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REVIEW ARTICLE

Table tennis research in Indonesia, 2016–2026: A bibliometric analysis of publication trends, collaboration, and thematic evolution

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ABSTRACT

Background: Table tennis research in Indonesia has addressed physical education, coaching, motor skills, instructional media, and athlete performance. However, no national bibliometric study has systematically mapped its publication growth, collaboration structure, geographical distribution, and thematic development. **Objective:** This study aims to map the development, contributors, collaboration patterns, institutional and regional distribution, and major research themes of table tennis research in Indonesia from 2016 to 2026. **Methods:** A bibliometric analysis was conducted using OpenAlex and Scopus. The search identified 421 records, consisting of 357 records from OpenAlex and 64 from Scopus. After removing 43 duplicates, 378 records were screened, 17 were excluded, and 361 were assessed for eligibility. A further 36 records were excluded because of incomplete metadata, resulting in a final corpus of 325 journal articles. Data were analysed using Bibliometrix and Biblioshiny. **Results:** The final dataset included 325 documents published across 186 sources and written by 754 authors. The annual publication growth rate was 14.87%, with an average of 2.83 co-authors and 1,345 citations per document. Publications increased from five documents in 2016 to 45 in 2025, while the 2026 count remained incomplete. Research was concentrated in Indonesian physical education and sport journals. The dominant themes included table tennis learning, basic techniques, student populations, athlete performance, forehand drive, experimental research, and correlational studies. International co-authorship remained very limited at 0.6154%. **Conclusion:** Table tennis research in Indonesia has grown substantially, but its collaboration networks, methodological standardisation, geographical integration, and international visibility remain limited. Future research should strengthen multi-institutional and cross-provincial collaboration, standardise research instruments, expand longitudinal and performance-based studies, improve metadata quality, and develop international research partnerships.

Keywords: Table Tennis; Indonesia; Bibliometric Analysis; Science Mapping; Sport Performance



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Authors' Contribution: a – Study Design; b – Data Collection; c – Statistical Analysis; d – Manuscript Preparation; e – Funds Collection

INTRODUCTION

Table tennis is a fast, intermittent racket sport that calls for perceptual anticipation, fine motor control, tactical selection, repeated efforts of short duration, and rapid adaptation of strokes. The sport's

performance outcomes arise from the interplay between technical execution, physical capacity, tactical decisions, and contextual constraints. Recent research has looked at lower-limb biomechanics during topspin forehands, physical-fitness profiles, technical-tactical actions, match phases, and fluctuations in elite stroke performance (He et al., 2022; Pradas De La Fuente, Ortega-Zayas, et al., 2023; Pradas et al., 2022; Wong et al., 2020; Yu & Gao, 2022; Yu et al., 2026). Collectively, these studies illustrate the multidimensional nature of table tennis research and the value of integrating perspectives from coaching, physical education, technology-supported learning, and match analysis.

The international field is increasingly characterised by methodological diversity. Recent work has evaluated tactical performance through integrated technical and tactical indicators, investigated the relationship between stroke performance and scoring, and modelled the efficiency of offensive sequences (Chen et al., 2025; Liu et al., 2025; Yu & Huang, 2025). Other studies have examined physiological, biomechanical, and tactical differences associated with age, sex, playing style, and stroke execution (Malagoli Lanzoni et al., 2024; Pradas De La Fuente, Toro-Román, et al., 2023; Zhao & Xiao, 2026). Recent bibliometric studies have also mapped the development of table tennis research, identified growing attention to performance, biomechanics, training, physiology, and technology-supported analysis (Andrijanto et al., 2025; Hasnah, 2024). Digital technology has also been incorporated through interventions combining learning frameworks with performance or fitness outcomes (Xie et al., 2025). This development provides a useful benchmark for examining whether a national research corpus is balanced across learning, measurement, training, and elite performance.

Indonesia provides a strong practical foundation for research on table tennis. The sport is delivered through physical education contexts, carried out via school extracurricular programmes, and further developed by clubs and local coaching systems. The dataset reflects a wide range of applied studies within this environment. Illustrations include immersive learning approaches for teaching table tennis (Yusro et al., 2022), life-kinetic practice aimed at forehand accuracy (Faris et al., 2022), return-board media designed for novice learners (Hasmarita, 2022), multiball training targeting the forehand drive (Jamaluddin & Arwih, 2022), and a TPACK-based problem-based learning model for junior high school classes (Siregar et al., 2022). These studies are particularly valuable because they address specific instructional and coaching needs, rather than relying solely on the transfer of elite-sport models from other countries.

Indonesian research also shows a broad focus on technological media, instructional design, the development of technical skills, and physical preparation. Digital Android-based teaching materials have been created for push techniques (Dwipayana et al., 2023). Imagery and concentration have been examined in relation to forehand-service accuracy (Sunjoyo et al., 2023). Interactive multimedia has been proposed to support blended learning (Raibowo et al., 2024), and other studies have assessed physical-training programmes and backhand-drive models (Hasmarita, 2022; Tumaloto et al., 2024). These publications suggest ongoing experimentation, yet the division across methods, participant groups, outcomes, and research settings may make the larger structure hard to discern when looking at individual articles alone.

Bibliometric research in Indonesian sport has already examined national sport-science production, sport management, Indonesian football, volleyball training, and badminton management (Jumareng et al., 2024; Pradana et al., 2024; Saharullah et al., 2023; Sofyan, 2022). These studies show that bibliometric mapping can reveal publication growth, productive institutions, contributor networks, and thematic concentrations. However, their units of analysis are broad sport disciplines or sports other than table tennis. To the best of our knowledge, no previous study has systematically mapped the Indonesian table tennis corpus, compared its pedagogical and performance orientations, or evaluated its national collaboration structure. This gap defines the contribution of the present study.

A bibliometric analysis can examine the visible organisation of a research field by quantifying annual output, identifying leading authors and institutions, locating publication sources, mapping collaboration, and tracking recurring concepts through keywords (Aria & Cuccurullo, 2017; Donthu et al., 2021). Database selection remains consequential because coverage, language, document type, citation counts,

and author prominence vary across sources. Scopus provides curated international indexing, while OpenAlex offers an open scholarly index and broader coverage of local and open-access publication channels (Priem et al., 2022). Comparative evidence indicates that OpenAlex (Haunschild & Bornmann, 2024), has reference coverage comparable to Scopus and Web of Science for records shared across the databases, although metadata completeness differs by field and source (Culbert et al., 2025). The combined use of Scopus and OpenAlex therefore supports both international indexing standards and the national-coverage objective of this study.

The study contributes in three ways. First, it provides a consolidated descriptive profile of 325 records related to table tennis research in Indonesia published between 2016 and 2026. Second, it connects publication growth and contributor patterns with the instructional, performance, and experimental structures revealed by the keyword analysis. Third, it identifies methodological and data-governance gaps that should be addressed before subsequent analyses can claim full reproducibility. The contribution is therefore both substantive and procedural: it clarifies what the available data show and, equally importantly, what the available data cannot yet support. Accordingly, five research questions guided the analysis: **RQ1.** How did scientific production on table tennis in Indonesia evolve between 2016 and 2026? **RQ2.** Which authors, journals, and institutions contributed most substantially to table tennis research in Indonesia? **RQ3.** What social and conceptual structures were evident in the collaboration and keyword networks? **RQ4.** Which themes were identified as motor, basic, niche, or emerging/declining themes? **RQ5.** What research gaps and future directions can be identified from the performance and thematic analyses while acknowledging the limitations of the underlying bibliographic records?

METHODS

Research Design

This study employed a bibliometric research design to examine publication growth, research contributors, collaboration patterns, and thematic development in Indonesian table tennis research. Bibliometric analysis is appropriate for systematically mapping scientific production and the conceptual development of a research field (Aria & Cuccurullo, 2017; Donthu et al., 2021; Zupic & Čater, 2015). PRISMA 2020 was used to transparently report the identification, screening, eligibility, and inclusion of records effectiveness (Page, McKenzie, et al., 2021; Page, Moher, et al., 2021). Indonesia was selected to specifically examine the national research ecosystem, including researchers, institutions, journals, and collaboration networks. The analysis covered 2016-2026, with 2026 treated as a partial publication year based on the date of data retrieval. The search date and dataset-selection procedures were documented to ensure transparency and reproducibility.

Data Sources and Database Selection

The bibliographic search was conducted on 29 July 2026 using Scopus and OpenAlex. Scopus was selected for its broad international coverage, whereas OpenAlex was included to broaden the retrieval of Indonesian-language and locally published research that may not be indexed in Scopus. OpenAlex has increasingly been used as a bibliometric data source (Haunschild & Bornmann, 2024; Konch & Hazarika, 2026; Priem et al., 2022), while comparative studies have demonstrated its complementary value alongside Scopus and Web of Science, although metadata quality requires careful validation (Cicero & Sarlo, 2026; Culbert et al., 2025). Therefore, the two databases were treated as complementary rather than equivalent sources, followed by record merging, deduplication, eligibility screening, and metadata validation.

To improve retrieval sensitivity and reduce language-specific bias, both databases used the English and Indonesian terms “table tennis” and “tenis meja.” The Scopus search was TITLE-ABS-KEY (“table tennis” OR “tenis meja”) AND AFFILCOUNTRY(“Indonesia”) AND PUBYEAR > 2015 AND PUBYEAR < 2027. The OpenAlex search similarly used “table tennis” OR “tenis meja” in the title and abstract fields, with publication years restricted to 2016-2026 and document type limited to articles.

Alternative terms such as “table-tennis” and “ping-pong” were assessed during search-sensitivity testing but were not included in the final strategy because they did not identify additional relevant records. The initial searches yielded 64 records from Scopus and 357 records from OpenAlex. Records from both databases were subsequently integrated and prepared for deduplication and eligibility screening. The complete search strategy and database coverage are summarized in **Table 1**.

Table 1. Search Strategy and Data Coverage

Component	Scopus	OpenAlex
Search date	29-Jul-26	29-Jul-26
Search fields	Title, abstract, author keywords	Title and abstract
Core terms	“table tennis” OR “tenis meja”	“table tennis” OR “tenis meja”
Country criterion	Indonesia affiliation	Indonesian affiliation/country metadata
Publication period	2016–2026	2016–2026
Document type	Article	Article
Records retrieved	64	357

Eligibility Criteria and Study Selection

Following the database searches described in **Table 1**, the retrieved records were assessed using predefined eligibility criteria. Records were included if they were (i) published between 2016 and 2026, (ii) classified as journal articles, (iii) substantively focused on table tennis (*table tennis* or *tenis meja*), and (iv) associated with Indonesia through author affiliation or relevant Indonesian research context. Records were excluded if they were (i) outside the specified publication period, (ii) not journal articles, (iii) only mentioned table tennis incidentally without substantive relevance to the study, or (iv) lacked sufficient bibliographic information for verification. The overall identification, screening, eligibility, and inclusion process is presented in the PRISMA flow diagram (**Figure 1**).

Data Screening and Deduplication

Records retrieved from Scopus and OpenAlex were merged into a single dataset. Duplicate records were identified and removed based on DOI, title, authorship, and publication metadata. The remaining records underwent title and abstract screening, followed by bibliographic verification and assessment of their relevance to the study scope. Records that did not meet the predefined eligibility criteria were excluded. The numbers of records identified, screened, excluded, and ultimately included are reported in **Figure 1**.

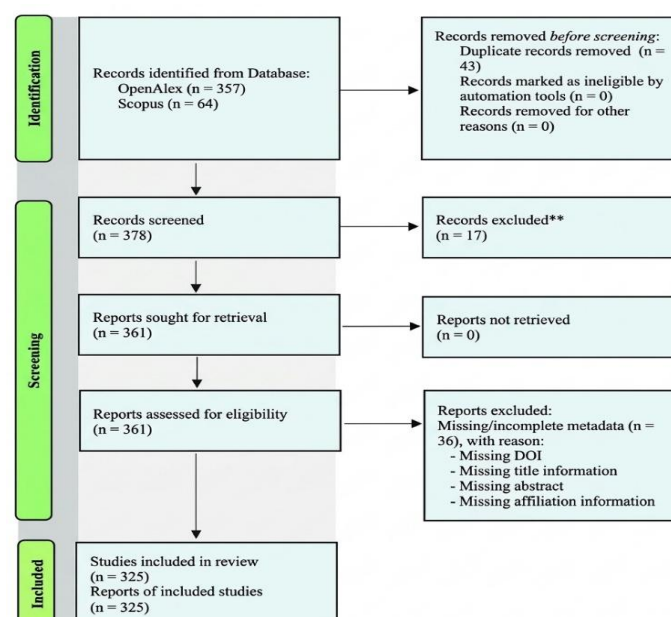


Figure 1. PRISMA 2020 Flow Diagram of Study Selection

Data Cleaning and Normalization

Before bibliometric analysis, the merged dataset was cleaned and standardised to improve metadata consistency across Scopus and OpenAlex. Duplicate records were identified using DOI, title, authorship, and publication metadata, while records with incomplete or inconsistent bibliographic information were manually verified where necessary. Author names, institutional affiliations, journal/source names, and keywords were standardised to reduce artificial fragmentation in co-authorship and keyword networks. Variants referring to the same concept, including differences in spelling, punctuation, and terminology, were harmonised while preserving the original bibliographic records. The cleaned dataset was then used for performance analysis, collaboration mapping, keyword co-occurrence analysis, and thematic analysis. This normalisation procedure was applied to minimise metadata inconsistencies and improve the reliability and interpretability of the resulting bibliometric networks (Aria & Cuccurullo, 2017; Donthu et al., 2021; Zupic & Čater, 2015).

Bibliometric Analysis

The cleaned dataset was analysed using R with the Bibliometrix package and its Biblioshiny interface for descriptive, performance, and thematic analyses (Aria & Cuccurullo, 2017). These analyses included annual scientific production, annual growth, productive sources, authors, affiliations, citation patterns, international co-authorship, and thematic evolution. VOSviewer was used to construct and visualise bibliometric networks, including author co-authorship, institutional and country collaboration, and keyword co-occurrence networks (Van Eck & Waltman, 2017). The thematic map was interpreted according to centrality and density, with motor themes characterised by high centrality and density, niche themes by low centrality and high density, basic themes by high centrality and low density, and emerging or declining themes by low centrality and density (Cobo et al., 2011). Citation counts were interpreted as database-dependent indicators of citation visibility rather than direct measures of research quality (Donthu et al., 2021).

Cited-reference analyses were not conducted because complete reference-list metadata were not consistently available across all records in the harmonised dataset. Consequently, analyses requiring complete cited-reference information, including co-citation analysis, bibliographic coupling, historiographic mapping, and local-citation analysis, were outside the evidential scope of the present study.

RESULTS

Publication Growth and Scientific Production

Following the database searches and data-coverage procedures reported in Table 2, the final corpus comprised 325 articles published across 186 sources between 2016 and 2026, involving 754 authors. As summarised in Figure 2, the corpus showed an annual growth rate of 14.87%, indicating sustained expansion of Indonesian table tennis research over the study period. The mean citation rate was relatively low (1.35 citations per document), with 191 of 325 articles (58.8%) receiving no citations. This citation pattern may partly reflect the relatively recent nature of the corpus, which had an average document age of 3.99 years, although citation counts should be interpreted as indicators of citation visibility rather than research quality. Because 2026 represents a partial publication year, its publication output should not be directly compared with those of completed years (see Figure 2 and Table 2).



Figure. 2. Bibliometric Overview of Indonesian Table Tennis Research, 2016-2026

Table 2. Main Bibliometric Indicators of the Final Research Corpus (2016-2026)

Indicator	Value	Note
Timespan	2016-2026	2026 is a partial year
Documents	325	Main bibliometric indicators of the final research corpus (2016-2026)
Sources	186	Journals/sources represented in the final corpus
Authors	754	Total authors contributing to the corpus
Authors of single-authored documents	62	Dashboard label; not the number of single-authored records
Co-authors per document	2.83	Descriptive collaboration indicator
International co-authorship	0.6154%	Equivalent to two documents with international co-authorship
Author keywords	101	Dashboard value
Document average age	3.99 years	Snapshot statistic
Average citations per document	1.345	OpenAlex citation snapshot, not a quality metric
Annual growth rate	14.87%	Compound rate from 2016 to 2026, not annual linear growth

Figure 3 shows that annual publication output increased from five articles in 2016 to 49 in 2020, representing the highest annual output during the study period. Manual inspection of the 2020 publications indicated a broad concentration of applied studies addressing school and university learning, forehand and service skills, training methods, instrument development, and club-based performance. Several highly cited articles in the final corpus were also published in 2020. The peak therefore appears to have been distributed across several applied topics rather than driven by a single research theme. Publication output subsequently fluctuated, with 37 articles in 2021, 43 in 2022, 31 in 2023, 48 in 2024, 45 in 2025, and 20 articles recorded for 2026 represent a partial publication year and should therefore not be directly compared with completed years. Because the available metadata do not document funding calls, editorial schedules, or policy interventions, the increase observed in 2020 cannot be attributed causally to the COVID-19 pandemic, a particular journal, or a single institutional programme.

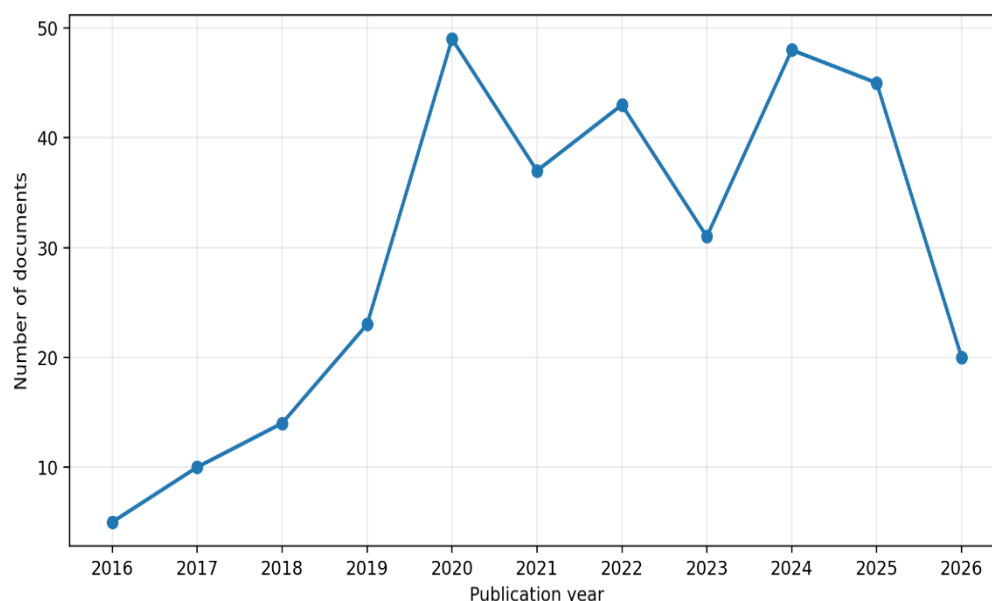


Figure 3. Annual Scientific Production

The database searches identified 421 records, comprising 357 records from OpenAlex and 64 records from Scopus. After removing 43 duplicate records, 378 records remained for title and abstract screening. Seventeen records were excluded because they did not meet the predefined eligibility criteria, leaving 361 records for further assessment. Of these, 36 records were excluded because of incomplete or insufficient bibliographic metadata. The final bibliometric corpus therefore comprised 325 journal articles. The complete selection pathway is presented in the PRISMA flow diagram (**Figure 1**).

Authors, Sources, and Institutional Contributions

The 325 records were distributed across a broad source base, as shown in **Figure 4**. Jurnal Ilmu Keolahragaan led with 10 documents; Gelanggang Olahraga Jurnal Pendidikan Jasmani dan Olahraga followed with nine; Jurnal Patriot and JISIP each contributed eight; and Journal of Sport contributed seven. The leading source accounted for only 3.1% of the corpus. This dispersion indicates that no single specialist outlet dominates the field, and that table tennis scholarship circulates across physical education, sport science, social education, coaching, and applied learning journals.

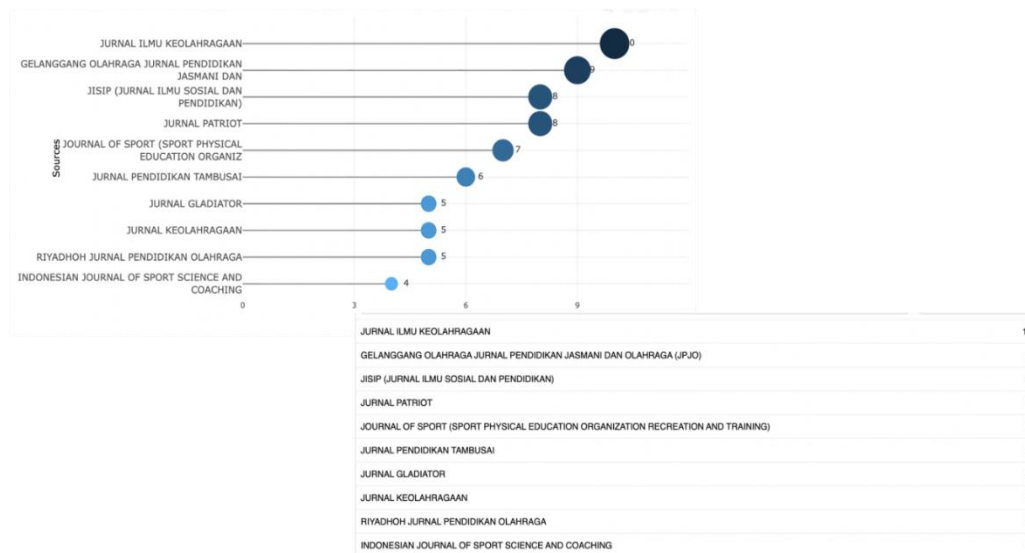


Figure 4. Most Productive Sources

Author productivity was relatively dispersed. Indra Safari was the most productive author with 14 publications, followed by Nurdin Nurdin with eight, while Argubi Silwan, Melya Nur Herliana, and Muhammad Ishak each contributed six. The mean of 2.83 co-authors per document indicates that collaborative authorship was common, although the relatively low international co-authorship rate suggests that collaboration remains predominantly domestic.

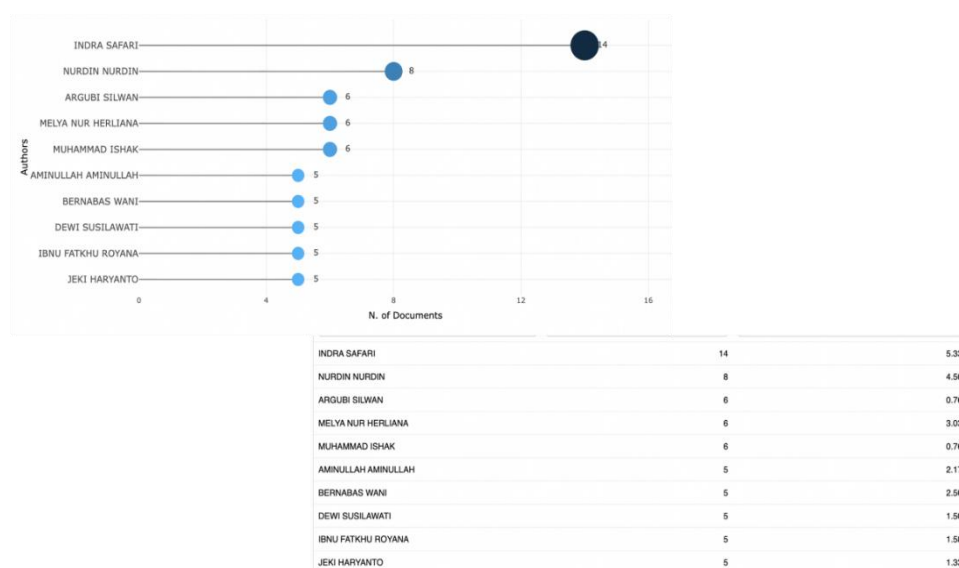


Figure 5. Most Productive Authors

Institutional affiliations are ranked in **Figure 6**. Universitas Muhammadiyah Tapanuli Selatan was the most productive institution with 28 documents, followed by Indonesia Pendidikan Indonesia with

- 15 20, Universitas Negeri Padang with 18, Universitas Negeri Medan with 13, and Universitas Negeri Malang and Universitas PGRI Semarang with 12 each. All remaining institutions contributed fewer than 10 documents. These counts represent the frequency of institutional names in the affiliation metadata and should therefore be interpreted as publication-output indicators rather than measures of research quality, funding capacity, or scientific influence.

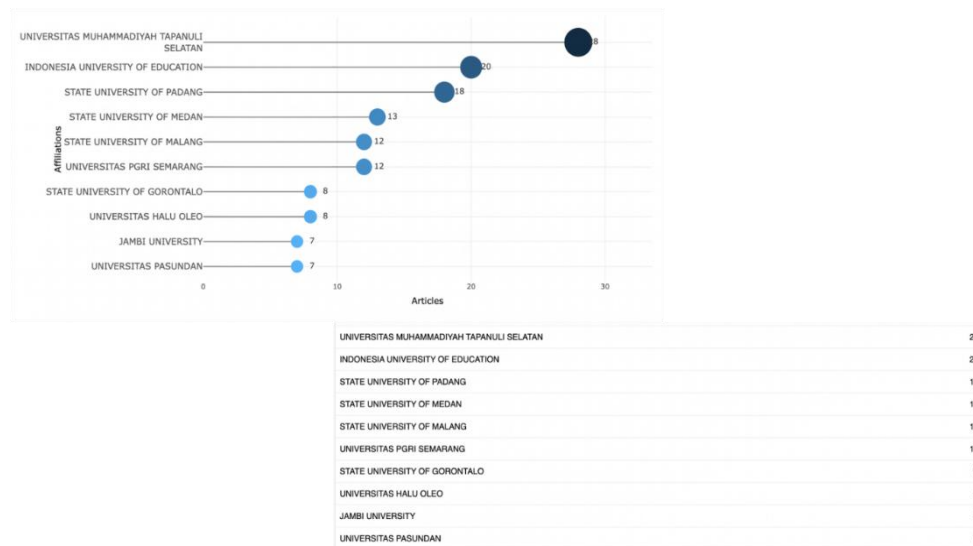


Figure 6. Most Productive Institutional Affiliations

- 11 International co-authorship accounted for 0.6154% of the corpus, equivalent to two of 325 documents. Country information was available for 297 records, although the metadata contained incomplete coverage and isolated anomalies. Accordingly, the international co-authorship indicator is reported descriptively, and the available metadata do not support a reliable assessment of the full country-level collaboration structure. The author co-authorship network in Figure 7 shows several small and visually separated clusters rather than a densely integrated network, suggesting a fragmented collaboration structure. However, because the network export did not preserve the threshold, node, edge, or normaliation parameters, this visualisation should be interpreted qualitatively rather than as a reproducible quantitative measure of network structure.

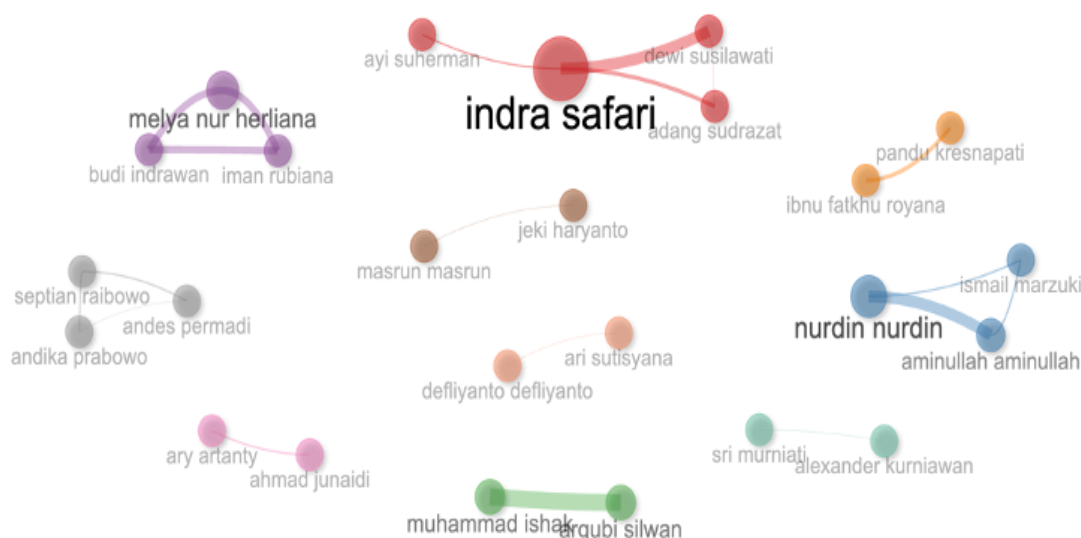


Figure 7. Author Co-authorship Network

Citation Impact, Collaboration, and Conceptual Structure

The ten highest-cited documents are presented in **Table 3**. The most-cited record was the 2020 instrument-validation study of reactive agility in table tennis by Tomoliyus and Sunardianta, with 17 citations, followed by Rahedin Suwo's (2019) study of hand-reaction speed and forehand topspin with 13 (Suwo, 2019). Purwanto and Suharjana's (2017) learning-model article (Purwanto & Suharjana, 2017), and Sari and Antoni's (2020) forehand-drive analysis each recorded 12 citations (Sari & Antoni, 2020). A data-quality concern was also identified: at least one highly cited record in the raw ranking was not unambiguously table-tennis focused, underscoring the need for manual topical review before citation rankings are treated as a definitive intellectual core.

Table 3 presents the ten most-cited publications in the final bibliometric corpus. The most-cited article received 17 citations, followed by articles with 13 and 12 citations. The remaining publications in the top 10 received between 8 and 12 citations. The highly cited publications primarily addressed instrument validation, technical performance, learning models, instructional approaches, and skill development in table tennis. This distribution suggests that highly cited research in the Indonesian corpus spans both performance-oriented and educational research, rather than being concentrated in a single topic. Citation counts should nevertheless be interpreted as indicators of citation visibility within the database snapshot rather than as direct measures of research quality or scientific importance.

Table 3. Top 10 Most-Cited Publications in the Final Bibliometric Corpus

Rank	Title	Year	Citations	Source	DOI
1	Validitas Aiken's instrumen tes untuk mengukur reaktif agility olahraga khusus tenis meja	2020	17	Jurnal Keolahragaan	10.21831/jk.v8i2.32492
2	Pengaruh kecepatan reaksi tangan terhadap kemampuan forehand topspin	2019	13	Riyadhoh : Jurnal Pendidikan Olahraga	10.31602/rjpo.v1i1.1703
3	Analisis kemampuan forehand drive atlet tenis meja	2020	12	Edu Sportivo: Indonesian Journal of Physical Education	10.25299/es:ijope.2020.vol1(1).5253
4	Pengembangan model pembelajaran pengenalan teknik dasar tenis meja untuk siswa SD kelas atas	2017	12	Jurnal Keolahragaan	10.21831/jk.v5i2.6419
5	Perbandingan hasil belajar teknik dasar pukulan permainan tenis meja dengan dan tanpa net	2016	9	EduHumaniora Jurnal Pendidikan Dasar	10.17509/eh.v1i2.2731
6	Hubungan koordinasi mata tangan, kekuatan lengan, dan motivasi dengan ketepatan forehand	2017	8	Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika	10.36312/e-saintika.v1i1.2
7	Pengembangan immersive learning berbasis natural user interface pada materi pembelajaran tenis meja	2022	8	JKTP: Jurnal Kajian Teknologi Pendidikan	10.17977/um038v5i32022p274
8	Kontribusi kekuatan otot tungkai, reaksi tangan, dan kelentukan terhadap forehand drive	2021	8	Jendela Olahraga	10.26877/jo.v6i1.6999
9	Penerapan kajian dan praktik lapangan pada mahasiswa pendidikan olahraga	2020	8	Biormatika : Jurnal Ilmiah Fakultas Keguruan Dan Ilmu Pendidikan	10.35569/biormatika.v6i02.791
10	Instrumen keterampilan smash dalam permainan tenis meja	2020	8	Gelanggang Olahraga: Jurnal Pendidikan Jasmani dan Olahraga (JPJO)	10.31539/jpjo.v3i2.1073

The author-keyword co-occurrence network (Figure 8) showed four visually distinguishable conceptual groupings. The first was centred on *tenis meja*, *materi olahraga*, *pembelajaran jasmani*, *model pembelajaran*, and *media pembelajaran*, indicating an emphasis on instructional and pedagogical contexts. The second included *atlet*, *klub olahraga*, *korelasional*, and *kondisi fisik*, reflecting performance- and athlete-oriented research. The third was associated with *eksperimen*, *mahasiswa*, *forehand drive*, *latihan multiball*, and *drill*, representing experimental and training-oriented studies. The fourth included *siswa SD*, *siswa SMP*, *observasi*, *teknik dasar*, *service*, and *extracurricular activity*, indicating research involving school-age learners and fundamental skills. These groupings should be interpreted as descriptive patterns in the visual network rather than statistically validated thematic clusters, because the original threshold and network parameters were not preserved in the available export.

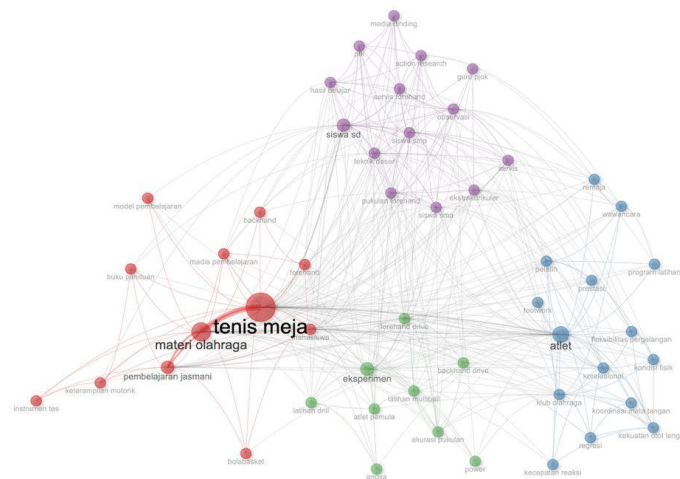


Figure 8. Author-Keyword Co-occurrence Network

Thematic Structure of Table Tennis Research

The thematic map (Figure 9) and the descriptive cluster information (Table 4) show four thematic quadrants based on the relative centrality and density of author-keyword groupings. *Atlet*, *klub olahraga*, and *korelasional* were positioned in the motor-theme quadrant, representing relatively well-developed and well-connected topics. *Tenis meja*, *materi olahraga*, and *pembelajaran jasmani*, together with *siswa SD*, *observasi*, and *teknik dasar*, were positioned as basic themes, indicating topics with broader relevance but comparatively lower internal development. *Eksperimen*, *mahasiswa*, and *forehand drive* appeared in the emerging-or-declining quadrant, while *atlet difabel*, *antropometri*, and *daya tahan kardiovaskular* were positioned as niche themes. These quadrant positions describe the relative configuration of the keyword network and should not be interpreted as evidence of future research growth, decline, or independent research importance.

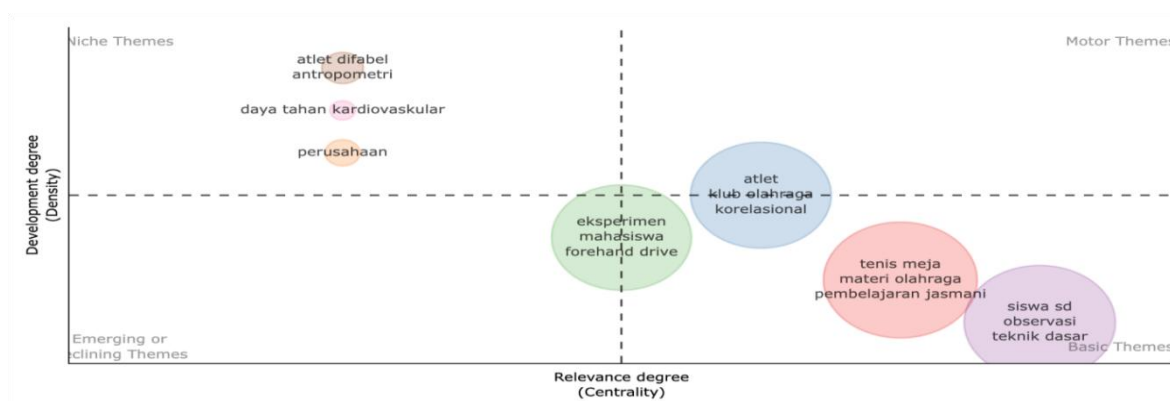


Figure 9. Thematic Map of Author Keywords

Table 4. Descriptive Thematic Clusters

Cluster / map location	Representative terms	Interpretation supported by supplied outputs
Basic theme	<i>tenis meja; materi olahraga; pembelajaran jasmani</i>	Core pedagogical and curricular orientation.
Basic theme	<i>siswa SD; observasi; teknik dasar</i>	School-based learning and foundational-skill studies.
Motor theme	<i>atlet; klub olahraga; korelasional</i>	Established athlete-focused performance and correlational studies.
Emerging or declining	<i>eksperimen; mahasiswa; forehand drive</i>	Technique practice, university populations, and experimental approaches.
Niche theme	<i>atlet difabel; antropometri</i>	Specialised inclusive and body-measurement topics.

The word cloud (**Figure 10**), keyword co-occurrence network, and thematic map collectively indicate that the literature has a strong pedagogical and applied orientation. Frequently occurring terms such as *tenis meja*, *materi olahraga*, *pembelajaran jasmani*, *siswa SD*, *mahasiswa*, *eksperimen*, and *forehand drive* reflect substantial attention to educational settings, learning activities, and foundational technical skills. In contrast, the thematic mapping did not show prominent keyword groupings related to advanced biomechanical modelling, match analytics, injury prevention, long-term athlete development, or gender-specific performance. These patterns should be interpreted as characteristics of the indexed keyword structure rather than evidence that such topics are absent from Indonesian table tennis research, because thematic mapping is dependent on database coverage, author-keyword selection, and keyword normalisation.



Figure 10. Author-KeyWord Word Cloud

DISCUSSION

Publication Growth and the Development of Indonesian Table Tennis Research

Indonesian table tennis research expanded substantially but unevenly between 2016 and 2026. Publication output increased from five documents in 2016 and reached its highest level in 2020, followed by fluctuations in subsequent years. The 2026 count should be interpreted cautiously because the search was conducted before the end of the year. Therefore, the annual growth rate should not be interpreted as a consistent year-to-year increase. In bibliometric studies, publication growth mainly reflects the development and research activity of a field rather than its scientific quality or impact (Aria & Cuccurullo, 2017; Donthu et al., 2021).

The 2020 peak coincided with a broad range of applied studies rather than a single dominant outlet or research theme. Research during this period addressed physical education, basic skills, training methods, learning models, instrument development, and athlete performance. This pattern indicates that Indonesian table tennis research has developed mainly within educational and applied sport settings. International research has also expanded toward biomechanics, technical-tactical performance, physical characteristics, and match analysis (He et al., 2022; Malagoli Lanzoni et al., 2024; Pradas De La Fuente, Ortega-Zayas, et al., 2023). At the national level, studies on immersive learning, return-board media, Android-based teaching materials, and interactive multimedia further demonstrate the growing role of technology in table tennis education (Dwipayana et al., 2023; Hasmarita, 2022; Raibowo et al., 2024; Ruqayah et al., 2025; Yusro et al., 2022).

Publication Sources, Authors, and Institutional Contributions

The publication landscape was widely distributed across journals. No single journal dominated the field, and the most productive source contributed only a small proportion of the total publications. Table tennis research was published across journals related to physical education, sport science, coaching, and educational research. Such dispersion reflects the multidisciplinary nature of the field, although it may make it more difficult to develop sustained scholarly communities around common methodological standards and cumulative research agendas.

Author productivity showed a similar pattern. The most productive authors contributed multiple publications, but research output was generally distributed across a large number of researchers. Institutional contributions were also concentrated among several Indonesian universities, including institutions with strong programmes in physical education and sport science. These findings indicate that Indonesian table tennis research has a broad national academic base. However, publication frequency should be interpreted as an indicator of research activity rather than as evidence of institutional or individual research quality (Donthu et al., 2021).

Collaboration and Conceptual Structures

International collaboration remained very limited. Only two of the 325 documents involved international co-authorship, indicating that Indonesian table tennis research is still predominantly domestic. Nationally focused research remains important because table tennis studies in Indonesia are often connected with local curricula, schools, clubs, coaching systems, and athlete-development environments.

Nevertheless, limited international collaboration may constrain opportunities for comparative research, methodological exchange, and access to specialised expertise. Recent international research increasingly integrates biomechanical assessment, tactical indicators, stroke performance, and match-based analysis (Chen et al., 2025; Liu et al., 2025; Yu et al., 2026). Broader collaboration could therefore support multi-site studies, shared research protocols, and comparative analyses between Indonesian and international table tennis contexts.

The keyword co-occurrence structure also revealed strong connections between educational and performance-related research. Prominent terms included *tenis meja* (table tennis), *materi olahraga* (sport learning materials), *pembelajaran jasmani* (physical education), *basic techniques*, *students*, *athletes*, *experiments*, and *forehand drive*. These patterns show that the conceptual development of Indonesian table tennis research remains strongly linked to *learning, skill acquisition, training, and athlete performance*.

Thematic Structure and Emerging Research Directions

Educational and basic-skill topics appeared as central themes in the thematic structure. Terms related to physical education, sport learning materials, school students, observation, and basic techniques occupied important positions. This finding confirms the strong educational orientation of Indonesian table tennis research.

The thematic concentration also suggests a need for greater standardisation in research reporting. Future studies should provide clearer information on participant characteristics, previous playing experience, intervention duration, training frequency, instructional procedures, equipment, and learning outcomes. More consistent reporting would improve comparability across studies and strengthen the cumulative evidence base.

Athletes, sport clubs, and correlational research appeared as established themes. These studies frequently examined physical and psychological factors such as hand-eye coordination, strength, reaction time, flexibility, motivation, and physical fitness in relation to technical performance. Similar international research highlights the importance of physical, biomechanical, and technical factors in table tennis performance (He et al., 2022; Malagoli Lanzoni et al., 2024; Pradas De La Fuente, Ortega-Zayas, et al., 2023; Zhao & Xiao, 2026). Future research may strengthen this area by integrating physical, technical, tactical, and match-performance indicators and by applying longitudinal or repeated-measures designs when appropriate.

Experimental themes involving university students, forehand drive, multiball training, imagery, and other training interventions appeared in the emerging-or-declining quadrant. This position should not be interpreted as evidence that these topics are becoming unimportant. Rather, these themes currently have weaker connections with other major areas of the research network. Studies on life-kinetic training, multiball practice, and imagery continue to demonstrate the practical value of intervention-based research (Faris et al., 2022; Jamaluddin & Arwih, 2022; Sunjoyo et al., 2023).

Niche themes included disability sport, anthropometry, and cardiovascular endurance. These topics represent specialised research areas with opportunities for further development. Future studies may connect inclusive sport, physical characteristics, and fitness research more closely with mainstream coaching, education, and athlete-performance studies.

Growth and Development of Indonesian Table Tennis Research

The present bibliometric analysis indicates a clear expansion of Indonesian table tennis research between 2016 and 2026, although publication output fluctuated considerably across individual years. The number of publications increased from five articles in 2016 to a peak of 49 articles in 2020, followed by fluctuations through 2025. This pattern suggests that table tennis research has become an increasingly visible area within the Indonesian sport and physical education research ecosystem. The observed growth is consistent with the broader expansion of sport-related research in which educational technology, athlete development, physical performance, and instructional innovation have increasingly become interconnected research areas (Ma et al., 2021; Xu et al., 2021).

The 2020 publication peak is particularly noteworthy because the records were distributed across several applied areas, including school and university learning, technical skills, training methods, instrument development, and club-based performance. Thus, the increase should not be interpreted as the consequence of a single research agenda or institutional programme. Rather, it appears to reflect the diversification of research interests within Indonesian table tennis scholarship. Similar bibliometric research has shown that increases in sport research output are often accompanied by diversification in topics, methods, and disciplinary applications rather than by the expansion of a single thematic area (Pradityana et al., 2023). Because 2026 represents a partial publication year, its lower output should also be interpreted cautiously and should not be directly compared with completed publication years.

An important implication of this growth is that Indonesian table tennis research appears to have moved beyond a narrowly performance-oriented perspective. The presence of studies addressing learning models, instructional media, physical characteristics, skill acquisition, and assessment instruments suggests that the field increasingly incorporates educational and applied sport-science perspectives. This multidimensional development is consistent with the broader understanding of sport research as an interdisciplinary field linking pedagogy, exercise science, psychology, technology, and athlete development areas (Ma et al., 2021; Pradityana et al., 2023; Xu et al., 2021).

Institutional and Collaboration Structure

The institutional distribution reveals a relatively concentrated but geographically diverse research landscape. Universitas Muhammadiyah Tapanuli Selatan, Indonesia Pendidikan Indonesia, Universitas Negeri Padang, Universitas Negeri Medan, Universitas Negeri Malang, and Universitas PGRI Semarang were among the most productive institutions. However, productivity should not be interpreted as a direct indicator of research quality or institutional influence. Rather, these patterns identify institutions that have contributed substantially to the visible publication corpus and may represent important nodes within the national research ecosystem (Pradityana et al., 2023).

A more important finding concerns the limited level of international collaboration. International co-authorship accounted for only 0.6154% of the final corpus, equivalent to two documents. This suggests that Indonesian table tennis research remains predominantly domestically oriented. Although nationally focused research is valuable for addressing context-specific issues, limited international collaboration may constrain exposure to comparative perspectives, international research networks, methodological exchange, and broader dissemination (Donthu et al., 2021; Pradityana et al., 2023). Bibliometric studies across sport and physical education have similarly identified international collaboration as an important mechanism for increasing knowledge exchange and strengthening the visibility of national research communities (Ma et al., 2021; Pradityana et al., 2023).

The fragmented appearance of the author co-authorship network further supports this interpretation. Rather than forming a highly integrated research community, the network consisted of several relatively small clusters. This pattern may indicate that researchers and institutions are working within relatively independent groups, with limited cross-institutional or international integration. However, this interpretation should remain descriptive because the available network metadata did not preserve sufficient threshold and normalization information to support more detailed structural inference.

Dominant Research Orientation: From Skill Performance to Pedagogical and Applied Research

The conceptual structure indicates that Indonesian table tennis research has a strong pedagogical and applied orientation. The frequent occurrence of terms such as *tenis meja*, *materi olahraga*, *pembelajaran jasmani*, *siswa SD*, *mahasiswa*, *eksperimen*, and *forehand drive* suggests substantial attention to educational settings, instructional processes, foundational technical skills, and applied performance variables. This pattern is consistent with the role of physical education institutions in producing sport-related research, where technical skill development is frequently examined together with instructional models, learning media, and student outcomes (Hasmarita, 2022; Raibowo et al., 2024).

The prominence of school- and university-related terms is particularly important. It suggests that table tennis research in Indonesia is not exclusively concerned with elite athletic performance but is also embedded within physical education and teacher education contexts. Such an orientation is consistent with contemporary perspectives that position sport as both a competitive activity and an educational medium for developing motor competence, engagement, and lifelong physical activity (Pérez-Gutiérrez et al., 2023; Pradityana et al., 2023).

At the same time, the prominence of technical terms such as *forehand drive*, *service*, and *drill* indicates that foundational skill acquisition remains an important research concern. The coexistence of pedagogical and performance-oriented keywords suggests that the field occupies an intermediate position between physical education and sport-performance research. This intersection may provide an opportunity for future research to integrate instructional design with more advanced performance analysis, rather than treating learning and performance as separate research domains (Hasnah, 2024; Ma et al., 2021).

Emerging and Underdeveloped Research Themes

The thematic structure also identifies several specialised topics, including *atlet difabel*, *antropometri*, and *daya tahan kardiovaskular*. Their positioning as niche themes indicates that these topics are relatively specialized within the overall keyword structure. Importantly, niche positioning should not be

interpreted as evidence of low importance. Instead, it suggests that these topics are less central to the overall research network while potentially representing areas with substantial specialisation (Cobo et al., 2011; Pérez-Gutiérrez et al., 2023).

The appearance of *atlet difabel* is particularly relevant from an inclusion perspective. Inclusive sport research has increasingly emphasised the need to understand participation, accessibility, performance, and developmental opportunities among athletes with disabilities (Cherappurath et al., 2025; Pérez-Gutiérrez et al., 2023). The relatively specialised position of disability-related research in the present mapping suggests an opportunity to expand Indonesian table tennis research beyond mainstream athlete populations and investigate inclusive pathways across participation, coaching, talent development, and competitive performance.

Similarly, the presence of anthropometric and cardiovascular-related themes indicates attention to athlete characteristics and physical capacity. However, these themes appear less central than pedagogical and basic skill-related topics. Future research could therefore investigate how physical characteristics interact with technical performance, training adaptation, talent development, and injury prevention using longitudinal and multidimensional designs.

The emerging-or-declining quadrant included terms such as *eksperimen*, *mahasiswa*, and *forehand drive*. These positions should not be interpreted as evidence that these topics are necessarily emerging or declining. Rather, they indicate relatively low centrality and density within the observed keyword configuration. Longitudinal thematic-evolution analysis would be required to determine whether these topics are genuinely increasing, decreasing, or simply occupying a peripheral position during the study period (Cobo et al., 2011; Jumareng et al., 2024; Pradityana et al., 2023).

Implications for Future Indonesian Table Tennis Research

Taken together, the findings suggest several priorities for strengthening the Indonesian table tennis research agenda. First, researchers could expand beyond predominantly descriptive, correlational, and short-term experimental studies toward longitudinal, comparative, and multidimensional designs. Such approaches would enable researchers to examine how technical skills, physical characteristics, psychological factors, instructional environments, and training exposure interact over time (Dwipayana et al., 2023; Jumareng et al., 2024; Pradityana et al., 2023).

Second, greater integration between physical education and sport-performance research may strengthen the field. The existing literature demonstrates substantial activity in school learning, instructional models, and fundamental skills, while more advanced analytical approaches appear less visible in the keyword structure. Future studies could integrate biomechanical analysis, match-performance analytics, technology-assisted assessment, and athlete monitoring with established pedagogical approaches (Hasmarita, 2022; Raibowo et al., 2024).

Third, the low level of international collaboration indicates an opportunity to develop broader research networks. Partnerships between Indonesian universities and international institutions could facilitate comparative studies, methodological development, researcher mobility, and greater international visibility. Such collaboration would be particularly valuable for research areas requiring larger samples, longitudinal monitoring, specialised equipment, or cross-cultural comparison (Hasnah, 2024).

Implications for Inclusive and Sustainable Research Development

The thematic structure also highlights the potential for broadening the scope of Indonesian table tennis research toward more inclusive and sustainable research agendas. The relatively specialised position of disability-related research suggests that athletes with disabilities remain less central within the overall research landscape. Future research could therefore examine accessibility, coaching practices, adapted training, participation pathways, and competitive development among athletes with disabilities (Cherappurath et al., 2025; Pérez-Gutiérrez et al., 2023).

More broadly, the development of the field could benefit from connecting technical and performance research with broader issues such as athlete well-being, injury prevention, talent development, gender, and long-term participation. This would allow table tennis research to address not only how performance can be improved, but also how participation and athlete development can be sustained across different populations and stages of development (Ma et al., 2021; Xie et al., 2025).

Research Gaps and Future Research Agenda

Several research gaps emerged from the bibliometric evidence. First, educational and basic-skill research remains dominant, but greater consistency in intervention reporting and outcome measurement is needed. Future studies may use validated measurement instruments, clearer intervention protocols, and retention or transfer assessments where appropriate.

Second, athlete-performance studies remain strongly associated with correlational approaches. Future research could integrate physical, technical, tactical, and match-context variables to provide a more comprehensive understanding of performance. Multilevel or repeated-measures models may be considered when the data structure is nested or longitudinal.

Third, intervention studies frequently focus on short-term skill outcomes. Where feasible, randomised or well-matched comparative designs, longer follow-up periods, and performance testing under reactive or competitive conditions may strengthen the evidence.

Fourth, international co-authorship remains limited. Stronger national, regional, and international research networks could support shared protocols, larger multi-centre samples, methodological exchange, and comparative research. Greater attention to disability sport and inclusive research may also broaden the scope of Indonesian table tennis scholarship.

Finally, metadata quality remains important for research visibility. Complete titles, abstracts, author affiliations, DOI information, standardised keywords, and author identifiers may improve the discoverability of Indonesian publications, particularly those published in national and local journals. The main research gaps and corresponding future research directions identified from the bibliometric evidence are summarised in Table 5.

Table 5. Research Gaps and Future Research Agenda

Evidence from bibliometric map	Identified research gap	Recommended research direction	Suggested methodological features
Education and basic-skill keywords dominate.	Limited standardisation of outcomes and instructional reporting.	Develop common reporting and assessment protocols.	Pre-registration, fidelity reporting, retention and transfer tests.
Athlete and correlational terms are motor themes.	Limited integration of physical, technical, and tactical data.	Use multilevel performance models.	Repeated measures, stroke coding, match context, validated field tests.
Experimental forehand-drive studies are peripheral.	Short-term outcomes may not capture durable learning.	Examine practice progression and ecological validity.	Randomised or matched designs, longer follow-up, reactive play tests.
International co-authorship is 0.6154%.	Sparse cross-border methodological exchange.	Build national, regional, and international networks.	Shared protocols, multicentre samples, joint analytic training.
Disability and anthropometry are niche themes.	Inclusive research remains weakly integrated.	Connect adapted sport with mainstream coaching and education.	Co-designed studies, accessibility measures, classification-sensitive outcomes.
Two-database integration improved coverage.	Source-specific metadata remain uneven.	Archive searches, screening, harmonisation, and code.	Versioned repository, data dictionary, source field, and reproducible script.

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19 Limitations and Future Research

Several limitations should be considered when interpreting these findings. First, the analysis was based on Scopus and OpenAlex, and therefore the resulting corpus depends on the coverage, indexing practices, and metadata completeness of these databases. Although the use of two complementary databases improves retrieval coverage, it does not guarantee complete identification of all Indonesian table tennis publications (Haunschild & Bornmann, 2024; Priem et al., 2022).

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Second, keyword-based thematic analysis is sensitive to authors' keyword choices, database metadata, and normalisation procedures. Consequently, the absence or low frequency of a keyword should not be interpreted as evidence that a research topic is completely absent from the field. Third, citation indicators represent database-specific citation snapshots and should not be interpreted as direct measures of research quality. Finally, the 2026 publication year is incomplete and should therefore be interpreted cautiously.

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Future bibliometric studies could extend the analysis by incorporating additional databases, longitudinal thematic evolution, cited-reference analysis, bibliographic coupling, and more comprehensive international comparisons. Empirical studies should also investigate whether the thematic patterns identified here correspond to measurable developments in athlete performance, physical education practice, inclusion, and sport development. Such integration between bibliometric evidence and empirical research would provide a stronger basis for understanding the future trajectory of Indonesian table tennis research.

CONCLUSION

This study mapped Indonesian table tennis research published from 2016 to 2026 using a combined Scopus and OpenAlex corpus. The field expanded substantially but unevenly, with a decentralised publication landscape and a strong emphasis on physical education, school-based learning, basic-skill development, and applied training. Athlete-performance research was also established but remained largely correlational, while tactical, biomechanical, and longitudinal perspectives were less prominent in the bibliometric structure.

International collaboration remained minimal, indicating opportunities for broader national and cross-border research networks. Overall, the findings suggest that future research should move toward more connected research programmes that integrate educational, physical, technical, tactical, and performance perspectives. Greater use of validated measurement tools, multi-site designs, inclusive research approaches, stronger reporting standards, and collaborative research networks may improve the comparability, visibility, and cumulative development of Indonesian table tennis research.

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CONFLICT OF INTEREST

Authors must disclose any financial, professional, institutional, personal, or other relationships that could be perceived as influencing the preparation, analysis, interpretation, synthesis, or publication of the manuscript.

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AI DISCLOSURE STATEMENT

The authors used ChatGPT solely for language editing and grammatical improvement. No generative AI tools were used to generate, analyse, interpret, synthesise, or write the scientific content of this manuscript.

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