


Review Paper

Bibliometric analysis of scientific production in badminton

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ABSTRACT

The aim of the present study was to analyse the scientific production in the sport of badminton. Publications were collected from the main collection of “Web of Science” platform, specifically from Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI) and Art & Humanities Citation Index (A&HCI) databases for the period 2007-2017, obtaining a total of 122 items. The analysis assessed annual trend of published articles from 2007 to 2017, country distribution of publications, first author’s institution distribution of publications, first author’s productivity, average number of authors per article, major journals, average number of citations per article, thematic area, sample characteristics and modality. Among the most relevant conclusions are the number of publications on badminton has increased significantly from 2007 to 2017, more specifically in the last 4 years (2014-2017); Asian and European countries have the highest productivity index, both continents with great trend in badminton, coinciding, in turn, with institutions and first authors; health and training are the most studied thematic areas, whose main disciplines are sports medicine and theory of sports training. This type of studies provides baseline information on future research directions in badminton. **Keywords:** Review; Racket sports; Research evaluation.

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INTRODUCTION

Nowadays, the scientific publication is used as one of the main divulgative ways of any area of knowledge, being in this case essential for the education of specialists in Sports Sciences (Sans-Rosell, Reverter Masià, Hernández González, & Jové Deltell, 2015). Considering this aspect, bibliometrics is of great relevance, due to its use to evaluate the publications of institutions and countries, as well as to identify the evolution or regression of a particular thematic area (Prieto, Gómez, & Sampaio, 2015).

Scientific production in the area of knowledge of Physical Activity and Sport Sciences has been significantly increased over the last few years. As a result, there are excessive information, which complicates the access and review of everything that has been published (Sans-Rosell et al., 2015). Hence bibliometric studies, which take into account not only the quantity but also the quality of publications, would be of great importance.

In this sense, following Palazón, Ortega, and García-Angulo (2015), three approaches have been identified to examine bibliometric studies. The first approach is in charge of analysing the scientific production of scientific journals, as well as the comparison with other journals. The second approach is dedicated to analysing the scientific production of a specific area through in-depth study of works presented (doctoral theses, congresses, etc.). Finally, the third approach of research, which is subdivided (psychology, injuries, physiology, etc.), is concerned with analysing the scientific production of specific sports specialties. In this way, some studies of this nature can be observed in collective sports such as futsal (Palazón et al., 2015), handball (Prieto et al., 2015) or rugby (Villarejo, Palao, & Ortega, 2010), combat sports like judo (Mancebo et al., 2013), water sports such as swimming (Nugent, Comyns, Burrows, & Warrington, 2017) and other racket sports like tennis or paddle (Allen, Choppin, & Knudson, 2016).

In badminton, a wide variety of publications with different topics can be found. Thus, there are articles focusing in notational analysis (Abdullahi & Coetzee, 2017), physiology (Bisschoff, Coetzee, & Esco, 2016) or game characteristics (Leong & Krasilshchikov, 2016) among other topics. However, in spite of this observation, there are no studies in the scientific literature that analyse the scientific production of this sport. Therefore, the aim of the present study was to analyse the scientific production in the sport of badminton.

MATERIAL AND METHODS

Procedures

The search process of existing literature was carried out in the core collection of *Web of Science* platform. Publications were collected from Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI) and Art & Humanities Citation Index (A&HCI) databases for the period 2007-2017.

The search was conducted following the guidelines PRISMA (Preferred Reporting Items for Systematic reviews and Meta-analyses) (Urrútia & Bonfill, 2010). All the records which contained the word “badminton” in the title were compiled for analysis. The initial search resulted in the identification of a total of 177 publications under study. The search was refined in order to select only “articles”, discarding “meeting abstract”, “editorial material”, “letter”, “book review”, “review”, “poetry”, “biographical item”, “proceedings paper”, “new item” and “correction”, and a total number of 132 studies remained for further analysis. Thereafter, a review of abstracts of the articles that the selected search showed was made, whose aim was to remove those studies that, despite containing the words used in the search strategy, did not have badminton as a theme. The final sample was composed of 122 scientific articles, which satisfied the inclusion criteria.

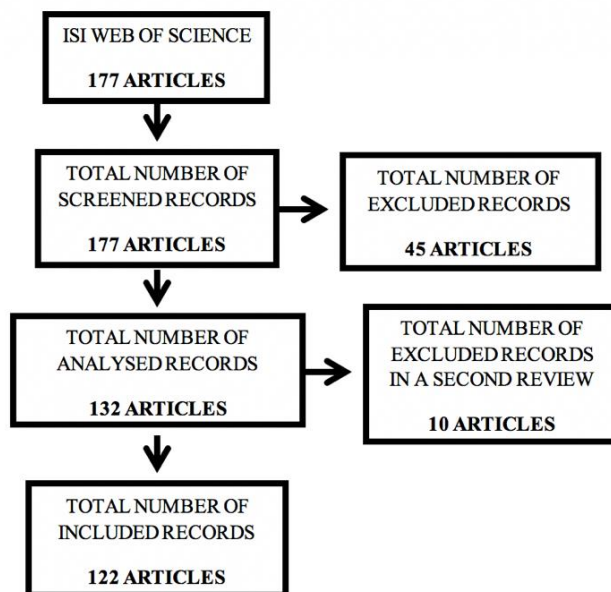


Figure 1. Flow diagram of the methodology used for the search

Measures

The subsequent bibliometric analysis considered the following variables: a) annual trend of published articles from 2007 to 2017; b) country distribution of publications; c) first author's institution distribution of publications; d) first author's productivity; e) average number of authors per article; f) major journals; g) average number of citations per article; h) thematic area (training, health, management, education, other and mixed) and main discipline (teaching, theory of sports training, psychology, sports medicine, physiology, biomechanics, psychomotor, anthropometry, physical activity and health, management, nutrition, ethics, engineering and information science); i) sample characteristics (type and size: people, other and both; gender: male, female, both and no gender; competitive level: school sport, federated child sport, federated senior sport, elite, amateur, disabled, coaches, physical education and other); j) modality (singles, doubles, mixed and nothing) and type of study characteristics (study: experimental, descriptive and correlational; variables: game analysis, regulatory adjustment, physiological, injuries and psychological; statistics: univariate, multivariate and no statistics; methodology: questionnaire, observational, interview and apparatus). Studies were classified according to the categories which were created. A preliminary reading of the abstract was made and, if it was necessary, a more exhaustive reading of the article was made.

To control their quality, the data were recorded by two researchers in two separate searches two months. A reliability of 1.00 was obtained, since the same number of articles was registered by both researchers. In order to control the quality of the data during the analysis of the different variables, a control of 10% of the cases was carried out, for which both the expert observer and the responsible observer analysed all those works (Losada & Manolov, 2015). Considering the Kappa concordance coefficient, a minimum concordance of 0.96 was obtained.

Statistical analysis

The statistical program SPSS 23.0 was used in order to carry out a descriptive analysis, with a calculation of frequencies and the absolute and relative percentages of each of the variables.

RESULTS

When including the inclusion criteria, 122 articles were analysed.

Figure 2 shows the total number of publications on badminton in the selected time period.

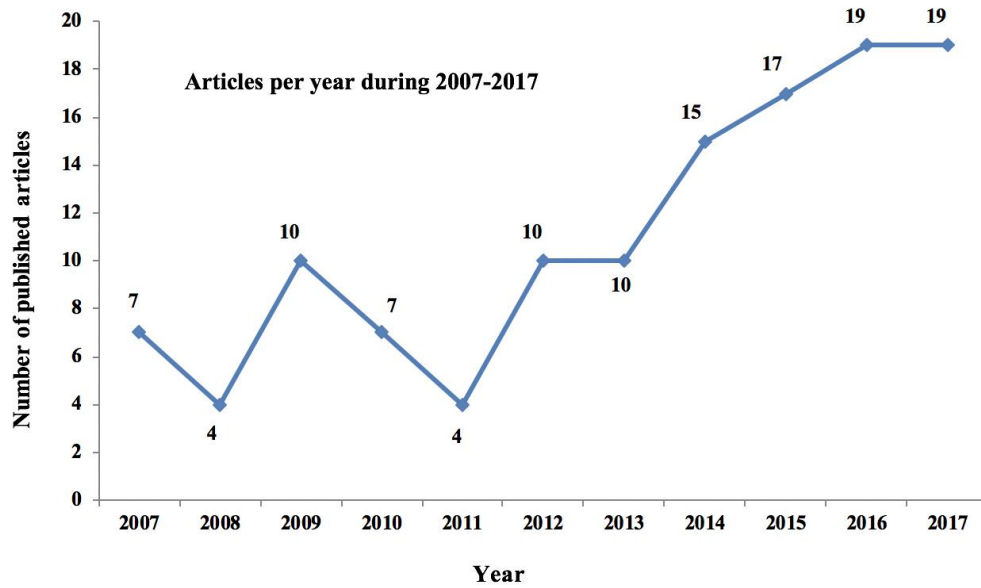


Figure 2. Evolution of productivity considering the number of publications

As shown in figure 2, different periods can be identified in terms of the evolution of the number of publications. First of all, a decrease in scientific production can be observed from 2007 (7 publications) to 2008 (4 publications). One year later (2009), there was an increase, reaching 10 publications. From 2009 to 2011, there was a further decline in scientific production (4 publications). Since 2011, a gradual increase in the number of publications can be observed, reaching 19 publications in 2017.

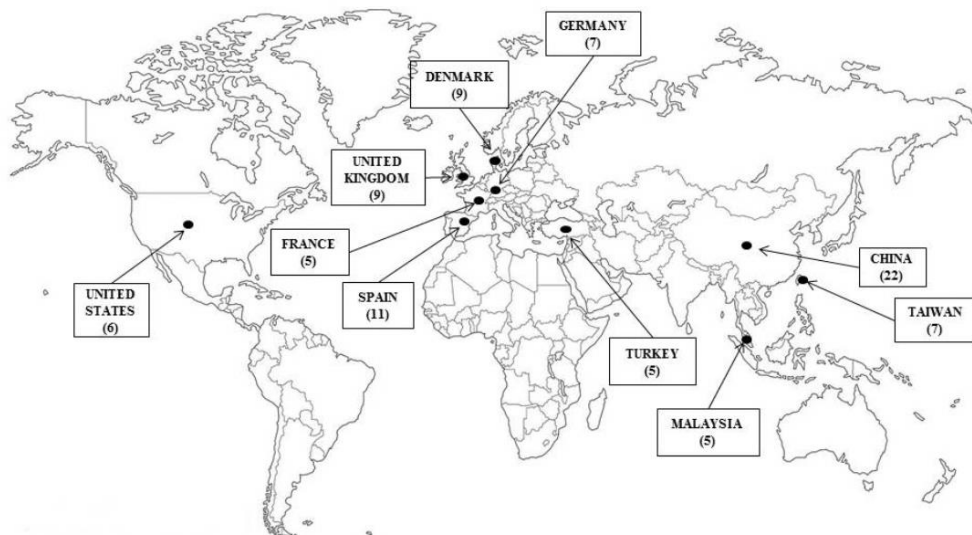


Figure 3. The ten most productive countries

Figure 3 presents the total number of publications on badminton in different countries.

A total of 27 countries contributed to the publication of the 122 studied articles. The 10 most productive countries can be seen in figure 3. The country with the highest scientific production is China with 22 publications, followed by Spain with 11 publications. Denmark and the United Kingdom have 9 publications. After these two countries, Germany and Taiwan have 7 publications. It is observed that United States has 6 publications and France, Turkey and Malaysia have 5 publications.

Table 1 shows the total number of publications on badminton in different institutions.

Table 1. Institutional productivity

Institution	Frequency	Percentage
University of Copenhagen	6	4.9%
Nanyang Technological University	4	3.3%
Polytechnic University of Madrid	4	3.3%
National Cheng Kung University	3	2.5%
North-West University	3	2.5%
Tianjin Normal University	3	2.5%
Camilo Jose Cela University	3	2.5%
Coventry University	2	1.6%
Cruzeiro do Sul University	2	1.6%
Gazi University	2	1.6%
German Sport University Cologne	2	1.6%
Health Science University: 7187 Kodachi	2	1.6%
Hirosaki University Graduate School of Medicine	2	1.6%
Keimyung University	2	1.6%
Li Ning Sports Science Research Center	2	1.6%
Ningbo University	2	1.6%
Shangai University Sport	2	1.6%
South China Normal University	2	1.6%
University of Saarland	2	1.6%
University of Wyoming	2	1.6%

According to the results shown in table 1, the 20 institutions with the highest number of publications is the University of Copenhagen with 6 publications (4.9%), followed by the Nanyang Technological University and the Polytechnic University of Madrid with 4 publications (3.3%). Institutions such as the National Cheng Kung University, the North-West University, the Tianjin Normal University and the Camilo Jose Cela University have 3 publications each one (2.5%). The rest of institutions mentioned in Table 1 (the Coventry University, the Cruzeiro do Sul University, the Gazi University, the German Sport University Cologne, the Health Science University: 7187 Kodachi, the Hirosaki University Graduate School of Medicine, the Keimyung University, the Li Ning Sports Science Research Center, the Ningbo University, the Shangai University Sport, the South

China Normal University, the University of Saarland and the University of Wyoming) have 2 publications, equivalent to 1.5%.

Table 2 presents the authors who have the largest number of articles published.

Table 2. The most productive authors

Author	Country	Frequency	Percentage
Abián, P.	Spain	4	3.3%
Lin, C. S. H.	Singapore	4	3.3%
Abián-Vicen, J.	Spain	3	2.5%
Bahía Loureiro, L.	Brazil	3	2.5%
Jin, H.	China	3	2.5%
Abdullahi, Y.	Nigeria	2	1.6%
Bisschoff, C. A.	South Africa	2	1.6%
Boesen, A. P.	Denmark	2	1.6%
Coupe, C.	Denmark	2	1.6%
Gawin, W.	Germany	2	1.6%
Huelsduenker, T.	Germany	2	1.6%
Kimura, Y.	Japan	2	1.6%
Lam, W. K.	China	2	1.6%
Madsen, C. M.	Denmark	2	1.6%
Masu, Y.	Japan	2	1.6%
Wang, C. H.	Taiwan	2	1.6%
Wang, Z.	China	2	1.6%
Zhu, Q.	United States	2	1.6%

A total of 97 different authors signed in the 122 retrieved articles. The most productive authors in badminton research in leading author publications and collaborating publications, along with their country of origin, are presented in Table 2. This is consistent with observations in most research fields, where a few prolific authors contribute to a significant share of publications. The most prolific authors in badminton research are: Abián, P. (Spain) and Lin, C. S. H. (Singapore) with 4 publications (3.3%). Abián-Vicen, J. (Spain); Bahía Loureiro, L. (Brazil) and Jin, H. (China) are first authors in 3 publications (2.5%) each one. Abdullahi, Y. (Nigeria); Bisschoff, C. A. (South Africa); Boesen, A. P. (Denmark); Coupe, C. (Denmark); Gawin, W. (Germany); Huelsduenker, T. (Germany); Kimura, Y. (Japan); Lam, W. K. (China); Madsen, C. M. (Denmark); Masu, Y. (Japan); Wang, C. H. (Taiwan); Wang, Z. (China) and Zhu, Q. (United States) have 2 publications (1.6%). Figure 4 shows the average number of authors who appear in the publications on badminton during 2007-2017.

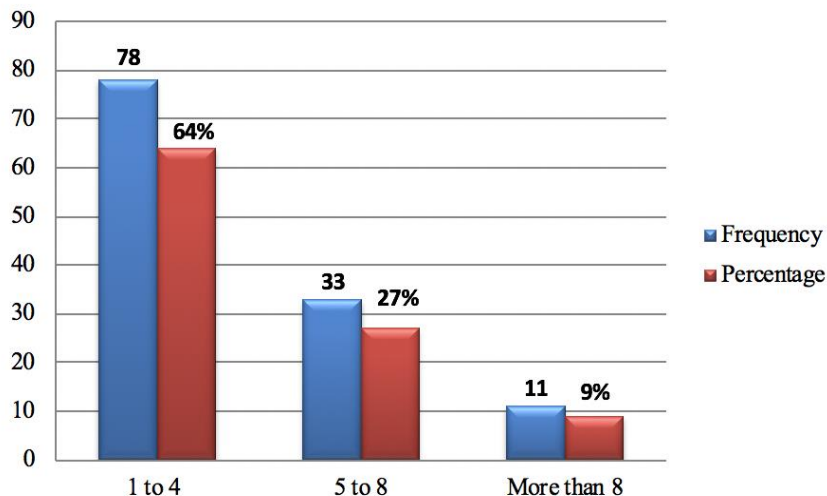


Figure 4. Average number of authors per article

Regarding the average number of authors, the number of publications in which 1 to 4 authors are involved is higher (78 articles; 64%) than publications in which 5 to 8 authors are collaborate (33 articles; 27%). More than 8 authors intervene in few publications (11 articles; 9%).

Table 3 presents the journals with the highest scientific production on badminton.

A total of 43 journals published the 122 articles under analysis. The 20 most active journals in badminton research are: the first, with a 9.8% (12 publications) the *Journal of Sports Sciences* followed by the *International Journal of Performance Analysis in Sport* (8 publications; 6.6%). The *International Journal of Sports Physiology and Performance*, the *Journal Human Kinetics*, the *Journal of Sport Science and Medicine*, the *Journal of Strength and Conditioning Research* and the *Scandinavian Journal of Medicine & Sport* have 4 publications (3.3%) each one and the *British Journal of Sport Medicine*, the *European Journal of Sport Science* and the *Perceptual and Motor Skills* have 4 publications each one (2.5%). The rest of journals from the list (the *Plos One*, the *Asia Life Sciences*, the *Frontiers in Psychology*, the *Human Movement Science*, the *International Journal of Morphology*, the *Journal of Applied Biomechanics*, the *Journal of Physical Therapy Science*, the *Journal of Sports Medicine and Physical Fitness*, the *Mechatronics* and the *Medicine and Science in Sports and Exercise*) have 2 publications, corresponding to 1.6%.

Table 3. Ranking of the 20 journals with the highest number of published works

Journal	Frequency	Percentage	Quartile (JCR-2017)
<i>Journal of Sports Sciences</i>	12	9.8%	Q1
<i>International Journal of Performance Analysis in Sport</i>	8	6.6%	Q4
<i>International Journal of Sports Physiology and Performance</i>	4	3.3%	Q1
<i>Journal of Human Kinetics</i>	4	3.3%	Q4
<i>Journal of Sports Science and Medicine</i>	4	3.3%	Q2
<i>Journal of Strength and Conditioning Research</i>	4	3.3%	Q2
<i>Scandinavian Journal of Medicine in Sport</i>	4	3.3%	Q1
<i>British Journal of Sport Medicine</i>	3	2.5%	Q1
<i>European Journal of Sport Science</i>	3	2.5%	Q2
<i>Perceptual and Motor Skills</i>	3	2.5%	Q4
<i>Plos One</i>	3	2.5%	Q1
<i>Asia Life Sciences</i>	2	1.6%	Q4
<i>Frontiers in Psychology</i>	2	1.6%	Q2
<i>Human Movement Science</i>	2	1.6%	Q3
<i>International Journal of Morphology</i>	2	1.6%	Q4
<i>Journal of Applied Biomechanics</i>	2	1.6%	Q3
<i>Journal of Physical Therapy Science</i>	2	1.6%	Q4
<i>Journal of Sports Medicine and Physical Fitness</i>	2	1.6%	Q4
<i>Mechatronics</i>	2	1.6%	Q2
<i>Medicine and Science in Sports and Exercise</i>	2	1.6%	Q1

Figure 5 presents the average number of citations on badminton publications during 2007-2017.

Depending on the average number of citations, there are a lot of publications with 0 to 10 citations (101 articles; 83%) in comparison with publications with 11 to 20 citations (15 articles; 12%) or publications with more than 20 citations (6 articles; 5%).

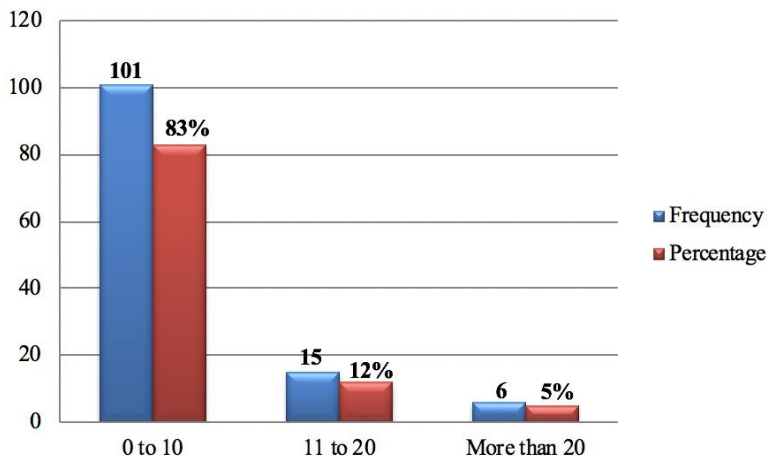


Figure 5. Average number of citations per article

Table 4 shows all the analysed variables in relation to the sample under study.

Table 4. Variables related to the sample

		Frequency	Percentage	
Type	Persons	97	79.5%	
	Other	23	18.9%	
	Both	2	1.6%	
Dimension				
Size	Persons	0 to 50	79	81.0%
		51 to 100	14	14.2%
		101 to 150	2	2.0%
		More than 150	2	2.0%
	Other	0 to 50	20	86.7%
		51 to 100	0	0.0%
		101 to 150	1	4.3%
		More than 150	2	8.6%
	Both	15	2	100%
	Gender	Male	42	34.4%
Female		4	3.3%	
Both		58	47.5%	
No gender		18	14.8%	
Competitive level	School sport	5	4.1%	
	Federated child sport	7	5.7%	
	Federated senior sport	29	23.8%	
	Elite	24	19.7%	
	Amateur	2	1.6%	
	Disabled	1	0.8%	
	Coaches	1	0.8%	
	Physical education	2	1.6%	
	Other	51	41.8%	

The results given in table 2 show, with regard to the type of sample, the majority of studies have been carried out with persons (97 articles; 79.5%), of which 81% have used sample size between 0 and 50 subjects. In publications in which the type of sample was not persons (23 articles, 18.9%), the size of the sample most used was between 0 and 50 (86.7%). A 1.6%, corresponding to 2 articles combined people with sports material and in 100% of the cases the sample size was 15.

The gender variable shows that nearly half of the studies (58 articles; 47.5%) were realized with both genders. 34.4% (42 articles) used a male sample. In 18 cases (14.8%) the sample had no gender. Finally, the female gender was the least used in carrying out studies (4 articles; 3.3%).

As far as competitive level is concerned, a large part of the studies were realized in senior federated sport (29 articles; 23.8%) and in elite (24 articles; 19.7%). 41.8% of 51 articles are produced at other levels.

Table 5 presents the analysed variables in relation to research disciplines and topics.

Table 5. Variables related to research disciplines and topics

		Frequency	Percentage
Thematic area	Training	30	24.6%
	Health	67	54.9%
	Management	1	0.8%
	Education	4	3.3%
	Other	19	15.6%
	Mixed	1	0.8%
Main discipline	Teaching	4	3.3%
	Theory of sports training	20	16.4%
	Psychology	10	8.2%
	Sports medicine	20	16.4%
	Physiology	9	7.4%
	Biomechanics	13	10.7%
	Psychomotor	4	3.3%
	Anthropometry	3	2.5%
	Physical activity and health	15	12.3%
	Management	1	0.8%
	Nutrition	3	2.5%
	Ethics	1	0.8%
	Engineering	15	12.3%
	Information science	4	3.3%

The results of table 3 show that the two thematic areas in which the greatest depth has been achieved are health with 54.9% (67 articles) and training with 24.6% (30 articles). It should be noted that in management and education there are not many publications (1 and 4 respectively). As for the main discipline, those with the highest percentages are theory of sports training and sports medicine (20 articles; 16.4%), followed by physical activity and health and engineering (15 articles; 12.3%) and biomechanics (13 articles; 10.7%).

Figure 6 shows the different types of game modalities.

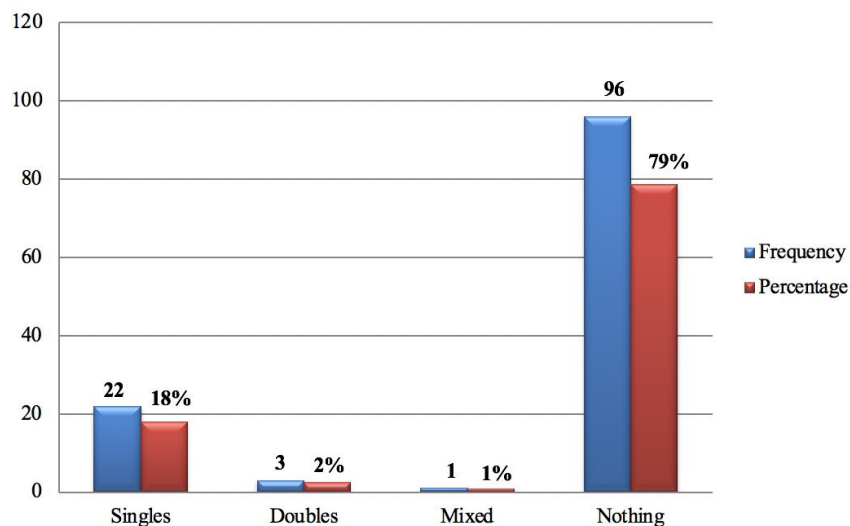


Figure 6. Game modality

Figure 6 shows that most of the studies were carried out without any specific modality (96 articles; 79%). 18% of the total, corresponding to 22 articles, were realized in singles. On the other hand, there are few publications in doubles (3 articles; 2%) and mixed (1 article; 1%).

Table 6 presents all the methodological aspects which they have been carried out.

The results in table 6 show, on the one hand, that more than half of the studies were experimental studies with 54.9% (67 articles), followed by descriptive studies with 41.0% (50 articles). Five correlational studies were also carried out (4.1%).

With regard to the statistics used in 91.8% of the cases, a multivariate statistical analysis was used and 1.6% used the univariate, whereas 6.6% did not use statistics.

The variables related to game analysis were present in 17.2% of the studies and only one study had variables linked to regulatory adjustments. 27.0% of the publications had associated physiological variables and 18.9% of the cases were related to injuries. Finally, 17.2% used psychological variables.

Regarding the use of questionnaires, 13.9% did use them; however, in half of the cases observation sheets were used (50.8%). In addition, 5.7% of the studies used an interview and 78.7% used instruments.

Table 6. Methodological aspects

		Frequency	Percentage
Study	Experimental	67	54.9%
	Descriptive	50	41.0%
	Correlational	5	4.1%
Game analysis	Yes	21	17.2%
	No	101	82.8%
Regulatory adjustment	Yes	1	0.8%
	No	121	99.2%
Physiological	Yes	33	27.0%
	No	89	73.0%
Injuries	Yes	23	18.9%
	No	99	81.1%
Psychological	Yes	21	17.2%
	No	101	82.8%
Statistics	Univariate	2	1.6%
	Multivariate	112	91.8%
	Non statistics	8	6.6%
Questionnaire	Yes	17	13.9%
	No	105	86.1%
Observational	Yes	62	50.8%
	No	60	49.2%
Interview	Yes	7	5.7%
	No	115	94.3%
Apparatus	Yes	96	78.7%
	No	26	21.3%

DISCUSSION

Bibliometric studies are increasingly being used by researchers and institutions as the years go by and science evolves (Prieto et al., 2015). The necessity of this study arises because of the importance of bibliometric studies, which are designed to analyse the scientific production of a specific thematic area in order to determine the evolution or regression of this field of knowledge. In this way, it is possible to detect, classify and categorize the scientific literature and determine the trends and fields of research in the area under study. Considering that badminton is a multidisciplinary research area whose scientific interest is increasing, it is necessary and interesting to carry out a more detailed review of this sport.

The findings of the present study show clarifying data on scientific production in badminton. First of all, it can be observed a period of ups and downs in the number of scientific publications between the years 2007-2011. From 2011 onwards there will be exponential growth until 2017. Given the scarce information on the analysis of scientific production in other racket sports (tennis, squash, paddle, etc.), it is not possible to make a comparison with other racket sports. However, although there are no studies of this type in racket sports, some studies have been carried out in other sports such as futsal (Palazón et al., 2015), handball (Prieto et al., 2015) or rugby union (Villarejo et al., 2010), the results of which are in line with those obtained in this work, demonstrating a notable increase in publications on Sciences of Physical Activity and Sport.

With regard to the analysis of scientific production by country and institution, it is important to highlight the practical relationship and sporting performance with the number of scientific contributions from Asian and European countries and institutions. Thus, those with the greatest number of studies are China and Spain

with 22 and 11 publications respectively. The same occurs with other sports such as basketball (Shao-ping & Fu, 2013) or rugby (Martin, Chiroso, Olmo, Carreras, & Sola, 2013), which the countries with the greatest participation and sporting performance produce the most at a scientific level. In the same way, when analysing aspects related to authorship it can be observed that the authors who publish the most belong to European countries (Abian, P.; Abian-Vicen, J.) or to Asian countries (Lin, C. S. H.; Jin, H.). However, the data obtained show that badminton publications are equally distributed among a multitude of authors.

The journals that have published the most in badminton are the *Journal of Sports Sciences* and the *International Journal of Performance Analysis in Sport*, which have 12 and 8 publications respectively. The fact that these are the most published journals in this sport is due to the fact that both admit studies related to “match analysis”. It could be supported that the profile of these journals is linked to health and healthy training, and it can explain the relationship with the results obtained in terms of the most studied subject areas. It is interesting, that of the 20 journals where more studies have been published, 30% of them are indexed in JCR-Q1, which indicates the importance of studies in this sport specialty.

With respect to the average number of authors per publication, 64% of the cases are studies in which between 1 and 4 authors participate, results similar to those obtained in other studies in which the average number of authors in Sport Science is 4 authors and in Hospitality Leisure Sport Tourism is between 2 and 3 authors (Ortega, Olmedilla, & Pérez-Picazo, 2015). 27% of the publications have an average of between 5 and 8 authors and only 9% of the total involves more than 8 authors. This could be due to the fact that it is not usual that in certain fields of knowledge the authorship is very numerous.

In terms of the number of citations, this is the number of times a publication is cited, that is, to what extent a publication is useful and what is its impact on the scientific community (Ruíz-Pérez, Marcos Cartagena, & Delgado López-Cózar, 2014). Following these authors, the average number of citations per national article is 0.32 with auto-cites and 0.08 without auto-cites and per international article is 3.60 with auto-cites and 1.86 without auto-cites. Considering the results obtained, a large part of the publications (83%) count very few citations (between 0 and 10). The cause of the shortage of citations could be related to the fact that badminton is a sport discipline that has not been sufficiently exploited in the field of Physical Activity and Sport Sciences.

Regarding the variables related to the sample, the most relevant aspects which the results obtained show have to do with the gender and the competitive level. In terms of the gender, it can be observed how the masculine gender has been used (34.4%) or failing both genders at the same time (47.5%). However, only 4 publications (3.3%) use women as a sample. These results can be compared with those obtained by other authors in collective sports such as futsal (Palazón et al., 2015) or union rugby (Villarejo et al., 2010) and in individual sports such as judo (Mancebo et al., 2013) or boxing (Balmaseda Alburquerque, 2011). Something similar happens regarding the competitive level, where most of the publications can be found in the senior federated sport (23.8%) and in high performance (19.7%), leaving a little to the margin the other categories. It shows the scarcity, within the scientific literature, of studies related to sports initiation, being this a crass error, because to reach the elite it is necessary to go through a previous training period. Palazón et al. (2015) stand out as the studying futsal at beginner levels can be very interesting and important to better understand aspects of what is already known at professional levels. According to these authors, sport in its formative stages must be given the importance it deserves. It is therefore clear that new fronts need to be opened for future research in these areas into to badminton analysis.

Considering the variables linked to the research disciplines and their corresponding subjects, the results obtained in this work reveal a great predilection for health (54.9%) and training (24.6%) as areas of study,

coinciding with sports medicine and the theory of sports training as the most studied main disciplines, both with a percentage of 16.4%. On the one hand, these results can be compared with those of Coronado, Wurtzel, Simon, Riddle, and George (2011), who carried out a bibliometric study of the *Journal of Orthopaedic & Sports Physical Therapy*, obtaining that the most studied discipline is sports medicine. On the other hand, there are no coincidences in publications on futsal (Palazón et al., 2015), taking into account how harmful this sport is. However, it is normal for it to be published in the field of health, considering its importance as well as the breadth of this field of knowledge.

With regards to the game modality, it can be observed that many of the studies do not have a specific modality, that is to say, a study of the modality is not carried out in itself, but other aspects are analysed. When specific modalities are considered, single studies predominate over double or mixed studies.

Taking into account the methodological aspects, specifically those related to the type of study carried out, it can be observed that experimental studies (54,9%) often predominate over descriptive studies (41%), results that are similar to those obtained in studies previously carried out in other sports (Angulo & Toro, 2015; Palazón et al., 2015). The reason could be found in the thematic area, thus publications related to health and training tend to be experimental as in this case, however, other fields of knowledge do not necessarily use this methodology.

The variables studied are another of the methodological aspects that must be considered. According to the results obtained in this work, physiological variables are the most used in publications (27%), followed by those related to injuries (18,9%) and those related to psychological characteristics and game analysis (17,2%). It makes sense that these variables are the most used in the scientific literature due to their link with the most studied thematic areas (health and training).

With regard to the type of statistics used, a large predominance of multivariate statistics (91.8%) over univariate statistics (1.6%) can be observed, a factor that reveals the evolution of the statistical treatment of data as science progresses, bringing the research problem closer and making better use of this tool to respond to this problem (Newell, Aitchison, & Grant, 2014).

Finally, as regards the methodology used, it can be seen that the most commonly used procedure is the use of instruments (78.7%). The fact that 50.8% of studies use observation sheets implies the existence of a large amount of observational research in this sport (Abdullahi & Coetzee, 2017; Abián, Castanedo, Feng, Sampedro, & Abian-Vicen, 2014; Gawin, Beyer, & Seidler, 2015). In 13.9% of the cases questionnaires are used, being this percentage very low if we compare it with other areas of knowledge (Cervelló & Santos-Rosa, 2007). Finally, very few studies (5.7%) use the interview as a methodology, assuming the lack of time and the difficulty in contacting the sample is the major problem.

CONCLUSIONS

By way of conclusion, and as far as this study is concerned, it can be said that:

The number of publications on badminton has increased significantly from 2007 to 2017, more specifically in the last 4 years (2014-2017).

Asian and European countries have the highest productivity index, both continents with great trend in badminton, coinciding, in turn, with institutions and first authors.

The authorship is between 1 and 4 authors in most of the publications.

The journals with the highest number of published studies are the *Journal Sports Sciences* and the *International Journal of Performance Analysis in Sport*.

The most of publications have been cited between 0 and 10 times.

Health and training are the most studied thematic areas, whose main disciplines are sports medicine and theory of sports training.

The female gender and the competitive level in sport in formative stages is not very exploited, just as there are hardly any studies whose game modality is doubles or mixed.

Practically all the studies are experimental and descriptive, with the former predominating over the latter. The most studied variables are those related to injuries. Multivariate statistical analysis is the most commonly used. The methodological technique used in most publications is the use of apparatus.

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