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GENDER TRENDS IN RADIATION ONCOLOGY IN THE UNITED STATES: A 30 YEAR ANALYSIS

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Abstract

Purpose/Objective—Although considerable research exists regarding the role of women in the medical profession in the United States, little work has described the participation of women in academic radiation oncology. We examined women's participation in authorship of radiation oncology literature, a visible and influential activity that merits specific attention.

Methods and Materials—We examined the gender of first and senior U.S. physician-authors of articles published in the Red Journal in 1980, 1990, 2000, 2004, 2010 and 2012. The significance of trends over time was evaluated using logistic regression. Results were compared to female representation in journals of general medicine and other major medical specialties. Findings were also placed in the context of trends in the representation of women among radiation oncology faculty and residents over the last three decades, using AAMC data.

Results—The proportion of women among Red Journal first authors increased from 13.4% in 1980 to 29.7% in 2012, and the proportion among senior authors increased from 3.2% to 22.6%. The proportion of women among radiation oncology full-time faculty increased from 11% to 26.7% from 1980 to 2012. The proportion of women among radiation oncology residents increased from 27.1% to 33.3% from 1980 to 2010.

Conclusion—Female first and senior authorship in the Red Journal has increased significantly, as has women's participation among full-time faculty, but women remain under-represented among radiation oncology residents as compared to their representation in the medical student

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CONFLICT OF INTEREST STATEMENT

The authors have no potential conflicts to declare.

body. Understanding such trends is necessary to develop appropriately targeted interventions to improve gender equity in radiation oncology.

Keywords

gender; radiation oncology; publications; career development; medical profession; medical education

INTRODUCTION

In the last 3 decades the US physician workforce has seen a rapid influx of women [1]. As of May 2012, women comprised 47% of medical school applicants, 46.2% of residents and 37% of full-time faculty [2]. The increasing number of female medical students entering the pipeline is rapidly increasing the number of women in medicine as a whole compared to 20 to 30 years ago [1]. However, the distribution of women across medical fields and specialties is not equal. In fields such as obstetrics and gynecology, pediatrics and primary care, women comprised more than half of full-time faculty in 2012, while they were substantially underrepresented in surgical disciplines [2].

The representation of women in senior leadership positions in radiation oncology has been a source of concern in recent years [3]. However, little is known about the pipeline of women in the field, or about their participation in the highly visible and influential role of authoring original research [4]. Conducting basic science and clinical research is an important aspect of academic medicine in general. There may be particular importance of scholarly activity in radiation oncology, an increasingly competitive discipline, where the proportion of matching applicants with a PhD is the highest for any specialty of medicine [5]. Publishing one's research findings is an integral part of scholarly research. The nature, quantity and quality of research activity are increasingly used in decisions regarding hiring and may influence the composition of the faculty who serve as role models and teachers for the large numbers of female medical students considering the field, as well as the residents already training in it. Thus, we believe that patterns of authorship by gender merit attention, not only because authorship is visible and influential but also because it is linked to career outcomes.

The proportion of female physician-authors of original research in major US medical journals has increased during the past 35 years. A study evaluating authorship in six major medical journals showed female first authors increased from 5.9% in 1970 to 29.3% in 2004. The increase in female representation was not evenly distributed among specialty journals, however, with the sharpest increases seen in obstetrics and gynecology and pediatrics journals and smaller increases seen in surgical journals [6].

This inspired interest in documenting women's participation in other regions and specialties. A study of first and senior authors in six major British journals showed female first authorship increased from 10.5% in 1970 to 36.5% in 2004 but female senior authorship only from 12.3% to 16.5% [7]. An observational study of 6 dermatology journals looking at the period from 1976 until 2006, showed female authorship increased from 12% to 48% in first authorship and 6.2% to 31% in senior authorship [8]. In 5 family medicine journals, women made up 33.5% of first authors between 2006 and 2008 [9]. Orthopedics has one of the lowest proportions of female faculty and residents. Between 1970 and 2007, women first authors increased from 0.8% to 6.5%, women senior authors increased from 0 to 4.3% [10].

To our knowledge, a gender analysis of authorship has not yet been done in the field of radiation oncology. This study examines gender trends in authorship in the field of radiation

oncology in comparison to other fields, as well as in the context of trends in the gender composition of the medical student body, radiation oncology residents, and full-time faculty.

METHODS

Data Collection

This study examined articles from the International Journal of Radiation Oncology Biology Physics, the journal of the American Society of Radiation Oncology, colloquially known as “the Red Journal.” The journal covers areas of interest relating to cancer treatment and radiation therapy. We chose to focus on the Red Journal because of its specificity to radiation oncology, its relatively high impact factor, its popularity within the field, and because it is the major journal of the American Society for Radiation Oncology (ASTRO). We examined all original articles published in 1980, 1990, 2000, 2004, 2010, and 2012. We selected these years as representative points in time and to allow comparison to studies completed in other fields [6]. For each of these articles, we determined the type of article, both the first and senior (last) authors' gender, graduate degrees, and institutional affiliation. An author's gender was determined by initial inspection of his or her first name. For cases in which an author's gender was not certain, attempts were made to discern it by visiting the institutional web site and performing internet searches with the use of the Google search engine.

In addition to the Red Journal, six prominent medical journals published in the United States were included for comparison in this study: the *New England Journal of Medicine (NEJM)*, the *Journal of the American Medical Association (JAMA)*, the *Annals of Internal Medicine (Ann Intern Med)*, the *Annals of Surgery (Ann Surg)*, *Obstetrics & Gynecology (Obstet Gynecol)*, and the *Journal of Pediatrics (J Pediatr)*.

Statistical Analysis

Our analysis was restricted to investigators from U.S. institutions with an M.D. degree; those whose gender could not be determined (2%) were omitted from the analytic sample. The tabulated data were stored in a Microsoft Access database and analyzed with the use of R statistical software (R Foundation for Statistical Computing, Vienna, Austria) to determine the gender distributions of the first and senior (last listed) authors of original articles for each journal.

We used logistic regressions for grouped author data to examine time trends in the proportion of female authors. For all journals, the change in female authorship was examined over time from 1980 to 2004 with the year 1980 used as the reference point for comparison. For the Red Journal the years 2010 and 2012 were also examined to coincide with full-time faculty data. Additionally, interactions between individual journals with various years are examined using the journals with the greatest increase and least increase in female authorship over time as references for comparison. For first authorship, the journals used for comparison were *Obstet Gynecol*, and *NEJM*, and for senior authorship, the journals used for comparison were *J Pediatr*, and *Ann Surg*.

RESULTS

Statistically significant trends of increased female representation are shown for each of the seven journals during a 24-year period (Table 1). The proportions of first and senior authors who were women increased most sharply in *Obstet Gynecol* and *J Pediatr*, respectively, and remained low in *Ann Surg* and the *NEJM*.

Table 2 shows pairwise comparisons between each journal and the journals with the greatest and smallest increase in female authorship for first and senior authors. Table 2A shows that trends in female first authorship in *NEJM*, the Red Journal, and *J Pediatr* were significant, but the increase was significantly less than the increase observed in *Obstet Gynecol*, which is the journal that experienced the greatest increase. Table 2B shows comparisons to the journal experiencing the smallest increase in female first authorship, *NEJM*. In those comparisons, the journals with significantly greater increases in female first authorship were *Obstet Gynecol*, *JAMA*, *Ann Intern Med*, and *Ann Surg*. Increases in *J Pediatr* and the Red Journal did not significantly differ from that of *NEJM*. Tables 2C and 2D show that all journals examined had similar increases in female senior authorship, with no statistically significant differences in pairwise comparisons when using the journals with the greatest and smallest increases as references for comparison (*J Pediatr* and *Ann Surg*, respectively).

Figure 1 shows the percentage of women among radiation oncology full-time faculty over the last three decades [11] along with the percentage of women among radiation oncology residents [12–16] and among medical school graduates for that same time period [17]. The percent of women among radiation oncology full-time faculty has increased from 11% in 1980 to 26.7% in 2012, while the percentage of women among radiation oncology residents has increased from 27.1% in 1980 to 33.3% in 2010. For medical school graduates, the percentage of women has nearly doubled from 24.9% in 1980 to 48.3% in 2010.

Figure 2 shows the percentage of female radiation oncology full-time faculty over the last 32 years (1980–2012) [1], this time alongside the percentage of female first authors and female senior authors in the Red Journal for that same time period. The proportion of women among first authors from US institutions for papers published in the Red Journal increased from 13.4% in 1980 to 29.7% in 2012, and the proportion among senior authors increased from 3.2% to 22.6%. The average percentage of female first authors and female senior authors in all the journals examined in this study are included for comparison for the period 1980–2004.

DISCUSSION

In this study, we analyzed data that together demonstrate that women are still not represented among academic radiation oncology faculty ranks in proportion to their presence in the medical community at large [18], but many of the time trends observed are encouraging. Women's representation among authors and faculty demonstrates heartening evidence of increases over time, but the proportion of women among residents remains well below the proportion of women graduating from medical school.

These findings complement those from other recent studies seeking to evaluate the presence of women among radiation oncologists [19]. For example, a study of publication productivity among academic radiation oncologists in 2007 reported 33%, 26%, 23% and 17% of instructor, assistant professor, associate professor and full professor/chairperson positions, respectively, occupied by women [20]. This study also reported a gender disparity in the number of publications, number of citations and h-index among radiation oncology faculty. However, this study also showed that among men and women in the same academic rank, the differences in h-index disappeared, suggesting that women achieving senior faculty status are as academically productive as men in the same position. Our findings support this idea, including the observation that the proportion of women among radiation oncology full-time faculty appears very similar to that of women among Red Journal first authors, as well as the relative similarity in slope over time of the participation of women as Red Journal senior authors and as full-time faculty members.

A more recent study of radiation oncology residency program directors and chairpersons reported that women comprise 24% of radiation oncology residency program directors and 9% of chairpersons indicating that although women are involved in training the next generation of radiation oncologists, they do not comprise a high percentage of leadership at the departmental level [18]. In 2011, women comprised 32% of radiation oncology residents, a percentage that remained stagnant from 2001 [17], but women made up nearly half of the total medical graduates in 2010. This raises the question: why has female representation among residents entering radiation oncology appeared to plateau while women enter the medical field as a whole in greater and greater numbers? The availability of senior female faculty to mentor or serve as role models to interested young medical students may be a contributing factor. One survey of medical students noted female students were significantly more likely to choose surgery if they came from a school with more female faculty [21]. A cycle may exist, whereby women fail to select the specialty of radiation oncology in part due to a dearth of female role models in visible positions such as academic authorship. This may in turn perpetuate less participation by women in these visible positions and slower increases in these roles being filled by women because female medical students are choosing other disciplines.

In this study, while there was a significant increasing trend in the proportion of female first and senior authors in all of the journals analyzed, for the Red Journal the increase was similar to those observed in the journals with the smallest increases. The increase in women among first authors in the Red Journal was not statistically different than the increase observed in the journals with the slowest increases and was significantly lower than the increases observed in the journals with the greatest increases, suggesting that radiation oncology is yet not a leader in this respect. In terms of senior authorship, there was no difference among the distribution of increases in female authorship in any of the journals despite the significant increasing trend in each journal; this is likely a result of the increase in the number of women entering the field of medicine, and does not appear to differ substantially by discipline.

A number of studies have proposed that unblinded review introduces bias, including gender bias [22–24]. The policy of “double blind peer review” wherein journal reviewers of a manuscript do not know the identity of the author(s), and the author(s) do not know the identity of the reviewer was implemented for the Red Journal beginning in October 2011. Although double-blind review is common in fields other than medicine, only a few academic medical journals have a double-blind peer review process. While the only data available after the policy change is from 2012, the results suggest that the policy may have resulted in increasing percentages of first and senior female authors (figure 2). More data will be needed to draw conclusions as to the statistical significance of such increases and whether they are causally related to the new blinding policy or to concurrent changes in other policies or secular trends.

We present a unique analysis comparing publication rates based on gender in journals from different fields. This study presents full-time radiation oncology faculty and resident gender data, and it is the first to present it over such a time period and in the context of shifting trends in authorship in a major radiation oncology journal. One limitation of the present study is, given the observational nature of our data, causal inferences cannot be drawn. Due to resource constraints, we could not collect data for all years nor could we consider middle author positions, but we feel sufficient data were collected in each year to limit outlier effects due to sampling error. Finally, our study was restricted to the Red Journal, and while it is one of the premier journals of radiation oncology, there are other journals that were not examined.

In conclusion, considerable evidence suggests that women may have novel leadership and differences in communication styles, research and practice priorities than their male counterparts [25–27]. It is therefore critically important that women's participation in our specialty be robust at every level. Only by examining trends like those documented in the current study can we begin to develop appropriately targeted interventions to improve gender equity in this unique and important field.

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SUMMARY

This study analyzes women's participation as authors in the Red Journal, in the context of trends in the radiation oncology workforce and trends at journals in other medical specialties. Female first and senior authorship in the Red Journal has increased significantly, as has women's participation among full-time faculty, but women remain under-represented among radiation oncology residents. Understanding such trends is necessary to develop appropriately targeted interventions to improve gender equity in radiation oncology.

Figure 1.

Shows the percentage of female radiation oncology full-time faculty over the last 32 years (1980–2012) [11], along with the percentage of female radiation oncology residents and female medical school graduates over the last 30 years (1980–2010) [12–17].

Figure 2.

Shows the percentage of female radiation oncology full-time faculty over the last 32 years (1980–2004) [1], along with the average percentage of female first authors and female senior authors in all the journals examined, along with the percentage of female first authors and female senior authors in the Red Journal.

Table 1

Female physician-investigators among first and senior authors of published original research in the *International Journal of Radiation Oncology Biology Physics* and six US journals (Restricted to authors from U.S. institutions holding an M.D. degree or equivalent for whom sex could be determined) [6].

	1980	1990	2000	2004	2010	2012
<i>IJROBP</i>						
First Author *	13/97 (13.4%)	30/158 (19.0%)	46/190 (24.2%)	39/178 (21.9%)	47/188 (25.0%)	90/303 (29.7%)
Senior *	3/95 (3.2%)	8/147 (5.4%)	24/183 (13.1%)	27/191 (14.1%)	34/203 (16.7%)	77/340 (22.6%)
<i>NEJM</i>						
First Author *	14/117 (12.0%)	23/143 (16.1%)	23/110 (20.9%)	13/92 (14.1%)		
Senior *	3/108 (2.8%)	11/122 (9.0%)	13/106 (12.3%)	11/97 (11.3%)		
<i>JAMA</i>						
First author *	7/151 (4.6%)	25/125 (20.0%)	26/121 (21.5%)	30/113 (26.5%)		
Senior *	3/128 (2.3%)	13/102 (12.7%)	19/115 (16.5%)	16/118 (13.6%)		
<i>Ann Intern Med</i>						
First author *	8/126 (6.3%)	13/106 (12.3%)	15/44 (34.1%)	17/54 (31.5%)		
Senior *	4/115 (3.5%)	4/92 (4.3%)	11/43 (25.6%)	7/52 (13.5%)		
<i>Ann Surg</i>						
First author *	7/168 (4.2%)	7/135 (5.2%)	13/110 (11.8%)	15/90 (16.7%)		
Senior *	1/149 (0.7%)	1/117 (0.9%)	2/101 (2.0%)	6/89 (6.7%)		
<i>Obstet Gynecol</i>						
First author *	13/161 (8.1%)	45/227 (19.8%)	62/164 (37.8%)	61/150 (40.7%)		
Senior *	6/116 (5.2%)	29/185 (15.7%)	41/140 (29.3%)	37/132 (28.0%)		
<i>J Pediatr</i>						
First author *	18/87 (20.7%)	24/78 (30.8%)	30/65 (46.2%)	42/108 (38.9%)		
Senior *	8/76 (10.5%)	11/63 (17.5%)	20/73 (27.4%)	35/92 (38.0%)		
<i>Total</i>						
First author *	80/907 (8.8%)	167/972 (17.2%)	215/804 (26.7%)	217/785 (27.6%)		
Senior *	28/787 (3.5%)	77/828 (9.3%)	130/761 (17.1%)	139/771 (18.0%)		

* denotes significant trends of increased female authorship.

Table 2

Significant trends of increased female representation were evident for each of the seven journals during the 24-year period. Pairwise comparisons were made between each journal and the journal experiencing the greatest increase in female authorship and the smallest increase in female authorship for both first and senior authorship. Trends were compared for statistically significant differences.

2A. *Obstet Gynecol* showed the greatest increase in female first authorship and was used as a reference.

2B. The *NEJM* showed the smallest increase in female first authorship and was used as a reference.

2C. The *J Pediatr* showed the greatest increase in female senior authorship and was used as a reference. No significant differences were observed among the increases in each journal relative to the increase in *J Pediatr*.

2D. The *Ann Surg* showed the smallest increase in female senior authorship and was used as a reference. No significant differences were observed among the increases in each journal relative to the increase in *Ann Surg*.

2A. Changes in gender of first authorship over time with <i>Obstet Gynecol</i> as reference for comparison	
Journal	p-value
<i>NEJM</i>	<0.01 *
<i>JAMA</i>	0.29
<i>Ann Intern Med</i>	0.87
<i>Ann Surg</i>	0.45
<i>J Pediatr</i>	<0.01 *
<i>IJROBP</i>	<0.01 *

2B. Changes in gender of first authorship over time with <i>NEJM</i> as reference for comparison	
Journal	p-value
<i>Obstet Gynecol</i>	<0.01 *
<i>JAMA</i>	<0.01 *
<i>Ann Intern Med</i>	<0.01 *
<i>Ann Surg</i>	<0.01 *
<i>J Pediatr</i>	0.20
<i>IJROBP</i>	0.53

2C. Changes in gender of senior authorship over time with <i>J Pediatr</i> as reference for comparison	
Journal	p-value
<i>NEJM</i>	0.53
<i>JAMA</i>	0.71
<i>Ann Intern Med</i>	0.58
<i>Ann Surg</i>	0.40
<i>Obstet Gynecol</i>	0.77
<i>IJROBP</i>	0.87

2D. Changes in gender of senior authorship over time with <i>Ann Surg</i> as reference for comparison	
Journal	p-value
<i>Obstet Gynecol</i>	0.47
<i>JAMA</i>	0.31
<i>Ann Intern Med</i>	0.62

2D. Changes in gender of senior authorship over time with *Ann Surg* as reference for comparison

Journal	p-value
<i>NEJM</i>	0.26
<i>J Pediatr</i>	0.40
<i>IJROBP</i>	0.35

* denotes journals for which the increase in female first authorship is significantly less than the increase observed in *Obstet Gynecol*.

* denotes journals for which the increase in female first authorship is significantly greater than the increase observed in the *NEJM*.