

Original Article (short paper)

## Chilean sport sciences scientific production indexed in the Web of Science (1981-2016)

Mikel Pérez-Gutiérrez<sup>1\*</sup>, Carlos Cobo-Corrales<sup>1</sup>, Eugenio Izquierdo-Macón<sup>2</sup>

<sup>1</sup>Department of Education. Universidad de Cantabria, Spain; <sup>2</sup>Department of Physical Education and Sports. Universidad de León, Spain.

**Abstract — Aim:** To carry out a bibliometric analysis of the Chilean Sport Sciences scientific production indexed in the Web of Science until 2016. **Methods:** Chilean Sport Sciences articles and reviews included in the Web of Science Core Collection indexes until 2016 were analyzed. Data was collected and filtered in Endnote X6 programme and then exported to Excel 2013, Bibexcel and Histcite for analysis. Bibliometrics was focused on productivity, subjects and collaboration patterns. **Results:** A total of 152 documents published from 1981 to 2016 were found. Life Sciences was the main research area (104), while Physiology (36) and Sports Training Theory (30) were the most represented subjects. The mean of authors per article was 5.26 and the percentage of collaboration was mainly between 94% and 100%. Ramirez-Campillo was the most prolific author (24) and Caniuqueo achieved the highest collaboration index (10.83). Two networks, with 20 and 10 scholars respectively and representing 19 different institutions, were discovered. A cluster of 53 different journals has disseminated Chilean Sport Sciences publications, but 12 of them collected 60.53% of total production. **Conclusion:** Chilean Sport Sciences scientific production indexed in the Web of Science shows the progressive development and strengthening of this field of knowledge, clearly oriented to Life Sciences, teamwork and international collaboration. The establishment of a network including scholars from Australia, Brazil, Canada, Chile and Spain, which is propelling Sport Sciences research in this country, should be also highlighted.

**Keyword:** bibliometrics, collaboration, scientific production, chile, sport sciences

### Introduction

The development of science in Chile was officially strengthened in 1967 with the establishment of the *Comisión Nacional de Investigación Científica y Tecnológica* [National Commission for Scientific and Technological Research] and its promotion and support of science and technology for contributing to the economic, social and cultural development of the country<sup>1</sup>. In 1982 the *Fondo Nacional de Desarrollo Científico y Tecnológico* [National Fund for Scientific and Technological Development] was also created for funding individual research, supporting more than 16.000 projects until present day<sup>2</sup>.

On the other hand, the constant, progressive and exponential rise of research information worldwide<sup>3,4</sup> has caused the appearance of new techniques for analyzing this information. Bibliometrics has proven to be “the main tool of science, quantitative analysis”<sup>5</sup> and it is a growing field whose procedures have been applied to Chilean scientific output<sup>6</sup>. Thus, the last report indicated Chile had grown an average of 8.2% every year during the period 2009-2013 while in the rest of world was at 2.4%. In 2013, 9.178 documents were published and the amount of researchers rose to 5.943<sup>6</sup>. This report also stated a 49.93% of international collaboration, being the United States of America, Spain, Germany, France and England the most collaborative countries. Regarding research area, Social Sciences and Arts and Humanities presented a significant rise of researchers from 2003 to 2012 due to the increase of international collaborators.

Regarding the development of Sport Sciences in Chile, its history dates back to 1906 with the establishment of the *Instituto de Educación Física y Manual* [Physical Education and Manual Institute] at the University of Chile<sup>7-10</sup>. From that time onwards, the spread of Sport Sciences field of knowledge

is represented by the progressive growth of institutions and universities<sup>11,12</sup>, academics and scholars<sup>13</sup> and consequently, the amount of courses and programmes<sup>11,14</sup>, journals<sup>15</sup> as well as research output<sup>13,16</sup>, influenced by the different social, economic, political and cultural events happened<sup>16-19</sup>. For instance, there are currently more than 30 universities, some of them with several campuses along the country and evening programmes, offering Sport Sciences-related degrees in Chile<sup>14,20</sup>, nine Master and one Doctoral programmes<sup>21</sup>.

From a bibliometric approach, several works have been developed in Chile in Sport Sciences field. These works have offered a comparison of the Sports Sciences scientific development of Chile within its South American context<sup>13</sup>, the history and contribution of its journals<sup>10,15,22</sup> as well as its evolution along time in Chile<sup>16,23</sup>. Nevertheless, the contribution of Chilean scholars to the development of Sport Sciences at the international level has not been studied yet. Thus, the aim of the present study was to carry out a bibliometric analysis focused on productivity, subjects and collaboration patterns of the Chilean Sport Sciences scientific production indexed in the Web of Science until 2016. This analysis could complement previous works, provide academics an international overview of this field along history and allow a national-international data comparison.

### Method

Chilean Sport Sciences articles and reviews included in the Web of Science Core Collection indexes such as Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI) as well as Arts & Humanities Citation Index (A&HCI) and published from 1900 to 2016 were included in the present

study. Those works classified as articles and reviews by the Web of Science were selected as the current main documents for the dissemination of knowledge. Web of Science indexes and time span were set following the methodology proposed by Andrade, López, Ramírez-Campillo, Beltrán, Rodríguez<sup>13</sup> and the recommendations offered by Thomson Reuters<sup>24</sup>, respectively.

Then, a search string was created for data mining including Chile as the country of affiliation of authors as well as Web of Science categories related with Sport Sciences. These were Hospitality, Leisure, Sport & Tourism; Psychology, Applied; Sport Sciences; Education & Educational Research; and Education, Special. These categories were selected due to the multidisciplinary approach of Sport Sciences<sup>25</sup>. In this way, search string was the following:

CU=Chile AND WC=(Hospitality, Leisure, Sport & Tourism OR Psychology, Applied OR Sport Sciences OR Education & Educational Research OR Education, Special)

It should be highlighted Chilean Sport Sciences scientific production does not represent the scientific output of Chilean academics and/or scholars since foreign authors are also working in Chilean universities and/or institutions. The advanced search tool included in the Web of Science presents the affiliation of authors but not their nationality. Moreover, authors affiliated to non-Chilean institutions are also included in the present study because they have collaborated and signed papers with authors working in Chilean organizations.

Results were then filtered by document type for including only articles and reviews. Full record of results was exported to the Endnote X6 reference manager and title, abstract and keywords were checked for considering article's final inclusion regarding its topic.

Obtained results were classified according to their subject and research area, following the criteria used by Devís-Devís, Valenciano Valcárcel, Villamón, Pérez-Samaniego<sup>25</sup> and the Web of Science<sup>26</sup> respectively, and then exported to Excel 2013 for developing the bibliometric analysis focused on productivity<sup>27</sup>.

The analysis included the following variables: distribution of articles per year, subject and research area, single-authored articles (SA), multi-authored articles (MA), mean of authors per article and percentage of collaboration. Percentage of collaboration (%C) was calculated following the methodology used by Valenciano Valcárcel, Devís-Devís, Villamón, Peiró-Velert<sup>28</sup>, being: %C = MA/SA+MA. Moreover, number of articles, signatures, collaborators and collaboration index were also calculated for those authors with six or more articles.

Then, Bibexcel and Histcite were selected for analysing the source journals and preparing the co-authorship network within Chilean Sport Sciences scientific production, following the methodology used by similar works<sup>29,30</sup>. Thus, number of published documents, number of citations in the collection to the journal (Total Local Citation Score; TLCS), total citations in the Web of Science to papers in the journal in the collection (Total Global Citation Score; TGCS) and co-authorship structure was determined. Finally, the map of collaboration for clusters of researchers with more than three members was depicted using Pajek software.

## Results

A total of 152 documents (145 articles and 7 reviews) were found. They were published between 1981 and 2016, first irregularly and constantly from 2008 onwards and appearing a significant rise from 2013 onwards (260% in relation to the amount of documents published in 2012). Documents have been classified in 3 different research areas and 15 subjects as shown in Table 1. Life Sciences was the main research area, collecting 104 documents, while Physiology and Sports Training Theory were the most important subject with 36 and 30 documents respectively. Within Social Sciences, the second most represented research area (42 documents), Psychology and Sociology achieved the highest figures with 14 and 12 documents respectively. On the other hand, some subjects such as Documentation or Management were only represented in one document.

Table 1- Frequency distribution of published articles by year of publication, research area and subject.

Research area & subject	1981	1984	1999	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
<b>Life Sciences</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>2</b>	<b>1</b>	<b>4</b>	<b>3</b>	<b>12</b>	<b>23</b>	<b>25</b>	<b>30</b>	<b>104</b>
Biomechanics		1									1	3	8	13
Kinesiology										1	2	1	1	5
Nutrition											3		2	5
Physiology	1		1	1		2			2	6	8	7	8	36
Sports Medicine							1	2			3	4	5	15
Sports Training Theory								2	1	5	6	10	6	30
<b>Social Sciences</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>5</b>	<b>12</b>	<b>8</b>	<b>11</b>	<b>42</b>
Didactics										2		1		3
Economics						1					1			2

Mathematical Methods												2	1	3
PE&ST								1		3		2	2	8
Psychology				1		1		1	3	3			5	14
Sociology							1				5	3	3	12
<b>Technology</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>3</b>	<b>2</b>	<b>6</b>
Documentation													1	1
Management												1		1
Scientometrics										1		2	1	4
<b>Total</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>2</b>	<b>5</b>	<b>5</b>	<b>18</b>	<b>35</b>	<b>36</b>	<b>43</b>	<b>152</b>

PE & ST: Physical Education and Sports Theory.

Source: prepared by authors.

The first published article in each subject is shown in Table 2, depicting two different periods for the inclusion of Chilean Sport Sciences scientific subjects within the Web of Science.

While the first published physiological and biomechanical articles were indexed during the 1980s, the rest of subjects have appeared from 2008 onwards.

Table 2- Reference of the first published article in each subject.

Reference	Subject
Quintana G, Puig A, Huberman J, Holzts H, Donoso H. Application and methodological analysis of measuring anaerobic capacity (Wingate test) in various sports specialities. <i>Int J Sports Med.</i> 1981; 2(4):265-6.	Physiology
Brandan ME, Gutierrez M, Labbe R, Menchacarocha A. Measurement of the terminal velocity in air of a ping-pong ball using a time-to-amplitude converter in the millisecond range. <i>Am J Phys.</i> 1984; 52(10):890-3.	Biomechanics
Tobar BU. Psychological intervention for detecting and managing attributional styles in two motorized sports: rally and competitive karting. <i>Rev Psicol Deporte.</i> 2008; 17(2):205-19.	Psychology
Chumacero RA. Altitude or Hot Air? <i>J Sport Econ.</i> 2009; 10(6):619-38.	Economics
Urbina E, de Baranda PS, Rodriguez-Ferran O. Assesment instrument for back posture knowledge: PE teachers' opinions. <i>Rev Int Med Cienc Act Fis Dep.</i> 2010; 10(40):630-51.	Sports Medicine
Guzman MEG, Cerda MAC, Castro LME, Astorga TCD. Sports activities in first year high school students in Osorno (Chile). <i>Rev Int Med Cienc Act Fis Dep.</i> 2011; 11(41):145-63.	Sociology
Gonzalez G, Oyarzo C, Fischer M, De la Fuente MJ, Diaz V, Berral FJ. Specific training of the postural balance in the young soccer players. <i>Rev Int Med Cienc Act Fis Dep.</i> 2011; 11(41):95-114.	Sports Training Theory
Dona AM, Cervantes CT, Garcia ER. The role of Physical Education in schools in 21st century. the university professor's view. <i>Movimento.</i> 2012; 18(4):33-54.	PE&ST
Mauricio CO, Rungue MS, Larraguibel R, Ortega DR. Inter-sesion confidence of balance assessment with TOBtrainer <sup>MR</sup> . <i>Rev Bras Med Esporte.</i> 2013; 19(5):376-8.	Kinesiology
Toro-Arevalo S, Oliva I, Tapia JQ. Development of a device for observation of Physical Education classes at elementary school level: a naturalist perspective from teaching experience. <i>Movimento.</i> 2013; 19(1):161-81.	Didactics
Andrade DC, Lopez BA, Ramirez-Campillo R, Beltran AR, Rodriguez RP. Bibliometric analysis of South American research in sports science from 1970 to 2012. <i>Motriz: J. Phys. Ed.</i> 2013; 19(4):783-91.	Scientometrics
Cox GR, Mujika I, van den Hoogenband CR. Nutritional Recommendations for Water Polo. <i>Int J Sport Nutr Exerc Metab.</i> 2014; 24(4):382-91.	Nutrition
Garcia-Rubio J, Gomez MA, Lago-Penas C, Ibanez SJ. Effect of match venue, scoring first and quality of opposition on match outcome in the UEFA Champions League. <i>Int J Perform Anal Sport.</i> 2015; 15(2):527-39.	Mathematical Methods
Sanchez-Martin M, Chacon-Moscoso S, Sanduvete-Chaves S. Enhancing quality in training programs: an application in the sport area. <i>Rev Int Med Cienc Act Fis Dep.</i> 2015; 15(60):613-29.	Management
Lebeau JC, Liu SC, Saenz-Moncaleano C, Sanduvete-Chaves S, Chacon-Moscoso S, Becker BJ, et al. Quiet Eye and Performance in Sport: A Meta-Analysis. <i>J Sport Exerc Psychol.</i> 2016; 38(5):441-57.	Documentation

PE & ST: Physical Education and Sports Theory.

Source: prepared by authors.

Regarding the collaboration patterns, Table 3 shows the predominance of multi-authored articles. The mean of authors per article was 5.26, ranging from one to 10. The percentage of

collaboration was between 94% and 100% with the exception of 2008, when a single-authored article was only published, and 2009, with a 66.67% of collaboration.

Table 3- Distribution of the amount of single-authored articles, multi-authored articles, mean of authors per article and percentage of collaboration per year.

Year	Single authored papers	Multi-authored papers	Mean authors/paper	% of collaboration
1981	0	1	5	100
1984	0	1	4	100
1999	0	1	10	100
2005	0	1	7	100
2008	1	0	1	0
2009	1	2	6	66.67
2010	0	2	4.5	100
2011	0	5	5.4	100
2012	0	5	5.4	100
2013	0	18	4.33	100
2014	2	33	4.43	94.29
2015	1	35	5.42	97.22
2016	1	42	5.91	97.67
Total	6	146	5.26	96.05

Source: prepared by authors

A group of 15 authors has published six or more documents, being Ramirez-Campillo the most prolific with 24 articles, followed by Izquierdo with 15 publications. The collaboration index fluctuated from 4.83 to 10.83; achieving Caniuqueo the highest score (Table 4). On the other hand, the most productive authors have collaborated at least with 23 scholars, representing the extent of the collaboration network surrounding the Chilean Sport

Sciences publications included in the Web of Science. Ramirez-Campillo was the most collaborative author, working with 166 scholars. Moreover, six foreign scholars from Brazil (Nakamura and Loturco) and Spain (Izquierdo, Mujika, Colado and Flandez) are included within this group of most productive authors, depicting they are working closely together with scholars affiliated to Chilean institutions for developing research in this field.

Table 4- List of most productive authors ( $\geq 6$  papers), with institutional affiliations and collaboration patterns.

Author	Papers	Signatures	Collaboration Index	Collaborators	Institutional affiliation
R. Ramirez-Campillo	24	190	7.92	166	Universidad de Los Lagos, Osorno, Chile
M. Izquierdo	15	136	9.07	121	Universidad Pública de Navarra, Tudela, Spain
C. Martinez-Salazar	13	126	9.69	113	Universidad de La Frontera, Temuco, Chile
C. Henriquez-Olguin	12	99	8.25	87	Universidad de Chile, Santiago, Chile
D. C. Andrade	12	95	7.92	83	Universidad de Antofagasta, Antofagasta, Chile
I. Mujika	12	43	3.58	31	University of the Basque Country, Leioa, Spain

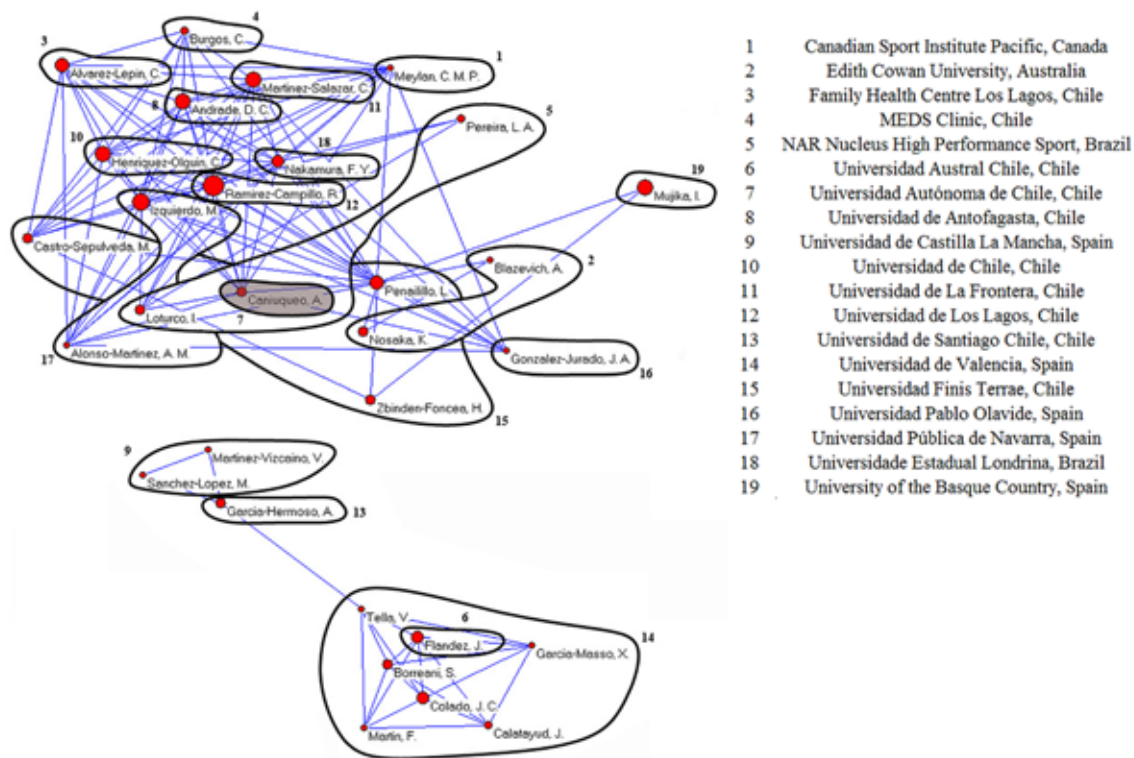
C. Alvarez-Lepin	11	94	8.55	83	Family Health Centre Los Lagos, Los Lagos, Chile
L. Penailillo	10	55	5.50	45	Universidad Finis Terrae, Santiago, Chile
F. Y. Nakamura	9	80	8.89	71	Universidade Estadual Londrina, Londrina, Brazil
J. C. Colado	7	43	6.14	36	Universidad de Valencia, Valencia, Spain
J. Flandez	7	43	6.14	36	Universidad de Valencia, Valencia, Spain
A. Caniuqueo	6	65	10.83	59	Universidad Autónoma de Chile, Temuco, Chile
H. Zbinden-Foncea	6	29	4.83	23	Universidad Finis Terrae, Santiago, Chile
I. Loturco	6	48	8.00	42	NAR Nucleus High Performance Sport, Sao Paulo, Brazil
M. Castro-Sepulveda	6	43	7.17	37	Universidad Finis Terrae, Santiago, Chile

Source: prepared by authors

Regarding the map of the collaboration patterns, two networks were discovered with 20 and 10 scholars respectively and representing 19 different institutions (Figure 1). The first network almost collects as many institutions as authors. There is a strong relationship between most of them, although some scholars such as Mujika, Pereira or Zbinden-Foncea collaborate

to a lesser extent. Moreover, this network shows the international collaboration of Chilean institutions with countries such as Australia, Brazil, Canada or Spain. The second network presents two clusters of scholars collaborating, being Colado and Flandez the most productive authors, and four different institutions from Chile and Spain are working together.

Figure 1 - Author clusters (>3 members) when a threshold of  $\geq 3$  co-authored publications is applied.



Source: prepared by authors.

Finally, a cluster of 53 different journals has disseminated the selected Chilean Sport Sciences documents. As shown in Table 5, twelve journals have published five or more articles collecting 92 articles, representing 60.53% of total production. The *Journal of Strength and Conditioning Research* published 16 articles while *Movimento* included 11 publications. On the other hand, 29 journals have only published one article. Regarding the citation scores of these journals, there is no direct relationship between TLCS and TGCS, although the *Journal of Strength and*

*Conditioning Research*, *European Journal of Applied Physiology and Medicine and Science in Sports and Exercise* have exhibited the highest scores in both. The *Journal of Strength and Conditioning Research* was the most cited journal within the Web of Science collection (155), while the *European Journal of Applied Physiology* achieved the highest citation score within the articles included in the collection (5). Some journals, such as the *Journal of Sports Science and Medicine* or *Journal of Sports Sciences*, have scored in TGCS but no in TLCS.

Table 5 - Source journals for the articles and citations.

ISSN	Journal	Articles	TLCS	TGCS
1064-8011	Journal of Strength and Conditioning Research	16	3	155
0104-754X	Movimento	11	0	3
1577-0354	Revista Internacional de Medicina y Ciencias de la Actividad Física y del Deporte	9	0	4
1600-0838	Scandinavian Journal of Medicine & Science in Sports	8	2	45
1474-8185	International Journal of Performance Analysis in Sport	7	1	14
1303 - 2968	Journal of Sports Science and Medicine	7	0	36
1132-239X	Revista de Psicología del Deporte	7	0	7
1439-6319	European Journal of Applied Physiology	6	5	64
0195-9131	Medicine and Science in Sports and Exercise	6	3	68
0172-4622	International Journal of Sports Medicine	5	0	13
0264-0414	Journal of Sports Sciences	5	0	18
1517-8692	Revista Brasileira de Medicina do Esporte	5	1	1
-	2 journals with 4 articles	8	-	-
-	3 journals with 3 articles	9	-	-
-	7 journals with 2 articles	14	-	-
-	29 journals with 1 article	29	-	-

TLCS – Total Local Citation Score = Total citations in the collection to the journal. TGCS – Total Global Citation Score = Total citations in WoS to papers in the journal in the collection. (Note that this is not necessarily the total citations to the journal in WoS; only to those papers in the journal included in the collection).

Source: prepared by authors.

## Discussion

The present study has shown the existence of 152 documents related to Chilean Sport Sciences scientific production published in the Web of Science Core Collection indexes from 1981 to 2016. After the indexation of the first Chilean Sport Sciences article in the Web of Science in 1981, there was an approximately 30-years period with a scarce scientific output. Then, up to 132 documents were published from 2013 onwards, drawing a progressive rise, and being Life Sciences the most represented research area. These results show the evolution of Chilean Sport Sciences scientific output, the orientation of Chilean Sport Sciences higher education and research institutions and the specialization and/or research focus of scholars in this country.

These results differ from those obtained by Andrade, López, Ramírez-Campillo, Beltrán, Rodríguez<sup>13</sup> despite a similar methodology was used and after considering the time span was 4 years longer in the present study. These authors studied the South American research output indexed in the Web of Science from 1970 to 2012, focusing on the analysis of the amount of articles, scholars, subjects, institutions, impact factor, citations and journals involved, including data from Chile and depicted a different amount and distribution along time of the Chilean Sport Sciences articles indexed in the Web of Science. For example, they found four and 11 documents in 1978-1982 and 1998-2002 periods respectively while the present study only reported one document published in each period, that is, 1981 and 1999. The constant update of journals, and consequently of articles, indexed in the

Web of Science may explain this situation. However, Andrade, López, Ramírez-Campillo, Beltrán, Rodríguez<sup>13</sup> depicted a similar development of Chilean Sport Sciences with a rise from 1998 onwards and particularly during the 2008-2012 period. They also discovered the orientation of Sport Sciences scientific production to Life Sciences, being Physiology (44% of total articles) the most-studied topic in the Sport Sciences within South American countries. In the same way, Pérez-Gutiérrez, Lagos-Hernández, Izquierdo-Macón<sup>16</sup> carried out a bibliometric analysis of Sport Sciences scientific production published in Chile from 1912 to 2014, determining the distribution of articles, authors, institutions and countries per decade, the distribution of articles per decade, subject, research area and journal and the collaboration patterns. They found Physiology as the second most important subject (16.18%) while in the present study it achieved 36 publications (23.68% of total articles), confirming the orientation of Chilean Sport Sciences scholars to Life Sciences. As they stated, the focus of scholars on subjects associated to Life Sciences, such as Physiology or Sports Medicine, was triggered to the biological approach fostered in the physical education institutions from 1930s onwards or the establishment of the Chilean Society of Sports Medicine in 1955<sup>8,9,16,31</sup>.

Social Sciences collected 42 documents, 27.63% of total Sport Sciences production, becoming the second most represented research area and widening the orientation of Sport Sciences studies developed in Chile. The appearance of certain subjects during the last years, such as Biomechanics, Didactics, Mathematical Methods, Nutrition or Scientometrics, with three or more articles, also shows the growth of this field and its multidisciplinary character<sup>16,25,32,33</sup>, improving, widening and strengthening the knowledge about physical activity and sports from other approaches.

The analysis of the collaboration patterns presented a predominance of multi-authored articles. Pérez-Gutiérrez, Lagos-Hernández, Izquierdo-Macón<sup>16</sup> study, regarding the Sport Sciences scientific output published in Chile from 1912 to 2014, showed single-authored articles predominated until the decade of 2010 and a mean of 1.54 authors per article. During the last period these authors analyzed (2010-2014), the amount of multi-authored articles increased significantly achieving 75% of collaboration and a mean of 2.96 authors per article. As collaboration has been defined as a key element to improve quality in scientific production, these results should be understood in two different but complementary ways. First, there has been a trend towards collaborative research within Sport Sciences in Chile from 2010 onwards, both in national- and international-indexed production although single-authored papers dominated the scientific documents published in Chile for almost a century<sup>16</sup>. And second, Chilean Sport Sciences scholars have usually participated in collaborative networks for those papers indexed in the Web of Science since it indexes the top international and regional journals in the world and these journals publish most of the significant scholar results<sup>34</sup>. Thus, the Web of Science demands foster teamwork among Sport Sciences scholars affiliated to Chilean institutions for publishing their papers. The best research works or projects, generally developed by a group of scholars, are published in top journals.

Regarding the collaboration of the most productive authors, a group of 15 scholars published six or more articles, being Ramírez-Campillo the most prolific author and Caniuqueo the most collaborative. Brazilian and Spanish scholars were also included within this collaboration network. These results show the importance of teamwork for getting published in journals indexed in the Web of Science but also for developing research since the three most productive authors have collaborated with at least 113 scholars. In the same way, Caniuqueo signed six papers but he achieved the highest score in the collaboration index, illustrating the extent of his collaboration network. This should be understood as a way for improving the quality of his research.

In the Spanish context, Valenciano Valcárcel, Devís-Devís, Villamón, Peiró-Velert<sup>28</sup> analyzed the collaboration among authors publishing in the 16 most important Sport Sciences journals published in Spain from 1999 to 2005. They discovered a mean of 2.50 authors per article in total and a group of 36 scholars publishing 10 or more articles with a mean of 3.89 authors per article. Despite the methodology, time span, context and results differences between both studies, it should be suggested collaboration benefits productivity and it is necessary for improving research quality.

The map of the collaboration patterns depicted two networks with 20 and 10 scholars respectively and representing 19 different institutions, including countries such as Australia, Brazil, Canada or Spain. Valenciano Valcárcel, Devís-Devís, Villamón, Peiró-Velert<sup>28</sup> also found a 16.39% of foreign authors, most of them from Brazil, Portugal and Argentina, participating in the 12.77% of total articles. Therefore, international collaboration is a widespread and frequent practice in Sport Sciences in Chile, corroborating previous results that showed the intensification of international collaboration in the last decade worldwide<sup>6</sup>. Thus, Switzerland and Ireland obtained the highest values regarding international collaboration, 70.3% and 67.4% respectively, in 2010-2011 period while Brazil, the only South American country included in the study, achieved a 40.7%<sup>6</sup>. In the case of the first network (Figure 1), most of the authors are collaborating among them although some scholars have participated to a lesser extent. This network should be highlighted due to the amount of institutions and the diversity of countries working together as well as the great number of interactions among authors. In the case of the second network, two clusters of Chilean and Spanish universities are shown, emphasizing the participation of four different institutions and the non-existence of relationship between scholars of the same country.

And regarding the dissemination of the Chilean Sport Sciences scientific output, 12 journals, mainly dedicated to Life Sciences, collected the 60.53% of total production. The *Journal of Strength and Conditioning Research* and the *European Journal of Applied Physiology* achieved the highest TGCS and TLCS, respectively. Similar results were obtained by Andrade, López, Ramírez-Campillo, Beltrán, Rodríguez<sup>13</sup> when analyzing South American Sport Sciences scientific output. Four of the 19 most recurrent analyzed journals were only multi-disciplinary while the rest were oriented to Life-Sciences, particularly to Medicine and Physiology. However, Pérez-Gutiérrez and

Lagos-Hernández<sup>15</sup> prepared a bibliography of Sport Sciences journals published in Chile from 1929 to 2014, presenting their bibliographic and bibliometric characteristics and assessing their quality. These authors discovered 12 journals, all of them with a multidisciplinary approach with the exception of *Archivos de la Sociedad Chilena de Medicina del Deporte* [*Archives of the Chilean Society of Sports Medicine*]. And the same situation was evidenced in the Spanish journals dedicated to Sport Sciences, being the majority multi-disciplinary although some of them were specialized in subjects such as Medicine, Didactics and Psychology<sup>33</sup>. Therefore, the analysis of national contexts shows the existence and relevance of multi-disciplinary journals for the dissemination of Sport Sciences scientific production within a country<sup>15,33</sup>, while the analysis of the literature indexed in international databases, such as the Web of Science, presents the predominance of Life-Sciences oriented journals for publishing Sport Sciences papers, probably as a consequence of the scholars' interest and specialization<sup>13</sup>.

Finally, the use of the Web of Science as the only source of information for data mining and the inclusion of article and review type of documents are the main limitations of the present study. In this way, future studies should analyze the Chilean Sport Sciences scientific output indexed in other international databases such as Scopus or Pubmed, the amount and characteristics of funded research projects of Chilean Sport Sciences scholars for complementing the present results, the development of Sport Sciences production in other South American countries for comparing results as well as periodically follow the development of this field of knowledge.

## Conclusions

A total of 152 Sport Sciences documents affiliated to Chilean institutions have been published from 1981 to 2016 in the Web of Science Core Collection indexes (SCI-EXPANDED, SSCI and A&HCI), with a significant rise from 2013 onwards and mainly dedicated to Life Sciences, particularly to Physiology and Sports Training Theory. Social Sciences and Technology research areas were also represented but to a lesser extent. Scholars have collaborated for developing Sport Sciences research, with a mean of 5.26 authors per article, including the participation of foreign authors from Australia, Brazil, Canada or Spain. Ramirez Campillo was the most important scholar regarding the number of papers, signatures and amount of collaborators while Caniuqueo achieved the highest collaboration index. Two networks were discovered, depicting different patterns of collaboration. In the first one, collaboration was established among most of the scholars including almost as many institutions as authors, while the second one involved four different institutions from Chile and Spain but there was no relationship between scholars of the same country. Finally, 60.53% of total Chilean Sport Sciences production has been disseminated in 12 journals, most of them Life Sciences-oriented.

In summary, Chilean Sport Sciences scientific production indexed in the Web of Science shows the progressive development and strengthening of this field of knowledge, clearly oriented to

Life Sciences, teamwork and international collaboration. Also, it should be highlighted the establishment of an important network including scholars from Australia, Brazil, Canada, Chile and Spain which is propelling Sport Sciences research in this country. This study complements the results of the previous works developed at the national level in Chile, allowing comparison between them and providing a deeper viewpoint of the Sport Sciences scientific production history and development in this country. Data provided could be considered by academics, institutions and/or policymakers for making decisions in relation to the strengthening of the research areas and subjects less represented as well as the communication and collaboration patterns within Sport Sciences.

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*\*Corresponding author*

Mikel Pérez-Gutiérrez  
 Department of Education, University of Cantabria. Avda. de Los Castros s/n,  
 39005, Santander, Cantabria, Spain.  
 Email: [mikel.perez@unican.es](mailto:mikel.perez@unican.es)

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