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Mapping global research trends in swimming anatomy and physiology: A bibliometric analysis (2015-2025)

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ABSTRACT

Background: Swimming performance is fundamentally influenced by the interaction between anatomical structures and physiological functions, both of which determine movement efficiency, endurance capacity, and overall athletic performance. Despite the increasing number of studies examining these aspects separately, there is still no comprehensive bibliometric investigation that systematically maps the research landscape on anatomy and physiology in swimming. **Objectives**: This study employs bibliometric analysis to comprehensively identify and characterize research trends within the field of anatomy and physiology as they pertain to swimming over the past decade (2015-2025). **Methods**: This study systematically analyzed 371 Scopus-indexed publications concerning the anatomy and physiology of swimming, published within the decade spanning 2015 to 2025. To discern prominent research trends, we employed co-word analysis and text mining techniques, facilitated by VOSviewer software. **Finding/Results**: The bibliometric analysis indicated an absence of a consistent upward trend in research within the field of anatomy and physiology related to swimming. Peak publication years were observed in 2015 and 2017, each recording 58 documents. Geographically, the United States was the most prolific contributor, accounting for 173 published documents. Lauder, G.V., was identified as the most influential author, having individually contributed 12 publications. Regarding subject focus, Agricultural and Biological Sciences constituted the predominant area of research, representing 193 documents (29.2%) of the total publications in this domain. **Conclusion**: This study provides a comprehensive overview of the evolution of research on anatomy and physiology in swimming and identifies key contributors and emerging themes for future investigation.

Keywords: Bibliometric analysis; swimming; anatomy; physiology

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INTRODUCTION

Swimming fundamentally necessitates a complex integration of the human body's anatomical and physiological systems to facilitate effective aquatic locomotion (Panagiotakis et al., 2017). This intricate interplay ensures that structural components (anatomy) function synergistically with vital processes (physiology), directly impacting a swimmer's ability to propel through water. Optimal performance is critically dependent on the biomechanical efficiency of movements, which dictates the body's effectiveness

in generating maximal propulsion while minimizing energy expenditure (Simbaña-Escobar et al., 2020). Concurrently, robust cardiovascular capacity is paramount for sustaining endurance across diverse swimming strokes, guaranteeing sufficient oxygen delivery to active musculature during prolonged exertion (Tofas et al., 2020).

Beyond the cardiovascular system, specific muscular strength and endurance are also critical for generating effective propulsion (Armitage & Moretti, 2019). This encompasses the primary musculature responsible for forward locomotion and maintaining buoyancy. Furthermore, the unique aquatic environment necessitates substantial neuromuscular adaptations, which are integral to the coordination and control of a swimmer's movements (Seifert et al., 2014). These adaptations facilitate the precise neural regulation of muscular actions within a medium that differs significantly from terrestrial environments, thereby enabling swimmers to execute fluid and controlled motions. Consequently, these interconnected aspects are fundamental to comprehensive swimming performance.

A comprehensive grasp of human anatomy and physiological responses to swimming is fundamental for designing effective and optimized training regimens, a principle underscored who emphasizes its critical role in maximizing training efficacy (Maulidin et al., 2019). The escalating volume of scientific literature concerning the anatomy and physiology of swimming, as noted by Pyne and Sharp (2014), highlights the increasing significance of this knowledge within the scientific community. Given the exponential growth of constantly updated research data and findings, a systematic approach to comprehensive analysis is imperative, as articulated by Page and Moher (2017) regarding the utility of systematic reviews in managing extensive information. Consequently, identifying prevailing trends, key contributors, and prominent areas of focus within this body of literature is crucial for directing future research and informing practical applications, as elucidated by Temm et al. (2022), without such clear mapping, subsequent research directions remain unclear, and the effective application of findings in the field is significantly hampered.

Bibliometric studies offer a robust quantitative framework for systematically analyzing extensive scientific literature (Strozzi et al., 2017). This methodology empowers researchers to discern emergent research trends and pinpoint highly influential authors and publications within a given field (Haiyirete et al., 2024). Moreover, bibliometrics proves instrumental in delineating global collaborative networks among researchers and institutions (Donthu et al., 2021). The application of this quantitative analysis is thus invaluable for objectively comprehending the evolution of knowledge and intellectual contributions, such as within the study of swimming anatomy and physiology (Khatra et al., 2021).

In the realm of rigorous scientific inquiry, bibliometric analysis offers a robust quantitative methodology for systematically evaluating scholarly output, this approach is indispensable for objectively quantifying and interpreting research trends, identifying influential scholars, and recognizing seminal publications within specific domains (Haiyirete et al., 2024). Furthermore, bibliometrics proficiently delineates global collaborative networks among researchers and institutions, thereby illuminating the intricate social architecture underpinning knowledge creation (Donthu et al., 2021). Consequently, the application of this quantitative framework is critically important for comprehensively understanding the progressive evolution of intellectual contributions within the field of swimming anatomy and physiology, consistent with Sweileh et al. (2017) assertion regarding the method's capacity to furnish a transparent and empirically-driven depiction of disciplinary advancement.

While numerous individual publications explore anatomy and physiology within the swimming domain, there is currently no specific bibliometric mapping of anatomy and physiology in swimming. Other studies, such as Costa et al. (2015) examined physiological adaptations and cardiovascular responses in elite swimmers, while Yu Kwok et al. (2021) reviewed biomechanical aspects and metabolic efficiency in swimming. Focusing on starting performance, this analysis often touches on biomechanical and physiological aspects of early movement (Özkadi et al., 2022). These studies delve into how the body functions and adapts in aquatic sports, including the implications for strength training, a notable absence persists regarding a comprehensive bibliometric study that systematically delineates this intricate research landscape (Blanco-Mesa et al., 2017). This deficiency of a holistic bibliometric review consequently impedes researchers and practitioners in effectively discerning critical knowledge gaps, identifying underrepresented areas, and

charting pertinent avenues for future inquiry (Donthu et al., 2020). Consequently, the present study endeavors to execute a bibliometric mapping of the existing literature pertaining to the anatomical and physiological facets of swimming. The anticipated outcomes of this investigation are poised to furnish a lucid overview of scientific advancements, highlight pivotal contributors, and delineate both prominent and nascent research domains within this specialized field.

This study aims to map and analyze the scientific literature on anatomy and physiology in swimming published between 2015 and 2025. The main objective is to identify publication trends, influential authors, research collaboration patterns, and emerging thematic areas. Specifically, this study seeks to address the following research questions (RQs):

RQ1: What are the publication trends in anatomy and physiology research related to swimming from 2015 to 2025?
RQ2: Which countries have contributed most significantly to this field?
RQ3: Which authors have contributed most significantly to this field?
RQ4: What are the most frequently occurring keywords and thematic clusters representing the intellectual structure of the field?

METHOD

This study, "Anatomy and Physiology of Swimming Through Bibliometric Study," employs a bibliometric approach. This methodology is integral for identifying nascent scientific and technological trends within a given field, thereby empowering researchers to make informed and strategic decisions for future investigations (Donthu et al., 2021; Mejia et al., 2021). Consequently, bibliometrics facilitates novel contributions and innovative avenues (Blegur et al., 2023; Marmoah et al., 2022) through the systematic examination of publication patterns, encompassing subject areas, authorship, citation networks, titles, and other relevant metrics. Fundamentally, bibliometric analysis aims to foster a comprehensive understanding of a research domain, delineate its scope, pinpoint influential scholars, and uncover promising directions for subsequent inquiry (Donthu et al., 2020; Endriani et al., 2024; Xue et al., 2018).

To achieve this objective, relevant articles were extracted from the Scopus database in CSV format and subsequently analyzed using VOSviewer software. Scopus is the primary database for reference searches due to its extensive and curated coverage, including non-English literature and conferences, making it more reliable than Web of Science, PubMed, or Google Scholar for bibliometric analysis and systematic reviews (van Eck & Waltman, 2010). VOSviewer is a robust tool capable of effectively visualizing and identifying trends, such as country-based visualizations and dominant topic areas (Cobo et al., 2011). Furthermore, VOSviewer can be employed to assess various types of bibliometric network information, including relationships between journal distributions for reference terms, collaborative efforts among researchers, and co-occurrence relationships between relevant papers (Strozzi et al., 2017). In this research, the application of VOSviewer for bibliometric studies involved integrating diverse analytical approaches, specifically bibliographic coupling and co-citation analysis. Bibliographic coupling analysis was utilized to measure the similarity of sources cited by two documents, while co-citation analysis focused on assessing citation similarity. These two analyses synergistically provide a more comprehensive overview (Novia et al., 2022). The bibliometric analysis conducted included co-authorship, co-citation, bibliographic merging, and keyword co-occurrence as well as visualization of at least 5 occurrences per keyword.

Search Strategies

The documents were systematically retrieved from established research sources within the Scopus database. The keywords used in Boolean expressions (AND or OR) were "anatomy" OR "biomechanics of swimming" AND "physiology" OR "exercise physiology" AND "swimming" OR "aquatic performance". The search was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021).

Eligibility Criteria

The inclusion criteria for this study exclusively comprised research investigating the anatomical and physiological aspects of swimming. Data acquisition was completed on June 20, 2025, with subsequent analysis covering the decade from 2015 to 2025. This temporal scope facilitates a comprehensive assessment of evolutionary patterns and emerging trends within the domain of swimming anatomy and physiology.

Database Abstraction

The publication identification and screening phase commenced with the retrieval of 492 documents from the Scopus database. Following an initial review based on titles, abstracts, and keywords, the document count remained at 492. Subsequently, a temporal filter was applied, limiting publication years to 2015-2025, which led to the exclusion of 121 documents. The resulting dataset, comprising 371 documents, then met the established criterion of over 300 documents for bibliometric analysis (Donthu et al., 2021). Consequently, the data underwent bibliometric analysis, as illustrated in **Figure 1**.

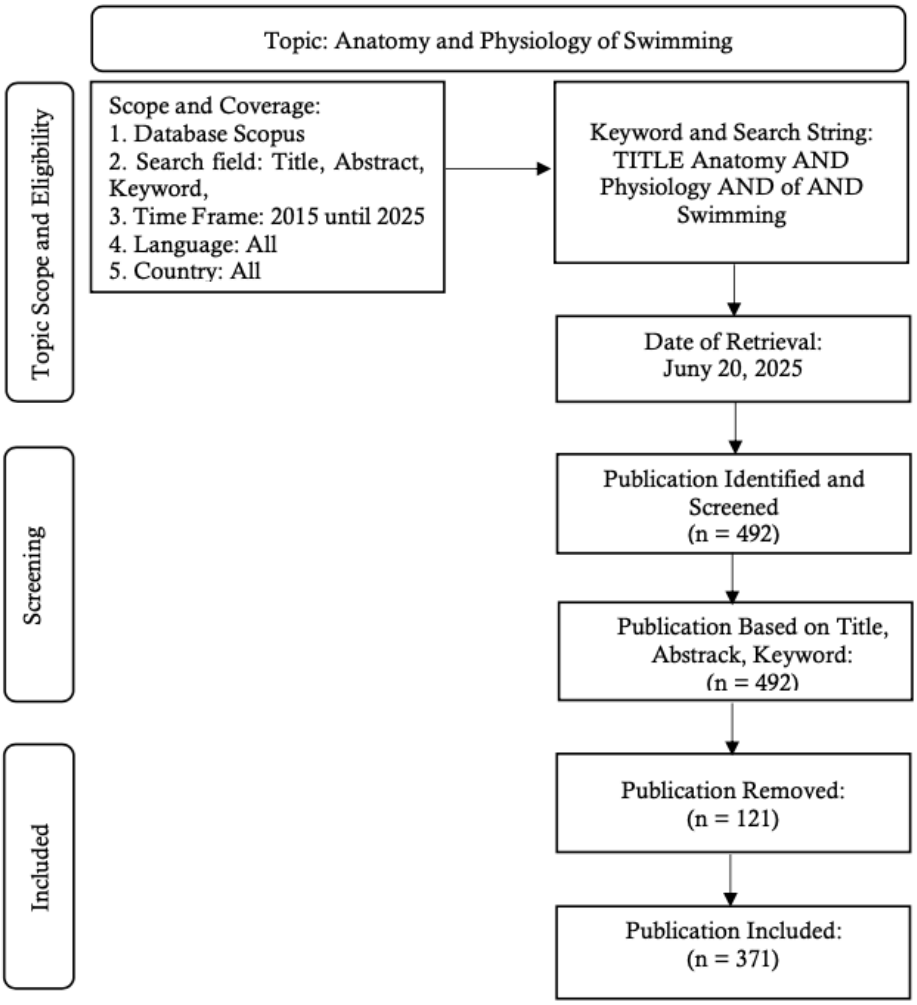

Figure 1. Search Design Method of Publication Documents from Scopus Database

RESULTS AND DISCUSSION

The study systematically examined the lowest frequency of terms utilized in Scopus-indexed research. Subsequent to this analysis, a four-category classification emerged, encompassing publication year, geographical origin, contributing authors, and respective fields of study.

RQ1: What are the publication trends in anatomy and physiology research related to swimming from 2015 to 2025?

Organizing documents by publication year marks the initial phase of this research. Strong interest in swimming anatomy and physiology was evident early in the analysis period, with 58 publications in 2015, followed by a consistent 55 in 2016 and 58 in 2017, indicating a sustained positive trend. Despite a slight decline in 2018 (49 documents) and 2019 (45 documents), research activity remained substantial. 2020 saw a recovery to 51 documents, before a drastic change occurred. The sharp decline after 2020 is likely related to the global disruption caused by the COVID-19 pandemic, which led to the postponement of the Tokyo Olympics until 2021 and impacted research broadly (Wong et al., 2020). This fluctuating pattern may also reflect the research cycle surrounding the Olympic Games and World Championships, where publications often increase before and after major events to analyze athlete performance (Millet et al., 2021). A significant decline began in 2021 with 30 documents and reached its lowest point in 2022 with only 7 documents, suggesting the impact of exogenous variables or a significant paradigm shift. Despite a slight increase in 2023 (9 documents), publication volume in 2024 (4 documents) and 2025 (5 documents, given incomplete data for the latter) remained very low, suggesting a slow recovery or ongoing volatility in this research field. (Refer to **Figure 2**).

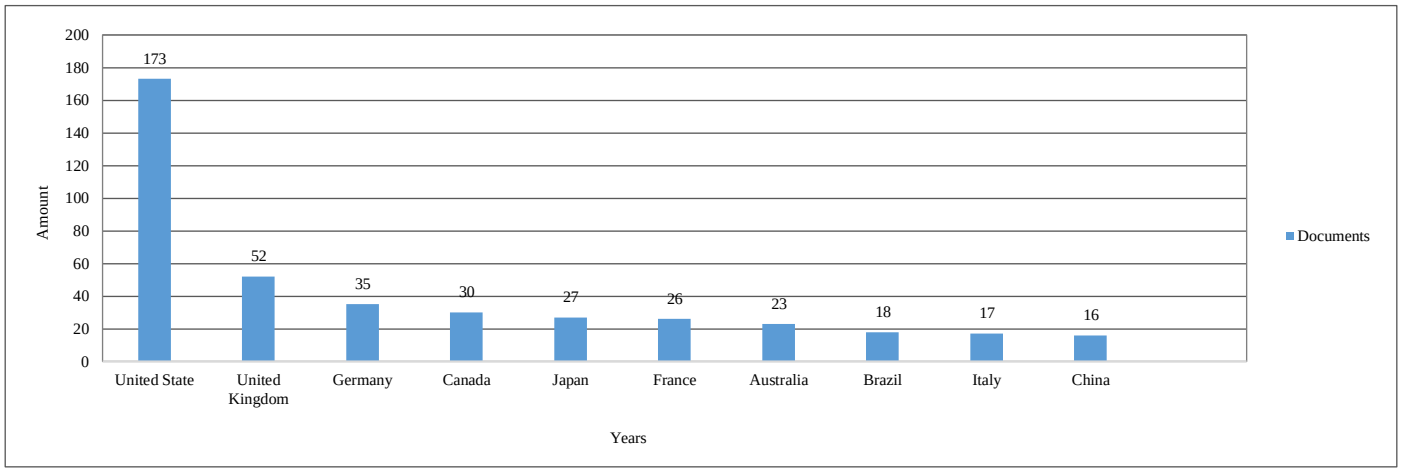

Figure 2. Research Trends on Anatomy and Physiology of Swimming in 2015-2025

RQ2: Which countries have contributed most significantly to this field?

The global landscape of publications concerning the anatomy and physiology of swimming reveals a prominent lead by the United States accounted for 46.6% of total publications, contributing 173 documents. Following this, the United Kingdom demonstrates substantial research output with 52 documents, while Germany secures the third position with 35 documents, indicative of robust research activity. Canada also exhibits considerable engagement with 30 documents. Significant contributions are further noted from Japan (27 documents) and a consistent presence from France (26 documents). Australia actively participates with 23 documents, preceding Brazil which, as a developing nation, has contributed 18 documents. Completing the top ten, Italy and China provided 17 and 16 documents, respectively, showcasing diverse international involvement in this specialized research domain. The prominence of developed countries like the US and the UK is likely driven by substantial research funding, robust university infrastructure, and integrated research ecosystems. Analysis of international collaboration, a key strength of bibliometrics, reveals a close-knit research network, with high-contribution countries tending to collaborate with each other (van Eck & Waltman, 2014). This demonstrates the importance of scientific networks in driving innovation and progress in this field. These contributions are visually represented in **Figure 3**.

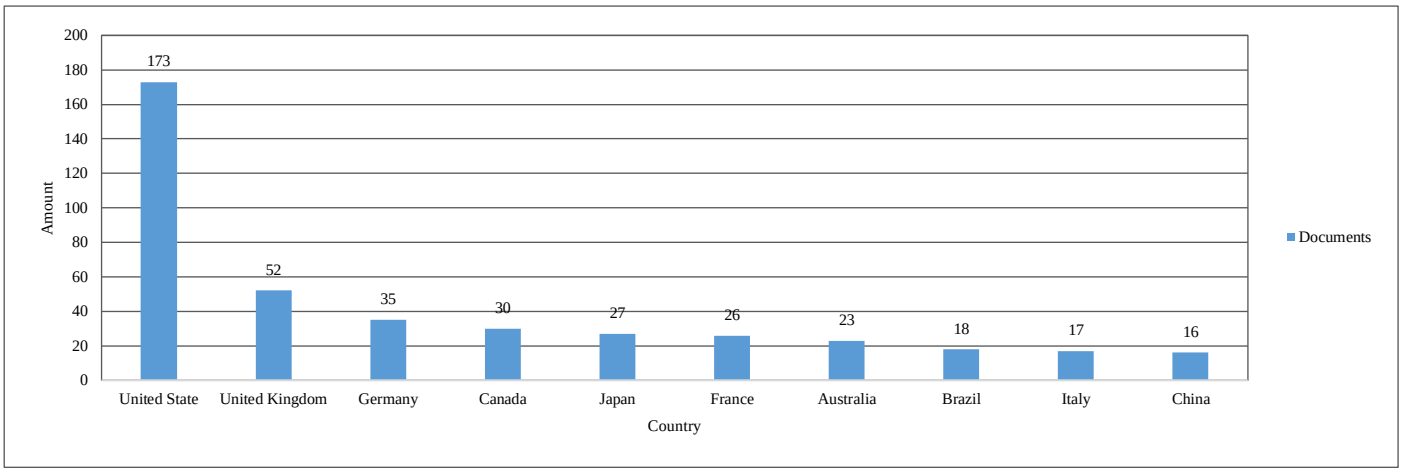

Figure 3. Top Ten Countries on Anatomy and Physiology of Swimming Research

RQ3: Which authors have contributed most significantly to this field?

Lauder, George V. is the most prolific and most cited author, with 433 citations and 12 articles because he is a leading swimming biomechanics expert from Harvard University and has a total H-Index of 113. His research focuses on fluid mechanics and swimming biomechanics, analyzing how body shape can be applied to understanding and improving human swimming efficiency. Blob, Richard W. is another major contributor with 117 citations and 8 articles. His work focuses on functional morphology and evolutionary biomechanics, which investigates the relationship between body structure (anatomy) and its function in aquatic locomotion. Fish, Frank E., has a remarkable dominance in the number of citations (208), despite having only 7 articles. This indicates that his work is highly influential and serves as a foundation for much other research. He focuses on hydrodynamics and propulsion efficiency, which are particularly relevant to swimmer physiology in the context of how they utilize arm and leg movements to overcome water resistance. Goldbogen, John A. has 46 citations and 6 articles. His research provides insights into how maintaining energy and body temperature in cold water can be applied to understanding swimmers' physiological responses to the aquatic environment. Porter, Matthew E., and Endo Hiromasa have fewer but still significant papers and citations. Their contributions relate to muscle anatomy and joint movement, as well as propulsive movement patterns, which are essential for analyzing efficient swimming technique. Fellich, K. L., Friedlaender, A. S., Gibb, A. C., and Houssaye, A. Houssaye are authors with smaller but still important contributions. Their research can range from specific physiological responses, sports pathology, or more specific anatomical aspects, all of which contribute to a deeper understanding of the relationship between the body and movement in water. Can be seen in **Figure 4** below.

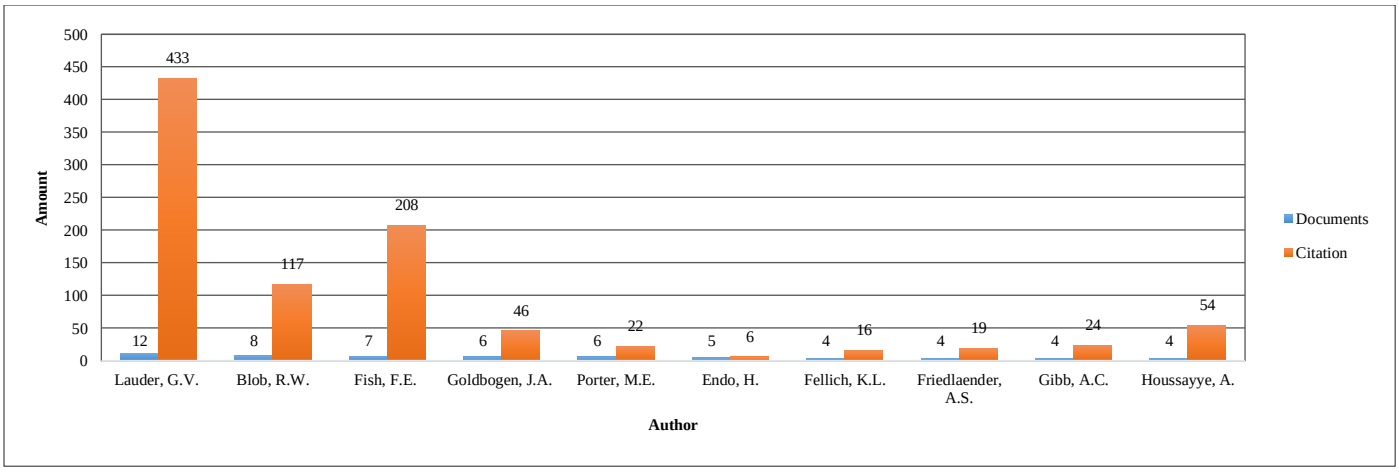

Figure 4. Top 10 Authors with Publications on Anatomy and Physiology of Swimming

Q4: What are the most frequently occurring keywords and thematic clusters representing the intellectual structure of the field?

The outcomes of a comprehensive keyword analysis conducted on academic publications are presented in this section. Serving as a macroscopic content descriptor, this analysis is instrumental in identifying the principal research themes and emergent trends in the anatomy and physiology of swimming. This methodology is consistent with the perspective that field-specific topics can be effectively delineated through the examination of keywords present in relevant scholarly literature (Arhesa et al., 2024).

Figure 5 displays a keyword network visualization of 164 items pertaining to the anatomy and physiology of swimming, organized into six distinct clusters containing 43, 38, 35, 21, 15, and 12 items, respectively. This visualization effectively illustrates the intricate interconnections among diverse research facets within the field. The bright green and red clusters emphasize core anatomical and biomechanical components, including keywords such as "fin," "fluke," "wing," "limb," "skeleton," "bone," "motion," "stroke," "thrust," and "power." This highlights a significant research focus on structural elements and the mechanisms underpinning thrust generation and movement. Conversely, the blue cluster centers on the practical application of anatomy and physiology in human athletic performance, featuring keywords like "swimmer," "athlete," "sport," "exercise," "strength," "posture," "group," and "level." Other clusters, such as the yellow and purple, denote comparative and developmental studies utilizing model organisms, with keywords including "larvae," "zebrafish," "temperature," "adult," and "juvenile." Collectively, this keyword network underscores that research in swimming involves a thorough examination of its fundamental biological and physical mechanisms, alongside its implications for performance across various species and contexts.

The keyword network visualization with publication year overlay **(Figure 6)** effectively elucidates the evolution of research themes. Early clusters, observed approximately between 2017.0 and 2017.5, were predominantly characterized by general descriptors such as "swimmer," "group," "sport," and "athlete," signifying an initial emphasis on the broader sports context and swimmer attributes. Subsequently, from approximately 2018.5 to 2019.0, a distinct transition emerged towards more specialized and granular keywords, encompassing "motion," "fin," "fluke," "power," "thrust," 'skeleton," "limb," "bone," "zebrafish," "larvae," and "temperature." This trajectory underscores a heightened focus on the meticulous analysis of biomechanical and anatomical mechanisms, alongside investigations into adaptive physiology. Furthermore, the increased prevalence of "zebrafish" and "larvae" in more recent periods signifies the widespread integration of animal models to elucidate intricate principles of swimming anatomy and physiology, thereby propelling research toward more exhaustive and model-driven analyses aimed at optimizing performance.

As depicted in **Figure 7**, the distribution of publications across subject areas reveals a comprehensive and interdisciplinary research landscape. Agricultural and Biological Sciences constitutes the largest proportion, accounting for 193 documents (29.2%). This is closely followed by Biochemistry, Genetics and Molecular Biology, with 169 documents (25.6%), collectively underscoring a substantial research emphasis on the fundamental biological and genetic underpinnings of swimming proficiency. Medicine contributes 68 documents (10.3%), thereby affirming the clinical and health-related significance of studies on swimming. Furthermore, the Multidisciplinary field encompasses 52 documents (7.9%). Noteworthy contributions are also observed from Engineering (30 documents, 4.5%), Neuroscience (28 documents, 4.2%), Environmental Science (27 documents, 4.1%), Immunology and Microbiology (23 documents, 3.5%), and Health Professions (20 documents, 3.0%), with the remaining categories aggregated as "Other" (5.9%). This dissemination pattern robustly indicates that a holistic comprehension of swimming anatomy and physiology necessitates an integrated methodological approach, drawing insights from diverse scientific disciplines, spanning from foundational biological sciences to advanced engineering and practical health applications.

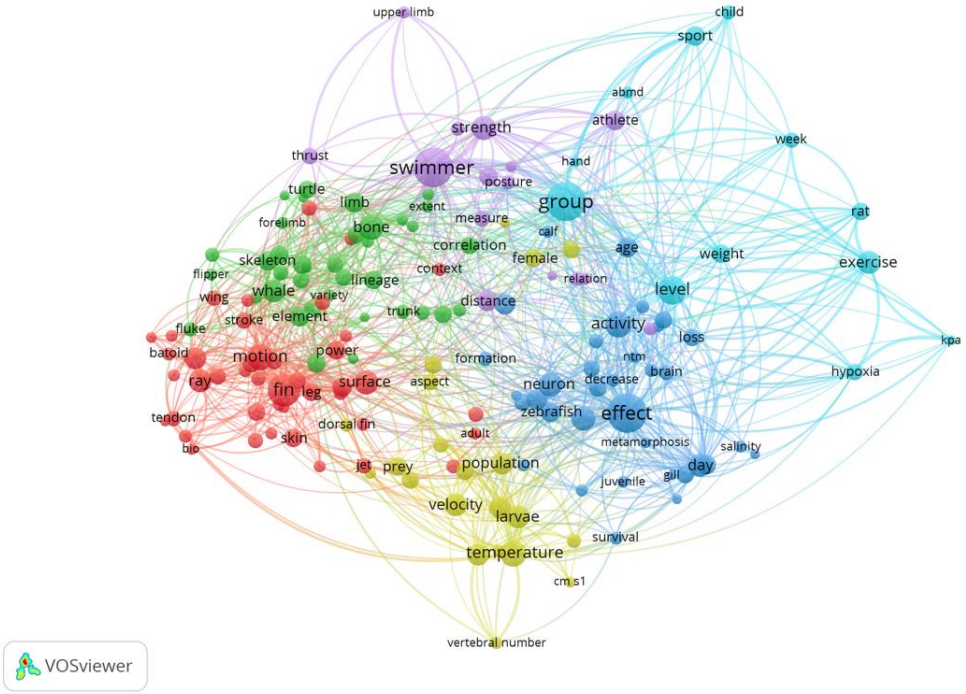

Figure 5. Topic Area Visualization Using VOSviewer Using Network Visualization

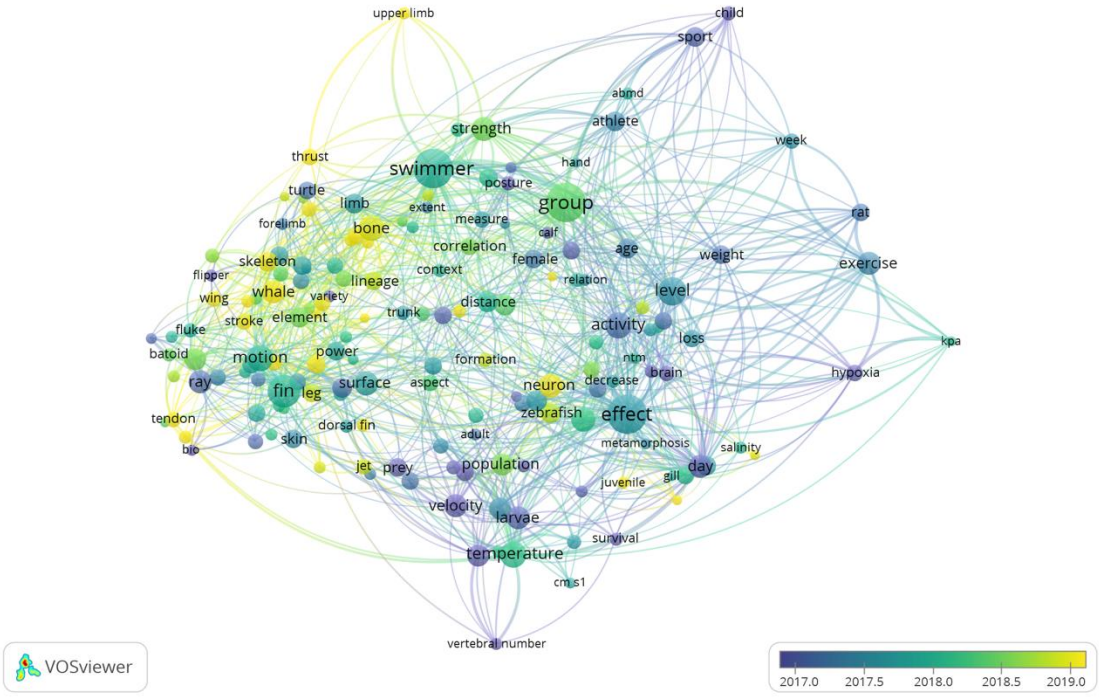

Figure 6. Visualization of Topic Areas Using VOSviewer Using Overlay Visualization

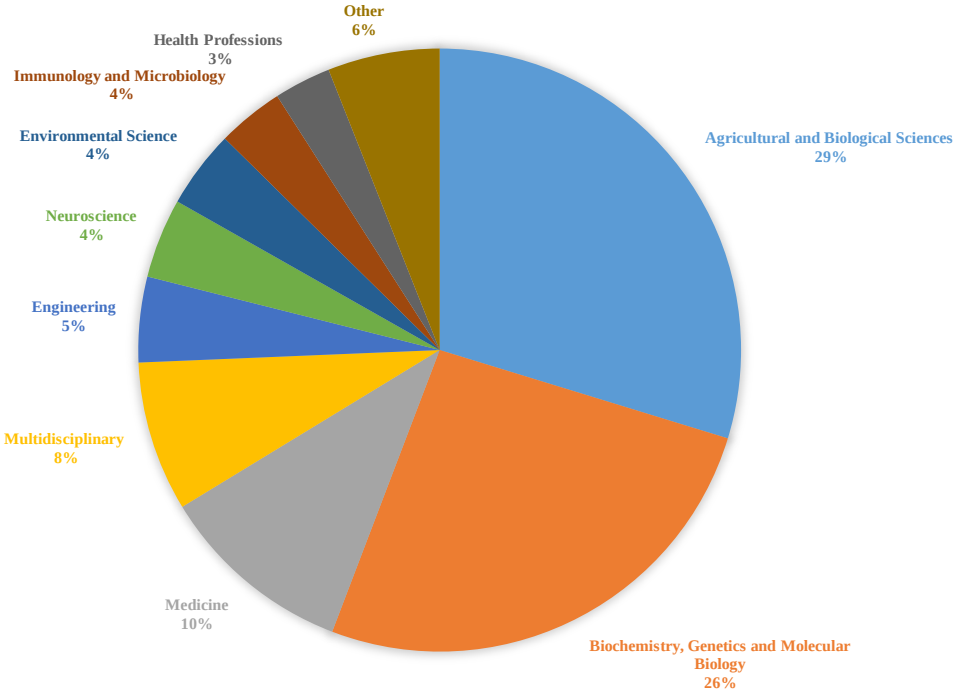

Figure 7. Subject Areas of Scopus Analysis

A review of publications on the anatomy and physiology of swimming shows strong and consistent research activity between 2015 and 2017. For example, a study by Mills et al. (2015), Trunk and chest movements during freestyle and breaststroke swimming underscore the need for sports bra support for female swimmers. After a decline from 2018 to 2019, and a brief surge in 2020, the number of publications between 2021 and 2025 saw a sharp decline, with annual output ranging from only 4 to 30 papers. Restrictions on access to research facilities, project delays, and a shift in funding priorities towards pandemic-related research have impacted many areas of exercise science (AlSamhori et al., 2023; Wackerhage et al., 2020; Wong et al., 2020). This trend is not limited to swimming research, as scientific publications across a range of other disciplines have also shown similar patterns of decline following the peak of the pandemic (Skinner & Smith, 2021), largely due to the global challenges and shifting research priorities brought about by COVID-19 (Perdima et al., 2022). The protracted recovery in subsequent years demonstrates the pandemic's lasting impact on funding. research and participant access, as well as the potential for a refocusing in sports science (Richards et al., 2024). The stagnation in the literature on swimming anatomy and physiology suggests a need for renewed impetus and focus.

The United States' leadership in global scientific contributions to swimming anatomy and physiology is evidenced by the 173 papers produced, highlighting its strong research capacity and significant investment in sports science. Funding systems, federal grants, private investment, institutional collaborations drive US dominance (Avcı et al., 2023). This trend aligns with a global pattern where high-income countries (Gui et al., 2019; Medeiros et al., 2021), such as the United Kingdom, dominate scientific contributions in this area due to their established research infrastructure (Jeong et al., 2024). Germany (35 papers) focused on biomechanics and movement efficiency. Canada, Japan, France, Australia, Brazil, Italy, and China made global contributions to performance optimization and injury mitigation, in line with research infrastructure and national interests (Wijaya et al., 2024), while contributions from developing countries such as Brazil, Italy, and China indicate increasing participation and the potential to reduce geographic bias in the future (Adenle et al., 2023).

Publication analysis shows Lauder, G.V. as a leading contributor in swimming anatomy and physiology with 12 papers and 433 citations, one of which examines the effects of swimming training on the physical characteristics of competitive adolescent swimmers (Hibberd et al., 2016). Lauder, G.V.'s excellence is often

attributed to access to substantial research funding through grants from agencies such as the National Science Foundation (NSF) and his ability to foster broad institutional collaborations, particularly with engineering and biology departments, which facilitate interdisciplinary biomechanical approaches (Kruss et al., 2015). Other prolific authors include Blob, R.W. (8 papers, 117 citations) and Fish, F.E. (7 papers, 208 citations) who focus on propulsion efficiency and morphological adaptations (Adams & Fish, 2019), and Goldbogen, J.A. and Porter, M.E. who each contribute 6 papers, highlighting functional mechanisms and evolutionary aspects of swimming behavior (Shadwick et al., 2019). The consistent and diverse contributions of Endo, H. (5 documents) along with Fellich, K.L., Friedlaender, A.S., Gibb, A.C., and Houssayye, A. (4 documents each) covering hydrodynamics (Xia et al., 2023), thermal physiology and environmental determinants of swimming performance, collectively underscore the dynamic nature and in-depth scope of research in this area (Morton et al., 2025).

Keyword analysis shows that swimming anatomy and physiology is an interdisciplinary field (164 items, six clusters). The primary focus is on biomechanics and anatomy through keywords such as "fin" and "style" (Fish et al., 2021). Conceptually, swimming research is evolving. Biomechanics and physiology are now integrated with neurophysiology, computational modeling, and genetics to holistically optimize swimming strokes (Fitrianto et al., 2025). The research focuses on biomechanics and musculoskeletal anatomy, not aerobic physiology. The "blue" cluster focuses on human athletic performance, with keywords like "swimmer" and "sport" (Hibberd et al., 2016; Morais et al., 2020; Nuraerni et al., 2023; Oosthuyse et al., 2017; Roelofs et al., 2017). This distinction is exemplified by research such as Whitlow et al. (2019), which specifically addresses aspects of human performance and practical application in swimming. Keyword analysis shows that swimming research is moving towards mechanistic and interdisciplinary analysis (Anatomy, Physiology). Although Biological Sciences dominate, contributions from Medicine, Engineering, and Neuroscience demand an integrated multidisciplinary framework (Kwak & Bae, 2017). Contemporary research further reinforces this, such as Ponciano et al. (2018) review of physiological responses in synchronized swimming and Baldassarre et al. (2017) study on the physiological and biomechanical characteristics of long-distance open water swimming, all demonstrating a holistic approach to understanding aquatic performance. Suggestions for future research based on keyword overlay include integrating AI-based biomechanics, neurophysiology, and genetic analysis to improve swimming performance research.

These bibliometric findings offer valuable insights for coaches and academics, but they need to be contextualized and their limitations acknowledged. Compared with previous bibliometric studies in similar fields (Arhesa et al., 2024; Özkadi et al., 2022), our analysis confirms core trends, such as the dominance of the United States and the strong focus on swimming biomechanics. However, these findings also have explicit limitations: First, there are limitations to using a single database (Scopus), which may have excluded important publications from non-indexed journals and created selection bias. Second, the limited keyword range may have filtered out relevant research subtopics. Finally, incomplete data for 2025 requires caution in interpreting recent trends. Nevertheless, this research map helps trainers identify best practices and innovations driven by dominant countries and influential authors such as Lauder, G.V., Blob, R.W., and Fish, F.E.. For curriculum developers, this analysis underscores the importance of integrating the ever-expanding knowledge of biomechanics and physiology, and encouraging a more comprehensive interdisciplinary approach, while recognizing the need for more diverse contributions from developing countries to reduce geographic bias.

CONCLUSION

Research on swimming anatomy and physiology showed strong activity between 2015 and 2017, but experienced a sharp decline post-pandemic (2021-2025), highlighting the urgent need for renewed focus. Globally, the United States (173 papers) led the contributions, in line with the dominance of high-income countries, while prominent authors such as Lauder, G.V., Blob, R.W., and Fish, F.E. reinforce the highly interdisciplinary research focus on Biomechanics and Musculoskeletal Anatomy. While dominated by Biological Sciences and Biochemistry, the role of Engineering, Medicine, and Neurosciences demonstrates the need for an integrated framework. This research map is highly useful for academics to identify gaps (e.g., aerobic physiology research and post-pandemic adaptation) and guide coaches and practitioners in adopting

evidence-based best practices. It is recommended that future research integrate neurological and genetic data with biomechanics through increased international collaboration to achieve a more holistic understanding of swimming performance. Future bibliometric studies should include multi-database approaches (Scopus, Web of Science, Dimensions) and combine bibliometric mapping with content or topic modeling to capture conceptual shifts within swimming physiology research.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interest in writing this article.

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