

Orthopaedic research. Bibliometrics of publication rates in the top 15 journals

Runnig head: Orthopaedic Research in Australia

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Abstract

Background:

To investigate the publications rates and characteristics of the authors for manuscripts originating from Australia in the 15 highest ranked orthopaedic journals over a five year period.

Methods:

The fifteen highest ranked journals in orthopaedics, based on their 2015 impact factor, were used to establish the total number of publications and cumulative impact factor points (IF) between January 2010 and December 2014. The affiliations of the primary author and co-authors were used to determine the involvement of Australian trained orthopaedic surgeons. Study location, research topic, and anatomic areas were recorded.

Results:

A total of 478 publications were identified; 110 of these manuscripts were principally authored by Australian trained orthopaedic surgeons or medical professionals affiliated with orthopaedics. In addition, 158 articles were published with orthopaedic surgery involvement where one of the co-authors was an Australian trained surgeon. Australian orthopaedic surgeon (FRACS) involvement was most commonly observed in the knee (n=90; 33.6%)

followed by the hip (n=69; 25.7%) and basic sciences (n=27; 10.1%). Surgeons in Sydney had the highest number of publications (n=95; 35.4%), followed by Adelaide (n=55; 20.5%) and Melbourne (n=54; 20.1%).

Conclusion:

The results of this study demonstrate that the minority (23%) of the publications originating from Australia in the 15 highest ranking orthopaedic journals were principally authored by either an Australian trained surgeon or a trainee surgeon. A total of 59% of the publications focused on the hip and knee. Sydney was the leading region, followed by Adelaide and Melbourne. These three regions published 76% of all manuscripts identified during the five-year study period.

Key Terms:

Bibliometrics; orthopaedic surgery; impact factor; publication productivity, Australian trained surgeons

Introduction:

Excellence in medicine is determined by a multitude of factors which include teaching, academic and administrative leadership, clinical activity, and finally research productivity.¹ Several metrics such as the h-index are increasingly used to measure research performance, but are considered only surrogate measures of research quantity.² However, the total number of publications by a country remains an excellent indicator of research productivity.³

Bibliometric analysis of the total number of orthopaedic articles over the last 10 years has consistently shown that the United States (USA), United Kingdom (UK), Germany, Japan, and Korea have ranked amongst the countries with the highest publications.^{4,5,6} Country specific bibliometric analysis of orthopaedic publication rates have only been performed by Ireland and Turkey.^{7,8} These authors focused on the institution, individual authors, and distribution of these publications among journals. In Turkey the total number of publications increased from 145 between 1990 and 2000 to 1099 between 2000 and 2010, and Turkey ranked 14th in the number of orthopaedic publications.⁷ Kennedy, et al investigated the contribution from Irish orthopaedic surgeons in the top 20 peer reviewed orthopaedic journals, and reported that a total of 109 articles (0.42% of all articles worldwide) were published, ranking Ireland 18th globally.⁸

Several authors have previously reported on the research output in Australia.⁹⁻¹⁴ However, none of these authors specifically investigated publication rates of surgical specialties. Askew, et al. demonstrated that between 1990 and 1999 the publication rate for medicine was 105/1000 physicians, 148/1000 for public health, and 61/1000 surgeons.¹³ In a later paper,

the publication rates for physicians had increased to 160/1000, but was only marginally increased for surgeons (68/1000).¹⁴ Mendis and McLean suggested that the increased expenditure on Australian health and medical research may have contributed to the increased publication rates.¹⁵ National research funding and funding by academic institutions has resulted in higher research publications in other countries,^{6,10,16} but surprisingly less than 50% of funded research projects in Australia are published in peer reviewed journals.¹⁰

The purpose of this study was threefold: (1) to investigate the total number of Australian publications and cumulative impact factor in Orthopaedic Surgery in the fifteen highest rated orthopaedic journals over a five year period, based on the 2015 impact factor, (2) to establish how many of these publications were authored or co-authored by Australian trained orthopaedic surgeons, and (3) to specifically investigate the subspecialty/anatomic region of the published article and the location where the research was performed.

Methods:

The fifteen highest ranked journals in orthopaedic surgery based on their 2015 impact factor were selected from the Journal Citation report on the Web of Science (Thomson Reuters, New York, USA).¹⁷ The abstracts of all articles published in these 15 journals between January 2010 and December 2014 were screened via the journals' websites.

If the journal's main purpose was to provide narrative reviews or the content was not directly related to the field of orthopaedics, they were excluded. In addition letters to the editor, editorials, editorial comments, historical articles, errata, proceedings, meeting abstracts, and notes were also excluded. Only level I-IV research articles, systematic reviews and meta-analysis, non-solicited review articles and case reports were included. The level of evidence was recorded for each article. If the journal did not assign the level of evidence, the level of evidence chart from the Journal of Bone and Joint Surgery was used.¹⁸ The total number of publications and the total number of impact factor points for all publications from Australia were collated.

The study location was recorded from the manuscript and defined as the primary authors principal institution. If the manuscript did not provide details about the study location, the address of the corresponding author was defined as the primary location. Discrepancies were addressed by performing a Google search and searching the website of the Australian Orthopaedic Association of both the primary and corresponding authors, and any discrepancies were resolved by agreement between the two senior authors.

The affiliations of the primary authors were divided into the following categories:

- (1) Orthopaedics if either the primary author's location and affiliation clearly stated 'orthopaedic' in his/her affiliations
- (2) Academic if the primary affiliation and institution where the research was conducted, was an academic or University affiliation. If the primary author or one of the co-authors was affiliated with an 'orthopaedic' department or the the main qualification was a fellowship (FRACS) awarded in Orthopaedic Surgery by the Royal Australasian College of Surgeons, the article was grouped under orthopaedics.
- (3) Allied Health if the primary author was a clearly identifiable allied health professional based on the qualifications provided. If the research was primarily performed in an academic institution the article was grouped under academic.
- (4) Engineering if the primary qualification of the first author was in the engineering field. If the research was performed in an academic institution the article was still grouped under the engineering category. It was felt that many basic science articles required special expertise and grouping these articles under academic would not have highlighted these skills appropriately.
- (5) Physician for any other medical subspecialty, general practitioners, neurosurgeons and sports physicians. Similar to (2) if the primary author or one of the co-authors was affiliated with an 'orthopaedic' department or their main qualification was a fellowship (FRACS) awarded in Orthopaedic Surgery by the Royal Australasian College of Surgeons, the article was grouped under orthopaedics.
- (6) IMG (International Medical Graduate) if the primary author was clearly identified as an IMG with no affiliations to either of the other groups.

(7) IMG – fellow if the primary author was clearly identifiable as an IMG working in an orthopaedic department or the affiliations clearly indicated overseas qualifications. In addition one of the co-authors' had to be an Australian trained orthopaedic surgeon with a FRACS.

(8) FRACS - all publications where either the primary authors' or one of the co-authors' qualification was a FRACS in orthopaedic surgery.

The specialty of orthopaedic surgery was subdivided into both anatomic areas and recognised subspecialties, in order to specifically investigate which of the subspecialty areas of interest had the highest number of publications. The following divisions were made: shoulder, elbow, hand, spine, hip, knee, foot and ankle, paediatric orthopaedics, tumour, basic science, sports medicine, and allied health.

Results

Between January 2010 and December 2014 a total of 478 articles of Australian origin were published in the 15 highest ranked orthopaedic surgery journals. Of these 478 publications, 110 manuscripts were published by orthopaedic surgeons or medical professionals with a clear affiliation to orthopaedic surgery. In addition, another 158 articles were published with orthopaedic surgery involvement where one of the co-authors was an Australian trained surgeon (FRACS). The largest number of articles was published in the Journal of Arthroplasty (n=71) followed by Spine (n=58) and the British Bone and Joint Journal (n=41). The highest involvement of Australian FRACS surgeons in published articles was observed in the British Bone and Joint Journal (n=41/42; 98%), followed by Acta Orthopaedica (n=12/13;92%) and International Orthopaedics (n=9/10; 90%). (Table 1).

Of all anatomic regions, publications of Australian origin reporting knee conditions were most frequent (n=112; 23.4%) followed by the spine (n=105; 22%) and the hip (n=75; 15.7%). (Table S1). Australian surgeons (FRACS) involvement was most commonly observed in the knee (n=90; 33.6%) followed by the hip (n=69; 25.7%) and basic sciences (n=27; 10.1%). (Table S2)

Researchers in Sydney published the most articles (n=160; 33.5%) followed by Melbourne (n=96; 20.1%) and Adelaide (n=69; 14.4%). (Table S3) Publications with involvement of Australian trained surgeons showed a very similar distribution. Surgeons in Sydney had the highest number of publications (n=95; 35.4%) followed by Adelaide (n=55; 20.5%) and Melbourne (n=54; 20.1%). (Table S4)

Table 1
Overview of publications and first authorship including involvement of FRACS holding Australian trained orthopaedic surgeons

	Total	Impact	Level 0 Meta	Level 1	Level 2	Level 3	Level 4	Level 5 Case report	Level 6 opinion	Lab	Etiol	Orth	acad	Allied	ENG	Phys	IMG	IMG fellow	FRACS involved
JBJS	26	137.3	0	6	3	1	8	0	0	5	3	8 (31%)	4	3	1	-	4	6	18 – 69%
AJSM	41	178.8	2	4	5	16	9	1	0	2	2	6 (15%)	14	10	-	4	1	6	21 – 51%
BJJ	42	139	0	1	1	1	30	2	0	6	1	18 (43%)	11	-	-	-	-	13	41 – 98%
Arthroscopy	16	51.3	0	1	1	2	8	0	0	4	0	1(6%)	7	3	1	-	1	3	14 – 87%
KSSTA	31	94.6	0	2	3	6	14	2	1	3	0	5 (16%)	13	2	1	-	6	4	18 – 58%
J Orth Res	36	107.5	0	0	0	0	1	0	0	34	1	0 (0%)	27	1	6	1	1	-	9 – 25%
Acta Orth	13	36	0	0	0	1	7	0	0	2	3	6 (46%)	7	-	-	-	-	-	12 – 92%
CORR	26	71.9	0	0	6	3	11	1	0	4	1	9 (35%)	4	8	1	-	3	1	20 – 77%
J Arthropl	71	189.3	3	6	2	7	36	4	0	13	0	18 (25%)	10	11	4	-	8	20	60 – 84%
Spine J	12	29.1	0	0	0	0	5	2	0	4	1	- (0%)	4	1	2	4	-	1	2 – 17%
Spine	58	133.2	8	5	2	1	24	7	2	8	1	6 (10%)	22	18	-	8	3	1	9 – 16%
J Should Elb	28	64.1	5	0	1	5	5	5	0	7	0	11 (39%)	3	4	-	-	9	1	13 – 46%
Injury	31	66.2	0	1	0	1	15	1	2	4	7	8 (26%)	13	2	1	3	2	2	12 – 39%
Int Orth	10	21.1	0	0	0	1	6	1	0	2	0	7 (70%)	1	-	-	-	-	2	9 – 90%
Eur Spine J	37	76.4	0	1	1	1	16	3	8	7	1	7 (19%)	21	4	-	2	3	-	10 – 27%
TOTAL	478	1395.8	18	27	25	46	194	29	13	105	21	110 (23%)	161	67	17	22	41	60	268 – 56%
Percent			3.8	5.6	5.2	9.6	40.6	6.1	2.7	22	4.4	23	33.7	14	3.6	4.6	8.6	12.6	

Discussion

During the five full years of the study period (2010-14), in the 15 highest ranked orthopaedic journals a total of 478 articles were published that had their origins in Australia. The minority (110 publications, 23%) of these were principally authored by either an Australian trained orthopaedic surgeon or a surgeon in training, although additional co-authorship was observed in another 158 (33%) manuscripts. Therefore, the total number of publications from Australian-trained orthopaedic surgeons, including primary authorship and co-authorship, was 268 (56%). Among the 66 countries that published an orthopaedic related manuscript during this study period, Australia ranked 12th for the total number of publications,¹⁹ and ranked 11th with regard to cumulative impact factor points.¹⁹ Despite ranking 12th overall, Australia was curiously among the top ten countries for the number of publications in each of the individual fifteen highest ranked journals.¹⁹

Lee, et al. has reported a substantial increase in the number of orthopaedic publications for the first decade of the 21st century.⁶ In an earlier study Moir, et al. had previously observed a 21% increase in orthopaedic publications from 1980 to 1994 in six selected journals.²⁰ Bosker & Verheyen reported an increased number of orthopaedic publications in the 15 major clinical orthopaedic journals from 2000-2004, with a total of 13,311 articles.⁴ Orthopaedic publications in Australia increased from 37 in 2000 to 91 in 2009, and the mean annual increase was 10.5% over those 10 years. Only Germany (11.9%), Canada (14.2%), Italy (15%) and Korea (20.2%) had a higher annual increase over this period. Over the last 30 years, English has become the international language of medical science.²¹ Of the current top 50 highest impact journals in orthopaedics, 45 are based in English speaking countries; all 50 of these journals publish their manuscripts exclusively in English.^{17,22} In those countries

where English is the primary language, one might expect relatively higher growth rates. Yet of these countries, only Australia and Canada are primarily English speaking countries. While Canada increased publication output from 48 in 2001 to 159 articles in 2009, Australia's output only increased from 37 to 91, a substantially lower rise.⁶ Both countries have a similar size population and GDP per capita, and one may have expected to observe a similar growth rate.

The 2015 report from the Australian Research Council attributed 21% of the research output in that country to medical and health sciences, while clinical sciences contributed 25% using only 18.5% of the funding.²³ In contrast, nursing produced 5.4% of the research output using only 3.1% of the funds. When comparing the cost effectiveness between these two groups, each publication in the clinical sciences on average cost \$369,000 AUD whereas nursing produced one publication for \$131,000 AUD. Lowcay, et al. showed that only 41% of the General Practice Evaluation Program funded research results were ever published.¹⁰ Although this finding may not be representative for other clinical specialties, it indicates that the real cost per published article could be significantly higher, as reported by the ARC. Garret-Jones et al. used international benchmarks to evaluate Australian health and medical research.⁹ The percentage of the total national expenditure for health care that is spent on medical research in Australia falls within the mid-range, spending 0.38% on medical research and ranked 9th for papers published per million population.

To our knowledge this is the first study investigating research output in the field of orthopaedic surgery in Australia. Peer reviewed publication rates in general practice in Australia between 1990 and 1999 were investigated by Lowcay, et al.¹⁰ Over a 10 year

period, a total of 201 publications were identified. This is substantially lower the total than in orthopaedic surgery (478 publications over five years), but when compared to first authored publications from Australian trained orthopaedic surgeons (110), the publication rate is very similar. In contrast, Mendis, et al. reported much higher publication rates from Australian rural health practitioners.¹² Between 2006 and 2012 a total of 1198 articles were published in 12 peer-reviewed journals, averaging 171 publications per annum over the observed period, over 50% more than in orthopaedics.

Other countries that have performed country specific bibliometric analyses of orthopaedic related publications are Ireland, Turkey, and China.^{7,8,24} Kennedy, et al. analysed 20 orthopaedic-related peer-reviewed journals and reported a total of 109 publications over a 5 year period, comparable to the Australian orthopaedic surgery research output.⁸ However, Kennedy included journals such as ‘Physical Therapy’, ‘Gait and Posture’, ‘Connective Tissue Research’, and ‘Clinical Biomechanics”, that also publish non-orthopaedic related topics, making it difficult to make direct comparisons to the current study. In contrast, this study has performed a specialty focused bibliometric analysis that has produced highly reliable and representative data. Similarly, Gurbuz et al. have analysed publication rates in orthopaedic surgery in 40 journals, but again included journals that do not exclusively publish articles directly related to orthopaedic surgery.⁷ Over a similar period (2009-2013) Turkey published 459 and Ireland 109 articles. The total number of publications per million population was 21 for Ireland, 151.7 for Turkey, and 181.5 for Australia. These comparative per capita figures are more representative, and clearly demonstrate that Australia has a higher rate of orthopaedic publications when compared to these two countries. Cheng investigated the publication activity from China, including Hong Kong and Taiwan.²⁴ From 2000 to 2009

a total of 1878 articles were published in 49 journals. Similar to Kennedy and Gurbuz, Cheng has also included non-orthopaedic journals, compromising any effort to make direct comparisons to this study.^{7,8,24} The strength of the current study relies instead upon the detailed and complete analysis of the authors, their affiliations, and their qualifications.

This study has recognized limitations. While the total number of articles and cumulative impact factor points were determined, the quality and level of evidence was not assessed. It is possible that there was a significant difference in the quality of a manuscript between the authors of different specialties. We have not evaluated the number of citations attributed to each publication, which may be a more accurate reflection of their scientific value, possibly introducing some selection bias. However over citation, biased citing, audience size, biased data, and ignorance of the literature are additional common criticisms of bibliometric studies.²⁵ The developed categories are possibly not mutually exclusive, and it is quite possible that some publications could have been placed into more than one of these categories. However, the main purpose of this study was to determine the number of publications authored or co-authored by Australian trained orthopaedic surgeons. To do this, clear search criteria were developed and uncertainties were resolved by a Google search. When necessary, results were confirmed by the Australian Orthopaedic Association website. Despite these efforts, it cannot be entirely assured that a limited number of publications included in the analysis were categorized incorrectly.

Conclusions

The results of this study demonstrated that the minority (23%) of the published articles originating from Australia in the 15 highest ranked orthopaedic journals were principally

authored by either an Australian trained surgeon or a surgeon in training. Fifty-nine percent of the published manuscripts focused on the hip and knee. Sydney was the leading region, followed by Adelaide and Melbourne. These three regions published 76% of all manuscripts originating from Australia during the study period, from 2010 through 2014.

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List of Supporting Information

Table S1: Australian publications per anatomic area and subspecialties

Table S2: Overview of all publications per anatomic area and subspecialties of Australian trained orthopaedic surgeons (FRACS)

Table S3: Australian publications per regional area

Table S4: Overview of all publications per regional area of Australian trained orthopaedic surgeons (FRACS)

Table S1: Australian publications per anatomic area and subspecialties

	Shoulder	Elbow	Hand	Spine	Hip	Knee	Foot Ankle	Trauma	Paeds	Tumour	Basic Science	Sports Medicine	Allied Health	TOTAL
JBJS	5	-	-	-	6	6	-	-	4	-	5	-	-	26
AJSM	2	1	-	-	2	24	-	-	-	-	2	10	-	41
BJJ	1	1	-	-	15	10	-	4	5	-	6	-	-	42
Arthroscopy	3	-	-	-	1	11	-	-	-	-	1	-	-	16
KSSTA	3	-	-	-	1	23	-	-	-	-	1	3	-	31
J Orth Res	4	-	-	1	-	4	1	2	-	-	24	-	-	36
Acta Orth	-	-	-	-	3	2	-	3	-	1	4	-	-	13
CORR	-	-	-	-	11	4	-	2	3	1	5	-	-	26
J Arth	-	-	-	-	33	25	-	3	-	-	10	-	-	71
Spine J	-	-	-	12	-	-	-	-	-	-	-	-	-	12
Spine	-	-	-	57	-	-	-	1	-	-	-	-	-	58
J Should Elb	25	2	-	-	-	-	-	1	-	-	-	-	-	28
Injury	-	-	1	-	-	-	-	25	-	-	5	-	-	31
Int Orth	-	-	-	-	3	3	1	1	2	-	-	-	-	10
Eur Spine J	-	-	-	35	-	-	-	1	1	-	-	-	-	37
TOTAL	43	4	1	105	75	112	2	43	15	2	63	13	-	478
Percentage	9	0.8	0.2	22	15.7	23.4	0.4	9	3.1	0.4	13.2	2.7	-	

Table S2 : Overview of all publications per anatomic area and subspecialties of Australian trained orthopaedic surgeons (FRACS)

	Shoulder	Elbow	Hand	Spine	Hip	Knee	Foot Ankle	Trauma	Paeds	Tumour	Basic Science	Sports Medicine	Allied Health	Total	Ortl Perce
JBJS	3	-	-	-	6	4	-	-	4	-	1	-	-	18	8 (44)
AJSM	-	-	-	-	1	20	-	-	-	-	-	-	-	21	6 (28)
BJJ	1	1	-	-	15	10	-	3	5	-	6	-	-	41	17 (41)
Arthroscopy	2	-	-	-	1	10	-	-	-	-	1	-	-	14	1 (7)
KSSTA	3	-	-	-	1	13	-	-	-	-	1	-	-	18	5 (28)
J Orth Res	1	-	-	-	-	1	-	1	-	-	6	-	-	9	- (0)
Acta Orth	-	-	-	-	3	2	-	3	-	1	3	-	-	12	6 (50)
CORR	-	-	-	-	10	3	-	2	1	1	3	-	-	20	9 (45)
J Arth	-	-	-	-	29	23	-	2	-	-	6	-	-	60	18 (30)
Spine J	-	-	-	2	-	-	-	-	-	-	-	-	-	2	-
Spine	-	-	-	9	-	-	-	-	-	-	-	-	-	9	9 (67)
J Should Elb	11	1	-	-	-	-	-	1	-	-	-	-	-	13	11 (85)
Injury	-	-	1	1	-	-	-	10	-	-	-	-	-	12	8 (67)
Int Orth	-	-	-	-	3	4	1	-	2	-	-	-	-	10	7 (70)
Eur Spine J	-	-	-	9	-	-	-	-	-	-	-	-	-	9	7 (78)
Total	21	2	1	21	69	90	1	22	2	2	27	-	-	268	112 (42)
Percentage	7.8	0.7	0.4	7.8	25.7	33.6	0.4	8.2	0.7	0.7	10.1	0	0		

Table S3: Australian publications per regional area

	Adelaide	Brisbane	Canberra	Melbourne	Perth	Sydney	Regional NSW	Regional QLD	Regional Tasmania	Regional Victoria	Total
JBJs	5	1	-	8	4	8	-	-	-	-	26
AJSM	-	3	1	10	8	16	-	3	-	-	41
BJJ	8	-	2	10	4	16	1	-	-	1	42
Arthroscopy	1	2	-	3	-	8	-	2	-	-	16
KSSTA	1	-	-	12	1	11	-	3	-	3	31
J Orth Res	3	5	2	10	4	10	-	1	-	1	36
Acta Orth	6	3	-	2	2	-	-	-	-	-	13
CORR	11	-	1	4	2	7	-	1	-	-	26
J Arthro	12	16	2	6	8	21	3	3	-	-	71
Spine J	-	2	-	-	-	9	-	1	-	-	12
Spine	4	20	1	12	7	10	3	-	1	-	58
J Should Elb	7	-	-	4	5	11	1	-	-	-	28
Injury	4	3	-	14	-	5	3	1	-	1	31
Int Orth	3	1	-	1	1	4	-	-	-	-	10
Eur Spine J	4	4	-	-	3	24	1	1	-	-	37
Total	69	60	9	96	48	160	12	16	1	6	478
Percentage Region	14.4	12.6	1.9	20.1	10	33.5	2.5	3.3	0.2	1.2	100

Table S4: Overview of all publications per regional area of Australian trained orthopaedic surgeons (FRACS)

	Adelaide	Brisbane	Canberra	Melbourne	Perth	Sydney	Regional NSW	Regional QLD	Regional Tasmania	Regional Victoria	Total	Percent of all pub loc
JBJS	4	-	-	7	1	6	-	-	-	-	18	69
AJSM	-	-	1	5	5	10	-	-	-	-	21	51
BJJ	8	-	2	11	4	16	-	-	-	-	41	98
Arthroscopy	1	2	-	3	-	7	-	1	-	-	14	87
KSSTA	-	-	-	8	-	9	-	-	-	1	18	58
J Orth Res	-	1	1	2	-	5	-	-	-	-	9	25
Acta Orth	6	3	-	1	2	-	-	-	-	-	12	92
CORR	11	-	1	1	-	6	-	1	-	-	20	77
J Arthro	11	15	1	5	6	20	1	1			60	85
Spine J	-	-	-	-	-	2	-	-	-	-	2	17
Spine	1	3	1	1	1	-	1	-	1	-	9	15
J Should Elb	4	-	-	2	3	3	1	-	-	-	13	46
Injury	3	-	-	7		2	-	-	-	-	12	39
Int Orth	3	-	-	1	1	4	-	-	-	-	9	90
Eur Spine J	3	2	-	-		5	-	-	-	-	10	27
Total	55	26	7	54	23	95	3	3	1	1	268	
Percentage Region	20.5	9.7	2.6	20.1	8.6	35.4	1.1	1.1	0.4	0.4	100	