

HAVE RESIDENTS PRODUCED MORE RESEARCH SINCE THE INCEPTION OF THE 80-HOUR WORKWEEK?

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ABSTRACT

Background: This study hypothesizes that resident involvement in research has increased since institution of the maximum 80-hour workweek in 2002.

Methods: All 571 papers published in the *Journal of Bone and Joint Surgery (JBJS)* in 1997 and 2007 (five years before and after the start of the 80-hour workweek) were reviewed. To identify resident authors, a search was performed in the American Board of Orthopaedic Surgery (ABOS) database for any U.S. author with a medical doctorate (MD). Any authors who were board-certified more than two years after the publication date were identified as "residents." Two-tailed Fisher's exact tests were used to assess proportional changes over time.

Results: Between 1997 and 2007, the percentage of U.S. MD authors who were orthopaedic residents increased significantly from 12% to 18% ($p = 0.01$). U.S. publications with a resident first-author increased from 17% to 27% ($p = 0.02$), and contributions from foreign nations also increased significantly ($p < 0.001$). The number of total authors per paper increased ($p < 0.001$), but linear regression showed that this had no particular association with the proportion of residents ($p = 0.20$). The relative proportions of MD and non-MD authors did not change between years. The LOE of resident-authored papers improved significantly over time ($p = 0.005$), while that of international papers did not.

Conclusions: Proportional resident authorship has increased significantly in one of the highest-impact, peer-reviewed orthopaedic journals. LOE of resident-authored papers has improved, and basic science papers are more likely to have a resident first author.

Level of Evidence: III, retrospective cohort study

Key Words: residents; attendings; level of evidence; publications; orthopaedic; research

INTRODUCTION

With the reduction of resident work hours to 80 per week, the expectation is that additional time devoted to medical research has likely increased. In residency programs, many residents dedicate time and energy to research, and the goal of this paper was to determine if orthopaedic residents have been doing more of that lately. Nearly 75% of residents may prefer to do a separate academic activity than conduct research,¹ and evidence has already shown that orthopaedic authorship has increased dramatically in the last 50 years.² While the level of evidence has improved significantly,³ this creates a new ordering of resident responsibilities and inappropriately favors research over academic instruction and improvement. Authorship proliferation has become an increasingly problematic trend,⁴ but that does not change the expectations residents put on themselves and have put on them. In addition, the number of authors cited has been correlated positively with the number of times an article is referenced,⁵ so the trend toward increased authorship among residents has only been enhanced.

The focus of this paper is to determine the proportion of residents involved in clinical research published in one of the preeminent orthopaedic journals, the *Journal of Bone and Joint Surgery (JBJS)*. We have hypothesized that more articles have been authored by residents and international writers since the institution of the mandated 80-hour workweek in 2002.

MATERIALS AND METHODS

In 2016, the two lead authors (DML, TJL) reviewed all 571 papers published in *JBJS* in 1997 and 2007, which was five years before and after the start of the 80-hour workweek. The study design, level of evidence (LOE) (general standardized ranking of the quality of

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Table I. Comparison of publications between 1997 and 2007

	1997	2007	P-value
Publications	219	352	
International (% of publications)	46 (21%)	115 (33%)	0.003*
U.S.	173	237	
Authors	821	1621	
Authors per publication	3.8 ± 1.7	4.6 ± 2.0	< 0.001*
MD Authors^λ (% of all authors)	662 (81%)	1303 (80%)	0.91
International (% of MD)	191 (29%)	566 (43%)	< 0.001*
U.S.	471	737	
MDs not found in ABOS database (including other specialties) (% of U.S. MD)	112 (24%)	184 (25%)	0.68
Orthopaedic attendings (% of U.S. MD)	326 (69%)	481 (65%)	0.17
Orthopaedic residents (% of U.S. MD)	58 (12%)	132 (18%)	0.01*
Non-MD Authors^λ (% of all authors)	157 (19%)	326 (20%)	0.59
PhD, ScD, DVM, or DDS (% of non-MD)	75 (48%)	145 (45%)	0.50
Bachelor's degree (% of non-MD)	35 (22%)	82 (25%)	0.57

* = statistically significant

λ = authors with multiple degrees were only counted once. Any patient with an MD or equivalent was considered an MD author; in all other cases, the highest educational degree was selected.

Abbreviations: JBJS = Journal of Bone and Joint Surgery; U.S. = United States; MD = doctor of medicine; ABOS = American Board of Orthopaedic Surgery; PhD = doctor of philosophy; ScD = doctor of science; DVM = doctor of veterinary medicine; DDS = doctor of dental surgery

research), country of origin, number of authors, and authors' educational degrees were abstracted from each article. In order to identify resident authors, a search was performed in the American Board of Orthopaedic Surgery (ABOS) database for any United States (U.S.) author with a medical doctorate (MD). To account for the traditional lag of board certification, any authors who were board-certified more than two years after the publication date were identified as "residents." All other MD authors were considered "attendings" and verified in the ABOS database. Doctors of osteopathic medicine (DO) and international medical doctorates were recorded as MDs. Some international authors could not be deconstructed into orthopaedic attendings or residents, and, for this reason, they were excluded from our review. Standard chi-square tests were used to assess proportional changes over time.

RESULTS

The number of articles in JBJS increased significantly from 219 in 1997 to 352 in 2007 ($p < 0.001$) (Table 1), and the number of publications based internationally increased significantly from 46 (21%) to 115 (33%) ($p = 0.003$). The number of authors per article increased significantly from 3.8 ± 1.7 to 4.6 ± 2.0 ($p < 0.001$). The percentage of MD authors did not change significantly

from 81% to 80% ($p = 0.91$), but the number of international MD authors did increase significantly from 191 (29%) to 566 (43%) ($p < 0.001$). The relative number of MD authors not found in the ABOS database and that of orthopaedic attendings did not change over time from 112 (24%) to 184 (25%) ($p = 0.68$) and 326 (69%) to 481 (65%) ($p = 0.17$). In addition, the relative number of non-MD authors did not change significantly over time from 157 (19%) to 326 (20%) ($p = 0.59$). The relative number of orthopaedic residents, however, did increase significantly over time from 58 (12%) to 132 (18%) ($p = 0.01$).

While the percentage of residents involved in basic science studies did not change significantly over time (22% to 22%, $p = 1.0$) (Table 2), 30% of basic science studies in 2007 had a resident first author, which was significantly greater than 11% in 1997 ($p = 0.05$). The percentage of residents involved in non-basic science studies with LOE I or II increased significantly from 2.2% to 20% ($p = 0.005$).

This same trend was not observed for international publications, for the percentage of international publications of basic science did not change significantly from 6.5% to 5.2% ($p = 0.72$), and the percentage of international authors involved in non-basic science studies with LOE I or II did not change significantly from 21% to 28% ($p = 0.54$).

Table II. Time-dependent changes in study design and level of evidence (LOE) for resident-authored and international publications

	1997	2007	P-value
Resident authors	58	132	
Basic science (% of residents)	13 (22%)	29 (22%)	1.0
Not basic science	45	103	
LOE I or II (% of non-basic science)	1 (2.2%)	21 (20%)	0.005*
LOE III, IV, or V	44	82	
International publications	46	115	
Basic science (% of international)	3 (6.5%)	6 (5.2%)	0.72
Not basic science	43	109	
LOE I or II (% of non-basic science)	9 (21%)	30 (28%)	0.54
LOE III, IV, or V	34	79	
ALL publications	219	352	
Basic science (% of all)	39 (18%)	46 (13%)	0.15
Not basic science	180	306	
LOE I or II (% of non-basic science)	18 (10%)	67 (22%)	0.004*
LOE III, IV, or V	162	239	

* = statistically significant

Abbreviations: LOE = level of evidence

When reviewing all publications, the percentage of basic science studies did not change significantly between years from 18% to 13% ($p = 0.15$). Studies that were not basic science but involved LOE I or II did increase significantly from 10% to 22% ($p < 0.001$). The number of total authors per paper increased ($p < 0.001$), but linear regression showed that this had no particular association with the proportion of residents ($p = 0.20$). The relative proportions of MD and non-MD authors did not change between years.

The percentage of first authors with a bachelor of arts (BA) or science (BS) degree increased significantly from only two (0.91 per study) in 1997 to 13 (3.7) in 2007 ($p = 0.04$), while the number of bachelor degree authors in general did not change significantly from 35 (0.16) in 1997 to 82 (0.23) in 2007 ($p = 0.09$). Overall, the number of non-MD authors increased significantly from 157 (0.72) to 326 (0.93) ($p = 0.04$). The number of doctor of philosophy (PhD), doctor of science (ScD), doctor of veterinary medicine (DVM), and doctor of dental surgery (DDS) authors did not change significantly from 75 (0.34) to 145 (0.41) ($p = 0.15$) nor did the number of authors with exclusively a masters degree change from 36 (0.16) to 63 (0.18) ($p = 0.68$). The number of authors with a physical trainer (PT) or athletic trainer (ATC) degree did not change significantly from 8 (0.037) to 9 (0.026) ($p = 0.53$). Finally, the number of authors with a physician's assistant (PA), nursing (RN), or bachelor

of science in nursing (BSN) degree did not change significantly from 4 (0.018) to 17 (0.048) ($p = 0.06$).

The number of MD authors increased significantly from 662 (3.0) to 1303 (3.7) ($p < 0.001$). Those who were confirmed to not have an orthopaedic degree did not change significantly from 112 (0.64) to 184 (0.76) ($p = 0.26$), while those who were confirmed to have an orthopaedic degree increased significantly from 438 (2.5) to 698 (2.9) ($p = 0.02$). Orthopaedic authors greater than 2 years before their certification date also increased significantly from 58 (0.34) to 132 (0.55) ($p = 0.002$), while those after their certification date did not change significantly (326 [1.9] to 481 [2.0]) ($p = 0.52$). International authors with an MD degree increased significantly from 191 (0.88) to 566 (1.6) ($p < 0.001$).

With respect to the actual studies themselves, there were no significant changes in the number of basic science studies from 39 (0.18) to 46 (0.13) ($p = 0.12$), animal studies from 13 (0.06) to 21 (0.06) ($p = 0.99$), and cadaver studies from 20 (0.09) to 20 (0.06) ($p = 0.12$). The level of evidence did significantly improve between years from 4.1 ± 1.0 in 1997 to 3.7 ± 1.3 in 2007 ($p < 0.001$), and there were a significantly greater proportion of case reports in 1997 (44) than in 2007 (39) ($p = 0.003$). In addition, a significantly greater proportion of studies were international in 2007 (0.33, or 115) than in 1997 (0.21, or 46) ($p = 0.003$).

DISCUSSION

It is well known that institution of the 80-hour workweek has had a profound effect on resident quality of life, sleep, and fatigue.^{6,7} The effects it has had on education and patient safety has been debated since its inception.⁸ As a result, physicians who were trained during the pre-work-hour restriction period have long argued that training has been negatively impacted. They cite a lack of volume,⁹ poor continuity of care,¹⁰ and other factors related to less time spent in the hospital.

Recently, a study assessed the possible effects of changing the 80-hour workweek restrictions to more flexible ones.¹¹ This study randomized general surgery residents into two groups, one with the current restrictions and the other with less stringent restrictions. This study was instituted in an effort to assess the implications of a return to longer work periods with less "sign-out" events on patient outcomes. The study is currently ongoing, but there is clearly a significant cohort of academic physicians who are suspicious of the possible negative effects of the 80-hour workweek.¹¹ While this is a hotly debated topic, the goal of this paper is not to confirm or deny specific criticism of the 80-hour workweek but rather to describe a novel benefit of it via increasing academic pursuits in clinical and basic science research.

While the proportion of attending and non-MD authors did not change over time, there was a significant increase in the percentage of resident authors in articles published in one of the premiere orthopaedic journals. The relative number of orthopaedic resident authors increased significantly over time from 58 (12%) to 132 (18%) ($p = 0.01$). This confirmed the primary hypothesis of our study. In addition, the proportion of resident first authors increased significantly from 11% in 1997 to 30% in 2007. The number of total authors per paper also increased ($p < 0.001$), but linear regression showed that this had no particular association with the proportion of residents. This data clearly demonstrates a trend toward greater orthopaedic resident activity toward time-consuming, high-impact literature.

There are limitations related to the content of this study. Given its retrospective nature, our findings are inherently subject to confounding. While it is difficult to assess the temporal relationship of our findings with those of the institution of the 80-hour workweek, we attempted to minimize this bias by choosing to collect data from publication years that are similarly spaced before and after institution of the 80-hour workweek in 2003. Similarly, only one top-tier orthopedic journal was evaluated, which limits the conclusions to other high-quality publications. In addition, our data collection is subject to misclassification bias. To minimize this bias, the two lead authors took steps to define clearly the vari-

ous categories of authors and study type. Likewise, we utilized the American Academy of Orthopaedic Surgeons (AAOS) guidelines for levels of evidence when defining each individual study.

CONCLUSION

To our knowledge, this is the first study to show a significant association between institution of the 80-hour workweek and resident involvement in research endeavors. There has been significant debate regarding the effects that such work restrictions have had on surgical training. While causality cannot be assumed based on the data presented here, there is no question that residents are involved in more research today than previously. Moving forward, an improved focus on academic pursuits and cultivation of a new generation of academic leaders should be an important consideration.

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