

## **THE KNEE**

### **TITLE PAGE**

**Title:** A bibliometric analysis assessing temporal changes in publication and authorship characteristics in *The Knee* from 1996 to 2016.

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## ABSTRACT

**Background:** Evidence-based practice is a foundation to clinical excellence. However there remains little evidence on the characteristics of authors who contribute to the evidence-base and whether these have changed over time. The purpose of this study was to explore these characteristics by undertaking a bibliometric analysis to explore publication and authorship characteristics in a leading sub-speciality orthopaedic journal (*The Knee*) over a 20-year period.

**Methods:** All articles published in *The Knee* in 1996, 2006 and 2016 were identified. For each article, data collected included: highest academic award; profession; gender; continent of first and last author; total number of authors; the level of evidence; and funding source. We analysed temporal changes in these variables using appropriate statistical models.

**Results:** A total of 413 papers were analysed. Between 1996 to 2016 there has been a significant increase in the overall number of authors, the number of paper submitted from Asia, the proportion of Level 1 or 2 tiered evidence, the proportion of people with Bachelor or Master-level degrees as their highest level of educational award and the proportion of non-medically qualified authors ( $P < 0.001$ ). From 2006 to 2016 there was a significant increase in the proportion of articles whose first author was female ( $P = 0.03$ ), but no significant change in the number of females as last author ( $P = 0.43$ ).

**Conclusion:** The findings indicate that there have been changes in publication and authorship characteristics in this sub-speciality orthopaedic journal during the past 20 years. This provides encouraging indication of greater diversification and internationalisation of orthopaedic research.

**Keywords:** Journal publication; evidence-base practice; research dissemination; author characteristics; The Knee

**Word Count:** 2072

## INTRODUCTION

There has been a growing interest in understanding publication and authorship trends in medicine research [1]. Evidence is a vital step for improving the quality and reducing the cost of care through health professionals providing interventions which are known to improve clinical outcomes [2]. Therefore clinicians implementing evidence-based practice need access to published reports and trials, especially high-quality evidence.

Previous authors have explored publication trends across medical journals. These have reported an increase in the number of authors contributing to papers, increasing from an average of two in the late 1980s to five in the 2010s [3-5]. There has been an increase in the number of papers submitted from developing countries such as in Asia, over the past 30 years [1,6-9] and the proportion of papers with female first or last authors [10-12]. Whilst the overall level of evidence has also increased with a transition for publishing a single-case study or case series to a higher proportion of rigorous systematic reviews and clinical trials [1]. There has also been a diversification in authors' professional backgrounds with an increase in the number of medical students, non-medical health professionals such as physiotherapists and nurses, and an increase in the number of authors whose highest educational awards were doctoral degrees [13-17].

Whilst this evidence provides guidance on overall medical journal trends, there has been little data on musculoskeletal or orthopaedic publication trends. This is an important omission as analysing trends in data could potentially provide an indirect indication on the evolution of research within this field, and provides a context to the evidence-base which currently underpins practice. Based on this, the purpose of this study was to undertake a bibliometric analysis of publication trends in *The Knee* journal during the past 20 years.

## METHODS

All papers published in *The Knee* in 1996, 2006 and 2016 were included in the analysis. We excluded corrigendum, meeting notes and BASK surveys. All other study designs were included. All papers were accessed electronically through *The Knee* website [18].

Data extracted from each paper included: level of evidence; source of funding (industry, research council or mixture); gender of first and last author and composition of males/females from all authors;

profession of first and last author; highest reported academic award of first and last author; geographical base of first and last author; geographical base of all authors; and total number of authors. Geographical basis was defined as where the authors were based or their address for correspondence listed on the paper. For each article where data were missing, the corresponding author was contacted in an attempt to obtain missing data. Data were extracted onto a database by one researcher (GS) and verified by a second researcher (EW). Any disagreement between the researchers for data extracted were resolved through discussion and adjudicated by a third researcher (TS).

### Data analysis

Data distribution was assessed through evaluation of histograms and Shapiro-Wilks tests. Summary statistics (frequency; median and inter-quartile range (IQR); mean and standard deviation (SD)) were assessed respecting data distribution. Analyses undertaken were to assess the temporal changes in the number of authors, geographical basis of authors, gender, highest academic award, level of evidence, profession of authors and source of funding, between 1996 to 2006 to 2016. To undertake this, when data were normally distributed for continuous data outcomes, an ANOVA was undertaken, where not normally distributed, a Krukshal-Wallis test was conducted. When data were categorical, a chi-squared test was undertaken. All statistical analyses were undertaken on SPSS Version 23.0 (IBM, USA). Statistical significance was deemed when  $P < 0.05$ .

## **RESULTS**

In total, 413 papers were identified for analysis over the three time intervals; 95 papers in 1996, 109 in 2006 and 209 in 2016. The results of each variable assessed are presented below:

### Number of Authors

The number of authors per paper significantly increased over the 20 year period ( $P < 0.001$ ). The median number of authors per article increased from one (IQR: 1-2) in 1996, four (IQR: 3-5) in 2006, to five (IQR: 4-7) in 2016. In 1996, 73% of studies had one author. This significantly decreased to 0% in 2016 ( $P < 0.001$ ). In 1996, the number of papers with three or more authors was 16%. This significantly increased to 92% in 2016 ( $P < 0.001$ ).

### Geographical Base

Significant differences were identified over time for the geographic base of authors ( $P < 0.001$ ). There was a 15% decrease in the number of papers from European countries over the 20 years. There was a significant increase in the number of papers from Asia-based authors, increasing from 1% in 1996 to 28% in 2016 ( $P < 0.001$ ). There was no consistent significant change in the proportion of papers from North America, South America, Africa and Australasia/Oceania based authors over 20 years ( $P > 0.05$ ).

For all authors attributed to each paper, significant differences were found in the number of European and Asian authors contributing towards an article ( $P < 0.001$ ). Whilst there was a significant decrease in the number of papers from North American-based teams between 1996 to 2006 ( $p < 0.001$ ), this was not statistically significant from 1996 to 2016 (49% versus 42%;  $P < 0.001$ ). This was attributed to the decrease in 2006 to 24%. There was no significant difference observed in authors contributing from South America, Africa or Australasia/Oceania ( $P > 0.05$ ) (**Table 1**).

### Gender

There was no significant difference in the proportion of male to female authors between 1996 to 2006 ( $P = 0.071$ ), but this was evident between 2006 to 2016. The number of female first authors increased from 7% in 2006 to 16% in 2016 ( $P < 0.026$ ). There was no significant difference in the gender of last authors over 20 years, where in 1996 all last authors were male (100%) whereas this was 94% in 2016 ( $P = 0.432$ ). For overall composition of males to females in author teams, there was a significant decrease in the proportion of males from 93% to 90% to 84% during the three time-intervals ( $P < 0.001$ ).

### Level of Evidence

The level of evidence significantly changed over the three time-periods ( $P < 0.001$ ). There was a significant increase in the number of Level 1 or 2-tier papers from 27% in 1996 to 30% in 2006 and 42% in 2016 ( $P < 0.001$ ; **Figure 1**).

### Academic Status

The highest academic award of the first author significantly changed from 1996 to 2016 ( $P < 0.001$ ). There was a decrease the proportion of authors whose highest award was an undergraduate degree (30% in 1996 versus 12% in 2016), and an increase in the number of authors with a doctorate (65% in 1996 versus 76% in 2016;  $P < 0.001$ ). Whilst only a small change, there was a significant increase in the number of authors whose highest educational qualification was pre-degree level (0% in 1996 versus 2% in 2016;  $P = 0.001$ ). This was converse to the findings from the last author highest education award, where there was a significant change with last author's whose highest degree was an undergraduate degree which increased from 4% in 1996 to 9% in 2016 ( $P < 0.001$ ). The number of last authors holding a doctoral degree decreased from 92% in 1996 to 86% in 2016 ( $P = 0.001$ ).

### Profession

Significant differences were found over the 20-year assessment for the professional backgrounds of authors ( $P < 0.001$ ; **Table 2**). The proportion of authors from an academic institution decreased from 20% in 1996 to 10% in 2016 ( $P = 0.016$ ). Whereas the proportion of authors who were physiotherapists increased from 2% in 1996 to 5% in 2016 ( $P = 0.016$ ). No significant differences were reported between 2006 to 2016 ( $P = 0.110$ ), although there was a decreased by 12% in authors from an academic institution during these intervals.

### Funding Source

The funding source reported in papers from 1996, 2006 and 2016 did not significantly change ( $P = 0.431$ ). However, this was poorly reported, documented in only two papers in 1996, 14 in 2006 and 49 papers in 2016, thereby limiting the analysis.

## **DISCUSSION**

The results indicate that there has been a change in publication characteristics with an increase in the number of authors per article, level of evidence of published research, the gender of authors, the professional background of authors, the highest academic award obtained and the geographical location of authors published in *The Knee* during the past 20-years.

These findings from *The Knee* mirrors those from other medical journals with increasing numbers of authors per paper [3-5]. This has been attributed to a number of factors including the increasing complexity of methodologies undertaken, with a shift in the research paradigm towards multidisciplinary research teams [19,20]. Alternatively, the results may also reflect the potential for honorary or gift authorship where teams believe the inclusion of an 'influential' senior author may facilitate publication [21]. Honorary authorship is not permitted through the meet International Committee of Medical journal Editors (ICMJE) criteria and COPE best practice guideline regard this as poor practice [22]. Both guidelines are advocated by *The Knee* [18]. However despite these designed to curb inappropriate assignment of authorship, this still occurs [23,24], and may have accounted, even in part, to this increase.

There has been an increase in the number of papers published in *The Knee* originated from Asia. This increase has been attributed to an increase in health and research funding and increasing internationalisation within Asian countries such as China and Taiwan [6,25]. Similarly, the results also reflect previous evidence on other changes such as an increase in female authorship. Sidhu et al [26] who reported that the prominence of female first authorship varied by clinical sub-speciality. In their analyses, there were higher percentages of female first authors within gynaecology and paediatrics sub-speciality papers [26]. Lewis et al [27] reported orthopaedic surgery, especially hip and knee surgery, represented the lowest percentage of women in a sub-speciality, with females representing 4% of orthopaedic surgeons in 2009. This may partly explain why the magnitude of increase in female first authors is far less within *The Knee* journal in comparison to other non-orthopaedic journals.

An encouraging finding from an evidence-base practice perspective was the reported increase in the proportion of papers which were Level 1 or 2-tier evidence. The trend towards higher levels of evidence is not unique to *The Knee*. Cvetanovich et al [1] reported a significant increase in Level 1 and 2-tiered evidence from 9% to 24% from 1996 to 2011 ( $P=0.007$ ). Although the majority of papers in *The Knee* were still Levels 3 to 5, the direction of change remains promising. With this, there have been changes in the professional background of authors, with greater diversification in authors. Whilst, understandably for *The Knee*, given its affiliation to surgical groups such as the British Association for Surgery of the Knee, the Australian Knee Society, the German Knee Society and the Sociedad Española de la Rodilla, orthopaedic surgeons remained most prevalent authorship (70% in 1996 and 63% in 2016), the number of physiotherapists (2.1% in 1996 to 5.3% in 2016) and other health professionals (2.1% in 1996 to 6.3%) has increased. Whilst the professional status of authors is likely to be journal-specific, dependent on the journals speciality, this is an encouraging finding both

from increasing the professional recognition of professions who have a more 'developing' evidence-base, whilst also increasing the diversity of papers to *The Knee* of a non-surgical focus, to aid broader evidence-based practice.

This study presented with three key limitations. Firstly, we evaluated only three time-periods (1996, 2006, 2016), not including intervening years. It was therefore not possible to detect intervening variability which may have occurred. However to answer the current research question, this was deemed an appropriate strategy to ensure data collection was achievable given the 413 citations screened using this approach alone. Secondly, to gain information on certain authorship characteristics, most notably author's professional background, a Google search was undertaken to access publicly-available professional websites such as LinkedIn, Researchgate and institutional websites. We therefore could not guarantee the accuracy of the source of data, although deemed appropriate for the level required in this analysis. Finally, there were analyses which were underpowered due to missing data, even after internet searching and contacting authors. This was most notably for funding source of study. This therefore reduced the power of the analysis compared to if full data were available.

## **CONCLUSION**

There has been a change in publication and authorship characteristics in papers published in *The Knee* during the past 20 years. These have included an increase in the number of authors per paper, increasing internationalisation of published papers, increasing female authorship, a greater proportion of higher-quality evidence and changes within the academic status and profession of authors. The results also provide encouraging evidence of greater diversification and internationalisation of orthopaedic research, enhancing the generalisability of knowledge to aid evidence-base practice.

## **DECLARATIONS**

**Conflicts of Interest:** TS is an Associate Editor and CH is Editor-in-Chief at The Knee.

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**Ethical Approval:** No ethical approval was required for the conduct of this study.

## FIGURE AND TABLE LEGENDS

**Table 1:** Mean percentage of continent origin of all authors contributing towards an article.

**Table 2:** Profession type for first and last author (First author n= 407: Last author n=333)

**Figure 1:** Percentage of articles level of evidence in the years 1996, 2006 and 2016 (n= 412)

## REFERENCES

1. Cvetanovich GL, Fillingham YA, Harris JD, Erickson BJ, Verma NN, Bach BR. Publication and level of evidence trends in the American Journal of Sports Medicine from 1996 to 2011. *Am J Sport Med* 2015;43:220-225.
2. Kazdin AE. Evidence-based treatment and practice: new opportunities to bridge clinical research and practice, enhance the knowledge base, and improve patient care. *Am Psychologist* 2008;63:146.
3. Geminiani A, Ercoli C, Feng C, Caton JG. Bibliometrics study on authorship trends in periodontal literature from 1995 to 2010. *J Periodontol* 2014;85:136-43.
4. Dotson B, McManus KP, Zhao JJ, Whittaker P. Authorship and characteristics of articles in pharmacy journals: changes over a 20-year interval. *Ann Pharmacother* 2011;45:357-63.
5. Camp M, Escott BG. Authorship proliferation in the orthopaedic literature. *J Bone Joint Surg* 2013;95:44.
6. Ajuied A, Back D, Smith C, Davies AJ, Wong F, Earnshaw PH. Publication Trends in Knee Surgery: A Review of the Last 16 Years. *J Arthroplasty* 2013;28:751-8.
7. Kanavakis G, Spinos P, Polychronopoulou A, Eliades T, Papadopoulos MA, Athanasiou AE. Orthodontic journals with impact factors in perspective: trends in the types of articles and authorship characteristics. *Am J Orthodont Dentofacial Orthop* 2006;130:516-22.
8. Juma C, Fang K, Honca D, Huete-Perez J, Konde V, Lee SH, Arenas J, Ivinson A, Robinson H, Singh S. Global governance of technology: meeting the needs of developing countries. *International J Technol Management* 2001;22:629-55.
9. Vose PB, Cervellini A. Problems of scientific research in developing countries. *IAEA Bulletin* 1983;25:37-40.
10. Filardo G, da Graca B, Sass DM, Pollock BD, Smith EB, Martinez MAM. Trends and comparison of female first authorship in high impact medical journals: observational study (1994-2014). *BMJ* 2016;352:847.
11. Feramisco JD, Leitenberger JJ, Redfern SI, Bian A, Xie XJ, Resneck JS. A gender gap in the dermatology literature? Cross-sectional analysis of manuscript authorship trends in dermatology journals during 3 decades. *J Am Acad Dermatol* 2009;60:63-9.
13. Al-Busaidi IS, Al-Shaqsi SZ. Students' contribution to the New Zealand Medical Journal: a 14-year review. *NZ Med J* 2015;128:47-52.
14. Al-Shaqsi S. To intercalate or not to intercalate. *NZ Med Stud J* 2010;11:29-30.
15. Lehman JD, Schairer WW, Gu A, Blevins JL, Sculco PK. Authorship Trends in 30 Years of the Journal of Arthroplasty. *J Arthroplasty* 2017;32:1684-7.
16. Schrock JB, Kraeutler MJ, McCarty EC. Trends in Authorship Characteristics in The American Journal of Sports Medicine, 1994 to 2014. *Am J Sport Med* 2016;44:1857-60.
17. Wickramasinghe DP, Perera CS, Senarathna S, Samarasekera DN. Patterns and trends of medical student research. *BMC Medical Education* 2013;13:175.

18. The Knee; 2017; The Knee Journal; Available at: <http://www.elsmediakits.com/international/journals/orthopedic-surgery/the-knee/THEKNEE> (Accessed: 18/09/17).
19. Tilak G, Prasad V, Jena AB. Authorship inflation in medical publications. *J Health Care Organiz, Provision, Financ* 2015;52:1-4.
20. Papatheodorou SI, Trikalinos TA, Ioannidis JP. Inflated numbers of authors over time have not been just due to increasing research complexity. *J Clin Epidemiol* 2008;61:546-51.
21. Psooy K. Undeserved authorship: too much of a good thing. *Canadian Urological Association journal. J de l'Association Urolog Canada* 2010;4:391-2.
22. COPE (2014). What constitutes authorship? COPE Discussion Document; Available at [https://publicationethics.org/files/Authorship\\_DiscussionDocument.pdf](https://publicationethics.org/files/Authorship_DiscussionDocument.pdf) ; (Accessed: 19/09/17).
23. Kressel HY, Dixon AK. Where is the honour in honorary authorship? *Radiology* 2011;25:324-7.
24. Bavdekar SB. Authorship issues. *Lung India* 2011;29:76–80.
25. Haustein S, Tunger D, Heinrichs G, Baelz G. Reasons for and developments in international scientific collaboration: does an Asia–Pacific research area exist from a bibliometric point of view?. *Scientometrics* 2011;86:727-46.
26. Sidhu R, Rajashekhar P, Lavin VL, Parry J, Attwood J, Holdcroft A, Sanders DS. The gender imbalance in academic medicine: a study of female authorship in the United Kingdom. *J R Soc Med* 2009;102:337-42.
27. Lewis VO, Scherl SA, O'Connor MI. Women in orthopaedics—way behind the number curve. *J Bone Joint Sur* 2012;94:30-7.

**Table 1:** Mean percentage of continent origin of all authors contributing towards an article.

<b>Continent</b>	<b>1996</b>	<b>2006</b>	<b>2016</b>	<b>Statistical Significance</b>
Europe	54.89 (49.76)	69.08 (43.52)	41.59 (48.57)	<0.001
North America	41.21 (49.21)	9.01 (23.78)	24.89 (41.63)	<0.001
South America	0 (0.0)	1.85 (13.54)	1.43 (11.92)	0.458
Australasia	3.26 (17.86)	4.48 (20.46)	4.47 (20.0)	0.874
Asia	1.09 (10.42)	14.67 (35.35)	26.67 (37.80)	<0.001
Africa	0 (0.0)	0.93 (9.62)	0.96 (9.76)	0.646

Values are expressed as mean % (standard deviation)

**Table 2:** Profession type for first and last author (First author n= 407: Last author n=333)

Type of Profession	Last Author Profession			First Author Profession		
	1996 (n= 92)	2006 (n= 107)	2016 (n= 208)	1996 (n=24)	2006 (n= 107)	2016 (n=206)
Doctor (medical)	2 (2.1)	2 (1.8)	2 (1)	1(4.2)	2(1.9)	0 (0)
Surgeon	66 (69.5)	92 (84.4)	131 (62.7)	14(58.3)	82(79.6)	130(63.1)
Academic	19 (20)	4 (3.7)	21 (10)	7(29.2)	8(7.8)	35(17)
Physiotherapist	2 (2.1)	5 (4.6)	11 (5.3)	1(4.2)	4(3.9)	5(2.4)
Scientific Officer	3 (3.2)	3 (2.8)	20 (9.6)	1(4.2)	3(2.9)	25(12.1)
Research Assistant	0 (0)	1 (0.9)	5 (2.4)	0 (0)	3(2.9)	3(1.5)
Student	0 (0)	0 (0)	9 (4.3)	0 (0)	0 (0)	0 (0)
Psychiatrist	0 (0)	0 (0)	0 (0)	0 (0)	1(1)	0 (0)
Technical Support	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1(0.5)
Scientologist	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1(0.5)
Vet	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1(0.5)
Radiologist	0 (0)	0 (0)	3 (1.4)	0 (0)	0 (0)	0 (0)
Engineer	0 (0)	0 (0)	3 (1.4)	0 (0)	0 (0)	3(1.5)
Rheumatology	0 (0)	0 (0)	1 (0.5)	0 (0)	0 (0)	1(0.5)
Administrator	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	1(0.5)

Values are expressed as n (%)

**Figure 1:** Percentage of papers based on level of evidence during the three time-periods (n=412)

