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Video Games for Physical Impairments Research: A Bibliometric Analysis

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Abstract

The objective of this research is to analyse video game development for individuals with physical impairments. It aims to identify trends, key contributors, frequently cited documents, and common keywords through bibliometric analysis. The study utilized Biblioshiny, a tool for the R statistical package 'bibliometrix,' with a dataset extracted from Scopus that includes publications from 2003 to 2024. The analysis shows that the University of Alabama at Birmingham leads in this research area, with significant publications in journals like "Disability and Rehabilitation" and the "Journal of Neuroengineering and Rehabilitation." Key focus areas include virtual rehabilitation, neurorehabilitation, and exergaming, particularly utilising augmented and virtual reality technologies. Common terms in the literature are "video games," "virtual reality," "rehabilitation," and "disability," with notable international collaboration, especially between the United States and Australia. This research offers a systematic overview of publications on video games for individuals with physical impairments. It serves as a valuable resource for scholars interested in gaming accessibility and lays a foundation for future studies on adaptive gaming technologies, promoting the development of inclusive video game systems that enhance the quality of life for individuals with physical impairments.

Keywords: Bibliometric Analysis, Biblioshiny, R Package, Video Games, Physical Impairment

Introduction

In the present era, marked by remarkable technological progress, video games have risen to significant prominence within both cultural and technological landscapes. This shift from an industrial to a digital age, boosted by advancements in computing and the advent of the Fourth Industrial Revolution, has deeply altered how we interact with technology. Initially designed as straightforward means of amusement, video games have evolved into intricate, engaging digital spaces that mirror the broader trends of digitalization and globalization. These interactive platforms now extend beyond mere entertainment, serving as venues for

social connection, creative expression, and economic activity. As digital technology becomes ever more integral to every facet of human existence, video games stand out as a key example of both the opportunities and challenges presented by our growingly interconnected, digital society (Filipović, 2024).

Video games stand as a dominant form of digital entertainment, yet they frequently create significant obstacles for individuals with motor impairments, due to the intricate and rapid nature of their control mechanisms. The accessibility challenges are acutely felt in games that demand instantaneous reflexes, refined coordination, or the use of multiple buttons simultaneously, posing difficulties for those with restricted motor abilities. This issue, noted by Kiecko (2024), highlights a critical area of concern. Despite the progress in technology, a considerable number of mainstream video games have yet to incorporate adequate options for modifying or simplifying controls. This oversight results in the exclusion of a portion of the gaming community. Addressing this issue necessitates a conscious effort in game design to include customizable control schemes and the integration of adaptive technologies. Such initiatives are essential to ensure that individuals with motor impairments can participate fully in gaming experiences, as stressed by Kiecko (2024).

This study is developed to answer following research questions:
RQ1: What are the current states and trend of publications in video games for physical impairments research?
RQ2: What are the most cited documents in video games for physical impairments research?
RQ3: Who are the most productive contributors in terms of authors, countries, affiliations in video games for physical impairments research?
RQ4: What are the most frequent keywords in video games for physical impairments research?
RQ5: What are the current states of knowledge structure in terms of co-citation, collaboration and co-occurrence network in video games for physical impairments research?

Based on the research questions, the research objectives are formed:
RO1: To identify the current states and trend of publications in video games for physical impairments research.
RO2: To analyse the most cited documents in video games for physical impairments research.
RO3: To determine the most productive contributors in terms of authors, countries, affiliations in video games for physical impairments research.
RO4: To examine the most frequent keywords in video games for physical impairments research.
RO5: To explore the current states of knowledge structure in terms of co-citation, collaboration and co-occurrence network in video games for physical impairments research.

Literature Review

Video Games for Physical Impaired

In the literature on digital media, video games are often distinguished from other forms such as books, television, and movies due to their interactive nature. Granic, Lobel, and Engels (2014) argue that the defining characteristic of video games is the active engagement they demand from players. Unlike traditional media, where individuals can passively absorb the content, video games require players to interact with the system, influencing its progression

and outcomes through their choices and actions. This interactivity sets video games apart, as the system responds dynamically to the player's behaviours, fostering a unique, agent-driven experience. Consequently, video games are not merely narrative-driven experiences but environments where players exert control, which significantly differentiates them from other media forms.

Video games are a notable example of how media and disability interact since they are considered physically demanding and necessitate the mastery of intricate and oftentimes difficult input devices and techniques (Grammenos et al., 2009). Previous research by Mott et al. (2020) and Gerling et al. (2020) has demonstrated that players with disabilities have similar game preferences to their able-bodied peers but are unable to enjoy them to the same extent because of physical limitations. Due to their physically demanding nature, disability groups and scholars have pushed toward greater accessibility requirements for video games (Powers, Nguyen, & Frieden, 2015).

Bibliometric Analysis

Faithorne coined the term "bibliometric" in 1969 to describe the statistical data regarding the articles that have been published in a specific topic or area and to draw attention to certain methodologies, sources, citations, trends, and keywords used in scientific publications (Broadus, 1987). A quantitative and qualitative technique called bibliometrics is used to examine patterns and trends within a certain field (Wang et al., 2023). Verma & Gustafsson (2020) assert that bibliometric research is important in a number of ways. For example, the scientific mapping approach was used in bibliometric studies to reduce bias. subsequently then expanded to include carrying out a thorough examination of a specific theme. Finally, it presented future practice in a specific field, examined the research issues, and indicated research gaps that needed to be filled (Verma & Gustafsson, 2020).

In the field of education research, bibliometric analysis has been used recently to evaluate published literature (Sobhi Ishak et al., 2023). As an illustration, consider the research on learning strategies (Song et al., 2019), educational leadership (Hallinger & Kovacevic, 2021), and virtual learning (Chen et al., 2021). This study uses bibliometric analysis to examine the literature in the subject of education, specifically video games for physical impairments-related material published between 1993 and 2023. The database used for the analysis is from Scopus.

Materials and Methods

This study employs bibliometric analysis, a systematic method for quantitatively examining scholarly literature and its patterns of knowledge dissemination (Abdul Rahman et al., 2022). The analysis was conducted using Biblioshiny, a web interface for the 'bibliometrix' R package, which provides comprehensive tools for bibliometric data analysis and visualization. This analytical framework enables the systematic examination of publication metadata, citation patterns, and knowledge transfer within the field.

The current study conducts a bibliometric analysis of papers obtained from the Scopus database. Scopus was chosen due to its extensive coverage and efficient paper indexing (Amaechi et al., 2022). As noted by Fahimnia et al. (2015), Scopus is the largest abstract and citation database for literature across the social sciences, humanities, arts, and sciences. It is

pertinent to highlight that all peer-reviewed literature available on Scopus is sourced from esteemed publishers such as Springer, Elsevier, and Emerald (Abdul Rahman et al., 2022). The research methodology employed a title-only search strategy to identify publications related to video games for physical impairments research. The flow of the bibliometric analysis using biblioshiny is depicted in Figure 1, while Figure 2 illustrates the flow diagram of the search strategy. Notably, the analysis encompasses all 288 publications identified in the initial record.

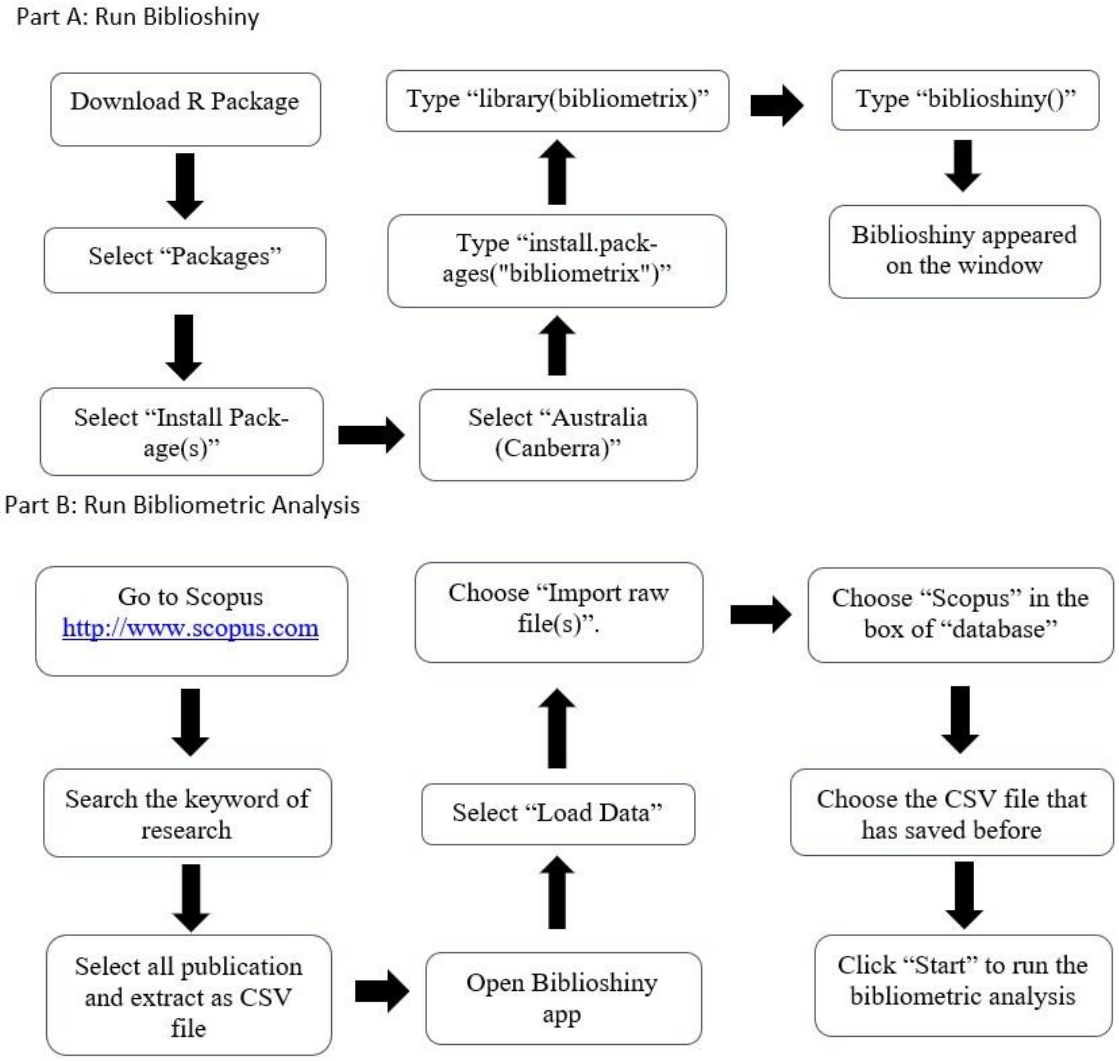

Figure 1: Flow of bibliometric analysis

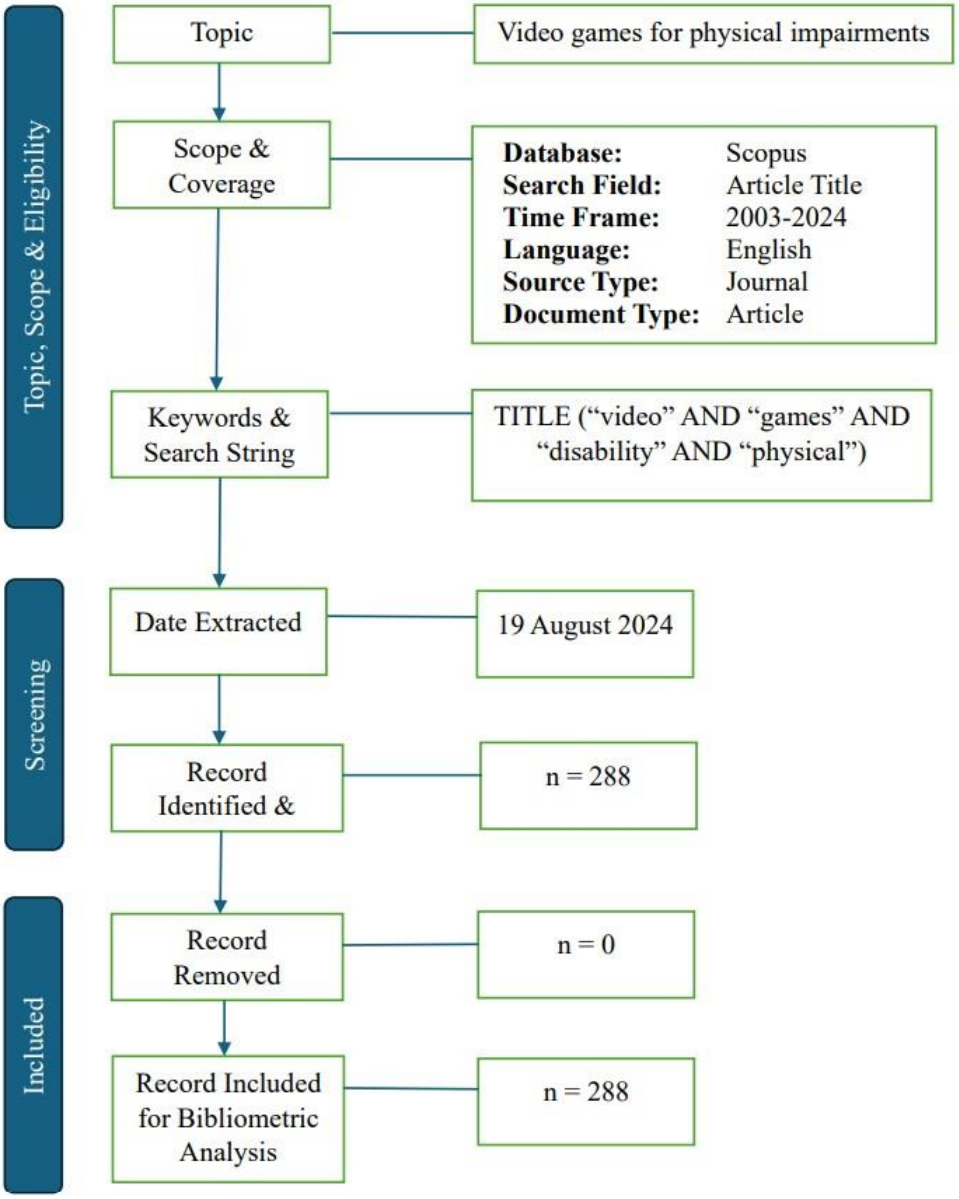

Figure 2: Flow diagram of the search strategy (Source: Zakaria et al., 2021)

Analysis and Results

The bibliometric analysis and findings of the state of publications on video games for physical impairments research are displayed in this part. The database was taken from Scopus.

Descriptive Analysis

The sources of publications related to video games for physical impairments research from 2003 to 2024 are covered in this section. The primary data, yearly trend publishing, most cited paper, most productive authors, most productive nations, most productive affiliations, and most common word are all included in this part.

Main Information

Publications regarding video games for physical impairments span the years 2003–2024. Table 1 presents key data about the chosen articles, such as average age of the documents,

average number of citations per document, contents of the documents, author details, author collaboration, and document types.

Table 1
Main Information Regarding Selected Article

Description	**Results**
MAIN INFORMATION ABOUT DATA	
Timespan	2003:2024
Sources (Journals, Books, etc)	186
Documents	288
Annual Growth Rate %	11.32
Document Average Age	7.05
Average citations per doc	26.54
References	0
DOCUMENT CONTENTS	
Keywords Plus (ID)	2181
Author's Keywords (DE)	702
AUTHORS	
Authors	1214
Authors of single-authored docs	15
AUTHORS COLLABORATION	
Single-authored docs	15
Co-Authors per Doc	4.63
International co-authorships %	21.18
DOCUMENT TYPES	
Article	176
Book	9
Book chapter	53
Conference paper	5
Editorial	2
Erratum	1
Letter	1
Note	2
Retracted	1
Review	38

Annual Publication Trend

The analysis of annual publication trends provides insight into the total number of publications, citations per year, and citable years spanning from 2003 to 2024. This data is visually represented in Table 2 and Figure 3. Notably, there was a substantial increase in the total number of publications from 2009 to 2010, surpassing the previous seven years. In 2021, the highest total publication count for video game research related to physical impairments reached 26.

Table 2
Total Publication Per Year, Citation Per Year and Citable Year

Year	Total Publication (N)	Citation per year (MeanTCperYear)	Citable year
2003	2	3.73	22
2004	0	0	0
2005	4	0.66	20
2006	4	1.84	19
2007	1	0.00	18
2008	3	4.94	17
2009	7	5.62	16
2010	12	6.37	15
2011	13	2.40	14
2012	14	1.92	13
2013	11	4.08	12
2014	13	2.42	11
2015	16	2.42	10
2016	24	2.15	9
2017	21	2.80	8
2018	15	3.46	7
2019	21	6.04	6
2020	25	4.54	5
2021	26	3.78	4
2022	22	1.85	3
2023	15	1.70	2
2024	19	0.53	1

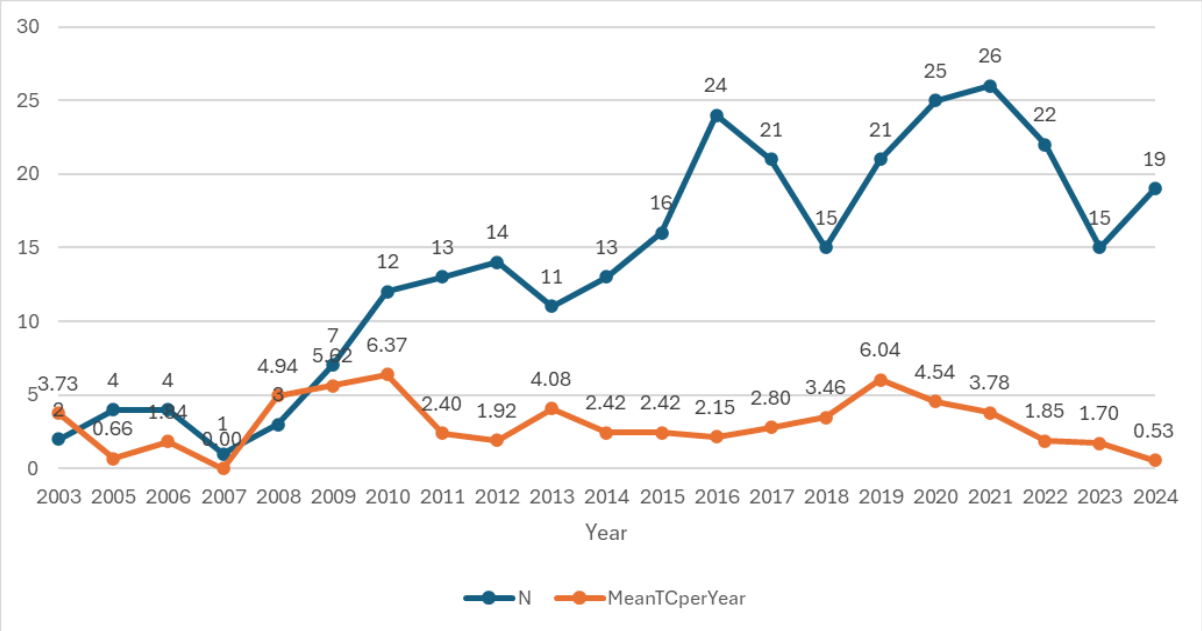

Figure 3: Total Publication (N) and Average Citation Per Year (MeanTCperYear)

Most Cited Papers

The table presents the top 10 most globally cited papers in the field. Notably, Biddiss E's (2010) paper has garnered the highest number of citations at 426. This study examines the effectiveness of active video games in promoting physical activity among children and youth. The second most-cited paper by Cameirão, M.S. et al. (2010), with 269 citations, focuses on neurorehabilitation through a virtual reality-based gaming system. The third-ranked publication by van Diest, M. et al. (2013), accumulating 200 citations, investigates the application of exergaming for balance training in elderly populations.

Table 3
Top 10 Most Cited Papers

Authors	**Title**	**Total Citation**	**Citation Per Year**
Biddiss E (2010)	Active Video Games to Promote Physical Activity in Children and Youth	426	28.40
Cameirão, M.S. et al. (2010)	Neurorehabilitation using the virtual reality based Rehabilitation Gaming System: methodology, design, psychometrics, usability and validation	269	17.93
van Diest, M. et al. (2013)	Exergaming for balance training of elderly: state of the art and future developments	200	16.67
Burke J. W. et al. (2009)	Measuring the Effect of Service Quality and Corporate Image on Student Satisfaction and Loyalty in Higher Learning Institutes of Technical and Vocational Education and Training	189	11.81
Rand & Kizony & Weiss (2008)	The Sony PlayStation II EyeToy: Low-Cost Virtual Reality for Use in Rehabilitation	159	9.35
Lange et al. (2010)	The Potential of Virtual Reality and Gaming to Assist Successful Aging with Disability	154	10.27
Weiss & Bialik & Kizony (2003)	Virtual Reality Provides Leisure Time Opportunities for Young Adults with Physical and Intellectual Disabilities	138	6.27
Lange, B. & Flynn, S. & Rizzo, A. (2009)	Initial usability assessment of off-the-shelf video game consoles for clinical game-based motor rehabilitation	134	8.38
Dicianno et al. (2015)	Perspectives on the Evolution of Mobile (mHealth) Technologies and Application to Rehabilitation	116	11.60
Burke J. W. et al. (2010)	Augmented Reality Games for Upper-Limb Stroke Rehabilitation	115	7.67

Most Productive Authors

Table 4 presents the top 10 productive writers, accompanied by their total citations, number of publications, start year of publishing, h-index, g-index, and m-index. According to Table 4, Malone LA emerges as the foremost author in the area of video games for physical

impairments study, having authored a total of 10 articles. Following Malone LA, Thirumalai M has 7 publications, while Padalabalanarayanan S and Rimmer JH have each contributed five times to the field.

Table 4
10 Most Productive Authors

Authors	h-indexed	g-indexed	m-indexed	Total Citation	Number of Publication	Publication Year Start
Malone LA	6	10	0.273	160	10	2003
Thirumalai M	5	7	0.556	75	7	2016
Rimmer JH	5	5	0.385	101	5	2012
Padalabalanarayanan S	4	5	0.444	68	5	2016
Lange B	3	3	0.188	179	3	2009
Rizzo A	3	3	0.15	177	3	2005
Rowland JL	3	3	0.231	104	3	2012
Shih C-H	3	3	0.214	71	3	2011
Shirley D	3	3	0.375	72	3	2017
Weiss Pl	3	3	0.136	159	3	2003

Most Productive Countries

Table 5 presents a ranking of the top ten most productive countries in terms of document output. The United States of America leads the list as the foremost productive nation, contributing a total of 284 documents. Following in second place is Spain, with a contribution of 112 documents. Brazil occupies the third position, having produced 96 documents.

Table 5
10 Most Productive Countries

Country	Total Publication
USA	284
Spain	112
Brazil	96
Italy	91
Australia	82
UK	68
Canada	63
China	58
Israel	33
Germany	32

Most Productive Affiliations

Analysis using Biblioshiny identified the top 10 most productive institutions in the field, as shown in Table 6. The University of Alabama at Birmingham (UAB) leads with 22 published articles, followed by the UAB/Lakeshore Foundation Research Collaborative with 17 articles. The University of Southern California ranks third, contributing 16 articles to the field.

Table 6
Top 10 Most Productive Affiliations

Affiliation	Articles
University Of Alabama At Birmingham	22
University Of Alabama At Birmingham/Lakeshore Foundation Research Collaborative	17
University Of Southern California	16
University Of Ulster	12
The University Of Sydney	11
Universidad Politécnica De Madrid	11
University Of Haifa	11
The Hong Kong Polytechnic University	10
University Of South Florida	10
Federal University Of Sergipe	9

Most Frequent Keywords

The most prevalent keywords used in video games for research on physical impairments are presented in Table 7, while Figure 4 depicts the word cloud of these keywords. The researcher conducted an analysis of these results using Biblioshiny. The most frequently used keywords in video games for physical impairments research are "male" (209), followed by "female" (202) and "human" (183). It is evident that the largest words in the word cloud are "male," "female," and "human," which aligns with the findings in Table 7.

Table 7
Most Frequent Keywords

Words	Occurrences
male	209
female	202
human	183
humans	153
video game	142
adult	123
video games	112
article	107
virtual reality	92
aged	88

Figure 4: Word Cloud

Network Analysis

Among the most widely used bibliometric analysis tools is network analysis. Numerous programs are available for network analysis, including Gephi and VOSviewer. According to Abdul Rahman et al. (2022), Biblioshiny is the most recent program that can perform network analysis. The co-occurrence network, cooperation analysis, and co-citation analysis carried out with Biblioshiny are covered in this section.

Co-Citation Analysis

Citation analysis examines the frequency with which texts are referenced within a specific field (Abdul Rahman et al., 2022). Co-citation analysis, a more specialized technique, helps identify both the most influential authors and significant references in video games research for physical impairments (Sobhi Ishak et al., 2023; Barbu, 2023). As shown in Figure 5, works that are frequently co-cited tend to cluster around common research themes (Abdul Rahman et al., 2022). Within this analysis, Malone L.A. emerges as the most frequently co-cited author, indicating their significant influence in the field.

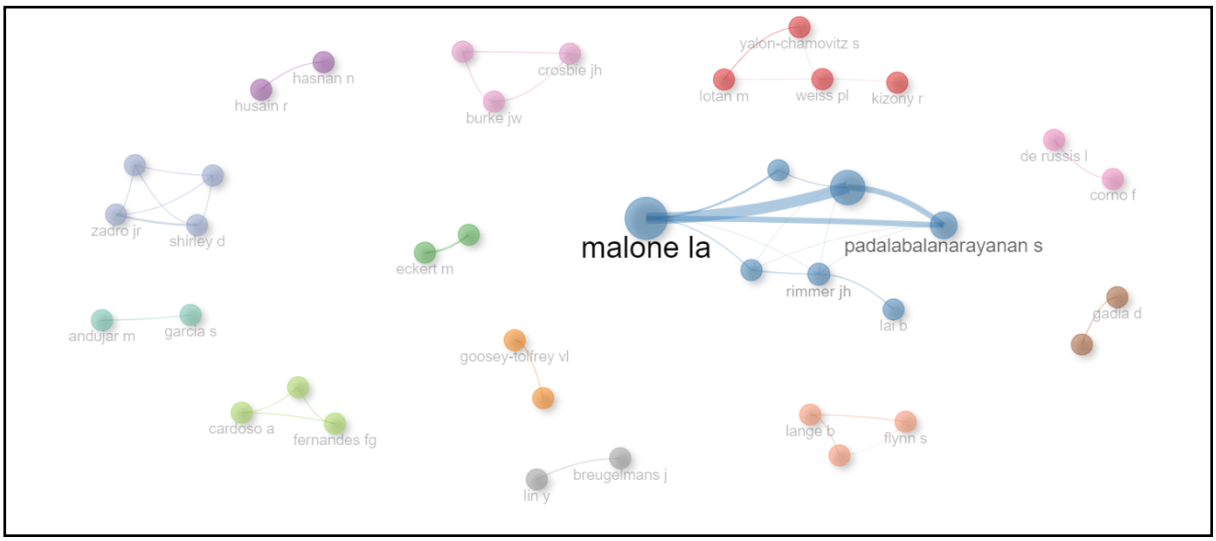

Figure 5: Co-citation Analysis

Collaboration Analysis

Table 8 outlines the global collaboration between countries in research on video games for physical impairments, with a minimum of 2 instances of collaboration. The data indicates that the collaboration between the USA and Australia has made the most substantial contribution to research in this area, with the two countries collaborating 4 times.

Table 8
Collaboration Analysis

Collaboration of Countries	**Frequency**
USA and Australia	4
Australia and Canada	3
United Kingdom and Canada	3
USA and Brazil	3
USA and Korea	3
Australia and France	2
Australia and Hong Kong	2
Australia and United Kingdom	2
Brazil and Australia	2
Brazil and Italy	2
Brazil and Portugal	2
Canada and Germany	2
China and Hong Kong	2
United Kingdom and Germany	2
United Kingdom and Netherlands	2
United Kingdom and Tunisia	2
USA and Denmark	2
USA and Egypt	2
USA and Italy	2

Co-Occurrence Network

The co-occurrence network of keywords is visually represented in Figure 6. The size of each keyword node is proportional to its frequency of usage. Different coloured clusters denote distinct thematic groupings. The proximity of keywords within the network reflects the strength of their relationships, as established by Abdul Rahman et al. (2022). Analysis of Figure 6 reveals the predominant theme cluster consisting of "human" and "video game," encompassing keywords such as "disabled persons," "disability," "exercise," "virtual reality," "rehabilitation," "quality of life," and "physiology," among others (Abdul Rahman et al., 2022).

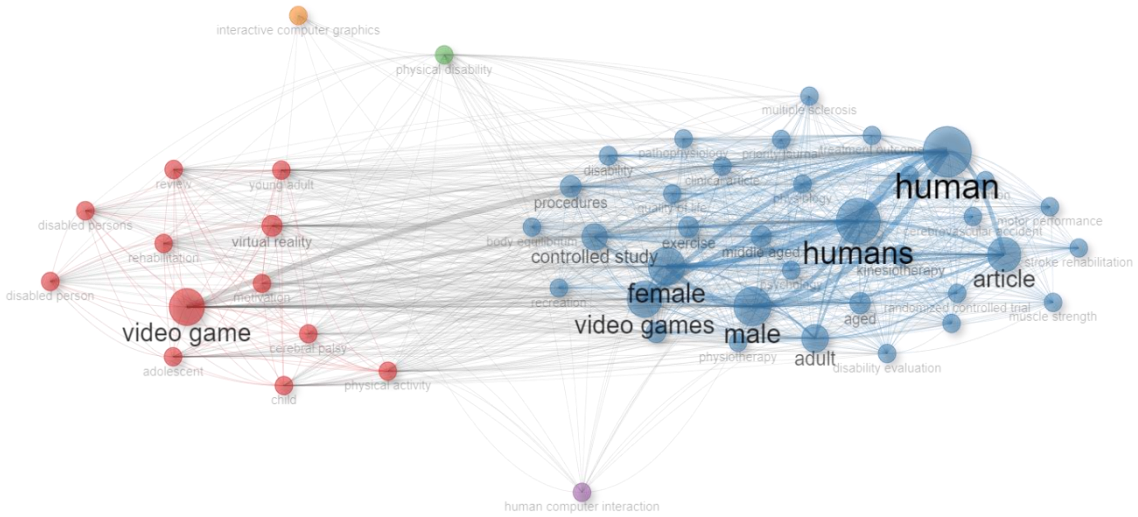

Figure 6: Co-Occurrence Network5.0 DISCUSSION

This study analyses publications related to video games for physical impairments, examining 288 publications from the Scopus database between 2003 and 2024. The field's first Scopus-indexed publication appeared in 2003, with publication trends showing consistent growth, particularly after 2010. This increase correlates with growing emphasis on gaming accessibility, driven by heightened awareness of digital media inclusivity and advancements in assistive technologies designed to enhance gaming experiences for individuals with physical impairments. While publications peaked in 2021, the apparent decline in 2023 reflects this study's data collection endpoint in July 2024.

The most influential and cited paper in the dataset is Biddiss (2010), who explored the role of active video games in promoting physical activity among children and youth. This indicates that the intersection of video games and physical rehabilitation is a major area of interest, especially in terms of utilizing games for therapeutic purposes. Similar trends are observed in other highly cited works, such as Cameirão et al. (2010) on neurorehabilitation using virtual reality systems, which highlights the potential of video games in medical rehabilitation for physical impairments. These findings suggest that video games are not only being studied for their entertainment value but also for their practical applications in rehabilitation and physical therapy for people with physical disabilities (Gerling et al., 2020).

In terms of research productivity, Malone L.A. emerges as the leading author by publication count. Geographically, the United States dominates research output, followed by Spain and Brazil, highlighting the field's global scope. The University of Alabama at Birmingham stands as the most productive institution, demonstrating sustained commitment to investigating video game adaptations and designs for individuals with physical impairments.

Analysis of keyword frequency reveals "male," "female," and "human" as the most common terms, closely followed by "video game" and "virtual reality". These keywords highlight the broad focus of the research on both the demographics of participants and the technological tools used in interventions. The frequent appearance of terms like "virtual reality" and "rehabilitation" further emphasizes the role of immersive technologies in developing accessible video games for users with physical impairments.

In the network analysis, co-citation, collaboration, and co-occurrence networks were examined. Co-citation analysis reveals that Malone L.A. is the most prolific author in the field, indicating a strong focus on accessibility in video games. Collaboration analysis shows that partnerships between the United States and Australia have contributed significantly to the field, indicating a high level of international collaboration. Co-occurrence analysis demonstrates that "human" and "video game" form the largest cluster of themes, accompanied by keywords such as "disabled persons," "disability," "exercise," "virtual reality," and "rehabilitation." These clusters highlight the critical themes being explored in the research, particularly the focus on how video games can be used as tools for rehabilitation and to enhance the quality of life for individuals with physical impairments.

Conclusion

This study analysed trends in publications on video games for individuals with physical impairments from 2003 to 2024 using bibliometric analysis via the Biblioshiny app for the R bibliometrix package. Key findings show that the University of Alabama at Birmingham leads in research output, with themes such as virtual rehabilitation, neurorehabilitation, and exergaming using augmented and virtual reality technologies dominating the field. Frequently used terms, including "video games," "virtual reality," and "rehabilitation," emphasise a focus on adaptive technologies to enhance accessibility.

The findings suggest that researchers should foster international collaborations to bridge knowledge gaps and advance accessible gaming. Incorporating emerging technologies such as AI-driven adaptive interfaces and haptic feedback could further enhance gaming experiences for individuals with physical impairments. Policymakers and game developers are urged to develop standardised guidelines that embed accessibility into game design processes to address current challenges in gaming accessibility.

Future research should broaden its scope by integrating data from multiple databases, such as Web of Science (WoS), to provide a more comprehensive analysis of global trends. This study lays the groundwork for advancing inclusive gaming technologies, highlighting the potential of video games to improve the quality of life for individuals with physical impairments.

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