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REVIEW

Global Insights and Key Trends in Physical Literacy Research: A Bibliometric Analysis and Literature Review from 2007 to 2024

Hongsheng Qian[1], Xueyan Ren[1], Huidi Wang[1], Yu Zou[2]

[1]School of Physical Education, Wuhan sports University, Wuhan, People's Republic of China; [2]Department of Sport and Exercise Science, College of Education, Zhejiang University, Hangzhou, People's Republic of China

Correspondence: Yu Zou, Department of Sport and Exercise Science, College of Education, Zhejiang University, Hangzhou, People's Republic of China, Email zouyuzy@zju.edu.cn

Background: Extensive research has been carried out on physical literacy (PL) over the past decades. Nonetheless, no comprehensive bibliometric analysis of relevant publications has been performed. In this study, we conducted a comprehensive bibliometric review of studies on PL to track research trends and highlight current research hotspots.

Methods: The Web of Science Core Collection (WoSCC) database was selected to retrieve publications from inception to 2024 on PL. Articles and reviews written in English with PL as the main topic were included. VOSviewer and CiteSpace software were used to perform analysis and visualization of scientific productivity and emerging trends.

Results: A total of 710 publications were retrieved. Canada dominated this field with the most publications (188). The institution and author with the largest number of articles were The Chinese University of Hong Kong (46 publications) and Cairney John (35 publications), respectively. BMC Public Health was the most influential journal with 41 articles and 1214 citations. Publications were primarily distributed across journals in sports science, education, public health, and other allied disciplines. Five topics were identified by reference co-citation analysis and keyword analysis: the definition of PL, PL in education, the association of PL, the intervention of PL, and the measurement and assessment of PL. The measurement, assessment and intervention of PL may become the frontiers.

Conclusion: PL research has witnessed growing scholarly interest over the past 18 years. The concept of PL lacks consensus, and the necessity of establishing a unified conceptualization remains contentious. Most existing PL measurement tools lack comprehensiveness in capturing conceptual components, highlighting the need for established instruments aligned with its theoretical foundations. PL interventions vary in design and effectiveness, making it essential to identify effective strategies. Furthermore, multidisciplinary collaboration is imperative. This study could offer strategic guidance for identifying potential collaborators and prioritizing research priorities.

Keywords: physical literacy, intervention, measurement, assessment, bibliometric review, visualization analysis

Introduction

Physical literacy (PL) is a multidimensional unified concept that has been defined and interpreted in various ways,[1,2] with one of the most common being the motivation, confidence, physical competence, knowledge, and understanding of lifelong participation in physical activity (PA).[3,4] It has become a major focus of physical education (PE), PA and public health worldwide.[5–8] It is hypothesized that PL serves as a gateway to lifelong participation in PA.[9] This can be partly explained by the fact that possessing higher PL will help address the challenging situation where 27.5% of adults and 81% of adolescents globally fail to meet the PA guidelines of the World Health Organization.[9,10] Therefore, promoting PL has emerged as an opportunity to enhance health benefits, such as preventing noncommunicable diseases, maintaining a healthy body weight, and improving mental health, quality of life, and well-being.[3,11,12] Improving individuals' PL may result in reduced financial expenses to healthcare systems[13] and increased academic performance.[14] Consequently, many scholars and educational administrations have proposed that PL plays an essential role in PE and public health areas.[11,15] In addition, the value of PL has also been incrementally acknowledged by

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various policies, including the Global Action Plan on Physical Activity 2018–2030,[16] the UNESCO Quality Physical Education (QPE) Guidelines for Policymakers,[17] and the United Nations 2030 Sustainable Development Goals.[18,19] On the national scale, several organizations in Canada,[20] USA,[19,21] Australia,[22] China,[23] and European countries[8] all have aligned their practical initiatives with PL. Undoubtedly, this explains the prevalence of PL among a wide variety of scholars and practitioners. This situation makes it particularly important to clarify the global research status and trends of PL related research fields.

Bibliometric analysis is a widespread and effective method to evaluate the quality and analyze the characteristics of publications in a specific field.[24] It is extensively applied to investigate the collaboration in countries, institutions, and authors, the co-occurrence frequency of keywords, and the top cited references, which will provide valuable insights into the research status and predict research trends,[25,26] such as in the fields of education reform[27] and health promotion.[28] Over the past decades, a large body of literature on PL has been published.[2] However, only two bibliometric reviews addressing PL have been identified in the existing literature.[29,30] The review by Mendoza-Muñoz et al[29] focused on PL literature from 2007 to 2021 and included grey literature, which enhanced data comprehensiveness but may compromise the review's accuracy and scientificity. The review by Urbano-Mairena et al[30] included PL literature from 2014 to 2022 but only incorporated documents related to children and adolescents, thus neglecting to provide insights across the entire population spectrum. Moreover, these two reviews[29,30] were primarily centered on health-related outcomes, neglecting the multidisciplinary implications of PL in education, sports science, and broader sociocultural contexts. Due to the limitations of these studies, a more comprehensive bibliometric analysis is needed to elucidate the global research landscape and emerging trends in PL.

Herein, we collected publications regarding PL research from the Web of Science Core Collection (WoSCC) database and evaluated the global research development status based on the network visualization data of the top-producing countries, institutions, authors, and journals. Additionally, research hotspots and frontiers were characterized through reference co-citation analysis and keyword co-occurrence analyses. The primary aims of this review are to: (1) analyze global trends in PL research; (2) determine the knowledge structure and key contributors (ie, countries, institutions, authors, and journals); and (3) explore the main research hotspots, evolutionary process, and frontiers in this field. This study will offer valuable insights and guidance for scholars conducting future research in this field.

Methods

This study adheres to the preliminary reporting guidelines for bibliometric analysis (BIBLIO) outlined by Montazeri et al[31] presenting a detailed description of data sources, search strategies, and analytical software. The analysis workflow, encompassing data extraction, processing, and visualization, was systematically documented to ensure transparency and reproducibility (the BIBLIO checklist are presented in Table S1).

Data Source and Extraction

It is a recognized fact that the Web of Science has emerged as the widely-utilized selective database for bibliometric analyses.[32,33] To ensure the authority and scientific validity of the research subjects, the Web of Science Core Collection (WoSCC) database was employed to search for relevant publications concerning PL up to December 31, 2024. The adopted search strategy was to set the Topic term as "physical literacy". The inclusion criteria were as follows: the main research focus of the publications should be on PL, the document types were limited to articles or review articles, and the language was required to be English. Grey literature (eg, conference abstracts, notes, letters, and expert opinions) and duplicate publications were excluded. A total of 710 documents met the selection criteria and were downloaded in the plain text format of "Full Record and Cited References". Each article incorporated data such as titles, authors, abstracts, keywords, the publishing journal, the publication year, author information, and references. Concurrently, information regarding annual publications, the average annual citations per publication, the 2023 journal Impact Factor (IF 2023), Quartile in Category, and h-index were also directly extracted from the WoSCC database. The detailed selection criteria and research framework are summarized in Figure 1.

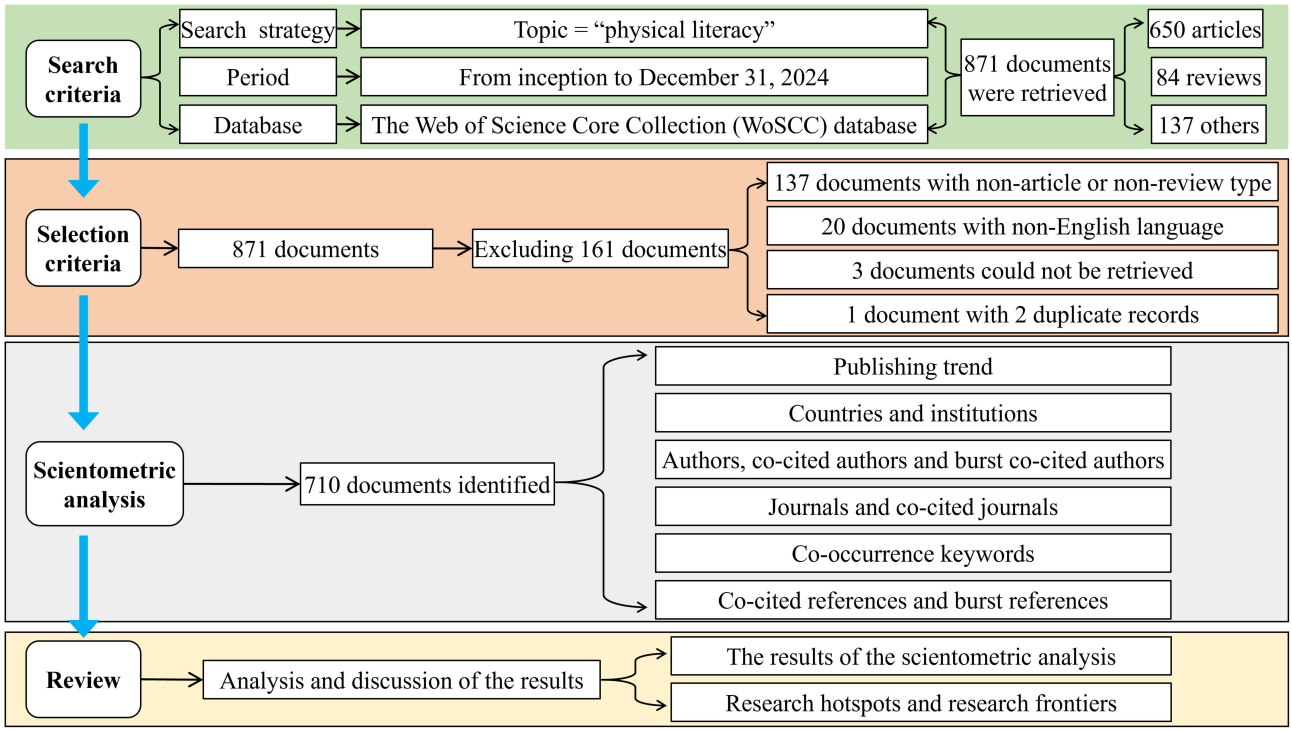

Figure 1 Flow chart of article selection and research framework.

Analytical Methods and Tools

The data analysis and visualization software employed in this study included Microsoft Office Excel 2021, VOSviewer 1.6.20, and CiteSpace 6.3 R1. Specifically, Microsoft Office Excel 2021 was employed for publication trend statistics and data collation. VOSviewer 1.6.20 was used to conduct visualization networks including countries/regions, institutions, authors, co-cited authors, journals, co-cited journals, and co-occurrence keywords. In the process of visualization analysis, synonymous single words and similar phrases were relabeled to enhance the bibliometric analysis. Manual standardization was performed on the author's name, affiliation, and other incomplete or non-normalized information. In addition, CiteSpace 6.3 R1 was applied to conduct a dual-map overlay of scientific journals and perform a co-cited references analysis.

Results

Analysis of Publishing Trend

A total of 710 publications were incorporated. Figure 2 presents the number of annual publications of PL research. From 2007 to 2014, the annual number of publications on PL remained below 5, showing a relatively stable trend at a low level. From 2015 to 2019, this number experienced its first rapid growth period, reaching 50 per year. Subsequently, it continued to increase at a relatively high rate over the following five years, peaking at 144 per year by 2024. This trend of the annual number of publications growing rapidly year-on-year indicates that researchers' interest in PL is constantly increasing.

Analysis of Countries/Regions, and Institutions

To understand the geographical distributions of PL publications, the network visualization maps of countries/regions and institutions in PL research were generated by VOSviewer (Figure 3A and B). According to the figures, 65 countries/regions and 845 institutions contributed to all publications in PL research. The top 10 productive countries/regions were summarized in Figure 3C. Canada was the most productive country with 188 (accounting for 26.48%) publications, followed by the USA (130), Australia (124), China (98), and England (85). The rest of the countries/regions had less than 50 publications. It is indicated that these five nations are the foremost power in PL research. The top 9 productive

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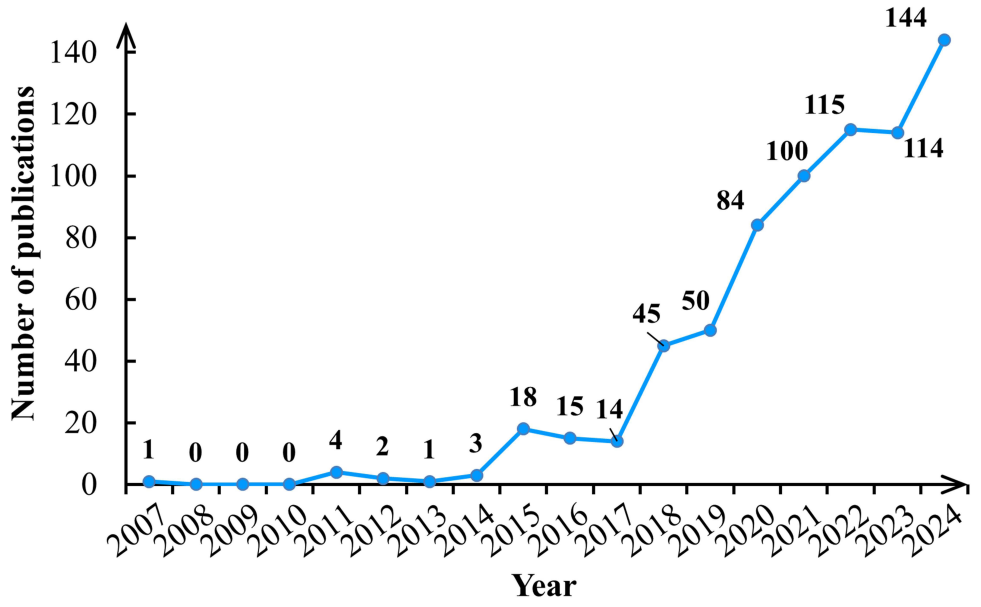

Figure 2 The number of annual publications of PL research.

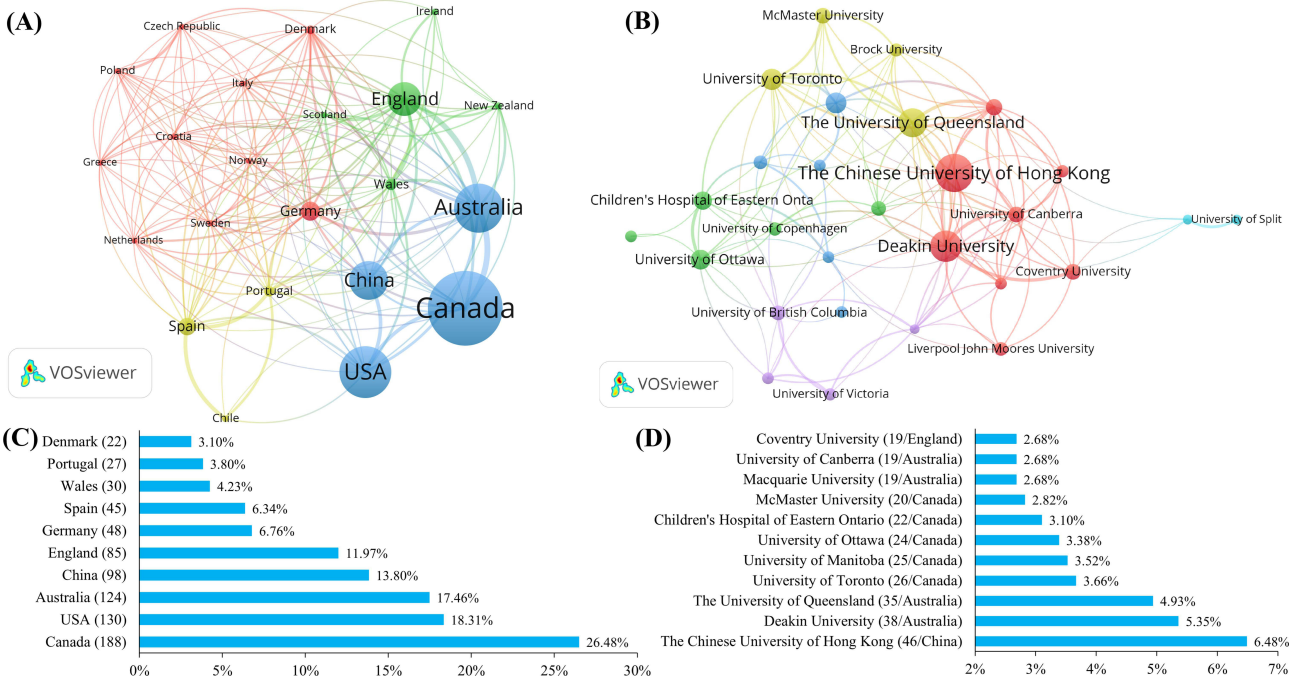

Figure 3 Each country/region or institution contributions to the PL research. (**A**) network visualization map of countries/regions, (**B**) network visualization map of institutions, (**C**) top 10 productive countries/regions, and (**D**) top 9 productive institutions.

institutions (with 3 institutions having an equal number of 19 publications, thus tied for the 9th place) were also figured in Figure 3D. The most prolific institution was The Chinese University of Hong Kong (46 publications, accounting for 6.48%), followed by Deakin University (38), and The University of Queensland (35). Moreover, 9 of the top 10 productive institutions were from Canada or Australia. The institutions in Canada or Australia also had more citations (as shown in Table S2).

Analysis of Authors and Co-Cited Authors

A total of 2185 authors have made contributions to PL research. The top 9 authors (with 3 authors having an equal number of 13 publications, thus tied for the 9th place) engaged in PL research are presented in Table 1. Collectively, these authors have published 221 articles in total, which accounts for 31.13% of all the published articles within the scope of PL research. Figure 4A illustrates the degree of author cooperation. Authors within the same color-coded cluster exhibit densely interconnected collaborative networks, suggesting they have enhanced collaborations. This might be associated with a common interest in the field as well as the institutions or countries within the same or adjacent regions. Cairney John (h-index=55) has been identified as the most active author in the PL research field, with 35 publications and 1226 citations, followed by Tremblay Mark S (24 publications, 1086 citations, and h-index=93) and Sum Raymond Kim Wai (23 publications). Co-cited author is also a crucial criterion for evaluating the contribution of researchers. Co-citation analysis was conducted among 15,164 cited authors (Figure 4B). The top 5 most highly co-cited authors are Whitehead M (987 citations), Edwards LC (391 citations), Cairney John (387 citations), Longmuir Patricia E (379 citations), and Tremblay Mark S (339 citations).

Analysis of Journals and Co-Cited Journals

All articles related to PL have been published in 202 scholarly journals, among which 116 journals have only published a single paper within the realm of PL research. The distribution of the publishing sources was analyzed in accordance with Bradford's law of scattering[34] for the purpose of identifying the core journals (Three distinct zones are presented in Table 2). 8 journals in Zone 1 indicate that they are core journals in PL research. The detailed information of the 8 core journals is presented in Table 3. The International Journal of Environmental Research and Public Health (with an IF 2021 of 4.614) has published the highest number of articles (43 publications, accounting for 6.06%), followed by BMC Public Health (41), Journal of Teaching in Physical Education (33), and Children Basel (26). Journal co-citation analysis was conducted using VOSviewer to assess the influence of the journals. The top 10 highly co-cited journals are listed in Table S3. BMC Public Health has been identified as the most influential within the field of PL research, with 1214 citations.

To characterize the subject distribution of PL research, we calculated the research area of all PL publications from the WoSCC database. All these journals covered 36 research areas. The top 10 research areas in PL research presented in Figure 5. Sport Sciences ranked first among the key research areas in PL search, with 240 publications (33.80%),

Table 1 Top 9 Active Authors With Published Studies on PL

Rank	Author	Institution/Country	Publications	Citations	h-index	Year of 1st-last PL Publication
1	Cairney, John	The University of Queensland/ Australia	35	1226	55	2016–2024
2	Tremblay, Mark S.	University of Ottawa /Canada	24	1086	93	2011–2024
3	Sum, Raymond Kim Wai	The Chinese University of Hong Kong/China	23	338	13	2016–2024
4	Barnett, Lisa M.	Deakin University /Australia	22	305	49	2019–2024
5	Carl, Johannes	University of Erlangen Nuremberg/Germany	22	229	14	2020–2024
6	Longmuir, Patricia E.	University of Ottawa/Canada	21	893	20	2015–2024
7	Kriellaars, Dean	University of Manitoba/Canada	19	734	24	2015–2024
8	Barnes, Joel D.	Children's Hosp Eastern Ontario/Canada	16	624	31	2016–2021
9	Bentsen, Peter	University of Copenhagen/ Denmark	13	167	29	2021–2024
9	Elsborg, Peter	University of Copenhagen/ Denmark	13	132	13	2021–2024
9	Mendoza-Munoz, Maria	Universidad de Extremadura/ Spain	13	98	11	2020–2024

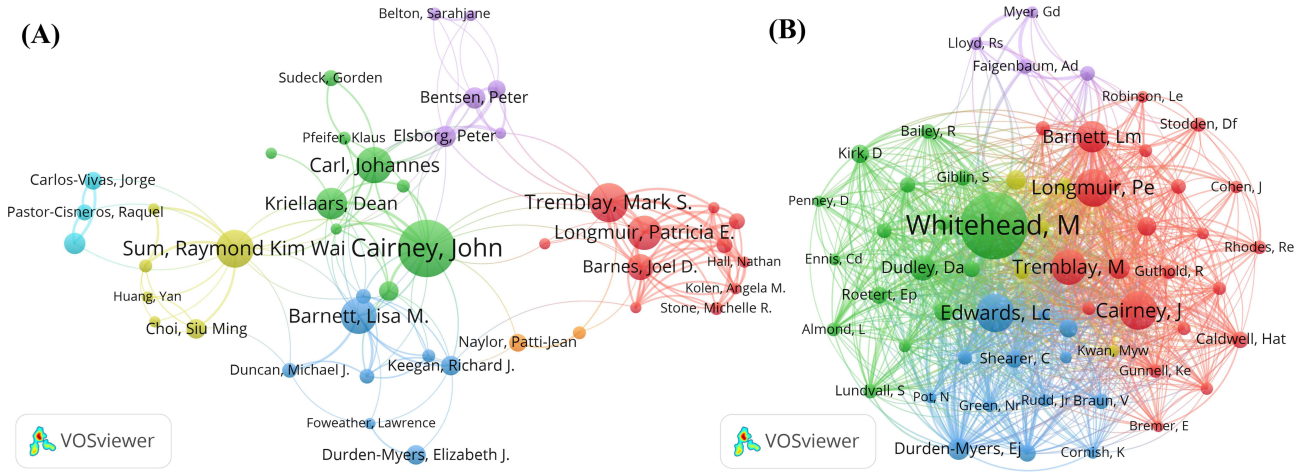

Figure 4 Network visualization maps of authors (**A**) and co-cited author (**B**) in PL research.

followed by "Education Educational Research" (25.92%), and "Public Environmental Occupational Health" (19.72%). Furthermore, the dual-map overlay of journals was calculated to characterize the flow of knowledge between disciplines. As shown in Figure 6, the left side of the map denotes citing journals and the right side denotes co-cited journals. Overall, most articles were published in the field of neurology, sports, ophthalmology (Part-A journals) and psychology, education, health (Part-B journals), which cited journals in the areas of health, nursing, medicine (Part-C journals), sports, rehabilitation, sport (Part-D journals), and psychology, education, social (Part-E journals).

Analysis of Reference Co-Citation

Reference co-citation analysis constitutes one of the core indices in bibliometrics, which is employed to explore the research origin and research hotspots within a specific academic field.[35] The cluster view map of the co-cited references related to PL research is depicted in Figure 7. The clustering map demonstrates a modularity Q score of 0.6819 (indicating well-structured

Table 2 Bradford's Law of Scattering for Journals That Published Articles in PL Research

Zones	Numbers of Journals	Percentage
Zone 1	8	3.96%
Zone 2	36	17.82%
Zone 3	158	78.22%

Table 3 The Core Journals Publishing Studies on PL

Rank	Journal	Publications (n/%)	IF 2023	Quartile in Category
1	International Journal of Environmental Research and Public Health (Switzerland)	43/6.06%	4.614 (IF 2021)	Q1
2	BMC Public Health (England)	41/5.77%	3.5	Q1
3	Journal of Teaching in Physical Education (USA)	33/4.65%	1.8	Q2
4	Children Basel (Switzerland)	26/3.66%	2	Q2
5	Physical Education and Sport Pedagogy (England)	24/3.38%	2.9	Q1
6	Frontiers in Sports and Active Living (Switzerland)	23/3.24%	2.3	Q2
7	Plos One (USA)	20/2.80%	2.9	Q1
8	Frontiers in Public health (Switzerland)	19/2.82%	3	Q2

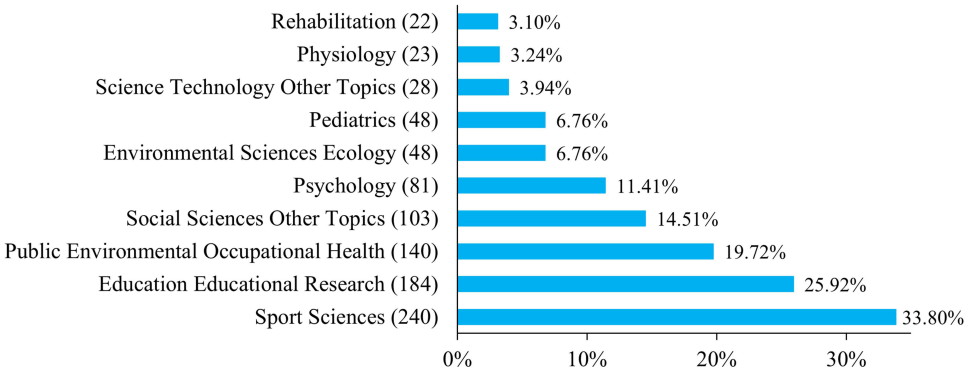

Figure 5 Top 10 research areas in PL research.

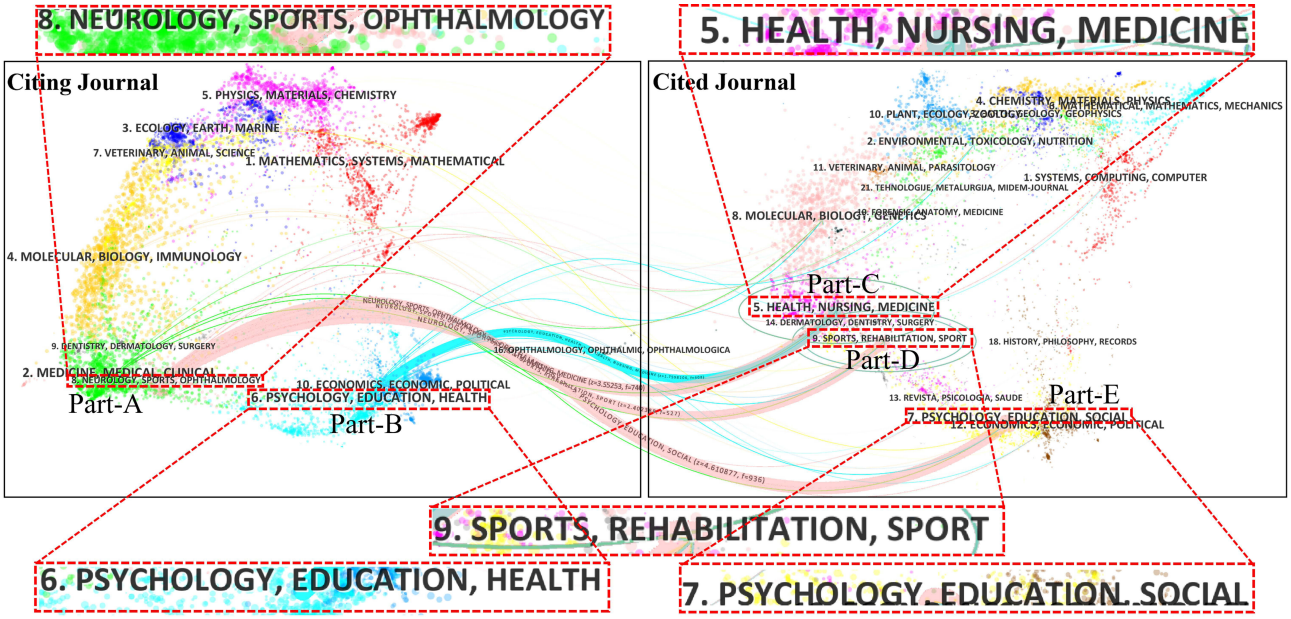

Figure 6 A dual-map overlay of journals that published work related to PL.

inter-cluster connections) and a weighted mean silhouette value of 0.8688 (reflecting high-quality partitioning), validating the rationality of the clustering approach.[35] The top 10 highly co-cited references and the top 10 highly co-cited references within each cluster are presented in Tables S4–S10, respectively. Cluster #0, labeled as "relationship", likely corresponds to the top-cited articles focusing on the interplay between PL and PA, health, and PE curriculum. Cluster #1, titled as "definitions", aligns with foundational studies elaborating on PL's conceptual frameworks, philosophical underpinnings, and structural components. Cluster #2, termed as "active living", presumably corresponds to the articles that concentrate on active-living communities, active commuting modes, and active physical pursuits. Cluster #4, named as "physical education", includes studies analyzing PL integration into PE programs and strategies for its enhancement. Cluster #5, labeled as "canadian assessment", centers on the development, validation, and implementation of the Canadian Assessment of Physical Literacy (CAPL). Cluster #6, called as "physical activity", aligns with research examining PA dimensions within PL. Moreover, according to the mean year of these clusters, the research hotspots have shifted from "active living (#2)", "physical activity (#6)", and "physical education (#4)" to "relationship (#0)" and "definitions (#1)".

Additionally, burst detection of co-cited references was conducted to identify research hotspots and emerging trends.[26] The top 20 references with bursts were extracted as shown in Table S11. Notably, although the burst in most of the

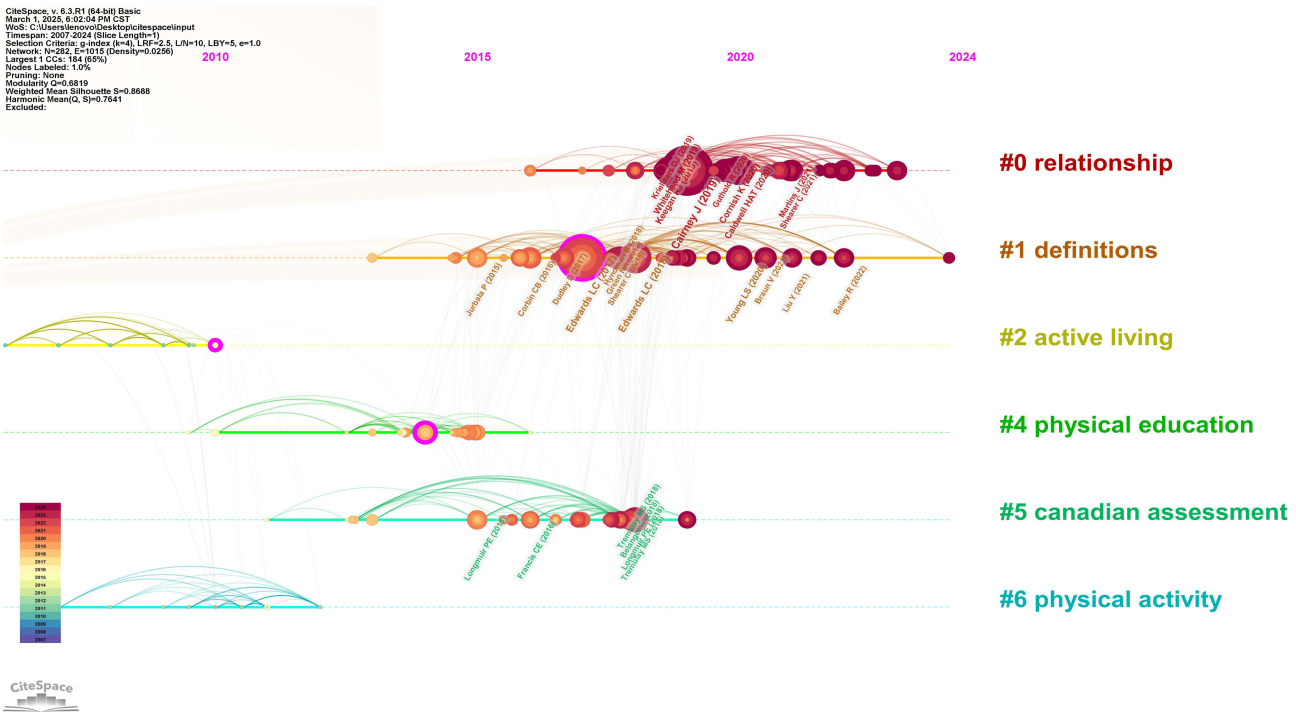

Figure 7 Timeline view map of co-cited references related to PL research.

references has ceased, the burst in several references persists. Among these, the majority of references pertain to the assessment of PL and how to promote PL through intervention.

Analysis of Keywords

A cluster visualization of high frequency keywords was performed using VOSviewer to understand the research topics in a more comprehensive manner.[25] Here, 2160 keywords were involved in PL research, and 85 keywords appeared at least 10 times. Figure 8A illustrates the clustering of four major themes, with top 10 highly occurrence keywords in each cluster listed in Table 4. These keywords could reflect the theme in different clusters. The blue cluster (Cluster 1)

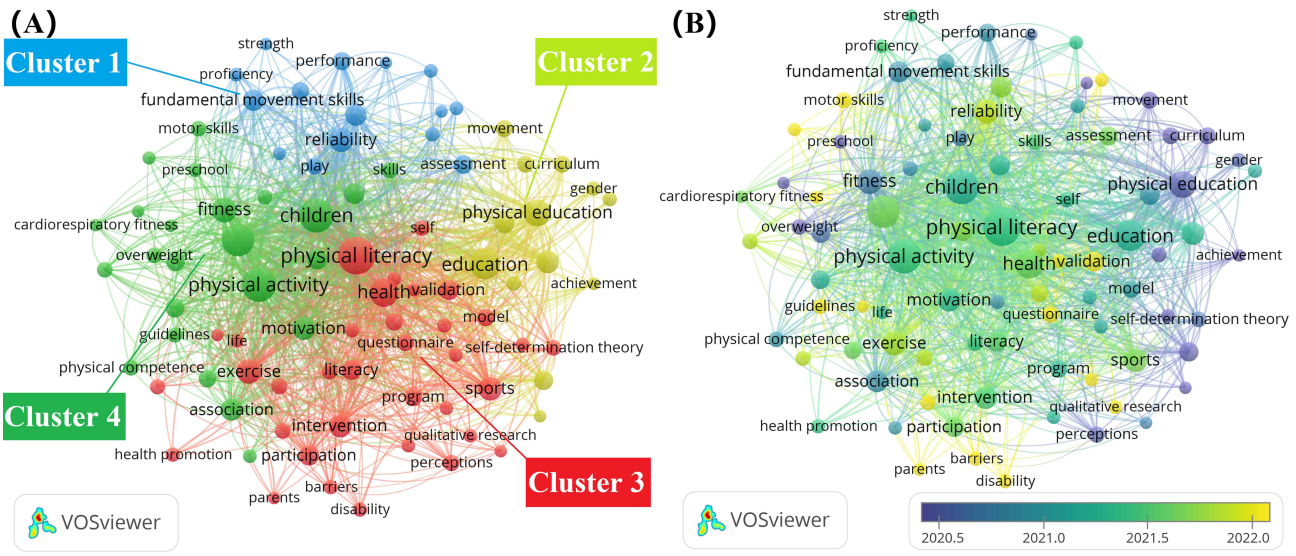

Figure 8 Network visualization map (**A**) and overlay visualization map (**B**) of keywords for PL publications.

Table 4 Top 10 highly Occurrence Keywords in the 4 Clusters

Cluster 1 (Blue)	Occurrence	Cluster 2 (Yellow)	Occurrence	Cluster 3 (Red)	Occurrence	Cluster 4 (Green)	Occurrence
Reliability	79	Education	169	Physical literacy	346	Physical activity	255
Fundamental movement skills	52	Physical education	111	Health	142	Children	252
Validity	50	Impact	64	Exercise	79	Adolescent	210
Assessment	36	School	45	Sports	78	Fitness	87
Performance	30	Students	38	Intervention	65	Motivation	70
Motor competence	27	Movement	26	Validation	44	Association	56
Play	22	Pedagogy	26	Participation	43	Competence	48
Measurement	14	Curriculum	25	Literacy	41	Behavior	43
Proficiency	13	Policy	17	Model	27	Knowledge	34
Instrument	12	Gender	15	Program	27	Obesity	34

primarily encompasses "measurement and assessment of PL" aspects, featuring methodological terms such as reliability, validity, and assessment. The yellow cluster (Cluster 2) represents "education studies of PL" contexts, with predominant keywords including education, physical education, and school. The red cluster (Cluster 3) concentrates on "intervention studies of PL", highlighted by terms like intervention, participation, and program. The green cluster (Cluster 4) relates to "associations of PL", prominently featuring physical activity, association, and obesity. The overlay visualization map of keywords was applied by VOSviewer (Figure 8B), and all these keywords were marked with different colors based on the average year of publication, which could reflect the research hotspots in different periods. These keywords, such as scale, instrument, validation, reliability, questionnaire, fit indexes, assessment, and validity, were colored in yellow, suggesting that measurement of PL may remain the research hotspot in the near future.

Discussion

Global Trends

The bibliometric analysis of PL publications revealed that the annual number of articles increased with time, indicating a growing research interest. The research on PL can be divided into three stages by years 2014 and 2019, indicating key events that have aroused the interest of more researchers. In 2013, the American National Standards for K-12 Physical Education was published. The goal of PE was to develop physically literate individuals.[21] In 2014, Canada has placed PL at the heart of the Sport for Life initiative, and has developed the CAPL.[36] In the same year, Giblin et al reported that PL plays a major role in PE, PA, and sports promotion worldwide.[7] In 2015, UNESCO geared the QPE guidelines toward systematically promoting PL in an educational context for policy makers.[17] In 2016, PL was included as one of the goals of The Australian Curriculum: Health and Physical Education.[22] Moreover, Edwards et al reviewed the definitions, foundations, and associations of PL in 2017.[4] They also reviewed the measurement and assessment of PL in 2018, recommending that researchers adopt more creativity in developing integrated philosophically aligned approaches to measuring and assessing PL.[37] In 2019, SHAPE America issued "Physical Literacy: A Strategic Priority", designating PL as a national priority and promoting relevant standard revisions.[19] Cairney et al presented empirical evidence supporting PL as a determining factor of PA and health.[9] Overall, these key events and studies have driven the advancement of PL research. The upward trend suggests that the number of publications in this field will likely continue to increase as studies become more in-depth.

General Knowledge Structures and Major Contributors

Among all countries, Canada, USA, Australia, China, and England were the top five most productive countries, serving as global research hubs for PL studies. The top three ranking of Canada, USA, and Australia was likely attributable to their integration of PL into national PE curricula.[19,21,22,36] Moreover, The Chinese University of Hong Kong, Deakin

University, and The University of Queensland were the most prevalent institutions within the collaboration network. In addition, 9 of the top 10 productive institutions were from Canada or Australia, also showing a higher number of citations. The results indicated that Canada and Australia had conducted extensive research on PL, demonstrating high credibility in this field. Moreover, the abundance of connection lines indicates extensive cooperation between countries/regions or institutions. Such collaboration facilitates the development of the research field.

Cairney John and Tremblay Mark S have the highest number of publications, citations, and the highest h-index. They are the most productive and influential authors in the field of PL. Their studies spearheaded the development and revision of the CAPL,[38,39] making pioneering contributions to PL assessment research. The co-authorship network knowledge map revealed numerous collaborating authors within the same cluster. Specifically, Cairney John was at the center of the green cluster, Tremblay Mark S. was central to the red cluster, and Sum, Raymond Kim Wai was central to the yellow cluster. Furthermore, Whitehead M was the co-cited author with the highest number of citations, providing foundational work in PL with recognized accomplishments.

International Journal of Environmental Research and Public Health, BMC Public Health, and Journal of Teaching in Physical Education were the most popular journals. This may be attributed to the alignment of their editorial scope with PL themes, as well as their high publication volumes. Simultaneously, the top 3 core journals emerged within the top 4 highly co-cited journals. Hence, they can be regarded as the most influential journals, showing high article quantity and quality. Our findings are in accordance with Bradford's law,[34] which posits that the majority of individuals usually obtain citations from a few principal journals within their respective fields. Researchers deviating from the core journals demonstrate declined citation rates and implications, resulting in the majority of citations originating from a few key journals. Consequently, scholars may prioritize such journals, leading to these journals accumulating the latest advancements in this domain. Furthermore, most of the journals and the flow of knowledge were related to the research areas of sports, education, psychology, rehabilitation, social and health, which highlights the significance of interdisciplinary collaboration in PL research.

Research Hotspots and Frontiers

Reference and keyword analysis is a key methodology and major indicator in bibliometrics. The reference co-citation analysis and keyword co-occurrence analysis results demonstrated the main research hotspots, the evolution process, and the developmental frontiers in the field of PL.[25,34] Research on PL aims to reduce global physical inactivity and enhance PE. Currently, the research hotspots in PL mainly focus on the definition of PL, PL in education, association of PL, intervention of PL, and assessment of PL. Future research may prioritize the measurement and assessment of PL and the promotion of health through interventions. Each topic is further described in detail below.

Definition of PL

In the past decades, multiple research articles have focused on the definition and conceptualization of PL.[2,18,40–42] The term PL was used as early as the early 20th century.[1] Whitehead M has introduced the ideas of PL since the early 1990s,[43] and has refined the definition of PL many times.[3,44,45] Hence, the most widely accepted definition of PL in the literature adheres to the Whiteheadian concept or has been derived from it.[4,41,42] The latest definition is "the motivation, confidence, physical competence, knowledge, and understanding to value and take responsibility for engaging in PA for life",[45] which has been adopted and promoted by the International Physical Literacy Association (IPLA),[46] the Physical and Health Education Canada (PHE Canada),[20] the Sport for Life Society,[20] etc. According to Whitehead PL is derived from the philosophical tenets of monism, phenomenology, and existentialism. Monism is the belief that the body and mind are indivisible and interdependent.[44] Existentialism proposes that everyone is a result of their experiences and interactions.[44] Phenomenology argues that an individual perceives the world from their unique point of view.[44] Based on these principles, PL can be regarded as a holistic and inclusive concept, which is applicable to nearly every individual and throughout all life stages.[42,43]

Additionally, numerous other organizations and individual researchers have also presented their definitions of PL. For instance, Sport Australia conceptualizes PL as the lifelong holistic learning acquired and applied in movement and PA contexts, which integrates physical, psychological, cognitive, and social capabilities.[22] The definition adopted in New

Zealand incorporates a spiritual element,[47] which contrasts with Whiteheadian core domains. SHAPE America describes PL as an achievable objective at a fixed point.[48] This is consistent with the view that PL is an outcome rather than a lifelong nature.[4] Furthermore, over 20 PL definitions have been proposed in the literature.[2,4] Each concept is complex and multi-dimensional, adding ambiguity to PL.[41,49] Jurbala proposed that PL is neither a discovery nor an innovation, and is a metaphor describing the capacity for embodied communication with the environment.[1] Moreover, some scholars emphasize a single element of PL, such as motor skills.[4,7] This approach seems to diverge from the original holistic and lifelong journey conceptions of PL.[18] The diversity in the definition of PL has led to the concept growing more abstract.[41]

Published literature has yielded various PL interpretations and conceptualizations.[2,18] This may be partially attributed to the cultural sensitivity of the PL concept.[49] Additionally, age-specific populations may necessitate distinct conceptual frameworks and interpretive models for PL.[50,51] Consequently, a universal definition of PL may not be viable.[18] However, other researchers argued that various definitions make the conception lost or confusing,[1,52,53] thus sparking discussion on establishing a unified one.[18,45,54] This could effectively improve the clarity of communication, the rationality of partnerships, the consistency among different sectors, the legitimacy of the sector, the consistency of assessment, as well as common outcomes.[55]

PL in Education

PE is a regular element of the school curriculum around the world. However, it has been described as a "non-cognitive activity" and has sometimes been relegated to a marginal role in schools.[56] Nevertheless, PE also serves to establish a credible philosophical foundation and is not limited to physical movement. Since the 1950s, the discussion about literacy has provided valuable inspiration to PE scholars.[53] As one of the leading professors in PL, Whitehead proposed that PL must encompass more than physical movement, and must include an ability to "read" the environment and to respond effectively.[43] PL can be regarded as an answer to the lack of philosophical ideas experienced in PE, a rationale that can underpin the school subject of PE, and a foundation for the development of children and youth throughout life.[15] PL is as important to an individual's education and development as numeracy and literacy.[45] Consequently, PL can be described as an outcome or aim of PE,[21] a topic of discussion among PE educators,[15] and an apparent synonym for PE.[21,52]

To date, a growing number of countries or regions have accepted the idea that PL is the goal of PE.[15,54,57] In some countries, PL has been introduced into government policy texts and teaching documents. The International Charter of Physical Education, Physical Activity and Sport proclaimed that PE plays a significant role in the development of participants' PL.[58] Furthermore, the UNESCO QPE Guidelines for Policy Makers aim to systematically promote PL in educational contexts.[17] PL has even been suggested as a goal for the 2030 Sustainable Development Goals by the United Nations.[59] On the national scale, Canada has placed PL as the foundation of PE, elite sport, and health.[52] In the USA, PL has been set as the learning objective of the National Physical Education Standards.[48,60] Similarly, the value of PL was acknowledged by England,[8] Australia,[22] and China.[23]

Despite the growing interest in PL,[4] caution is still warranted. To date, no evidence supports the pedagogical strategies advocated based on the concept of PL in improving the reorganization and revitalization of school subjects.[15] Additionally, the term PL may present a somewhat idealized narrative, positing that high-quality PE will result in a series of nebulous (often health-related) outcomes.[61] Other scholars have indicated that within the realm of PE, PL has caused a shift from psychomotor outcomes to cognitive outcomes. However, shifting the primary outcome away from PA and physical fitness may increase the vulnerability of PE to extinction.[62] Therefore, PL must be measured to be applied within the broader context of PE.[52] Measurement is crucial for accurately analyzing the actual role of PL in PE, rationally guiding the practice path of PE, and avoiding the negative impacts on PE caused by the vagueness of the concept or its improper application.

Association and Relationship of PL

To date, numerous studies have focused on the relationship and causal association of PL. These studies can be categorized into three themes based on their content: (i) behavioral characteristics, (ii) psychological factors, and (iii) social or environmental factors. Most of these studies are related to health promotion. This also explains why the disciplinary knowledge of PL is related to psychology, social, health, nursing, medicine, etc.

The studies of behavioral characteristics primarily explain the influence of PL on behaviors such as PA, sports participation, sedentary behaviors, active lifestyle, and other health behaviors. Thus, the relationship between PA and PL should be discussed. PA is described as a central foothold of the PL concept, and the development of PL enables an individual to participate in PA. On the other hand, it is arguably necessary to participate in PA to progress one's PL.[45] Furthermore, PL promotes freedom and comprehensive development of life, as it represents the journey of the whole life cycle. Children are encouraged to develop fundamental movement skills and self-confidence within PA, whereas secondary school curriculums focus on grasping motor skills, understanding the importance of PA, and valuing engaging in PA throughout the life course.[45] Secondly, all of us interact with the world through PA based on monistic PL. Every moment of PA participation must go through the procedure of perceiving the world-processing information. This process not only enhances our physical abilities but also elevates our spiritual world. Therefore, PL can be identified as the basis for a healthy lifestyle.[63] Various studies revealed that developing PL can help reduce inactivity, sedentary behavior, and obesity levels.[37,64] Obesity-related diseases such as cardiovascular disease and metabolic disease may also be related to PL.[4] Valuing and participating in PA is an effective method to improve health.[7,37] Therefore, promoting PL encourages individuals to make healthy and active decisions throughout their life course.[8,9,60]

The theme of psychological factors, people with PL have the motivation, confidence, knowledge, and understanding to participate in PA.[45] Physically literate people realize the intrinsic value of PA in improving their quality of life and well-being[65] and make outstanding contributions to improving the quality of life by using their motor competence.[66] Besides, when confronted with challenging situations, physically literate people generate positive self-esteem and confidence to maintain PA participation, and to experience the health benefits and satisfaction brought by PA.[9,11]

In terms of social or environmental factors, interpersonal relationship plays a crucial role in promoting an individual's PL.[67] PE teachers are directly related to the cultivation of students' PL but are not the only responsible persons.[45] Parents, nursery teachers, peers, coaches, employers, personnel, and carers can all impact and shape the development of individuals' PL.[67] Notably, negative comments from others can be detrimental to the development of PL, particularly in children and adolescents.[68] Furthermore, the environment (social and physical) is also closely related to the development of PL. Castelli et al suggested that QPE, before/after school, during school, staff involvement, and family and community engagement can increase opportunities for PA participation, leading to PL among children.[67] Edwards et al performed a systematic review, revealing that the sports administrative department and related policies influence PL.[4]

Intervention of PL

Recently, a growing number of articles on PL have attempted to translate conceptual ideas into interventional practices. Previous research indicated that 85% of students demonstrated an inadequate PL level.[36] Hence, PL intervention is warranted. PL can be nourished through a range of experiences.[69] The article by Longmuir and Tremblay pointed out that the key individual and environmental factors can be optimized to enhance PL, representing the three most important research questions of the PL field.[70] In this regard, practitioners such as educators, teachers, exercise and fitness instructors, therapists, and health consultants are often given the responsibility to create situations (eg, through specific methods) that systematically build and enhance PL.[57,71]

Due to the large number of PL intervention studies, a focused summary of intervention designs and their effectiveness was conducted. Firstly, existing studies have more frequently applied quantitative research methods than qualitative research methods.[72–74] Some studies followed a theory-driven approach such as the social-ecological model,[67] the health belief model,[67] and the self-determination theory.[75] The intervention population comprised individuals of all ages, including children[76] and older adults.[77,78] Moreover, individuals of all physical capabilities were included, such as physically active individuals[79] and people with developmental disorders and disabilities.[80] However, a systematic review pointed out that the existing intervention population is unbalanced in terms of age, gender, and species, and calls for more research into older adults, people with disabilities, and women.[40] In terms of intervention characteristics, most of the intervention settings were in schools[81,82] or PE classes,[83,84] while very few were in communities,[80] clubs,[79] or hospitals.[85] Hence, a well-designed PE curriculum/program[86,87] was a common intervention measure, and active video games[88] and rehabilitation training[85] were also used by some scholars. In addition, existing interventions show a large variation in length, frequency, and duration. Most interventions were studied for several weeks, and most of them were

carried out at a frequency of once or twice a week. The duration of the intervention ranged between 15 min in a repetitive format to an accumulated daily amount of 200–285 min of activities in the block format.[40] From a methodological point of view, this disparity may affect the robustness of empirical findings. Certainly, the differences in methodical approaches are related to the diversity of PL concepts.[71]

Finally, the outcomes in existing intervention studies were consistent with the elements of the PL concept, involving physical competence, motivation and confidence, knowledge and understanding, PA behavior, and overall PL achievement. Specifically, the intervention studies most frequently addressed physical competence, followed by motivation and confidence, PA, and knowledge and understanding.[71] Regrettably, interventional studies aiming to promote individuals' overall PL achievement are scarce.[74] This is largely due to the inconsistent definition and assessment of PL (ie with varying components). The PHE Canada-Passport for Life is a program designed to promote multifaceted aspects of PL. It focuses on training teachers to offer quality lessons to increase students' knowledge, skill, fitness, awareness, and understanding related to PL.[17] Therefore, future interventions should commit to systematically addressing all elements of PL simultaneously. In terms of intervention effects, existing review studies demonstrated the effectiveness of PL interventions on several outcomes.[71,74,86,87] However, existing intervention research shows significant heterogeneity and diversity. To better inform current practices, future studies are advised to identify those program characteristics that significantly influence the effectiveness of PL interventions.[40,71]

Measurement and Assessment of PL

Measurement and assessment play an essential role in the education and health fields. A universal instrument that measures the essence of PL is required, which will help identify areas for improvement.[52] Therefore, researchers have focused on the measurement and assessment of PL in the areas of sports science, education, and health fields. In 2010, Lloyd et al[89] proposed that the operationalization of PL should include four dimensions: (a) physical fitness, (b) motor skills, (c) PA behaviors, and (d) psycho-social/cognitive factors. This model was used as a theoretical basis to develop CAPL.[38,52] Subsequently, CAPL has undergone a second revision (the Canadian Assessment of Physical Literacy Literacy-2), and it has become a widely used measurement tool for a comprehensive assessment of all aspects of childhood PL.[39]

At present, several reviews have covered the measurement and assessment of PL. These instruments were designed for various populations. The Physical Literacy Observatory tool (PLOT) was developed for young children.[74,90] In contrast, CAPL, Chinese Assessment and evaluation of physical literacy (CAEPL), Passport for Life (PFL), Physical literacy assessment for youth tools (PLAY), National standards for K-12 physical education and PE metrics (SHAPE America), Perceived physical literacy inventory (PPLI), Physical Literacy self-Assessment Questionnaire (PLAQ), and Conceptual model of observed physical literacy (CMOPL) were developed for school-aged children and adolescents.[2,91] Furthermore, PPLI, Perceived Physical Literacy Instrument Simple Chinese (PPLI-SC), Senior Perceived Physical Literacy Instrument (SPPLI), and College Student Physical Literacy Questionnaire (CSPLQ) were developed for adults.[92] In general, all existing PL assessment tools, except the PL Charting Tool, were developed for a specific age group.[90]

Furthermore, the assessment of PL depends on the conceptualization of PL and its domains, which shows inconsistencies among scholars.[74] Most of the assessments mainly assess one domain or a combination of two, while few of the assessment tools (ie, PFL and CAPL) assess all three domains of PL.[90] The physical domain is often evaluated in PL assessment, followed by the affective domain, and the cognitive domain.[2,37,90] Separating the physical, affective, and cognitive domains of PL for assessment purposes may conflict with its holistic philosophical foundation. Moreover, current assessments of adopt diverse methodologies in assessing PL, such as interviews, questionnaires, reflective diaries, and visual methods as qualitative methods, and monitoring devices, psychometrics, and observable measures as quantitative methods. Qualitative methods can effectively capture the cognitive and affective dimensions of PL through in-depth exploration. However, they have limitations in systematically assessing physical competencies. Additionally, qualitative research is inherently vulnerable to researcher subjectivity, which may introduce interpretive biases in study findings. Although quantitative methods are cost- and time-effective in administration and can objectively evaluate PL interventions, the predominant positivist paradigm in quantitative research often conflicts with the philosophical tenets of monism, phenomenology, and existentialism that underpin PL. Therefore, future research should focus on developing philosophically aligned approaches to measuring PL.[2,37]

Importantly, systematic reviews reported that the majority of the existing PL assessment tools still have a long way ahead to meeting a high level of validity, reliability, and feasibility.[90–92] Existing assessment instruments for adults[92] and children with disability[91] lack validity and reliability data. These findings indicated that appropriate instruments should be selected to assess PL based on the actual needs.[93]

Limitation

This study also encountered limitations inherent to bibliometric analysis. Firstly, the publications on PL were retrieved from WoSCC, while other databases (such as Scopus, Google Scholar, and Embase) were not included, which may have led to incomplete coverage. However, WoSCC is widely recognized as a suitable database for bibliometric studies,[27,28,32] and its comprehensive dataset sufficiently reflects current PL research trends. Additionally, database-specific differences in file formats and citation counts complicate cross-database integration.[33] Secondly, the inclusion of only English-language articles and reviews may have undervalued contributions from non-Anglophone regions.

Conclusion

This study provides a missing comprehensive bibliometric review of global research progress on PL. Analysis of PL publications showed that the role of PL has gradually attracted the attention of scholars. So far, major contributions have been from institutions and authors in Canada and Australia. The top three influential journals are International Journal of Environmental Research and Public Health, BMC Public Health, and Journal of Teaching in Physical Education. Enhancing interdisciplinary collaboration is a key priority for PL researchers. Current research focuses include the definition of PL, PL in education, the association with PL, intervention of PL, and measurement as well as assessment of PL. Future research is likely to develop a culturally inclusive conceptual consensus, innovate methods to create valid measurement tools aligned with PL's philosophical and conceptual foundations, and identify effective intervention design elements. Overall, this timely review scrutinizes research trends and frontiers related to PL, which could progress the field and form the basis for forthcoming studies.

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