

Current Status, Hotspots, and Trends in Physical Education for Psychological Health Development - A Bibliometric Perspective

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Abstract

With the rapid development of the global economy and society, mental health issues have become increasingly prominent, and the critical role of physical education in promoting mental resilience is gaining recognition. This study aims to analyze the current state of research, key focuses, and future trends concerning the effects of physical education on mental health resilience from an international perspective. Relevant publications were retrieved from the Web of Science Core Collection, and a bibliometric analysis was conducted using VOSviewer and CiteSpace. The methodology involved clustering co-occurrences of authors, institutions, and keywords; generating keyword time-zone views; and performing burst analysis to identify development trends in the field. The results indicate that the volume of publications in this domain has been increasing, especially after 2019, with significant contributions from European countries and the United States. However, there is a relatively low overall connection strength among institutions, highlighting the need for enhanced international cooperation. Research in this field clusters into three main categories: physiological health and activity; autonomy and intrinsic motivation; and learning performance and educational environment. Future research trends may focus on interdisciplinary integration, personalized physical education programs through data science and artificial intelligence, the role of cultural and social contexts, and the use of innovative technologies like wearable devices and virtual reality. This study provides a comprehensive overview of the domain, elucidating how physical education can improve mental health among college students, and offers insights for practitioners to leverage physical education benefits while addressing associated challenges and impacts.

Keywords: Physical Education, Psychological Health, Bibliometric, Vosviewer, Citespace.

Introduction

The significance of physical education in contemporary society is increasingly recognized, especially in terms of promoting physical and mental health through physical activity behaviors (Loiselle & Travis, 2023). As society develops and the pace of life accelerates, an increasing number of individuals are experiencing health challenges (Castro et al., 2018; Seo et al., 2012). Early modern philosopher John Locke famously posited that “a sound mind in a sound body,” capturing the essence of the belief that physical health is foundational to mental well-being, a notion further supported by recent studies. Physical education has the potential to enhance not only physical fitness but also mental resilience, offering a holistic approach to well-being that addresses both body and mind.

Despite this growing recognition, there remains a notable gap in academic research concerning comprehensive strategies and structured approaches for enhancing mental health through physical education. Most existing studies have focused on isolated aspects of physical education's

impact on mental health, often examining specific psychological benefits of physical activity but overlooking integrative methods and broader applications (Kalia et al., 2022). Opstoel et al. (2020) investigated the contribution of PE to the personal and social development of school-aged children and youth through a literature review. It indicates that the influence of PE on individual work ethic, goal setting, problem-solving and re-sponsibility is generally positive. López-Pastor et al. (2013) studied assessment methods in PE, including traditional assessment tools (such as physical fitness tests) and supervisory criteria, found that in alternative assessments, PE places more emphasis on education. Bailey (2006) explored the scientific evidence of the benefits and outcomes of PE to children and the education system. The research evidence suggests that PE has the potential to make significant and unique contributions in children's physical, lifestyle, emotional, so-cial, and cognitive aspects. Richards, Templin and Graber (2014) analyzed the cultural adaptability, profes-sional preparation, and socialization organizations required for PE teachers and investi-gated

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the factors influencing the decisions and behaviors of PE teachers. Casey and Goodyear (2015) studied the effects of cooperative learning in the physical, cognitive, social, and emotional domains in PE, revealing that cooperative learning shows better outcomes in physical, cognitive, and social domains, while in the emotional domain, more work is needed.

Quantitative studies have shed light on various psychological benefits of physical activities. For instance, Zhang et al. utilized structural equation modeling (SEM) and data mining techniques to explore the positive effects of Cooperative Learning Physical Education (CL-PE) on children's mental health (Zhang, Yang, & Yang, 2022). Additionally, a prior study demonstrated the efficacy of deep learning algorithms in analyzing the impact of physical education on mental health, revealing significant performance improvements in mental health studies within the physical education context. On the theoretical front, Zhu and Li (2022) developed models that incorporate mental health education within university physical education curricula, offering strategic insights for curriculum development and enhancement. These studies provide a theoretical underpinning that can guide future educational frameworks. However, these contributions have yet to produce a cohesive, integrative framework that fully leverages physical education for mental health resilience across diverse populations.

The present study seeks to fill this gap by providing a comprehensive analysis of current research trends and identifying key strategies for integrating mental health education within physical education curricula. By systematically mapping the research landscape in the field of Physical Education and Psychological Health (PEDPH), this study aims to offer valuable insights that can inform educational strategies, public health initiatives, and policy-making efforts. These findings are intended to guide educators in designing physical education programs that support mental well-being, and to assist policymakers and health organizations in planning mental health initiatives that leverage the benefits of physical activity. Ultimately, this research contributes to a deeper understanding of how structured physical education programs can be employed to address mental health challenges and promote resilience on a broad scale.

The remainder of the manuscript is structured as follows: Section 2 details the methodology, including data collection and analysis processes. Section 3 presents the results, highlighting key trends and research clusters within PEDPH. Section 4 discusses the identified research hotspots and future directions, and Section 5 concludes with a summary of findings, implications, and limitations.

Methods and Data Sources

Introduction to Research Methods

Bibliometrics utilizes the quantitative characteristics of literature for analysis, applying statistical and mathematical methods to explore research progress, hotspots, and trends in a specific field (Zupic & Cater, 2015). Knowledge visualization maps, graphical depictions of knowledge evolution and structural relationships, are generated from statistical analysis of target literature and citations in temporal databases. They highlight research focuses and key terms, revealing trends in the field. In recent years, an increasing number of scholars have been utilizing various knowledge mapping tools to analyze the potential driving mechanisms behind disciplinary evolution. Among these tools, CiteSpace and VOSviewer stand out for their powerful functionalities and complementary advantages. CiteSpace is utilized in this study for its time-zone view functionality, which enables a clear delineation of the knowledge evolution process over time, and its burst term detection feature, which identifies emerging trends within the discipline (Xu et al., 2024). VOSviewer is chosen for its ability to produce aesthetically pleasing network, overlay, and density visualizations, facilitating comprehensive analysis. This study integrates both VOSviewer and CiteSpace tools, combining VOSviewer's probabilistic approach to identify research trends and hotspots regarding the impact of physical education on mental health resilience: (1) using VOSviewer, co-occurrence cluster maps of authors, institutions, and keywords are created for statistical analysis of the foundational data; (2) applying CiteSpace to draw keyword time-zone views and conduct keyword burst analysis, studying the characteristics and development trends of PEDPH.

Publication Status

The publication status of papers is commonly regarded as a crucial indicator of a discipline's development level and scientific output. It serves as a measure of research achievements and contributions, reflecting the overall progress and trends within the field (Chen & Liu, 2020). The evolution of scientific knowledge is intricately linked to the volume and dispersion of scholarly literature. Analyzing the yearly distribution of pertinent publications can offer a window into the pace, profundity, and maturity of the field's global advancement. The number of the published scientific paper is one of the key indicators of a country's research strength (Azam et al., 2021). In a specific field, a higher volume of publications generally indicates a stronger scientific capacity of a country in that field. Based on Origin

software, the attention of numerous experts and scholars towards PEDPH and the research intensity on the subject across different countries is explored. The results are analyzed from two perspectives: (1) annual publication (Figure 1); (2) publication volume by country (Figure 2).

Clustering of Authors, Research Institutions, and Keywords

Conducting a quantitative analysis based on the authors of sample literature not only allows for the identification of representative scholars in the field of sports education but also enables the assessment of collaborative relationships among researchers (Zhou et al., 2023). The core authors in a field and the extent of collaboration among them can be identified through an analysis of author collaborations. In the domain of scientific research, collaboration has emerged as a crucial means for knowledge dissemination, with the advancement of technology and research globalization fostering a mainstream culture of cooperative endeavors (Zhang et al., 2020). Analyzing the collaboration network in PEDPH research can swiftly identify institutions with significant expertise and influence in the field. This is beneficial for understanding inter-institutional connections, facilitating talent recruitment, and promoting cross-institutional academic exchanges and cooperation. Keywords are words and phrases that represent themes related to literature. By conducting a co-occurrence analysis of keywords across a research field and creating knowledge maps, one can use the frequency of keyword appearances to analyze research hotspots and the evolution of themes. These advantages make keywords analysis become a widely applied bibliometric method (Yuan et al., 2022). The frequency of keywords, indicative of the number of times a keyword appears in the research process, can reveal the hot topics within a research domain. Cluster analysis, based on the frequency with which keywords or terms co-occur in literature, groups closely related keywords into categories. This method extracts high-frequency keywords that encapsulate the core content of a knowledge domain, thereby identifying research themes.

Keyword Time-zone and Burst

Keyword time-zone analysis, based on co-occurrence, enables the temporal examination of research hotspots, shedding light on PEDPH research trends (Zuo et al., 2021). Time-zone visualization maps are inclined to display the chronological development and changes of keywords, offering a more intuitive representation of the evolution of individual keywords and their interrelations (Lin, Shen, & Guo, 2021). By integrating the current state and characteristics of sports education research, the development process of hot topics is analyzed and

summarized, thereby forecasting future evolution trends. Sudden variations in citation frequency can be visualized through keyword burst maps, highlighting the evolution and transitions within research hotspots as evidenced by the emergence of keywords (Geng, Zhang, & Zhu, 2023). Keyword burstiness refers to the rapid increase in the occurrence of a particular keyword within a period, leading to shifts in the hotspots of the research field. Burstiness keywords, also known as burst terms, can reflect influential research areas over a period, representing highly focused research themes in academia and indicating the frontier and development trends of research (Li, Li, & Sang, 2022). By utilizing the burst detection feature in CiteSpace, the intensity and temporal distribution of keyword bursts are examined, resulting in a burst graph of keywords in the field of PEDPH research.

Data Sources

A literature search was conducted using an advanced search in the Web of Science (WOS) Core Collection database. The search scope was from January 1, 2000, to December 31, 2023. The searched term was setting as TS = (("Physical education" OR "Sport education") AND ("mental*" OR "psychological*" OR "depression" OR "stress" OR "PTSD" OR "anxiety" OR "bipolar disorder" OR "borderline personality disorder" OR "schizophrenia")). The searched article type was selected as "Article" and "Review Article", while the searched language was "English". The criteria for selecting references included relevance to the topic, peer-reviewed status, and availability of full text. After a comprehensive retrieval, 5861 articles were obtained. Among them, 1732 articles were valid after filtering out those containing conference solicitations, book reviews, column prefaces, literature lacking authors, and other irrelevant literature to the subject matter.

Methodology Motivation

The adoption of bibliometric analysis without empirical data collection is appropriate for this study as it aims to provide a comprehensive overview of existing research rather than conduct primary empirical research. Bibliometric methods allow for the quantitative assessment of publication trends, collaboration networks, and research hotspots within a field. This approach leverages existing literature to map the intellectual landscape, identify gaps, and suggest future research directions. By analyzing a large volume of scholarly works, the study can uncover patterns and insights that might not be apparent through empirical methods alone. Therefore, this methodology effectively addresses the research objectives by utilizing existing data to explore the impact of physical education on mental health resilience from an international perspective.

Analysis of Publication Trends and Cooperation Network

Analysis of Annual Publication Trend

The annual distribution of published articles provides insights into research activity and developmental priorities within the PEDPH field. For this domain, publication trends can be categorized into three phases, each reflecting significant shifts in focus and intensity of research related to physical education and mental health. (1) **Initial Growth Phase (2000-2006)** marked a gradual increase in publications, coinciding with rising awareness of the benefits of physical activity on mental health. During this period, foundational studies highlighted the potential for physical education to enhance mental well-being, laying the groundwork for further research. This trend likely reflects improvements in physical education infrastructure and heightened public awareness of health issues. Since the early 2000s, physical education has evolved into a significant field of academic inquiry, with scholars investigating the profound effects of exercise on mental health. For instance, during this period, the United States revised its National Physical Activity Guidelines, enhancing the promotion of physical activities. Concurrently, as societal focus on mental and physical well-being intensified, research connecting psychological health and physical exercise gained momentum.

(2) **Steady Growth Phase (2007-2018)** saw a noticeable rise in research output, fueled by enhanced international collaboration and increased policy support. This phase reflects growing global interest in understanding and

promoting mental health through physical education. Research during this period also benefitted from increased funding and supportive policies, encouraging further investigation into the mental health benefits of physical education. Several nations boosted their investments in research on physical education and mental health, driven by policy initiatives and funding. For example, following the 2008 Beijing Olympics, China not only promoted physical activities but also increased funding for sports science research. Additionally, the EU and its member states augmented their financial contributions to health and welfare projects during this time, including those focused on physical education and mental health.

(3) **Rapid Growth Phase (2019-2023)** represents a significant surge in publications, largely driven by heightened awareness of mental health due to global health crises, such as the COVID-19 pandemic. This period is characterized by a swift increase in publications, with a growth rate of 84.81% in 2019 (Fan et al., 2024). Isolation measures and social restrictions enhanced recognition of the role of physical activity in promoting mental health, prompting several nations to implement health promotion programs that included physical activities. For instance, the World Health Organization issued recommendations to strengthen public mental health, spurring governments worldwide to adopt supportive measures. This period underscores a crucial shift as physical activity's role in mental health gained recognition worldwide, leading to expanded research initiatives and greater public interest in health-promoting behaviors.

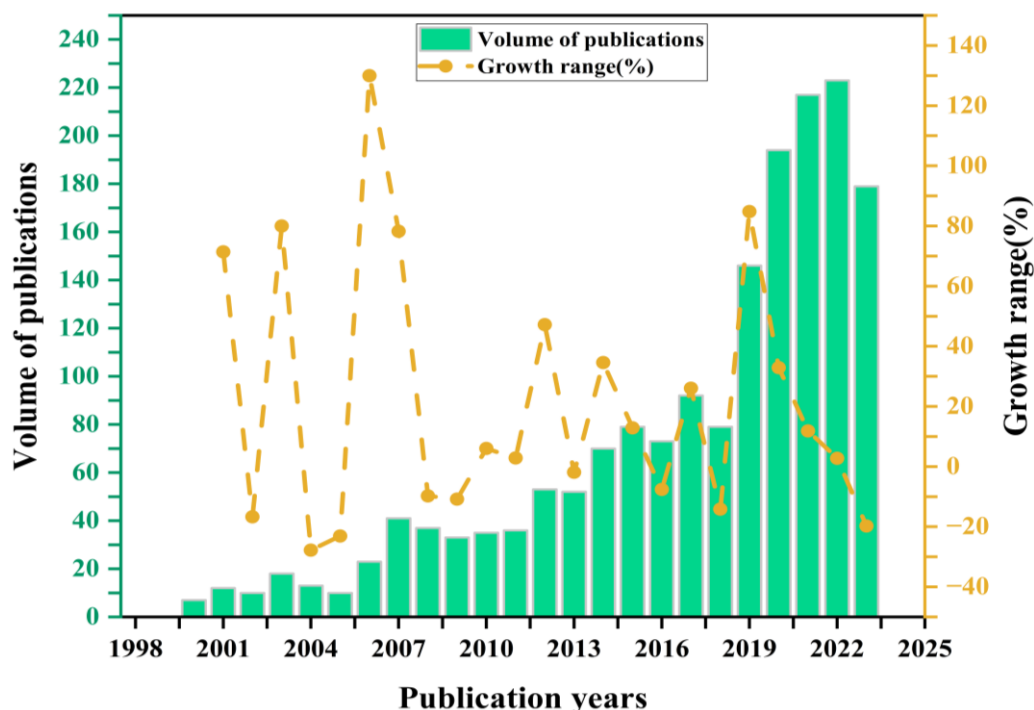


Figure 1: The Annual Publication Trends.

Analysis of Journal Distribution

Statistical analysis of 1,713 academic papers reveals their distribution across 436 journals, showing significant variability in publication frequency per journal. According to Bradford's Law using a ratio of 1: n : n^2 where $n=5$, the core journals in this field have been identified. These journals are divided into three zones based on the number of publications they host, arranged such that each zone

approximately contains an equal number of papers, resulting in distributions of 14:70:352 journals per zone.

The core group consists of 14 journals, listed in Table 1. Within this elite group, 57.14% of the journals have a Journal Citation Reports (JCR) ranking of Q2 or higher, indicating a high level of quality. The predominant themes of these core journals encompass Sport Sciences, Applied Education Psychology, and comprehensive interdisciplinary studies.

Table 1

Distribution of Core Journals

Rank	Core Journal	Publication Volume	Impact Factor	WOS Category
1	International Journal of Environmental research and Public Health.	99	4.6 (2021)	Q2 (2021)
2	Frontiers in Psychology.	80	3.8	Q1
3	European Physical Education Review.	67	3.4	Q2
4	Physical Education and Sport Pedagogy	65	3.6	Q1
5	Journal of Teaching in Physical Education.	57	2.8	Q2
6	Sustainability.	55	3.9	Q2
7	Revista de Psicología del Deporte.	50	1	Q4
8	Psychiatria Danubina.	48	2.7 (2021)	Q3 (2021)
9	Psychology of Sport and Exercise.	48	3.4	Q1
10	Journal of Sport and Exercise Psychology.	35	2.4	Q3
11	Perceptual and Motor Skills.	30	1.6	Q4
12	Research Quarterly for Exercise and Sport.	28	2.2	Q3
13	Sport Education and Society.	28	2.9	Q2
14	Plos One.	23	3.7	Q2

Note: International Journal of Environmental research and Public Health and Psychiatria Danubina not indexed by SCIE after 2021.

Analysis of National, Institutional, and Author Collaboration Networks

National Collaboration Networks

Between 2000 and 2023, the distribution of published research in the PEDPH field reveals the participation levels of various countries. Spain leads with 365 research papers, closely followed by the United States with 283 papers. Both countries are forefront runners in the field, a prominence likely due to their efforts in enhancing institutional support and implementing robust educational policies that particularly emphasize the importance of physical education. China and the United Kingdom have also demonstrated strong research outputs with 220 and 165 papers, respectively, while Australia's active contribution of 154 papers can chiefly be attributed to its robust engagement in developing health-oriented educational programs.

In contrast, Brazil, Turkey, and South Korea exhibit

relatively lower publication activities with fewer than 70 papers each. This may reflect disparities in these countries regarding economic development, policy support, and the allocation of resources for sports education research. Typically, more developed nations display a superior performance in the allocation and commitment to research funding, which consequently leads to higher publication volumes.

European countries maintain a dominant position in this field, underscoring a regional prioritization of sports education, which stems from a cultural emphasis on health and education. However, nations from Africa, Asia, and South America lag in publication volume, primarily due to insufficient governmental policy support and limited financial and institutional resources dedicated to physical education. This global research imbalance highlights the differing infrastructure available for exploring the benefits of sports education on mental health.

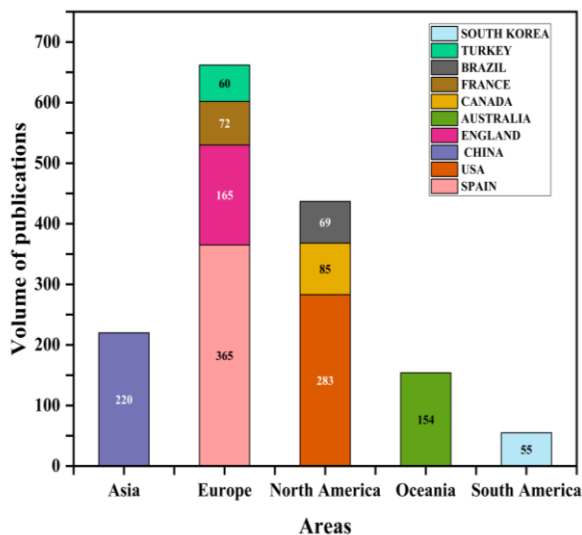


Figure 2: The National Collaboration Networks.

Institutional Collaboration Network

Using VOSviewer for a visual analysis of publishing institutions, we present a map that features only those institutions with more than 10 publications for aesthetic clarity, omitting entities with a collaboration strength of zero. Following this filtering, 49 institutions are effectively displayed, as shown in Figure 3. Table 2 lists the top ten leading institutions in the PEDPH field, detailing their publication count, number of citations, and overall network connectivity strength.

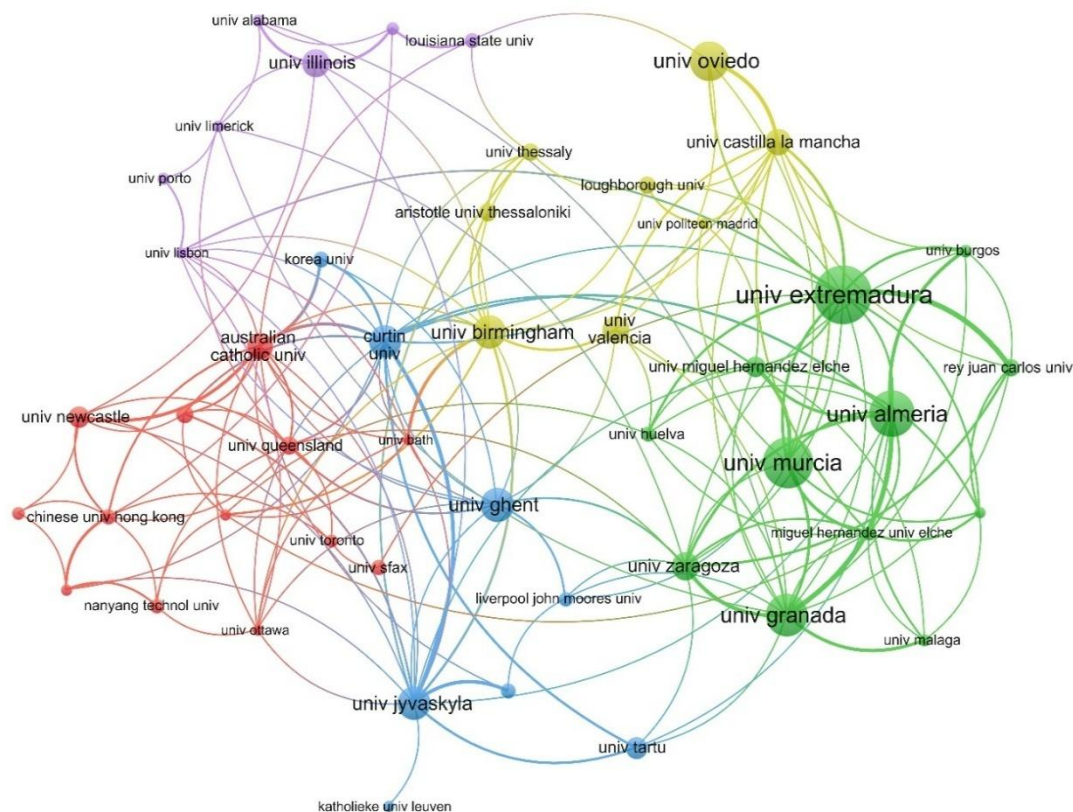


Figure 3: The Institutional Collaboration Network.

It is noteworthy that institutions from Spain dominate the publication output, with the top five universities by volume all located in Spain: University of Extremadura, University of Murcia, University of Almeria, University of Granada, and University of Oviedo. The University of Extremadura stands out with 58 papers and a total of 844 citations, indicating significant influence in this field of research.

Additionally, contributions from universities outside Spain, such as the University of Birmingham and Curtin University, are considerable. These institutions have not only produced a high volume of papers but also demonstrated significant citation impact, with 2532 and 2048 citations respectively, suggesting their research has wide-reaching influence in the academic community. Moreover, the University of Jyväskylä showcases strong academic collaboration with a total linkage strength of 34, indicating effective network connectivity.

The participation of these institutions from diverse regions underscores the global interest and varied contributions to the research on physical education and its impact on mental health. However, the generally low total linkage strength across most institutions suggests that there is room for improvement in international cooperation and deeper research integration. Actively fostering inter-institutional collaboration and enhancing communication channels could further stimulate advancements in this vital research field.

Table 2*The Top Ten Leading Institutions in The PEDPH Field*

Rank	Organization	Documents	Citations	Total link strength	Country
1	Univ extremadura	58	844	42	Spain
2	Univ murcia	50	812	31	Spain
3	Univ almeria	45	1086	41	Spain
4	Univ granada	41	416	40	Spain
5	Univ oviedo	38	752	12	Spain
6	Univ ghent	33	2532	15	Belgium
7	Univ birmingham	32	3355	26	England
8	Univ jyvaskyla	32	1048	34	Finland
9	Curtin univ	31	2048	40	Australia
10	Univ illinois	27	518	12	United States

Author Collaboration Network

Through the use of VOSviewer for visual analysis, the author collaboration network within the PEDPH field has been mapped and is detailed in Figure 4. Table 3 enumerates the top 10 prolific authors in the field, specifying their publication counts, citation numbers, and overall network connectivity strengths.

The publication metrics of the top researchers in the field of Physical Education and its impact on Psychological Health capture a dynamic scholarly landscape. Nikos Ntoumanis emerges as a pivotal figure with 27 documents accumulating the highest citation count of 2,966, reflecting significant scholarly impact and influence in the field. His research work, featuring substantial depth and reach, underscores the global recognition of his contributions to understanding the complex interrelations in physical education settings.

Following close are authors such as Leen Haerens with 21 publications and a robust citation count of 1,677, and Maarten Vansteenkiste with 17 publications yet commanding a citation count of 1,777, further highlighting the quality and robust influence of their research outputs. Such figures suggest that while volume of publications is crucial, the impact discerned through citations demonstrates substantial contributions to the academic community and beyond.

A notable range in the total link strength among these authors reveals differing levels of collaborative engagement. For instance, Leen Haerens shows the highest collaborative interactivity with a total link strength of 50. This implies a significant level of co-authorship, indicative of collaborative research efforts and academic networks that likely extend the reach and implications of her work. In contrast, other researchers

like K. Andrew R. Richards and Javier Fernandez-Rio who show considerably lower connection strengths of 18 and 17 respectively, may indicate more focused or insular research pursuits.

This quantifiable snapshot underscores the importance of both individual scholarly output and collaborative engagements that together shape the academic discourse in Physical Education's impact on Psychological Health. Government and institutional support to facilitate further research collaborations could potentially amplify the scope and depth of findings, fostering a richer understanding that could translate into actionable educational and health policies. As such, insights gleaned from the productivity and connectivity of these top researchers could guide future research agendas and encourage emerging scholars to contribute to this evolving field robustly.

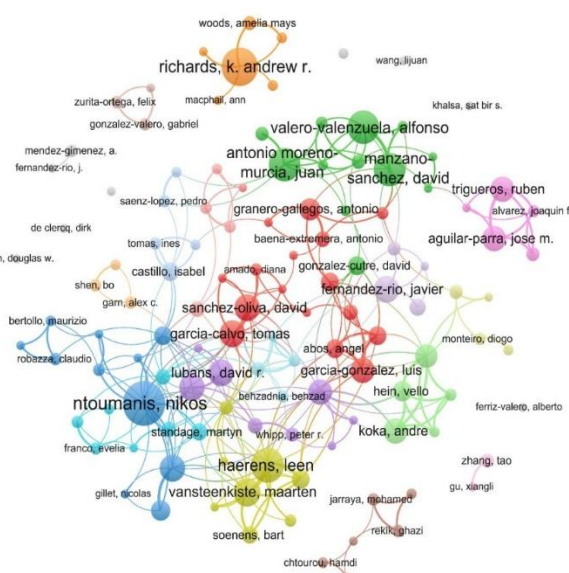
**Figure 4:** The Author Collaboration Network.

Table 3*The Top Ten Prolific Authors in the PEDPH Field*

Rank	Author	Documents	Citations	Total link strength
1	Ntoumanis, nikos	27	2966	42
2	Richards, k. andrew r.	23	426	18
3	Haerens, leen	21	1677	50
4	Antonio moreno-murcia, juan	20	334	24
5	Manzano-sanchez, david	20	217	27
6	Valero-valenzuela, alfonso	20	256	33
7	Vansteenkiste, maarten	17	1777	39
8	Fernandez-río, javier	16	461	17
9	Garcia-calvo, tomas	16	292	40
10	Lonsdale, chris	16	1343	23

Analysis of Research Hotspots and Future Trends

Analysis of Research Hot Topics

The accuracy and frequency of keywords are crucial factors in identifying research hotspots within a field. To enhance the reliability of the analysis, an initial cleansing and organization of keywords in the literature was conducted. Using VOSviewer to analyze these cleaned keywords, those occurring more than 20 times were categorized as high frequency, with irrelevant and generic terms like "physical education" and "sport education" omitted. The resulting keyword co-occurrence network map is shown in Figure 5. Based on this clustering of keyword co-occurrences, current research directions in the PEDPH field are divided into three main categories: physiological health and activity (red area #1), autonomy and intrinsic motivation (green area #2), and learning performance and educational environment (blue area #3). These clusters represent the three core avenues through which physical education influences psychological health development, examining the themes from physiological, psychological, and educational environmental perspectives.

(1) Cluster #1 Physiological Health and Activity

This cluster centers on keywords related to physical activity, sports, and fitness, including "physical activity," "exercise," "fitness," "health," and "obesity," with a particular emphasis on the role of physical education. It explores the impacts of organized sports and physical education programs on various aspects of physical health, such as youth physical activity, related fitness behaviors, and physiological health conditions. Research by [Arija et al. \(2018\)](#), [Elagizi et al. \(2020\)](#), and [Oppert, Bellicha and Ciangura \(2022\)](#), among others, underscores the importance of curriculum-based physical education in

promoting regular physical activity and improving overall health outcomes. Regular participation in physical education can significantly reduce obesity risks, enhance cardiovascular health, and improve musculoskeletal health. For example, the work of [Elagizi et al. \(2020\)](#) highlights that obesity and sedentary lifestyles are major risk factors for cardiovascular diseases; physical education programs that encourage increased physical activity and healthy weight management are essential in mitigating these risks. Additionally, physical education that incorporates resistance training (RT) effectively enhances musculoskeletal system functions, cognitive functions, and psychological health ([D'Onofrio et al., 2023](#)). On the flip side, certain types of intensive physical activities within physical education, such as excessive training or specific exercise modalities like eccentric contractions, may introduce substantial physiological stress. For instance, excessive training, frequently involving elements such as downhill running, has been linked to increased levels of pro-inflammatory cytokines in serum, muscle tissues, and joint cartilage ([Morais et al., 2021](#)). This cluster underscores the importance of structured physical education programs, especially in the context of public health challenges like the COVID-19 pandemic.

Moreover, physical education has an indirect impact on psychological health through improvements in physiological health. Physical activities incorporated into school programs release endorphins, which elevate mood and reduce pain perception ([Garcia-Falgueras, 2015](#); [Rokade, 2011](#)), and enhance self-esteem and self-efficacy among students ([Joseph et al., 2014](#)). These programs also social skills. Team-based physical education activities, like football, basketball, or volleyball, not only provide enjoyment but also teach teamwork and social skills, which are crucial for psychological health development ([Ngooi et al., 2022](#); [Nielsen et al., 2021](#)). Interestingly, the COVID-19

pandemic highlighted the critical need for structured physical education programs, as restrictions led to a decrease in physical activity among children and adolescents. Hence, maintaining physical education and encouraging comprehensive participation in various physical activities are vital for sustaining psychological health and well-being (Moreira-Neto et al., 2021).

(2) Cluster #2 Autonomy and Intrinsic Motivation

This cluster includes keywords linked with Self-Determination Theory (SDT) and intrinsic motivation, such as "self-determination theory," "intrinsic motivation," "autonomy," and "basic psychological needs." These keywords underscore the importance of individuals' agency and autonomy and focus on how enhancing intrinsic motivation can foster the development of psychological health. SDT, a significant psychological theory, elaborates on how the three basic psychological needs—autonomy, competence, and relatedness—influence individual's intrinsic motivation and behaviors (Ryan & Vansteenkiste, 2023). Within the context of physical education, these concepts are used to explain how individuals can improve psychological health through sports activities (Vasconcellos et al., 2020; White et al., 2021). When educators support students' autonomy, allowing them more choice and control over activities, students are generally more willing and actively engage, enhancing not only their physical performance but also positively affecting their psychological health. For instance, studies by Abós et al. (2021), and others show that when students are granted high autonomy in sports activities, they experience greater enjoyment and satisfaction, which not only promotes their long-term development in the sports field but also helps to boost self-efficacy and self-esteem, key indicators of psychological health. Furthermore, by meeting students' basic psychological needs, physical education can serve as a significant venue for promoting individual psychological development. This cluster suggests that autonomy-supportive environments in physical education can significantly contribute to psychological health development.

An autonomy-supportive environment is one that encourages individuals' independent decision-making and self-exploration, crucial for sustaining engagement in physical activities (Gurgis, Kerr, & Stirling, 2020; West, Rice, & Vella-Brodrick, 2023). These environments, by offering choices, respecting individual perspectives, and encouraging self-discovery, help individuals process information more deeply and establish firmer behavioral intentions impacting behavioral change (Gill, Trask-Kerr, & Vella-Brodrick, 2021). Experimental intervention

explored the relationship between teachers' autonomy-supportive teaching and learners' autonomy, finding that learners' perceived choice, competence, teacher support, and intrinsic motivation causally modulate this relationship, with perceived choice being the strongest predictor of learner autonomy. Cheon et al. (2022) through randomized controlled trial designs, confirmed that interventions for physical education teachers that increased autonomy-supportive teaching significantly enhanced the psychological needs of sports students.

(3) Cluster #3 Learning Performance and Educational Environment

This cluster features keywords related to learning, school educational environments, achievement, and their assessments, such as "students," "school," "achievement," "performance," and "education." The research topics involved in this cluster include educational strategies, learning outcomes, and the effects of school environments on student performance.

Physical activities not only aid in the physical and psychological development of students but also positively impact their academic achievements and social skills (Haverkamp et al., 2020; Sember et al., 2020). Students regularly involved in physical activities typically exhibit lower stress and anxiety levels and higher self-esteem and self-efficacy. These improvements in psychological health are vital supports for students' academic success, helping them maintain higher focus and better cognitive functions in school (Gueldner, Feuerborn, & Merrell, 2020).

Optimizing the school educational environment, integrating physical education into students' daily learning, is especially crucial for promoting students' psychological health and academic achievements (He et al., 2023). Education policymakers and school administrators need to recognize that a supportive learning environment should include adequate space and time for physical activities (Niemi, 2021). Physical education should not be viewed as an optional filler in the curriculum but as a necessary part of fostering students' holistic development. By offering a variety of physical activities and ensuring all students can participate, schools can effectively use physical education to enhance students' intrinsic motivation, improve their psychological health, and thereby boost academic performance (Anthony et al., 2023; Gkintoni et al., 2024; Starowicz et al., 2022). This cluster reinforces the importance of positioning physical education as an integral part of educational environments to support holistic student development, particularly as it contributes to academic success alongside psychological well-being.

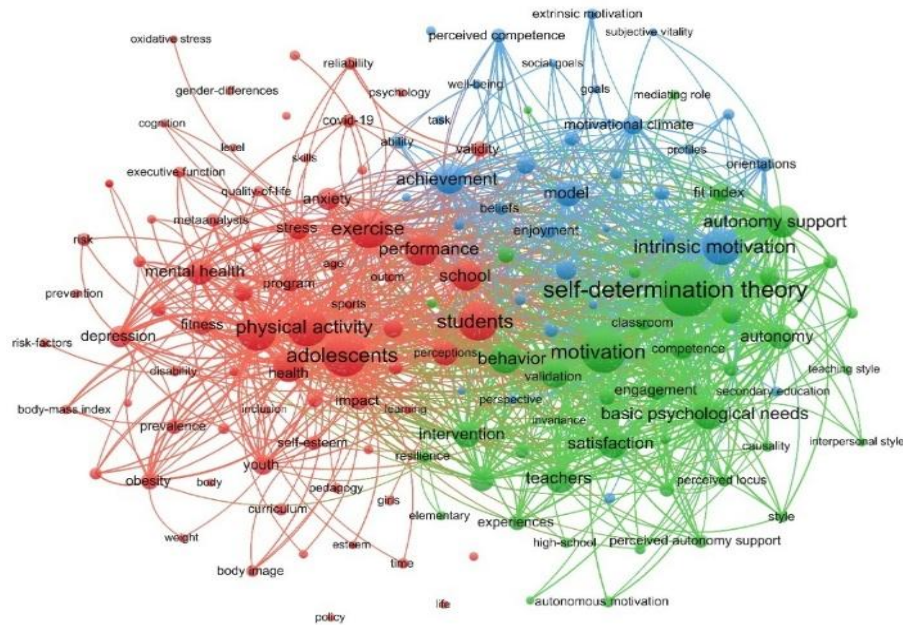


Figure 5: The Resulting Keyword Co-Occurrence Network Map.

Analysis of Future Trends

Considering the appearance of keywords in the PEDPH field since 2007 in the chronological map, this section analyzes the trends from 2007 to 2023, with the temporal distribution of keywords and emergent terms featured in [Figure 6](#) and [Table 4](#). The analysis summarizes the research directions in the PEDPH field over the period as follows:

2007-2011: During this phase, research primarily focused on fundamental concepts such as "physical activity," "intrinsic motivation," "exercise," "children," and "adolescents." Keywords like "performance" and "model" indicate studies exploring the correlation between physical activities and learning performance as well as psychological models ([Rasberry et al., 2011](#); [Trudeau & Shephard, 2008](#)). Additionally, the emergence of "self-determination theory" marks the beginning of attention towards the application of motivational theories in sports education ([Silva et al., 2010](#)).

2012-2016: Research shifted towards exploring psychological traits in supportive sports environments, evidenced by the emergence of keywords such as "autonomy support," "motivation," and "need satisfaction." This period saw an increased focus on physical activities within adolescent and school environments ([Loprinzi et al., 2012](#); [Morton et al., 2016](#)), illustrated by keywords like "school" and "adolescents." The mention of "mental health" began to surface, indicating a direct investigation into the impacts of physical activities on mental health ([VanKim & Nelson, 2013](#)).

2017-2020: The research in this stage deepened further, incorporating quantitative analysis and assessment tools ([Oberste et al., 2020](#)) such as "scale," "fit index," and "meta-analysis." Keywords like "program" and "quality of life"

appeared, indicating a shift towards examining the tangible effects of sports programs on improving life quality (Diaz et al., 2019). Additionally, "autonomy" and "competence" linked with psychological health needs became more pronounced, reflecting a focus on the satisfaction of intrinsic needs among participants (Holt et al., 2019).

2021-2023: The most recent research has increasingly focused on the profound impacts on mental health (Li et al., 2021), as seen with terms like "psychological need satisfaction" and "emotional intelligence." This suggests a deeper exploration of the subtle mechanisms by which physical activities influence mental health. Moreover, interdisciplinary approaches are being utilized, with keywords like "resilience," "climate," and "psychometric properties" highlighting the connections between physical activities, academic achievements, and environmental factors (Bernard et al., 2021; Takiguchi et al., 2023).

As the research field continues to expand, future trends in PEDPH research may concentrate on interdisciplinary integration, incorporating knowledge from psychology, education, sociology, and neuroscience to comprehensively understand the mechanisms by which physical activities affect mental health. Additionally, leveraging data science and artificial intelligence, future sports education may emphasize more precise and personalized health intervention programs, designing sports education plans tailored to individual needs through big data analysis. Considering the potential long-term effects of physical activities on mental health, longitudinal study methods are likely to become more widespread to accurately assess the benefits and lasting impacts of sports education. Moreover, research will also consider the role of cultural and social

contexts in the acceptance of sports education and its effects on mental health, along with the use of innovative technologies like wearable devices and virtual reality to enhance participation and evaluate health outcomes. This

deepening and broadening of research in sports education and mental health seeks to provide more scientific support for promoting public health and well-being.

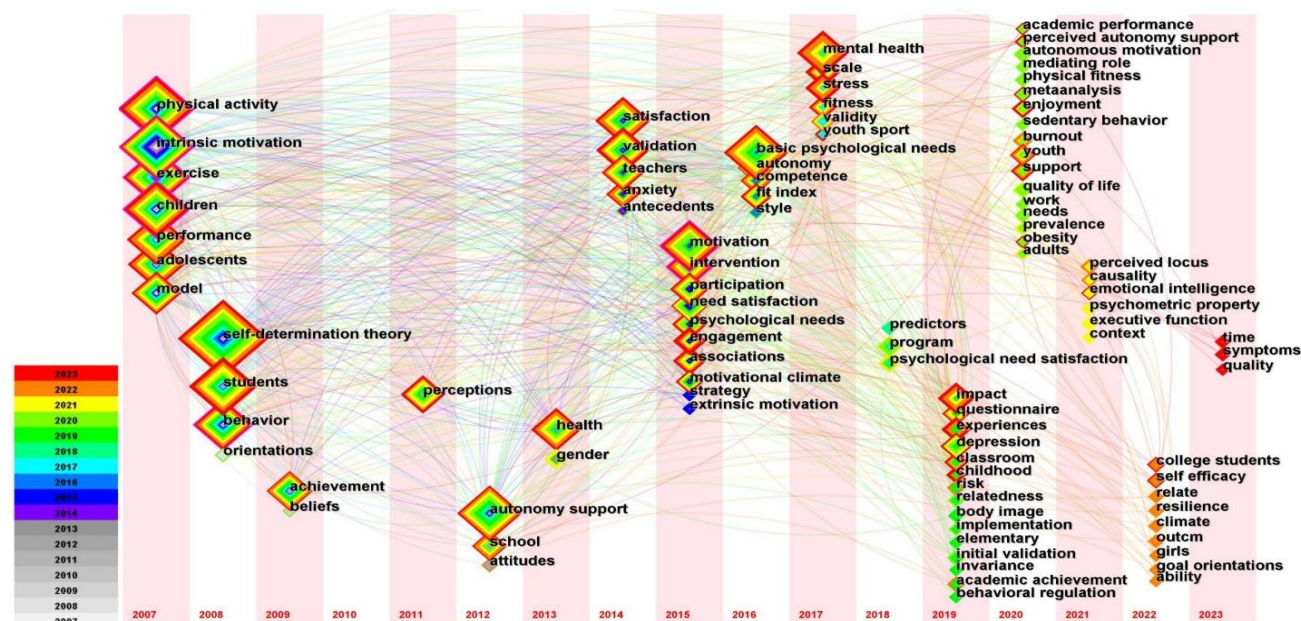


Figure 6: The Keyword Time Zone Map.

Table 4

Emergent Terms Table

Keywords	Strength	Begin	End	2007-2023
intrinsic motivation	35.08	2007	2015	<div><div></div></div>
performance	14.25	2007	2011	<div><div></div></div>
exercise	9.69	2007	2012	<div><div></div></div>
model	9.38	2007	2011	<div><div></div></div>
self-determination theory	13.17	2008	2016	<div><div></div></div>
behavior	10.21	2008	2014	<div><div></div></div>
physical activity	8.68	2011	2014	<div><div></div></div>
adolescents	7.89	2011	2016	<div><div></div></div>
school	7.42	2012	2013	<div><div></div></div>
children	5.47	2012	2015	<div><div></div></div>
anxiety	5.03	2014	2015	<div><div></div></div>
participation	6.78	2015	2016	<div><div></div></div>
need satisfaction	5.29	2015	2018	<div><div></div></div>
autonomy	6.61	2016	2020	<div><div></div></div>
program	6.43	2018	2020	<div><div></div></div>
quality of life	5.35	2020	2021	<div><div></div></div>
prevalence	4.96	2020	2021	<div><div></div></div>
mental health	7.64	2021	2023	<div><div></div></div>
perceived locus	6.14	2021	2023	<div><div></div></div>
causality	4.5	2021	2023	<div><div></div></div>

Conclusions

The analysis presented here offers a comprehensive view of trends, research hotspots, and potential directions

within the field of Physical Education and Psychological Health (PEDPH). An increasing volume of PEDPH publications has been observed, particularly after 2019, with the majority appearing in high-quality journals.

European countries and the United States lead the field, while countries in Africa, Asia, and South America lag behind. Notably, Spain's universities hold significant influence, though limited collaboration across institutions indicates opportunities for stronger international partnerships.

Three primary research clusters emerge as focal points: physiological health and activity, autonomy and intrinsic motivation, and learning performance within educational environments. These clusters capture the essential ways in which physical education impacts mental health, spanning physiological, psychological, and educational aspects. Looking ahead, future research may prioritize interdisciplinary approaches and the integration of data science and artificial intelligence to create tailored physical education programs. Additionally, examining cultural and social contexts, as well as incorporating technologies like wearable devices and virtual reality, could further enhance engagement and support mental health outcomes.

The findings enrich the theoretical understanding of PEDPH and provide actionable insights for applying physical education to mental health initiatives. Policymakers, health organizations, and educators can leverage these insights to guide future strategies and improve outcomes in mental health through physical education.

Certain limitations must be acknowledged. The reliance on the Web of Science database, while extensive, may not encompass all relevant literature. Incorporating additional databases, such as CNKI, SciVal, and Scopus, would offer a more comprehensive perspective. Additionally, this study provides a broad overview of physical education's impact on mental health; however, future research focused

on specific populations or behaviors, such as the effects of exercise on mood disorders among youth, would yield valuable targeted insights. By addressing these areas, future studies can deepen our understanding and broaden the practical applications of PEDPH.

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Consent for publication: Not applicable.

Availability of data and materials: Not applicable.

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Author Contributions

Conceptualization, L.N. and M.S.; investigation, H.L. and L.N.; methodology, X.H. and L.N.; supervision, X.H.; data curation, H.L. and M.S.; writing—original draft, H.L. and X.H.; writing—review and editing, L.N. and M. S. All authors have read and agreed to the published version of the manuscript.

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