

Scientific production on Physical Education in Early Childhood Education: bibliometric analysis (1973-2019)

Producción científica sobre Educación Física en Educación Infantil: análisis bibliométrico (1973-2019)

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Short title:

Production on Physical Education in Early Childhood Education

How to cite this article:

García-Pérez, R., Pérez-Gutiérrez, M., Cobo-Corrales, C., & Rodríguez-Gutiérrez, V. (2022). Scientific production on Physical Education in Early Childhood Education: bibliometric analysis (1973-2019). *Cultura, Ciencia y Deporte*, 17(52), 97-116. <http://doi.org/10.12800/ccd.v17i52.1679>

Received: 19 January 2021 / Accepted: 15 March 2022

Abstract

Physical Education in Early Childhood Education is a topic that increasingly attracts the attention of researchers, but the evolution and characteristics of this field of knowledge are not known. In this way, the aim of this work was to carry out a bibliometric analysis on the articles related to Physical Education in Early Childhood Education published until 2019. Thus, Dialnet, ERIC, SciELO, SPORTDiscus, Scopus and Web of Science databases were checked. Obtained results were sent to Endnote X9 programme and then exported to Excel 2016 for their statistical analysis focused on productivity, topic and collaboration aspects. A total of 292 articles published from 1973 to 2019 were obtained. The most represented scientific field was Pedagogy. The most productive author was Gil-Madrona, while the collaboration varied from 2.50 to 4.40 authors per article. The main journals for the dissemination of this output were *RETOS* and *Teoriya i Praktika Fizicheskoy Kultury*. In conclusion, Physical Education in Early Childhood Education has consolidated itself as a new field of knowledge, in which collaborative work and from Spanish institutions stand out.

Keywords: scientometrics, productivity, topics, collaboration.

Resumen

La Educación Física en Educación Infantil es un tema que atrae cada vez más la atención de los investigadores, pero no se conoce la evolución y características de este campo de conocimiento. De esta manera, el objetivo del trabajo fue realizar un análisis bibliométrico de los artículos relacionados con la Educación Física en Educación Infantil publicados hasta 2019. Así, se revisaron las bases de datos Dialnet, ERIC, SciELO, SPORTDiscus, Scopus y Web of Science. Los resultados extraídos fueron enviados al programa Endnote X9 y posteriormente exportados a Excel 2016 para su análisis estadístico centrado en los aspectos de productividad, materias y colaboración. Se obtuvieron un total de 292 artículos publicados entre 1973 y 2019. El campo científico más representado fue la Pedagogía. El autor más productivo fue Gil-Madrona, mientras que la colaboración osciló entre 2.50 y 4.40 autores por artículo. Las principales revistas para la diseminación de esta producción fueron *RETOS* y *Teoriya i Praktika Fizicheskoy Kultury*. En conclusión, la Educación Física en Educación Infantil se ha consolidado como un nuevo campo de conocimiento, en el que destaca el trabajo colaborativo y desde instituciones españolas.

Palabras clave: ciencia métrica, productividad, materias, colaboración.

Introduction

Early Childhood Education is a stage that, according to the international policy standards, includes the population aged between zero and eight years, in which there is a significant growth in brain development and children are highly influenced by the environment and people around them (Organización Mundial de la Salud [OMS], 2007; OMS & Fondo de las Naciones Unidas para la Infancia [UNICEF], 2013). The aim of Early Childhood Education is the holistic development of a child's social, emotional, cognitive and physical needs in order to build a solid and broad foundation for lifelong learning and wellbeing (Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura [UNESCO], 2021). Although the educational environment has a crucial influence during this stage (Palacios & Castañeda, 2009), it is only partially regulated in approximately 80 countries and, 30 of them have made one year of Early Childhood Education compulsory (Marope & Kaga, 2015; UNESCO, 2012).

On the other hand, Physical Education is considered a scientific field developing motor skills from an educational viewpoint (Vicente-Pedraz, 1988), that refers to free, suggested, assisted or directed activities promoting socialization through movement (Gil-Madrona, 2004) and helping people to define their affective, cognitive, social, emotional and motor development while generating motivation and habits in the practice of physical activity (Zagalaz-Sánchez et al., 2014). As a subject, Physical Education is understood like the planned and progressive learning that takes place in school curriculum timetabled time and which is delivered to all pupils (Harris, 2015), that should be compulsory in all educational levels and stages since it is the only school curriculum subject concerned with the development of student's competences and confidence in sport and physical activity and that provides the skills, attitudes and knowledge necessary to practice physical activity and sport throughout life (UNESCO, 2015). In the Early Childhood Education stage, the implementation of Physical Education through play promotes the motor development of children and improves the acquisition of basic motor skills such as movements, turns, jumps, throws or catches (Torres-Luque, 2015; Zarco-Resa, 1992). González-Rodríguez (2001) points out Physical Education promotes the acquisition of skills and habits, strengthens the health and improves both moral and social characteristics, promoting all the capabilities of the children. Thus, the implementation of this subject from the Early Childhood Education stage leads to a personal development of the individual in all his/her competences. It should be highlighted it influences the improvement of elements related to progress and motor growth, but also in an adequate global development and in a better interaction with their environment, having been totally justified by Gil-Madrona et al. (2008). Although Physical Education in Early Childhood Education is a topic grasping more and more attention of researchers, no work has been developed for analysing the evolution and characteristics of this field of knowledge until now.

Bibliometrics is a field of knowledge using statistical techniques for studying publishing and communication patterns in the dissemination of information (Diodato, 2012), offering a more comprehensive perspective on what is really occurring in research (Pendlebury, 2008). The application of bibliometrics is frequent in the field of Physical Education. For example, the last published works were related to the consumption of scientific literature by Brazilian Physical Education researchers (Barros-Carneiro et al., 2020) or the integration of ICT to

Physical Education (Cabrera-Ramos, 2020). Thus, the work carried out by Barros-Carneiro et al. (2020) concluded that the researchers on Biomechanics area used mainly articles for the theoretical and scientific background of their papers, while those associated to the Sociocultural and Pedagogical areas also used books and chapters, together with articles. Moreover, both areas presented similar obsolescence rates, being classified as a classic-ephemeral or intermediate half-life. On the other hand, the study performed by Cabrera-Ramos (2020) showed ICT within Physical Education is a growing field, being Pedagogy, Technology and Sociology its main topics. This field has been mainly developed in the United States of America, China and Spain, presenting most of the works a high national collaboration and a low citation score. Nevertheless, in the field of Early Childhood Education is less common and only two papers were found. The study of Khodabandelou et al. (2018) aimed to analyse the features of the Early Childhood Education research indexed in the Web of Science from 2000 to 2016, concluding this production grew exponentially from 2015 onwards, discovering six thematic changes in the research throughout the analyzed period and the United States of America standing out as the country producing the greatest impact articles. On the other hand, Yilmaz et al. (2019) analysed the scientific production about foreign language teaching in the Early Childhood Education stage indexed in the Web of Science. Their work found that the studies mostly focused on English teaching and the effectiveness of its teaching on acquisition and teacher education, being the *Journal of Educational Psychology* and *Applied Psycholinguistics* the main vehicles for the dissemination of this production.

Two studies focused on the content analysis of the scientific papers on Physical Education in Early Childhood Education have been also carried out, including several bibliometric results for presenting a fragmented view of the evolution and features of this field of knowledge. Thus, Picelli (2002) performed a content analysis of the Master dissertations and PhD thesis on Physical Education but also orientated to the Early Childhood Education stage, defended in Brazil for the period 1979-2000. A total of 31 works were found, highlighting the Master dissertations, mainly focused on the pedagogical and psychological aspects, considering Early Childhood Education as a preparatory stage for Primary Education without its own objective, and being the University of Sao Paulo the most represented institution (Picelli, 2002). Following the same research interest, Farias et al. (2019) assessed the content and approach of Master dissertations and PhD thesis on Physical Education in Early Childhood Education presented in the Physical Education and Education postgraduate programmes in Brazil for the period 1987-2018. This paper showed an increase for documents, predominating the dissertations, focused on the pedagogical practices, using a phenomenological-hermeneutical approach, interview as the main research instrument, and becoming the Federal University of Espírito Santo as the most represented institution (Farias et al., 2019). Therefore, to the best of our knowledge, there is no study analysing the evolution of the scientific production on Physical Education in Early Childhood Education and its characteristics, so the aim of the present study was to carry out a bibliometric analysis of the scientific articles and reviews on Physical Education in Early Childhood Education indexed in Dialnet, ERIC, SciELO, SPORTDiscus, Scopus and Web of Science databases until 2019 inclusive. This analysis allows scholars and researchers to assess their field of study for guiding their future works and provide data to policymakers for analysing the research performance and behaviour for

directing their policies to those most promising or less-represented fields, taking decisions based on evidence.

Method

All article and review documents, written in Spanish or English, focused on Physical Education in the Early Childhood Education stage published until 2019 inclusive and indexed in Dialnet, ERIC, SciELO, Scopus, SPORTDiscus and the core collection of the Web of Science databases were the object of study of the present paper. Regarding documents included, articles and reviews were only selected, as they are the main vehicles for disseminating research (Pérez-Gutiérrez et al., 2021), being excluded other kind of documents such as conference papers, letters, editorial materials, book reviews or notes, due to they are no research results.

For the topic delimitation of the documents, Early Childhood Education was considered as the stage of global development that extends from birth to the beginning of Primary Education, usually at six years of age, in which cognitive, physical, social and emotional development is developed from a holistic approach (UNESCO Institute for Statistics, 2012). Regarding Physical Education, the definition of Harris (2015) was used, which understands it as the planned and progressive learning that takes place in school curriculum timetabled time and which is delivered to all pupils, being the only area of the school curriculum concerned with the development of students' competence and confidence in relation to physical activity and sport (UNESCO, 2015).

In relation to databases, Dialnet was selected as one of the largest bibliographic databases of Hispanic scientific literature (Fundación Dialnet, 2021), while ERIC indexes the scientific output focused on educational studies from 1966 (EBSCO, 2020a). On the other hand, SciELO collects the scientific production of 15 different countries published in 1805 different journals (SciELO, 2020). SPORTDiscus is the main database concerning sports and sports medicine research, with coverage from 1930 to the present (EBSCO, 2020b). Scopus and the Web of Science are considered two of the main international databases (Pérez-Escoda, 2017). Except for Dialnet, the rest of accessed databases are considered as principal sources of information (Gusenbauer & Haddaway, 2020).

Data mining

Data mining was performed in June 2020, limiting the search to those documents published until 2019 for filling out the last decade analysed. No lower time limit on the publication of documents was applied and it depended to the time coverage of each database, determining, in this way, the beginning of the scientific production on Physical Education in Early Childhood Education.

Several terms were used in relation to the object of study for data mining, both in Spanish and English, due to the international scope of the databases accessed. Following the recommendations of Mitchell and Taylor (2015) for the field of Early Childhood Education, as well as a similar methodology to that one used by Farias et al. (2019), based on the thesaurus of the ERIC database, the terms for data mining were: educación física, physical education, educación infantil, educación preescolar, educación preescolar, early childhood education, preschool education, pre-school education, nursery education, preprimary education and pre-primary education. To facilitate data collection, these terms were bonded by means of Boolean operators AND and OR, creating a search string that was individually introduced in the different databases. The search was performed on the title, keywords and abstract

of the documents. The search string used in Scopus, similar to the rest of the databases, was the following:

((TITLE-ABS-KEY ("Educación infantil") OR TITLE-ABS-KEY ("early childhood education") OR TITLE-ABS-KEY ("educación preescolar") OR TITLE-ABS-KEY ("preschool education") OR TITLE-ABS-KEY ("educación pre-escolar") OR TITLE-ABS-KEY ("pre-school education") OR TITLE-ABS-KEY ("nursery education") OR TITLE-ABS-KEY ("pre-primary education") OR TITLE-ABS-KEY ("preprimary education")) AND ((TITLE-ABS-KEY ("educación física") OR TITLE-ABS-KEY ("physical education"))))

Using the filters of each database, by type of document, language and date of publication, articles and reviews documents, written in Spanish or English were only selected, and those documents published in 2020 were excluded, for meeting the definition of the object of study. A total of 1156 documents were retrieved. They were exported to the Endnote X9 reference manager programme, including the bibliographic information of each document, as well as their abstract and keywords. Then, documents were individually checked by two independent researchers for determining its final inclusion, by means of the reading of each document's abstract. Full text was only accessed in some cases. When discrepancies appeared, a third researcher was consulted for determining its final inclusion. Finally, the total amount of documents included was 292.

Data analysis

Documents included were exported to Excel 2016 programme for their analysis by descriptive statistics, calculating frequency and percentage of documents distributed by year, decade, database and field of science. Bibliometric analysis was focused on the productivity, topic and collaboration aspects (López-López, 1996). For the productivity analysis, documents were distributed by year, decade, database and journal. Regarding the topic analysis, through a process of inductive categorization, documents were classified by the field of science grounding theoretically the study, belonging each document to only one field, and following the UNESCO nomenclature for fields of science and technology (Simple Knowledge Organization System [SKOS], 2021). Two researchers independently performed the categorization of documents by field of science. When discrepancies appeared between them, a third researcher was consulted.

In relation to the collaboration patterns, the amount of single-authored articles (AI), multi-authored articles (AC), the mean of authors per article and the percentage of collaboration (%C) was calculated. The definition proposed by Subramanyam (1983) was used for calculating the percentage of collaboration, being $\%C = (AC/AC+AI)*100$. Moreover, most productive authors (> 4 documents) were also determined, presenting their total amount of published articles, the amount of signatures, collaborators, their collaboration index and institutional affiliation. Collaboration index (IC) was calculated as the relation between the number of collaborators and the published articles by an author.

Results

A total of 292 documents focused on Physical Education in Early Childhood Education were found. This scientific production began in 1973 irregularly, being continuously from 1994 onwards. A progressive increase of documents appears during the last decade analysed (Figure 1).

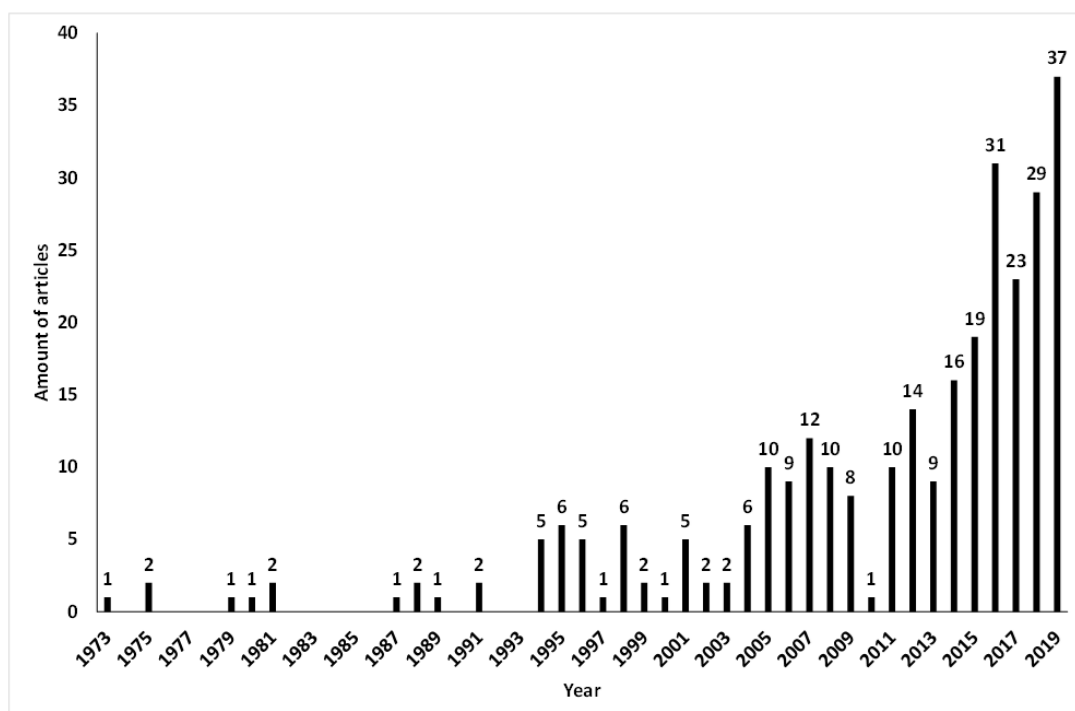


Figure 1. Distribution of articles per year

Regarding the fields of science represented in the documents analysed, Pedagogy, Sociology and Psychology highlighted with 89, 68 and 46 documents respectively,

compiling a 69.52% of total scientific production. On the contrary, fields of science such as Anthropology or History scarcely appeared represented in two documents (Table 1).

Table 1. Distribution of documents by field of science and decade

Field of science	1970		1980		1990		2000		2010		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Anthropology									2	0.68	2	0.68
History							2	0.68	2	0.68	4	1.37
Life Sciences			2	0.68	3	1.03	4	1.37	16	5.48	25	8.56
Linguistics							1	0.34	14	4.79	15	5.14
Logic					2	0.68	1	0.34	3	1.03	6	2.05
Medical Sciences							1	0.34			1	0.34
Pedagogy	2	0.68			12	4.11	27	9.25	48	16.44	89	30.48
Philosophy	2	0.68	1	0.34	2	0.68	6	2.05	8	2.74	19	6.51
Political Science			2	0.68	4	1.37	6	2.05	5	1.71	17	5.82
Psychology			1	0.34	2	0.68	7	2.40	36	12.33	46	15.75
Sociology			1	0.34	2	0.68	10	3.42	55	18.84	68	23.29

Note. n: frequency; %: regarding total documents (292)

As Table 2 shows, the amount of single-authored articles and collaboration increased progressively along the decades. The mean of authors per article and the percentage of collaboration presented the same

evolution. However, from the 1990s multi-authored articles predominated. The percentage of collaboration exceeded 75% during the last decade analysed and the mean of authors per article was 2.68.

Table 2. Distribution of single-authored articles (AI), multi-authored articles (AC), mean of authors per article and percentage of collaboration (%C) by decade

Decade	AI	AC	Mean	%C
1970	3	1	1.25	25
1980	5	2	1.57	28.57
1990	13	14	1.59	51.85
2000	25	40	2.48	61.54
2010	43	146	2.68	77.25

The patterns of collaboration of the most productive authors are shown in Table 3. The most productive author and with the highest number of collaborators was

Gil-Madróna, while the highest collaboration index was obtained by Hastie. Among the eight most productive authors, four of them were affiliated to Spanish universities.

Table 3. Most productive authors (> 4 documents), with their institutional affiliation and collaboration patterns

Author	Doc.	Sig.	IC	Col.	Affiliation
Gil-Madróna, Pedro	11	37	3.36	18	University of Castilla-La Mancha (Spain)
López Pastor, Víctor Manuel	10	25	2.50	11	University of Valladolid (Spain)
Rudisill, Mary E.	7	28	4.00	13	Auburn University (U.S.A.)
McEvilly, Nollaig	6	15	2.50	3	University of Chester (U.K.)
Chiva Bartoll, Oscar	5	18	3.60	6	University Jaume I (Spain)
Gómez Mármol, Alberto	5	15	3.00	4	University of Murcia (Spain)
Hastie, Peter A.	5	22	4.40	10	Auburn University (U.S.A.)
Mello, André da Silva	5	17	3.40	8	Federal University of Espírito Santo (Brazil)

Note Doc: documents published; Sig.: signatures; IC: collaboration index; Col.: collaborators.

The scientific production on Physical Education in Early Childhood Education was disseminated in 147 journals. Table 4 presents the main journals publishing the documents related with this topic, compiling between

them 29.45% of total output. *RETOS* and *Teoriya i Praktika Fizicheskoy Kultury* were the main journals collecting 11 documents respectively. On the other hand, 98 journals only published one article.

Table 4. Main journals for the dissemination of the scientific production about Physical Education in Early Childhood Education

Journal	n	%
RETOS: Nuevas Perspectivas de Educación Física, Deporte y Recreación	11	3.77
Teoriya i Praktika Fizicheskoy Kultury (Theory and Practice of Physical Culture)	11	3.77
JOPERD: The Journal of Physical Education, Recreation & Dance	10	3.42
TRANCES. Transmisión del Conocimiento Educativo y de la Salud	9	3.08
La Peonza: Revista de Educación Física para la paz	8	2.74
Physical Education & Sport Pedagogy	8	2.74
Revista Brasileira de Ciências do Esporte	8	2.74
Teaching Elementary Physical Education	8	2.74
Revista Infancia, Educación y Aprendizaje	7	2.40
Physical Educator	6	2.05
4 journals with 5 documents	20	6.85
6 journals with 4 documents	24	8.22
6 journals with 3 documents	18	6.16
23 journals with 2 documents	46	15.75
98 journals with 1 document	98	33.56

Note n: frequency; %: regarding total documents (292).

Discussion

The beginning of the scientific output on Physical Education in Early Childhood Education began in 1973, with the publication of Barret (1973) study, describing the Physical Education philosophical and theoretical foundations, as well as its relevance for the holistic development of the child and the different models for its implementation.

This output was irregularly and discontinuously published during a first stage (1973-1993) and then with a continuously and increasingly trend, except for some years where only one (1997, 2000, 2010) or two articles (1999, 2002, 2003) were published (Figure 1). The results of the first stage may be due to the evolution of the concept of Early Childhood Education throughout history, since different terms were used along the history such as infants, preschool education and finally Early Childhood Education (Sanchidrián-Blanco, 1991). Possibly, the use of different terms related to Early Childhood Education was also reflected on the scientific production, being a common and frequent term only from 1995 onwards. Moreover, it should be highlighted the evolution of this concept involved different social and educational considerations of this educational stage and its characteristics, becoming the concept of Early Childhood Education the one that gives it a meaning, and not being exclusively seen as a propaedeutic stage (Sanchidrián-Blanco, 1991; Väg, 1991).

It is difficult to date the beginning of the Early Childhood Education concept, however, Kamerman (2006) points out that it was in the 1990s after the World Conference on Education for All, the World Summit for Children and the publication of the UNESCO's Global Monitoring Reports, the Convention on the Rights of the Child and the OECD Thematic Review of Early Childhood Education and Care. This cluster of events launched a new era in the history of education and contributed to a growing public awareness of the value of Early Childhood Education (Haddad et al., 1990) and, consequently, the popularization of this term (Väg, 1991), as well as the beginning of the second stage in the scientific production

on Physical Education in Early Childhood Education with the ongoing publication of articles from 1995 onwards. A similar pattern was observed in the Master dissertations and PhD thesis defended in Physical Education and Education postgraduate programmes in Brazil, which began publishing in 1996 and from 2005 their production increased irregularly until 2018 (Farias et al., 2019).

On the other hand, until 2005, when the scientific production was not zero it was less than 10 articles per year, ranging between one and six. This situation may be also due to the Physical Education progress as a scientific field and science (Vicente-Pedraz, 1988) or to the advances in biomedical, psychological, pedagogical and sociological sciences, which promoted the understanding of Physical Education in various ways such as psychomotricity, body language or educational sports (López-Rodríguez, 1996). Thus, the use of different terms related to Physical Education may have also blurred the boundaries of this field of knowledge, causing the irregularity and discontinuity of published documents during the first stage and the scarcity of articles until 2005.

In contrast, an exponential growth of scientific output is presented during the last decade, collecting 64.73% of total output, which should be understood as a greater concern of scholars and academics for this topic and, therefore, a greater interest in teaching Physical Education bonded to childhood. Early Childhood Education is a key tool for compensating inequalities (González-Motos & Saurí-Saula, 2019) and, at the same time, Physical Education is a favorable area to develop both individual and collective needs that promote personal well-being and psychological and social capabilities, distancing children from stereotypes and discrimination (UNESCO, 2015). Moreover, this growth of the output during the last years shows this scientific field is in the second stage of Price's law of exponential growth (López-López, 1996; Tomás-Gorriç & Tomás-Casterá, 2018), characterized by an exponential rise of the scientific literature in a certain field of knowledge. This pattern was also confirmed in Brazil regarding the publication of

academic studies associated to Physical Education in Early Childhood Education (Farias et al., 2019; Picelli, 2002).

In relation to the scientific fields, documents only represented 11 out of the 24 existing fields included in the UNESCO nomenclature for fields of science and technology (SKOS, 2021). This situation, together with the starting of the exponential growth of the scientific production, shows this field of knowledge is in its beginnings. Therefore, the viewpoints of less-represented scientific fields such as Anthropology, for understanding the several manifestations of Physical Education in Early Childhood Education in different societies and cultures, or the Medical Sciences, for determining possible injuries and pathologies associated to Physical Education in this educational stage and suggesting recommendations for its safe practice, should strengthen this field of knowledge. Research should be also broadened with no-represented fields of science until now, such as Economic Sciences, for determining the management of economic resources, or the Juridical Sciences and Law, for comparing the rules and regulations pertaining Physical Education in Early Childhood Education in different countries and regions. The development of research studies from other fields will provide teachers with new evidence on Physical Education in Early Childhood Education, improving their educational action and the understanding of this topic.

Since Physical Education and Early Childhood Education are related to the educational field, the main fields of science represented were Pedagogy, Sociology and Psychology, collecting a 69.52% of total scientific output. Pedagogy was the most represented field, compiling a 30.48% of total documents and representing the interest of researchers for knowing and reflecting about the techniques and methodologies associated with Physical Education applied in Early Childhood Education stage (Brian & Taunton, 2018; Giráldez, 2020; Molina-Soria & López-Pastor, 2017). Sociology gathered 23.29% of total documents, studying the opinions and knowledge of the different educational agents involved in Physical Education in Early Childhood Education (Nicolás-Belmonte & Alonso-Roque, 2018; Petrie & Clarkin-Phillips, 2018). Both fields are focused on the study of human behaviour and methods helping teachers improve their teaching activity, confirming the principle stated by Domínguez-Alfonso (2011) that the teacher should adapt to social changes and modify his/her teaching to the individualities of the students to promote higher quality learning. On the other hand, 15.75% of the articles were dedicated to the study and analysis of psychological aspects, principally for determining teachers' and trainee teachers' beliefs, attitudes, reasons and habits regarding the introduction of Physical Education in Early Childhood Education (León et al., 2019; Marinsek & Kovac, 2019). Pedagogical and psychological areas were also the most represented in the Master dissertations and PhD thesis about Physical Education in Early Childhood Education defended in Brazil (Picelli, 2002).

On the other hand, fields like History or Logic compiled a scarce number of articles (Table 1) and contributed slightly to the scientific knowledge through the description of the historical evolution of Physical Education in Early Childhood Education or the validation of instruments to apply in this field (Capella-Peris et al., 2018; Konstantinou et al., 2007). These studies are broadening the diversity of perspectives for studying Physical Education in Early Childhood Education, enriching its comprehension and understanding, but it is necessary to continue developing studies from these and other scientific fields such as the aforementioned Economic Sciences, Juridical Sciences and Law or Mathematics, Demography and Ethics, to deepen its knowledge.

Regarding the collaboration patterns, results showed a progressive increase along time both in the single-authored and multi-authored articles. From the 1970s, the percentage of collaboration increased gradually, predominating multi-authored articles from the 1990s. However, the mean of authors per article was over two only during the last two decades. These data broaden the characterization of the two stages aforementioned. In the first stage (1970s and 1980s), single-authored articles overcame multi-authored articles, with a mean of authors per article less than two, while the second stage (from the 1990s to the present) was characterized by a predominance of collaboration reaching scores of 2.5 authors per article and percentages of collaboration above 50%. Therefore, considering the law of exponential growth of science (Price, 1986) and the features of current research (Kyvik & Reymert, 2017), a first stage of incipient research related to Physical Education in Early Childhood Education is observed, in which initiatives and single-authored articles began to study and analyse the relationship between these two areas of knowledge. Then, a second stage of research strengthening on this topic appears, characterized by an increase in the number of documents, as well as the relationships between researchers to deepen the understanding of these areas and carry out collaborative studies. It should be pointed out collaboration is essential to improve the quality of research and increase productivity (Kyvik & Reymert, 2017).

Gil-Madróna and López-Pastor were the most productive authors. Both authors published a similar amount of documents related to Physical Education in Early Childhood Education (11 and 10 articles respectively), but their collaboration patterns are quite different, since Gil-Madróna collaborated with a more extensive network (18 collaborators versus 11) and, therefore, achieved a highest collaboration index. Discrepancies between productivity and collaboration are also observed in the rest of authors presented in Table 3. In this way, two authors publishing five articles like Gómez-Mármol and Hastie achieved different collaboration indexes (3 and 4.40 respectively) and had a different number of collaborators (four and 10 respectively). Nevertheless, most productive authors presented an important collaborative activity for developing their research, with more or less extensive collaboration networks and collaboration indexes ranging from 2.50 and 4.40, confirming the trend towards collaborative work in science in general (Kyvik & Reymert, 2017; Price, 1986) and in the Sport Sciences in particular (Wang et al., 2015). Attending to their affiliation, research on Physical Education in Early Childhood Education grasped mainly the attention of authors pertaining to Spanish institutions, reflecting the interest and the level of development of research on this topic in this country. Moreover, a scholar affiliated to the Federal University of Espírito Santo was also involved, confirming the support of this institution with research on this topic and the leading role of Brazil with the publication of 19 academic works (Farias et al., 2019).

In relation to the journals disseminating the knowledge about Physical Education in Early Childhood Education, a cluster of 10 journals (Table 4) collected 29.45% of total documents, confirming Bradford's law that a few journals publish a large number of articles (Diodato, 2012; Salini, 2016). The rest of journals published less than five documents about this topic. It should be pointed out there was a predominance of Physical Education- or Sport Sciences-oriented journals in this cluster of the most important ones. Only the journal titled *Infancia, Educación y Aprendizaje* was dedicated to the Early Childhood Education stage. Due to the global character of this educational stage, it seems the specialization of the Physical Education

field is essential to determine the orientation of the research carried out and, consequently, the submission of the studies to specific journals, from Physical Education or related fields of knowledge, such as Sport Sciences (*Revista Brasileira de Ciências do Esporte*) or Physical Culture in general (*Teoriya i Praktika Fizicheskoy Kultury*). These data mean teachers and researchers with training in Physical Education are applying their knowledge to the Early Childhood Education stage. Although research focused on Physical Education in Early Childhood Education is also disseminated in journals of this educational stage, specialized journals in Physical Education compiled a greater number of studies.

Finally, the history of the *Teoriya i Praktika Fizicheskoy Kultury* journal, began in 1925, as well as the relevance of *RETOS* in Spain derived from its history and indexation, could explain their outstanding position as the main journals disseminating research on Physical Education in Early Childhood Education. Considering half of the most productive authors (Table 3) were affiliated to Spanish institutions, it seems to be reasonable that these authors use their mother language to inform about the results of their studies and that, therefore, four of the 10 most important journals (Table 4) are also published in Spanish.

Conclusions

The scientific production on Physical Education in Early Childhood Education began in 1973, becoming gradually as a new field of knowledge. The analysis of results showed two stages clearly differentiated in its evolution. The first stage took place during the 1970s and the 1980s and was characterized by an irregular production, based on the single-authored articles. During the second stage, from the 1990s onwards, the strengthening of this field of knowledge takes place with a continuous and progressive increase in the number of articles and the development of the scientific communication among authors, reflected on the predominance of multi-authored articles with a mean of more than two authors per article in the last decades analysed. These data confirm the law of exponential growth, characterized by an increase in the number of documents and relationships between researchers.

Due to the educational field of both Physical Education and Early Childhood Education, documents were mainly developed from Pedagogy, Sociology and Psychology. These fields of science were complemented by the production of articles from other fields that collected scarcely a third of total production. Thus, works from less- or not-at-all represented fields of science such as Economic Sciences or Juridical Sciences and Law, are necessary to enrich the understanding of Physical Education in Early Childhood Education and address possible existing knowledge gaps.

The collaboration patterns of the most productive authors showed no relationship between productivity and the collaborators network. Despite presenting different patterns, it is confirmed that these authors carried out their research activity in collaboration, reflecting one of the essential features of research nowadays. In relation to the institutional affiliation of the most productive authors, research on Physical Education in Early Childhood Education especially grasped the attention of academics affiliated to Spanish universities, indicating that it is a line of research that causes great interest in that country. The relevance of this topic within the Federal University of Espírito Santo in Brazil was also confirmed.

The distribution of articles per journal confirmed the Bradford's law, indicating that a small group of journals collects a considerable amount of scientific production.

In this case, *RETOS* and *Teoriya i Praktika Fizicheskoy Kultury* journals were highlighted for the dissemination of knowledge due to their history and indexation, respectively. Physical Education journals were the main vehicles for the dissemination of this production, what seems to indicate that the specialization of the Physical Education area is essential for determining the orientation of the research carried out and, consequently, the sending of the articles to journals of that area.

This paper showed researchers and teachers the features of research on Physical Education in Early Childhood Education allowing them to orientate their future studies to the knowledge gaps found. In addition, it presented evidence of the patterns exhibited by research and its scientific community, allowing policymakers to direct policies towards the strengthening of certain fields of knowledge or the increase of collaboration networks.

Future studies should analyse the contents and methodological orientations of the scientific production on Physical Education in Early Childhood Education for discovering the scholars' themes of interest, as well as the methodological approaches used, for determining the features of the investigations and the possible existing knowledge gaps.

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