2013	2014	
australian football	2015	4.38	2015	2018	
wrist	2016	7.12	2016	2019	
wearable devices	2017	5.68	2017	2019	
strategy	2018	4.32	2018	2019	
wearable technology	2018	4.14	2018	2021	
technology	2019	4.27	2019	2020	
individuals	2011	4.23	2019	2020	
telehealth	2017	8.83	2020	2023	
social media	2016	6.67	2020	2021	
therapy	2011	4.24	2020	2023	
machine learning	2014	4.23	2020	2023	
sport	2015	4.97	2021	2023	
physical therapy	2012	4.38	2021	2023	

Figure 9. Top 25 keywords With the Strongest Citation Burst.

3.7. Keyword Clustering Analysis

There were 16 distinct keyword clustering results, as depicted in Figure 10. The module value (Q = 0.7617) exceeded the threshold of 0.3, and the mean profile value (S = 0.8906) exceeded 0.7, indicating a strong clustering effect and high credibility. Among the clusters, “physical activity” (#0) had the largest size, followed by “cardiorespiratory fitness” (#1), “energy expenditure” (#2), “virtual reality” (#3), “fatigue” (#4), and “multiple sclerosis” (#5).

Further analysis of the 16 clusters revealed the following main areas of focus: “virtual reality” (#3), “activity loggers” (#6), “social media” (#7), “activity monitors” (#15), and “motion sensors” (#16)

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indicated the prominent digital health technologies employed in this field. “Cardiorespiratory fitness” (#1), “fatigue” (#4), “multiple sclerosis” (#5), and “anterior cruciate ligament” (#9) were indicative of specific physical indicators or conditions of interest. The cluster labelled “adolescents” (#11) highlighted the primary population of interest. “Randomized controlled trials” (#13) emerged as the primary type of study conducted. Lastly, “physical activity” (#0), “energy expenditure” (#2), and “walking” (#8) indicated the main areas of focus regarding physical activity within the target population.

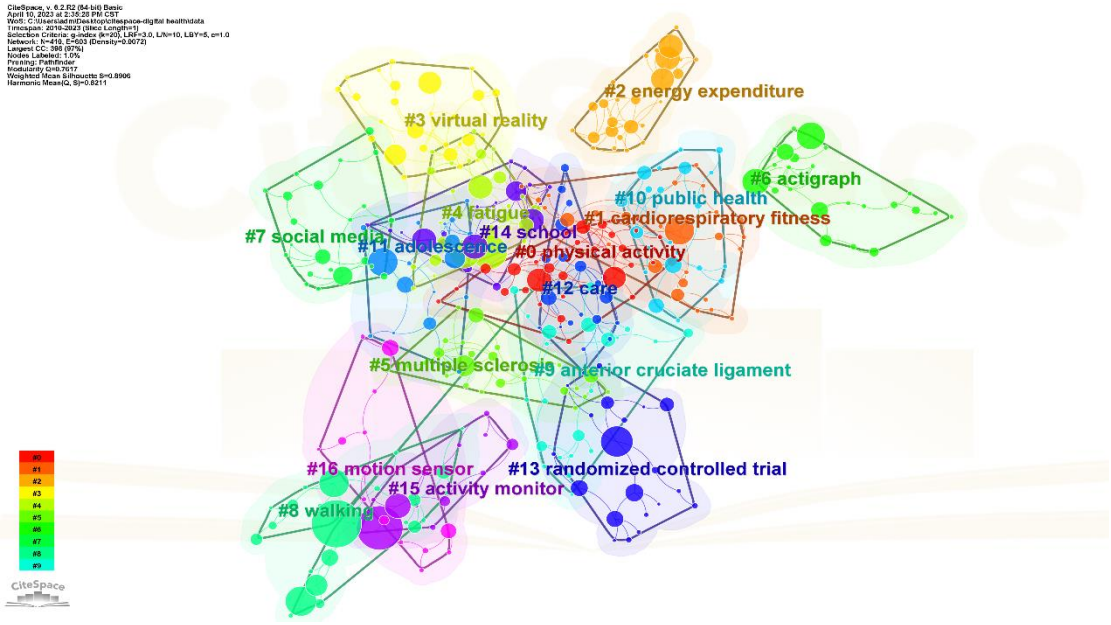

Figure 10. Visualized map of the keyword clusters.

3.8. Analysis of Keyword Timeline Graphs

The timeline plot of keyword clusters illustrates the relationship between the publication year and the keyword clusters. The horizontal axis (X) represents the publication year, while the vertical axis (Y) displays the names of the keyword clusters. Each cluster’s font color indicates the corresponding time of year when the cluster emerged, and the keywords within each cluster are arranged horizontally to show the sequential appearance of each keyword in subsequent years.

Upon examining Figure 11, we observed that certain clusters, such as “physical activity,” “virtual reality,” “fatigue,” “randomized controlled trials,” and “school,” spanned the longest duration from 2010 to 2023, indicating extensive research in these areas over time. Additionally, these clusters exhibited larger study sizes. Following these clusters were “multiple sclerosis,” “social media,” “walking,” “public health,” “youth,” and “motion sensors.” On the other hand, “walking” and “activity monitors” received more attention in the earlier years of the timeline.

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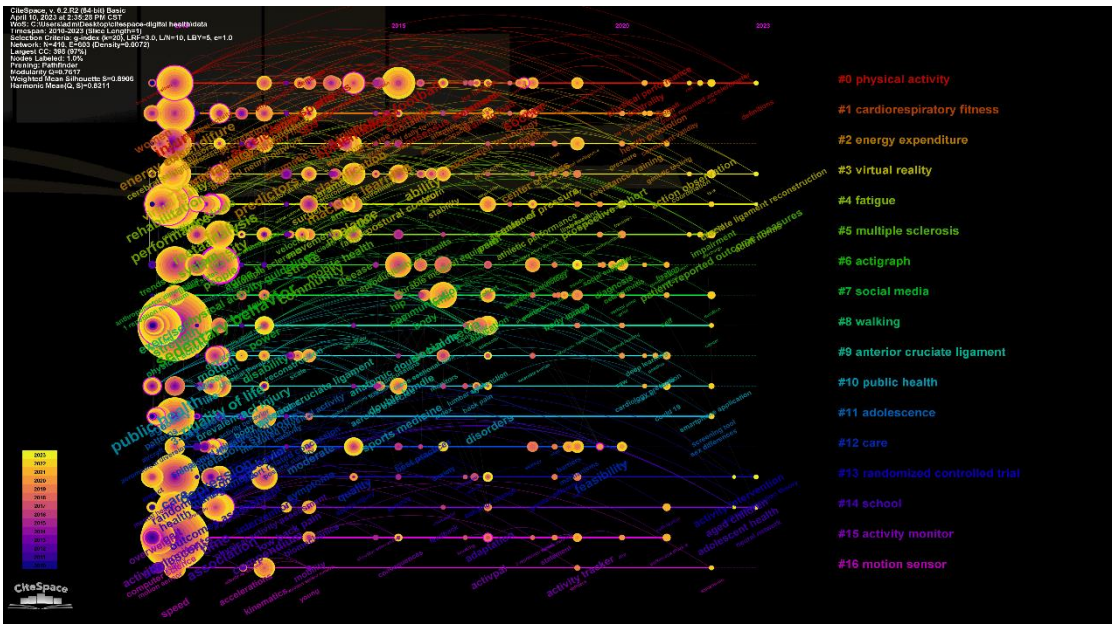

Figure 11. Keyword time zone mapping.

4. Discussion

The findings of this study reveal that the field of sport science related to digital health has witnessed substantial growth with a total of 1,870 publications between 2010 and 2023. Notably, there has been a consistent upward trend in the number of publications each year, particularly exceeding 200 publications annually after 2019. These results suggest that digital health holds significant potential for development and offers promising prospects within the realm of sports disciplines. Following 2016, several influential policy documents such as the "Monitoring and Evaluating Digital Health Intervention" and the "Global Strategy on Digital Health 2020-2025" issued by the World Health Organization (WHO) [13], along with the Digital Health Innovation Action Plan by the Food and Drug Administration (FDA), have played a pivotal role in consolidating the concept of digital health and establishing its central importance. Consequently, numerous scholars have actively engaged in research on digital health. Furthermore, the release of the 24-hour activity guidelines by Canada and the World Health Organization has revolutionized the traditional paradigm of exercise behavior [14,15]. This shift emphasizes the integration of various exercise behaviors, including physical activity, sedentary behavior, and sleep. The author believes that this paradigm shift has been a key driver contributing to the rapid increase in the number of publications in the field of sport science.

Regarding national and institutional publication volume, the United States, along with the Commonwealth of Pennsylvania System of Higher Education (PCSHE), emerged as the most productive contributors. Their research focus centered on areas such as physical activity [16,17], falls [18,19], soccer [20], traumatic brain injury [21,22], and anterior cruciate ligament(ACL) [23], significantly contributing to sports injury rehabilitation and soccer training in relevant populations. On the other hand, Harvard University's research primarily targeted sports injury rehabilitation in populations affected by traumatic brain injury [24], ankle [25] and femoral hip displacement disorders[26], and spinal cord injury rehabilitation [27]. Australia and Harvard University ranked highest in centrality, indicating their research's influential and central position. Australian research shared similarities with the United States, with a primary focus on physical activity [28–30] and ball exercise [31,32]. One impactful study by Mirelman et al. from Harvard University titled "Effects of virtual reality training on gait biomechanics of individuals post-stroke" garnered significant citation frequency, with 109 citations [33]. In this study, participants were randomly assigned to either the virtual reality (VR) group (n=9) or the non-virtual reality (NVR) group (n=9). The VR group underwent training three times a week for approximately 1 hour per session over a period of 4 weeks.

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The results demonstrated that the VR group exhibited a greater improvement in ankle range of motion and a significant increase in force generation during push-ups. These findings support the notion that virtual reality training can enhance ankle motion control in post-stroke patients. Additionally, an analysis of highly cited Australian literature revealed that researchers primarily focused on evaluating the validity [34,35] and reliability [36] of accelerometers for measuring physical activity. This research laid a solid foundation for the widespread adoption of accelerometers as a data collection tool.

Keyword co-occurrence analysis, clustering, and timeline plots provide valuable insights into research trends and future directions in the field of digital health-related sport science. Based on our analysis, we have identified the following research hotspots and emerging trends:

Hotspot 1: Assessing the validity, reliability, and accuracy of digital health technologies for objective measurement of physical activity. Keywords associated with this hotspot include reliability, validity, accuracy, standard, accelerometer, and activity monitor. In sport science, there is a growing emphasis on using physical activity as an outcome measure. Accelerometers and pedometers are commonly used tools for objectively measuring physical activity. Previous studies have evaluated the effectiveness of different types of accelerometers in various exercise settings. For example, Maddocks, M et al., [37] explored the relative accuracy of ActivPAL, PALlite, and Digi-Walker accelerometers in treadmill walking and motorized driving and found that the ActivPAL accelerometer accurately measured steps at walking speeds of 0.6 m/s-1.4 m/s, with the other two accelerometers having significantly higher measurement errors. John, D et al., [38] and Janssen, I et al., [39] also analyzed the effectiveness of different accelerometers. In recent years, mobile devices including wearable sensors or devices and smartphones have attracted the attention of researchers. Fuller, D et al., [40] used Apple Watch and Fitbit data to predict individuals' lying, sitting, walking and running, Viciana, J et al., [41] explored whether wrist-worn activity trackers and mobile apps could be used to assess physical activity of high school students, Lyu, S et al., [18] who used suspended wearable sensors to assess postural stability and balance.

Hotspot 2: Digital health technology and assessment and rehabilitation of sports injuries. Keywords associated with this hotspot include risk, injury, rehabilitation, gait, fatigue, ACL, fall, and care. Sports injuries, whether acute or chronic, are a significant concern in athletes' training. Consequently, research on sports injuries has garnered substantial attention. Through keyword analysis, studies on traumatic brain injury, spinal cord injury, ACL, ankle, shoulder, and multiple sclerosis were identified as highly relevant. The application of digital health technology in the diagnosis, risk assessment, and rehabilitation of these injuries has become a focal point for current research. Representative scholars in this area include Lawrason et al., [42] (mHealth physical activity intervention), Jacobsson et al., [43] (web-based digital health platform), and Carey et al., [24] (wearable sensors). Gait analysis and postural control also play a crucial role in determining the risk of sports injuries, as demonstrated by Llorens et al., [44] who used a virtual reality-based telerehabilitation program to facilitate balance-related motor skills reacquisition in stroke patients.

Hotspot 3: Digital health technology and physical activity, motor training. Keywords associated with this hotspot include walking, exercise, sedentary behavior, energy expenditure, and performance. The current research in this area focuses on evaluating the effectiveness of different digital health technologies in objectively measuring physical activity and sedentary behavior (e.g., accelerometers, and wristband devices). Researchers are also investigating the application of digital health interventions to improve individual physical activity [45] and sedentary behavior [46,47], exploring the relationship between digital health technologies and exercise behavior [48,49], and studying the correlation between digital health and exercise performance [50,51]. Prominent digital health technologies used in this area include virtual reality, social media, and wearable devices such as activity monitors, accelerometers, and motion sensors. The types of studies conducted include meta-analyses, randomized controlled trials, and cross-sectional studies.

Overall, the field of digital health-related sport science is witnessing significant advancements in assessing physical activity, rehabilitation of sports injuries, and exploring the intersection of digital health technologies with physical activity and motor training. Researchers are employing various

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methodologies and technologies to gain insights into these areas, leading to promising advancements in the field.

Frontier direction: Looking towards the future, telemedicine, machine learning, therapy/therapy, and physical therapy emerged as promising frontiers in the field.

Telemedicine refers to the use of electronic communication technologies to provide remote clinical healthcare, education, and public health management [52]. Its significance has been amplified in the past two years due to the COVID-19 pandemic. In the field of sport science, telemedicine is anticipated to be utilized for structured physical activity interventions, including physical exercise and sports training. It offers the potential to deliver remote guidance and monitoring, making exercise programs more accessible and convenient. Furthermore, telemedicine can be employed in physiotherapy, which is a vital component of rehabilitation. Various techniques such as joint mobility exercises, mobility exercises, muscle strengthening exercises, and total body conditioning exercises can enhance joint and muscle function, aiding individuals in improving their balance, walking, and overall physical abilities [53].

Moreover, advancements in digital technology have opened new avenues for artificial intelligence (AI)-enabled medical imaging and disease prediction [54]. In recent years, machine learning techniques based on AI have been increasingly integrated into sports science. The role of machine learning in enhancing sports decision-making, performance prediction, and various other applications has garnered significant attention in academia and industry. Moving forward, AI-based machine learning is expected to play a pivotal role in advancing the field of sports science, providing valuable insights and aiding in the development of innovative approaches.

5. Research Strengths and Limitations

This study possesses several strengths that contribute to its significance and reliability. Firstly, it stands as the first comprehensive bibliometric analysis conducted to systematically review the field of sport science in the context of digital health. This novel approach enables a thorough examination and evaluation of the research landscape in this area. Secondly, the study employed a comprehensive literature search strategy, meticulously reviewing the titles and abstracts of all identified articles. This rigorous research process enhances the interpretation of the findings and strengthens the overall persuasiveness of the study. However, it is essential to acknowledge the limitations of the study. Firstly, the search was confined to the core collection database of Web of Science, and other databases such as PubMed and Embase were not utilized. This selective approach may have resulted in the omission of relevant literature that could have provided additional insights. Additionally, the study focused solely on articles, leading to the exclusion of other types of literature and potentially overlooking valuable original data. Secondly, while the study explored the relationship between digital health and sport science, a deeper analysis of this relationship was not conducted. Further examination of this connection could have provided a more nuanced understanding of the field.

Despite these limitations, the study maintains a relatively high level of validity in its bibliometric analysis. Future studies should strive to address these limitations by broadening the scope of databases searched and incorporating diverse types of literature. By doing so, the potential bias can be minimized, and a more comprehensive understanding of the field of sport science in the context of digital health can be achieved.

6. Conclusion

In conclusion, this study provided a comprehensive overview of the research hotspots and emerging trends in the field of digital health-related sport science from 2010 to 2023. The identified research hotspots include the assessment of digital health technologies for objective measurement of physical activity, as well as the application of these technologies in the assessment and rehabilitation of sports injuries. Research on digital health and exercise training, particularly in the context of sports performance, is an area of growing interest and importance. This field focuses on utilizing digital health technologies to optimize training methods, enhance athletic performance, and improve overall fitness levels. The study highlighted the prominent use of virtual reality, social media, and wearable

devices, such as activity monitors, accelerometers, and motion sensors, as key digital health technologies in this field. Moreover, the study found that meta-analysis, randomized controlled trials, and cross-sectional studies were the predominant types of research conducted in this area. These study designs contribute to the accumulation of evidence and the advancement of knowledge in digital health-related sport science.

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