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## Bibliometric analysis of taekwondo ...

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## Bibliometric analysis of taekwondo articles published in the Web of Science (1989–2013)

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### Abstract

**Aim.** The aim of the present study was to provide an overview of the scientific literature on taekwondo indexed in the Web of Science main databases (SCI-Expanded, SSCI and A&HCI) until 2013.

**Method.** For that purpose, a bibliometric analysis focused on the distribution of articles per year, research areas, authors, countries represented and journals was performed. One-hundred-seventy-six articles were retrieved from 1989 to 2013, with an increase from 2009 onwards.

**Results.** Among the 38 research areas observed, Sport Sciences accounted the highest percentage (57.4%), whereas Pieter resulted the most represented author (i.e., 15 contributions). South Korea, the USA and Turkey produced the 45.5% of the retrieved papers, whereas the *Journal of Strength and Conditioning Research* resulted the journal which published the majority of taekwondo articles (i.e., 5.6%).

**Conclusions.** An overview on how the inclusion of taekwondo within the Olympic programme, the development of the Sport Sciences field, and the increase of the Web of Science master journal list could explain the important rise of the scientific production on taekwondo was provided. Despite the considerable amount of research areas, authors, countries and journals involved in taekwondo research, there is a scarcity of scholars developing a continuous and solid research on this martial art.

### Introduction

Taekwondo is arguably among the most important martial arts and combat sports worldwide in considering that it is an official Olympic sport practiced by several millions of athletes [Svinth 2010; WTF 2014c]. Moreover, taekwondo has grown rapidly from 1988 due to its inclusion as a demonstration sport within Seoul Olympic Games [WTF 2014a]. From that time onwards, the number of affiliated countries has increased progressively reaching 205 members [WTF 2014b]. Furthermore, several institutions have been established to manage the development of taekwondo (i.e. the World Taekwondo Federation (<http://www.worldtaekwondofederation.net/>); the International Taekwondo Federation ([www.tkd-itf.org](http://www.tkd-itf.org)); the International Taekwondo Association (<http://www.itatkd.com/>); the World Taekwondo Headquarters – Kukkiwon (<http://www.kukkiwon.or.kr>)).

The popularity of taekwondo started to catch the attention and interest of the scientific community in the last decades of the 20th century, producing a great variety of specific literature about this martial art. For example, Fong and Ng [2011] reviewed 23 papers related to physical fitness improvement through taekwondo, while Pieter, Fife and O’Sullivan [2012] found 41 studies regarding competition injuries in taekwondo, and Lystad, Swain and Graham [2013] included 16 studies in their review on risk factors for injury in Olympic-style competition taekwondo. Nevertheless, as far as we know an attempt for globally evaluating the current state of taekwondo scientific research has not been published in a scientific journal to date. The only similar study we have found was presented at the 4th International Symposium for Taekwondo Studies (Puebla, México) in 2013, for which just a short abstract is available [Costa-Guajardo 2013].

To globally evaluate the scientific research on a certain field, bibliometrics has proven to be "the main tool of science, quantitative analysis" [Thomson Reuters 2008]. Bibliometrics is the application of statistical methods to different information, in particular to scientific literature [Pritchard 1969]. It is mainly focused in three aspects such as productivity, collaboration and citation. Productivity refers to the distribution of articles, works among authors, journals, topics, etc. Collaboration refers to the relationship among different authors who work together (or not), while citation analysis is focused on the usage and impact of cited works and articles [López 1996]. The usefulness of bibliometrics can be observed in a wide variety of analyses, including: i) the representation of authors, topics, and type of documents within a research area; ii) authors' cooperation within a certain research area; iii) the citation pattern; and iv) the representation of journals and their impact factor [López 1996]. Thus, bibliometrics is a crucial tool for investigating the evolution of science in general, the development of a particular research area, and to assess research performance [Thomson Reuters 2008].

Bibliometrics has been recently applied to martial arts and combat sports. Studies include the scientific literature on judo [Peset, Ferrer-Sapena, Villamón *et al.* 2013], karate [Čihounková, Reguli 2011; Pérez-Gutiérrez, Gutiérrez-García 2009] or martial arts and combat sports in general [Gutiérrez-García, Pérez-Gutiérrez, Tuero-Calderón 2011; Pérez-Gutiérrez, Gutiérrez-García 2008]. Nevertheless, to our knowledge a bibliometric approach to taekwondo scientific research has not been available until recently [Costa-Guajardo 2013]. As said, this study was presented at The 4th International Symposium for Taekwondo Studies but unfortunately the short abstract published in the proceedings of this meeting

makes not possible to assess the reliability of this study. Therefore, the aim of the present study was to develop a bibliometric analysis on taekwondo research collected in the Web of Science, one of the most influential scientific databases nowadays.

## Methods

### *Object of study*

Taekwondo articles or reviews indexed until 2013 in the Web of Science (WoS) main databases such as Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI) were included in the present study. Other document types such as book reviews, editor's notes or letters were not included. Articles or reviews should be focused on taekwondo or including taekwondo practitioners among their sample.

### *Document search*

Regarding searching strategies, according to Pérez-Gutiérrez, Gutiérrez-García and Escobar-Molina's [2011] recommendations the terms "taekwondo", "taekwando", "tae-kwon-do", "tae-kwan-do", and "taekwon-do" were used for data collection. A unique search was carried out linking these terms by the Boolean operator "OR" for retrieving all taekwondo variants and avoiding double documents. To obtain a comprehensive data retrieval a temporal interval between 1900 and 2014 was set according to WoS recommendations since "year selection refers to the processing year" [Thomson Reuters 2009]. This means that documents published in the late months of 2013 could have been processed in 2014. Once filtered by real year of publication, only articles and reviews

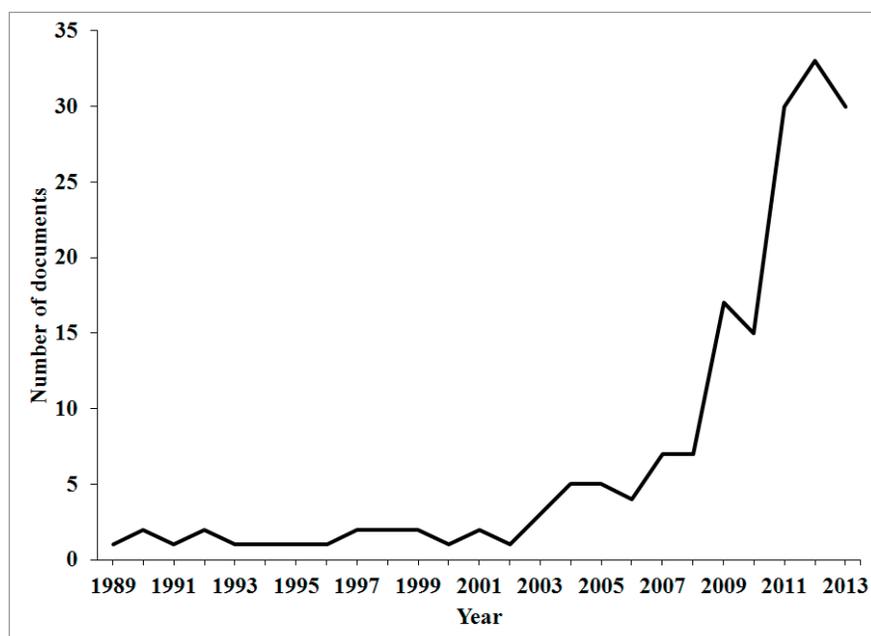


Figure 1. Distribution of taekwondo articles per year of publication.

were considered eligible to be included in the analysis, using the WoS “Refine Results” tool for selecting them. Secondly, only studies focused on taekwondo or including taekwondo practitioners in their sample were considered eligible to be included in the analysis, consulting documents’ title and abstract for that purpose. In some cases, access to full text was necessary for determining their inclusion. Data mining was performed on May, 2014.

*Data analysis*

Data were exported to Endnote X6 reference manager software to perform the analysis. First, results were verified individually according to inclusion criteria. Once the final list of articles was complete, it was re-entered in the WoS database to develop the bibliometric analysis. Descriptive statistics were used for data analysis in relation to the distribution of articles per year, the research area, authors, countries involved and journals.

**Results**

A total of 176 articles were retrieved, published from 1989 to 2013 in the WoS. As shown in Figure 1, the distribution of taekwondo papers along time presented a steady state period until the beginning of the first decade of the 21<sup>st</sup> century, in which less than 1.2% of total articles were published by year. This was followed by a slight rise from that time to 2008 (2.8 to 4.0% of total articles by year), and a considerable increase from 2009 onwards, reaching a peak in 2011 (9.7 to 18.8% of total articles by year).

Regarding research areas represented in taekwondo papers, a total of 38 different research areas were observed, which shows the wide variety of areas involved in this research domain. Sport Sciences accounted for

57.4% of total (see Figure 2), followed by Psychology and Rehabilitation (7.9% and 6.2%, respectively). Conversely, a group of 28 research areas (73.7% of the total) were represented by ≤ 4 papers each.

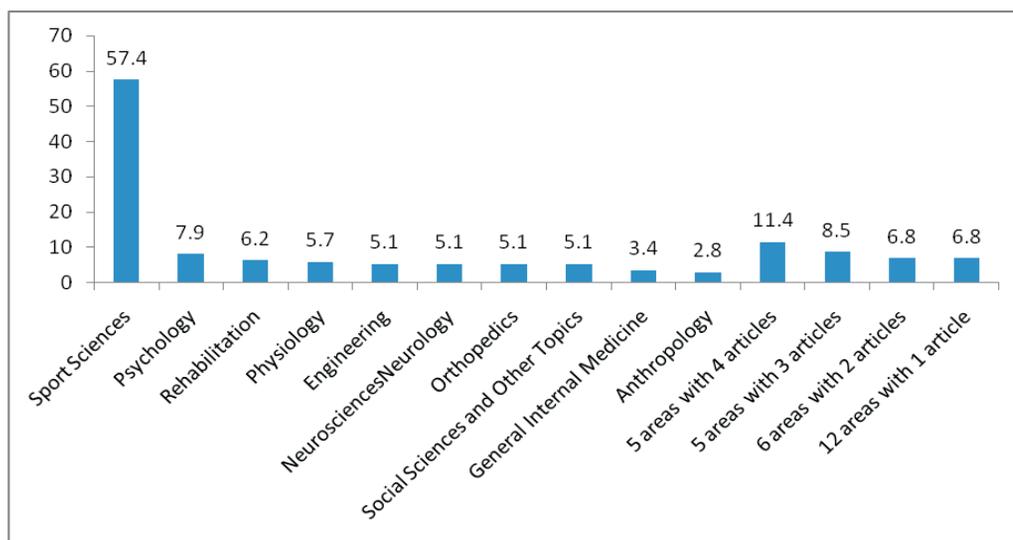
In considering authorship, a total of 476 authors were identified (Table 1). Among them, Pieter resulted the most represented with 15 contributions (8.5%) published. Chiodo, Capranica and Falco emerged as important contributors in taekwondo research since they respectively coauthored the 4.5% and 4% of total papers. Conversely, the 79.2% of total authors have published one article only.

Also regarding authorship, we studied the collaboration index, which refers to the ratio of authors writing papers. In this way, authors signing each paper ranged between 1 and 13 (*M* = 2.7): 1 author (8%); 2 authors (16.5%); 3 authors (28.4%); 4 authors (17%); 5 authors (13.6%); 6 or more authors (16.5%).

**Table 1.** Percentage of taekwondo articles distributed by authorship.

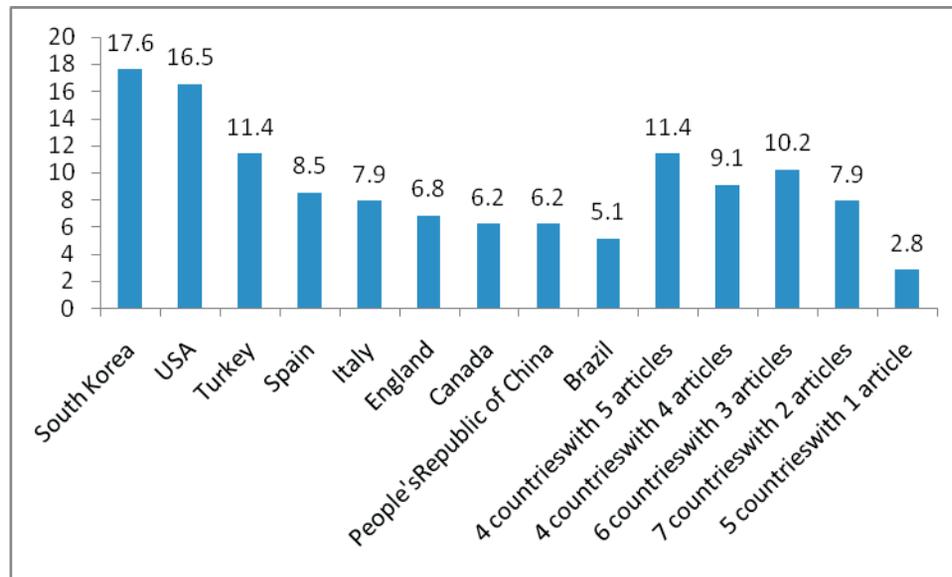
Author	%
Pieter, W.	8.5
Chiodo, S.	4.5
Capranica, L.	4.0
Falco, C.	4.0
Cortis, C.	3.4
Estevan, I.	3.4
Lupo, C.	3.4
Tessitore, A.	3.4
5 authors with 5 articles	14.2
6 authors with 4 articles	13.6
34 authors with 3 articles	54.5
48 authors with 2 articles	54.5
377 authors with 1 article	214.2

Note: % with respect to the total number of taekwondo papers published (n = 176).



Note: % with respect to the total number of taekwondo papers published (n = 176).

**Figure 2.** Percentage of taekwondo articles distributed by research area.



Note: % with respect to the total number of taekwondo papers published (n = 176).

**Figure 3.** Percentage of taekwondo articles distributed by countries.

According to the distribution of taekwondo papers by country, a total of 35 different countries were observed (Figure 3). South Korea resulted the most represented country with the publication of the 17.6% of total articles, followed by the USA (16.5%) and Turkey (11.4%). These three countries therefore gathered the 45.5% of total taekwondo research. Moreover, nine countries (South Korea, USA, Turkey, Spain, Italy, England, Canada, People's Republic of China and Brazil) collected the 86.4% of total research on taekwondo.

**Table 2.** Percentage of taekwondo articles distributed by journals.

Journal	%
Journal of Strength and Conditioning Research	5.7
British Journal of Sports Medicine	5.1
Journal of Sports Science and Medicine	5.1
Perceptual and Motor Skills	5.1
Archives of Budo	4.5
Biology of Sport	4.5
Collegium Antropologicum	2.8
Journal of Sports Medicine and Physical Fitness	2.8
European Journal of Applied Physiology	2.3
International Journal of Sports Physiology and Performance	2.3
2 journals with 4 articles	4.5
9 journals with 3 articles	15.3
14 journals with 2 articles	15.9
50 journals with 1 article	28.4

Note: % with respect to the total number of taekwondo papers published (n = 176).

Finally, scientific literature on taekwondo has been published in 83 different journals. The Table 2 reports the ten most relevant scientific journals in this research area. Among them, the *Journal of Strength and Condition-*

*ing Research* accounted for the 5.7% of total documents, followed by *The British Journal of Sports Medicine*, the *Journal of Sports Science and Medicine* and *Perceptual and Motor Skills* (5.1% each). It should be also highlighted the appearance of a journal specifically dedicated to martial arts and combat sports, *Archives of Budo*, which published the 4.5% of taekwondo articles as well. Conversely, a group of 50 journals (60.2%) published one article only.

## Discussion

This study collected a total of 176 articles indexed in the WoS main databases until 2013. Most of them were published from 2009 onwards. Sport Sciences has become the most productive research area, while 476 authors have been involved in taekwondo research highlighting Pieter who has co-authored the 8.5% of total articles. Among countries supporting taekwondo research, South Korea resulted the most represented one, followed by the USA and Turkey. Finally, 83 different journals have participated in the publication of these papers, being the *Journal of Strength and Conditioning Research* the most represented.

The presence of taekwondo articles in the WoS databases started in 1989 but it did not showed an increase until 2003 and onwards, being most of taekwondo papers (71%) published from 2009 to 2013. To understand the reasons supporting this publishing development, several factors should be considered. In particular, taekwondo publications could be related with its inclusion within the Olympic programme, the growth and development of the Sport Sciences research area, and the increase of the number of journals included within the WoS master journal list.

The international relevance of taekwondo, supported by its Olympic status, has triggered the development of its technical [Moenig 2011; Moenig, Cho, Song 2012] and tactical characteristics, [Kwok 2012; Menescardi Royuela, Bermejo, Herrero *et al.* 2012], its competition rules and technology [Del Vecchio, Franchini, Del Vecchio *et al.* 2011; Moenig *et al.* 2012; O'Sullivan, Fife, Pieter *et al.* 2013; Ramazanoglu 2012; Woo, Ko, Choi *et al.* 2013], as well as the interest of coaches and scholars in describing and improving the performances of taekwondo athletes [Bercades and Pieter 2007; Bouhlel, Jouini, Gmada *et al.* 2006; Bridge, Jones, Hitchen *et al.* 2007; Butios, Tasika 2007; Casolino, Lupo, Cortis *et al.* 2012; Chiodo, Flotti, Davalli 2010; Estevan, Álvarez, Falcó *et al.* 2014; Haddad, Chaouachi, Wong *et al.* 2011; Markovic, Vucetic, Cardinale 2008; Pieter 2010; Pieter, Heijmans 2007].

Secondly, it could be also related with the growth and development of the Sport Sciences research area, in considering the constant and progressive increase of scholars interest in this particular scientific domain.

Thirdly, Thomson Reuters reviews over 2,000 journals every year for being included within the WoS master journal list. Around 10-12% of these journals are finally included [Testa 2012], suggesting that the relevance of WoS coverage, is widening each year.

Nevertheless, to assess the relevance of taekwondo research and its scientific production it should be compared with other martial arts. In this respect, Peset *et al.* [2013] analysed the scientific literature on judo published in the WoS using a similar methodology compared to the present study. In particular, the authors included all research articles and reviews, with no limit on publication year or language, presented in the Science Citation Index and Social Science Citation Index. A total of 383 contributions since 1956 were observed, being most of them (74.93%) published between 2001 and 2010 [Peset *et al.* 2013]. Although there is a considerable difference in the total amount of papers retrieved between the two studies (176 on taekwondo articles vs. 383 on judo), probably due to the earlier history of judo as a globalized martial art and combat sport [Brousse, Matsumoto 1999; Gutiérrez-García 2004; Sato 2013], these findings show a similar pattern of publication. In fact, as said the 71% of taekwondo papers were published from 2009 to 2013.

Regarding the research areas involved in taekwondo articles the Sport Sciences research area is the main one achieving the 57.4% of total papers. While artistic, cultural and self-defence practices are popular among many taekwondo practitioners [Svinth 2010], competitive approach is leading its practice worldwide since 205 countries are members of World Taekwondo Federation [WTF 2014b]. Other research areas supporting taekwondo competitive approach are Psychology, Rehabilitation and Physiology, which published the 8%, 6.3%, and 5.7% of total papers respectively. On the other

hand, the 31.6% of research areas have only published one article, showing the appearance of new fields of study for improving taekwondo's understanding such as Asian Studies [Cho, Moenig, Nam 2012], Behavioural Sciences [Pettersson, Ekstrom, Berg 2012] or Physics [Lee, Lee, Han 2008], to name a few. Leading topics among taekwondo researchers include injuries, force analyses and physiological variables related to taekwondo training and competition.

In considering the articles' authorship, a total of 476 scholars emerged, highlighting the contribution of Pieter, who has become a reference source with the publication of the 8.5% of total articles. Other authors with a considerable amount of publications are Chiodo (4.5%), Capranica (4%) and Falco (4%). These authors have studied taekwondo from different viewpoints but they have been mainly focused on certain topics such as Pieter on taekwondo injuries, Chiodo and Capranica on physiological variables, and Falco on taekwondo biomechanics. On the other hand, nearly 80% of listed authors have only published one paper about taekwondo that could be interpreted as a sporadic approach to taekwondo research that does not present a subsequent development. Also, taking into consideration the rate of articles and scholars (176 vs. 476), it should be pointed out that taekwondo research seems to present a collaborative pattern with an article/author index of 2.70, what it is similar to Peset *et al.*'s [2013] results of 2.40 for those academics publishing 5 or more articles.

South Korea, birthplace of taekwondo, has produced the highest number of studies on taekwondo. A considerable amount of publications accounted also for the USA, probably due to the popularity of taekwondo in that country and its general research development. In fact, according to SCIMAGO [2014], the USA is at the top of the country ranking of papers published between 1996 and 2013. Regarding Turkey, its relevance in the scientific production on taekwondo could be due its important sport results in this combat sport at international level [TaekwondoData 2014]. In any case, it also has to be considered that most of the journals indexed in the WoS are published in English what represents a handicap for those no English-speaking authors [Archambault *et al.* 2006; Leon-Sarmiento *et al.* 2007; Van Leeuwen *et al.* 2001]. Few journals are published in other languages and they should provide additionally the article's title, abstract and keywords in English for its final indexation in the WoS.

Finally, regarding the distribution of articles by journal, only ten journals have published four or more articles, so this group of journals collects the 40.3% of total documents. Moreover, it should be highlighted the role played by Sport Sciences journals for presenting taekwondo research results since there is only one journal, *Archives of Budo*, dedicated to martial arts and combat sports specifically. However, *Archives of Budo*

is in fifth place with the publication of the 4.5% of total taekwondo articles, strengthening its specialisation and widening its martial arts coverage [Peset *et al.* 2013]. On the other hand, the dispersion of taekwondo articles is evident as the 59.7% of total articles were published in 73 (88%) different journals. Taekwondo's sporting approach together with the prevalence of Sport Sciences research orientation seems to play a key role for understanding this situation.

## Conclusion

The present study has highlighted the important rise of taekwondo scientific production published in the Web of Science, especially from 2009 onwards. Reasons that could explain the development of taekwondo research are its inclusion within the Olympic programme, the growth and development of the Sport Sciences research area and the increase of WoS master journal list each year.

A considerable amount of research areas, authors, countries involved and journals have been observed, although this fact should not conceal that there is a scarcity of scholars developing a continuous, solid research on this martial art. In this framework, there is a need to implement the research activity in this field.

Bibliometric analysis of taekwondo research considering other databases as Google Scholar, Scopus, Pubmed, SportDiscus, Eric, PsycINFO, or Scielo, as well as other type of documents as books or conference proceedings should be performed for obtaining a clearer and more realistic view of international taekwondo research. The language barriers presented by the WoS and other English language-based databases should be also considered as an important mediating factor in the assessment of this research. In this way, our study represents a no comprehensive overview of taekwondo research indexed in one of the important databases nowadays, and becomes a first approach to this growing field of study.

Future studies should consider the limitations cited above. Also, future studies should analyse the relationship between sport results and scientific production on taekwondo, since a possible bond between most prolific countries on judo research and those countries which won medals in World Judo Championship in Paris 2011 and Olympic Games in London 2012 was stated by Peset *et al.* [2013] in their study about judo.

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### **Bibliometryczna analiza artykułów dotyczących taekwondo opublikowanych w „Web of Science” (1989-2013)**

**Słowa kluczowe:** bibliometryka, literatura naukowa, przegląd, taekwondo, „Web of Science”

#### **Abstrakt**

Wstęp. *Taekwondo* jest prawdopodobnie jednym z najważniejszych sportów walki / sztuk walki na całym świecie, a jego popularność zwróciła uwagę społeczności naukowej już w ostatnich dekadach 20 wieku. Niemniej jednak, o ile autorom wiadomo, próba ogólnej oceny aktualnego stanu badań dotyczących taekwondo nie została do tej pory opublikowana w czasopiśmie naukowych. Stąd celem niniejszego badania było przedstawienie przeglądu naukowego rozwoju taekwondo przez bibliometryczną analizę artykułów dotyczących tego sportu opublikowanych w „Web of Science”.

Metody. W niniejszym badaniu uwzględnione zostały artykuły lub recenzje dotyczące taekwondo indeksowane w „Web of Science” (SCI-Expanded, SSCI i & HCI) do roku 2013. Dane zostały przeniesione do Endnote X6 dla oceny roku publikacji i tematów uzyskanych artykułów do ich ostatecznego włączenia / wyłączenia z badania. Następnie dokumenty zostały ponownie wprowadzone do „Web of Science” w celu przeprowadzenia analizy bibliometrycznej, która skupiła się na ilości publikacji artykułów rocznie, obszarze badań, autora, kraju i rodzaju czasopisma.

Wyniki. Łącznie 176 artykułów zostało pobranych, opublikowanych od 1989 do 2013 roku, z tego 71% prac zostało

opublikowanych w latach 2009 i 2013. Wśród 38 różnych obszarów badawczych, artykuły opublikowane w Sport Sciences stanowiły 57,4% wszystkich artykułów, natomiast w grupie 12 obszarów badawczych odnotowano po jednym artykule. Jeśli chodzi o autorów, 476 autorów było zaangażowanych w badania taekwondo, w tym Pieter był autorem 15 artykułów, a 377 autorów (79,2%), opublikowało tylko po jednym artykule. Jeśli chodzi o kraje biorące udział w badaniach taekwondo to stwierdzono ich w sumie 35, z Koreą Południową jako liderem (17,6% wszystkich artykułów), następnie USA i Turcją (16,5% i 11,4% wszystkich publikacji). Literatura naukowa na temat taekwondo została opublikowana w 83 różnych czasopiśmie, najwięcej w „Journal of Strength and Conditioning Research” (5,7%), a następnie w „Archives of Budo” (czyli czasopiśmie dot. sztuk walki) (4,5%) .

Dyskusja. Wyniki sugerują, że rozwój badań taekwondo mógł być związany z jego włączeniem do programu olimpijskiego, wzrostem i rozwojem dziedziny nauk o sporcie oraz zwiększeniem liczby czasopiśmie uwzględnionych na liście czasopisma „Web of Science”. Znaczący był też fakt, że 205 krajów stało się członkami Światowej Federacji Taekwondo. Stwierdzono także fakt współpracy badaczy, gdyż wiele opublikowanych prac miało dwóch lub więcej autorów. Jeśli chodzi o zaangażowanie w badania taekwondo to Korea Południowa, jako miejsce narodzin taekwondo, miała najwięcej opublikowanych analiz dotyczących tego sportu, na kolejnych miejscach były USA i Turcja.

Wnioski. Włączenie taekwondo do programu olimpijskiego, rozwój badań w dziedzinie nauk o sporcie, wzrost znaczenia listy publikacji „Web of Science” mogły przyczynić się do istotnego wzrostu prac dotyczących taekwondo indeksowanych w „Web of Science” od 2009 r. Pomimo znacznej ilości obszarów badawczych, autorów, krajów i czasopiśmie dotyczących badań taekwondo, istnieje niedobór uczonych zajmujących się ciągłymi i solidnymi badaniami nad tym sztukami walki.