

THE PROFILE OF THE ACADEMIC PRODUCTION ON MEN'S ARTISTIC GYMNASTICS FROM THE WEB OF SCIENCE AND SCOPUS

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Abstract

The objective of this study was to describe the scientific production on men's artistic gymnastics (MAG) in journals indexed on the Scopus and Web of Science platforms. To this end, we searched on both platforms for the keywords "men's artistic gymnastics" and "male artistic gymnastics", with a non-specified date range. After applying the exclusion criteria, 52 scientific articles were found, distributed between 1994 and 2019. The year with the highest number of publications so far is 2018, with emphasis on the period between 2014 and 2018. The authors who contributed the most were Maurice Yeadon and Michael Hiley (both from British universities), Marco Bortoleto (from Brazil), and Ivan Čuk (from Slovenia). There is a predominance of MAG-related articles in the Science of Gymnastics Journal (21%), followed by the Journal of Biomechanics (7%). The articles deal with the biomechanics of gymnastics (34%), the rules of the sport and its judging (19%), the social, historical and political aspects of gymnastics (14%), morphological characteristics of athletes (10%), athletes' health (10%), gymnastics training aspects (8%), and finally, analyses of athletes' age over the years (6%).

Keywords: *scientific production, bibliometric, web of science, scopus.*

INTRODUCTION

Artistic gymnastics has been part of the Olympic Games since its first edition, in 1896, and has officially been in the Olympic programme since 1924, undergoing several changes since then. From these changes, we may highlight the following: the nomenclature change from Olympic gymnastics to artistic gymnastics, the change in the equipment used and its technical requirements, and the inclusion of the modality for women (Atiković, Kalinski, & Smajlović, 2017; Carrara, Amadio, Serrão, Irwin, & Mochizuki, 2016; Oliveira & Bortoleto, 2011; Pajek, 2015; Schiavon & Locci, 2018).

The studies by Silva, Santos-Rocha and Barata (2016) emphasize that there is currently a greater participation of women

in artistic gymnastics when compared to men. Such majority is also found when searching for scientific production about the sport. For example, Mkaouer, Hammoudi-Nassib, Amara and Chaabène (2018) claim that while there are several studies on the identification of talents for women's artistic gymnastics (WAG), there are few studies on the same matter regarding the men's sport. By conducting an initial search on the main academic platforms (*Scopus, Web of Science, PubMed, and Google Scholar*), it was possible to identify the scarce literature on men's artistic gymnastics (MAG). In this sense, as a result of the need to analyze the scientific production of specific themes, bibliometric studies are being increasingly used in academic research to assess the advances or lack thereof in a given academic field (Clancy, Herring, & Campbell, 2017; Jamali, Md Zain, Ali

Samsudin, & Ale Ebrahim, 2015; Tsigilis, Grouios, Tsorbatzoudis, & Koidou, 2010). Consequently, with bibliometry, it is possible to detect, classify and categorize the scientific literature on a given subject (Blanca-Torres, Ortega, Nikolaidis, & Torres-Luque, 2019).

Various databases are used in bibliometric research and each one has particular characteristics. However, the most recurring are *PubMed*, *Google Scholar*, *Web of Science (Clarivate Analytics)*, and *Scopus (Elsevier)*. PubMed is the most widely used for biomedical disciplines and life sciences. *Google Scholar* is an easy-to-use tool, but it has some shortcomings, especially the inclusion of non-scientific peer-reviewed content. The last two are the most used bibliographic databases in academic research for almost all disciplines and are used by many universities to establish *educational rankings*(AlRyalat, Malkawi, & Momani, 2019; Harzing & Alakangas, 2016; Mongeon & Paul-Hus, 2016).

This study is part of a broader research that intends to analyze the sports training of male artistic gymnastics athletes. Therefore, as a starting point for the bibliographic survey on MAG, we sought the profile of this academic production in the main databases, which then resulted in the production of this article. It is assumed, then, that from the scientific production profile of a given area it is possible "[...] to analyze the body of literature and research performance easily and efficiently." (AlRyalat et al., 2019, p. 1). Be that as it may, we agree with Sánchez-Pay's statement (2019, p. 14): "Analyzing the scientific production of a particular specialty helps to find research trends as well as the main courses of action."

Thus, this research aims to describe the scientific production on MAG in journals indexed on the *Scopus* and *Web of Science* platforms. The specific objectives are: 1) to indicate the year of publication of the articles; 2) to verify the authors and institutions; 3) to highlight the journals that

have published the most on the subject; 4) to thoroughly identify the subjects addressed in the articles.

METHODS

In order to accomplish the proposed objectives, a search was performed in the entire *Web of Science* database, using the descriptors "men's artistic gymnastics" or "male artistic gymnastics" in the topic of the articles (title, keywords and abstract), without setting a date range. The justification for the choice of these descriptors is based on the understanding that male artistic gymnastics is a sport with its own characteristics. The equipment used in MAG is different from the ones used in the women's modality, as is the scoring system (Kilijanek & Sanchez, 2020). This search found 52 results.

In order to assure the comprehensiveness of the study, we used the *Scopus (Elsevier) database*, which, together with the *Web of Science*, is considered the most important database due to their breadth (Archambault, Campbell, Gingras, & Larivière, 2009; Jamali et al., 2015). The search with the aforementioned uniterms resulted in 41 articles, including title, abstract and keywords. When comparing searches, 30 results were found in both databases.

No date range was set in the search, since the objective of this research is to outline the profile of academic production regarding the theme, given the temporal implications. Therefore, we selected all articles found up to November 2019, the period in which the data were collected, so this research contemplated articles from 1994 to 2019.

63 results were initially catalogued for this research; however, 11 articles that were not published in full in scientific journals were excluded, namely summaries published in conferences (9) and book chapters (2). Ultimately, 52 articles were analyzed in this paper, and they were cataloged in a spreadsheet containing the

following information: title of the article, name of the publication journal, name of the author(s) and institution, year of publication, abstract, and thematic area of the article.

Data on the journals, such as the hindex (it numerically evaluates the journal's scientific prestige (Minasny, Hartemink, Mcbratney, & Jang, 2013)), country, date range, and journal categories were found on the Scientific Journal Rankings (SJR) platform. In cases where the journal is not indexed in the SJR platform, the h-index field was filled with the acronym "NI" (not included) and the subject area was defined by the authors after reading the scope of each journal. Information regarding the affiliation of the authors was obtained from the *ResearchGate* social network and the *websites* of the affiliated institutions. The theme of the articles was assigned by means

of inductive categorization, based on the reading of the titles, keywords and abstracts.

The data analysis presented here was performed in a descriptive way, in four thematic axes: year of publication of the articles, authorship and affiliation, journals, and research subject.

RESULTS

Considering that the *Fédération Internationale de Gymnastique* (FIG) is the oldest sports entity in the world (1881) and that men's artistic gymnastics was the first gymnastics modality in the Olympic program, it is important to highlight the temporality of the 52 scientific articles dealing with the subject (Čuk & Sibanc, 2018), as shown in figure 1.

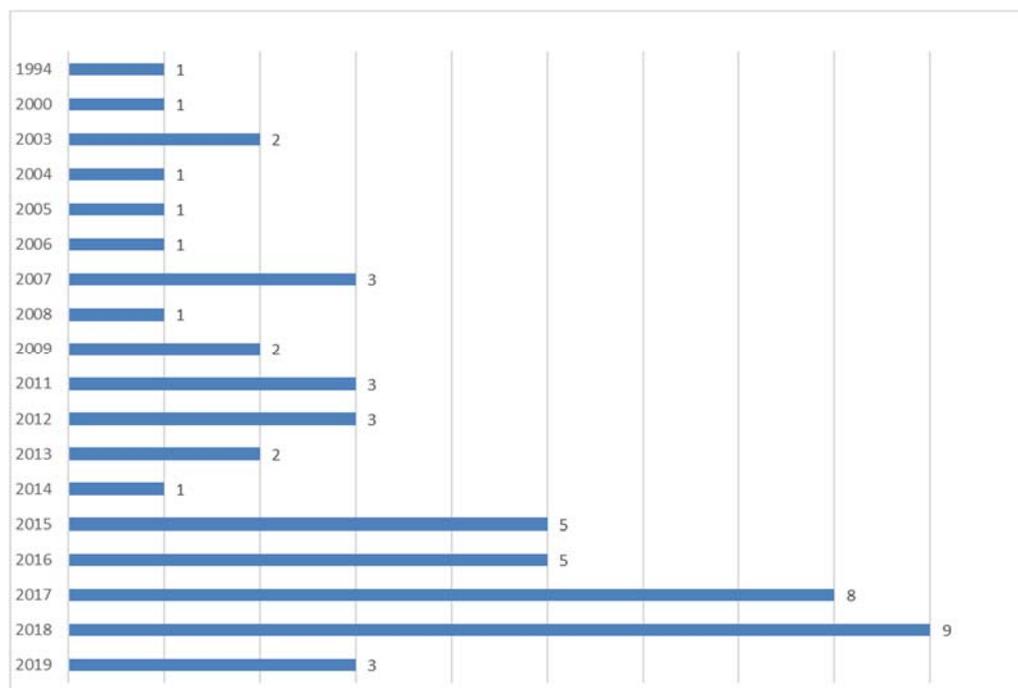


Figure 1. Number of articles per year of publication.

Table 1
Main author and affiliation.

| Authors | | Institution | Country |
|------------------------------|---|-----------------------------------|------------------------|
| Yeadon, Maurice Raymond Fred | 8 | Loughborough University | United Kingdom |
| Hiley, Michael | 8 | Loughborough University | United Kingdom |
| Bortoleto, Marco Antônio | 5 | Universidade Estadual de Campinas | Brazil |
| Čuk, Ivan | 5 | University of Ljubljana | Slovenia |
| Atiković, Almir | 4 | Univerzitet u Tuzli | Bosnia and Herzegovina |
| Kim, Dong-min | 4 | Korea National Sport University | South Korea |
| Irwin, Gareth | 3 | Cardiff Metropolitan University | United Kingdom |
| Mkaouer, Bessem | 3 | Université de la Manouba | Tunisia |
| Chaabene, Helmi | 3 | Universität Potsdam | Germany |
| Amara, Samiha | 3 | Université de la Manouba | Tunisia |
| Kalinski, Sunčica Delaš | 3 | Sveučilište u Splitu | Croatia |
| Oliveira, Mauricio Santos | 3 | University of Espírito Santo | Brazil |

Table 2
Journals that published the most about MAG.

| Journal | | Subject Area | H index | Country | Coverage |
|---|----|--|---------|----------------|----------|
| Science of Gymnastics Journal | 11 | Health Professions; Medicine; Social Sciences. | 7 | Slovenia | 2012 |
| Journal of Biomechanics | 4 | Biochemistry, Genetics and Molecular Biology; Engineering; Health Professions; Medicine. | 177 | Netherlands | 1968 |
| Journal of Applied Biomechanics | 3 | Biochemistry, Genetics and Molecular Biology; Health Professions; Medicine. | 50 | United States | 1995 |
| The Korean Journal of Sport | 3 | Biochemistry, Genetics and Molecular Biology; Health Professions; Medicine | NI | Korea | 1992 |
| The Korean Society of Sports Science | 3 | Sports Science; Health Professions. | NI | Korea | 1991 |
| Motriz. Revista de Educação Física | 3 | Health Professions; Medicine; Social Sciences. | 11 | Brazil | 2010 |
| Revista Brasileira de Educação Física e Esporte | 3 | Biochemistry, Genetics and Molecular Biology; Health Professions; Social Sciences. | NI | Brazil | 2004 |
| Biology of Sport | 2 | Health Professions; Medicine. | 20 | Poland | 1996 |
| Human Movement Science | 2 | Biochemistry, Genetics and Molecular Biology; Health Professions; Medicine; Psychology. | 80 | Netherlands | 1982 |
| Journal of Physical Education and Sport | 2 | Health Professions. | 21 | Romania | 2011 |
| Sports Biomechanics | 2 | Health Professions; Medicine. | 34 | United Kingdom | 2002 |

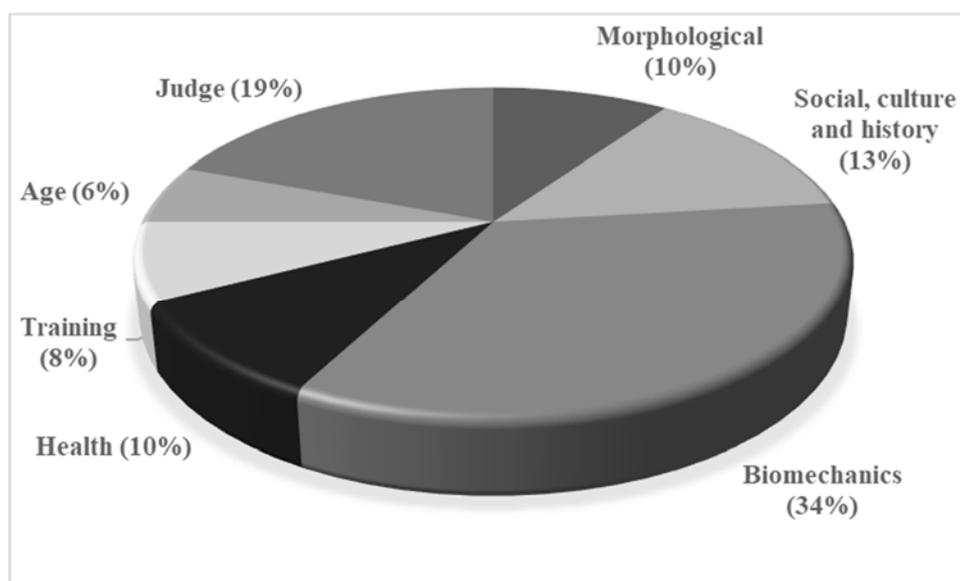


Figure 2. Distribution of articles by subjects.

In the Table 1, we present the authorship of the articles found, considering the name of the author regardless of the order of authorship, the number of articles, the affiliated institution, and the country of origin. For this purpose, authors with three or more occurrences, amongst the 52 articles catalogued for analysis, were presented.

Table 2 presents the journals that published at least two studies on men's artistic gymnastics.

The subjects covered by the articles were classified into seven categories (figure 2): 1) biomechanical aspects of gymnastics (18); 2) scoring code and judging of gymnastics elements (10); 3) social, historical and political aspects of gymnastics (7); 4) athletes' morphological characteristics (5); 5) athletes' health, which includes injuries, pathologies, hydration and nutrition (5); 6) gymnastics training, including metabolic variables, strength training, and training methods (4); 7) analysis of athletes' age over the years (3).

DISCUSSION

Describing the scientific production of a specific area from a bibliometric research can help in understanding its evolution (or lack thereof), as well as point out the trends

of publications that cover a certain object of study (Blanca-Torres, et al., 2019). Therefore, we believe that the results presented here may contribute to the specific knowledge of MAG, particularly in order to guide researchers in training (Job, 2006).

Thus, the temporality of the articles found was first verified. Concerning temporality, the oldest article found in this research dates from 1994. However, the *Web of Science* platform features scientific articles since 1945. The *Scopus* database is more recent, with the oldest articles dating from the late 1990s. It is possible that the productions about MAG in the past used the term *men's olympic gymnastics*, a nomenclature that was used in reference to the sport until the 1980s. This change, according to Nunomura, Nista-Piccolo and Eunegi (2004) was made after the inclusion of new gymnastics modalities in the Olympic program - rhythmic gymnastics in 1984 and trampoline gymnastics in 1996 -, thus avoiding confusion since there would be four Olympic gymnastics modalities (men's artistic gymnastics, women's artistic gymnastics, rhythmic gymnastics and trampoline gymnastics).

Also with regard to the temporality of the articles published on male artistic gymnastics, the years 2017 and 2018 stand

out as the period with most publications on the sport, approximately 15% (8) and 17% (9), respectively. This substantial increase in production in recent years is possibly the result of the world's overall increase in academic production in line with the expansion of search platforms, as bibliometric research has pointed to the growth, especially in the last decade, of research in different areas of Sport Science (Ciomaga, 2013; Lindahl, Stenling, Lindwall, & Colliandera, 2015; Peset et al., 2013; Prieto, Gómez, & Sampaio, 2015).

Thus, according to the time period of the articles found, scientific production regarding male artistic gymnastics has increased in recent years. This data shows the growing interest in this topic, which might encourage new researchers to look further into it.

Verifying the authorship of scientific articles may help to recognize authors and research groups of a particular area. In this sense, Maurice Raymond Fred Yeadon and Michael Hiley stand out in scientific production on men's artistic gymnastics. The two researchers published eight papers each, each representing approximately over 15% of the total. Together, they published 7 articles, with alternate authorship orders, focusing their research on biomechanical topics. Professor Yeadon is "Emeritus Professor of Computer Simulation in Sport" and one of his projects is entitled "Springboard diving and gymnastics". This project focuses on studies of computerized simulation models of gymnastics movements and ornamental jumps. Yeadon's only research without the collaboration of his colleague Hiley was precisely the one published in 1994, entitled "Twisting techniques used in dismounts from the rings", published in the *Journal of Applied Biomechanics*. This leads to the interpretation that this author is one of the pioneers in studies that link biomechanics and male artistic gymnastics. Hiley, in turn, is the main author of "Optimization of the felge on parallel bars" in partnership with two other authors. As Yeadon, he is a

researcher at Loughborough University and holds the position of Senior Lecturer at the institution.

Researchers Marco Antônio Bortoleto and Ivan Čuk stand out with five (9.8%) publications regarding MAG each. Professor Bortoleto teaches at the State University of Campinas (BR) and coordinates research groups about gymnastics and circus, focusing especially on cultural aspects of gymnastics training, circus pedagogy, and promotion and participation in gymnastics for all. His production is concentrated in the socio-cultural dimension of the sport. The article entitled "Public sports policy: The impact of the athlete scholarship program on Brazilian men's artistic", from 2012, is an example of this. Bortoleto is part of the select group of FIG authorities and is also part of the scientific board of the *Science of Gymnastics Journal*, where Čuk is editor in chief. Čuk belongs to the faculty of the University of Ljubljana, Slovenia, where the journal is from, as a member of its Faculty of Sport, where he occupies the position of "Head of Gymnastics and Kinesiology Department". From the articles he has published, it is evidenced that his research subject is likewise the biomechanics of gymnastics.

Still aiming to verify the authorship of articles about MAG, two other researchers were found with four (5.88%) articles each: Almir Atiković and Don-Min Kim. Atiković, who published two studies co-authored with Croatian researcher Sunčica Dela Kalinski, is a researcher from the Faculty of Physical Education and Sport of the Univerzitet u Tuzli, and stands out for his production regarding the age of MAG athletes. In the article entitled "Age trends in artistic gymnastic across world championships and the olympic games from 2003 to 2016", which highlights the linear increase in the age of participants in the Olympic Games and World Championships in artistic gymnastics for men and women, Atiković found the highest age among men in AG when comparing the two groups

(Atiković et al., 2017). It is worth mentioning that this author is also part of the scientific board of the *Science of Gymnastics Journal*.

From the Korea National Sport University, researcher Dong-min Kim stands out for his production on the assessment (referees' scores) of certain MAG equipment in different international competitions. In the results of this research, he is the author who presented the most number of individual research (3). Nevertheless, we did take into consideration the difficulty of reading the articles he has published, as all four of them are in Korean journals that present only the abstract in English.

Other authors were listed with three (5.8%) articles regarding MAG. They are Gareth Irwin - research leader at Cardiff Metropolitan University, United Kingdom, and member of the project "Biomechanics of Gymnastics Rings"; the aforementioned Sunčica Dela Kalinski from the Faculty of Kinesiology, University of Split, Croatia; and the Brazilian researcher Mauricio dos Santos de Oliveira, who is the main author in three articles co-authored with Marco Antônio Bortoleto. This indicates that the studies were conducted by Oliveira with the guidance of Professor Bortoleto.

Bessem Mkaouer, who also appears as the main author of three articles, is Head Professor of the Department of Gymnastics at the Higher Institute of Sport and Physical Education of Ksar Saïd, University of Manouba, Tunisia. In those three articles, researchers Samiha Amara – assistant professor at the same institution – and Helmi Caaabene – guest professor at the Universität Potsdam – occupy different positions of authorship in the same articles. This fact indicates that these articles are the result of the research group from the gymnastics department led by Professor Mkaouer.

The observation of the countries of affiliation of the main authors regarding MAG indicates the predominance of the United Kingdom (three), followed by Brazil

(two). The ranking of the countries that have published the most about Sport Science, according to the search carried out on the SJR platform, shows that the United States, the United Kingdom, and Canada occupy the top positions. Accordingly, the study conducted by Jamali et al. (2015) indicated that 39% of the publications on Physics Education on the *Web of Science* between the years 1980-2013 are from the United States, followed by Turkey (17%) and Spain (8%). For this reason, it is noteworthy that no US nor Canadian researcher is among the most productive ones regarding MAG research.

By highlighting the journals that have published the most about a specific area, it is possible to identify the journals that address men's artistic gymnastics. In this sense, the *Science of Gymnastics Journal* stands out. The journal features 11 articles on the modality, approximately 21% of the articles published between 1994 and 2019 on this theme. This fact is certainly not surprising given that it is the only specific international gymnastics journal. The journal is supported by the *Fédération Internationale de Gymnastique* and is edited by the Department of Gymnastics of the University of Ljubljana. The editorial board evidences the representativeness of different countries, namely: Bosnia and Herzegovina, Brazil, Canada, Croatia, Germany, Hungary, Japan, Russia, Spain, United Kingdom and United States of America (SCIENCE OF GYMNASTICS JOURNAL, 2019). It is worth noting that, while the journal in question is completing ten years of existence, its indexation in the SJR platform only occurred in 2012. This may be the reason for it presenting a lower H index than most of the journals categorized. For example, the *Journal of Biomechanics*, the second journal that published the most on MAG, with approximately 7% of the total number of articles (four), has featured articles since 1968, and its H index is 177.

Some consequences are brought up by the fact that there is only one journal that

specifically addresses gymnastics, namely: the journal's publications should be frequently followed by researchers who deal with gymnastics; professionals who work directly with gymnasts should be encouraged to access this journal to improve their scientific knowledge about the sport; at least one more journal should address gymnastics, as this would increase the diversity of opinions and approaches on the subject (Franchini, Gutierrez-Garcia, & Izquierdo, 2018).

Following this, there are five journals that have three (5.8%) published articles on MAG each, namely: *Journal of Applied Biomechanics* (United States); *The Korean Journal of Sport* and The Korean Society of Sports Science (Korea); *Motriz. Revista de Educação Física* and *Revista Brasileira de Educação Física e Esportes (Brazil)*. In this sense, it is worth noting that the *Web of Science* platform privileges Anglo-Saxon content and presents greater coverage in the area of science than in arts and humanities (Villarejo, Palao, & Ortega, 2010). Although *Scopus* presents a greater coverage from other countries, in addition to those whose official language is English (Pérez-Gutiérrez, Cobo-Corrales, & Izquierdo-Macón, 2018), the articles found in Korean journals were only identified through the *Web of Science* platform, while the articles in Portuguese were detected by the *Scopus* platform.

Among all the journals found in this research, none is in the top 10 of the scientific journals of Physics Education pointed out by Jamali et al. (2015). This data indicates the need for researchers of male artistic gymnastics to seek publications in the main journals in the Physical Education area, in order to gain prominence within their field.

Table 2 presents the countries of the periodicals that have published the most on MAG. The numerical predominance (55%) of journals from the European continent is highlighted. The second continent with more periodicals is America (27%), but with the representation of only two

countries: United States and Brazil. The Asian continent, which stood out for its bibliometric research on judo (Peset et al., 2013), appeared in the third position (18%).

The detailed identification of the subjects addressed in the articles enables the recognition of research trends regarding male artistic gymnastics, as well as the identification of the main authors by subject. In this sense, regarding the Subject Area of the journals, the predominance of the biological area to the detriment of the social area is remarkable. This is not surprising, considering that, in general, there are fewer researchers, and, consequently, fewer publications in the social area of sport. For instance, the research by Corrêa, Corrêa and Rigo (2019) indicates that, in Brazil, there are about 32 graduate programs in Physical Education, with 666 researchers. Among them, approximately 72% are focused on the biodynamics area, 25% in the social area, and another 3% in both.

When observing the distribution by subject, a lack of articles on the pedagogy of sport was identified. Nevertheless, the predominance of articles on biomechanical aspects (34%) was observed, especially regarding the analysis of movements in gymnastics equipment. By presenting the journals that published the most, as well as the authors who produced the most on MAG, it has been possible to identify a larger production on biomechanics.

Prassas, Know and Sands (2006) has already indicated the growth in the number of research on the biomechanics of movement in gymnastics. As an example, Hiley and Yeadon (2016) analyzed the execution of Kovacs - exercises of release and regrasp in the high bar - of nine athletes to help in the execution of the movement, in order to, consequently, avoid falls. For this purpose, the authors used a computer simulation model, and the movement was analyzed before and after the simulation. The success rate of the movement increased from 11% to 93%, indicating an effective

technological possibility for the improvement of athletes' performance.

The second subject most addressed in the articles was the judging of gymnastics (19%). In this sense, Carrara and Mochizuki's (2011) research stands out, which verified, from interviews with Brazilian and Portuguese coaches, the influence of new rules (from 2006 on) on the scoring code of the FIG in the training of MAG. The analysis of the content of the interviews indicated an increase in the complexity of the series. This led the coaches to increase the amount and intensity of the trainings, as well as to make adaptations in the physical, technical and tactical preparation.

Social, historical and political aspects of MAG occupy the third position (13%) among publications. Within this group, it was possible to observe different approaches, such as the research by Rohleder and Vogt (2018), which aimed to evidence the challenges for MAG in view of the debate regarding the German sports training system. Čuk and Sibanc (2018) conducted a historical survey of the Olympic medalists from the individual modality since its first edition. The results of the survey also point to the change in the rules of MAG featuring a historical factor, since specialists in certain equipment are increasingly standing out to the detriment of general athletes.

Nonetheless, through the thematic distribution presented, it is possible to notice that the number of articles on MAG under the bias of the Human Sciences is inferior to the ones under the Biological Sciences. This is not surprising considering that previous research on sports already points to this numerical discrepancy. Palazón, Ortega and García-Angulo (2015) indicated that only 2.4% of the academic production regarding indoor soccer, between the years 2005 and 2014, falls into the category they call "sociology of sport", the smallest representation among the nine categories listed by the authors.

It is worth noting that analytical studies that compared the different bibliographic databases indicate that both the *Web of Science* and *Scopus* tend to privilege studies from Biological Sciences (Archambault, et al., 2009; Mongeon & Paul-Hus, 2016).

CONCLUSIONS

By describing the scientific production on MAG in journals indexed on the *Scopus* and *Web of Science* platforms, we concluded that 1) the first article published on the subject dates back to 1994, and the year with the greatest number of publications to date has been 2018, with emphasis on the period between 2015 and 2018; 2) among the authors who produced the most were two British (Maurice Yeadon and Michael Hiley), one Brazilian (Marco Bortoleto), and one Slovene (Ivan Čuk); 3) the numerical predominance of articles on MAG in the *Science of Gymnastics Journal* (21%), followed by the *Journal of Biomechanics* (7%); 4) 34% of the articles are on the biomechanics of gymnastics, 19% on the rules of the modality and judging, 14% on social, historical and political aspects of gymnastics, 10% on the analysis of morphological characteristics of athletes, 10% on the athletes' health, 8% on gymnastics training aspects (including metabolic variables, strength training, and training methods), and 6% are studies that have analyzed the age of athletes over the years.

Nevertheless, it was possible to identify correlations between the investigated variables. By verifying authorship and highlighting the journals that have published the most about MAG, the relationship between the researchers and the journal *Science of Gymnastic Journal* was identified (Ivan Čuk, Marco Antonio Bortoleto and Almir Atiković). Regarding the subject area of the journals and the identification of the subjects addressed in the articles, biomechanics stood out.

Although it is understood as a limitation of this study the methodological

choice of the search platforms and the keywords, the intention was to point out a panorama of the specific academic production on MAG through the methodological requirements mentioned above. Relevant research on this subject is certain to have escaped the filter used in this study, indicating the care authors should take when writing the title, keywords and abstracts of their articles. In addition, it was observed that, when using the *Web of Science* and *Scopus* databases, the content of the Biological Sciences has been privileged to the detriment of the Human Sciences. English-language journals were also favored.

Therefore, it is hoped that this study can provide subsidies for the expansion of knowledge of scientific production on the subject, and encourage researchers to focus on specific themes of MAG. After all, the data presented here may help in choosing which journals to follow and submit future works to, as well as to direct the development of new investigations and locate the main authors and institutions of a particular subject.

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