



From the Court to the Laboratory: The Scientific Evolution of Handball through Global Research and Performance Outcomes

Jose M. Saavedra^{1#}, Sveinn Þorgeirsson¹, Dimitris Hatzimanouil², Yolanda Escalante^{3#}

Affiliations: ¹Physical Activity, Physical Education, Health and Sport Research Centre (Sports Science Department). School of Social Sciences. Reykjavik University, ²School of Physical Education and Sports Science, Aristotle University of Thessaloniki, Thessaloniki, Greece, ³Department of Didactics of Musical, Plastic and Corporal Expression, Faculty of Education, University of Valladolid, Soria, Spain, [#]These authors contributed equally.

Correspondence: Jose M. Saavedra. Physical Activity, Physical Education, Health and Sport Research Centre (PAPESH). School of Social Sciences. Reykjavik University. Menntavegur 1, Nauthólsvík, 101 Reykjavík, Iceland. E-mail: saavedra@ru.is

Abstract

The objectives of this study were: (i) to analyze the evolution in the number of articles published on handball and the citations received; (ii) to determine whether there is a relationship between scientific production and the number of medals won in the Olympic Games and World Championships; (iii) to identify the research topics with the highest publication rates in handball; and finally, (iv) to identify the most cited articles, as well as the journals and countries that published the most on handball. Articles published between January 1, 1980, and December 31, 2024, were retrieved from the Web of Science Core Collection database. For each article, the following information was analyzed: authors; journal (year, volume, issue, pages, DOI); institution and country; funding agency; number of citations; and research topic. Absolute values and percentages were presented for articles and citations per year. Regression analyses calculated the coefficients of determination for the relationships between the number of articles and year, citations and year, and medals and publications by country. A total of 1,412 articles were analyzed. Significant relationships were found between year and number of articles ($R^2=0.6625$, $p<0.001$), year and citations ($R^2=0.6697$, $p<0.001$), and publications and medals by country ($R^2=0.1575$, $p<0.01$). The four countries that published the most articles were Spain, Germany, Norway, and Brazil. The main research topics were physical capacities – measurements, injuries and sports medicine, and physiological responses and adaptation (training programs). Five journals accounted for 19% of all publications.

Keywords: *Sports sciences, performance, physical fitness, physiology, medals*



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HANDBALL THROUGH GLOBAL RESEARCH AND PERFORMANCE OUTCOMES

<http://mjssm.me/?sekcija=article&artid=317>

Cite this article: Saavedra, J.M, Þorgeirsson, S, Hatzimanouil, D., Escalante, Y. (2026) From the Court to the Laboratory: The Scientific Evolution of Handball through Global Research and Performance Outcomes. *Montenegrin Journal of Sports Science and Medicine*, 22 (2), Ahead of print. <https://doi.org/10.26773/mjssm.260902>. <https://doi.org/10.26773/mjssm.260302>

Received: 08 November 2025 | Accepted after revision: 14 April 2026 | Early access publication date: 30 April 2026 | Final publication date: 15 September 2026

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Conflict of interest: None declared.

Introduction

Team handball is a dynamic, high-intensity team sport that combines technical skill, tactical awareness, and physical fitness. Originating in Northern Europe in the early 20th century, it evolved from an outdoor 11-a-side game to the modern 7-a-side indoor version (Saavedra, 2018), it is the youngest of the major team sports (Constanti et al., 2008). It has been part of the Olympic Games since 1972 for men and 1976 for women. Considering the multifaceted nature of the sport, handball performance is influenced by a wide range of factors, including anthropometric characteristics, coordination, strength, endurance, nutrition, cognitive abilities, tactical understanding, social dynamics, and external conditions (Wagner et al., 2014). In recent decades, rule changes, such as faster restarts and goalkeeper substitutions—have made the game faster and more spectator-friendly (Þorgeirsson et al., 2022b). The popularity of this sport and its participation have been increasing, going from around 19 million players (International Handball Federation, 2014) to approximately 30 million, with 211 national federations and more than 28,000 clubs (IHF, 2025).

Bibliometric studies are systematic analyses of scientific literature aimed at identifying patterns, trends, and impacts within a specific field (Passas, 2024). In addition, bibliometrics serves descriptive, evaluative, and monitoring purposes in the analysis of research activity. Furthermore, bibliometric studies have practical applications in policy-making, resource allocation, and strategic planning. They support evidence-based decisions in research management, help guide the development of science and technology policies, and are essential for evaluating the progress and impact of research initiatives (Salinas-Ríos, & García-López, 2022). In the field of sports science, bibliometric studies have proliferated in recent years, either focusing on specific aspects such as the relative age effect (Bilgiç & Işın, 2002) or small-sided games (Endriani et al., 2024), or on specific sports such as adapted sport (Liu et al., 2022), judo (Rahmawati et al., 2024), squash (Liu et al., 2025), swimming (Morais et al., 2024), tennis (Kumar & Das, 2024) or volleyball (da Silva et al., 2023). Moreover, some research has conducted bibliometric analyses comparing Olympic sports (Millet et al., 2021). In that study, football was the sport with the highest number of citations, while the summer Olympic sports with the fewest citations included mountain biking, archery, diving, trampoline, and skateboarding. Among the six research topics analyzed (Physiology, Performance, Injuries – Medicine, Biomechanics – Equipment, Psychology, and Training and Testing), the first three were the most extensively studied. However, their distribution varied depending on the sport in question (Millet et al., 2021).

In relation to handball, the first bibliometric analysis (Prieto et al., 2015) examined publications up to 2012, identifying 373 articles indexed in the Web of Science and PubMed databases, with an increase in the number of publications between 2010 and 2012. The most frequently published disciplines were: (i) injuries (26.54%), (ii) physical capacities and conditions (17.96%), and (iii) physiological variables measurement (12.87%). Subsequently, another study that analyzed articles published between 2013 and 2018 in PubMed found that physical capacities and conditions was the most studied topic (19.14%) (Saavedra, 2018). A more recent study that analyzed articles published up to

2018 using the Web of Science database found 1,727 records, showing a significant increase in research related to handball (Pardo-Ibáñez et al., 2020) Although the research topics were not analyzed, the keywords used were examined, with the most frequent being handball (3.35%), Anterior Cruciate Ligament (ACL) (1.655) and sport (1.43%). Nevertheless, a later study conducted on all Olympic sports concluded that, in the case of handball, 50% of the articles could be ascribed to the field of physiology (Millet et al., 2021). If the publications are analyzed by country, it was found that up to 2012, the most scientifically productive countries were Norway (12.06% of the total articles), Germany (11.26%), and Spain (9.65%) (Prieto et al., 2015). Furthermore, interest in handball and bibliometric studies is also present in countries with less tradition, such as Chile (Hernández-Mosqueira et al., 2024), which demonstrates the growing interest in this sport beyond European countries. However, the main gap is that, beyond bibliometric studies (topics, countries, or authors), there are no studies that take into account bibliometric indicators alongside other performance indices. Therefore, the novelty of the present study lies in combining bibliometric indicators with performance outcomes (medals), providing a more comprehensive perspective on the development of handball research and its possible links with elite sport performance. In this way, in this context of multidisciplinary research and increased scientific production, and considering the need to better understand both the evolution of research and its potential implications for performance, the objectives of this study were: (i) to analyze the evolution in the number of articles published on handball and the citations received; (ii) to determine whether there is a relationship between scientific production and the number of medals won in the Olympic Games and World Championships; (iii) to identify the research topics with the highest publication rates in handball; and finally, (iv) to identify the most cited articles, as well as the journals and countries that published the most on handball.

Materials and methods

Literature search strategy

Articles published between January 1, 1980, and December 31, 2024, were retrieved using searches in the Web of Science Core Collection database. The terms used were handball in both the title and the abstract. No additional filters were applied. Only articles published in journals were considered. This database was chosen because it is used as the basis for calculating the impact factor in the Journal Citation Reports. All articles were included except those focused on beach handball. Beach handball was not considered because it has a different internal logic (number of players, match duration, final scoring system, etc.), which distinguishes it from “traditional” handball. Secondly, its international trajectory is more recent (the first World Championship was held in 2004, and it has never been an Olympic sport). The search was conducted between October 1 and October 10, 2025.

Data collection

After removing duplicate records, two of the authors (JMS, YE) independently screened the titles and abstracts. From each article, the following information was analyzed: authors; journal (year, volume, issue, pages, DOI); institution and country of each author; funding agency; and the

number of citations of each paper. Finally, each article was assigned a research topic according to the following classification shown below. In cases where an article addressed two or more topics, it was assigned to the topic considered to be its main focus. In case of disagreement between the authors, it was resolved by consensus. The classification used for the topics was (alphabetically) (adapted from Devis-Devis et al., 2010; Prieto et al., 2015; Saavedra, 2018): (i) Biomechanics: studies that focus on body movements and the forces involved in technical actions. (ii) Body composition and somatotype: studies that focus on players' anthropometric and body composition characteristics and somatotypes. (iii) Injuries and sports medicine: studies that focus on the prevention, types, frequency, and treatment of injuries. (iv) Nutrition: studies that focus on diet, hydration, or supplementation. (v) Performance analysis: studies that focus on technical, tactical, or overall performance during matches. (vi) Physical capacities – measurements: studies that focus on strength, speed, endurance, or agility through tests designed to quantify players' abilities. (vii) Physiological responses and adaptation (training programs): studies that focus on how the body reacts and adapts to physiological stimuli or to specific training programs. (viii) Physiological variables – measurements: studies that focus on parameters such as heart rate, lactate concentration, or oxygen uptake during training, competition, or laboratory testing. (ix) Psychology and cognitive processes: studies that focus on motivation, concentration, decision-making, perception, and other psychological factors influencing performance. (x) Tactics: studies that focus on game strategies, offensive and defensive organization, and collective behavior patterns on the court. (xi) Others: studies not classified in any of the above groups.

Statistics

Absolute values and percentages were presented for the total number of articles per year and citations per year. A regression analysis was performed to calculate the coefficient of determination and the regression line for the number of articles and year, the number of citations and year, and finally, the number of medals and the number of articles by country. This approach allowed us to examine temporal trends in scientific production and citations, identifying patterns and the strength of these relationships over time. In addition, regression analysis was used to explore the association between the number of publications and performance outcomes (medals), providing a quantitative perspective on the potential link between research activity and sporting success. Absolute values and percentages were also presented for the journals in which the articles were published, as well as for the topics studied.

Results

From an initial search yielding 1,484 records in the Web of Science Core Collection, 48 articles were excluded for being conducted in beach handball; two for being conducted in Australian football; one for being conducted in Valencian pilota; four for being duplicate records; and 17 for being indexed as 2025 publications, resulting in a final dataset of 1,412 articles included for analysis. Figure 1 presents the regression analyses, showing coefficients of determination for the relationship between the number of articles and year ($R^2=0.6625$, $p<0.001$) and between citations and year ($R^2=0.6697$, $p<0.001$). The number of articles increases from 2020 onward, reaching its peak in 2022 with 176 articles, while citations also rise from 2020, reaching their highest value in 2024 with 3,536 citations.

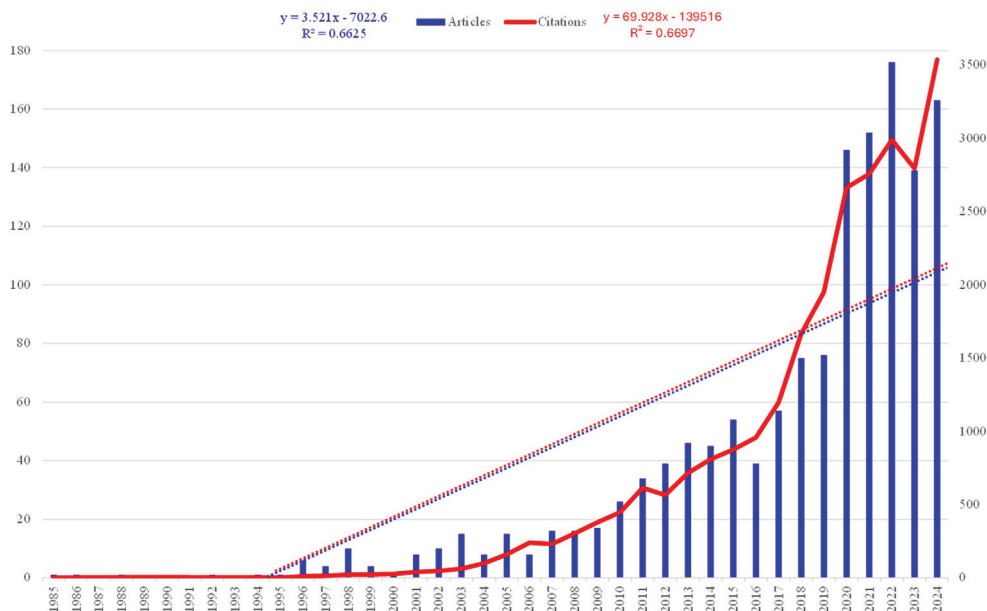


Figure 1. Evolution of the number of articles and citations from 1985 to 2024, and regression line and equation for articles/year and citations/year.

In terms of publications by country, the five countries with the highest number of articles were: (i) Spain, 297 articles (21.03%); (ii) Germany, 184 articles (13.03%); (iii) Norway, 138 articles (9.77%); (iv) Brazil, 112 articles (7.98%); and (v) Tunisia, 89 articles (6.30%), accounting for 58.06% of the total publications. Figure 2 presents the regression

analysis showing a coefficient of determination for the relationship between (for the number of medals in Olympic Games and World Championships (men plus women) and the number of articles ($R^2=0.1575$, $p<0.01$). Countries that did not win any medals, as well as the USSR, were not included in the analysis.

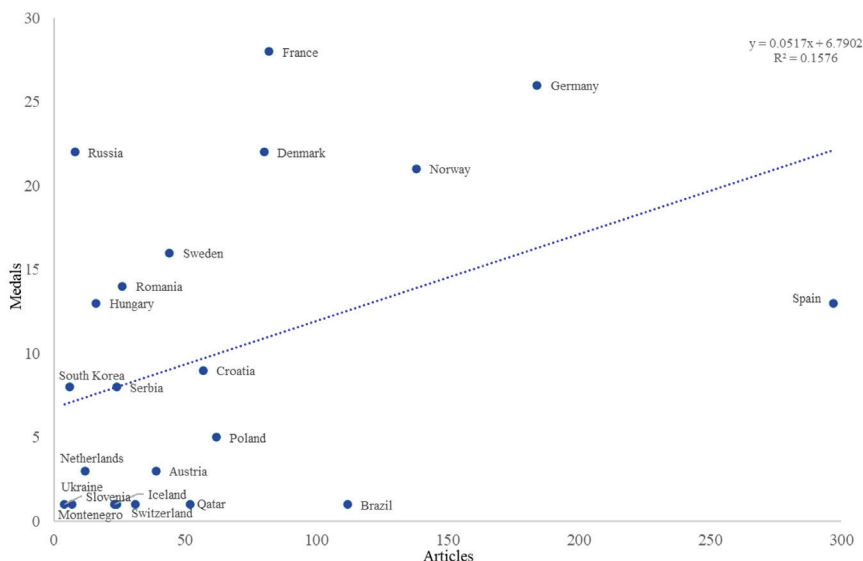


Figure 2. Relationship between the number of articles and the number of medals in the Olympic Games and World Championships by country.

Focusing on the topics studied, Table 1 indicates that the five most frequently researched were: (i) Physical capacities – measurements, 217 articles (15.37%); (ii) Injuries and sports medicine, 202 articles (14.31%); (iii) Physiological responses and adaptation (training programs), 178 articles (12.61%); (iv)

Physiological variables – measurements, 143 articles (10.13%); and (v) Performance analysis, 103 articles (7.29%), accounting for 59.71% of the total publications. However, there was a considerable number of articles, 247 (17.49%), that could not be classified under any of the established topics.

Table 1. Distribution (total number and percentages) of articles according to the established topics.

Topic	Articles	
	n	%
Physical capacities - measurements	217	15.37
Injuries and sport medicine	202	14.31
Physiological responses and adaptation (training programs)	178	12.61
Physiological variables – measurements	143	10.13
Performance analysis	103	7.29
Psychology and cognitive process	98	6.94
Biomechanics	81	5.74
Body composition and somatotype	77	5.45
Nutrition	36	2.55
Tactics	30	2.12
Others	247	17.49
Total	1412	100.00

Table 2. The five most cited articles

Authors (year)	Title	Journal	Citations
Olsen, O.-E., Myklebust, G., Engebretsen, L., & Bahr, R. (2004).	Injury mechanisms for anterior cruciate ligament injuries in team handball: A systematic video analysis.	American Journal of Sports Medicine, 32(4), 1002–1012.	927
Koga, H., Nakamae, A., Shima, Y., Iwasa, J., Myklebust, G., Engebretsen, L., Bahr, R., & Krosshaug, T. (2010).	Mechanisms for noncontact anterior cruciate ligament injuries: Knee joint kinematics in 10 injury situations from female team handball and basketball	American Journal of Sports Medicine, 38(11), 2218–2225.	651
Myklebust, G., Engebretsen, L., Brækken, I. H., Skjølberg, A., Olsen, O.-E., & Bahr, R. (2003).	Prevention of anterior cruciate ligament injuries in female team handball players: A prospective intervention study over three seasons	Clinical Journal of Sport Medicine, 13(2), 71–78.	570
Myklebust, G., Maehlum, S., Holm, I., & Bahr, R. (1998).	A prospective cohort study of anterior cruciate ligament injuries in elite Norwegian team handball.	Scandinavian Journal of Medicine & Science in Sports, 8(3), 149–153.	317
Gorostiaga, E. M., Granados, C., Ibáñez, J., & Izquierdo, M. (2005).	Differences in physical fitness and throwing velocity among elite and amateur male handball players.	International Journal of Sports Medicine, 26(3), 225–232	289

In terms of funding, 39.09% (552 out of 1,412 articles) were funded. The five funding agencies with the highest number of supported publications were: (i) the Spanish Government (Spain), 23 articles (1.63%); (ii) the Fundação para a Ciência e a Tecnologia (Portugal), 16 articles (1.13%); (iii) the Royal Norwegian Ministry of Culture (Norway), 16 articles (1.13%); (iv) the South-Eastern Norway Regional Health Authority (Norway), 15 articles (1.06%); and (v) the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Brazil), 14 articles (0.99%).

Finally, the five that have published the most articles was: (i) Journal of Strength and Conditioning Research, 78 articles (5.52%); (ii) Journal of Human Kinetics, 65 articles (4.60%); (iii) International Journal of Environmental Research and Public Health, 50 articles (3.54%); (iv) Journal of Sports Medicine and Physical Fitness, 39 articles (2.76%); and (v) Scandinavian Journal of Medicine and Science in Sports, 35 articles (2.48%), accounting for 18.91% of the total publications. The five most cited articles (Table 2) account for 2,754 citations, representing 10.51% of the total citations.

Discussion

The objectives of this study were: (i) to analyze the evolution in the number of articles published on handball and the citations received; (ii) to determine whether there is a relationship between scientific production and the number of medals won in the Olympic Games and World Championships; (iii) to identify the research topics with the highest publication rates in handball; and finally, (iv) to identify the most cited articles, as well as the journals and countries that published the most on handball. In general terms, there has been an increase in the number of articles and citations, especially since 2020. Similarly, the countries that publish the most are Spain, Germany, and Norway, with only a weak relationship between the number of publications and the number of medals won by countries. The most studied research topics focus on physical capacities – measurements, injuries and sports medicine. This reflects a current update in research on handball, helping to highlight both its strengths and weaknesses.

There was a relationship between the number of published articles and year ($R^2=0.6625$, $p<0.001$), as well as between the number of citations and year ($R^2=0.6697$, $p<0.001$). The increase in articles becomes more significant from 2020 onwards. These data appear to follow the trend observed in previous studies (Prieto et al., 2015; Saavedra, 2018), which reported a growth in publications related to handball. This may be due not only to researchers' increasing interest in the sport, but also to the rising number of journals indexed in the Journal Citation Reports. For example, in the Sport Sciences category, the number of indexed journals rose from 83 in 2018 to 116 in 2020, and to 134 in 2024. When analyzing the countries with the highest publication output, Spain, Germany, Norway, and Brazil lead, representing a shift compared to previous studies where the order was Norway, Germany, Spain, and France (Prieto et al., 2015). It could be assumed that this shift is driven by differences in available research funding (Beneke, 2013). However, this does not seem to be the case. Although among the top five institutions funding the most studies are one Spanish institution (Spanish Government), two Norwegian institutions (Royal Norwegian Ministry of Culture and South-Eastern Norway Regional Health Authority), and one Brazilian (Coordenação de Aperfeiçoamento de Pessoal de

Nível Superior), it is noteworthy that no German institution appears in the top five funding agencies. On the contrary, a Portuguese institution (Fundação para a Ciência e a Tecnologia) is listed among the top funders, even though Portugal is not among the countries with the highest publication output. However, the funding of handball-related studies does not even reach 40%. In this sense, research funding could perhaps be enhanced through greater involvement of the International Handball Federation and the European Federation, as occurs in other sports such as football (UEFA, 2025). In turn, the relationship between published articles and medals is low ($R^2=0.1575$, $p<0.01$). This seems to indicate that the publication of articles may be more closely related to other factors, such as the number of practitioners or the tradition in the practice of this sport, as shown by the fact that the countries winning the most medals are European, where handball originated.

The most frequently studied research topics were Physical capacities – measurements (15.37%), Injuries and sports medicine (14.31%), and Physiological responses and adaptation (training programs) (12.61%) (Table 2). These data reveal a shift in trend, as Injuries and sports medicine no longer occupy the leading position as they did up to 2012 (Prieto et al., 2015), while articles focusing on physiology continue to hold relevance as objects of study (Millet et al., 2021). This shift may reflect an increasing emphasis on performance-oriented and applied research, aimed at directly enhancing athletes' physical capacities and training adaptations. Such a trend suggests a closer alignment between scientific research and the practical demands of high-level handball performance. Although injuries and sports medicine no longer occupy the top position among the studied topics, it is worth noting that four of the most cited articles (Table 2) account for 9.30% of the total citations from 1,412 articles. However, it should be considered that the most recent of these four articles is more than 14 years old, making it reasonable to assume that, over time, newer articles will increase in citation count. It is worth highlighting the increase in Physiological responses and adaptation (training programs) (12.61%), which seems to indicate a growing interest in conducting applied research (Bishop 2008) through programs that enhance athletes' actual performance. It is also necessary to draw attention to the fact that articles within the research topic Psychology and cognitive processes are limited (6.94%), especially considering that cognitive processes are an integral part of performance in handball (Wagner et al., 2014; Kristjánsdóttir et al., 2019). Similarly, it is surprising that, despite handball being a team sport, only 2.12% of the articles examine tactical aspects, perhaps due to the complexity inherent in studying team sports (Espoz-Lazo, & Hinojosa-Torres, 2025). In any case, it is necessary to highlight that there is still a relatively high percentage (17.49%) of studies classified under the "Others" category, which reflects the heterogeneous and diverse interests within research.

Although there are no journals dedicated exclusively to handball, publications in five of them account for 18.9% of the total output: Journal of Strength and Conditioning Research, Journal of Human Kinetics, International Journal of Environmental Research and Public Health, Journal of Sports Medicine and Physical Fitness, and Scandinavian Journal of Medicine and Science in Sports. Two of these journals (Journal of Strength and Conditioning Research and Scandinavian Journal of Medicine and Science in Sports) were already in the

top five when handball publications up to 2012 were analyzed (Prieto et al., 2015). This seems to indicate a diversification among journals which, although generally multidisciplinary, including some published in countries not traditionally linked to handball (for example, the *Journal of Strength and Conditioning Research*, published in the USA), are now paying greater attention to the sport.

This article has some limitations. First, the use of only one database may have resulted in the exclusion of certain articles; however, the Web of Science database was chosen, which can be considered the gold standard. Second, the classification of the selected research topics is not unanimous across bibliometric studies, which has made comparisons somewhat difficult in certain cases. Third, the use of citation-based metrics may be influenced by time-dependent bias. Older publications have had more time to accumulate citations, potentially over-representing their impact compared to more recent studies; for example, the five most cited articles were published between 1998 and 2010. Therefore, citation counts should be interpreted with caution, as they may not fully reflect the current relevance or scientific quality of newer research.

Conclusions

The conclusions of this study were as follows: (i) there was a clear increase in research related to handball, especially from 2020 onwards; (ii) the relationship between the countries that published the most (Spain, Germany, Norway, and Brazil) and the number of medals obtained in the Olympic Games and World Championships is weak; (iii) the research topics that developed the most were physical capacities – measurements, injuries and sports medicine (14.31%), and physiological responses and adaptation (training programs); (iv) five journals accounted for 19% of the total publications. Several practical implications can be drawn from this study. First, it seems necessary to sport governing bodies (e.g. International, European and national federations) and research institutions in handball to ensure that the scientific knowledge of a sport that has been part of the Olympic Games for more than 50 years continues to grow and be applied to practice. Second, studies in important areas such as psychology, cognitive process, and tactical analysis, it is recommended that researchers and coaches prioritize these fields. Third, there appears to be sufficient interest to potentially create special issues within scientific journals to make handball research more visible. Finally, future research should aim to develop more applied and interdisciplinary studies, particularly those that integrate physical, psychological, and tactical dimensions of performance, while also enhancing the translation of laboratory-based findings into real-world practice.

Conflicts of Interest

The authors declare no conflict of interest.

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