Review Paper

Bibliometric analysis of the scientific evolution of physical activity in preschool children

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ABSTRACT

The aim of this study was to analyse scientific developments in physical activity in preschool children. The publications were collected from the Core Collection of the "*Web of Science*" platform, which had the words "*Preschool or Kindergarten*" and "*physical activity*" in the titles, during the period 2015-2020, obtaining 136 articles. The analysis assessed the annual trend of published articles, distribution of publications by country and first author's institution, first author's origin, the average number of authors and citations per article, leading journals, subject area, sample characteristics, methodologies, and intervention programs. There has been an evolution of scientific production in recent years; English-speaking countries and China have the highest productivity rate; health and education are the most studied subject areas, the main disciplines being physical activity and didactics. More than half of the studies use an intervention program. This type of study provides essential information on future research directions in this area.

Keywords: Science production, Physical activity, Pre-school.

Cite this article as:
Jiménez-Jiménez, J. F., Díaz-Quesada, G., García-Martínez, D., & Torres-Luque, G. (2023). Bibliometric analysis of the scientific evolution of physical activity in preschool children. *Journal of Human Sport and Exercise, 18*(4), 925-940. https://doi.org/10.14198/jhse.2023.184.16

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Submitted for publication May 16, 2023.
Accepted for publication June 16, 2023.
Published October 01, 2023 *(in press* July 24, 2023).
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202.

doi:10.14198/jhse.2023.184.16

INTRODUCTION

Scientific publication is respected as an essential activity to produce knowledge, disseminate it and thus make the work of researchers credible since, without it, science would lose its solidity (Devís-Devís et al., 2003). Journals, along with their articles, not only showcase and disseminate science but also evaluate research, the scientific community, and its interests (Martin-Martin et al., 2016).

Scientometrics is the science that studies scientific production in order to measure and analyse it; this is usually put into practice through bibliometrics. Bibliometrics is the application of mathematics and methods to any written source based on facets of communication. It considers elements of it such as its authors, publication title, type of document, and language (Solano et al., 2009). This fact has become increasingly important in the last decade, specifically in research evaluation, where it has played a prominent role (Juárez-Rolando, 2016).

Revising the scientometric indicators used and consolidating the systems responsible for recording and processing scientific production is necessary to improve its visibility and position worldwide (Arencibia & de Moya, 2008).

The practice of physical activity provides health benefits during the child's developmental stages and is considered adequate for the prevention of different diseases, especially cardiovascular diseases (Cardon et al., 2017; Wyszynska et al., 2020). Preschool age is ideal for establishing proper physical activity and nutrition habits to improve physical fitness (Coelho et al., 2020; Zhang et al., 2021). Given the importance of physical activity at early ages, many scientific publications are related to that topic (Kwon et al., 2019; O'Neill et al., 2016). In contrast, the need for more published bibliometric studies on this point hinders their investigation and evaluation. Bibliometric studies aim at the quantitative analysis of scientific publications, currently constituting for knowledge, providing data on the scientific status of a research topic, allowing to evaluate its performance and impact on the community (Tomás-Górriz & Tomás-Casterá, 2018).

Various publications with different topics can be found regarding scientific productions related to physical activity. Thus, some articles focus on tennis (Allen et al., 2016), badminton (Blanca-Torres et al., 2019), rugby (Martín et al., 2013), indoor soccer (Palazón et al., 2015), swimming (Nugent et al., 2017) or on soccer goalkeeping (García-Angulo & Ortega, 2015). There are also scientific productions related to education on various topics, such as social education with the elderly (Muñoz-Galiano et al., 2020) or music education (Morales et al., 2017). However, despite this observation, no studies analyse the scientific production of physical activity in children. That is why the present study aimed to perform the scientific production of physical activity in preschool children.

Therefore, a bibliometric analysis of the physical activity in preschool children can provide future researchers with indicators regarding publications and information to identify the most active subjects and disciplines, the different contexts in which they are developed, and the possible studies and intervention programs they apply. In addition, the analysis could provide helpful information on the journals evaluated, their authors, and the countries most active in research.

MATERIALS AND METHODS

Published articles were retrieved from the Web of Science Core Collection (Science Citation Index Expanded; Social Science Citation Index; Arts & Humanities Science Citation Index), which had the words "*Preschool or Kindergarten*" and "*physical activity*" in the title, during the period 2015-2020 were selected.

From a total of 191 articles, the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Moher et al., 2014) were followed in their identification, screening, suitability, and inclusion phases, obtaining a total sample of 136 articles, as shown in the flow diagram (Figure 1).

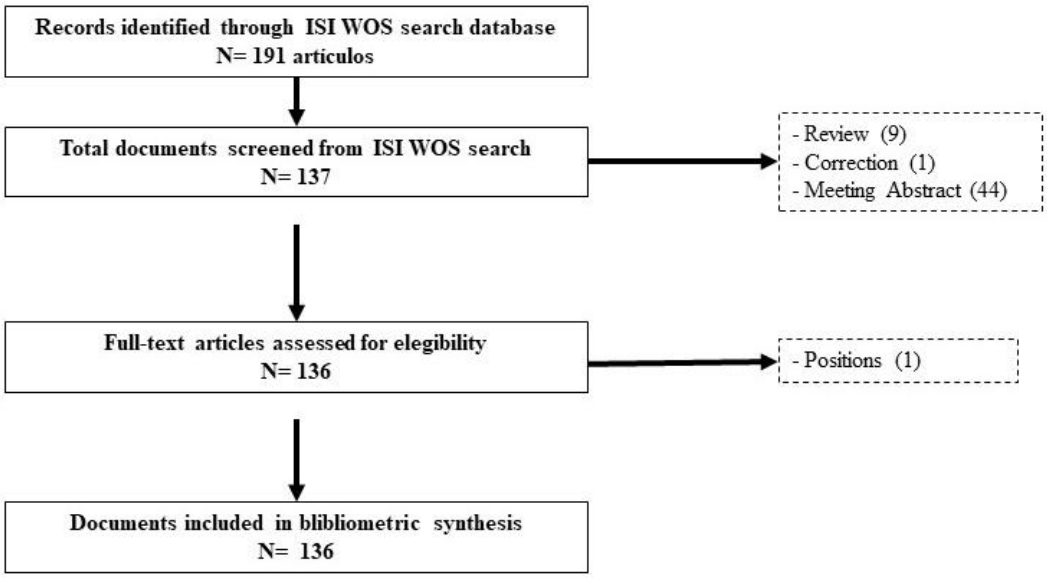

Figure 1. Flow diagram used to select articles.

The subsequent bibliometric analysis considered the following variables: (a) annual trend of published articles from 2015 to 2020; (b) country distribution of publications; (c) distribution of publications of the first author's institution; (d) top journals and quartile; (e) number of authors; (f) subject area (training, health, management, education, other or mixed); (g) type of study (experimental, descriptive, correlational, other); h) average number of citations per article; i) sample (male, female, both, no gender); j) type of sample (students, faculty, parents/family, students and faculty, students and family, other); k) sample age; l) context (school, out-of-school, leisure, mixed, other); m) sample status (healthy, pathology, other); n) orientation of the study (health recommendations, fractional analysis, physiological variables, didactic variables, injuries, psychological variables); o) statistics (univariate, multivariate, not used); p) use of different instruments (questionnaire, observation sheet, interview, smart devices, HF bracelets, accelerometery); q) study with intervention program (duration in weeks, groups (experimental, control and experimental, two experimental and one control), time of measurement (initial, final, initial and final, initial-intermediate and final, initial-final and retest, initial-intermediate-final and retest, only during the program), methodology used (physical education material, training program, active breaks, active classes, use of ICT).

For quality control, the data were recorded by two researchers in two separate searches during one month. The reliability was 1.00 in controlling the number of items detected. To verify the data quality during the

analysis of the different variables, a control of 15% of the cases was carried out, for which both the expert observer and the responsible observer analysed all those papers (Losada & Manolov, 2015). Considering the Kappa concordance coefficient, a minimum concordance of .97 was obtained.

For the statistical analysis, the SPSS 25.0 statistical program was used to perform descriptive analysis, calculating frequencies and the absolute and relative percentages of each variable.

RESULTS

Figure 2 shows the total number of publications during the selected period time.

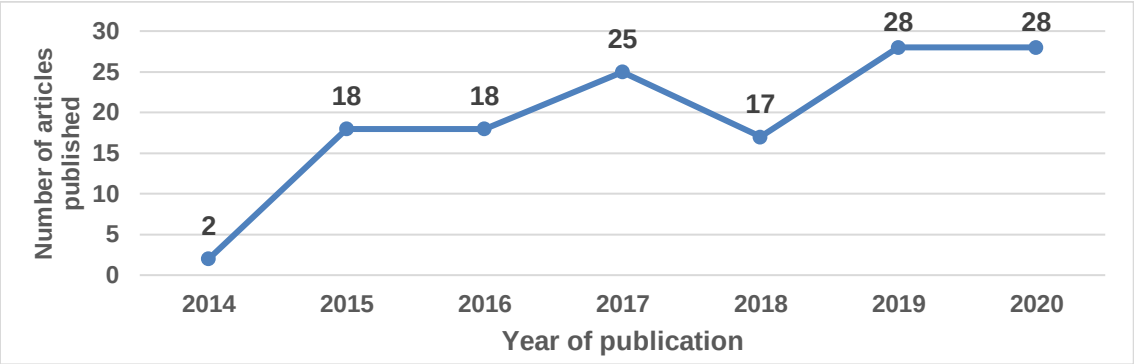

Figure 2. Evolution of the number of publications per year.

As shown in Figure 2, different periods can be identified in the evolution of the number of publications. First, a significant increase in scientific production can be observed from 2014 (2 publications) to 2015 (18 publications). From 2015 to 2018, the production remained the same, although it is worth noting a rise in 2017 (25 publications). From 2018, an increase in the number of publications was observed, reaching 28 in 2020.

Figure 3 shows the total number of publications in different countries.

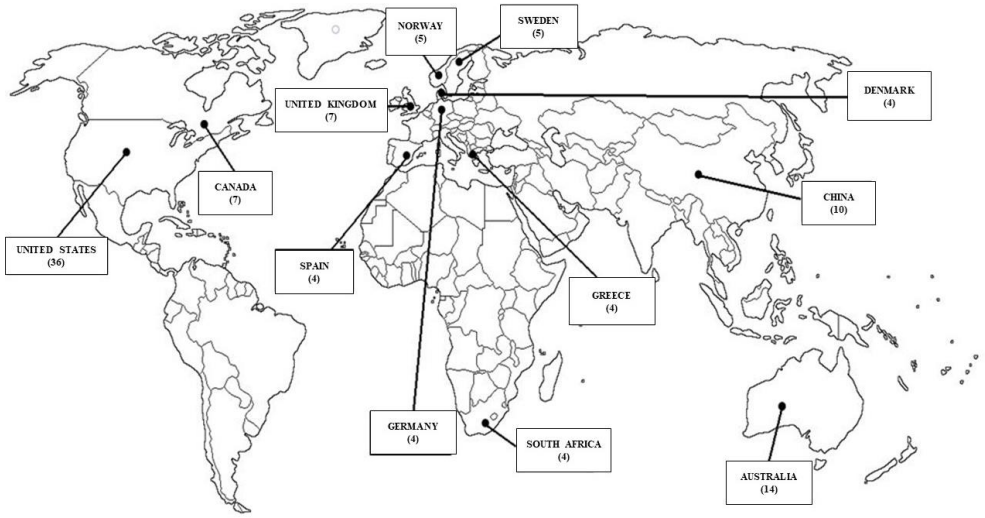

Figure 3. The 12 most productive countries.

A total of 32 countries contributed to the scientific production of the 136 articles studied. The 12 most productive countries can be seen in Figure 3. The country with the highest scientific production is the United States, with 36 publications, followed by Australia, with 14 publications, and China, with ten publications. The United Kingdom and Canada have seven publications. We also note that Norway and Sweden have five publications. These countries are followed by South Africa, Greece, Spain, Germany, and Denmark, with four publications.

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

Table 1. Institutional productivity.

Institution	Frequency	Percentage
University of South Carolina	6	4.4%
University of Wollongong	4	2.9%
University of Cape Town	4	2.9%
Karolinska Institute	4	2.9%
National and Capodistrian University of Athens	3	2.2%
University of Massachusetts	3	2.2%
University of Southern Denmark	3	2.2%
Deakin University	3	2.2%
University of the Pacific	2	1.5%
Shanghai Sport University	2	1.5%
University of Zurich	2	1.5%
University of Victoria	2	1.5%
University of Vermont	2	1.5%
Queensland University of Technology	2	1.5%
University of Rzeszów	2	1.5%
Rutgers University	2	1.5%
University of Novi Sad	2	1.5%
Amsterdam University of Applied Sciences	2	1.5%
University of Alberta	2	1.5%
Nord University	2	1.5%
University of Oporto	2	1.5%
Rest	1	58.8%

According to the results shown in Table 1, the institution with the highest number of publications is the University of South Carolina, with six publications (4.4%), followed by the University of Wollongong, the University of Cape Town and the Karolinska Institute with four publications (2.9%). Institutions such as the National and Capodistrian University of Athens, the University of Massachusetts, the University of Southern Denmark, and Deakin University have three publications each (2.2%).

Table 2 shows the authors with the highest number of published articles.

A total of 119 different authors participated in the 136 articles studied. The most productive authors in the research are presented in Table 2. The most prolific author is Alhassan, S., with three publications (2.2%). After this, we observe authors such as Vale, S.; Toussaint, N.; Tomaz, SA.; Rush, E.; Roscoe, CMP.; Pate, RR.; Lindsay, AC.; Howie, EK.; Hinkley, T.; Crane, JR. and Chen, C. who have two publications (1.5%).

Table 2. Most productive authors.

Authors	Frequency	Percentage
Venetsanou, Fotini	3	2.2%
Mavilidi, Myrto-Foteini	3	2.2%
Alhassan, Sofiya	3	2.2%
Vale, Susana	2	1.5%
Toussaint, Nicole	2	1.5%
Tomaz, Simone A.	2	1.5%
Rush, Elaine	2	1.5%
Roscoe, Clare M. P.	2	1.5%
Pate, Russell R.	2	1.5%
Lindsay, Ana Cristina	2	1.5%
Howie, Erin K.	2	1.5%
Hinkley, Trina	2	1.5%
Crane, Jeff R.	2	1.5%
Chen, Chu	2	1.5%
Rest	1	77.2%

Figure 4 shows the mean number of authors appearing in the publications investigated.

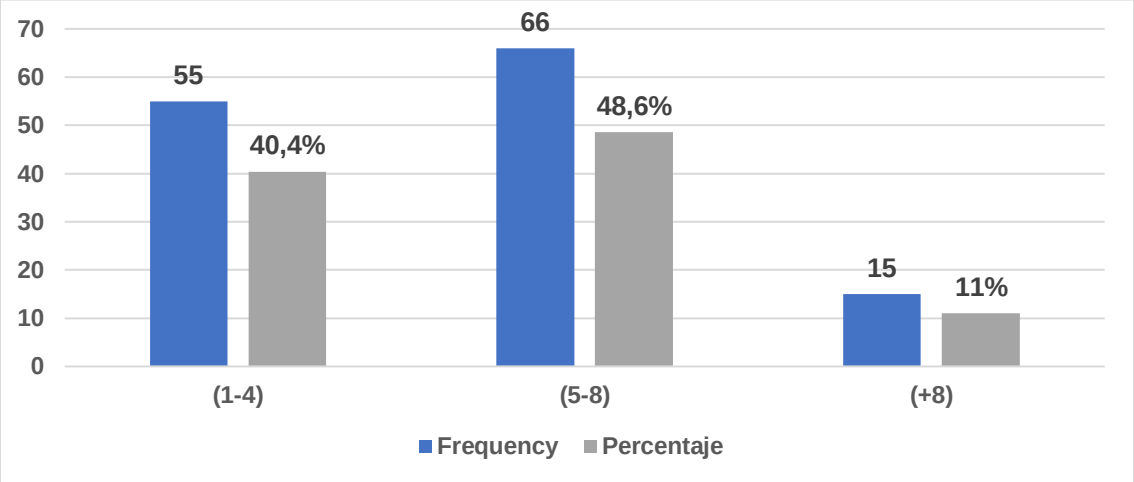

Figure 4. Mean number of authors per article.

Regarding the mean number of authors, the number of publications in which one to four authors participate is lower (55 articles; 40.6%) than those in which five to eight authors collaborate (66 articles; 48.6%). Few publications involve more than eight authors (15 articles; 11%).

Table 3 shows the journals with the highest scientific production on physical activity in preschool children.

A total of 78 journals published the 136 articles analyzed. The most active journals in research are the first, with 8.8% (12 publications) International Journal of Environmental Research and Public Health. This was followed by the Journal of Physical Activity & Health and BMC Public Health (7 publications; 5.1%). Plos One and International Journal of Behavioral journals have six publications (4.4%) each, and Pediatric Exercise Science has five (3.7%).

Table 3. Journals with the highest number of published articles.

Journal	Frequency	Percentage	Quartile
International Journal of Environmental Research and Public Health	12	8.8%	Q2
Journal of Physical Activity & Health	7	5.1%	Q2
Bmc Public Health	7	5.1%	Q2
Plos One	6	4.4%	Q2
International Journal of Behavioral Nutrition and Physical Activity	6	4.4%	Q1
Pediatric Exercise Science	5	3.7%	Q3
Journal of School Health	4	2.9%	Q2
Bmj Open	4	2.9%	Q2
Nutrients	3	2.2%	Q1
Childhood Obesity	3	2.2%	Q1
Bmc Pediatrics	3	2.2%	Q2
Preventive Medicine	2	1.5%	Q1
Medicine and Science in Sports and Exercise	2	1.5%	Q1
Journal of Pediatrics	2	1.5%	Q1
Frontiers in Psychology	2	1.5%	Q2
Evaluation and Program Planning	2	1.5%	Q2
European Journal of Pediatrics	2	1.5%	Q2
Early Childhood Research Quarterly	2	1.5%	Q1
Children-Basel	2	1.5%	Q2
Biomed Research International	2	1.5%	Q3
Rest	1	42.6%	

Figure 5 presents the mean number of citations in publications on physical activity in preschool children.

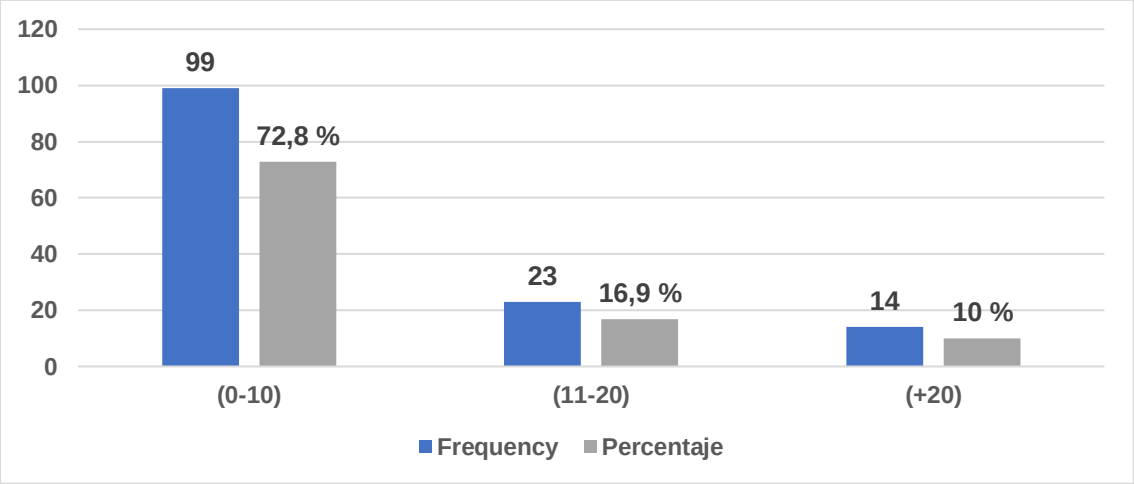

Figure 5. The mean number of citations per article.

Depending on the mean number of citations, there are many publications with 0 to 10 citations (99 publications; 72.8%) compared with publications with 11 to 20 citations (23 articles; 16.9%) or publications with more than 20 citations (14 articles; 10%).

Table 4 shows all the variables analyzed in the study sample.

Table 4. Variables related to the sample.

			Frequency	Percentage
Type of sample	Students		102	75%
	Father/Mother/Family		11	8.1%
	Students and Teachers		6	4.4%
	Students and Family		5	3.7%
	Teachers		3	2.2%
	Others		9	6.6%
Gender	Both		119	87.5%
	Female		7	5.1%
	No gender		10	7.4%
Status	Healthy		128	94.1%
	Pathology		5	3.7%
	Other		3	2.2%
Study characteristics	Health Recommendations Study	Yes	18	13.2%
		No	118	86.8%
	Fractionated Analysis Study	Yes	131	96.3%
		No	5	3.7%
	Physiological Variables Study	Yes	10	7.4%
		No	126	92.6%
	Didactic Variables Study	Yes	40	29.4%
		No	96	70.6%
	Psychological Variables Study	Yes	1	0.7%
		No	135	99.3%
	Injuries Study	Yes	7	5.1%
		No	129	94.9%
Statistics	Multivariate		124	91.2%
	Univariate		11	8.1%
	No use		1	0.7%
Methodological aspects	Questionnaire Use	Yes	51	37.5%
		No	85	62.5%
	Observation Sheet Use	Yes	32	23.5%
		No	104	76.5%
	Interview Use	Yes	19	14%
		No	117	86%
	Smart Devices Use	Yes	32	23.5%
		No	104	76.5%
	PA Wristband Use	Yes	2	1.5%
		No	134	98.5%
	Accelerometer Use	Yes	66	48.5%
		No	70	51.5%

The results given in Table 4, regarding the type of sample, show that most of the studies carried out are students (102 articles, 75%). The family participates alone in 11 studies (8.1%) and together with students in 5 cases (3.7%). On the other hand, 2.2% (3 articles) of the studies are carried out with teachers and 4.4% (6 articles) with teachers and students.

The gender variable shows that in 119 articles (87.5%), both genders were involved. A female sample was used in 5.1% (7 articles), and in 10 cases (7.4%), the sample had no gender.

Finally, the status of the sample in this study is almost healthy (128 articles, 94.1%), with the sample having some pathology in 3.7% (5 articles) of the studies.

Table 5 presents all the aspects related to the type of study.

Table 5. Aspects related to the type of study.

		Frequency	Percentage
Type of study	Descriptive	47	34.6%
	Correlational	39	28.7%
	Experimental	35	25.7%
	Review	12	8.8%
	Others	3	2.2%
Context	School	51	37.5%
	Mixed	13	9.6%
	Others	72	52.9%

The results in Table 5 show, on the one hand, that there is excellent diversity concerning the type of study of the articles investigated, there being 47 descriptive studies (34.6%), followed by correlational studies with 28.7% (39 articles) and experimental studies with 25.7% (35 articles). There were also 12 review studies (8.8%).

The studies were conducted in a school context in 37.5% of the cases (51 articles) and 9.6% (13 articles) in a mixed context. The remaining 52.9% were carried out in other types of context.

Study characteristics related to healthy recommendations were present in 13.2% of the studies, and 5.1% were related to injuries. A total of 96.3% (131 articles) of the publications were fractionated analyses. On the other hand, 7.4% of the studies had associated physiological variables, and only one study had psychological variables. Finally, 29.4% used didactic variables.

Regarding the statistics used, in 91.2% (124 articles) of the cases, multivariate statistical analysis was used, and 8.1% used univariate statistical analysis, while only 1 article (0.7%) did not use statistics.

Regarding the use of questionnaires, 37.5% did use them; 23.5% used observation sheets, and interviews were used in 14% of the cases. In addition, 23.5% of the studies used smart devices and accelerometers, 48.5%. Physical activity wristbands were also used in 1.5% of the cases.

Table 6 presents the variables analyzed concerning subject areas and disciplines.

The results in Table 6 show that the two thematic areas in which the greatest depth has been achieved are health with 47.8% (65 articles) and education with 33.8% (46 articles). It is worth noting the presence of other areas such as entertainment and management, with 5 and 4 articles respectively. In terms of disciplines, physical activity and health is the pioneer with 54.4% (74 articles), followed by didactics with 19.9% (27 articles) and nutrition and motor skills, both with 8.1% (11 articles).

Table 7 shows the aspects related to the intervention program of the articles investigated.

Table 6. Variables related to thematic areas and disciplines.

			Frequency	Percentage
Topic area	Health		65	47.8%
	Education		46	33.8%
	Entertainment		5	3.7%
	Management		4	2.9%
	Mixed		9	6.6%
	Other		7	5.1%
Discipline	Physical Activity and Health		74	54.4%
	Didactics		27	19.9%
	Nutrition		11	8.1%
	Motor Skills/Physical Education		11	8.1%
	Information Science		3	2.2%
	Social Education		2	1.5%
	Physical Education Theory and Sports		2	1.5%
	Training Theory		2	1.5%
	Documentation		1	0.7%
	Sociology		1	0.7%
	Sports Medicine		1	0.7%
	Psychology		1	0.7%
Methodology	Physical Education Material Use	Yes	16	11.8%
		No	66	48.5%
	Academic Training Program	Yes	23	16.9%
		No	59	43.4%
	Activity Breaks	Yes	1	0.7%
		No	81	59.6%
	Active Lessons	Yes	42	30.9%
		No	40	29.4%
	ICT Use	Yes	7	5.1%
		No	75	55.1%

Table 7. Aspects related to the intervention program.

		Frequency	Percentage
Intervention Program	Yes	82	60.3%
	No	54	39.7%
Groups	Experimental	53	39.0%
	Control And Experimental	27	19.9%
	Two Experimental and One Control	2	1.5%
Measure	At the end	53	39%
	Initial and Final	16	11.8%
	Initial-Intermediate and Final	5	3.7%
	During the program	4	2.9%
	At the beginning	3	2.2%
	Initial - Intermediate - Final and Re-test	1	0.7%

A total of 82 publications (60.3%) carried out an intervention program. The type of group involved in the interventions of the publications, 39% (53 articles) is an experimental group, 19.9% (27 articles) present an experimental group and a control group, there are two articles (1.5%) that involve two experimental groups and one control group.

Concerning the measurement of the intervention, 39% (53 articles) are measured only at the end, and there are 16 articles (11.8%) that measure the intervention at the beginning and the end of the intervention. Of note is one article that uses a re-test (0.7%).

Regarding physical education materials, 16 articles used them; 23 articles carried out an academic training program. In addition, 42 articles used active lessons, and seven used ICT. There was also one article that was carried out through activity breaks.

DISCUSSION

Bibliometric studies are increasingly used by institutions and researchers as the years go by and science evolves (Prieto et al., 2015). The need for this study arises from the importance of bibliometric studies, which are designed to analyze the scientific production of a specific subject area to determine the evolution or regression of this field of knowledge. In this way, it is possible to detect, classify and categorize scientific study, thus determining the trends and fields of research in this area. Considering that physical activity in children is an extensive multidisciplinary research area of increasing scientific interest, it is necessary and exciting to carry out a detailed review of it.

The review studies on the different disciplines in the Sciences of Physical Activity and Sport have a big problem, the immense amount of databases that can register works related to the subject. Web Of Science (WOS) implies that only the results in it will be analyzed, given the potential of the database used (WOS) (Peset et al., 2013) and the number of publications obtained and analyzed, making the work done more reliable and representative of the scientific production on physical activity in preschool children.

The results of the present study show clarifying data on the scientific production of physical activity in preschool children. First, it can be observed an exponential increase until 2017. Given the scarce information on the analysis of scientific production in physical activity in preschool children, it is impossible to compare with these. However, studies have been conducted in other sports, such as handball (Prieto et al., 2015), indoor soccer (Palazón et al., 2015) or badminton (Blanca-Torres et al., 2019), whose results are in line with those obtained in this work, demonstrating a remarkable increase in publications on Physical Activity and Sport Sciences.

Regarding scientific production by country and institution, the contribution of countries such as the United States and Australia stands out with 36 and 14 publications, respectively, as does that of the institutions where the University of South Carolina is the institution that contributes the most productivity with six publications. However, when analyzing aspects related to authorship, the data obtained show that the publications on physical activity in preschool children are distributed among many authors, with 119 authors participating.

Many journals have been published on this subject (78 journals), the most important being the International Journal of Environmental Research and Public Health, the Journal of Physical Activity & Health, and BMC Public Health, the first being the pioneer with 12 articles published.

Regarding the average number of authors per publication, 48.6% of the cases are studies involving between 5 and 8 authors, a result slightly higher than those obtained in other studies in which the average number of authors in Sport Sciences is 3.8 authors (Ortega et al., 2015). Eleven percent of the total involves more than eight authors; this could be because it is expected that authorship is very numerous in specific fields of knowledge.

Regarding the number of citations, the number of times a publication is valid, and its impact on the scientific community (Ruíz-Pérez et al., 2014). Based on these authors, the average number of citations per international article is 3.6 with self-citations and 1.86 without self-citations. Considering the results, most publications (72.8%) have very few citations (between 0 and 10). The cause of the scarcity of citations could be the underestimation of the role of the preschool child in Physical Activity and Sport Sciences.

The variables related to the sample, the most relevant aspects shown by the results obtained, have to do with the sample type and gender. About the type of sample, it is noteworthy that in 75% of the cases, the sample is students (102 articles). Concerning gender, it can be observed that both genders are involved in most cases (87.5%). However, only seven publications use women as a sample, results that can be compared with those obtained by other results in sports such as indoor soccer (Palazón et al., 2015) or badminton (Blanca-Torres et al., 2019).

Considering the methodological aspects, specifically those related to the type of study conducted, it is observed that descriptive and correlational studies (34.6% and 28.7%, respectively) predominate over experimental studies (25.7%), results contrary to those obtained in previously conducted studies of other sports (García-Angulo & Ortega, 2015; Palazón et al., 2015). This indicates that the approach that predominates in the publications of our study is descriptive, that being health and education as the most usual thematic areas; it is strange this approach since they have to be experimental.

The variables studied are another methodological aspect to be taken into account. According to the results obtained in this study, fractional analysis is the most studied in the publications (96.3%), followed by didactic variables (29.4%), health-related variables (13.2%), physiological variables (7.4%) and injury-related variables (5.1%).

It was also observed that the most frequently used procedures were using accelerometers (48.5%) and completing questionnaires (37.5%). Observation sheets are used in 23.5% of the studies, as well as smart devices.

Only some studies (14%) use interviews as methodology, assuming that the lack of time and difficulty contacting the sample is the biggest problem; this last result can be compared with other results, such as the badminton study (Blanca-Torres et al., 2019).

Regarding the type of statistics used, a significant predominance of multivariate statistics (91.2%) over univariate statistics (8.1%) can be observed; this shows the evolution of the statistical treatment of data as science advances, posing the research problem closer and making better use of this tool to answer the problem posed (Newell et al., 2014).

Finally, about the realization of an intervention program, it is observed that 82 articles (60.3%) realize an intervention program, 53 publications where an experimental group participates in the intervention, and 27 articles where an experimental group and a control group participate.

Regarding the measurement of the program, the great majority of the articles are measured only at the end (53 articles); there are also 16 articles that are measured at the beginning and end of the program. Only four articles are evaluated continuously during its development, and one intervention program uses a retest.

Finally, concerning the methodology used, 42 articles used active classes, and 23 articles used a theoretical training program. The scarcity of physical education material (16 articles) and the introduction of ICT in physical activity (7 articles) stand out.

CONCLUSIONS

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

The number of publications on physical activity in preschool children has increased significantly from 2014 to 2020, even having a decrease in 2018. English-speaking countries (United States, Australia, and United Kingdom) and China have the highest scientific productivity rate, coinciding with the first institutions, the University of South Carolina and the University of Wollongong. Authorship is between 5 and 8 authors in half of the publications, and the other half corresponds to between 1 and 4 authors. The journals with the most published studies are the International Journal of Environmental Research and Public Health, Journal of Physical Activity & Health, and BMC Public Health. Most of the publications have been cited between 0 and 10 times. Health and education are the most studied subject areas, whose main disciplines are physical activity and didactics. The sample is mainly students of both genders and without any pathology.

Practically all the studies are descriptive, correlational, and experimental, with the former predominating over the rest. The most studied variables are didactic and health-related, and most studies perform a fractional analysis. Multivariate statistical analysis is the most widely used. The most commonly used methodological techniques are questionnaires and accelerometers. More than half of the studies use an intervention program where an experimental group usually participates. The program is measured only at the end and developed through active classes or academic training programs.

AUTHOR CONTRIBUTIONS

GTL and GDQ contributed to the conception and design of the study. JF and DGM organised the database. JF and GDQ performed the statistical analysis. JF, GDQ, DGM, GTL wrote the first draft of the manuscript. JF, GDQ, DGM, GTL drafted sections of the manuscript. All authors contributed to the revision of the manuscript and read and approved the submitted version.

SUPPORTING AGENCIES

No funding agencies were reported by the authors.

DISCLOSURE STATEMENT

No potential conflict of interest were reported by the authors.

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