

# THE ORTHOPAEDIC FORUM

## Update on Misrepresentation of Research Publications Among Orthopaedic Surgery Residency Applicants

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**Background:** Our 2 previous studies (1999, 2007) examining misrepresentation of research publications among orthopaedic residency applicants revealed rates of misrepresentation of 18.0% and 20.6%, respectively. As the residency selection process has become more competitive, the number of applicants who list publications has increased. The purpose of this study was to determine current rates of research misrepresentation by orthopaedic surgery applicants.

**Methods:** We reviewed the publication listings and research section of the Common Application Form from the Electronic Residency Application Service (ERAS) for all applicants applying to 1 orthopaedic residency program. The PubMed-MEDLINE database was principally used to search for citations. The PubMed Identifier (PMID) number was used; if no PMID number was listed, a combination of authors or the title of the work was used. If the citations were not found through PubMed, a previously developed algorithm was followed to determine misrepresentation. Misrepresentation was defined as (1) nonauthorship of a published article in which authorship was claimed, (2) claimed authorship of a nonexistent article, or (3) self-promotion to a higher authorship status within a published article.

**Results:** Five hundred and seventy-three applicants applied to our institution for residency in 2016 to 2017: 250 (43.6%) of 573 applicants did not list a publication, whereas 323 (56.4%) of 573 applicants listed  $\geq 1$  publication. We found 13 cases of misrepresentation among a total of 1,100 citations (1.18% in 2017 versus 18.0% in 1999 and 20.6% in 2007,  $p < 0.001$ ). Ten cases of misrepresentation were self-promotion to a higher authorship status. There were 2 cases of claimed authorship of an article that could not be found. Only 1 applicant misrepresented more than once.

**Conclusions:** Based on our findings, orthopaedic surgery residency applicants are accurately representing their publication information. The incorporation of the PMID number on the ERAS application has streamlined the process for finding publications, and has possibly encouraged veracity on residency applications. Faculty involved in the resident selection process should be aware of the significant decline in the rate of misrepresentation by medical students applying for orthopaedic surgery residency versus the rate in our prior studies.

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While the residency match rate has remained relatively stable in recent years among U.S. orthopaedic surgery residency applicants, there is an increasing level of academic accomplishment among medical students hoping to become orthopaedic surgeons. For example, from 2007 to 2014, the mean number of publications, presentations, and abstracts more than doubled for orthopaedic surgery residency applicants<sup>1</sup>. This has contributed to the competitive, high-stakes environment among medical students applying for orthopaedic surgery residency. Additionally, it has become increasingly difficult for faculty involved in the residency selection process to select applicants from such a qualified pool.

One metric that programs use to stratify applicants is their scholarly activity. Specifically, the number of publications that one has authored or contributed to is thought to show an understanding of the scientific process and the ability to see a project through to completion, as well as the potential to continue scholarly activity during residency. Unfortunately, misrepresentation of scholarly work has been documented not only in orthopaedic surgery but also among many subspecialties, and may be due to the competitive nature of matching in these fields<sup>2-8</sup>.

Our previously published studies (1999, 2007) examining misrepresentation of research publications among orthopaedic residency applicants revealed rates of misrepresentation of 18.0% and 20.6%, respectively<sup>9,10</sup>. The Electronic Residency Application Service (ERAS) underwent substantial changes in 2014 after the publication of our prior studies. As a result, the PubMed Identifier (PMID) number became a requirement for works listed in the peer-reviewed publication section<sup>4,11</sup>. We hypothesized that rates of misrepresentation among orthopaedic surgery residency applicants would be less than previously reported, possibly due to the added requirement of the PMID number on the ERAS for peer-reviewed publications and the relative ease of finding publications on the Internet.

The purpose of this study was to determine current rates of research misrepresentation by U.S. orthopaedic surgery applicants by examining the following: (1) non-authorship of a published article in which authorship was claimed, (2) claimed authorship of a nonexistent article, or (3) self-promotion to a higher authorship status within a published article. Additionally, we sought to determine if the presence of an additional advanced degree or foreign medical graduate (FMG) status was associated with the likelihood to misrepresent publications. We hypothesized that there would not be an increased likelihood to misrepresent publications in these cohorts.

### Materials and Methods

The publication listings and research section of the Common Application Form from the ERAS for all applicants applying to the 2016 to 2017 orthopaedic surgery application cycle at our program (a university-affiliated hospital with two 6-year research tracks) were reviewed. The 2007 study and the current study were both conducted at the same institution.

Publications were verified with identical methodologies as in prior studies, with the addition of the PMID number and use of an Internet search engine, if necessary<sup>9,10</sup>. Citations listed as book chapters, in press, accepted, or submitted were excluded. Additionally, non-peer-reviewed online publications and blog posts were excluded. The PubMed-MEDLINE database was principally used to search for citations, as in the prior studies<sup>9,10</sup>. The PMID number listed with the citation on the ERAS was used to identify the article. If no PMID number was listed, a combination of authors or the title of the work was used. If the citations were not found through PubMed, *Ulrich's Periodicals Directory* was consulted to determine if the listed journal existed. If the journal was not found in *Ulrich's Periodicals Directory*, it was excluded. If the journal was found in *Ulrich's Periodicals Directory*, the journal's web site was accessed to determine if the article was present. If there was difficulty finding the article through the journal's web site, an Internet search engine was used. When no match was found, the citation was deemed a misrepresentation. Misrepresentation was further defined as (1) nonauthorship of a published article in which authorship was claimed, (2) claimed authorship of a nonexistent article, or (3) self-promotion to a higher authorship status within a published article. Presence of an advanced degree was recorded for those applicants noted to have misrepresented citations, as well as whether or not the applicant was an FMG. Chi-square analysis was used to test the frequencies of misrepresentation in the current study compared with our 2 previously published studies. Chi-square analysis also was used to determine any differences in misrepresentation rates across FMGs, holders of an additional advanced degree, and all other applicants. Fisher exact tests were used to determine whether rates of misrepresentation were disproportionately higher among applicants from foreign medical schools versus domestic applicants, and between applicants with and without additional graduate degrees. We also included a Bonferroni correction for multiple comparisons, with a critical value of  $p < 0.025$ .

### Results

There were 573 applicants for residency in 2017 versus 213 in 1999 and 396 in 2007 (Fig. 1, top). We found that 250 (43.6%) of 573 applicants did not list a publication, whereas 323 (56.4%) of 573 applicants listed  $\geq 1$  publication. In total, these 323 applicants listed 1,100 publications that we reviewed and verified, versus 76 verified publications in 1999 and 131 verified publications in 2007 (Fig. 1, middle). Among the current 1,100 citations, we found 13 cases of misrepresentation (1.18% versus 18.0% in 1999 and 20.6% in 2007,  $p < 0.001$ ) (Fig. 1, bottom). Ten cases of misrepresentation were self-promotion to a higher authorship status. If these were removed in accordance with our prior studies, only 3 instances of misrepresentation among 1,100 verified publications were identified. In 1 case, the applicant claimed authorship of an existing article that did not include the applicant in the author list. There were 2 cases of claimed authorship of an article that could not be found despite the journal's verification in *Ulrich's Periodicals Directory*. Only 1 applicant misrepresented multiple citations (2 citations),

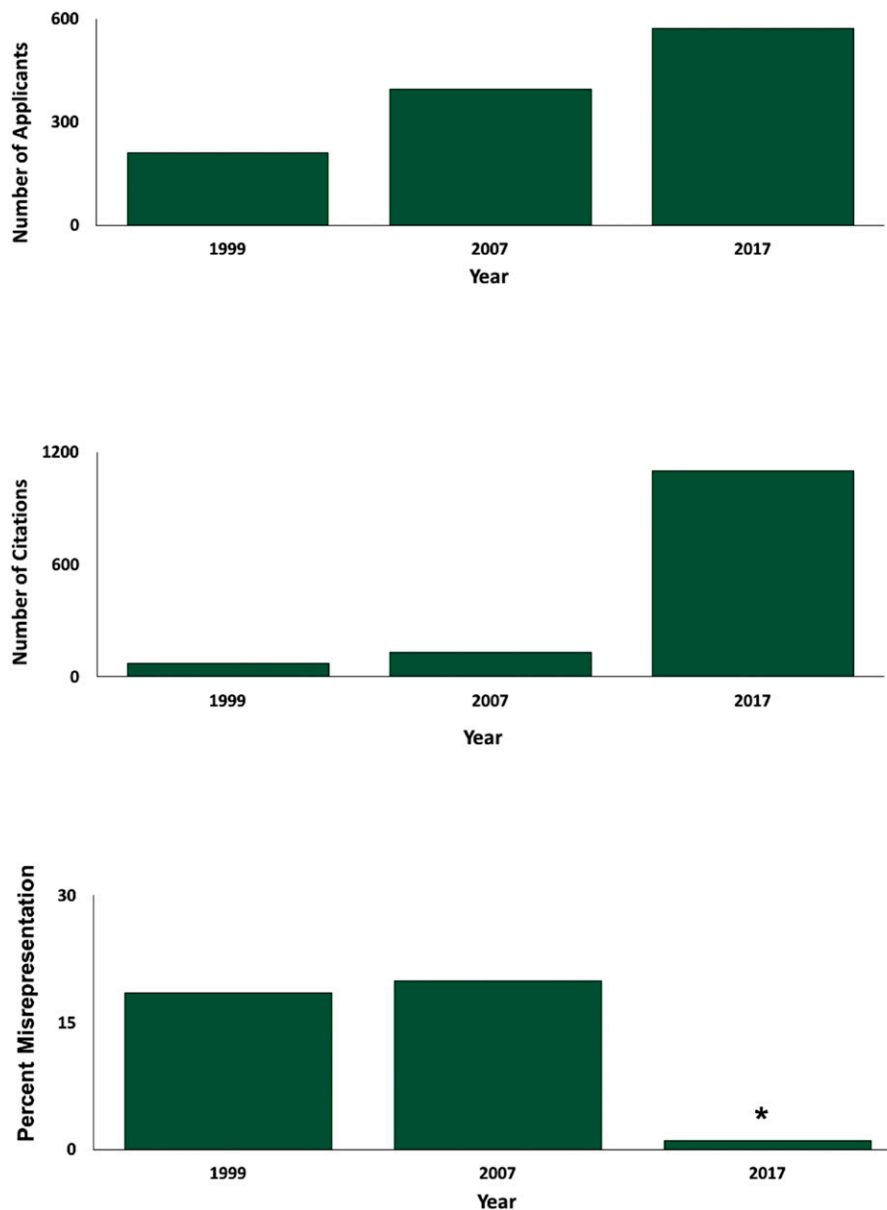


Fig. 1  
Bar graphs representing the number of applicants in 2017 versus 1999 and 2007 (top), the number of verified publications in 2017 versus 1999 and 2007 (middle), and the percentage of publication misrepresentation in 2017 versus 1999 and 2007 (bottom). \* $P < 0.001$ .

both of which were classified as self-promotion on the author list. A total of 12 (3.7%) of 323 applicants who listed published research on their ERAS application were found to have misrepresented their research contributions. Ultimately, 96.3% of applicants who cited research publications were found to have accurately represented their work. Moreover, 98.8% of research publications were found to have been honestly recorded.

Among the applicants found to have misrepresented their research publication, 5 of 12 were noted to be FMGs, and 6 of 12 were noted to have a graduate degree in addition to their medical degree. The overall sample included 47 (8.2%) FMGs, versus 526 (91.8%) domestic applicants. We examined

3 outcomes: publication rate, misrepresentation rate as a percentage of all applicants in each group, and misrepresentation rate as a percentage of only those applicants with a publication in each group. These outcomes were compared among FMGs, holders of an additional advanced degree, and the rest of the applicants ("other"). First, we ran chi-square tests to determine if there were any differences in outcome frequencies across all groups. The  $p$  value was not significant for the overall publication rate ( $p = 0.38$ ), but was significant for the misrepresentation rate among all applicants ( $p = 0.001$ ) and misrepresentation rate as a percentage of only those applicants with a publication in each group ( $p = 0.001$ ). Next, we ran a post hoc series of Fisher exact tests, comparing each of

the FMGs and graduate-degree holder groups independently to the “other” group. To determine significance, we included a Bonferroni correction for multiple comparisons, which meant that instead of  $p < 0.05$  being the threshold for significance, the critical value became  $p < 0.025$ . By normal significance standards, neither group differed from the “other” group for publication rate. However, FMGs had significantly higher rates of misrepresentation, calculated either way, compared with the “other” group ( $p = 0.03$  compared with misrepresentation rate of total applicants,  $p = 0.04$  compared with misrepresentation rate within applicants with publications). On the other hand, graduate-degree holders did not differ significantly from the “other” group for either the misrepresentation rate ( $p = 0.047$  compared with the misrepresentation rate of total applicants,  $p = 0.093$  compared with the misrepresentation rate within applicants with publications).

### Discussion

Misrepresentation of scholarly work among applicants has varied widely among medical specialties, with rates ranging from 1.8% to 45%<sup>2,6,8,12,19</sup>. Many authors have speculated on reasons that medical students may misrepresent their scholarly work. These reasons include honest mistakes, trouble understanding the application, academic dishonesty, the perception that embellishing a curriculum vitae (CV) is common, and a desire to appear more competitive<sup>2,6,8,12,15,20</sup>. It is difficult to differentiate between honest mistakes and academic dishonesty. Medical students often think, or are told, that they would be listed as 1 of the authors of an article, only to find out later that they had been removed. Moreover, the originally agreed-upon author list is sometimes changed just before publication without the student’s knowledge. Thus, what appears to be dishonesty may not be the fault of the applicant. However, at least some degree of academic dishonesty is present, and this is quite troubling for a profession that is grounded in ethical decision-making.

In 2013, Hsi et al. proposed that the ERAS system require a unique PMID number with each publication (this was optional at the time), as well as a hyperlink to the publication<sup>4</sup>. In this regard, confusion over the ERAS system would be minimized and publication misrepresentation would be discouraged. Grimm and Maxfield made another proposal in 2014: they suggested better ways to delineate published from nonpublished works, as well as peer-reviewed from non-peer-reviewed work. Additionally, they advocated for published manuscripts to be directly imported from PubMed and listed separately<sup>21</sup>. ERAS responded, and the publication section underwent many changes, including a required PMID number for works listed in the published peer-reviewed section<sup>11</sup>. Our prior studies (1999, 2007) were performed before these changes to the ERAS<sup>9,10</sup>. We hypothesized a decline in misrepresentation among orthopaedic surgery residency applicants, possibly due to the ERAS changes and the requirement of the PMID number for peer-reviewed publications, as well as the ease of searching citations on the Internet.

We evaluated 573 of 1,013 total applicants in 2017 (56.6% of the applicant pool)<sup>22</sup>. We found 1,100 verified citations in the current study versus 76 verified citations in 1999 and 131 verified citations in 2007 (Fig. 1, middle). This is consistent with recent National Resident Matching Program data showing a more than twofold increase in the number of research publications, presentations, and abstracts from 2007 to 2014<sup>1</sup>. Over 56% of applicants to our institution listed  $\geq 1$  publication. These data show that the orthopaedic surgery applicant pool has become more competitive with respect to scholarly activity compared with our prior studies.

The misrepresentation rate in the current study was 1.18% of publications, which was significantly lower than our prior studies’ findings of an 18.0% rate in 1999 and a 20.6% rate in 2007 (Fig. 1, bottom,  $p < 0.001$ ). We attribute the significant drop in misrepresentation to the use of the required PMID number and the ease of finding citations with an Internet search engine, which were the only additions to our search methodology. Our misrepresentation rate of 1.18% in publications by orthopaedic surgery applicants was similar to but slightly lower than the 1.8% found by Hebert et al. among internal medicine applicants and the 1.9% found by Wiggins among ophthalmology applicants<sup>12,13</sup>. Both of those studies applied stringent search criteria to identify misrepresentation and had rates similar to ours. Our prior studies may have overestimated misrepresentation due to an inability to locate articles. Indeed, some studies have suggested that rates of misrepresentation have been overestimated due to variability in search criteria<sup>3-5,12,13,15</sup>. Moreover, the updated ERAS has likely discouraged misrepresentation from applicants and contributed to our significant finding.

The most common type of misrepresentation in our study (10 cases, 77% of all cases of misrepresentation) was self-promotion to a higher authorship status. This categorization of misrepresentation was not included and available for comparison in our prior studies, and was added to the current study after our literature review determined that it was a common mode of misrepresentation, with rates ranging from 1% to 50%<sup>2-4,12,15,16,18,20</sup>. Our results fall outside of the upper limit of rates reported by other authors. This may be the result of the ERAS updates and subsequent changes in applicant behavior. We found 1 (7.7%) case where the applicant claimed authorship of an existing article that did not include the applicant in the author list, and there were 2 (15.4%) cases of claimed authorship of an article that could not be found. In our 2007 study, there were 12 (44%) citations claiming authorship of an existing article that did not include the applicant, and 15 (56%) citations claiming authorship of an article that could not be found<sup>9</sup>. Based on our results, when orthopaedic applicants are misrepresenting their work, it is now most likely to be self-promotion to a higher authorship status.

Among the applicants found to have misrepresented their research publications, 5 of 12 were noted to be FMGs. Additionally, 6 of 12 were noted to have an additional graduate degree. Our hypothesis was partially confirmed because the presence of an additional advanced degree was not associated

with a higher likelihood to misrepresent citations; however, FMG status was associated with a higher likelihood to misrepresent citations. These data were not recorded in our prior studies, but a comparison with current literature shows that our results are in agreement with those of Sater et al., who found that additional academic degrees did not relate to likelihood to misrepresent<sup>20</sup>. This was not surprising because those with additional advanced degrees have more training and the possibility of formal education in research and publication ethics. Other studies found that being an FMG was associated with misrepresentation, in line with our results<sup>4,12</sup>. FMGs may be more likely to misrepresent due to cultural differences, misunderstanding of the application process, or the increased difficulty of obtaining a residency position when applying as an FMG. These statistics may fluctuate with each application cycle, and it may be difficult to draw definitive conclusions. However, based on our results and those of others, applicants with citations who are FMGs may require more scrutiny during the application process to verify publications.

Our results apply to the publication section of the ERAS where a PMID number is now required. Other research activity should not be ignored in the absence of a PMID number. However, articles that are in press, submitted, or accepted, as well as book chapters and articles from obscure journals, should be interpreted with caution. We recommend that all in-press articles be accompanied by a verification letter from the journal that includes the full title and authorship. This may limit the misrepresentation of in-press articles.

There were several limitations to the current study. First, our study is limited by its retrospective nature. All applicants to a single institution during the 2016 to 2017 application cycle were evaluated, and the results are not representative of the entire applicant pool. Our program has two 6-year research tracks available, and this may skew the cohort toward more research-oriented applicants. Additionally, although we employed strict search criteria, it is possible that a published article was unable to be located and thus was classified incorrectly as misrepresented. However, there were only 2 cases of claimed authorship of an article that could not be found, which would be unlikely to have a meaningful impact on our results. It is possible that some citations classified as misrepresentation in our study were honestly recorded by applicants and the applicants' names were subsequently removed, or the author list was reordered without their knowledge. Additionally, because of our exclusion criteria, our results are only applicable

to those citations in the publication section and not to overall research activity. Finally, it is possible that enhanced Internet search capability contributed to the drop in misrepresentation rate. Our prior studies may have overestimated misrepresentation, and, therefore, the decline in the misrepresentation rate should be interpreted with caution.

We found that 96.3% of applicants who cited research publications had accurately represented their work. Moreover, 98.8% of research publications were found to have been honestly recorded. When misrepresentation did occur, it was most likely to be self-promotion to a higher authorship status. If misrepresentation is discovered, faculty should be aware that honest mistakes do occur, and medical students should attempt to verify all publications listed on their ERAS application prior to submission. The incorporation of the PMID number on the ERAS application has streamlined the process for finding publications. This possibly has discouraged misrepresentation on residency applications. Thus, based on our findings, current orthopaedic surgery residency applicants are, by and large, accurately representing their publication information. ■

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