



# Authorship and study characteristic trends in spine publications from years 2004 to 2017

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**Background:** The goal of this study was to analyze the trends in authorship and study characteristics in *Spine* using two overlapping ten-year time periods: 2004–2014 and 2007–2017. To our knowledge, no other literature reports study characteristics and authorship in the same time period for spine that would allow for the assessment of confounding factors of trends.

**Methods:** Authorship and study characteristic data was collected from all scientific manuscripts published in *Spine* during the years of 2004, 2007, 2014, and 2017. Basic statistics and Kruskal-Wallis test were used to analyze the data.

**Results:** We found a significant increase in total number of authors ( $P < 0.0001$ ) without discrepancy of unequivocal increases in author degree type: MD/Equivalent ( $P \leq 0.0001$ ), PhD/Doctorate ( $P = 0.0017$ ), Masters ( $P = 0.0015$ ), and Bachelors ( $P \leq 0.0001$ ). We observed an increase in industry authorship ( $P \leq 0.0001$ ), but without a significant increase in industry funding during the same time span. Increases in administration database studies ( $P \leq 0.0001$ ) and economic/value studies ( $P \leq 0.0001$ ) were also noted. A significant change in percentage of articles with trauma pathology (decrease,  $P < 0.0001$ ) and deformity (increase,  $P = 0.0002$ ) occurred. The number of multi-institutional studies increased ( $P \leq 0.0001$ ), while no change in the number of multi-disciplinary studies.

**Conclusions:** Increases in author number for spine articles over time are a result of a general increase in authors in all degree types, not just non-doctorate degrees. This may be potentially influenced by the increase in multi-institutional studies. From 2004–2017, higher percentages of articles focus on economics. An increase in industry authorship without a corresponding increase in funding suggests industry's more 'hands-on' approach to publication results from their funded studies.

**Keywords:** Authorship; study design; economics; interprofessionalism

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## Introduction

Authorship has been increasingly investigated in literature, commonly attributed to the importance of publications for physicians and students as competition in the field increases (1). A prior study analyzed authorship over a

15-year period in *Spine* and found an increasing number of authors, which they attributed to the increasing pressures to publish for not just physicians, but also medical students, as recent trends show number of publications is correlated with increased likelihood of matching into orthopaedics (2-4).

The first objective of this study was to look at changes in author numbers for each degree type (Bachelors, Masters, PhD/Doctorate, MD) occurring within two ten-year overlapping time periods: 2004–2014 and 2007–2017. By looking at changes in numbers of non-MD authors, we can identify a possible reason for author number increase—whether increasing competition in the match is responsible along with spine research fellowships becoming more prevalent.

To the authors' knowledge, there has not been any recent research within the specialty of spine on the changes of study characteristics over time. The second objective of this study was to assess more recent changes in spine research, as measured by the types of articles published from 2004–2017. This information could be used to shed light on the study designs and pathological processes which are getting the most attention in the spine community in 2017 and if these have changed since 2004.

## Methods

All research articles published in *Spine* from the years 2004, 2007, 2014, and 2017 were included in this study. Characteristics about authorship and the studies themselves were recorded. Articles that were not research manuscripts, such as point of view, letter to the editor, and other commentary, were excluded from this study. For each article, the following details were collected regarding authorship; total author number, number of MD, PhD/Doctorate, Masters, & Bachelor's degrees, degrees of first and last authors, industry author, and whether the authors collaborated between disciplines or institutions. The following characteristics pertaining to the study were also collected: study type, anatomical region, pathological process, level of evidence, and whether or not the article was an economic/value study. Level of evidence was not reported in years 2004 and 2007, so it was only recorded for years 2014 and 2017; thus limiting such analysis.

Study types were categorized as meta-analysis, systematic review, randomized controlled trial, cohort study, cross-sectional study, review article, biomechanical cadaveric study, animal model, basic science or other. Articles that included more than one study type were recorded as such. The pathological process recorded for each article was recorded as degeneration, surgical complication, trauma, deformity, infectious, pain or tumor. Following the completion of data collection, statistical analyses were

performed using Kruskal-Wallis test and ANOVA analyses (Minitab software, State College, PA, USA).

## Results

### *Authorship*

The average number of authors per article for years 2004, 2007, 2014, & 2017 were used to assess trends in number of authors. We found an increase in number of authors over time. Furthermore, we also found an increase in the average number of authors per article each year when separated by degree (*Figure 1*): total author number ( $P \leq 0.0001$ ), MD/Equivalent ( $P \leq 0.0001$ ), PhD/Doctorate ( $P = 0.0017$ ), Masters ( $0.0015$ ), and Bachelors ( $P \leq 0.0001$ ). When compared with respect to each other, no trends were observed for changes in proportion of authors with each degree type over this time period.

### *Industry involvement*

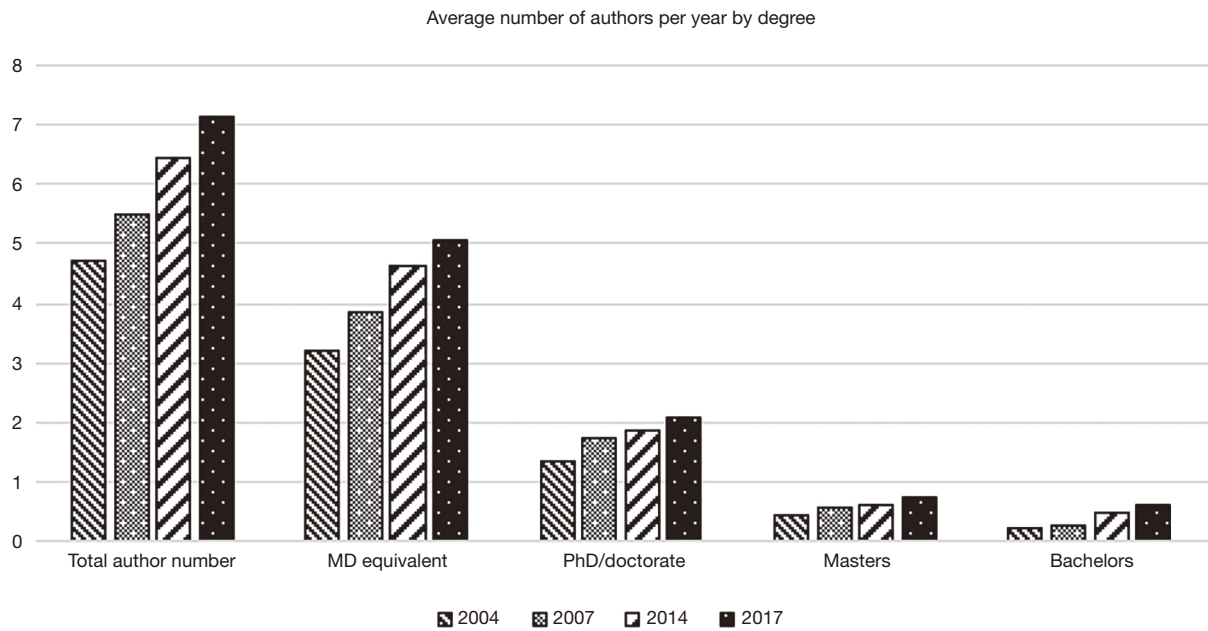
An increase was seen in percentages of articles per year with an industry author when comparing the two ten-year time periods assessed. When comparing the full time period (2004–2017) the trend is an increase in percentage of articles with an industry author ( $P \leq 0.0001$ ) (*Figure 2*). Interestingly, there was no trend in the percentage of articles with industry funding observed in neither the time period assessed [2004–2017] nor when comparing the ten-year periods (2007–2017 & 2004–2014) (*Figure 2*).

### *Specialized study type*

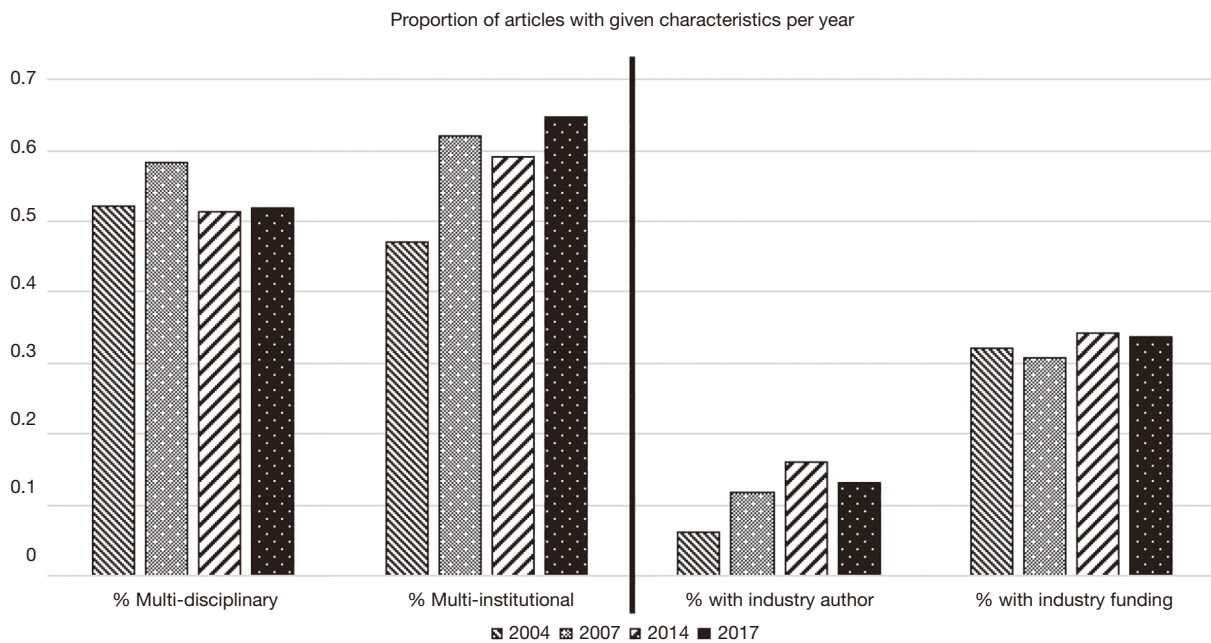
A dramatic increase was seen in the percentage of articles reporting administration database studies per year over time (*Figure 2*). The large jump is seen between years 2007 and 2014. Similarly, the percentage of articles that were economic/value studies increased over the time period assessed, with a slight decrease in 2017 ( $P \leq 0.0001$ ).

### *Study characteristics*

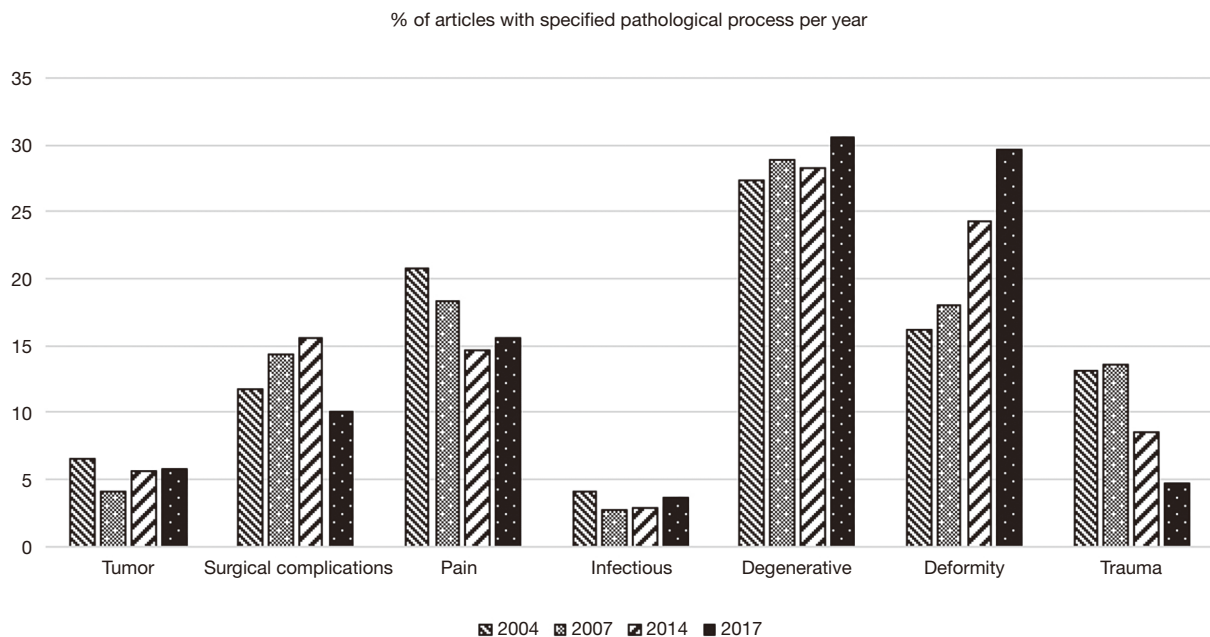
Significant changes in percentage of articles per year were noted with trauma (decrease,  $P < 0.0001$ ) or deformity (increase,  $P = 0.0002$ ) as the main pathological process. Percentage of articles with tumor, surgical complications, pain, infection, or degeneration as the main pathological process showed no statistically significant change over time



**Figure 1** An increase in average number of authors per article per year was seen along with a similar increase in each degree type over these years.



**Figure 2** This graph shows the recognizable trends over time of the each of the binary variables assessed per year. The graph presents the percentage of articles per year with each of the following characteristics: economic/value-based study, admin database study, industry author, and industry funding.



**Figure 3** A statistically significant decrease in percentage of articles with trauma pathology was seen over time ( $P < 0.0001$ ) along with an increase in the percentage of deformity articles ( $P = 0.0002$ ).

(Figure 3).

Percentage of articles with their focus on thoracic (decrease,  $P = 0.0149$ ) or multiple levels ( $P = 0.0006$ ) also significantly changed over time. Cervical, sacral and lumbar levels showed no observable trends or statistical significance in percentage of articles per year over the time period assessed.

Changes in percentage of articles that were meta-analyses (increase,  $P < 0.0001$ ), cohorts (increase,  $P = 0.0004$ ), case reports (decrease,  $P < 0.0001$ ), review articles (increase,  $P < 0.0001$ ), animal (increase,  $P = 0.0086$ ) or cadaver (decrease,  $P < 0.0001$ ) studies were also noted from 2004–2017. No obvious trends were observed in change of percentage of articles reporting a systematic review, randomized controlled trial, case control, cross-sectional study, case series, basic science, or other study type over the time period assessed.

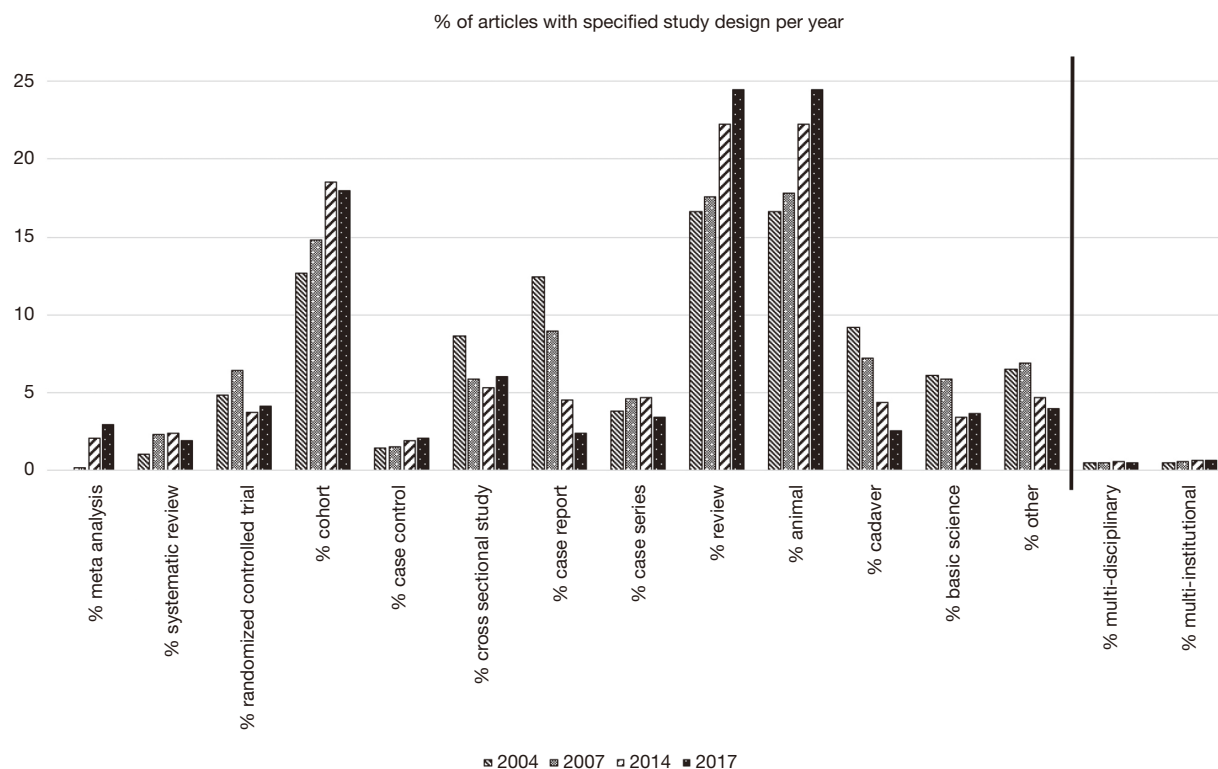
### Collaboration

We observed an increase in the percentage of articles that were multi-institutional when comparing the two ten-year time points starting in 2004 & 2007 (Figure 4). A significant difference was seen in the percentage of multi-institutional articles with one-way ANOVA analysis ( $P \leq 0.001$ ). However,

no trend was observed when comparing percentages of articles per year that were multi-disciplinary (Figure 4).

### Conclusions

Authorship and publications have become areas of interest in recent orthopaedic literature due to their importance in securing research funding and employment opportunities for physicians and matching for medical students (4–6). Consistent with the current literature, we saw a statistically significant increase in the total number of authors per article from 2004 to 2017 (3). In addition, we also found statistically significant increases in number of authors within each degree type (MD, PhD/Doctorate, Masters, Bachelors). Previous literature has postulated that the increasing number of authors per article could be explained by increase in medical student publication, but here we show that the increase in author number is due to an increase in authors across all degree types. We also found no increase in the proportion of authors without doctorate degrees, which was an unexpected finding. Haws *et al.* proposed that increase in author number for spine specific literature was a result of the increased competitiveness of the field putting pressure on increasing number of publications for those within or interested in entering the field; the increase we found in



**Figure 4** A significant increase in percentage of articles containing meta-analyses ( $P < 0.0001$ ), reviews ( $P < 0.0001$ ), cohort studies ( $P = 0.0004$ ) and animal studies ( $P = 0.0086$ ) were seen. A significant decrease in percentage of articles containing cadaver studies ( $P < 0.0001$ ) and case reports ( $P < 0.0001$ ) was observed. Additionally, an increase in multi-institutional studies ( $P \leq 0.0001$ ) was seen without an increase in multi-disciplinary studies.

authors of all degree types supports this explanation (3).

Another possibility for the increase in author number would be an increase in multidisciplinary studies, with the increasing focus of institutions on interprofessional collaboration, but no significant increase in multidisciplinary collaboration was seen. With an increase accessibility of communication between institutions, a possible explanation for increase in number of authors is an increase in collaborative efforts between institutions. We found an increase seen in multi-institutional collaboration supporting this multi-institutional collaboration as a contributing factor to increases in author number.

The increase seen in industry authorship without an increase in industry funding suggests that companies have been seeking to have more control over what is published using their money and/or products. The current literature has shown correlations between industry funding and positive results when looking at randomized controlled trials within neurosurgery, but comparison of publication

rates between industry funded *vs.* not funded within the field of degenerative spinal conditions yields no correlation (7,8). To the authors knowledge, no literature exists looking at the relationship between industry authorship, study results, and publication bias; our findings show a need for further research on this topic, as bias is a pertinent issue in spinal literature.

The percentage of economics/value studies increased dramatically between the two ten-year time frames assessed (2004–2014 & 2007–2017). This was is not surprising in the face of current spine, and medicine in general, becoming more focused on cost efficiency with the rapidly changing face of healthcare. Aside from national news, the literature has shown increases in the utilization of business models for development and maintenance of health care organizations in general (9). Further research is needed in order to apply this generalization to the specialty of spine as the backing behind the observed increase in proportion of economic/value studies seen here.

Assessment of the pathological processes at the focus of each paper showed significant changes in the prevalence of deformity and trauma pathology. Prevalence of deformity focused papers increased significantly ( $P=0.0002$ ), while trauma papers decreased significantly ( $P<0.0001$ ). This further underscores the increased appreciation and understanding of deformity and its burden on healthcare; yet with an unknown value in its treatment at this point in time. Recent increases in the prevalence of these risk factors could explain the trend of increasing deformity research as this continues to become a costly health care problem (10,11).

In terms of the changes seen in the types of studies, these results correlate with the increasing availability of software and accessibility to large volumes of information. Within the field of lumbar spine, a study in 2006 reported an increase in articles containing studies with experimental design and a reciprocal decrease in descriptive papers between the years of 1978 to 2002 (12) Significant increases were seen in meta-analyses, yet no increase in randomized controlled trials pointing to the increase being a result of the papers methods and not the high level of evidence. There was also a significant decrease in cadaver studies; a contributing factor for this finding would be the availability of software able to produce biomechanical models (i.e., finite models) more practically and quickly than traditional biomechanical cadaver studies.

This study was not without limitations. We purposely focused our attention on a single spine specific journal in order to allow for more uniform comparisons across time points. While *Spine* is generally acknowledged as one of the leading subspecialty journals for spinal pathology treatment across this time period with highest average impact factor, there are other subspecialty journals whose publications were not included in this study warranting further investigation prior to potentially generalizing these findings to the subspecialty as a whole (13). Another limitation includes the limited time frame, as this study only encompassed publications in *Spine* for years 2004, 2007, 2014, and 2017. Further investigation is needed to determine if the trends seen here remain consistent with time.

In summary, the data supports that increase of author number with time is a result of increase in authors in all degree types, rather than an increase in one or several degree types, possibly due in part to the increase seen here in multi-institutional studies published in *Spine*. An increase in industry authorship without an increase in funding supports the notion that industry has more control over what is published using their money and/or products. The

increase seen in the proportion of economic/value-based studies suggests that spine as a sub-specialty is gaining an increased focus on cost efficiency consistent with the trend seen in medicine in general.

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## Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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