

Original Articles

Trends in female representation in published ophthalmology literature, 2000–2009

Deepika N. Shah, MD, MPH,^{ab} Jiayan Huang, MS,^c Gui-shuang Ying, PhD,^c Ricardo Pietrobon, MD, PhD, MBA,^d and Joan M. O'Brien, MD^a

Author affiliations: ^aScheie Eye Institute, Department of Ophthalmology, University of Pennsylvania, Philadelphia, Pennsylvania;

^bDepartment of Ophthalmology, Massachusetts Eye and Ear Infirmary, Harvard Medical School, Boston, Massachusetts;

^cCenter for Epidemiology and Biostatistics, Department of Ophthalmology, University of Pennsylvania, Philadelphia Pennsylvania;

^dResearch on Research, Department of Surgery, Duke University Medical Center, Durham, North Carolina

Abstract

Purpose—To examine trends in female first and last authors in clinical ophthalmology literature published from January 2000 to December 2009.

Methods—A total of 3760 articles in *American Journal of Ophthalmology* (AJO), 2347 articles in *Archives of Ophthalmology* (Archives), and 3838 articles in *Ophthalmology* spanning 10 years of published ophthalmology peer-reviewed literature were examined. All original research articles and brief reports indexed online were included. Author gender was determined by an exhaustive Internet search. Articles were excluded if the sex of the author could not be determined or was not applicable (for example, articles by a study group rather than an individual author).

Results—Gender information was identified in 86.8% of articles for first authors and 86% for last authors. The number of female first authors ($P < 0.0001$) and last authors ($P = 0.005$) increased significantly in the study period in all journals examined, with a significant association between the sex of the first and last authors (OR = 2.19; 95% CI, 1.96–2.46; $P < 0.0001$), when examining all articles. Female representation increased for last authors significantly only in *Ophthalmology*. There was a significant correlation between gender of the first author and total number of authors that was not observed with last-author sex.

Conclusions—Female first authorship has increased from 2000 to 2009 and is correlated with the gender of the last author; however, there were fewer female last authors compared to female first authors in the same period.

Introduction

From the Association of American Medical Colleges (AAMC)'s most recent data, it appears that women are entering and graduating from medical school in rates that are almost equal to men (48.3% of total graduates in 2010).¹ The same trend was not observed in the percent-

age of women holding tenure track positions, where numbers of male faculty significantly outnumbered female faculty.¹ This gender gap is even more apparent when examining women in leadership positions.¹ The AAMC data does show an increasing percentage of

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Correspondence: Deepika Nemani Shah, MD, MPH, Massachusetts Eye and Ear Infirmary, 243 Charles Street, Boston, MA 02114 (email: Deepika_Shah@meei.harvard.edu).

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female medical students entering ophthalmology as well as an increase in the percentage of female ophthalmology residents over the years.¹ However, in spite of an increase in the proportion of graduating female ophthalmology residents over the last decade, the representation of female ophthalmologists in academic medicine lags far behind that of male colleagues.¹

Publication records and scientific productivity continue to be important criteria for career advancement, and previous studies have examined gender trends in various fields. In a single large retrospective analysis of gender in six medical journals, including the *New England Journal of Medicine*, the *Journal of the American Medical Association*, the *Annals of Internal Medicine*, the *Annals of Surgery*, *Obstetrics & Gynecology*, and the *Journal of Pediatrics*, Jagsi et al² analyzed gender data for the first and last listed author for five selected years from 1970 to 2004 and concluded that female authorship of original research had progressed measurably.² A similar study published in 2007 concluded that female representation in emergency medicine literature had increased significantly over the past two decades.³ Similar research in surgical fields is much more limited. The purpose of the present study was to quantify authorship trends in the major clinical ophthalmology journals over ten years with respect to female representation in the roles of first or last author.

Methods

An extensive search of the English-language current ophthalmology journals was undertaken. Clinically oriented journals were analyzed based on impact factor and overall prestige. Three journals were selected: *American Journal of Ophthalmology (AJO)*, *Archives of Ophthalmology (Archives)*, and *Ophthalmology*. All published research articles and brief reports from January 2000 to December 2009 were included in a hand search and full-text review. All issues from each year were included.

Gender was classified initially on the basis of author name. In cases of gender-neutral names and authors who identified themselves only with initials, we attempted to ascertain the author's sex by other means, primarily exhaustive Internet search using standard search engines, often linked with the home institution and/or corresponding address published in the article. Biographies, resumes, and/or author images on institutional home pages were examined as necessary. Any articles for which author sex for either the first or last author could not be determined were excluded. All information was entered in a spreadsheet with names of the first and

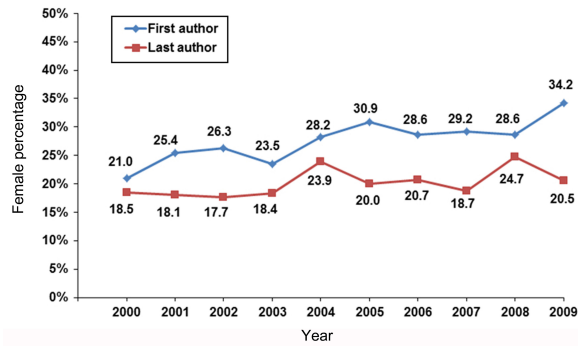


Figure 1. Trends showing percentage of female authorship among first and last authors in the *American Journal of Ophthalmology*, *Archives of Ophthalmology*, and *Ophthalmology*.

last author, article name and type, as well as a link to the article. If a research group was named as the author or only one author was listed, then the publication was excluded from the analysis, since correlation between the first and last author could not be performed.

The proportion of female first authors and last authors over a 10-year period in each of three major ophthalmology journals and all three journals combined was calculated. A linear trend test was used to determine whether the proportion of female first author and last author increased with time. A logistic regression analysis was used to examine the data for associations between the sex of the first and last author. A comparison of the total number of authors between female versus male first author and between female versus male last author was performed. All statistical comparisons were made in SAS V9.2 (SAS Institute Inc, Cary, NC).

Results

We examined a total of 3760 publications in *AJO*, 2347 in *Archives*, and 3838 in *Ophthalmology* published during the study period. Author sex was confirmed for the first author in 8717 articles (86.8%) and for the last author in 8554 (86%) articles.

Figure 1 shows the percentage of female first authors and female last authors over 10 years for articles published in *AJO*, *Archives*, and *Ophthalmology*. When all three journals were considered together, there was a significant increasing trend in the percentage of female first author (from 21.0% in 2000 to 34.2% in 2009, trend $P < 0.0001$) and last author (from 18.5% in 2000 to 20.5% in 2009, trend $P = 0.005$). When each journal was considered separately, the rise in female first authorship remained significant ($P < 0.05$) for all journals; how-

Table 1.

The gender association between first and last author

Journal	First author	Last author		OR (95% CI)	P value
		Female	Male		
<i>American Journal of Ophthalmology</i>	Female	187	525	1.72 (1.40-2.11)	<0.0001
	Male	330	590		
<i>Archives of Ophthalmology</i>	Female	194	443	2.06 (1.65-2.58)	<0.0001
	Male	225	1060		
<i>Ophthalmology</i>	Female	300	578	2.74 (2.29-3.28)	<0.0001
	Male	368	1944		
All journals	Female	681	1546	2.19 (1.96-2.46)	<0.0001
	Male	923	4594		

Table 2.

Comparison of total number of authors between male and female first authors by journal

Journal	Total number of authors	First author		P value
		Male	Female	
<i>American Journal of Ophthalmology</i>	Mean (SD)	4.62 (0.05)	5.12 (0.08)	<0.0001
	Bycategory			
	=1 to <5	1235 (54.2%)	358 (45.5%)	<0.0001
	=5 to <10	976 (42.8%)	395 (50.2%)	
<i>Archives of Ophthalmology</i>	Mean (SD)	4.73 (0.07)	5.26 (0.10)	<0.0001
	Bycategory			
	=1 to <5	745 (51.7%)	279 (41.5%)	<0.0001
	=5 to <10	626 (43.5%)	354 (52.6%)	
<i>Ophthalmology</i>	Mean (SD)	4.76 (0.05)	4.97 (0.07)	0.023
	Bycategory			
	=1 to <5	1305 (51.0%)	430 (46.6%)	0.051
	=5 to <10	1154 (45.1%)	454 (49.2%)	
All journals	Mean (SD)	4.70 (0.03)	5.10 (0.05)	<0.0001
	Bycategory			
	=1 to <5	3285 (52.3%)	1067 (44.8%)	<0.0001
	=5 to <10	2756 (43.9%)	1203 (50.5%)	
	=10	238 (3.8%)	112 (4.7%)	

ever, only in *Ophthalmology* was there an increase in female last authorship ($P < 0.05$) as well.

The association between first author and the last author by sex for each journal is shown in Table 1. For all the journals examined, the association between the sex of the first and last author for each journal is highly significant ($P < 0.0001$) as well as for all the journals combined ($P < 0.0001$).

Table 2 shows the comparison of total number of authors between articles first-authored by women versus articles first-authored by men. There was a statistically

significant difference in total number of authors between the sex of the first author, with female first-authored articles having more authors than the male first-authored articles. This relation was significant ($P < 0.05$) for *AJO*, *Archives*, and *Ophthalmology* considering all articles combined (Table 2). A similar analysis between total number of authors and gender of last author did not yield a significant result for any of the journals examined (Table 3).

Table 3.

Comparison of total number of authors between male and female last authors by journal

Journal	Total number of authors	Last author		Pvalue
		Male	Female	
<i>American Journal of Ophthalmology</i>	Mean (SD)	4.90 (0.04)	4.94 (0.10)	0.69
	By category			
	>0 to <5	1241 (49.2%)	288 (50.1%)	0.69
	=5 to <10	1206 (47.8%)	260 (45.2%)	
	=10	78 (3.1%)	27 (4.7%)	
<i>Archives of Ophthalmology</i>	Mean (SD)	5.04 (0.06)	5.13 (0.12)	0.51
	By category			
	>0 to <5	754 (46.9%)	199 (44.5%)	0.30
	=5 to <10	772 (48.0%)	221 (49.4%)	
	=10	83 (5.2%)	27 (6.0%)	
<i>Ophthalmology</i>	Mean (SD)	5.06 (0.04)	4.85 (0.09)	0.034
	By category			
	>0 to <5	1225 (46.4%)	341 (49.6%)	0.21
	=5 to <10	1308 (49.5%)	319 (46.4%)	
	=10	108 (4.1%)	28 (4.1%)	
All journals	Mean (SD)	5.00 (0.03)	4.95 (0.06)	0.50
	By category			
	>0 to <5	3220 (47.5%)	828 (48.4%)	0.93
	=5 to <10	3286 (48.5%)	800 (46.8%)	
	=10	269 (4.0%)	82 (4.8%)	

Discussion

Female representation increased among first authors in published ophthalmology literature over the decade from 2000 to 2009. Increases among last authors are modest at best, with rates much lower than those observed for female first authors. Our data suggests a gender lag in the rise of last authors that was not present among first authors. As first authorship often indicates junior ranks among faculty, whereas last authorship often indicates positions of leadership in academic departments, our findings may suggest that while the number of women at the junior level is increasing, this has not translated into more women publishing in senior positions. We also found a very clear association between the sex of the first and last authors, suggesting perhaps that there is more likely to be a mentor-mentee relationship between authors of the same sex. Additionally, female first authors tend to have a greater number of collaborators, as reflected by the number of authors, compared to male first authors. However, this difference was not found when examining last-author gender distribution with number of authors.

Information on gender trends among surgical specialties is limited. This may be due in part to the fact that fewer women physicians are represented among surgical specialties compared to other medical specialties.¹ Prior studies examining otolaryngology research showed a

significant increase in the percentage of female authors over the past two decades.^{4,5} The authors reported a high number of female first authors were non-physicians and were predominantly in pediatric otolaryngology.⁴ A similar study examining representation of female authorship in orthopedic surgery over four decades also showed a trend toward increased representation of female first authors.⁶ They also demonstrated that the gender composition among the editorial boards had increased over the study period.⁶ A study in the urology literature examining gender trends in authorship found an increase in both female first and last authors that far surpassed the growth in numbers of female urologists.⁷ A study of several British journals, including the *British Journal of Surgery*, revealed a significant trend toward increased female first authors that was not mirrored among last, presumably senior, authors.⁸ Feramisco et al⁹ conducted a similar study of the dermatology literature over three decades, finding an increase in female authors in both first and last author positions, in contrast to our study. The authors also found a correlation between the gender of the first and last author, as did the present study. A recent study in ophthalmology literature examining five years of data since 1969 over the last five decades found that even though women authors are increasing overall among published ophthalmology literature, their prevalence as editors has not increased commensurately.¹⁰ It is promising, however, that over the same time period that we examined, American Asso-

ciation of Medical Colleges data shows a small percentage increase in women among positions of leadership.¹ This suggests that the talent pool for female last authors, although small, has the potential to increase.

Several studies have sought to identify what factors are associated with the gender gap noted in the medical literature today. There is some data to suggest that a similar gender gap on the editorial boards of most journals could contribute to the gender gap among male and female authors as first and last authors.^{11,12} It is possible that a lack of academic female role models may deprive more junior female faculty of mentors. If so, this lack may also be depriving junior female faculty of potential coauthors because, as our data indicates, the gender of first and last authors is likely to be highly correlated.

The reasons behind the trends revealed by the present study may of course be much more complex and multifactorial than the raw data can elucidate. Institutional culture and policies, lack of mentors in senior positions (whether as principle investigators, or editorial board members), and societal influences may all be at play.^{13,14} A recent study examining determinants of the lack of advancement of women in senior positions in academic medicine concluded that women faculty feel a sense of exclusion, lack confidence, and perceive a conflict between personal goals and institutional goals.¹⁵ It is important to consider that unconscious biases against women, inflexible institutional support for childbirth, childcare, and eldercare as well as unequal pay compared to male colleagues of similar rank may all contribute to the lower representation of women in academic medicine.^{13,16}

This study has several limitations. Because we were limited to articles that were available online, articles that were not indexed online could not be searched. Furthermore, we did not examine articles that preceded our time period of interest; thus trends preceding those observed in our study dates were not considered. Despite the fact that publications for which we could not identify the sex of the first or last author were excluded from analysis, our results are similar to other studies examining gender trends, suggesting that the excluded data did not significantly affect our results.² The last listed author for any given article was presumed to be the senior or principal investigator. Although this format is widely used for a majority of publications, there are numerous ways to specify authorship in publications.¹⁷ However, because the same approach was used to identify both male and female last authors, we are confident that bias was minimized. We did not limit our analysis only to articles from US institutions, which may influence our results

because gender trends can vary enormously by country and culture.

Much has been said about the “pipeline” problem,^{18–20} which has been described as a lack of female physicians in senior and/or leadership positions in academia despite the steady increase in the number of women entering ophthalmology training over the past few decades.^{1,18} This suggests that the disparity is not simply due to a lack of graduating female ophthalmologists but rather due to fewer women choosing to pursue academic ophthalmology or advancing appropriately through the ranks from junior to senior faculty. Some evidence does suggest that women fail to progress or to be promoted in academic departments relative to their male colleagues due to institutional barriers, societal constraints, lack of support systems and absence of mentorship.^{16,19}

Our results suggest that the number of female first authors, who often hold relatively junior level academic positions, has increased significantly. The same trend is not significant when examining last authors, who often hold senior level positions. Furthermore, the number of female first and last authors still lags behind their male counterparts. Our findings raise concerns about the position of women in academia. A study examining abstracts submitted to the Association for Academic Surgery and the Society of University Surgeons found higher impact factors for those articles published by women relative to their male counterparts.¹⁷ Research and publication by female ophthalmologists must be fostered for the overall well-being of academic ophthalmology. Additional studies are necessary to examine the causal factors for the gender lag in first and last authorship in peer reviewed ophthalmology literature.

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