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# Bibliometric study of the application of engineering and materials science in sports

Sholeh Khodadad-Kashi<sup>1</sup>

<sup>1</sup> K.N.Toosi University of Technology

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## Abstract

Leveraging bibliometric methods, this study delves into the application of engineering and materials science within the domain of sports. The analysis encompasses a diverse range of materials, including established ones like polymers, ceramics, metals, and composites, alongside emerging advancements such as nano materials, bio-materials, and smart materials. Initially, the study explores the various types of published research, categorizing them by format (books, review articles, research papers, conference proceedings, etc.) and quantifying their respective numbers. Subsequently, it delves into detailed information associated with these publications, including publishers, authors, affiliated institutions, publication year, and originating countries. This comprehensive analysis aims to contribute to the organization and facilitation of future research endeavors in this dynamic field.

## Introduction

Materials science plays a crucial role in shaping the landscape of sports equipment. A diverse array of materials is utilized across equipment, apparel, and even beverages to optimize performance, enhance safety, extend durability, and minimize costs. The integration of cutting-edge materials in sports equipment has a longstanding history, drawing upon a wealth of technological advancements. While this propels the connection between innovative technologies and the sporting goods market, it also presents challenges in the form of restrictions or bans in certain scenarios.(Shalaby & Saad, 2020)

Beyond simply considering the equipment itself, material selection and development for sports equipment must extend to encompass the human interface and system design that ensures optimal material utilization. Ultimately, research in this domain strives to enhance material properties, increasing abilities, performance, and user interaction. (Jenkins, 2002)

Governing forces for material development extend beyond scientific and governmental regulations, encompassing sport-specific laws as well.(Paital & Dahotre, 2009) The profound impact of sports on individuals, both as participants and spectators, elevates the field of materials science in sports equipment to a prime platform for research and development efforts. This study aims to facilitate and organize future research endeavors in the application of engineering and materials science across various sports-related domains, including equipment, apparel, beverages, and even

medications.

This chapter delves into the methodology employed and the resulting findings. It commences by outlining the specific search strategy and keywords utilized. Subsequently, the results are presented, encompassing the number of analyzed studies categorized by document type, country, author affiliation, institution, publisher, and publication year. Additionally, the percentage representation of each category within the total dataset is reported. Finally, the chapter concludes by providing a comprehensive summary of the extracted key insights. The results and discussions presented herein primarily focus on highlighting the most frequent occurrences and distributions observed within each of the examined parameters.

1- Methodology

This section details the methodology employed for the study. A top-down search strategy was adopted within the Scopus database. Initially, a broad search was conducted using the term "sports" (including synonyms) combined with the term "materials." Subsequently, the search was refined to include more specific terms related to materials, such as nanomaterials, nanotechnology, biomaterials, smart materials, shape-memory materials, advanced materials, composites, polymers, ceramics, and carbon. The retrieved articles were then subjected to bibliometric analysis.

Results:

Table 1 and Figure 1 present the distribution of articles according to document type. Based on the data obtained, 250 studies covering various document types have been conducted in this field, with research articles dominating the share. Table 2 displays the number and proportion of articles per country (the top ten countries). China, the United States, and the United Kingdom exhibited the highest level of activity in this domain, respectively. Table 3 showcases the number and percentage of articles per author (the top ten active authors). Subic. A. and Strangwood. M. stands out as the top two active authors in this field, with each contributing four articles. Table 4 depicts the number and percentage of articles per institution (the top ten institutions). University of Birmingham, Loughborough University, and RMIT University emerge as the most active institutions in researching and studying the application of materials in sports. Table 5 provides insights into the number and percentage of articles per publisher (the top ten publishers). The publishers Applied Mechanics and Materials, Advanced Materials Research, and Materials In Sports Equipment held the top ranks in this field with 24, 24, and 9 publications, respectively. Table 2-6 and Figure 2-2 document the article count per publication year (2000-2023), revealing a notable surge in studies concerning the application of engineering and materials science in sports, steadily rising over the past five years.

Table 1 - Number of articles by document type

Quantity	Document Category
3	Book
15	Review Paper
134	Research Paper
10	Season of Book
88	Conference Paper

Table 2 - Number and percentage of total articles by country

Percentage of Total	Quantity	Country
42%	90	China
16%	33	United States of America
15%	31	England
7%	15	Germany
6%	12	Australia
4%	8	Japan
3%	6	France
2%	5	Italy
2%	5	Finland
2%	5	Czechia

Table 3: Number and Percent of Total Articles by Author

Percentage of Total	Quantity	Author
15%	4	Subic. A.
15%	4	Strangwood. M.
11%	4	Troynikov. O.
11%	3	Nishiwaki. T.
7%	2	Zhou. X.
7%	2	Yip. J.
7%	2	Yildiz. E.
7%	2	Wei. L.
7%	2	Uttu. T.S.
7%	2	Tong. Y.

Percentage from total	Quantify	Institute
15%	6	University of Birmingham
13%	5	Loughborough University
13%	5	RMIT University
10%	4	Nishiwaki. T.
10%	4	Nanyang Technological University
10%	4	Hebei University
7%	3	Clemson University
7%	3	Beijing University of Technology
7%	3	Freie Universität Berlin
7%	3	School of Mechanical and Aerospace Engineering

Table 2-4: Number and Percent of Total Articles by Institution

Table 2-5: Number and Percent of Total Articles by Publisher

Percentage of Total	Quantify	publisher
27%	24	Applied Mechanics and Materials
27%	24	Advanced Materials Research
10%	9	Materials In Sports Equipment
8%	7	Procedia Engineering
8%	7	Journal Of Nanomaterials
5%	4	Sportwissenschaft
5%	4	Materials And Design
3%	3	Composites
3%	3	Zairyo Journal of The Society of Materials Science Japan
3%	3	International Journal of Nanotechnology

Table 2-6: Number of Articles by Year of Publication

Quantify	Year of Publication
9	2023
31	2022
20	2021
11	2020
16	2019
6	2018
3	2017
7	2016
5	2015
24	2014
18	2013
25	2012
10	2011
6	2010
7	2009
2	2008
7	2007
4	2006
4	2005
4	2004
4	2003
4	2002
2	2001
1	2000

## Conclusion:

This project delved into a bibliometric analysis concerning the utilization of engineering and materials science in sports. The results encompass the number of documents in this domain categorized by document type, country, author, institution, publisher, and publication year. The findings indicate a substantial proliferation of studies in recent years, with

research endeavors focusing on the design and selection of optimal materials for sports equipment, accessories, apparel, beverages, pharmaceuticals, and more. This trend persists through 2023. Notably, China, the United States, and the United Kingdom emerged as the most actively engaged countries in this research. The dataset also highlights the ten authors with the highest publication counts on materials application in sports, alongside the top ten publishers and institutions in terms of study volume. This information not only aids future research endeavors but also serves as a roadmap for publishing articles or other documents in this field and facilitates collaboration or networking with stakeholders. Finally, it's worth emphasizing the paramount importance of investigating the application of engineering and materials science in sports to advance the use of optimal materials for enhancing the properties, performance, durability, and safety of sports equipment, attire, and accessories. Furthermore, the integration of materials with unique characteristics in these domains is crucial.

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