

Original article

Bibliometric analysis of South American research in sports science from 1970 to 2012

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Abstract—Sports science article publication in South American countries (n=11) was studied between 1970-2012, using all citation database of ISI Web of Knowledge. We evaluated: number of published articles; the number of publications divided by the number of people in science and technology (number pub/number peo); the top incidence of research subjects; public or private institutional predominance; impact factor (IF); average citations per document per country; and frequency of published articles per journals per country. Brazil showed the highest number of published articles, followed by Argentina. Bolivia showed the highest number pub/number peo, followed by Peru. Most studied themes were physiology, orthopedic and rehabilitation. Public institutions showed a higher published articles number than did private institutions. Peru and Bolivia were the only countries with a mean IF of 2 or higher. Average citation was higher in Peru (higher coefficient variation). In conclusions, our results show that, in most South American countries, their published articles rate has increased over time. This could be related to new government and institutional policies. However, production was low compared with other areas of science.

Keywords: database bibliographic, sport sciences, bibliometrics, research

Resumo—“Análise bibliométrica da pesquisa na América do Sul em ciências do esporte 1970-2012.” Produção de artigos científicos do esporte em países da América do Sul (n = 11) foi estudada entre 1970-2012 utilizando: todos os dados de citações do ISI Web of Knowledge. Foram avaliados: número de artigos publicados; número de artigos publicados/número de pessoas em ciência e tecnologia (no.pub/no.pes); assuntos mais estudados; predominância de instituições públicas ou privadas; fator de impacto (FI); citações média por documento por país no ISIweb; frequência de artigos publicados por periódicos por país. Brasil teve o maior número de artigos publicados, seguido pela Argentina. Bolívia mostra o mais elevado no.pub/no.pes, seguido pela Peru. Os temas mais estudados foram: ortopedia, fisiologia e reabilitação. As instituições públicas que apresentam maior número de artigos publicados. Peru e Bolívia foram os únicos países com uma média IF de 2 ou superior. Citação média foi maior no Peru (maior coeficiente de variação). Nas conclusões, nossos resultados mostram que, na maioria dos países, a sua taxa de artigos publicados aumenta ao longo do tempo. Isso pode estar relacionado com o novo governo e políticas institucionais. No entanto, a produção foi baixa em comparação com outras áreas.

Palavras-chaves: base de dados, ciência dos esportes, bibliometria, pesquisa

Resumen—“Análisis bibliométrico de la investigación en América del Sur en las ciencias del deporte 1970-2012.” Se estudió la producción de artículos en ciencias del deporte en países de América del Sur (n=11) entre 1970-2012, usando: todas las bases de datos de citas de ISI Web Knowledge. Se evaluó: número de publicaciones de artículos; número de publicaciones de artículos / número de personas en ciencia y tecnología (no.pub/no.peo); temas más estudiados; predominancia de instituciones públicas y privadas; factor de impacto (IF); promedio de citas por documento por país; frecuencia de publicaciones de artículos por revista por país. Brasil tuvo más publicaciones de artículos, seguido de Argentina. Bolivia muestra el mayor no.pub/no.peo, seguido por Perú. Los temas más estudiados fueron fisiología, ortopedia y rehabilitación. Las instituciones

públicas muestran un mayor número de publicaciones de artículos. Perú y Bolivia son los únicos países con una media de IF de 2 o mayor. El promedio de citas fue elevado en Perú (elevado coeficiente de variación). En conclusión, nuestros resultados muestran que en la mayoría de los países el rango de publicaciones de artículos se incrementó con el tiempo. Esto puede ser relacionado con nuevas políticas gubernamentales e institucionales. Sin embargo, la producción es baja comparado con otras áreas.

Palabras claves: base de datos bibliográfica, ciencias del deporte, bibliometría, investigación

Introduction

Scientometrics is an applied scientific discipline that works with quantitative aspects associated with generating, disseminating and utilizing of scientific information, with the objective of promoting the understanding the developmental mechanisms and research as a social activity by the scientific community (Krauskopf, 1994). Other authors similarly use the concept of bibliometrics as a discipline that covers all quantitative aspects of research as well as communication, storing, dissemination and recovery models of scientific information (Glänzel & Schoepflin, 1994).

Currently, the process of evaluating scientific investigation has become a central element in management policies in research centers and institutions (Abramo, D'Angelo, & Pugini, 2008). There are several approximations as to how to evaluate scientific productivity; be that by area, country or institution. Among these, bibliometric analysis is the most used tool because it helps to verify trends and make projections (Baskurt, 2011). Normally, publications, citation indices and impact factors (IF) are important tools to compare production on several levels (countries, institutions, disciplines, etc.) (Baskurt, 2011; Cartes-Velásquez & Aravena-Torres, 2012). On the other hand and strictly speaking scientific productivity is defined as the number of published articles and generally only includes the "articles" that appear in indexed journals (Cartes-Velásquez & Aravena-Torres, 2012).

Bibliometric analysis of research disciplines has increased in the last twenty years (Krauskopf, 1994), and it reflects the successful changes in policies on an institutional level (Gokceoglu, Okay, & Sezer, 2008), as well as the influence that journals, authors, or countries have had in specific areas of research (Shilbury, 2011). Bibliometric analysis could shine some light on the effectiveness and efficiency of the dissemination of research, which can be measured, for example, by the number of studies published per year in certain areas (Baskurt, 2011). Generally speaking, the Latin America as a whole is responsible for a small fraction of the total world scientific production (López, 2000; RICYT, 2012). The causes for this performance can be explained by some of the following factors: scarce and discontinuous financial support; low social value of science; researchers and research do not respond to the issues and developmental demands required in the businesses market; concentration of economic, physical and human resources in few discipline areas; low added value to primary national

products; poor quality of schooling in the undergraduate and graduate programs; limited access to international sources of financing and international circles defining the value of research themes; and lack of macroeconomic policies providing a support matrix for private investment in research and development (López, 2000). However, in the last decade the number of undergraduate and graduate students in Latin American universities appears to have increased. This increment is in the same proportion as the growth of professional perfection in AngloSaxon countries, as well as in the increase in the number of published articles and technology products (i.e., patents requests) (RICYT, 2012). Brazil especially has shown an increase in the number of articles published by year in all areas (Helene & Ribeiro, 2011), which is related to the number of doctorate holders in that country. Similar patterns can be observed in other South American countries (Krauskopf, 1992; Krauskopf & Vera, 1995; Krauskopf & Vera, 1997; Krauskopf, Vera, Krauskopf, & Welljamsdorff, 1995). Bibliometric analysis also can be used to compare production and trends within a geographic region. Likewise, they can be used to discriminate with respect to world development in a specific research area (Vioque, Ramos, Navarrete-Munoz, & Garcia de la Hera, 2010). Consequently, bibliometric analyses can generate rankings among countries, areas, etc. (Hirsch, 2005; Torres-Salinas, López-Cózar, & Jiménez-Contreras, 2009).

Despite the usefulness of this tool (i.e. bibliometric analysis), to the best of these authors' knowledge, there are no published studies that have evaluated productivity in sports science, especially in the South American countries; much less studies that contrast productivity between them. Therefore, the purpose of this study was to a) describe the bibliometric traits in sports science disciplines in South American countries, b) compare these traits between South American countries, and c) verify the level of development and scientific impact of each area.

Methods

A descriptive and comparative study was done to determine the bibliometric traits of sports science in eleven countries that constitute the majority of South America. In this study, articles published between January 1st, 1970 and October 1st, 2012 were included from the following databases: Science Citation Index Expanded (SCI-E), Social Science Citation Index (SSCI) and Art & Humanities Citation Index (A&HCI) (the latter is only

present since 1975), all of which belong to Thomson Reuters. To determine bibliometric indices, an advanced search on the Web of Knowledge (WOK) platform was performed on October 1st, 2012 (www.webofknowledge.com). In this study we excluded other databases (i.e. HEBSCOHOST, SCOPUS and PUBMED) because they were not compatible with the algorithm search system of the Thomsons Reuters platform. The search was filtered by country, research area and Web of Knowledge category, similar to the protocols used by other researchers (Cartes-Velásquez & Aravena-Torres, 2012). To determine the journal's IF the Journal Citation Reports (JCR) and SCImago platforms were used, and to make analysis easier, we only considered the year 2011. An algorithm was used to search the database using Boolean connectors based on set theory, junctions (OR) and intersection (AND) that increase the scope and resolution of items found. The following is an example of the search algorithm used for each country:

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(CU=Argentina AND SU=Sports Science) OR
(CU=Argentina AND WC=Hospitality, Leisure,
Sport & Tourism)
CU= country; SU= research area
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The country parameter was modified accordingly in WOK search. The countries were: Argentina; Bolivia; Brazil; Chile; Colombia; Ecuador; Guyana; Paraguay; Peru; Uruguay and Venezuela. French Guiana and Suriname were excluded because these countries did not publish articles in the last 42 years; they are indexed in WOK.

The algorithm system used was similar to previous research (Cartes-Velásquez & Aravena-Torres, 2012). The purpose of applying this algorithm was to measure the participation of at least one author from each country in the sport sciences area, regardless of whether they were the author or coauthor. This is because an increase in the number of coauthors has been observed (Abramo, D'Angelo, & Solazzi, 2011). Descriptors of health science (DECS) 2013 version were used as the criterion of technical terms (Virtual Health Library, 2013). After applying the algorithm, a filter was implemented to allow only results classified as "review" and "article," which usually belong to original research articles; eliminating document types considered "grey literature" or options such as "proceeding's papers," "editorial material" and "meeting abstract," which comprise less than 10% of the used sample.

An analysis was done on the obtained results to determine the total number of published articles and the number of published articles in five-year intervals; and the ratio between total number of published articles versus the number of people associated with science and technology in each country. This indicator was calculated adding researchers, fellows of science and technology, technicians and persons treated, support staff and service personnel in science and technology (RICYT, 2012). Guyana was excluded from this analysis because this country did not

have data in this area. Other parameters analyzed were: most studied subjects; public or private institutional predominance per country; IF per country; average citations per document per country in ISIweb; and frequency of published articles per journals per country. All of the descriptive analyses and graphic illustrations were done using the statistical package GraphPad Prism 5.

Results

The total number of published articles and reviews in South American countries for the considered period was 2,357, with Brazil, Argentina, and Chile as the countries with the highest number of publications. On average, for each five-year period, each country published 26.34 ± 71.17 articles, showing a high level of variability between countries. In general, and particular in nations such as Brazil, Argentina, and Chile, in the last years of the studied period we have noticed an increase in the number of published articles (Table 1). Peru and Bolivia evidenced a drop in the number of published articles in recent years. Countries, such as Paraguay, Guyana and Ecuador, presented only one article in the considered period (Table 1). Also, when standardizing the total number of published articles for each country with respect to the number of people in science and technology, we found that the differences became smaller between countries, with Bolivia and Peru having higher coefficients than others countries (Figure 1).

The most studied research subject was physiology, which covered 44% of the articles, followed by research associated with orthopedics, rehabilitation, environmental and occupational public health, and neuroscience; all of which together with physiology, constituted 78.4% of all published articles in the analyzed period (Table 2).

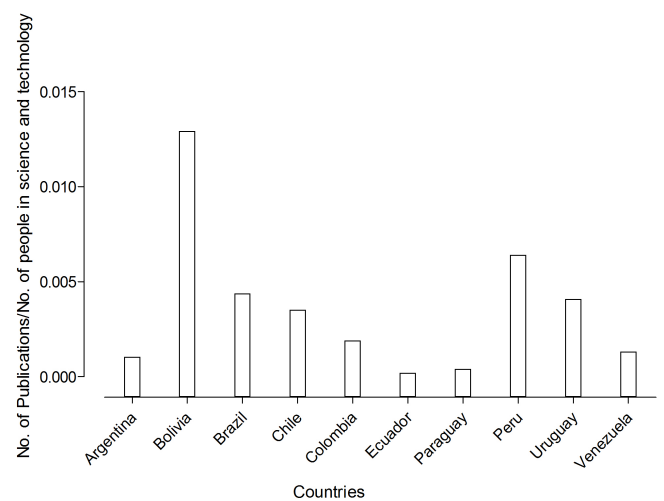


Figure 1. Distribution of the total number of publications in sports science by country with respect to people related to science and technology (2011).

Table 1. Distribution of the number of publications in sports science in South American countries, in the 7-year period from 1970 to 1977, and in 5-year periods from 1978 to 2012.

Countries	1970 – 1977	1978 – 1982	1983 – 1987	1988 – 1992	1993 – 1997	1998 – 2002	2003 – 2007	2008 – 2012
Argentina	4	0	2	10	4	12	28	37
Bolivia	5	0	0	8	22	2	4	3
Brazil	1	1	9	15	18	89	260	1665
Chile	0	4	1	2	1	11	15	29
Colombia	1	2	0	2	2	7	4	13
Ecuador	0	0	0	0	0	0	0	1
Guyana	0	0	0	0	0	0	1	0
Paraguay	0	0	0	0	0	0	0	1
Peru	6	3	2	3	4	5	19	12
Uruguay	0	0	0	1	0	4	3	5
Venezuela	0	0	0	1	0	0	5	3

Table 2. Frequency and percentage of the most-studied topics in the sports science in South American countries from 1970 to 2012.

Topics	Number of articles	Percentage (%)
Physiology	805	44
Orthopedics	190	10
Rehabilitation	178	10
Public environment and ocup. health	134	7
Neurosciences	127	7
Recreational therapy and sport tourism	74	4
Nutrition dietetics	68	4
Biomedical engineering	60	3
Surgery	58	3
Psychology	52	3
Biophysics	45	2
Experimental psychology	37	2

When we analyzed the IF (2011) of the journals in the JCR by the countries in which the authors published, Bolivia, Peru, and Colombia were the only countries with a mean IF of 2 or higher (Figure 2). Interestingly, Brazil shows one of the lowest IF among South American countries, although the total number of publications in Brazil is by far the highest in the continent. Additionally, Table 3 (JCR and SCImago) shows that, even though Brazil is the country with highest number of published articles (total article mass), the majority (63%) are published in local journals (Revista Brasileira de Medicina do Esporte,

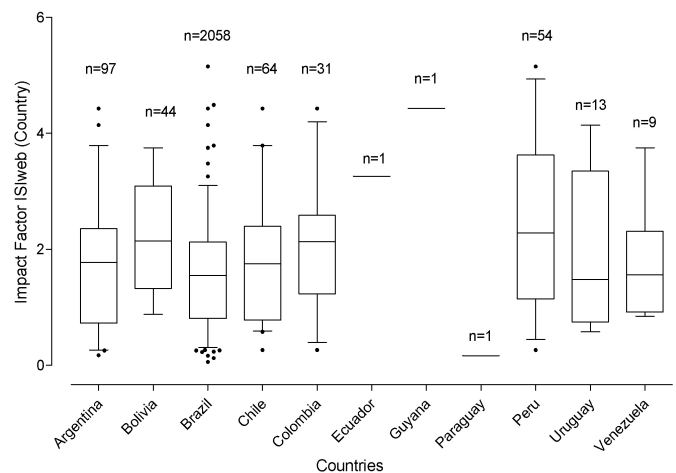


Figure 2. Box and Whisker plots of impact factors of publications in sports science for each country from 1970 to 2012. n = total number of publications per country. The values are expressed in mean, standard deviations, maximum and minimum values of impact factor.

JCR IF 0.167, SCImago IF 0.215; and Motriz Journal of Physical Education, JCR IF 0.124, SCImago IF 0.167). Other countries, like Argentina and Chile tend to publish in other than local journals. Additionally, we observed that the IF differs little between JCR and SCImago.

Relative to the average number of times an article is cited, Peru (21.76), Uruguay (16), Bolivia (14.2) and Chile (12.37) showed the highest indicators (Table 4). However, these results reflect greater variability in Ecuador (77.77%), Peru (12.36%), Uruguay (27.68%), and Venezuela (33.3%). These results contrast with the total number of articles

Table 3. Frequency of published articles in sports science in the most recurrent analyzed journals (based on their respective IF 2011) of South American countries.

Journal title	IF ISIweb	IF SCImago	Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	Guyana	Paraguay	Peru	Uruguay	Venezuela
American Journal of Physical Medicine & Rehabilitation	1.581	1.67					2						1
Annals of Tourism Research	3.259	3.26						1			1		
Applied Physiology Nutrition and Metabolism	2.131	2.332	4								1		
Aviation Space and Environmental Medicine	0.879	0.735	13	1			3						
British Journal of Sports Medicine	4.144	4.193	10									1	
European Journal of Applied Physiology	2.147	2.251		3	124	6							
High Altitude Medicine Biology	1.771	1.622	5	7		13					19		
International Journal of Sports Medicine	2.433	2.611		9			3				2		
Journal of Applied Physiology	3.753	3.813	26	24	106	11	3				24		2
Journal of Orthopaedic Trauma	2.135	2.483										2	
Journal of Sports Economics	0.718	0.649										2	
Journal of Sports Medicine and Physical Fitness	0.847	0.979										2	1
Journal of Strength and Conditioning Research	1.831	1.918			160								1
Knee	1.736	2.01				8							
Medicine and Science in Sports and Exercise	4.431	4.228					5						
Motriz Journal of Physical Education	0.124	0.167			321								
Revista Brasileira de Medicina do Esporte	0.167	0.215			340					1			
Tourism Economics	0.579	0.632										2	
Wilderness Environmental Medicine	0.939	1.019				4							3

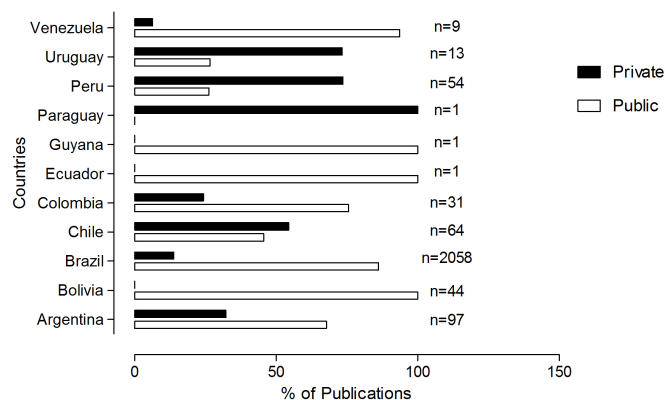


Figure 3. Percentage distribution of public versus private institutional predominance by country in the last 42 years of sports science research.

published per country, where Brazil, Argentina and Chile showed the highest results (Table 4).

Finally, when analyzing the predominance of public and private institutions represented in the published articles, in countries such as Bolivia, Guyana, and Venezuela have the highest predominance of public institution (100%, 100% and 93.6%, respectively) (Figure 3). Production by state sponsored institutions is also high in Argentina (67.8%), Colombia (75.8%), and Brazil (86.3%). On the other hand, in Uruguay, Peru, and Chile private institutions had the upper hand (73.3%, 73.7% and 54.4% respectively). In the case of Ecuador, Guyana and Paraguay, a trend is not easy to determine because of the low frequency of published articles.

Table 4. Mean \pm 1 standard deviation (SD) value of the number of citations per document, coefficient of variation (CV) and number of articles in ISI web.

Country	Mean citation	SD	CV (%)	Number of articles
Argentina	8.49	0.86	10.12	97
Bolivia	14.2	2.14	15.07	44
Brazil	4.65	0.11	2.37	2058
Chile	12.37	1.54	12.44	64
Colombia	9.82	1.76	17.92	31
Ecuador	4.5	3.5	77.77	1
Guyana	0	0	0	1
Paraguay	0	0	0	1
Peru	21.76	2.96	12.36	54
Uruguay	16.0	4.43	27.68	13
Venezuela	11.44	3.81	33.30	9

Discussion

One of the main results of this research was to quantify the number of published articles (and related indicators) in sports science in almost all of the South American countries. This is an important and novel result, considering that there is no bibliometric research in this discipline in the Southern cone. The total scientific production in sports science in almost all of the South American countries has increased during the studied period. This is similar to the findings in other studies (Helene & Ribeiro, 2011). Brazil is an obvious example of this growth, since it has more than tripled its production in the last five years. The production increase in sports science in South America is similar to that observed in Spain, where the annual rate of published articles has increased concurrently with the number of citations of the published documents (Pastor-Pradillo, 2008). However, number of published articles in sport science is marginal when compared to the knowledge generation in other areas of biology such as medicine (SCIMAGO, 2012), representing only 0.3% in the period considered for this study. Likewise, within the context of total number of published articles by country, sports science articles average annually only 0.75% of the total number of published articles for countries such as Brazil, Argentina, and Chile. These results show the imperative need for sports science to keep growing. Further research would be needed to analyze possible strategies to achieve this objective.

Regarding the total number of published articles during the studied period, Brazil is the country with the highest number, followed by Argentina, and Chile. This pattern seems to be a general tendency in scientific and

technological production in South America (Cano, Harris, Schonhaut, & Ugarte, 2012; SCIMAGO, 2012). Also, in similar areas, such as physiotherapy and kinesiology, during the period between 2000 and 2007, 70.1% of the published articles in South America is credited to Brazil, followed by Chile with 13.4% (Vernaza-Pinzón & Alvarez-Bravo, 2011). The number of published articles may be correlated with the number of graduating doctorates (Helene & Ribeiro, 2011), however, an increased efficiency (i.e. number of published articles divided by the number of people in science and technology) may be related to increased productivity. In the same vein, another important result observed in this study is the efficiency of getting articles published by all the countries. Bolivia and Peru showed a high efficiency coefficient in comparison with others with a higher number of total published articles. Indicators such as the number of published articles in SCIE per 100 active researchers show Chile, Uruguay and Venezuela among the most productive (with 30 published articles on average), above other countries such as Brazil and Argentina (with 15.4 and 11.4 average published articles, respectively) (RICYT, 2012). On the other hand, by applying the same methodology on total scientific production, the proportions do change; with Chile in first place, Argentina in second and Brazil in third (Cano et al., 2012). This shows that, in sports science, the difference between Brazil and the other countries is extremely high. In the same way, Brazil shows similar efficiency to Uruguay. However, in the last 42 years, Brazil has 2058 papers and Uruguay only 13.

Another important finding is the IF of the journals in which researchers of each country publish. Peru, despite not having the highest number of published articles, has

the highest IF. Brazil, on the other hand, despite having the highest number of published articles, has a relatively low IF, suggesting that a high number of researchers in Brazil publish in journals of relatively low IF. According to this, it can be observed in Table 4 that the average citations in sports science in Brazil is 4.65, unlike in Peru and Uruguay where it would have an average of 21.76 and 16, respectively. This result suggests that the published articles' impact in Brazil does not coincide with the published articles number. In this context, a study (Delwiche & Hall, 2007) that divided some sports science journals in two categories according to the number of citations that each journal received, found that South American authors publish mostly in journals with lower citation index, which has fluctuated between 27 to 212 citations during 2005. However, the variability of the citations is high in Ecuador, Venezuela and Uruguay, which can be explained by outlier papers (high citations). On the other hand, another study separated cardiology and sports journals in quartiles by IF ranging from more to less citations (Martínez-Morilla, Ruiz-Caballero, Brito-Ojeda, & Navarro-Valdivielso, 2012), suggesting that South American authors publish homogeneously in all four quartiles. Concurrently, in the last decade incentives are to push local journals to higher demand levels such as SCIELO and ISI (SCIELO, 2012). In the year 2000 only around 150 institutional or organizational journals were subscribed to SCIELO, but by 2011 that number had climbed to 630, of which at least between 25 and 40% were in the databases of ISI and around 170 journals are related to health sciences (SCIELO, 2012). An important number of Brazilian research papers are published in these "new" journals (i.e. Brazilian journals), and many of them have a low IF due to their recent addition to the index base. This may help explain the relationship between Brazil high published articles number and relatively low IF. This "endogamic" pattern is repeated in other countries (Chile and Mexico) where local health sciences journals have high membership papers (70%) from researchers from the same country of origin as the journal (Macías-Chapula, 2010). It is important to mention that the distribution of citations reflects the impact of scientists' production (Dorta-González & Dorta-González, 2011). On the other hand, IF has a series of limitations, both in impact and activity; and often is just an indicator of quantity and not quality, besides limiting comparison to other areas (Camps, 2008).

Another important result of this research is the very low scientific production in sports science shown in countries such as Ecuador, Guyana, and Paraguay. Lack of government or institutional policies that stimulate research in this area may help explain this result (Gokceoglu et al., 2008). However, it is important to consider that only databases indexed in Thomson-Reuters (ex-ISI) were reviewed; therefore, it is not possible to show the entirety of published papers by country. However, if data on comparative state expenditures in research and development (R&D) in relation to gross domestic product

(GDP) are taken into account, in recent years Brazil earmarked nearly 1.62% of its GDP to research, Peru 1.15%, and Uruguay, 1%. The other countries did not surpass 1% in this index, and, while this does not fully coincide with the scientific productivity trends observed in this study, it does indicate a low rate of expenditure destined for science and technology, as compared to the USA (RICYT, 2012). This also explains the results of Ecuador, Guyana, and Paraguay. Likewise, indicators such as the number of published articles per million dollars in R&D expenditure show high efficiency in countries such as Bolivia and Chile (8.35 y 5.69, respectively) compared to Brazil (1.45) and Ecuador (2.44)-considering that for the Latin American and Caribbean countries the average is 1.86 (RICYT, 2012). However, this does not explain the case of Paraguay, which has 5.22 published articles per million dollars in R&D. Notice that Guyana has not indicator.

Another important finding of our research was the predominance of public over private institutions in generating knowledge within sports science. This may be attributed to government policies focused on stimulating scientific production in the public sector and/or to a larger number of investigators in state sponsored institutions (Caputo, Requena, & Vargas, 2012). In some countries, like Peru and Chile, the majority of published articles are from private institutions, which could be explained by the high interest of some institutions in supporting certain disciplines, along with an apparent disinterest on the part of the state or public organizations with respect to stimulating research in sports science.

One limitation of this study was the non differentiation between authors and coauthors. Thus, this study did not assess collaboration between countries and institutions (Abramo et al., 2011). It has been noted that in Latin American journals in health sciences, over 60% of publications have between 2-5 coauthors, although detailed international collaboration in authorship information was available (Macías-Chapula, 2010). Additionally, in the last few years, there was an increase in the number of coauthors of published articles, which suggests that the quality of scientific work likely has improved (Abramo et al., 2011). Another limitation of this study was to consider only the Web of Knowledge (Thomson Reuters) database, and not Scopus (Elsevier), PubMed (MEDLINE) or SPORTDisscus (Hebscohost). This could limit the interpretation of this analysis. However, a study showed that SPORTDisscus has 14.7% more citations in Scopus than Web of Knowledge, but it does not show differences in terms of citation rank (Torres-Salinas et al., 2009). Also, Scopus has nearly 5,300 journals in health sciences against 2,500 in Web of Knowledge (Torres-Salinas et al., 2009). Additionally, about 2/3 of the documents referenced in any of the two databases (WOK and Scopus) may be found in both databases while a minority of 1/3 are only referenced in one or the other (Vieira & Gomes, 2009). Despite these limitations the major findings of this study are likely to stand, i.e., that

total scientific production in sports science in most South American countries has increased in the last 42 years, and Brazil's research output is far superior to others countries. Therefore, the main patterns on findings of this study shouldn't differ substantially if articles from other database were included. Another limitation in our study is the high number of published articles from researchers in Brazil; which may have biased the results of public vs. private institutional predominance by continent, where it is shown that 80% of research originated from public institutions (data not shown).

In summary, this study evidences an increase in the scientific production in sports science in the last 42 years. Also, it shows that Brazil has the most prevalent number of published articles in the continent. However, their average citation is low compared to other countries and most papers are published in national journals. Peru and Bolivia show the most efficiency (number of published articles divided by the number of people in science and technology), and the best average citation number in the continent is from Peru. Finally, this paper reveals countries (Ecuador, Guyana and Paraguay) that have only one published article in the past 42 years.

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