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Shali Zhang  
*Emory University*

Ha-Young Kim  
*Emory University*

Rachel E.S. Hill  
*Emory University*

Emir Veledar  
*Department of Biostatistics, Florida International University, [eveledar@fiu.edu](mailto:eveledar@fiu.edu)*

Suephy C. Chen  
*Emory University; Atlanta Veterans Administration Medical Center*

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## A ten-year comparison of women authorship in U.S. dermatology literature, 1999 vs. 2009

Shali Zhang, MD<sup>a</sup>, Ha-Young Kim, BA<sup>b,1</sup>, Rachel E.S. Hill, MD<sup>a,2</sup>, Emir Veledar, PhD<sup>c,3</sup>, Suephy C. Chen, MD, MS<sup>a,d,\*</sup>

<sup>a</sup> Department of Dermatology, Emory University School of Medicine, Atlanta, GA, USA

<sup>b</sup> Emory College of Arts and Sciences, Emory University, Atlanta, GA, USA

<sup>c</sup> Department of Biostatistics, Florida International University, Miami, FL, USA

<sup>d</sup> Division of Dermatology, Atlanta Veterans Administration Medical Center, Decatur, GA, USA

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### ABSTRACT

Women are entering medicine at increasing rates, particularly in dermatology. In this study, we compared women's influence and status in academic dermatology with that of men by examining authorship roles in peer-reviewed dermatology literature. We examined the literature in 2009 and compared that to 10 years prior (1999). A total of 1399 articles were reviewed, 594 of which met study criteria and were included in statistical analysis. There was a marked increase in senior female authorship over a decade (22% vs. 38%,  $p < 0.001$ ). Female first authorship increased as well (41% vs. 51%,  $p < 0.001$ ). In contrast, changes in male senior and first authorship were not statistically significant. Federal funding for female senior authors increased over a decade (19% vs. 37%,  $p = 0.05$ ), and female senior authors in the 2009 cohort were more likely to hold a dual MD/PhD degree (0% vs. 11%,  $p = 0.04$ ) or pure PhD degree (11% vs. 27%,  $p = 0.04$ ). Women are approaching parity with men in terms of authorship in the dermatology literature, and additional research training and attainment of federal funding have helped women publish as senior authors.

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### Introduction

Over the past five decades, women have drastically increased enrollment at U.S. medical schools. In 1965, women comprised only 9.3% of the matriculants, but nearly half (47.2%) of incoming medical students in 2013 were female (American Association of Medical Colleges [AAMC], 2014; Boulis and Jacobs, 2008). In some medical specialties such as dermatology, female residents already outnumber their male colleagues, at 62.4% (AAMC, 2014). Such trends suggest that women are approaching parity with men in medicine, particularly in dermatology. However, despite this increased influx of women to medicine, the question remains whether their presence is also seen in the academic sphere of medicine. Can women compete with men to hold greater leadership positions and status in academia?

The core missions of academic medicine, in addition to patient care, include educating the next generation of physicians and biomedical scientists by fostering research and innovative thought. Academic physicians exert tremendous influence on the future of medicine and their respective specialties by disseminating their research findings through publications, which in turn brings professional recognition. As the editor of *Academic Medicine* wrote, a considerable portion of

academic medicine pertains to publishing “original articles and research reports, critical review, perspectives, and commentaries that address topics across the full spectrum of broad-based concerns” (Kanter, 2008). Thus, one approach to evaluate women's standing in academic medicine is to measure their publishing activity, which has traditionally been viewed as an indicator of academic impact and success.

A 2004 study published in the *New England Journal of Medicine* explored the “gender gap” in authorship of academic literature in fields of internal medicine, surgery, pediatrics, and obstetrics and gynecology (Jagsi et al., 2006). However, studies of such kind are few in dermatology.

In this study, we set out to compare women's influence in academic dermatology with that of men by examining authorship roles in peer-reviewed dermatology literature from 2009 to 2010 compared to 10 years prior (1999–2000). Specifically, we looked at the quantity of peer-reviewed articles published and the role of authorship (first and last) with the aim of shedding light on the overall status of women in academic dermatology. A study examining data from 2006 also looked at the gender gap in manuscript authorship in dermatology (Feramisco et al., 2009); however, unique to our study, we also examined the level of education and research training and the source of research funding, which may help explain any underlying trends.

### Materials & methods

Data were extracted from 12 issues each of the “1999 cohort” (August 1999 through July 2000) and the “2009 cohort” (August 2009 through July 2010) from the *Journal of Investigative Dermatology* (JID)

\* Corresponding author.

E-mail address: [schen2@emory.edu](mailto:schen2@emory.edu) (S.C. Chen).

<sup>1</sup> Current affiliation: Department of Dermatology, Seoul National University, Seoul, South Korea.

<sup>2</sup> Current affiliation: Daniel Island Dermatology, Charleston, SC, USA.

<sup>3</sup> Current affiliation: Center for Healthcare Advancement and Outcomes, Baptist Health South Florida, Miami, FL, USA.

and *JAMA Dermatology*, formerly called *Archives of Dermatology* (Archives), two of the most highly cited peer-reviewed scientific journals in dermatology based on impact factor in recent years.

Non-peer reviewed pieces such as “Archives a Century Ago,” “Book Reviews,” and “News and Notes” were excluded. “In-reply” pieces were also excluded, as these are typically responses to commentaries from the author of the original article.

Since the focus of the present study is the status of women in academic medicine in the United States, we focused solely on U.S.-authored articles and excluded non-U.S.-authored articles. We defined articles as U.S. authored if the first, senior (last), and corresponding authors were affiliated with a U.S. institution. If an article failed to meet this criterion, it was identified as a non-U.S.-authored article. For the U.S.-authored articles, data collected included number of authors, gender, postgraduate degree of first and last authors, and sources of funding. Types of funding were categorized as federal, private, or industry. Articles funded solely by a department or division of a university were considered unfunded. Data from articles with two or more authors were analyzed first. The same analysis was then performed for single-author papers.

We compared female authorship roles of the 2009 cohort with that of the 1999 cohort using Fisher and binomial tests. The Fisher test was used to compare the proportion of women between the two time cohorts, whereas the binomial test accounted for absolute numbers. Additionally, we compared male authorship roles of the 2009 cohort with that of the 1999 cohort, as well as female authorship roles with that of males for each cohort. A  $p$  value of  $< 0.05$  was considered statistically significant. We used SAS, version 9.2 (SAS Institute Inc., Cary, NC, USA), for all statistical analyses.

## Results

A total of 1399 articles were reviewed, 761 of which were from JID and 638 from Archives. Comparing journals from the 1999 cohort, 347 articles were from JID, of which 259 articles were excluded because of their non-U.S. authorship, and 322 articles were from Archives, of which 153 articles were excluded due to their non-U.S. authorship. From the 2009 cohort, 414 articles were from JID, of which 267 were excluded, and 316 articles were from Archives, of which 126 were excluded. Therefore, a total of 594 articles were included, 235 of which were from JID and 359 from Archives.

### Female authors

Combining eligible articles from both journals in the 1999 cohort, there were 213 U.S.-based articles with two or more authors, of which 47 (22%) of the senior authors were female (Table 1). In the 2009 cohort, there were 303 U.S.-based articles with two or more authors, of which 115 (38%) of the senior authors were female. There was a marked increase in senior female authorship over a decade (22% vs. 38%,  $p < 0.001$ ).

In characterizing the senior authors, there was a notable change in the distribution of postgraduate degrees amongst female senior authors from the 1999 to the 2009 cohort. Over a decade, there was a considerable decrease in MDs (85% vs. 57%,  $p = 0.001$ ), but an increase in MD/PhDs (0% vs. 11%,  $p = 0.04$ ) and PhDs (11% vs. 27%,  $p = 0.04$ ). With respect to funding sources, there was a significant increase in funding for female senior authors ( $p < 0.001$ ) in the more recent cohort. Female senior authors in the 2009 cohort were more likely to receive federal funds compared to those in the 1999 cohort (37% vs. 19%,  $p = 0.05$ ). Although the proportion of female senior authors receiving funding from other sources (private and industry) also increased, those changes were not statistically significant.

Comparing the 1999 cohort with the 2009 cohort, there was an increase in female first authors in the latter (41% vs. 51%,  $p < 0.001$ ).

**Table 1**  
Female Senior and First Author Characteristics of U.S. Articles with at least Two Authors.

	1999-2000	2009-2010	$p$ value Fisher	$p$ value Binomial
Female Senior Author	$N = 47$ (22.1%)	$N = 115$ (38.0%)		$<0.001$
Degree				
MD	40 (85.1%)	66 (57.4%)	0.001	
MD/PhD	0 (0%)	13 (11.3%)	0.04	
PhD	5 (10.6%)	31 (27.0%)	0.04	
None	2 (4.3%)	5 (4.3%)	N/S	
Funding <sup>a</sup>				
Federal	9 (19.1%)	42 (36.5%)	0.05	
Private	7 (14.9%)	19 (16.5%)	N/S	
Industry	0 (0%)	7 (6.1%)	N/S	
None	36 (76.6%)	64 (55.7%)	0.02	
Female First Author	$N = 87$ (40.8%)	$N = 154$ (51.2%)		$<0.001$
Degree				
MD	59 (67.8%)	79 (51.3%)	0.02	
MD/PhD	7 (8.0%)	16 (10.4%)	N/S	
PhD	18 (20.7%)	25 (16.2%)	N/S	
None	3 (3.4%)	34 (22.1%)	$<0.001$	
Funding <sup>a</sup>				
Federal	37 (42.5%)	59 (38.3%)	N/S	
Private	24 (27.6%)	27 (17.5%)	N/S	
Industry	1 (1.1%)	6 (3.9%)	N/S	
None	44 (50.6%)	82 (53.2%)	N/S	

<sup>a</sup> Percentages do not add up to 100% because some authors received no funding, while others received funding from one or more sources.

There was a decrease in the proportion of female first authors holding MDs (68% vs. 51%,  $p = 0.02$ ), although the absolute number of MDs had increased. Furthermore, there was an increase in both the absolute number and proportion of female first authors without a postgraduate degree (3% vs. 22%,  $p < 0.001$ ). Changes in funding for female first authors were not statistically significant.

U.S.-based articles with only one author were examined separately. Of a total of 44 articles in the 1999 cohort with a single author, 9 (20%) were written by female authors. Of a total of 34 articles in the 2009 cohort, 8 (24%) were written by female authors. This difference was not statistically significant. Due to the small sample size, comparisons of the distribution of degrees and funding in this subset were not feasible.

### Male authors

Of the 213 U.S.-based articles with two or more authors in the 1999 cohort, 166 (78%) of senior authors were male (Table 2). Of the 303 U.S.-based articles with two or more authors in the 2009 cohort, 188 (62%) of senior authors were male. The observed change in male senior authorship was not statistically significant. However, with reference to the types of postgraduate degrees held by senior male authors in the 1999 compared to the 2009 cohort, there were statistically significant changes. There was a decrease in MDs (72% vs. 59%,  $p = 0.01$ ), but a significant increase in MD/PhDs (10% vs. 25%,  $p < 0.001$ ). No statistical trends were observed regarding funding sources for male senior authors.

As was the trend for male senior authors, there was a decrease in the proportion of male first authors from 1999 to 2009 (59% vs. 49%), although again this difference was not statistically significant. With respect to the distribution of postgraduate degrees, there was a decrease in male first authors with MDs (68% vs. 52%,  $p = 0.01$ ). For other postgraduate degrees, the absolute numbers of MD/PhD, PhD, and non-postgraduate degree holders increased, but these changes

**Table 2**  
Male Senior and First Author Characteristics of U.S. Articles with at least Two Authors.

	1999-2000	2009-2010	p value Fisher	p value Binomial
<b>Male Senior Author</b>	<b>N = 166 (77.9%)</b>	<b>N = 188 (62.0%)</b>		N/S
Degree				
MD	120 (72.3%)	111 (59.4%)	<b>0.01</b>	
MD/PhD	17 (10.2%)	47 (25.1%)	<b>&lt;0.001</b>	
PhD	27 (16.3%)	28 (15.0%)	N/S	
None	2 (1.2%)	1 (0.5%)	N/S	
Funding <sup>a</sup>				
Federal	71 (42.8%)	75 (39.9%)	N/S	
Private	42 (25.3%)	38 (20.2%)	N/S	
Industry	2 (1.2%)	10 (5.3%)	N/S	
None	85 (51.2%)	97 (51.6%)	N/S	
<b>Male First Author</b>	<b>N = 126 (59.2%)</b>	<b>N = 147 (48.8%)</b>		N/S
Degree				
MD	86 (68.3%)	77 (52.4%)	<b>0.01</b>	
MD/PhD	9 (7.1%)	21 (14.3%)	N/S	
PhD	22 (17.5%)	30 (20.4%)	N/S	
None	9 (7.1%)	19 (12.9%)	N/S	
Funding <sup>a</sup>				
Fed	43 (34.1%)	57 (38.8%)	N/S	
Private	25 (19.8%)	30 (20.4%)	N/S	
Industry	1 (0.8%)	10 (6.8%)	<b>0.02</b>	
None	77 (61.1%)	79 (53.7%)	N/S	

<sup>a</sup> Percentages do not add up to 100% because some authors received no funding while others received funding from one or more sources.

were not significant. With regards to funding sources, the proportion of the types of funds in the 1999 and 2009 cohorts remained relatively stable, except for an increase in funds from industry sources (1% vs. 7%,  $p = 0.02$ ).

Of the 44 U.S.-based articles in the 1999 cohort with only one author, 35 (80%) were written by male authors, and of the 34 articles in the 2009 cohort, 26 (76%) were written by male authors, but this difference was not statistically significant. Due to the small sample size, statistical analysis of the distribution of degrees and funding was not performed.

#### Comparison between men and women

We compared the difference in the absolute numbers of men and women as first and last authors in the 1999 and the 2009 cohorts. For first authorship, the difference between the absolute numbers in the 1999 cohort was statistically significant, but in the 2009 cohort, the difference was not ( $p = 0.009$  vs.  $p = 0.73$ ). As for senior authorship, the difference between men and women was highly significant in both the 1999 (166 vs. 47,  $p = 2e-16$ ), and in the 2009 cohort (188 vs. 115,  $p = 3e-5$ ), but inspection of the absolute difference reveals that this difference is diminishing.

In relation to funding, the difference in the distribution of funding sources for men and women senior authors was more noticeable in the earlier cohort. The discrepancy in the proportion of funds from federal sources was significant between men and women senior authors in 1999 ( $p = 0.003$ ), but not in 2009 ( $p = 0.63$ ). More senior female authors were unfunded when compared to men in 1999 than in 2009 ( $p = 0.003$  vs.  $p = 0.55$ ). The differences in the distribution of private and industry funds for male and female first authors for both the 1999 and 2009 cohorts were not significant.

## Discussion

This comparison study of published female authorship in two high-impact dermatology journals in 1999 and 2009 strongly suggests that women are moving toward parity with men in terms of the number of authors and the distribution of postgraduate degrees and funding sources. There was a remarkable increase in female authorship, especially for senior authors, both in terms of proportions and absolute numbers. This result is consistent with several prior studies measuring the gender gap and female authorship in various other medical specialties in both the United States and abroad (Feramisico et al., 2009; Jagsi et al., 2006; Li et al., 2007; Sidhu et al., 2009). The significant increase in senior and first female authorship over a decade, as opposed to the nonsignificant change in senior and first male authors, indicates that women are acquiring senior and first authorship positions at compelling rates as compared to men.

While results of previous studies have been confirmed by this study, no study, to the best of our knowledge, has attempted to explain this positive trend. Identifying reasons that may promote increased female involvement is important as it can reveal useful interventions to further support women in academia.

The most straightforward explanation for the increased proportion of women authorship is simply the increased prevalence of women in the dermatology training programs and thus the workforce. According to the 1998 AAMC data tables, 51.2% of residents in dermatology were female; in 2008, 61.3% were female (AAMC, 2009).

In this study, our results also suggest the changes in attainment of postgraduate degrees may explain the authorship trends observed. We found that there has been a decrease in the distribution of MDs but an increase in the distribution of dual MD/PhDs or pure PhDs for both male and female senior authors. This suggests that more senior male and female physicians are pursuing additional education and research training, and in the process, acquiring a PhD degree. Furthermore, an increase in the distribution of PhDs for senior female authors suggests that more women with PhDs are publishing. Another explanation is that a smaller proportion of pure MD-degree physicians are publishing because of clinical or teaching demands. However, the absolute increase in numbers calls into question this speculation. For first authors, there has been a significant decrease in the proportion of MDs and an increase in nondegree first female authors, suggesting that a greater portion of first authors is comprised of medical or undergraduate female students. This may be a result of more women entering medicine (and dermatology in particular), as well as the increasing pressure to publish for undergraduate and medical students who plan to pursue competitive specialties.

Another explanation for the changing authorship roles may be explained by funding sources. There was a significant trend toward more funds for women senior authors. The distribution of federal funds increased (while the proportion of senior female authors without funding decreased), mirroring the increase in female senior authors. There has been little or no change in the distribution of the types of funds for senior male authors, nor has the number of senior male authors changed significantly over a decade.

When interpreting these results, we acknowledge the study's limitations. One notable limitation is that our cohort is from 2009. Nonetheless, the trend illustrated by this study is still informative to those who are interested in gender status of academic dermatologists. A second limitation of this study is the small sample size. Only two journals and two years were studied, possibly resulting in a selection bias, and only U.S. articles were examined. We had limited our study to U.S. articles because of the difficulty in ascertaining gender and postgraduate level of training of authors of non-U.S. articles. However, in doing so, our number of eligible publications was significantly reduced. Our strict definition of U.S. authorship also does not account

for authors who may have returned to their countries of origin before publication of their research. Thus, the senior authors may better represent the output and prominence of U.S. women. Furthermore, we did not stratify the articles by their research type, nor did we compare the citation numbers of the articles written by females compared to those authored by males to determine which wrote more impactful articles. For future studies, it would be interesting to examine the trend in the distribution of types of research being performed as well as citation numbers and to investigate developments in the last 5 years. Finally, for the purposes of this study, we treated the last author as the most senior or lead author, which is not always the case. However, in the large majority of the articles, the author listed last was, in fact, the lab director or a senior faculty member, which lends validity to our assumption. Despite these limitations, this study provides valuable information that can help future women entering academia, and inspire further research in the future to look at more recent data as women's presence in the landscape of medicine continues to evolve.

In conclusion, over a period of 10 years, we have demonstrated a progressive trend toward parity in the distribution of male and female authorship roles. Our findings regarding degrees and funds suggest that additional research training and attainment of federal funding have helped women to publish as senior authors. As more women enter

academic dermatology, adequate mentoring to guide them toward formal research training and grantsmanship may be instrumental to the success of their scholarly pursuits.

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