

BIBLIOMETRICS

EMERSON FRANCHINI^{1,2,3(ABCDEF)}, CARLOS GUTIERREZ-GARCIA^{2(ABCDEF)},
EUGENIO IZQUIERDO^{2(ABCDEF)}

1 Martial Arts and Combat Sports Research Group, School of Physical Education and Sport, University of Sao Paulo (Brazil)

2 Universidad de Leon, Leon (Spain)

3 Combat Centre, Australian Institute of Sport (Australia)

Corresponding author: Emerson Franchini, Av. Prof. Mello Moraes, 65, Cidade Universitaria, Sao Paulo, Brazil, ZIP: 05508-030;
e-mail: efranchini@usp.br; phone: 55 11 309102124

Olympic combat sports research output in the Web of Science: a sport sciences centered analysis

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Abstract

Background and aim. The Olympic Games are the world's most important sport competition, and Sport Sciences have been regarded to play an important role for sport success at the Olympics. The combat sports of boxing, fencing, judo, taekwondo and wrestling represent 20-25% of all medals disputed in this competition, and karate will be included Tokyo Olympic Games in 2020. In this context, this study aimed at describing the scenario of scientific research on Olympic combat sports in the Sport Sciences field.

Methodology. Data search was performed in the area of Sport Sciences of the Web of Science core collection database. The variables selected for analysis were total number of publications, *h*-index, citations analyses and top ten types of documents, countries, research institutions, languages and journals.

Results. A total of 2,752 publications were retrieved, achieving an *h*-index of 74, 34,255 citations and an average of 12.45 citations per item. The research was mainly published in English (95.35%), in article form (75.14%) and in the United States of America (27.87%), while the University of Sao Paulo (4.69%) and *Medicine and Science in Sports and Exercise* (11.56%) were respectively the institution and the source leading their top ten lists.

Conclusion. Combat sports literature indexed in the Web of Science database amounted to nearly 1% of the Sport Sciences research area, showing that this field of study is still starting to consolidate. The connection between sport practice and research, the indexation of more combat sports journals, and the increase in the number and collaborations among researchers are suggested as potential ways to strengthen combat sports research.

Introduction

Olympic Games are the most prestigious multi-sport competition in the World. They have impact at all levels – culture, society, policy, economy, ecology, architecture, demography, etc. – which also include science. Indeed, the proportion of research papers about the Olympic Games have risen rapidly, with the social sciences, medicine and engineering occupying the first, second and third position of papers published [Skibba, Cressey, Van Noorden 2016]. According to these authors, “the Olympic Games have long fascinated researchers as well as the general public” (p. 18).

Many countries invest considerable amounts of resources to succeed in the medal table, and the con-

tribution of sport sciences for achieving such success has been reported recently [Rees, Hardy, Gullich *et al.* 2016]. At the Olympic Games, combat sports are represented by boxing, fencing, judo, taekwondo and wrestling (freestyle and Greco-Roman). Wrestling and fencing have been present at the modern Olympic Games since their first edition in Athens 1896 [Roi, Bianchedi 2008; Sayenga 1995], then boxing followed in St. Louis 1904 [Svinth 2010a], and several decades later judo (Munich 1972) and taekwondo (Sydney 2000) were also officially included in the Olympic Program [Gutierrez-Garcia, Perez-Gutierrez, Svinth 2010; Svinth 2010b]. As a whole, these sports represented between 20-25% of all medals disputed in the history of this competition+ [Franchini, Brito, Artioli 2012].

Indeed, with the introduction of karate and mixed team in judo during Tokyo Olympic Games in 2020, this percentage can increase even more.

Thus, considering the number of medals distributed by these sports as a whole, any country desiring to be placed in the best positions of the medal table should consider investing in the preparation of athletes in these combat sports. In fact, when considering the outstanding results obtained by China during the Beijing 2008 Olympic Games, it is possible to infer that this strategy was well applied as the country finished in the first position in the medal table (48 gold, 22 silver and 30 bronze medals) and this can be partially attributed to Chinese athletes' performance in the combat sports. China finished in the first position in boxing (two gold, one silver and one bronze medals), second in judo (three gold and one bronze medals), third in taekwondo (one gold and one bronze medals), fourth in wrestling (one gold and two silver medals) and fifth in fencing (one gold and one silver medals). Recently, the extraordinary results obtained by Great Britain during the Rio 2016 Olympic Games (i.e., finishing second in Rio 2016, with 27 gold, 23 silver and 17 bronze medals), made that country to be the first in improving its performance in a subsequent edition of the Olympics, after having organized London 2012 Olympic Games (where Great Britain finished third in the medal table, with 29 gold, 17 silver and 19 bronze medals). This has been partially attributed to the Sport Sciences approach used by Great Britain [Rees *et al.* 2016].

Although sport performance is not solely determined by the country investment in research, and even sport sciences research sometimes has been observed to be far from the desired application [Buchheit 2017], its contribution can be important to improve coaches and sport personnel's interventions, and it was found to be correlated to the medal table in the last Olympic Games edition (Spearman $r = 0.84$ between papers published about Olympic sports and total medals and Spearman $r = 0.70$ between papers published about Olympic sports and gold medals) [Moreira, Franchini 2017]. Additionally, details concerning the scientometrics of this type of publications can aid combat sports researchers to improve their strategy to conduct new investigations and improve their own scientific profiles, while contributing to solve relevant questions in the competitive aspect of these modalities.

Thus, considering the relevance of sports sciences for the improvement of procedures in the athletes' preparation, and the fact that combat sports have a relevant contribution to the medal table classification in the Olympic Games, the aim of the present study was to describe the scenario of scientific investigation about combat sports in the sport sciences field.

Material and Methods

Olympic combat sports (i.e., boxing, fencing, judo, karate, taekwondo and wrestling) were the object of study for this research. Despite karate will not make its debut as an official Olympic sport until Tokyo 2020 summer Olympic Games, it was officially accepted in 2016 [IOC, 2016] and therefore it was included in this study. Data search was performed in the Web of Science (core collection, including SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH and ESCI), which is considered nowadays, with Scopus, one of the two most relevant multidisciplinary scientific database worldwide [Gorraiz, Melero-Fuentes, Gumpenberger *et al.* 2016], if not the most [Merigo, Nunez 2016]. The research area of Sport Sciences was selected as a reference as it is the most relevant for sports performance. This same criterion has been used in bibliometric research in different scientific disciplines [Andrade, Lopez, Ramirez-Campillo *et al.* 2013; Fiala, Tutoky 2017; Gumus, Bellibas, Esen *et al.* 2018], as a way to refine results and avoid high "noise" rates (i.e., the retrieval of documents that are not relevant to the intended search).

In April 6th, 2018, when data for this research were retrieved, the Sport Sciences research area included 282,512 references from 394 sources, mainly scientific journals. Following Perez-Gutierrez, Gutierrez-Garcia and Escobar-Molina's [2011] recommendations, entry terms included the names of the cited Olympic combat sports and their variations. No limits of date were used. The search string finally used was "TS= ("boxing" OR "boxer" OR "boxers" OR "pugilism" OR "pugilist" OR "pugilists" OR "fencing" OR "fencer" OR "fencers" OR "judo" OR "judoka" OR "judokas" OR "judoist" OR "judoists" OR "karate" OR "karate*" OR "taekw*" OR "wrestling" OR "wrestler" OR "wrestlers") AND SU=sport sciences". Importantly, we used quotation marks ("") for every term, as the database search engine automatically performs proximity searches if quotations marks are not used. For example, the string "TS= ("boxing" OR "boxer" OR "boxers") AND SU=sport sciences" retrieved 469 results, while "TS= (boxing OR boxer OR boxers) AND SU=sport sciences" retrieved 1,066, as the term "box", which is a term widely used, is also included in the latter search.

Data analysis was performed by using the Web of Science database analysis tools, namely *Analyze results* and *Create Citation Report*. The variables selected for analysis were: total number of publications, *h*-index for these publications considered altogether, sum of citations, sum of citations excluding self-citations, articles that cited, articles that cited excluding self-citations. In addition, the top ten of the following variables were also considered: types of documents, countries, research institutions, languages and journals.

Results

A total of 2,752 publications (0.97% of all publications in the Sport Sciences research area) from 189 sources (47.97% of all Sport Sciences sources) were found in our search. These publications generated an *h*-index of 74, a total of 34,255 citations (24,163 excluding self-citations) by 18,462 articles (16,823 excluding self-citations), resulting in an average of 12.45 citations per item. Table 1 presents the type of documents published on Olympic combat sports in the Sport Sciences area. Tables 2, 3 and 4 present, respectively, the top ten countries, institutions and sources with most publications about Olympic combat sports in the Sport Sciences research area. Concerning the languages used in these publications, the most utilized was English ($n = 2,624$, 95.35%), followed by French ($n = 30$, 1.09%), German ($n = 28$, 1.02%), Portuguese ($n = 28$, 1.02%), Italian ($n = 17$, 0.62%), Japanese ($n = 10$, 0.36%), Russian ($n = 7$, 0.25%), Spanish ($n = 7$, 0.25%) and Chinese ($n = 1$, 0.04%).

Discussion

The main findings of this search were that a little more than 2,750 items were published about Olympic combat

sports, which means nearly 1% of all publications in the Sport Sciences research area. Taking into consideration that, as said, combat sports represented between 20-25% of all medals disputed in the Olympic Games [Franchini *et al.* 2012], it may seem a quite short output, although similar studies on other sports should be necessary in order to facilitate comparison. Each of these items has been cited an average of 12.5 times, with self-citation reaching 29.46%. Most of the publications were articles, mainly published in well recognized journals of the Sport Sciences field based on United States of America and Europe. Institutions from America and Europe were the most active in this area, although countries from America, Europe, Asia and Oceania appeared among the top ten in the list.

Previous research in specific combat sports such as judo [Peset, Ferrer-Sapena, Villamon *et al.* 2013] showed slightly lower values for items published in English (87.2% vs. our 95.35%) and higher values for French and German (4.9% and 3.9% vs. our 1.09% and 1.02% respectively). Up to six of the top-ten journals publishing on combat sports were also listed for judo (i.e., *Archives of Budo*, *Journal of Strength and Conditioning Research*, *British Journal of Sports Medicine*, *Journal of Sports Medicine and Physical Fitness*, *International Journal of Sports*

Table 1. Type of documents published about Olympic combat sports considering the Web of Science core collection database in the Sport Sciences research area.

Document type	Number	% of total
Article	2068	75.14
Meeting abstract	276	10.03
Proceedings paper	212	7.70
Review	121	4.40
Editorial material	43	1.56
Book chapter	28	1.02
Letter	16	0.58
Note	14	0.51
Correction	10	0.36
News item	7	0.25
Book review	5	0.18
Discussion	2	0.07

Note: n total = 2,802 instead of 2,752 as the database usually includes some documents in more than one category (e.g., articles and proceedings papers).

Table 2. Top ten countries with the highest amount of published items about Olympic combat sports considering the Web of Science core collection database in the Sport Sciences research area.

Country	Number	% of total
United States of America	767	27.87
Poland	291	10.57
Brazil	236	8.58
England	187	6.79
Japan	148	5.38
France	141	5.12
Spain	123	4.47
Italy	121	4.40
Canada	106	3.85
Australia	97	3.52

Table 3. Top ten institutions concerning published items about Olympic combat sports considering the Web of Science core collection database in the Sport Sciences research area.

Institution	Number	% of total
University of Sao Paulo (Brazil)	129	4.69
Gdansk University of Physical Education Sport (Poland)	105	3.82
University of Zagreb (Croatia)	64	2.33
Institute of Sport National Research Institute (Poland)	61	2.22
University of North Carolina (USA)	59	2.14
Jozef Pilsudski Univ. Physical Education in Warsaw (Poland)	42	1.53
Nippon Sport Science University (Japan)	36	1.31
University of Nebraska system (USA)	35	1.27
Ohio State University (USA)	34	1.24
University of Wisconsin system (USA)	33	1.20

Table 4. Sources of publication about Olympic combat sports considering the Web of Science database in the Sport Sciences research area.

Source	Number	% of total
Medicine and Science in Sports and Exercise (USA)	318	11.56
Archives of Budo (USA)	249	9.05
Journal of Strength and Conditioning Research (USA)	161	5.85
British Journal of Sports Medicine (England)	128	4.65
Journal of Sports Medicine and Physical Fitness (Italy)	101	3.67
Journal of Sports Sciences (England)	85	3.09
International Journal of Sports Medicine (Germany)	82	2.98
American Journal of Sports Medicine (USA)	71	2.58
Biology of Sport (Poland)	69	2.51
Physician and Sports Medicine (England)	66	2.40

Medicine and Biology of Sport), but for our study six of these journals are published in Europe and four in the United States of America (three of the latter occupying the three first positions), while for Peset et al. [2013] six journals were published in Europe (one of them occupying the second position), three in the United States of America and one in Asia. Peset et al. [2013] did not provide data on countries but on researchers and institutions publishing on judo, revealing Brazil, Europe and Japan as the leading countries/territories in judo research. As Table 2 of our study shows, this situation is different when referring to the Olympic combat sports as a whole, where the United States of America are clearly prominent.

Interestingly, bibliometric research on another specific Olympic combat sport, i.e. taekwondo [Perez-Gutierrez, Valdes-Badilla, Gomez-Alonso et al. 2015; Perez-Gutierrez, Valdes-Badilla, Gutierrez-Garcia et al. 2017], also shows some differences and similarities with respect to our research. Up to six of the top-ten journals publishing on combat sports were also listed for taekwondo (i.e., *Archives of Budo*, *Journal of Strength and Conditioning Research*, *British Journal of Sports Medicine*, *Journal of Sports Medicine and Physical Fitness*, *Biology of Sport* and *Journal of Sports Sciences*). In both cases the first one is published in the United States of America, and six of these journals are published in Europe. Nevertheless, for the case of taekwondo the top leading publishing country is South Korea (17.6% of total papers),

followed by the United States of America (16.5%), Turkey (11.4%), Spain (8.5%), Italy (7.9%), England (6.8%), Canada (6.2%), People's Republic of China (6.2%) and Brazil (5.1%), and only one of the top 24 publishing researchers works in an institution from the United States of America. Thus, the situation of judo and taekwondo reveals that, despite their common characteristics as Olympic combat sports, they are unique and have individual features that also affect the scientific production on such sports.

The main limitation of this study refers to the search strategy used for document retrieval, which was based in free language keywords. Some relevant documents may not have been retrieved, if our selected search keywords were not included in the title, abstract and keywords of such documents. Conversely, some irrelevant documents could have been retrieved if they have included our selected search keywords in the title, abstract and keywords of such documents. We have tried to minimize these limitations by using specific search terms and avoiding proximity searches. We also want to highlight that our analyses specifically refer to the Web of Science Sport Sciences research area, and by no means refer to the entire scientific production on Olympic combat sports indexed in the Web of Science databases.

The information of these study can be used to spread out the knowledge produced in this field to professionals involved with combat sports via strategies to popularize the content explored in these items, scrutinizing the

possible applications for interventions, especially concerning technical and tactical, strength and conditioning and psychological development of athletes from these modalities. Probably, an evidence-based and/or a best practice based on the available knowledge can result in significant improvements in the work carried out by these professionals.

These data can also be used by researchers to direct their efforts concerning the development of investigations and knowledge in this specific field, as well as to improve their career-related progress. Basically, an average researcher focusing exclusively on this field has limited possibility to achieve a *h*-index higher than 12 or 13, considering that the mean citation for a given paper is around this number, and even lower if the researcher just is focused on one of these sports [see e.g. Peset *et al.* 2013 for judo]. According to Peset *et al.* [2013: 89], “research into judo is still in its early stages. In quantitative terms, it is obvious that the results exposed above show an insufficient number of documents and citations for stating that is a visible knowledge field”, which is also true for taekwondo [Perez-Gutierrez *et al.* 2015; Perez-Gutierrez *et al.* 2017] and in general for Olympic combat sports.

At the moment, our study shows that only one combat sports-specific journal (*Archives of Budo*) is listed among the top ten journals in the Sport Sciences area of Web of Science database publishing on Olympic combat sports. Indeed, *Archives of Budo* is nowadays the only combat sports-specific journal indexed in the Science Citation Index of the Web of Science, with an impact factor in 2016 of 1.506 (Journal Citations Report). This has several implications: (1) researchers in this field should follow closely the publications in this journal; (2) professionals working directly with combat sport athletes should be encouraged to access this journal to improve their scientific knowledge about the sports they work with; and (3) at least one more journal should try to find this indexation level to increase the diversity of opinions and approaches concerning combat sports. With regard to the latter implication, the martial arts and combat sports-specific journals *Ido Movement for Culture – Journal of Martial Arts Anthropology* and *Archives of Budo Science of Martial Arts and Extreme Sports* have been recently accepted for indexation in the Emerging Sources Citation Index of the Web of Science, which may lead to the increase of combat sports literature indexed in this database in the near future.

Special strategies should be applied to increase the connection among combat sports researchers. Specifically, collaboration with African researchers should be promoted, as a way to include them in the still young combat sports scientific community. Indeed, there exists researchers from this continent who are nowadays active in combat sports research [see e.g., Ben Cheikh, Latiri, Dogui *et al.* 2017; Chaabene, Negra, Bouguezzi *et al.* 2017; Shariat, Shaw, Kargarfard *et al.* 2017; Slimani, Davis,

Franchini *et al.* 2017; Tadesse 2015, 2016], although they are scarce in number. The leading institutions in the field could indicate at least one representative to the creation of a task force to improve research in combat sports, conducting a deeper analysis of our initial results, and developing strategies to encourage researchers from different countries to interact in multi-center studies.

Conclusion

The scientific research about Olympic combat sports indexed in the Web of Science core collection database amounted to nearly 1% of the Sport Sciences research area. This research was mainly published in English (95.35%), in article form (75.14%) and in the United States of America (27.87%). Institutions and sources of publication analysis showed a more balanced output. The bibliometric indexes confirmed that this field of study is still starting to consolidate. The connection between combat sports practice and research, the indexation of more journals specifically devoted to the study of combat sports, and the increase in the number of combat sport researchers and in the collaboration patterns among them are suggested as potential ways to strengthen the volume and impact of Olympic combat sports research.

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Wyniki badań dotyczące olimpijskich sportów walki opublikowane na platformie Web of Science: analiza obejmująca nauki przyrodnicze

Słowa kluczowe: sporty walki, igrzyska olimpijskie, nauki o sporcie, badania naukowe, bibliometria, scientometria

Abstrakt

Tło i cel. Igrzyska Olimpijskie są najważniejszym wydarzeniem sportowym na świecie, a „nauki o sporcie” przyczyniają się do osiągnięcia tam sukcesu sportowego. 20-25% wszystkich medali w tych zawodach przyznawanych jest w sportach walki, boksie, szermierce, judo, taekwondo i zapasach. Natomiast karate zostanie włączone do Igrzysk Olimpijskich w Tokio w 2020 roku. W związku z tym badanie miało na celu opisanie scenariusza

badan naukowych dotyczacych olimpijskich sportow walki w obrębie nauk sportowych.

Metody. Wyszukiwanie danych zostalo przeprowadzone w dziedzinie nauk o sporcie na podstawie bazy danych z *Web of Science*. Zmiennymi wybranymi do analizy byly: calkowita liczba publikacji, indeks-*h*, analizy cytowan i dziesiec najwazniejszych typow dokumentow, krajow, instytucji badawczych, jezykow i czasopism.

Wyniki. Łacznie pobrano 2 752 publikacji, uzyskujac indeks-*h* w 74, 34255 cytowan i srednio 12,45 cytowan na pozycje. Badania zostaly opublikowane glownie w jezyku angielskim (95,35%),

w formie artykulu (75,14%) oraz w Stanach Zjednoczonych (27,87%), podczas gdy Uniwersytet w Sao Paulo (4,69%) oraz *Medycyna i Nauka w Sporcie i Ćwiczeniach* (11,56%) to instytucja i zrodlo prowadzace na liscie dziesieciu najlepszych. Wniosek. Literatura sportowa walki indeksowana w bazie danych *Web of Science* wyniosla prawie 1% obszaru badan Nauk o Sporcie, co wskazuje, ze ten kierunek studiow wciąz sie konsoliduje. Związek między praktyką sportową a badaniami, indeksacja wiekszej liczby czasopism o sportach walki oraz wspolpraca naukowcow, sa wskazywane jako potencjalne sposoby umocnienia badan nad sportami walki.