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Mental Imagery Effects on Athletes' Mental Toughness and Sports Performance: A Bibliometric Review

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Abstract

This study aims to systematically map the development of research on mental imagery in relation to athletes' mental toughness and sports performance using a bibliometric approach. Data were obtained from the Scopus database, resulting in 183 journal articles published between 1977 and 2025. The analysis includes publication trends, citation structures, journal productivity, and keyword co-occurrence mapping using VOSviewer and RStudio.The results show a substantial increase in research output after 2010, with more than 40% of total publications produced after 2020, and a peak in 2023 with 17 articles. Citation analysis indicates that a limited number of highly cited studies dominate the field, reflecting a concentrated pattern of scientific influence. Keyword co-occurrence analysis identifies mental imagery as a central construct linking performance enhancement, psychological regulation, and injury rehabilitation, with four main thematic clusters. This study addresses the fragmented nature of previous research by providing an integrated bibliometric mapping of mental imagery studies across performance and psychological domains. The main contribution lies in identifying research trends, intellectual structures, and emerging directions, particularly in technology-based interventions and longitudinal approaches in sport psychology.

Keywords: *mental imagery, mental toughness, sports performance, athletes, bibliometric analysis.*

INTRODUCTION

In competitive sports, athletes' performance is influenced by the interaction of physical, technical, and psychological factors. Psychological components play a crucial role, particularly in high-level competition where differences in physical and technical abilities are often minimal. Previous studies indicate that psychological skills can determine how athletes manage pressure, regulate emotions, and maintain focus during performance situations. Empirical evidence

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further suggests that psychological interventions, including mental training strategies, contribute significantly to performance enhancement and overall athletic readiness (Simonsmeier et al., 2021). One of the most widely used psychological strategies in sport is mental imagery. Mental imagery is defined as the mental representation or simulation of an experience without the presence of external stimuli, involving sensory, perceptual, and emotional components under the control of the individual (Guillot & Collet, 2008).

In the context of sport, imagery enables athletes to rehearse movements, anticipate competitive situations, and regulate cognitive and emotional responses. Research has shown that imagery facilitates both cognitive functions, such as skill acquisition and strategy planning, and motivational functions, including confidence enhancement and emotional regulation (Callow & Hardy, 2017). These dual functions highlight the importance of imagery as a multidimensional psychological tool in sport performance. A growing body of empirical evidence supports the effectiveness of mental imagery in improving athletic performance. Mental imagery practice has been shown to enhance motor skill execution, strengthen neural activation patterns associated with movement, and improve performance outcomes through cognitive rehearsal processes (Roure et al., 1999). In addition, imagery interventions have been associated with improvements in attention, reaction time, and performance accuracy, particularly in precision-based sports (Keskin, Nur, & Berg, 2025). These findings indicate that mental imagery contributes not only to physical performance but also to cognitive and psychophysiological processes underlying athletic success.

Despite the increasing number of studies on mental imagery, research in this field remains fragmented, with varying focuses on performance, psychological outcomes, and methodological approaches. This fragmentation highlights the need for a comprehensive overview of how mental imagery research has developed over time. Bibliometric analysis offers a systematic approach to examining publication trends, citation patterns, and thematic developments within a research field. Therefore, this study aims to analyze the development of mental imagery research in sport from 1977 to 2025 using a bibliometric approach, in order to identify research trends, intellectual structures, and future research directions. This study

employs a bibliometric approach to address several key research questions related to the development of studies on mental imagery in sports. The research questions are formulated as follows:

Q1. How has the volume of scientific publications examining mental imagery and its relationship with mental toughness and athletic performance in athletes evolved between 1977 and 2025?

Q2. What patterns and trends can be observed in publication output and citation impact concerning studies on mental imagery, mental toughness, and athletic performance?

Q3. Which researchers, publications, journals, and nations have made the greatest contributions to studies exploring links between mental imagery, mental toughness, and sports performance in athletes?

Q4. What are the most prolific academic journals publishing research on mental imagery's effects on athletes' mental toughness and performance?

Q5. What forms or approaches of mental imagery are currently being investigated by researchers, and which emerging themes indicate promising opportunities for future research?

METHODS

Research Design

This study employs a bibliometric analysis approach to systematically examine the development of research on mental imagery in relation to athletes' mental toughness and sports performance. Bibliometric analysis, originally introduced by Pritchard (1969), is a quantitative method used to evaluate scientific publications through statistical and mapping techniques. This approach enables the identification of publication trends, citation structures, influential authors, and thematic developments within a specific research field.

Data Source

The data for this study were obtained exclusively from the Scopus database. Scopus was selected due to its status as one of the largest and most comprehensive databases of peer-reviewed scientific literature, providing high-quality, standardized, and structured bibliographic metadata (Donthu et al., 2021).

Compared to other databases such as Google Scholar or PsycINFO, Scopus offers more consistent indexing, advanced filtering capabilities, and reliable citation tracking, which are essential for conducting accurate bibliometric analysis. The use of a single database is considered sufficient in bibliometric studies when the database provides broad coverage and high-quality metadata. Scopus has been widely recommended in recent bibliometric research due to its extensive journal coverage and compatibility with bibliometric tools such as VOSviewer and Bibliometrix (Donthu et al., 2021). Therefore, the use of Scopus alone is justified to ensure data consistency, reliability, and comparability.

Search Strategy

The data collection process was conducted using an advanced search query in Scopus with a comprehensive boolean search string that incorporates relevant keywords and their synonyms: *TITLE-ABS-KEY (("mental imagery" OR "imagery" OR "motor imagery" OR "visualization" OR "sport imagery") AND ("mental toughness" OR "psychological resilience") AND ("sports performance" OR "athlete performance" OR "sport performance"))*. The use of multiple synonyms ensures broader coverage of relevant literature and reduces the risk of missing important studies due to variations in terminology.

Inclusion Criteria

The ensure the quality and relevance of the dataset, the following inclusion criteria were applied: Articles published between 1977–2025; Documents categorized as journal articles; Publications written in English; Articles indexed in the scopus database; Studies focusing on team mental imagery in relation to athletes, mental toughness, and sports performance.

Exclusion Criteria

The following exclusion criteria were applied: Non-article documents (e.g., books, book chapters, conference proceedings); Articles not directly related to sports or mental imagery; Duplicate records; Articles with incomplete bibliographic data; Articles with irrelevant scope based on title and abstract screening.

After applying these criteria, a total of 183 journal articles were included in the final dataset.

Screening Procedure

The article selection process followed a systematic procedure adapted from the PRISMA framework, including four stages: identification, screening, eligibility, and inclusion. Initially, all records retrieved from Scopus were screened based on titles and abstracts. Subsequently, full-text eligibility was assessed according to the inclusion and exclusion criteria until the final dataset was obtained.

Data Analysis Techniques

The collected data were analyzed using three main bibliometric tools: Scopus Analysis, Used to examine publication trends, including annual growth and citation distribution. VOSviewer Analysis, Used to construct bibliometric networks, including: Keyword co-occurrence analysis; Cluster identification; Thematic mapping. Rstudio (Bibliometrix) Analysis, Used to perform: Citation analysis ; Journal productivity analysis; Author and country contribution analysis

The integration of these analytical tools enables a comprehensive understanding of the intellectual structure, research trends, and development patterns of mental imagery research in sports.

RESULT

Number of Articles In The Period From 1977 To 2025

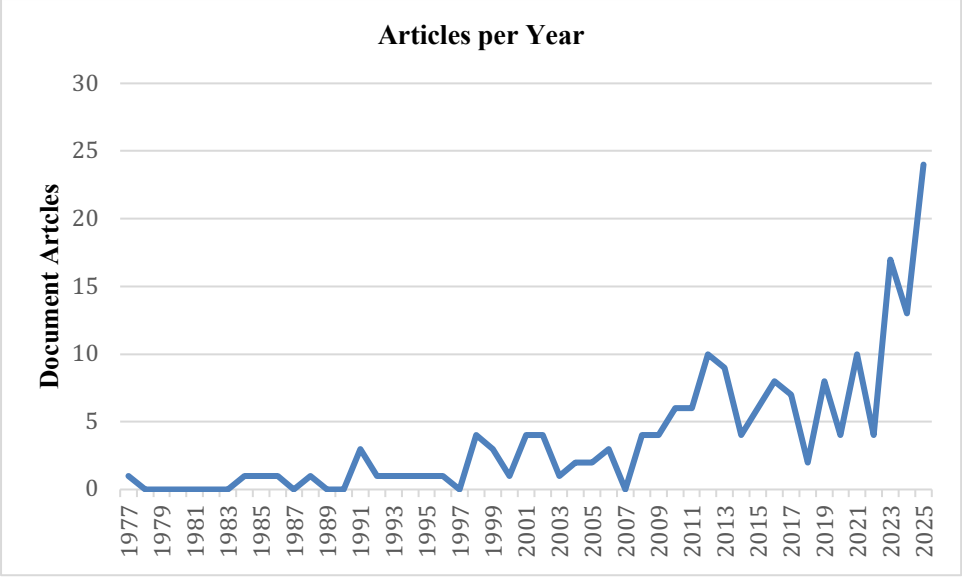

Figure 1. Annual Growth in Imagery Publications on Mental Toughness And Athletic Performance in Athletes.
Source: Scopus Database with Bibliometrix.

A total of 183 journal articles were identified from the Scopus database. Publication output remained low between 1977 and 2008, accounting for less than 10% of total studies, indicating limited early research activity. A noticeable increase occurred after 2009, with publications rising from 4 articles to 10 articles in 2012, reflecting a growth of approximately 150%. Although fluctuations were observed, including a temporary decline in 2018, research output continued to expand in subsequent years. A significant increase occurred after 2020, where more than 40% of total publications were produced, highlighting the recent acceleration of research in this field. The highest number of publications was recorded in 2023 with 17 articles. Overall, the trend demonstrates a sustained upward trajectory, indicating increasing academic attention toward mental imagery research in sports.

Table 1. Top Journal Articles Most Cited on Imagery in Relation to Mental Toughness and Athletic Performance in Athletes

No	Author Name	Article Title	Journal	Total Citations	Citations of The Year
1	Michael J. Mahoney & Marshall Avener	Psychology of the Elite Athlete: An Exploratory Study	Cognitive: Therapy And Research Springer Journal	354	7.22
2	P Gaudreau & JP Blondin	Development of a Questionnaire for the Assessment of Coping Strategies Employed by Athletes in Competitive Sport Settings	Psychology of Sport and Exercise Elsevier Journal	192	8.00
3	Melanie Gregg, Craig Hall, & Andrew Butler	The MIQ-RS: A Suitable Option for Examining Movement Imagery Ability	Evidence – Based Complementary and Alternative Medicine, Wiley Journal	186	11.63
4	Aidan Moran, Aymeric Guillot, Tadhg MacIntyre, & Christian Collet	Re-imagining motor imagery: Building Bridges Between Cognitive Neuroscience and Sport Psychology	British Journal of Psychology, The British Psychological Society	174	12.43

No	Author Name	Article Title	Journal	Total Citations	Citations of The Year
5	Jennifer Cumming & Craig Hall	Deliberate Imagery Practice: the Development of Imagery Skills in Competitive Athletes	Journal of Sports Sciences, Taylor & Francis	126	5.25
6	Sandra E. Moritz, Craig R. Hall, Eva Vadocs & Kathleen A. Martin	What Are Confident Athletes Imaging?: An Examination of Image Content	The Sport Psychologist, Human Kinectics	103	3.43
7	Nichola Callow & L. Hardy	Types of Imagery Associated with Sport Confidence in Netball Players of Varying Skill Levels	Journal of Applied Sports Psychology	102	4.08
8	R. Roure, C. Collet, C. Deshaumes-Molinaro, G. Delhomme, A. Dittmar & E. Vernet-Maury	Imagery Quality Estimated by Autonomic Response Is Correlated to Sporting Performance Enhancement	Psychology & Behavior, Elsevier Science	97	3.59
9	Thomas Schack, Kai Essig, Comelia Frank and Dirk Koester	Mental Representation and Motor Imagery Training	Frontiers in Human Neuroscience, Hypothesis And Theory Article	95	7.92
10	Angela H. Nippert, PhD & Aynsley M. Smith, RN, PhD	Psychologic Stress Related to Injury and Impact on Sport Performance	Physical Medicine And Rehabilitation Clinics Of North America, Elsevier	94	5.22

Across the top-cited studies, mental imagery is consistently identified as a multidimensional psychological strategy that contributes to performance enhancement, coping processes, and injury rehabilitation. Several studies demonstrate that mental imagery supports motor skill development and neural

activation, even in the absence of physical movement, reinforcing its effectiveness in both training and recovery contexts (Moran et al., 2012; Schack et al., 2014). In addition, mental imagery is closely associated with self-confidence, emotional regulation, and coping strategies, with its effectiveness influenced by factors such as imagery type, athlete skill level, and imagery quality. Evidence also shows that structured imagery interventions, including cognitive, motivational, and mastery imagery, significantly improve performance outcomes and psychological readiness. Overall, these findings confirm that mental imagery functions as a key psychological mechanism linking cognitive processes, emotional regulation, and performance outcomes, and plays a critical role in both performance enhancement and rehabilitation in sports. Several articles demonstrate relatively high citation rates per year, particularly those focusing on motor imagery, coping strategies, and performance-related psychological constructs. These findings indicate that citation patterns in this field are highly concentrated, where a limited number of influential studies dominate the development of knowledge related to mental imagery in sports.

The Most Productive Journals

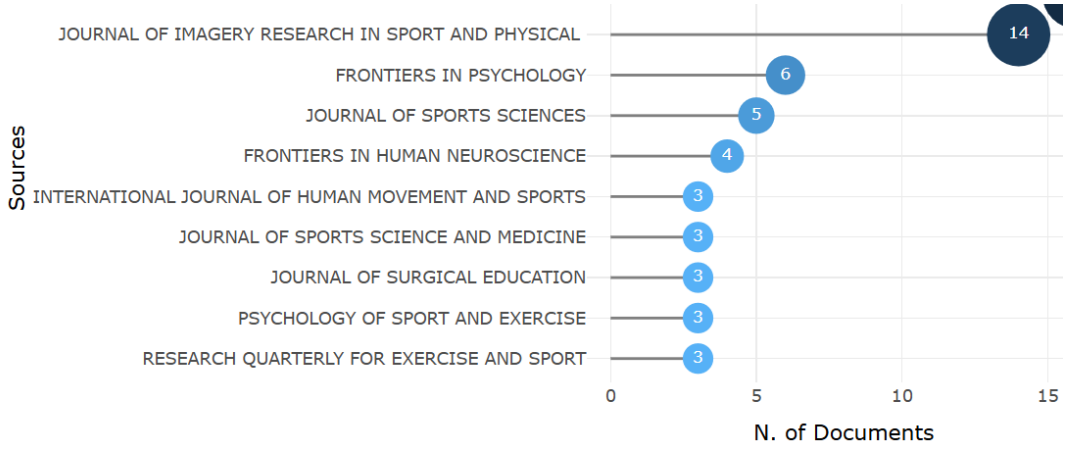

Figure 2. Journal – Productive Journal Publishing Mental Imagery on Mental Toughness and Athletic Performance in Athletes.
Source: Scopus Database with Bibliometrics.

The journal productivity analysis shows that 183 articles on mental imagery in sports are distributed across journals in the fields of sport psychology, sport science, and neuroscience. The most productive journal published 14 articles, followed by *Frontiers in Psychology* (6 articles), *Journal of Sports Sciences* (5 articles), and *Frontiers in Human Neuroscience* (4 articles). Several other journals contributed 3 articles each, indicating a moderate distribution of publications across sources. Overall, the findings demonstrate that research on mental imagery is concentrated in interdisciplinary journals, reflecting the integration of psychological, cognitive, and performance-based approaches. The prominence of leading journals indicates

that mental imagery is not only applied as a practical training strategy but is also studied as a scientifically grounded psychological and cognitive process. This distribution further highlights the growing academic relevance of mental imagery as a key topic in sport performance and rehabilitation research. In terms of geographical distribution, research on mental imagery is primarily concentrated in developed countries, particularly: United States, United Kingdom, Canada & Australia. These countries contribute a substantial proportion of publications, reflecting stronger research infrastructure and a higher level of development in sport psychology research. Contributions from other regions remain relatively limited, indicating an imbalance in global research distribution.

Keywords That Appear In The Influence Of Mental Imagery On Mental Toughness And Athletic Performance In Athletes

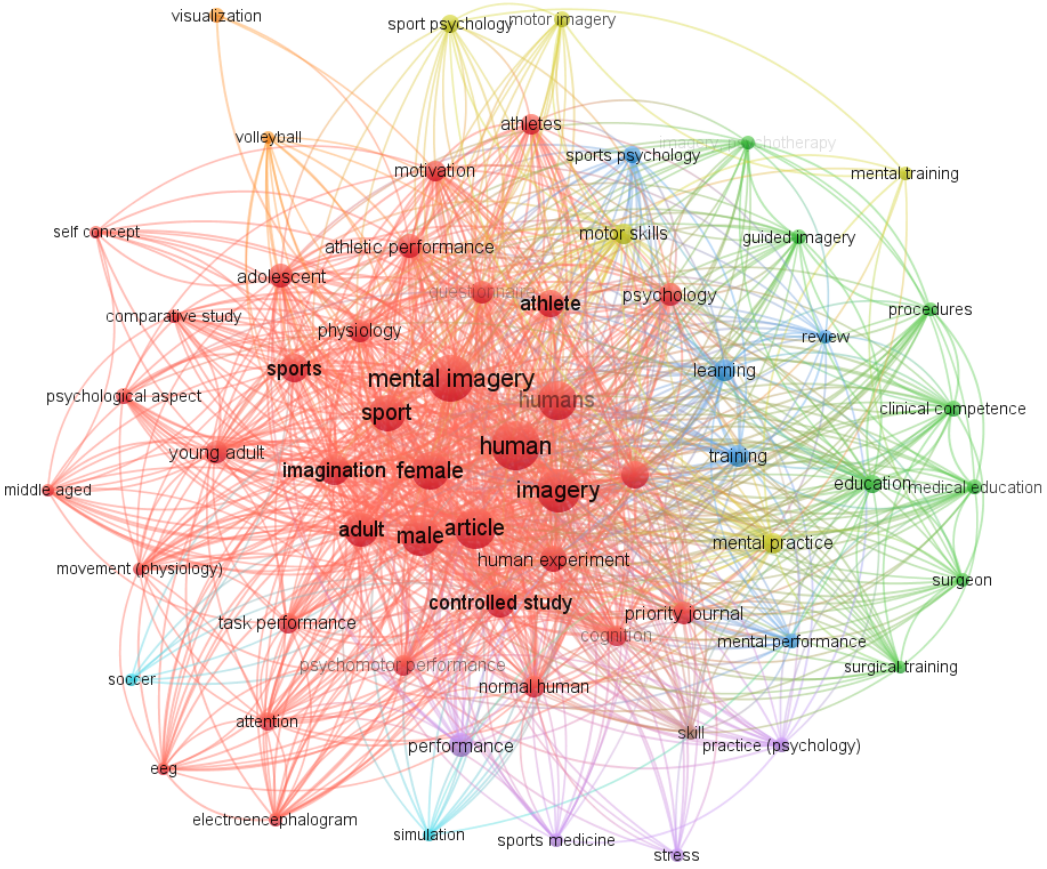

Figure 3. Topics Related to Mental Imagery on Mental Toughness And Athletic Performance in Athletes.
Source: Scopus Database with Bibliometrics.

Figure 3 presents a bibliometric keyword map generated using VOSviewer, illustrating relationships among research topics based on frequency and co-occurrence. Key terms such as *mental imagery*, *imagery*, *athlete*, *sport*, and *mental*

toughness are centrally positioned, indicating high connectivity and confirming mental imagery as a core construct linking psychological, physiological, and performance-related aspects. The analysis identifies four main clusters. The red cluster (highest density) focuses on mental imagery as a psychological strategy for enhancing performance, including variables such as motivation, attention, and task performance. The yellow cluster represents sport psychology applications, highlighting the role of imagery in structured mental training and skill development. The green cluster relates to training and rehabilitation, emphasizing the use of mental imagery in injury recovery and return-to-play preparation. The purple–blue cluster reflects physiological and methodological approaches, including experimental studies examining neural activity, stress regulation, and bodily responses. Overall, the findings indicate that mental imagery functions as a multidimensional construct integrating performance enhancement, psychological regulation, and rehabilitation processes. Current research trends emphasize mental training, stress management, and recovery, while future directions include technology integration, longitudinal studies, and broader application across athlete populations.

DISCUSSION

Findings show that research on mental imagery has experienced a significant increase over time, particularly after 2010 and accelerating after 2020. This trend indicates a growing recognition of psychological factors as essential components in athletic performance. The sharp increase in publications reflects a shift in sport science toward integrating mental training strategies alongside physical and technical preparation. This development aligns with the broader movement in sport psychology emphasizing the role of cognitive and emotional regulation in optimizing performance outcomes. The citation analysis reveals that the field is characterized by a concentrated citation structure, where a limited number of highly cited studies dominate scientific influence. Foundational works, such as those by Mahoney & Avener and Gaudreau & Blondin, continue to serve as key references in understanding imagery, coping, and performance relationships. This pattern suggests that the development of knowledge in this field is strongly shaped by core theoretical and empirical contributions, particularly those focusing on cognitive processes, coping strategies, and motor imagery mechanisms. The results indicate that several authors, such as Craig Hall, Aymeric Guillot, and Aidan Moran, play a central role in advancing mental imagery research, particularly in the areas of motor imagery and sport psychology. In addition, the distribution of publications is dominated by developed countries, including the United States, United Kingdom, Canada, and Australia. This imbalance suggests that research on mental imagery is still concentrated in regions with stronger academic infrastructure and resources. The limited contribution from developing countries indicates an opportunity for

expanding research in more diverse cultural and sport contexts.The findings show that mental imagery research is primarily published in interdisciplinary journals within sport psychology, sport science, and neuroscience. The presence of leading journals, such as *Frontiers in Psychology* and *Journal of Sports Sciences*, indicates that mental imagery is recognized both as a practical training strategy and as a scientifically grounded research domain. The distribution across journals also reflects the integration of cognitive, psychological, and physiological perspectives in understanding athletic performance. Keyword analysis demonstrates that mental imagery functions as a multidimensional construct, linking performance enhancement, psychological regulation, and rehabilitation processes. The identified clusters highlight that current research focuses on mental training, stress management, and injury recovery. Emerging trends indicate increasing attention toward technology-based interventions, such as virtual reality, and the need for longitudinal research designs to better understand long-term effects. These findings suggest that future research should move toward more integrative and applied approaches, combining mental imagery with other psychological interventions and exploring its effectiveness across different athlete populations and competitive contexts. From a practical perspective, mental imagery should be implemented as a structured and systematic training strategy within athlete development programs. Coaches and sport practitioners are encouraged to integrate imagery exercises into daily training routines to enhance performance, mental toughness, and recovery processes. However, several limitations remain, including the dominance of short-term studies and the limited application of advanced technologies in imagery interventions. Addressing these gaps will be essential for strengthening the practical relevance of mental imagery in sport.

CONCLUSION

This study provides a comprehensive bibliometric mapping of mental imagery research in sport, highlighting its increasing relevance in performance enhancement and rehabilitation. The novelty of this study lies in integrating publication trends, citation structures, and thematic developments within a single analytical framework. The findings confirm that mental imagery is an effective psychological strategy for improving performance, strengthening mental toughness, and supporting injury recovery. Practically, mental imagery should be integrated into training programs through structured and evidence-based approaches. Future research is recommended to adopt longitudinal designs and explore technology-based interventions to enhance the application of mental

imagery in sport.

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