International Journal of Education, Vocational and Social Science
https://e-journal.citakonsulindo.or.id/index.php/IJEVSS
E-ISSN : 2963 4954
IJEVSS

Physically Active Learning and Primary Students' Outcomes: A Bibliometric Science Mapping Study (2000–2026)

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Abstract

This study presents a bibliometric analysis of Physically Active Learning (PAL) and its relationship with primary school students' learning outcomes. To the best of the authors' knowledge, no prior bibliometric study has exclusively focused on PAL as a pedagogical construct. Using the Scopus database (2000–2026), a modified PRISMA approach, and VOSviewer v.1.6.20, 1,001 articles from 374 journals were analyzed. The dataset yielded 21,897 citations, an h-index of 68, and a CAGR of 17.1% (2010–2025). Three temporal phases were identified: health-oriented foundation (2000–2010), pedagogical diversification (2011–2017), and expansion–consolidation (2018–2026). Thematic analyses suggest a gradual paradigm shift from PAL as a health intervention toward a pedagogically oriented strategy, reflected in the increasing prominence of embodied learning and movement integration. The United States dominates global production (45.1%), while Indonesia remains underrepresented (1.5%). This study proposes research directions for Indonesian scholars, including traditional game-based PAL interventions and Merdeka Belajar curriculum integration.

Keywords: Efficiency, knowledge management, tax administration, tax officer, training

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INTRODUCTION

Physical inactivity among school-age children continues to receive attention from both public health and educational researches. More than 80% of children and adolescents aged 5–17 worldwide reportedly fail to meet the WHO recommendation of 60 minutes of moderate-to-vigorous daily physical activity ("Global Status Report on Physical Activity 2022," 2022), a pattern also reflected in Indonesian classroom where teacher-centered instruction remains prevalent (Kusumawati & Umam, 2025). At the same time, schools face increasing pressure to improve student performance in mathematics, literacy, and higher-order thinking, yet predominant classroom practices remain largely sedentary (Kuzik et al., 2022; Sales et al., 2023). Evidence from cognitive neuroscience suggest that insufficient physical activity may slow prefrontal development a region associated with attention, working memory, and learning regulation with potential implications for learning readiness (Hillman et al., 2008; Li et al., 2022).

Physically Active Learning (PAL) has been as an approach that addresses this tension by intentionally incorporating movement into academic instruction, positioning physical activity as a medium for learning rather than a break from it (Donnelly et al., 2009; Mahar et al., 2006). A number of studies suggest potential benefits, though findings vary across context and design: Norris et al. (2020) reported notable within-lesson gains in educational attainment (d = 0.81; 95% CI 47–1.14) across 42 studies; He et al. (2025) found a statistically significant positive association with mathematics performance (SMD = 0.11; p = 0.001) and Watson et al. (2017) documented improvements in on-task behavior across 39 studies. Notwithstanding these findings, the intellectual structure, thematic development, collaboration networks, and geographical distribution of PAL research have not been systematically mapped. Existing meta-analyses assess intervention effectiveness but offer limited insight into how the field is evolving or where knowledge gaps remains (Norris et al., 2020). Adjacent bibliometric studies on physical education have not isolated PAL as a distinct pedagogical construct (Hernández-González et al., 2025), leaving researchers from developing regions including Indonesia without a structured evidence base for identifying where contributions are most needed (Donthu et al., 2021).

This study aims to provide a bibliometric mapping of PAL research and its relationship with primary school students' learning outcomes (2000 – March 2026), guided by four research questions: first, what are the growth patterns and temporal evolution of PAL research over two decades? Second, who are the key intellectual contributors, and how are collaborative networks structured? Third, what thematic clusters characterize PAL research, and how have they evolved over time? Fourth, what geographical gaps are evident, and what are the potential implications

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for Indonesia and Southeast Asia?

This study offers three contributions to the literature: 1) a knowledge map focused specifically on PAL as a pedagogical construct; 2) a description of three phases of thematic development from a health-focused to a more pedagogy-oriented discourse; and 3) an identification of geographical gaps in Southeast Asia, accompanied by suggested directions for future research relevant to Indonesia scholars.

RESEARCH METHOD

This study adopted a bibliometric design a quantitative approach for systematically examining publications patterns, collaborations structures, citation behavior, and thematic development within a field (Donthu et al., 2021; Zupic & Čater, 2015). Following a PRISMA 2020 framework adapted for bibliometric purposes (Page et al., 2021; Pham & Le, 2024)

Bibliographic data were retrieved from Scopus, accessed on March 2026, selected for its broad multidisciplinary coverage and demonstrate capacity to identify more than 80% of relevant studies in educational intervention fields (Martín-Martín et al., 2018). The exclusion of Web of Science, ERIC, and PsycINFO represents a limitation that may have resulted in omission of studies index solely in those repositories. The search string, applied to TITLE-ABS-KEY, combined three AND-linked domain groups, as presented in Table 1.

Table 1. Complete Search String Applied in Scopus

Domain	Search Terms
PAL Terminology	"physically active learning" OR "active lesson*" OR "movement integration" OR "brain break*" OR "embodied learning" OR "physically active lesson*" OR "movement break*" OR "activity break*" OR "classroom-based physical activity" OR "active school" OR "physically active classroom*"
Learning Outcomes	"learning outcome*" OR "academic achievement" OR "academic performance" OR "cognitive outcome*" OR "mathematics achievement" OR "literacy" OR "on-task behavior" OR "educational outcome*"
Target Population	"primary school" OR "elementary school" OR "primary student*" OR "elementary student*" OR "school-age child*" OR "primary education" OR "grade 1" OR "grade 2" OR "grade 3" OR "grade 4" OR "grade 5" OR "grade 6"

Table 2 presents the criteria applied consistently across all section stages. Only peer-

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reviewed English-language journal articles published between 2000 and 2026 addressing PAL, learning outcomes, and primary school population were retained.

Table 2. Inclusion and Exclusion Criteria for Corpus Selection

Criterion	Inclusion	Exclusion
Document type	Journal articles	Reviews, book chapters, conference papers, editorials
Publication stage	Final published	Articles in press
Language	English	Non-English
Year	2000–2026	Before 2000
Topic domain	PAL + learning outcomes + primary school	Studies outside all three domains
Source type	Peer-reviewed journals	Non-peer-reviewed sources

Four sequential stages were followed (Figure 1): (1) Identification 1,357 records retrieved; (2) Filter I (document type, language, publication stage) 336 excluded, 1,021 retained; (3) Filter II (source type, year range) 20 excluded; (4) Final corpus 1,001 articles with unique DOIs, exported in CSV and RIS formats. All filtering decisions were carried out by the first author and independently checked by the second author.

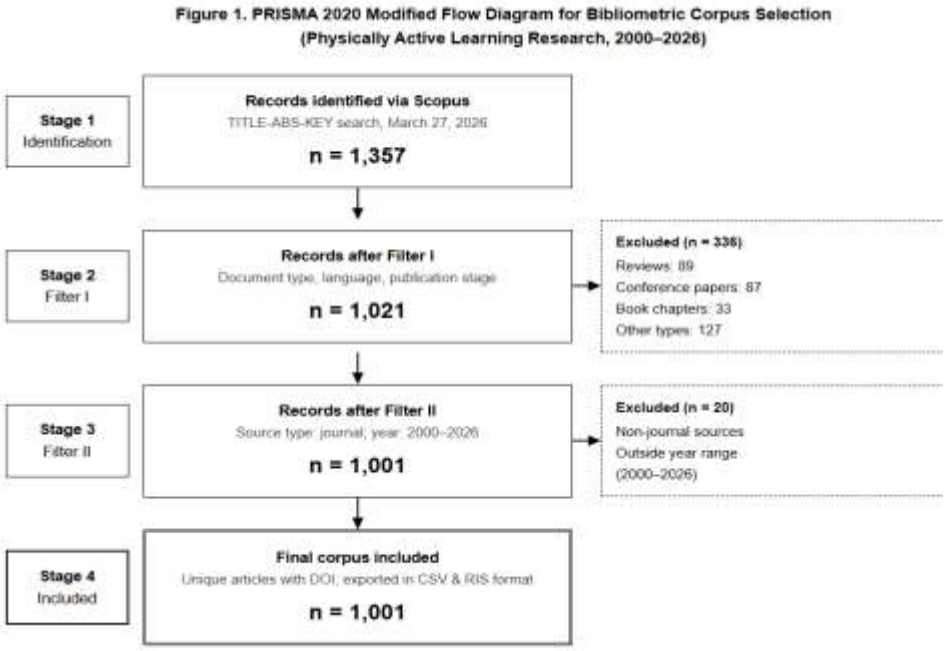


Figure 1.PRISMA Diagram

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Two complementary analytical approaches were applied: (1) *Performance analysis*annual article counts, CAGR, citations, h-index, journal and author distributions, verified against Bradford's (1934) and Lotka's (1926) Laws; and (2) *Science mapping* via VOSviewer v.1.6.20 (van Eck & Waltman, 2010) co-authorship networks (minimum 3 documents per author; 281 authors; 7 clusters) and keyword co-occurrence analysis (minimum 5 occurrences; 139 keywords; 6 clusters). Thresholds were adopted following established bibliometric practice (Cobo et al., 2011; Donthu et al., 2021). Thematic evolution was examined by comparing keyword frequencies across three temporal phases, with phase boundaries determined inductively from points in the annual growth curve.

RESULT

A. Publication Growth Trend

The corpus of 1,001 articles yielded 21,897 citations (mean= 21.88 per article), an h-index of 68, and a CAGR of 17,1% (2010-2025), peaking at 107 articles in 2025. The COVID-19 pandemic was associated with a temporary decline to 68 articles in 2020, followed by gradual recovery. As summarized in Table 3, three distinct temporal phases were identified. Phase 1 (2000-2010) accounts for 4.7% of the corpus (n=47), reflecting an early and exploratory period dominated by health-focused discourse. Phase 2 (2011-2017) contributes 24.1% (n=241), marking the field's initial transition toward pedagogical integration. Phase 3 (2018-2026) encompasses 71.2% (n=713), reflecting a sustained increase in output and thematic scope. For Indonesian researchers, Phase 3's emphasis on implementation, curriculum integration, and teacher training may represent a particularly accessible area for contribution, as Indonesian-context studies remain largely absent from the corpus.

Table 3. A summary of the three temporal phases of PAL research (2000-2026)

Phase	Period	N	%	Domain Characteristics
1	2000–2010	47	4.7%	Foundation: PAAC, PA & health, active school
2	2011–2017	241	24.1%	Diversification: embodied learning, brain breaks, movement integration
3	2018–2026	713	71.2%	Expansion: meta-analysis, curriculum implementation, peak 2025 (n=107)
Total	2000–2026	1,001	100%	CAGR 17.1% (2010–2025)

Note. 27 articles from early 2026 are early online as of the March 27, 2026 search date.

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1. Most Productive Journals

Journal distribution is broadly consistent with Bradford's Law (Zone 1→2: 4.0×; Zone 2→3: 3.9×), suggesting a well-structured and diversified literature, consistent with Bradford's Law predictions. As shown in Table 4, the ten most productive journals are dominated by Q1 sources. The most frequently represented is the *International Journal of Environment Research and Public Health* (52 articles, 5.2%), reflecting the field's public health roots. Notably, five of the top ten journals are primarily education or pedagogy outlets including *Journal of Teaching in Physical Education* (22), *Teaching and Teacher Education* (15), and *Physical Education and Sport Pedagogy (12)* consistent with PAL's pedagogical reorientation in Phase 3.

Tabel 4. Ten most productive journals in PAL research

	Journal	n	%	Field	Q
	Int. J. Environmental Research & Public Health	52	5.2%	Health, environment	Q1
	BMC Public Health	35	3.5%	Public Health	Q1
	Journal of Physical Activity and Health	25	2.5%	PA and Health	Q1
	Journal of Teaching in Physical Education ★	22	2.2%	Physical Education	Q1
	PLoS ONE	19	1.9%	Multidisciplinary	Q1
	Journal of School Health	19	1.9%	School health	Q1
	Preventive Medicine	18	1.8%	Preventive Medicine	Q1
	Journal of PE, Recreation and Dance ★	17	1.7%	Physical Education	Q2
9	Teaching and Teacher Education ★	15	1.5%	Education	Q1
10	Physical Education and Sport Pedagogy ★	12	1.2%	Pedagogy	Q1

Note: ★= pure education/pedagogy journal, Q = Scimago Quartile

2. Most Productive Authors

Author productivity is broadly consistent with Lotka's Law: 81.2% of 3,580 authors contributed a single article. The most prolific contributors is Webster, C.A (25 articles, 830 citations, USA), followed by Salmon, J. (20 articles, Australia) and Lubans, D.R. (18 articles, Australia). Vazou, S. (12 articles, 579 citations) recorded a notably high citation-to-output ratio. VOSviewer co-authorship analysis identified 281 authors across seven clusters: (1) Australia/USA Neuroscience-Education; (2) USA Classroom-PA Implementation; (3) USA Comprehensive School PA; (4) Australia/Italy Embodied Learning; (5) USA Behavioral Science; (6) USA Intervention Design; (7) Scandinavia. Relatively limited inter-cluster connectivity suggests that PAL research tends to develop within distinct collaborative communities, which may indicate productive entry

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points for Indonesian researchers through strategic collaboration particularly with Cluster 4 (embodied learning: Salmon, Mazzoli, Pesce) and Cluster 7 (Scandinavia: Bensten's udeskole tra

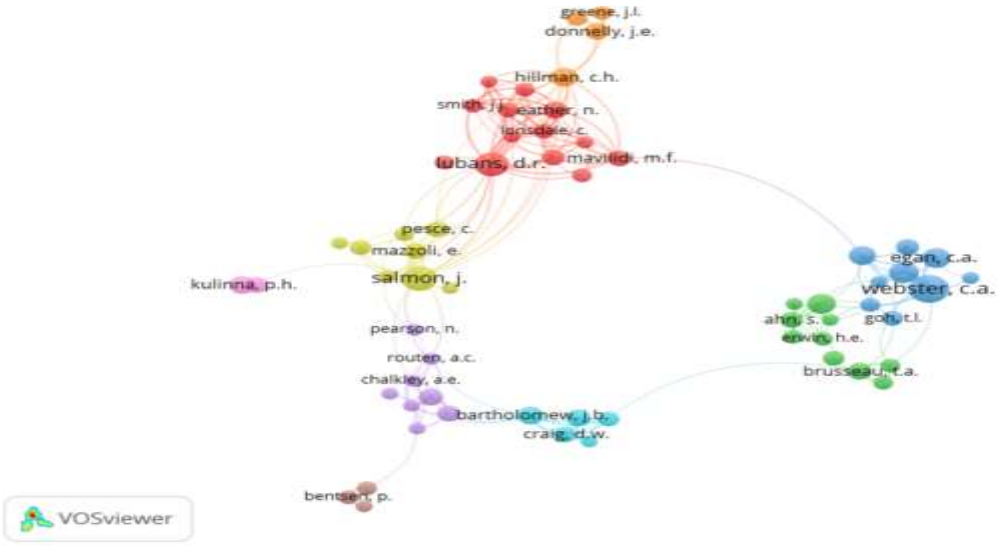


Figure 2. Co-authoring network of PAL field authors (VOSviewer, min. 3 documents, 281 authors, 7 clusters). Node size = number of articles; color = cluster

B. Geographic Distribution

The USA accounted for 451 articles (45.1%), followed by Australia (128, 12.8%), UK (83, 8.3%), Spain (74, 7.4%), and Canada (60, 6.0%). Indonesia contributed only 15 articles (1.5%) and Malaysia 9 articles, with neither ranking in the top 13. This disparity warrants attention given Indonesia's large primary school system (Peserta Didik – Data Pendidikan Nasional, 2026). The concentration in high-income Western contexts may reflect epistemic conditions in which PAL frameworks are developed and validated in settings that differ substantially from Indonesia classrooms typically characterized by larger class sizes (35-45 students), limited resources, and teacher-directed instructional traditions (Kusumawati & Umam, 2025; OECD, 2020).

1. Most Cited Documents

Three seminal works dominate the citation landscape: Mahar et al. (2006) with 510 citations, demonstrating that classroom-based activity increases on-task behavior without reducing instructional time; Donnelly et al. (2009) with 462 citations, providing large-scale RCT

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evidence linking PA integration with reduced overweight and improved academic outcomes; and Donnelly & Lambourne (2011) with 418 citations, offering a conceptual framework connecting classroom-based PA integration with cognition. Together these account for approximately 1,390 citations. Additional influential works include Johnson-Glenberg et al. (2014) with 295 citations on embodied learning, Webster et al. (2015) with 222 citations on a PAL implementation framework, and Resaland et al. (2016) with 153 citations on longitudinal PA effects on academic achievement.

2. Keyword Co-occurrence Map and Thematic Clusters

Index keyword co-occurrence analysis produced 139 keywords across six clusters: Cluster 1 (red classroom-based PA and cognitive outcomes*): physical activity, cognition, attention, embodied learning*; Cluster 2 (green teacher pedagogy and implementation): *teacher training, implementation, pedagogy*; Cluster 3 (yellow health and PA): *physical fitness, obesity, sedentary behavior*; Cluster 4 (purple research design): *randomized controlled trial, effect size*; Cluster 5 (dark blue equity): *poverty, outdoor play*; Cluster 6 (orange school PA policy): *CSPAP, child nutrition*. Among the 20 most frequent Author Keywords, *physical activity* leads (313 occurrences), followed by *embodied learning* (45) and *movement integration* (30).

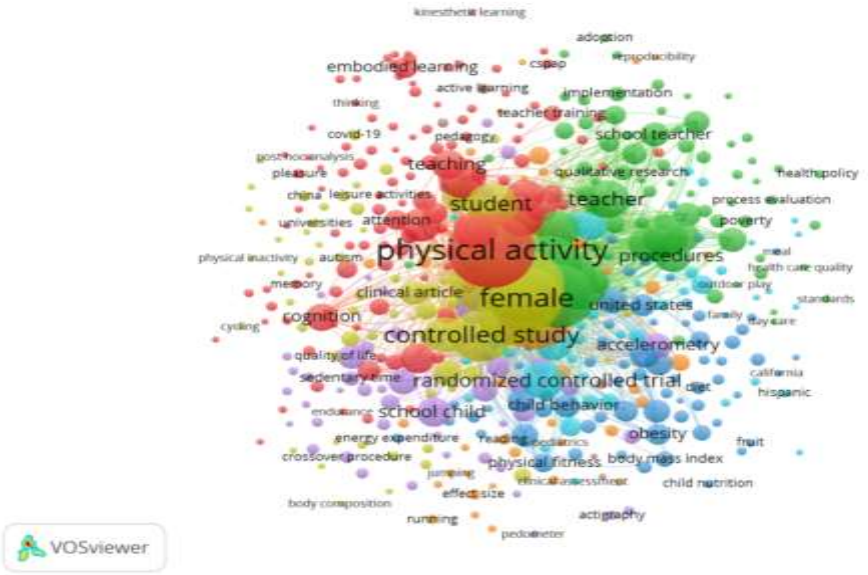


Figure 3. Co-occurrence map of Index Keywords in PAL field (VOSviewer, min. 5 occurrences, 139 keywords, 6 clusters). Node size = frequency; color = thematic cluster

Temporal analysis reveals a gradual concept shift. Phase 1 was dominated by *nutrition,*

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obesity, and overweight, reflecting a health-oriented discourse. Phase 2 introduced *academic achievement* (12 occurrences), marking movement toward instructional integration. Phase 3 shows the most pronounced shift: *embodied learning* surged from near zero to 40 occurrences; *movement integration* reached 23; and *academic achievement* (27), *primary school* (22), and *implementation* (21) collectively indicate that field's central question has shifted from "does PA impact health?" toward "how can PAL be effectively designed and implemented?"

DISCUSSION

From a bibliometric perspective, the keyword distribution within Cluster 1 reflects a meaningful reorientation of the field's outcome priorities over time. This pattern is broadly consistent with empirical syntheses: He et al. (2025) reported a significant association between PA and mathematics performance (SMD = 0.11; p = 0.001), while Muntaner-Mas et al. (2024) identified content-relevance as a notable moderator (Hedges' g = 0.54) a finding that is broadly consistent with the corpus-level keyword shift toward *movement integration* and *embodied learning*. These patterns are suggestive rather than conclusive, as bibliometric evidence does not in itself established causal relationships.

The increase in *embodied learning* from near zero in Phase 1 to 40 occurrences in Phase 3 represents one of the more notable conceptual developments in this corpus. Embodied cognition theory posits that cognitive processes arise through dynamic interactions of body, mind, and environment (Clughen, 2024), suggesting that bodily engagement may support abstract understanding through sensorimotor grounding (Way & Ginns, 2024). In the Indonesian context, traditional games such as *engklek* and *gobaksodor* appear to share structural characteristics associated with embodied learning particularly in relation to spatial reasoning and counting though empirical investigation of these games within PAL contexts remains absent. This represents a gap that may warrant future investigation.

The proximity of Cluster 2 (teacher pedagogy and implementation) to Cluster 1 in the co-occurrence map suggests a recognized relationship between implementation quality and PAL effectiveness. Daly-Smith et al. (2021) identified ongoing professional development and school leadership support as key facilitators, while Wood et al. (2025) documented substantial gains in teacher confidence (M = 2.86 to M = 8.31) following structured professional learning. For Indonesia, these findings are relevant to pre-service PGSD programs and in-service development within the Merdeka Mengajar platform.

The geographical disparity with over 66% of the corpus from three high-income countries

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raises questions about the transferability of existing frameworks to different educational contexts. The following research directions are proposed for Indonesian scholars: (1) develop and evaluate PAL ineterventions drawing on traditional games (engklek, gobak sodor, congklak) with mathematics and literacy outcomes; (2) design protocols adapted for large Indonesian classroom (35-45 students); (3) examine alignment between PAL principles and the Merdeka Belajar framework, including P5 initiatives; (4) explore collaborative opportunities with integration of PAL competencies into pre-service PGSD teacher education.

RECOMMENDATION

Future research is encouraged to expand database coverage beyond Scopus to include Web of Science, ERIC, and PsycINFO, and to combine bibliometric analysis with systematic review or meta-analytic approaches to assess the methodological quality and practical effectiveness of individual PAL studies. Strategic collaboration with established international research clusters particularly those specializing in embodied learning and outdoor education would accelerate the development of cross-cultural PAL frameworks applicable to diverse educational settings, including those in Southeast Asia.

CONCLUSION

This bibliometric analysis of 1,001 Scopus-indexed PAL articles (2000-March 2026) describes a field has grown substantially over two decades, evidence by 21,897 citations, an h-index of 68, and a CAGR of 17.1% across three identifiable phase. A gradual thematic shift from health-focused toward pedagogically oriented is indicated by the increasing prominence of *embodied learning* (near zero to 40 occurrences) *academic achievement* in Phase 3. The USA accounts for 45.1% of the corpus while Indonesia contributes only 1.5% a disparity that highlights both a gap and a potential area for scholarly contribution. Five research directions have been proposed to guide future PAL research, with priority given to traditional game-based interventions, large-classroom adaptations, and Merdeka Belajar curriculum integration. For educational policymakers within Kemendikbudristek and provincial education offers, this bibliometric evidence may serve as a useful reference for strengthening PAL related research and practice. Limitations include reliance on a single database (Scopus) and the inherently descriptive nature of bibliometric analysis, which documents patterns without establishing causality. Future updates at three-to-five-year intervals and expanded database coverage are recommended.

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