



Original article

Bibliometric evaluation of orthopaedics and traumatology publications from France: 20-year trends (1998–2017) and international positioning

Julien Dartus^{a,b,*}, Marc Saab^{a,b}, Roger Erivan^c, Nicolas Reina^d, Matthieu Ollivier^e, Patrick Devos^f

^a Université de Lille Nord de France, 59000 Lille, France

^b Service d'Orthopédie, Hôpital Roger-Salengro, Centre Hospitalier et Universitaire de Lille, place de Verdun, 59037 Lille, France

^c Université Clermont Auvergne, CHU Clermont-Ferrand, CNRS, SIGMA Clermont, ICCF, 63000 Clermont-Ferrand, France

^d Département de Chirurgie Orthopédique, Hôpital Pierre-Paul-Riquet, CHU de Toulouse, place du Dr-Baylac, TSA 40031, 31059 Toulouse cedex 9, France

^e Institut du Mouvement et de l'Appareil Locomoteur, Département d'Orthopédie Traumatologie, Hôpital Sainte-Marguerite, 13000 Marseille, France

^f Université Lille, CHU Lille, EA 2694 – Santé publique : épidémiologie et qualité des soins, 59000 Lille, France



ARTICLE INFO

Article history:

Received 14 May 2019

Accepted 15 July 2019

Keywords:

Bibliometrics

Impact factor

Scientific literature

France

ABSTRACT

Background: Little is known about the scientific publication output for individual countries and medical specialties. The contribution of French authors to the currently expanding volume of publications on orthopaedics and traumatology (OT) is unclear. *Orthopaedics & Traumatology: Surgery & Research (OTSR)* is an English-language version of a preexisting French journal that was launched in 2009 to increase the dissemination of research done in France. The objective of this study was to use Web of Science (WoS) data from 1998 to 2017 to determine (i) the contribution of OT publications to the total worldwide volume of scientific publications, (ii) the contribution of OT publications from France to the total worldwide volume of OT publications, and (iii) changes over time in the proportion of OT publications from France with special attention to potential effects of the creation of *OTSR*.

Hypothesis: The proportion of OT publications from France increased after 2010–2012, indicating a positive effect of *OTSR*.

Material and methods: WoS data were used to identify original studies and review articles written by at least one French author, published between 1998 and 2017, and dealing with OT (defined as orthopaedics and/or traumatology in adult and/or paediatric patients). The worldwide volumes of publications in OT and other specialties were compared. Within worldwide OT publications, the proportion from France was determined. Indicators of impact were evaluated during successive 5-year periods. Finally, the position of OT in worldwide research was assessed and OT journals were analysed.

Results: Among worldwide scientific medical publications, the proportion dealing with OT increased year on year from 1.93% in 1998 to 2.65% in 2017. Among annual publications from France, the proportion dealing with OT rose similarly, from 1.32% to 2.40%. Over the 20-year study period, France moved from the sixth to the ninth position, chiefly due to a large increase in publications from Asia. However, France remained in third position among European countries and increased its OT production 3-fold between 1998 and 2017. The proportion of OT articles from France that ranked among the top 1% most cited articles increased by 65% from 2008–2012 (20 articles) to 2013–2017 (33 articles), and the proportion in the top 10% increased by 31.8% (211 in 2008–2012 and 278 in 2013–2017). This rate of progression was faster than in any of the other western countries. Between 1998–2011 and 2012–2017, the contribution of French OT to publication output showed a 1.56-fold greater increase than did the contribution of OT to the worldwide volume of scientific medical publications.

Discussion: OT publications from France have kept pace with the steady increase seen worldwide over the last 20 years. Although the US and UK remain in the lead, and despite the considerable growth in the output of Asian countries, France occupies a prominent position on the international OT scene. The creation of *OTSR* has elevated the international profile of French OT centres.

Level of evidence: IV, retrospective study with no control group.

© 2019 Published by Elsevier Masson SAS.

* Corresponding author at: Service d'Orthopédie, Hôpital Roger-Salengro, Centre Hospitalier et Universitaire de Lille, place de Verdun, 59037 Lille, France.
E-mail address: julien.dartus@gmail.com (J. Dartus).

1. Introduction

There is a paucity of country-specific data on the number of scientific medical publications relative to the number produced worldwide. In the field of orthopaedics and traumatology (OT) [1,2], Meneghini et al. [1] reported that the proportion of publications on hip and knee arthroplasties originating in the US declined from 65.8% in 1999 to 46.9% in 2008. Despite this relative decline, a study by Çatal et al. [2] showed that the US still had the largest number of publications in 2006–2016, whereas France was in seventh place. No specific information was available on *Orthopaedics & Traumatology: Surgery & Research (OTSR)*, a French English-language journal created in 2009. The annual production of OT publications per million population between 2006 and 2016 was 27 in France compared to 29 in the US; production was higher in Denmark, with 100/10⁶ population [2]. A study by Hohmann et al. [3] of the 15 journals with the highest impact factors (IFs) between 2010 and 2014 put France in tenth place. However, no data on *OTSR* were available, and time trends over the study period were not assessed.

Publication productivity in the field of OT is on the rise [1–4] but the contribution of France to this trend is unclear. In 2009, *OTSR* was created as the English-language version of the *Revue de Chirurgie Orthopédique et Traumatologique* (previously known as the *Revue de Chirurgie Orthopédique et Réparatrice de l'Appareil Moteur, RCO*), with the goal of improving the dissemination of French OT research. An evaluation of how well this goal is being achieved was timely.

This study therefore evaluated the production in France of OT research papers between 1998 and 2017 to assess:

- the contribution of OT publications to the total worldwide volume of scientific publications;
- the contribution of OT publications from France to the total worldwide volume of OT publications;
- changes over time in the proportion of OT publications from France with special attention to potential effects of the creation of *OTSR*.

The working hypothesis was that the proportion of OT publications from France increased after 2010–2012, indicating a positive effect of *OTSR*.

2. Material and methods

2.1. Material

The data source was the Web of Science (WoS), which is a multidisciplinary citation index edited by Clarivate Analytics (Philadelphia, PA, USA). Based on their field of interest, scientific journals are divided into 254 Web of Science categories, one of which is OT. In 2017, the OT category had 77 journals (see the [electronic appendix](#)), compared to 51 in 2009. For this study, papers published between 1998 and 2017 in any of the OT category journals were identified, as well as OT articles published in general journals such as *The Lancet*, *Plos One*, and *Presse Médicale* ([electronic appendix](#)). Only original articles and review articles were counted; other publication types such as letters and editorials were excluded. Each publication was assigned to a country based on the addresses of the authors. Each publication could be counted only once for a given country, even when several authors were from that country.

2.2. Methods

The InCites database provided by Clarivate Analytics clusters citation data obtained from WoS by medical specialty, country,

and/or institution. In addition, impact can be assessed based on the following parameters:

- citation count;
- number and percentage of articles published in the top 1% of journals (defined as the 1% most often cited journals worldwide with adjustment on specialty and year of publication);
- number and percentage of articles published in the top 10% of journals (defined as the 10% most often cited journals worldwide with adjustment on specialty and year of publication).

The OT category in InCites includes all the journals in the WoS OT category, as well as OT articles published in general journals (*Lancet*, *Plos One*, *Presse Médicale*, and others) and classified as dealing with OT ([electronic appendix](#)).

2.3. Assessment methods

The following indicators were determined:

- publication count, as an indicator of productivity;
- number and percentage of articles published in the top 1% and top 10% of journals;
- specialisation index (SI), defined as the ratio of OT over total medical scientific production by a given country divided by the ratio of OT over total medical scientific production worldwide: $SI = \frac{\text{proportion of OT publications from France}}{\text{proportion of OT publications worldwide}}$. An SI equal to 1 indicates that the proportion in the country is the same as the proportion worldwide.

Data from the Emerging Sources Citation Index (Clarivate Analytics) were incorporated into the analysis of InCites data. The bibliometrics platform in Lille (France) was used for the analysis (Lillometrics, <https://lillometrics.univ-lille.fr/>).

2.4. Statistical methods

Numbers, market shares, and time trends percentages were described. No comparisons were performed.

3. Results

3.1. Contribution of OT to overall medical research output

OT publications accounted for about 2.5% of the worldwide output of medical and health sciences research. They grew steadily in number and proportion over the 20-year study period, from 5080/263,424 (1.93%) in 1998 to 16,668/629,110 (2.65%) in 2017 ([Table 1](#), [Fig. 1](#)). In France, a similar trend was apparent, although the productivity share held by OT articles grew faster than worldwide, from 207/15,676 (1.32%) in 1998 to 619/25,752 (2.40%) ([Table 2](#), [Fig. 1](#)).

The OT share, although modest, grew dramatically compared to the shares held by other specialties ([Table 3](#), [Fig. 2](#)). Thus, OT publications increased by 329% over the 20-year study period, compared to 239% for medical and health sciences publications, 214% for applied physics, and 183% for surgery. OT is among the specialties with the strongest growth in publication output, behind biomaterials (which grew by 861% between 1998 and 2017) ([Table 3](#)).

3.2. Contribution of France to worldwide and European OT research production – influence and time trends

3.2.1. Contribution of France to worldwide OT output

The US clearly dominates the worldwide production of OT research ([Table 4](#), [Fig. 3](#)). The number of published OT articles

Table 1

Number of scientific publications worldwide over the 20-year period from 1998 to 2017 – share held by orthopaedics and traumatology.

Publication year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Medical & Health Sciences	263,424	267,024	271,618	268,886	272,451	282,455	293,013	326,131	346,603	375,632	407,419	433,789	467,929	494,518	525,856	552,771	574,278	597,303	613,147	629,110
Orthopaedics	5080	5011	5239	5234	5542	5776	6212	7106	7764	8907	9649	10,237	11,348	12,022	13,077	13,843	14,732	14,946	16,006	16,688
Share (%)	1.93	1.88	1.93	1.95	2.03	2.04	2.12	2.18	2.24	2.37	2.37	2.36	2.43	2.43	2.49	2.50	2.57	2.50	2.61	2.65

Table 2

Number of scientific publications from France between 1998 and 2017 – share held by orthopaedics and traumatology.

Publication year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Medical & Health Sciences	15,676	15,766	15,526	15,271	14,968	15,443	15,160	16,420	16,921	18,149	19,452	20,115	21,311	21,498	22,632	23,216	23,086	24,201	25,086	25,752
Orthopaedics	207	199	189	187	215	190	224	247	307	394	410	396	487	507	457	511	556	528	624	619
Share (%)	1.32	1.26	1.22	1.22	1.44	1.23	1.48	1.50	1.81	2.17	2.11	1.97	2.29	2.36	2.02	2.20	2.41	2.18	2.49	2.40

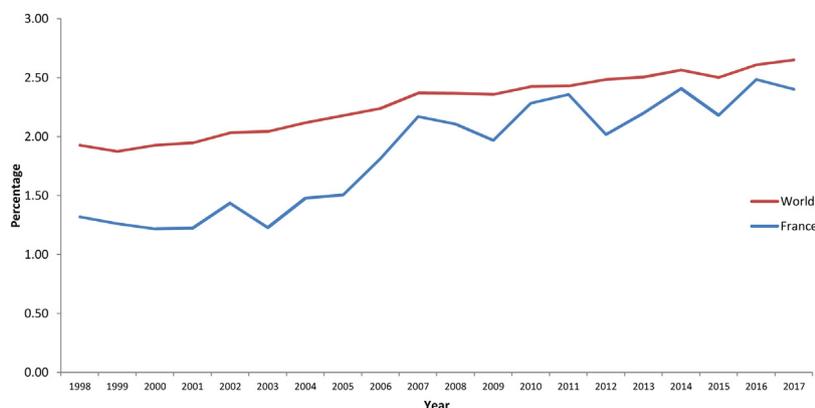


Fig. 1. Share of worldwide research production held by orthopaedics and traumatology. The share held by France increased starting in 2009, when the English-language journal *Orthopaedics & Traumatology: Surgery & Research* was launched.

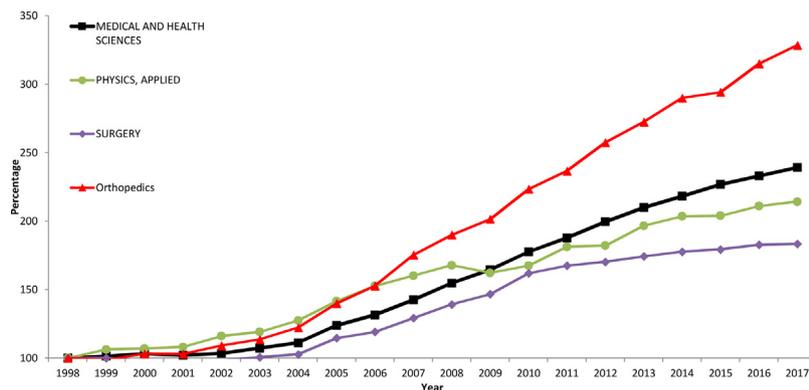


Fig. 2. Time trends in publications in four major fields.

from the US increased by 254%, from 2356 in 1998 to 5997 in 2017. Although the productivity of European and Asian countries increased, the US remained far in the lead, with a number of articles similar to that produced by the UK, Germany, Japan, Canada, and China combined. However, productivity in Asia increased dramatically over the study period (by 332% in Japan, 4734% in China, and 1672% in South Korea), outstripping the productivity gains seen in western countries (224% in the UK, 244% in Germany, 320% in Canada, and 574% in Australia).

The number of OT articles published each year in France increased 3-fold, from 207 in 1998 to 619 in 2017. This rate of increase is higher than in any other western country except Australia but lower than in Asian countries (Table 4, Figs. 4 and 5).

In Europe, France remained in third position behind the UK and Germany in terms of OT research output (Table 5, Fig. 6). The share of European OT publications held by France increased from 10.9% in 1998 (vs. 27.2% and 25.1% for the UK and Germany, respectively) to 11.1% in 2017 (vs. 26.3% and 23.2% for the UK and Germany, respectively). The rate of the productivity increase was faster in France ($\times 2.99$) than in the UK ($\times 2.24$) and Germany ($\times 2.45$). Several other European countries increased their productivity faster than did France (Austria, Belgium, Denmark, Italy, Norway, Spain, Switzerland, and The Netherlands) but had smaller annual outputs (Table 5).

3.2.2. Specialisation index (SI)

The SI was assessed over four 5-year periods, 1998–2002, 2003–2007, 2008–2012, and 2013–2017 (Table 6). The results showed a gradual rise in France between 1998 and 2007, from 0.66 to 0.75, followed by a sharper rise starting in 2008 (0.89), up to 0.91 in 2017. This evidence of increasing specialisation mirrors changes

reported worldwide. The SI in France has moved closer to the value in the whole of Europe, which has remained stable over time (0.93 in 1998–2002 and 0.94 in 2013–2017) (Table 6).

3.2.3. Influence of French OT

Tables 7 and 8 reporting the results for the four time periods studied show that the number of OT publications from France that were among the 1% most cited increased 3-fold over time, from 11 in 1998–2002 (1.1%) to 33 articles in 2013–2017 (1.16%). A slightly larger, 3.2-fold increase was noted for the number of publications among the 10% most cited (from 85 [8.5%] in 1998–2002 to 278 [9.8%] in 2013–2017). These values remained lower in France than in the US, Canada, and Australia, as well as in several European countries such as the UK, Sweden, and Switzerland. Asian countries had substantially fewer publications among the 1% and 10% most cited compared to France between 1998 and 2017.

In sum, France increased its number of top 1% most cited articles by 65% between 2008–2012 (20 articles) and 2013–2017 (33 articles) and also substantially grew its top 10% most cited articles, by 31.8% (from 211 in 2008–2012 to 278 in 2013–2017), thus outstripping all other western countries. Only Asian countries had far greater improvements in these two indicators. Progression was fastest in China, with a 675% increase in the top 1% most cited articles (from 4 in 2008–2012 to 31 in 2013–2017). In India, the increase in the number of top 10% most cited articles was 182.6% (from 23 in 2008–2012 to 65 in 2013–2017). However, these most cited articles constitute only a very small share of the total number of publications for 2008–2017 (7836 and 3975, respectively).

Table 3
Number of publications between 1998 and 2017 in the four following fields: medical and health sciences, applied physics, surgery, and materials sciences. Absolute values are reported in the top part of the table and percentages relative to the value in 1998.

Publication Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Medical and health sciences	263,453	267,055	271,644	268,914	272,451	282,487	293,011	326,183	346,655	375,718	407,585	433,885	468,037	494,708	526,076	553,163	574,807	597,813	613,916	630,375	8,267,936
Physics, applied	31,181	33,117	33,358	33,703	36,181	37,131	39,740	44,131	47,615	49,949	52,322	50,616	52,225	56,503	56,802	61,328	63,484	63,623	65,803	66,772	975,584
Surgery	22,647	22,651	22,105	22,201	22,268	22,773	23,263	25,961	26,973	29,259	31,515	33,232	36,684	37,934	38,578	39,487	40,255	40,613	41,387	41,522	621,308
Orthopaedics	5080	5011	5239	5234	5542	5776	6212	7106	7764	8907	9649	10,237	11,348	12,022	13,077	13,843	14,732	14,946	16,006	16,688	194,419
Materials science, biomaterials	1106	1241	1446	1380	1681	2117	2434	3153	2839	3105	3620	4227	4994	5151	5503	7433	8304	7904	8627	9525	85,790
Publication year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Cumulative percentage gains
Medical and health sciences	100	101	103	102	103	107	111	124	132	143	155	165	178	188	200	210	218	227	233	239	3139
Physics, applied	100	106	107	108	116	119	127	142	153	160	168	162	167	181	182	197	204	204	211	214	3128
Surgery	100	100	98	98	98	101	103	115	119	129	139	147	162	168	170	174	178	179	183	183	2744
Orthopaedics	100	99	103	103	109	114	122	140	153	175	190	202	223	237	257	273	290	294	315	329	3828
Materials science, biomaterials	100	112	131	125	152	191	220	285	257	281	327	382	452	466	498	672	751	715	780	861	7758

Table 4
Worldwide orthopaedic publications by country between 1998 and 2017. France remained in 7th place for the number of publications, although a slight decline occurred in recent years. France was outstripped by South Korea starting in 2012 and by Australia starting in 2015; (France moved from 6th place in 1998 to 9th place in 2017, whereas in 2017 China moved to 2nd place before Japan, the UK, and Germany).

Publication year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
USA	2356	2194	2234	2161	2370	2482	2594	2919	3264	3425	3578	3661	3948	4164	4522	4791	5129	5343	5796	5997	72,928
United Kingdom	515	519	564	525	588	610	671	839	835	988	970	997	956	1016	1128	1201	1258	1134	1210	1156	17,680
Germany (FED REP GER)	476	556	472	487	548	519	571	566	642	717	757	854	935	953	959	1098	1088	1085	1160	1164	15,607
Japan	362	376	385	420	405	403	485	545	555	548	553	584	621	663	776	798	954	876	968	1204	12,481
Canada	232	262	237	263	257	294	301	353	377	423	492	503	550	557	634	602	658	679	701	744	9119
China Mainland	27	17	18	23	12	35	35	55	72	118	237	318	399	558	659	776	943	1065	1190	1279	7836
France	207	199	189	187	215	190	224	247	307	394	410	396	487	507	457	511	556	528	624	619	7454
South Korea	44	58	67	78	66	107	97	155	166	258	316	404	451	506	549	640	584	613	652	736	6547
Australia	124	142	123	143	134	183	188	221	230	290	299	303	381	460	476	480	490	531	633	712	6543

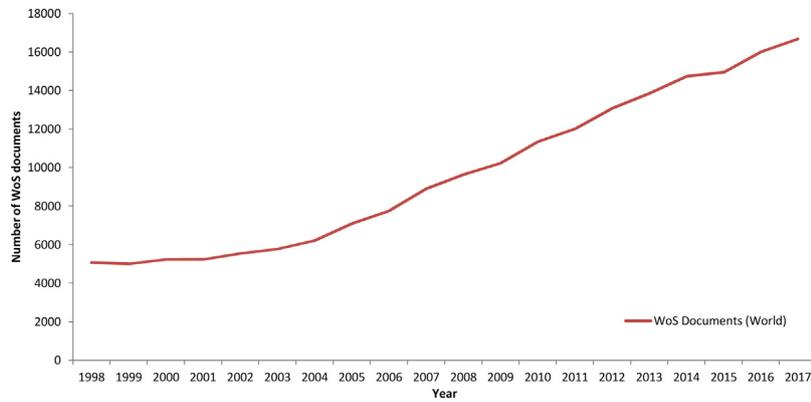


Fig. 3. Number of Web of Science (WoS) publications between 1998 and 2017.

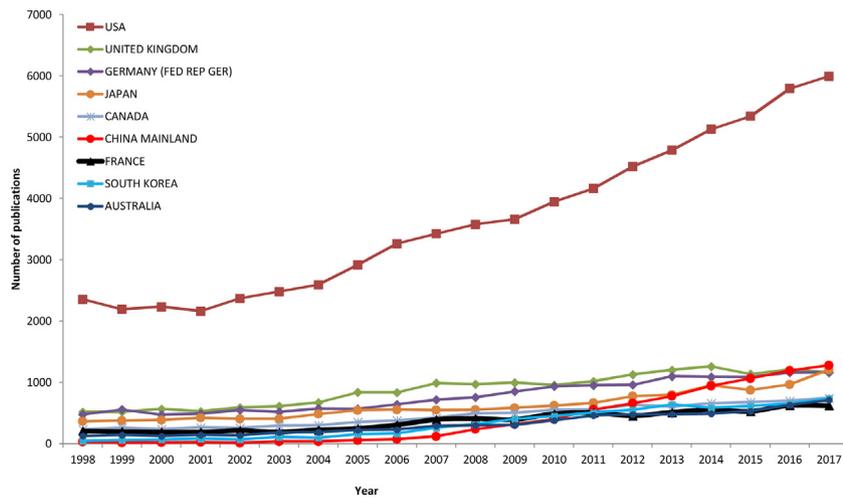


Fig. 4. Changes in the number of orthopaedics and traumatology (OT) publications worldwide from 1998 to 2017. The US output of OT publications remained in the lead and showed the fastest growth between 1998 and 2017.

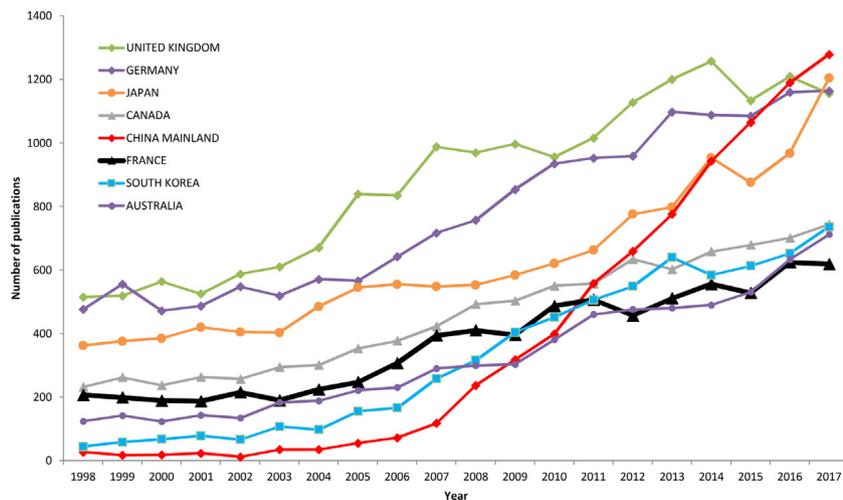


Fig. 5. Changes over time in the number of orthopaedics and traumatology publications worldwide, excluding the US. The number grew sharply in France starting in 2010–2011, i.e., after the launch of *Orthopaedics & Traumatology: Surgery & Research*.

3.3. Effect of OTSR on the contribution of France to OT research output

The share of OT publications held by France started to grow rapidly in 2012, 3 years after the creation of OTSR (Tables 1 and 2, Fig. 1):

- after 2012, France’s share remained above 2.18%, a proportion rarely achieved previously (Table 2);
- between 1998–2011 and 2012–2017, the mean increase was 0.39% for the OT share of worldwide scientific medical production (Table 1) and 0.61% for the OT share of French scientific medical production (Table 2).

Table 5

Orthopaedics research production in Europe by country from 1998 to 2017. France remained in 3rd place among European countries throughout the study period.

Country	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
EU-28 Totals	1896	2003	1911	1897	2033	2049	2266	2565	2880	3416	3528	3705	4017	4155	4453	4699	4854	4662	5073	5135	67,197
United Kingdom	515	519	564	525	588	610	671	839	835	988	970	997	956	1016	1128	1201	1258	1134	1210	1156	17,680
Germany (FED REP GER)	476	556	472	487	548	519	571	566	642	717	757	854	935	953	959	1098	1088	1085	1160	1164	15,607
France	207	199	189	187	215	190	224	247	307	394	410	396	487	507	457	511	556	528	624	619	7454
Netherlands	123	100	126	127	131	139	170	202	227	278	275	309	357	377	415	439	460	441	555	533	5784
Switzerland	139	122	175	142	156	142	193	194	248	244	268	275	369	405	419	451	359	432	475	482	5690
Italy	70	90	84	78	87	106	95	171	176	239	295	313	375	357	443	436	434	439	474	544	5306
Sweden	165	189	168	171	131	133	155	152	221	174	189	201	177	210	227	251	241	227	289	291	3962
Spain	77	78	61	52	50	48	70	82	100	118	131	137	199	189	205	220	265	253	297	327	2959
Austria	75	88	73	81	81	79	83	88	111	123	130	144	129	174	189	211	196	207	236	244	2742
Belgium	63	59	45	59	68	74	71	66	93	136	124	148	174	173	165	202	201	182	203	210	2516
Denmark	49	59	41	43	46	44	60	54	80	68	102	83	106	124	139	173	180	170	218	242	2081
Greece	32	20	34	52	37	62	83	117	123	127	161	152	131	138	130	110	99	105	92	110	1915
Norway	50	46	32	33	48	37	49	49	55	59	78	96	124	100	115	110	140	103	139	189	1652
Finland	70	73	58	63	68	60	67	71	84	67	69	76	70	86	77	90	111	80	109	123	1572

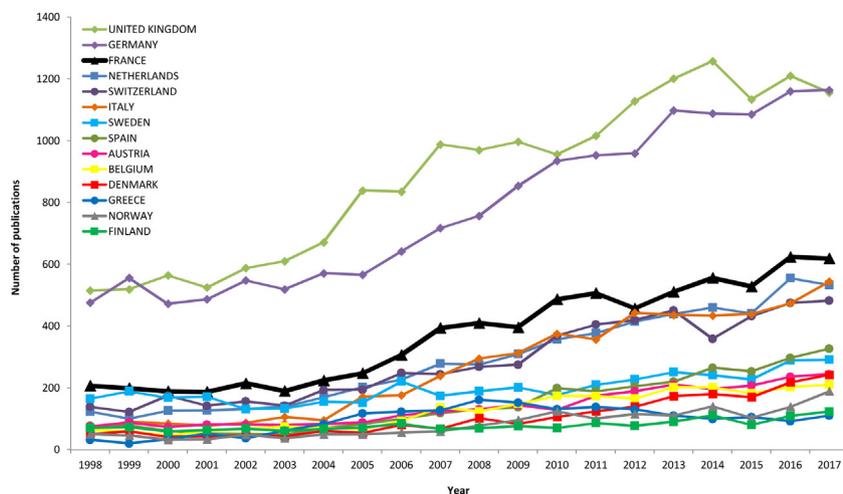


Fig. 6. Changes over time in the number of orthopaedics and traumatology publications in Europe between 1998 and 2017. France remained in third place among European countries, with a steady increase in the number of publications starting in 2006–2007 that became sharper after the launch of *Orthopaedics & Traumatology: Surgery & Research* in 2010–2011. Between 2014 and 2017, the UK was the only country with a decrease in the number of publications; in 2013, the *Journal of Bone and Joint Surgery British* was replaced by the *Bone & Joint Journal*.

Thus, the increase in France was 1.56 times greater than the increase worldwide between 1998–2011 and 2012–2017.

Between 2009 and 2017, *OTSR* published 1692 articles (Appendix 1). This number puts *OTSR* in 22nd place among indexed OT journals in 2009–2017.

From 2000 to 2008, the number of articles published in *RCO* showed little change. The creation of *OTSR* resulted in a 2-fold increase in the number of published articles, from 123 in 2009 to 257 in 2017.

Of the articles published in *OTSR* between 2009 and 2017, 1322 (75%) were written by French authors. The next most common origins of published articles were China ($n=76$, 4.3%), Switzerland ($n=61$, 3.4%), the US ($n=56$, 3.2%), Japan ($n=37$, 2.1%), Germany ($n=34$, 1.9%), the UK ($n=33$, 1.8%), Tunisia ($n=33$, 1.8%), Canada ($n=31$, 1.7%), Italy ($n=29$, 1.6%), and South Korea ($n=28$, 1.6%). The contribution of authors from countries other than France increased considerably over time, from 15% in 2009 to nearly 40% in 2017.

The impact factor (IF) of *OTSR* also increased markedly, from 0.52 in 2010 to 1.572 in 2018. *RCO* achieved its best IF value over its 12 years of existence (1998–2010) in 2010, with 0.546 (Fig. 7).

Fig. 8 compares the bibliometric characteristics of the two journals. Penetration improved markedly, with an h-index of 40 and a mean citation count per article of 8.67 for *OTSR*, compared to 30 and 6.59, respectively, for *RCO*. Citation rates were 11,697 (11,118 after excluding self-citations) for *OTSR* and 5696 (5457 without self-citations) for *RCO*.

4. Discussion

The results corroborate the working hypothesis: the share of OT publications originating in France started to increase in 2012, about 3 years after the creation of *OTSR*. The overall findings from the bibliometric evaluation are consistent with earlier reports [5–8] describing an increase in the worldwide production of medical and healthcare research in all specialties. In addition, OT research output expanded dramatically, by 329% over 20 years, with increases in the numbers of articles and of indexed medical journals. The US remained the largest source of OT publications over the 20-year study period [9–15], had the highest number of indexed high-IF journals, and led in all the bibliometric parameters including the numbers of articles among the top 1% and 10% most cited. Lee et al. [4] reported that 57.3% of OT articles published between 2000 and 2009 originated in the US. Nonetheless, a marked increase has

occurred in the contribution of Asian countries such as Japan, China, and South Korea [16–21], which now make a major contribution to the worldwide production of scientific research, leading to a decrease in the share held by the US, from 50% to 30% over the 20-year study period. This strong quantitative growth coincides with a more modest improvement in research quality, as shown by the analysis of the top 1% and top 10% most cited articles. The results of the present study are consonant with those reported by Çatal et al. [2]: France makes a major contribution to the volume of OT research, ranking seventh worldwide and third in Europe. During the 20-year study period, France, together with the UK and Germany, was a key driver of European research in OT. The production of OT research in France grew rapidly and steadily, at a faster pace compared to overall medical research, and the SI nearly reached the value for Europe as a whole.

Yan et al. [22], however, found a sharp increase in recent years in the number of publications that were retracted due to fraud, plagiarism, duplicate publication, and data errors [22]. Increases in the numbers of publications and of citations in high-IF journals do not necessarily indicate an improvement in research quality. Thus, for meta-analyses, which provide the highest level of evidence, quality as assessed using AMSTAR and PRISMA criteria was better in *OTSR* than in *Clinical Orthopaedics and Related Research* and *Journal of Bone and Joint Surgery Am* [23].

OTSR replaced *RCO* in 2009. The InCites data showed marked improvements in *OTSR* bibliometric parameters over time, suggesting that the availability of the articles in English increased the influence of French authors on international research. As shown in the electronic appendix, *OTSR* is by far the main source of French studies available in the English language. Furthermore, the share of French medical research held by OT expanded markedly from 2012 onwards. The emergence of the Internet and development of publication databases have considerably facilitated access to the *OTSR* platform, whereas *RCO* articles may have been less readily available before 2000. Despite a large increase in the number of published articles, *RCO* followed the worldwide growth in OT productivity until 2008. The creation of *OTSR* ensured that productivity remained abreast of international trends over the last decade and elevated the profile of articles from France, as shown by the top 1% and top 10% citation data and by French-author citation counts [24]. In a study of the most often cited articles published in the *European Journal of Orthopaedic Surgery and Traumatology* (EJOST), Mavrogenis et al. [25] showed that citation rates rose sharply after

Table 6
Change over time in the specialisation index by country from 1998 to 2017 overall and in orthopaedics. Four periods were compared. The specialisation index in France increased gradually, reaching values near those for Europe and the world in 2008–2012.

Country	Medical & Health Sciences					Orthopaedics					Specialisation index			
	Total	1998–2002	2003–2007	2008–2012	2013–2017	Total	1998–2002	2003–2007	2008–2012	2013–2017	1998–2002	2003–2007	2008–2012	2013–2017
World	8,263,357	1,343,403	1,623,834	2,329,511	2,966,609	194,419	26,106	35,765	56,333	76,215	1	1	1	1
USA	2,825,171	508,632	597,024	784,987	934,528	72,928	11,315	14,684	19,873	27,056	1.14	1.12	1.05	1.13
EU-28 Totals	3,038,407	540,878	633,639	852,806	1,011,084	67,197	9740	13,176	19,858	24,423	0.93	0.94	0.96	0.94
United Kingdom	739,462	133,674	155,399	202,002	248,387	17,680	2711	3943	5067	5959	1.04	1.15	1.04	0.93
Germany	612,843	114,832	131,515	169,242	197,254	15,607	2539	3015	4458	5595	1.14	1.04	1.09	1.10
England	649,353	115,366	135,172	177,205	221,610	15,465	2346	3452	4409	5258	1.05	1.16	1.03	0.92
Japan	540,601	120,851	122,931	137,968	158,851	12,481	1948	2536	3197	4800	0.83	0.94	0.96	1.18
Canada	403,980	61,336	79,086	116,642	146,916	9119	1251	1748	2736	3384	1.05	1.00	0.97	0.90
China Mainland	472,081	11,776	36,580	118,610	305,115	7836	97	315	2171	5253	0.42	0.39	0.76	0.67
France	385,649	77,207	82,093	105,008	121,341	7454	997	1362	2257	2838	0.66	0.75	0.89	0.91
South Korea	207,760	13,610	30,714	66,001	97,435	6547	313	783	2226	3225	1.18	1.16	1.39	1.29
Australia	310,474	38,984	53,065	87,604	130,821	6543	666	1112	1919	2846	0.88	0.95	0.91	0.85
Netherlands	266,691	39,702	51,843	76,317	98,829	5784	607	1016	1733	2428	0.79	0.89	0.94	0.96
Switzerland	170,570	26,486	32,360	47,443	64,281	5690	734	1021	1736	2199	1.43	1.43	1.51	1.33
Italy	409,996	61,747	80,017	118,014	150,218	5306	409	787	1783	2327	0.34	0.45	0.62	0.60
Turkey	184,233	14,309	36,803	56,369	76,752	5127	372	910	1590	2255	1.34	1.12	1.17	1.14

Table 7
Changes over time in the numbers of top 1% and top 10% most cited articles by country from 1998 to 2017. Four time periods were compared. The data are n (%). The proportion of French articles among the top 1% (1.1% to 1.16%) remained unchanged whereas the percentage among the top 10% increased slightly (from 8.5% to 9.8%) in parallel with an increase in orthopaedics production.

Country	Total	Number of Articles				Number of Top 1%				Number of Top 10%				% of Top 1%				% of Top 10%			
		1998–2002	2003–2007	2008–2012	2013–2017	1998–2002	2003–2007	2008–2012	2013–2017	1998–2002	2003–2007	2008–2012	2013–2017	1998–2002	2003–2007	2008–2012	2013–2017	1998–2002	2003–2007	2008–2012	2013–2017
USA	72,928	1,315	14,684	19,873	27,056	204	253	368	446	1761	2214	2988	3729	1.80	1.72	1.85	1.65	15.6	15.1	15.0	13.8
United Kingdom	17,680	2711	3943	5067	5959	30	50	85	80	280	450	638	702	1.11	1.27	1.68	1.34	10.3	11.4	12.6	11.8
Germany	15,607	2539	3015	4458	5595	13	21	30	43	172	236	442	516	0.51	0.70	0.67	0.77	6.8	7.8	9.9	9.2
JAPAN	12,481	1948	2536	3197	4800	10	13	9	26	159	153	206	326	0.51	0.51	0.28	0.54	8.2	6.0	6.4	6.8
Canada	9119	1251	1748	2736	3384	31	38	57	51	264	316	414	502	2.48	2.17	2.08	1.51	21.1	18.1	15.1	14.8
China Mainland	7836	97	315	2171	5253	0	1	4	31	3	34	159	404	0.00	0.32	0.18	0.59	3.1	10.8	7.3	7.7
France	7454	997	1362	2257	2838	11	23	20	33	85	128	211	278	1.10	1.69	0.89	1.16	8.5	9.4	9.3	9.8
South Korea	6547	313	783	2226	3225	1	6	6	21	32	82	169	250	0.32	0.77	0.27	0.65	10.2	10.5	7.6	7.8
Australia	6543	666	1112	1919	2846	13	23	34	45	124	203	339	423	1.95	2.07	1.77	1.58	18.6	18.3	17.7	14.9
Netherlands	5784	607	1016	1733	2428	11	14	36	25	105	143	294	336	1.81	1.38	2.08	1.03	17.3	14.1	17.0	13.8
Switzerland	5690	734	1021	1736	2199	25	35	27	31	142	188	272	295	3.41	3.43	1.56	1.41	19.3	18.4	15.7	13.4
Italy	5306	409	787	1783	2327	4	8	26	35	43	87	239	303	0.98	1.02	1.46	1.50	10.5	11.1	13.4	13.0
Turkey	5127	372	910	1590	2255	0	1	1	6	10	26	38	69	0.00	0.11	0.06	0.27	2.7	2.9	2.4	3.1
India	3975	155	326	1149	2345	1	0	2	6	9	14	23	65	0.65	0.00	0.17	0.26	5.8	4.3	2.0	2.8
Sweden	3962	824	835	1004	1299	22	13	33	28	148	151	203	202	2.67	1.56	3.29	2.16	18.0	18.1	20.2	15.6

Table 8
Changes between 2008–2012 and 2013–2017 in the numbers of articles among the top 1% and top 10% most cited, by countries, relative to orthopaedic production. France had a 65% increase in top 1% articles and a 31.8% increase in top 10% articles over the study period. These increases indicate a faster rate of progression than in any other western country; (Asian countries had faster rates of progression but started from lower values in 2008).

Country	Total	Number of Articles			Number of Top 1%			Number of Top 10%		
		2008–2012	2013–2017	Change	2008–2012	2013–2017	Change	2008–2012	2013–2017	Change
USA	72,928	19,873	27,056	36.1	368	446	21.2	2988	3729	24.8
United Kingdom	17,680	5067	5959	17.6	85	80	−5.9	638	702	10.0
Germany (FED REP GER)	15,607	4458	5595	25.5	30	43	43.3	442	516	16.7
Japan	12,481	3197	4800	50.1	9	26	188.9	206	326	58.3
Canada	9119	2736	3384	23.7	57	51	−10.5	414	502	21.3
China Mainland	7836	2171	5253	142.0	4	31	675.0	159	404	154.1
France	7454	2257	2838	25.7	20	33	65.0	211	278	31.8
South Korea	6547	2226	3225	44.9	6	21	250.0	169	250	47.9
Australia	6543	1919	2846	48.3	34	45	32.4	339	423	24.8
Netherlands	5784	1733	2428	40.1	36	25	−30.6	294	336	14.3
Switzerland	5690	1736	2199	26.7	27	31	14.8	272	295	8.5
Italy	5306	1783	2327	30.5	26	35	34.6	239	303	26.8
Turkey	5127	1590	2255	41.8	1	6	500.0	38	69	81.6
India	3975	1149	2345	104.1	2	6	200.0	23	65	182.6
Sweden	3962	1004	1299	29.4	33	28	−15.2	203	202	−0.5

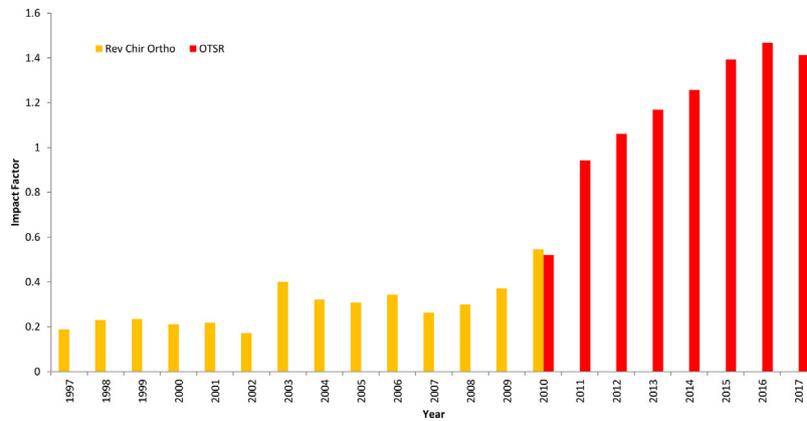


Fig. 7. Changes in the impact factor of the *Revue de Chirurgie Orthopédique et Réparatrice de l'Appareil Moteur* (RCO) between 1997 and 2010 and of *Orthopaedics & Traumatology: Surgery & Research* (OTSR) between 2010 and 2017.

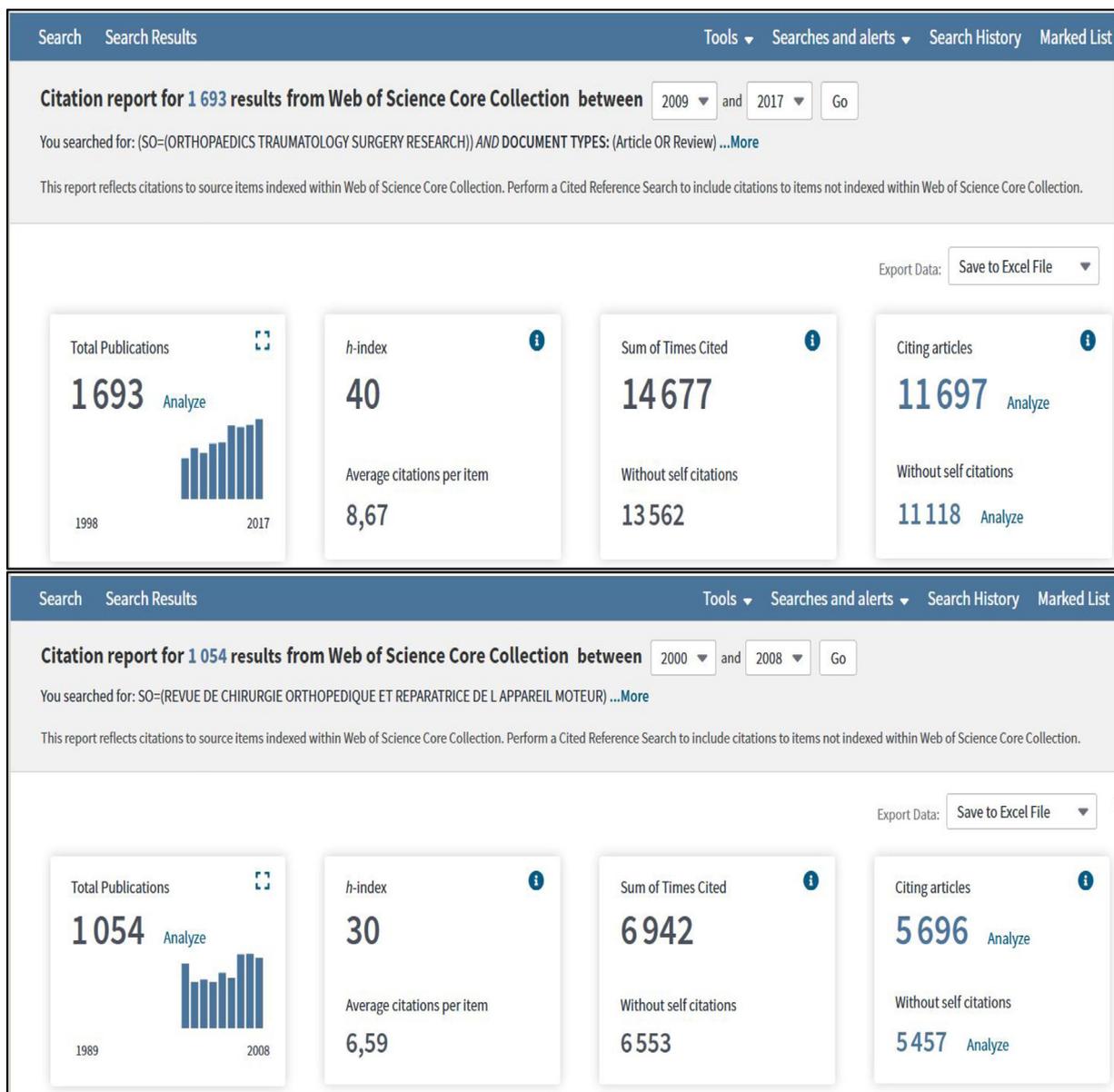


Fig. 8. Journal Citation Reports data for the *Revue de Chirurgie Orthopédique et Réparatrice de l'Appareil Moteur* (below) from 2000 to 2008 and for *Orthopaedics & Traumatology: Surgery & Research* for 2009 to 2017(above).

the articles were published in English instead of in French, thereby supporting our working hypothesis.

Our study has several limitations. First, in bibliometric databases, articles are classified according to journal specialty and not to the specialty of the authors. Consequently, we measured the production published by OT journals, as opposed to the impact of OT surgeons. Due to the close connections between OT and other fields such as infectious diseases, oncology, biomaterials, and many others, some of the studies done by OT surgeons are published in journals that focus on other specialties. The contribution of French OT surgeons to the OT literature could be assessed by using the *Système d'Interrogation, de Gestion et d'Analyse des Publications Scientifiques* (SIGAPS) to identify publications based on author name instead of specialty. This work is under way. Second, our study relied on the WoS, which, similar to all bibliometric databases, is not exhaustive. For instance, WoS does not show articles published in journals that are indexed on PubMed but not in WoS (labelled NC in the SIGAPS database). The impact of this limitation is minimised by the focus of our study on comparisons of market shares, time trends, and rankings. Third, in addition to the number of articles, the number of journals has risen considerably (Appendix 1). The number of journals indexed in the Journal Citation Reports (JCR) was 42 in 1998 and 77 in 2017, but 522 journals were investigated in the OT category of InCites. The journals indexed in JCR could be used as the basis for a study, although this would result in substantial loss of information, with 1 in 6.5 journals being excluded, resulting in the loss of 12% of articles. Fourth, our study is descriptive. No statistical tests were used to determine whether the differences between *OTSR* and *RCO* were significant. These two journals stem from the same root, and *OTSR* was not designed to replace *RCO* but simply to elevate the profile of French studies on the international scene by providing their results in English. Statistical testing would have led us to compare journals published in two time periods that differ substantially due to the massive growth of the worldwide scientific literature over the last decade. The original design of our study is a major strong point: no other study had assessed the role of France in the worldwide OT literature or the potential impact of dissemination of French research studies in the English language via *OTSR*.

5. Conclusion

The OT research production originating in France has increased in lockstep with the worldwide surge that has occurred over the last 20 years. Although the US, the UK, and Japan remain in the lead, France occupies a prominent place among the countries that dominate the OT literature. The conversion of *RCO*, published in French, to the English-language *OTSR* has increased the visibility of French OT surgeons on the international scene, as shown by the steadily increasing IF values. Other studies are needed to more clearly delineate the place of French OT in the world by taking into account publications in journals for connected specialties such as infectiology, oncology, and basic research.

Disclosure of interest

Julien Dartus, Marc Saab, Patrick Devos and Roger Erivan declare that they have no competing interest.

Nicolas Reina has had personal expenses unrelated to this study covered by BBraun, Stryker, and Zimmer.

Matthieu Ollivier has served as an occasional educational consultant on matters unrelated to this study for Zimmer/Biomet and Smith & Nephew.

Funding

None.

Contributions of each author

JD and MS analysed the data and drafted the manuscript.
RE, NR, and MO revised the manuscript for important intellectual content.
PD extracted and analysed the data and drafted the manuscript.

Acknowledgements

We are grateful to Henri Migaud and Philippe Beaufils for their help in conducting this study.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.otsr.2019.07.025>.

References

- [1] Meneghini RM, Russo GS, Lieberman JR. Research in THA and TKA from the United States has declined over the past decade relative to other countries. *Orthopedics* 2017;34:e245–50.
- [2] Çatal B, Akman YE, Şükür E, Azboy İ. Worldwide arthroplasty research productivity and contribution of Turkey. *Acta Orthop Traumatol Turc* 2018;52:376–81.
- [3] Hohmann E, Glatt V, Tetsworth K. Worldwide orthopaedic research activity 2010–2014: publication rates in the top 15 orthopaedic journals related to population size and gross domestic product. *World J Orthop* 2017;8:514–23.
- [4] Lee KM, Ryu MS, Chung CY, Choi IH, Kwon DG, et al. Characteristics and trends of orthopedic publications between 2000 and 2009. *Clin Orthop Surg* 2011;3:225–9.
- [5] Xin Z, Jin C, Zhengrong G, Liehu C, Weizong W, Quan L, et al. Orthopedics research output from China, USA, UK, Japan, Germany and France: a 10-year survey of the literature. *Orthop Traumatol Surg Res* 2016;102:939–45.
- [6] Wang L, Li L, Cheng C, Tian H, Li Y, Zhao M. Global scientific production in the field of knee arthroplasty: a cross-sectional survey of research activities. *J Int Med Res* 2017;45:897–903.
- [7] Urrutia J, Zamora T, Prada C. The fifty most cited Latin-American articles in the orthopaedic literature. *Inter Orthop* 2014;38:1723–9.
- [8] Gürbüz Y, Sığün TS, Özaksar K. A bibliometric analysis of orthopedic publications originating from Turkey. *Acta Orthop Traumatol Turc* 2015;49:57–66.
- [9] Sun J, Ding R, Ma T, Shi X, Bao C, Guan H. Worldwide research productivity in fracture surgery: a 10-year survey of publication activity. *Exp Ther Med* 2017;14:1260–4.
- [10] Mei X, Zhu X, Zhang T, Jia Z, Wan C. Worldwide productivity in the hand and wrist literature: a bibliometric analysis of four highly cited subspecialty journals. *Int J Surg* 2016;28:8–12.
- [11] Luo X, Liang Z, Gong F, Bao H, Huang L, Jia Z. Worldwide productivity in the field of foot and ankle research from 2009–2013: a bibliometric analysis of highly cited journals. *J Foot Ankle Res* 2015;8:12.
- [12] Kelly JC, Glynn RW, O'Briain DE, Felle P, McCabe JP. The 100 classic papers of orthopaedic surgery: a bibliometric analysis. *J Bone Joint Surg Br* 2010;92:1338–43.
- [13] Nayar SK, Dein EJ, Bernard JA, Zikria BA, Spiker AM. Basic science research trends in orthopedic surgery: an analysis of the top 100 cited articles. *HSS J* 2018;14:333–7.
- [14] Jiang Y, Hu R, Zhu G. Top 100 cited articles on infection in orthopaedics: a bibliometric analysis. *Medicine (Baltimore)* 2019;98:e14067.
- [15] Malik AT, Noordin S. The top 50 most-cited articles on total ankle arthroplasty: a bibliometric analysis. *Orthop Rev (Pavia)* 2018;10/7498.
- [16] Sheridan G, Wisken E, Hing CB, Smith TO. A bibliometric analysis assessing temporal changes in publication and authorship characteristics in the knee from 1996 to 2016. *Knee* 2018;25:213–8.
- [17] Sun J, Guo Y, Scarlat MM, Lv G, Yang XG, Hu YC. Bibliometric study of the orthopaedic publications from China. *Int Orthop* 2018;42:461–8.
- [18] Cheng T. Research in orthopaedics from China has thrived over the last decade: a bibliometric analysis of publication activity. *Orthop Traumatol Surg Res* 2012;98:253–8.
- [19] Lao L, Daubs MD, Phan KH, Wang JC. Comparative study of scientific publications in orthopedics journals originating from USA, Japan and China (2000–2012). *Acta Cir Bras* 2013;28:800–6.
- [20] Jiang H, Nong B, Yang L, Zong S, Zhan X, Wei Q, et al. Assessing the evolution of scientific publications in orthopedics journals from mainland China, Hong Kong, and Taiwan: a 12-year survey of the literature. *J Orthop Surg Res* 2016;11:69.

- [21] Zou Y, Li Q, Xu W. Scientific research output in orthopaedics from China and other top-ranking countries: a 10-year survey of the literature. *BMJ Open* 2016;6:e011605.
- [22] Yan J, MacDonald A, Baisi LP, Evaniew N, Bhandari M, Ghert M. Retractions in orthopaedic research: a systematic review. *Bone Joint J* 2016;5:263–8.
- [23] Zhi X, Zhang Z, Cui J, Zhai X, Chen X, Su J. Quality of meta-analyses in major leading orthopedics journals: a systematic review. *Orthop Traumatol Surg Res* 2017;103:1141–6.
- [24] Erivan R, Villatte G, Ollivier M, Reina N, Descamps S, Boisgard S. The top 100 most-cited Orthopaedics & Traumatology: Surgery & Research articles. *Orthop Traumatol Surg Res* 2019;105, <http://dx.doi.org/10.1016/j.otsr.2019.01.016> [In press].
- [25] Mavrogenis AF, Megaloikonomos PD, Mauffrey C, Scarlat MM, Simon P, Hasegawa K, et al. The best cited articles of the European Journal of Orthopaedic Surgery and Traumatology (EJOST): a bibliometric analysis. *Eur J Orthop Surg Traumatol* 2018;28:533–44.