

BIBLIOMETRICS

FABIANA D.G. REIS^{1(A-G)}, EMERSON FRANCHINI^{2(DEF)}, ANDRE M. CAPRARO^{1(ADEF)}

1 Federal University of Parana (Brazil)

2 University of Sao Paulo (Brazil)

Corresponding Authors: Fabiana D. G. Reis,

Master's student of Physical Education at the Federal University of Parana; e-mail: bia_dgr@hotmail.com , tel.: +55(41)99661-5921

Postal code: Rua Max Schubert, 348, casa 27. CEP – 81720-300. Curitiba, Parana, Brazil.

Researchgate: https://www.researchgate.net/profile/Fabiana_Reis2

ORCID: <https://orcid.org/0000-0002-7529-8054>

Emerson Franchini - e-mail: emersonfranchini@hotmail.com

Researchgate: https://www.researchgate.net/profile/Emerson_Franchini2

ORCID: <https://orcid.org/0000-0002-0769-8398>

Andre M. Capraro - e-mail: andrecapraro@onda.com.br

Researchgate: https://www.researchgate.net/profile/Andre_Capraro

ORCID: <https://orcid.org/0000-0003-3496-3131>

Profile of scientific productions on judo: an analysis of the *Web of Science* database (1956–2019)

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Abstract

Problem and aim. Judo is one of the most popular combat sports in the world. An evaluation of the presence of scientific knowledge, for example, using the Sport Policy Factors Leading to International Sporting Success (SPLISS) model, is necessary to develop high-performance sport. The objective of this work was to map the scientific articles on judo catalogued in the *Web of Science* platform. **Material and Method.** We analyzed variables such as the distribution of these articles by year; distribution by field of knowledge as set by the *Web of Science* platform; scientific journals that published the most on the subject; countries with the highest number of publications; funding agencies that promoted the most research; articles with the most citations; and words most frequently cited as keywords. **Results.** In total, 637 articles published between 1956 and 2019 were analyzed. These works generated an h-index of 42, with an average of 12.7 citations per article. In addition, 75.3% of the studies were published between 2010 and 2019, and 62.9% are catalogued in the Sport Sciences field. In all, 191 journals published research on judo. Brazil published 25.1% of these articles, followed by Poland, with 17.7%.

Conclusions. It was found that there were two milestones for the increased number of research papers published. The first is linked to the inclusion of judo in the 1972 Olympic Games. The second is related to two factors: the overall global increase in scientific publications, and the interest of researchers, for example, Brazilians and Poles, who have adopted this subject as a relevant object of study.

Introduction

Judo – meaning gentle or soft path - is a martial art that was sportivized in the 20th century and is now considered one of the most popular combat sports in the world [Peset *et al.* 2013; Gorner *et al.* 2019; Machado, Plapler 2019]. The number of practitioners has grown

considerably in the last ten years, both in the male and female categories [Machado, Plapler 2019]. Currently, 205 countries and over 40,000 athletes compete in the world circuit of the International Judo Federation [IJF 2020a]. However, the estimated number of practitioners far exceeds this figure, and it would be impossible to make an accurate estimate.

The sport emerged in the late 19th century through the Japanese master Jigoro Kano, during the Meiji era [Tazawa 1973; Kano 2008]. Official competitions, however, started to take place only in the first decades of the 20th century, such as the European Championship in Dresden, in 1934 [IJF 2020b]. Judo was officially introduced in the Olympic Games in 1972¹, and, according to the International Federation, Japan is still the highest reference: "The sport, not surprisingly, has been dominated by the Japanese, who have won three times as many gold medals as their nearest rival France. Other strong countries in Judo today are Korea, Russia, China, Brazil and Cuba." [IJF 2019].

Likewise, until 2010, Japan and France were the countries that produced the most research on the subject [Peset *et al.* 2013]. Thus, academic interest matched the increase in competition. This type of result is not exclusive to judo; the relationship between winning medals and the production of scientific research has been identified for other sports modes [Rees *et al.* 2016]. In addition, after hosting an Olympic Games event, the host countries have recorded an increase in research and, consequently, an increased number of earned medals [Moreira, Franchini 2017; Franchini, Kokubun 2019].

Interest in conducting studies about sport has steadily grown. This concern is important because, according to De Bosscher *et al.* [2006], creators of the SPLISS model (Sports Policy Leading to International Sporting Success), it is necessary to invest in what they called "nine pillars", so that a sport can be developed in a country. The authors state that one of these pillars is scientific research and innovation, and that within this pillar it is necessary to evaluate the evolution of sports science in order to develop the high-performance sport.

In line with this idea of analyzing the evolution of science, Peset *et al.* [2013] conducted a survey of the publications on judo between 1956 and 2010, where 383 articles, published in 162 journals, were analyzed. The results showed that, up to that time, 74.93% of studies had been published between 2001 and 2010. In addition, Franchini *et al.* [2018] analyzed publications on Olympic combat sports catalogued in the *Web of Science*. The authors identified the United States as the country with the most research on the subject, followed by Poland and Brazil. In both studies, the journal *Archives of Budo* was the only one found with an exclusive focus on martial arts and combat sports studies.

It should be noted that judo underwent some changes during this period. For example, in 2009, the International Judo Federation (IJF) established a ranking system to classify Senior athletes for both the World Judo Championship and the Olympic Games [Julio *et al.* 2013]. In this system, athletes earn points from their

ranking in competitions throughout the season; the score may vary according to the level of the competition [IJF 2020c]. Years later, in 2014, IJF established a similar model for the Junior and Cadet classes [Breviglieri *et al.* 2018]. In addition, since 2009, the Judo World Championship has been held annually² [Judo Encyclopedia 2020]. Finally, team competitions were included in the 2020 Tokyo Olympic Games³.

The mixed team event will make its debut at the Tokyo 2020 Games. In this format, teams of three male judoka (under 73kg, under 90kg and over 90kg) and three female judoka (under 57kg, under 70kg, and over 70kg) drawn from the individual competition will join forces to become the inaugural Olympic Judo team champions. Countries with well-rounded men and women teams are expected to do well in this event [Tokyo2020 2020].

One decade after the research by Peset *et al.* [2013], our study hypothesizes about the possible increase in the number of scientific publications based on the aforementioned changes in the modality, which may have caused greater interest and repercussions. Therefore, we recognize the importance of continuing to monitor scientific productions so as to understand how this practice is developing. For this, the objective of the present research was to map the scientific articles whose central theme is judo as catalogued on the *Web of Science* platform. As this work is part of the Sports Intelligence Institute, a project linked to the Federal University of Paraná in partnership with the Brazilian Government's Special Secretariat of Sport, in which the main focus is research related to public policies for sport, greater emphasis has been given to how judo is being researched in the sports field.

Methodological Processes

The *Web of Science* platform was used for data collection since it contains bibliometric indicators, which according to Soares *et al.* [2016]:

Bibliometry is a method of quantitative analysis for scientific research. The data elaborated through bibliometric studies measure the contribution of scientific knowledge derived from publications in certain areas. Production indicators are useful for the planning and execution of public policies, and for the knowledge of the scientific community about the system in which it is inserted [Soares *et al.* 2016:175].

Studies that use this methodology can identify how a theme has been treated in the literature, these trends, their gaps, and also indicate new paths to be traveled [Freitas

¹ Its first appearance in the event was in 1964, but as a demonstration sport.

² Until this date, it was held every two years.

³ Postponed to 2021 due to the pandemic caused by COVID-19.

et al. 2013]. Currently, there are several tools that gather bibliometric information, but the most used are *Scopus*, *Google Scholar Metrics*, and *Web of Science*. According to Mugnaini et al. [2011], the creation of structured information bases enables the researcher to gain a wider view of scientific production. *Web of Science* is considered multi-disciplinary, as it gathers information from the *Science Citation Index* (SCI), *Social Sciences Citation Index* (SSCI), and *Arts and Humanities Citation Index* (AHCI) [Archambault et al. 2009]. *Web of Science* has over 34,000 scholarly journals published worldwide and more than 170 million records, being updated daily [Web of Science 2020].

The descriptor “Judo” was used to perform the search on the platform because, according to Peset et al. [2013], this word is widely accepted and used in most languages that are represented on the *Web of Science* platform. At first, we sought articles that addressed judo and had this descriptor in the title, abstract, or keywords. However, we noticed that many publications diverted from the main theme with studies focused on other sports practices or events (Olympic Games, Military Games etc). For this reason, only the articles containing the descriptor in their title were selected, so that texts dealing primarily with the modality could be assessed. The time frame of this research spanned from 1956, the year of the first publication on the subject provided by *Web of Science*, to 2019. This research was conducted in September 2019 and updated in May 2020.

Eight-hundred forty-one results were found, including articles, books, conference proceedings, letters, posters, reviews, and biographies, among others. As this research aimed to analyze only scientific articles, a filter was used to restrict the search to original and review articles. With this as a filter, a total of 647 publications were found and briefly analyzed. It became apparent that, although some studies were indexed as review articles, they did not meet the criteria. These were either publications on Facebook, or a special issue in a journal. Thus, ten publications were excluded from the sample, resulting in a total of 637 articles to be analyzed in this work. Subsequently, aiming at the objective proposed by this study, some different variables were analyzed, such as: the distribution of these articles by year; distribution by field of knowledge as set by the *Web of Science* platform; scientific journals that published the most on the subject; authors and countries with the highest number of publications; co-authored network; funding agencies that promoted the most research; articles with the most citations; and words most frequently cited as keywords. To account for this last variable, a word cloud was created from the keywords, using Nvivo software, which is one of the main software platforms used in qualitative research [Lage 2011]. Words that had a compound name were unified for better understanding. This software provides different colors based on the number of word appearance, for example, keywords containing seven or more

appearances are indicated as follows: keywords with more than 90 appearances are depicted in orange; keywords with more than 20 citations and less than 90 citations are depicted in black; keywords with more than seven and less than 20 appearances are depicted in light gray.

Results

Among the 637 articles found in the *Web of Science* database, we identified the first article published on the subject, in 1956, entitled “*The philosophical and biological basis of judo*” [Holker 1956]. According to Figure 1, most (75.3%) of the studies were published in the last decade, between 2010 and 2019. These studies generated an h-index of 42, with a total of 8,083 citations (5,344 excluding self-citations) per 3,826 articles (3,370 excluding self-citations), resulting in an average of 12.7 citations per article.

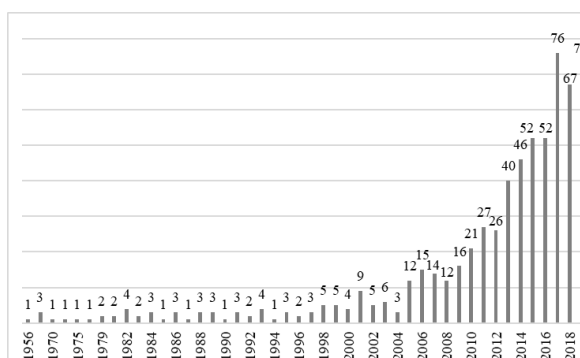


Figure 1. Distribution of publications on judo by year of publication.

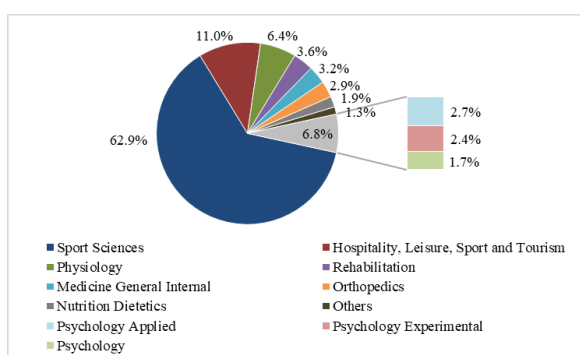


Figure 2. Distribution of publications on judo according to fields of knowledge.

In relation to the fields of knowledge defined by the *Web of Science*, an article may be catalogued in more than one area, increasing the total number of results. The studies were divided into 79 areas; the ten most commonly found are shown in Figure 2. Most of the works related to judo are catalogued in the Sport Sciences field, with 62.9% (400) of the total number of studies. Next comes the field of Hospitality, Leisure, Sport and Tourism with 11% (70), and Physiology with 6.4% (41). *Web of Science*

divides the Psychology field into three different areas - Psychology Applied; Experimental Psychology; and Psychology. Together, they represent 6.8% (43) of the total productions, showing that they are more researched than Physiology.

Table 1. Journals that published the most articles on judo.

ISSN	Journal	n° of publications
1643-8698	Archives of Budo	95
1533-4287	Journal of Strength And Conditioning Research	28
1474-8185	International Journal of Performance Analysis in Sport	26
2300-8822	Archives of Budo Science of Martial Arts And Extreme Sports	23
2082-7571	Ido Movement for Culture Journal of Martial Arts Anthropology	23
0264-0414	Journal of Sports Sciences	17
1827-1928	Journal of Sports Medicine and Physical Fitness	15
2174-0747	Revista de Artes Marciales Asiaticas	13
1640-5544	Journal of Human Kinetics	13
0031-5125	Perceptual and Motor Skills	13

Table 2. Authors who have published the most about Judo.

Author	n° of publications	Country	University
Emerson Franchini	83	Brazil	University of São Paulo
Stanislaw Sterkowicz	33	Poland	Akademia Wychowania Fizycznego im. Bronisława Czecha w Krakowie
Bianca Miarka	20	Brazil	Federal University of Pelotas
Katarzyna Sterkowicz – Przybycien	19	Poland	University of Physical Education in Krakow
Ursula Ferreira Julio	17	Brazil	University of São Paulo
Daniele Detanico	16	Brazil	Federal University of Santa Catarina
David H. Fukuda	15	United States of America	University of Central Florida
Wladyslaw Jagiello	15	Poland	Gdansk University of Physical Education and Sport
Monica Yuri Takito	14	Brazil	University of São Paulo
Rafael Lima Kons	12	Brazil	Federal University of Santa Catarina
Michel Calmet	12	France	Universite Montpellier - Aix-Marseille Université
Fabricio Boscolo Del Vecchio	12	Brazil	Federal University of Pelotas

In all, 191 journals published works on judo. Table 1 shows the ten that published the most. *Archives of Budo* published the highest number of articles on the subject, with 14.9% (95). Among the twelve authors that have published the highest number of articles (Table 2), seven are Brazilian, three Polish, one North American, and one French – each with at least 12 publications, and 83 at most. In addition, Figure 3 shows that there is a constant linking among the authors with more publications. As an example, Emerson Franchini partnered with 10 of the 11 authors, and only Wladyslaw Jagiello did not partner with another author on this list. The countries that have published the most, as shown in Figure 4. Brazil published 25.1% (160) of the works, followed by Poland, with 17.7% (113). The ten agencies that provided the most funding for research on judo are shown in Table 3. Five of them are Brazilian. Among the 637 articles analyzed in this study, 497 (78%) of the studies did not receive financial support, either from government or private initiatives.

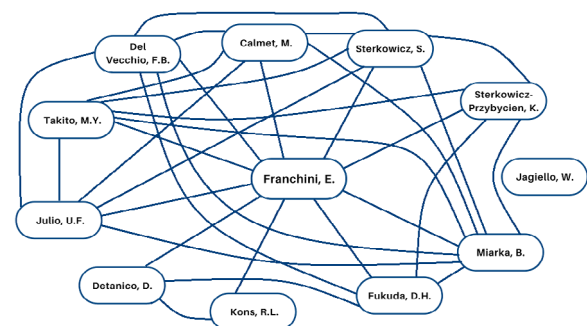


Figure 3. Co-authored map of the authors with more publications.

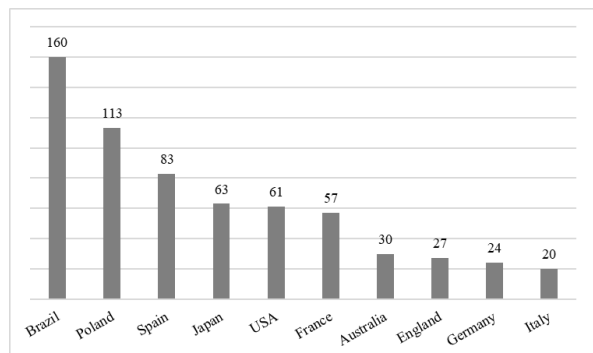


Figure 4. Distribution of publications on judo by country.

Amid the ten most cited articles, two were published in the last decade, a period that comprises the largest number of total publications. The most cited article (233), entitled *Physiological Profiles of Elite Judo Athletes* [Franchini et al. 2011] is also the article with the highest average citation per year (29.1). In addition, the second most cited article (198), entitled *Judo, better than dance, develops sensorimotor adaptabilities involved in balance control* [Perrin et al. 2002], is also among the three publications with the highest average citation per year (11.6), followed by the article *Prevalence, Magnitude, and Methods of Rapid Weight Loss among Judo Compet-*

more research [Franchini *et al.* 2018; Franchini, Kokubun 2019].

Another factor that must be considered regarding the increase of studies focusing on judo is the global increase of research in general. The study by Peset *et al.* [2013] showed that, between 2001 and 2010, 112 studies on judo were published. Ten years later, this number had increased, amounting to 459 publications between 2011 and 2019. Moreover, between 2006 and 2016, the average global scientific production increased by 46.4% [National Science Foundation 2018]. In comparison, judo-related studies catalogued on the *Web of Science* platform increased by 246.7% over the same period. These data show that the interest in researching the modality is beyond the global average of interest in publishing. This phenomenon is also observed in other modalities. In a 10-year period, between the first and second decades of the 21st century, the number of articles about surfing increased its production in 192.3% [Perez-Gutierrez, Cobo-Corrales 2020], handball increased by 740.0% [Prieto *et al.* 2015], artistic gymnastics increased by 800.0% [Vargas, Capraro 2020], and taekwondo increased by 3200.0% [Pérez-Gutiérrez *et al.* 2015]. In addition, studies in sports sciences had an increase in the publication of 3500.0% between 2005 and 2015 [Pérez-Gutiérrez *et al.* 2018].

Also noteworthy is the growing interest in research on combat sports and martial arts, to the point where journals dealing exclusively with the subject have emerged. According to Peset *et al.* [2013] and Franchini *et al.* [2018], *Archives of Budo* was the only journal among the top ten publications that focused exclusively on the study of combat sports and martial arts. In our study, four journals illustrate this growing interest: *Archives of Budo*; *Archives of Budo Science of Martial Arts and Extreme Sports*⁴; *Ido Movement for Culture Journal of Martial Arts Anthropology*; and *Revista de Artes Marciales Asiaticas*. This might be explained by the fact that such journals were recently launched, as all of them were created in the 21st century.

As the number of articles increased, so did the number of citations, as in 2010 the average was 6.03 citations per article [Peset *et al.* 2013]. The result found in this work (12.7) is close to the one from a study on all Olympic combat sports, in which the average number of citations per article is 12.5 [Franchini *et al.* 2018]. In addition, the predominance of studies catalogued in the Sport Sciences field remains. Although the three fields of knowledge that had the most publications until 2010 were linked to Biological and Health Sciences [Peset *et*

al. 2013], currently, there is an inversion. The second most published field - Hospitality, Leisure, Sport and Tourism - is linked to Social Sciences and Humanities. As much as there is still a preference from the researchers in studies related to Biological and Health Sciences, as evidenced by the other categories in Figure 2, their interest in more sociological studies related to Social Sciences and Humanities has increased. One of the reasons for this growth may also be connected to the indexing of the *Ido Movement for Culture Journal of Martial Arts Anthropology* on the *Web of Science* platform, as it focuses on sociological research.

Brazil has seven researchers with more than 12 publications, and it is also the country with the most research on judo. The large number of publications linked to the country is mainly explained by the fact that there is a research group focused on studies related to the theme. In this group, *Grupo de Estudos e Pesquisas em Lutas, Artes Marciais e Modalidades de Combate* (Martial Arts and Combat Sports Research Group) [CNPQ 2020], the coordinator is Emerson Franchini, who is also the researcher with more publications in this field. Peset *et al.* [2013] reported that institutional exchanges are recurrent in judo research. This is likely due to the existence of research groups, which allow authors to work in partnership, both with researchers from the same group and with others.

Another relevant factor is that Brazil is not only interested in judo-related research, but also in combat sports in general [Peset *et al.* 2013; Franchini *et al.* 2018]. Another factor that indicates this interest is that Brazil was the country that provided the most funding for research on the subject, through five different funding agencies. Of the ten agencies highlighted in Table 2, the only private one is the German Research Foundation. Some studies have also been financed by more than one funding agency. De Bosscher *et al.* [2015] states, based on the SPLISS model, that

[...] different countries may create competitive advantages just by developing strength in one (or a few) pillar(s) over others. For example, Australia has the strongest level of development in pillar 9 (research) but scores below the average in pillar 8 (international competition) [De Bosscher 2014:2].

This shows that it is possible for a country to develop sport by investing in only one pillar, which can be that of scientific research. However, in order to achieve better results, full dedication to the nine pillars proposed by the author is necessary.

In fact, 78% of the articles in this study did not receive financial support. This result is not limited to judo: research on combat sports, between 2000 and 2009, showed that 93% of the studies had not received financial support [Gutierrez-Garcia *et al.* 2011]. This indicates that investment in combat sport research is quite recent

⁴ The journals *Archives of Budo* and *Archives of Budo Science of Martial Arts and Extreme Sports* have similar names as they share the same origin and editorial group, but the first one accepts articles that present various perspectives on combat sports, while the second is more focused on high-performance and military training.

[Franchini, Del Vecchio, 2011].

As previously mentioned, from 2006 onward the number of studies on judo has increased, leading to a greater variety of research approaches, methods, and techniques. These results may be linked to each article's number of citations. It is worth highlighting that the number of citations needs to be ascertained year per year, considering that, if only the gross number is taken into account, an older publication would certainly have an advantage over a more recent one. For example, the oldest article among the most cited, published in 1983 [Gelman, Salop 1983], has a gross citation number of 118 citations, but only an average of 3.27 citations per year. The study entitled "Prevalence, Magnitude, and Methods of Rapid Weight Loss among Judo Competitors" [Artioli *et al.* 2010], on the other hand, was cited 106 times (fewer times than the aforementioned one) but presents a higher average of citations per year (11.4), the second-highest among the most cited. Moreover, the article entitled "Physiological Profiles of Elite Judo Athletes" [Franchini *et al.* 2011] was the most cited one (233), as well as the one with the highest average of citations per year (29.12), which shows its relevance to the academic environment and the researchers' interest in this subject.

Finally, in the keyword cloud, surrounding the most found (in larger print) words, there are medium-sized words, which were mentioned more than 20 times. Most of these are linked to studies of Biological and Health Sciences, such as training, analysis, athletes, strength, competition, test, exercise, muscle, weight, power, injury, and anaerobic. This reinforces the idea that research on judo is still primarily linked to Biological and Health Sciences. The same trend was observed in other Olympic sports [Perez-Gutierrez *et al.* 2018; Perez-Gutierrez, Cobo-Corrales 2020; Vargas, Capraro 2020].

Final Considerations

This study aimed to map the scientific articles produced on judo catalogued on the *Web of Science* platform; 637 results were found and analyzed. It was observed that the modality in question has been studied since 1956. The most significant increase in the frequency of publications, however, only occurred after judo officially joined the Munich Olympic Games, in 1972. A new leap in the number of publications per year was also observed from the beginning of the 21st century. This fact may be associated with two factors: the global increase of scientific publications, and the interest of authors, such as Brazilians and Poles, who have adopted the modality as a relevant object of study. Consequently, there was also an increase in journals specialized in combat sports and martial arts. Besides that, it was possible to perceive the importance of research groups for the deepening and production on a certain theme. In this case, a group

located at the University of São Paulo (Brazil) increased the number of judo publications worldwide.

The survey showed that most of the articles published on judo were catalogued in the Sport Sciences field of the *Web of Science* platform and are principally focused on Biological and Health Sciences; a fact that can also be observed through the keywords of the articles. However, there has been an increase in researchers' interest regarding sociological research. It was observed that only one of the agencies that funded the scientific research analyzed in this study came from private initiative. Approximately 80% of the publications did not receive financial resources from these agencies, showing a lack of government investment in one of the pillars of the SPLISS model for sport development.

This study sheds light on the tendencies of judo-focused research, as well as identified a lack of studies related to Social Sciences and Humanities, an alert for future publications. Furthermore, studies including the descriptors "judoka" and "judoist" are necessary in order to create a global understanding of the sport.

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Profil materiałów naukowych na temat judo: analiza bazy danych Web of Science (1956–2019)

Słowa kluczowe: sporty walki, sztuki walki, nauka o sporcie, przegląd systematyczny, publikacje, bibliometria

Streszczenie

Problem i cel. Judo to jeden z najpopularniejszych sportów walki na świecie. Ocena obecności wiedzy naukowej, na przykład przy użyciu modelu *Czynniki polityki sportowej prowadzą do międzynarodowego sukcesu sportowego* (SPLISS (SPLISS)), jest niezbędna do rozwoju sportu wyczynowego. Celem tej pracy było zmapowanie artykułów naukowych dotyczących judo skatalogowanych na platformie Web of Science.

Materiał i metoda. Autorzy przeanalizowali zmienne, takie jak: rozkład tych artykułów według roku; dystrybucja według dziedzin wiedzy zgodnie z platformą Web of Science; czasopisma naukowe, które najczęściej publikowały na ten temat, kraje o największej liczbie publikacji, agencje finansujące, które promowały najczęściej badań, artykuły z największą liczbą cytowań oraz słowa najczęściej cytowane jako słowa kluczowe.

Wyniki. W sumie przeanalizowano 637 artykułów opublikowanych w latach 1956-2019. Prace te wygenerowały indeks h równy 42, ze średnią 12,7 cytowań na artykuł. Ponadto 75,3% badań opublikowano w latach 2010-2019, a 62,9% skatalogowano w dziedzinie nauk o sporcie. W sumie 191 czasopism opublikowało badania nad judo. Brazylia opublikowała 25,1% tych artykułów, a po niej Polska z 17,7%.

Wnioski. Stwierdzono, że zwiększenie liczby opublikowanych artykułów naukowych miało dwa kamienie milowe. Pierwszy wiąże się z włączeniem judo do igrzysk olimpijskich w 1972 roku. Drugi wiąże się z dwoma czynnikami: ogólnym wzrostem publikacji naukowych na świecie oraz zainteresowaniem badaczy, np. Brazylijczyków i Polaków, którzy przyjęli ten temat jako istotny przedmiot badań.