

SPECIAL ARTICLE

The “Gender Gap” in Authorship of Academic Medical Literature — A 35-Year Perspective

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ABSTRACT

BACKGROUND

Participation of women in the medical profession has increased during the past four decades, but issues of concern persist regarding disparities between the sexes in academic medicine. Advancement is largely driven by peer-reviewed original research, so we sought to determine the representation of female physician-investigators among the authors of selected publications during the past 35 years.

METHODS

Original articles from six prominent medical journals — 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) — were categorized according to the sex of both the first and the senior (last listed) author. Sex was also determined for the authors of guest editorials in NEJM and JAMA. Data were collected for the years 1970, 1980, 1990, 2000, and 2004. The analysis was restricted to authors from U.S. institutions holding M.D. degrees.

RESULTS

The sex was determined for 98.5 percent of the 7249 U.S. authors of original research with M.D. degrees. The proportion of first authors who were women increased from 5.9 percent in 1970 to 29.3 percent in 2004 ($P<0.001$), and the proportion of senior authors who were women increased from 3.7 percent to 19.3 percent ($P<0.001$) during the same period. The proportion of authors who were women increased most sharply in *Obstet Gynecol* (from 6.7 percent of first authors and 6.8 percent of senior authors in 1970 to 40.7 percent of first authors and 28.0 percent of senior authors in 2004) and *J Pediatr* (from 15.0 percent of first authors and 4.3 percent of senior authors in 1970 to 38.9 percent of first authors and 38.0 percent of senior authors in 2004) and remained low in *Ann Surg* (from 2.3 percent of first authors and 0.7 percent of senior authors in 1970 to 16.7 percent of first authors and 6.7 percent of senior authors in 2004). In 2004, 11.4 percent of the authors of guest editorials in NEJM and 18.8 percent of the authors of guest editorials in JAMA were women.

CONCLUSIONS

Over the past four decades, the proportion of women among both first and senior physician-authors of original research in the United States has significantly increased. Nevertheless, women still compose a minority of the authors of original research and guest editorials in the journals studied.

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DURING THE PAST FOUR DECADES, THE participation of women in medicine has increased dramatically. Women now represent 49 percent of all medical students,¹ as compared with 6 percent in 1960.² Overall, 25 percent of practicing physicians in the United States are women,³ and women now make up 32 percent of full-time medical faculty members.⁴ However, there is considerable evidence that women continue to be underrepresented in the top tiers of academic medicine.⁵⁻⁷ Women currently make up 10 percent of medical school deans, 11 percent of department chairs, and 14 percent of full professors among the clinical faculty in medical schools.⁴ Women last composed 14 percent of all medical students in 1972.⁸ In addition, only 10 percent of female clinical faculty members as compared with 28 percent of male clinical faculty members are full professors.⁴ Figure 1 depicts the number of female faculty members who served as professors and role models for both male and female residents in the main medical specialties in 2004. For example, in internal medicine, the ratio of residents to female professors was 31 to 1; this ratio was 44 to 1 with the inclusion of fellows.^{9,10}

Publication in medical journals is an important measure of academic productivity. It is also highly emphasized in the academic promotion process and an important means by which the academic

medical community communicates. Although several survey studies have suggested that female faculty members may be less likely to publish academic papers than their male colleagues,^{11,12} other studies have not found apparent differences.¹³⁻¹⁵ Few studies have attempted to quantify the sex distribution of authors of published research, and those that have done so have focused on the fields of otolaryngology¹⁶ and epidemiology¹⁷ or on authors of research published in journals outside the United States.^{18,19} In this study, we examined whether there was a “gender gap” in the authorship of six prestigious medical journals in the United States and we sought to quantify its magnitude. In addition, we examined the patterns of change in this gap over time and variations according to specialty area. We focused on published original research in these journals from 1970 to the present. We also assessed the sex composition of authors of guest editorials published during the same period.

METHODS

DATA COLLECTION

We focused on the four medical specialties that have traditionally constituted the core clerkships in the education of medical students. These specialties, which together include the largest proportion of practicing physicians, include internal medicine, surgery, pediatrics, and obstetrics and gynecology. Journals were selected on the basis of “impact factors,”^{20,21} citation half-life,²⁰ and comments solicited from faculty members regarding the long-term prestige and importance of the various journals in their fields. Six prominent medical journals published in the United States were included 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)*.

All original articles published in 1970, 1980, 1990, 2000, and 2004 were included in the data set. For each of these articles, we determined both the first and senior (last listed) authors’ sex, graduate degrees, and institutional affiliation. An author’s sex was determined by initial inspection of his or her first name. For cases in which an author’s sex was not certain, attempts were made to discern the sex by visiting the institutional Web

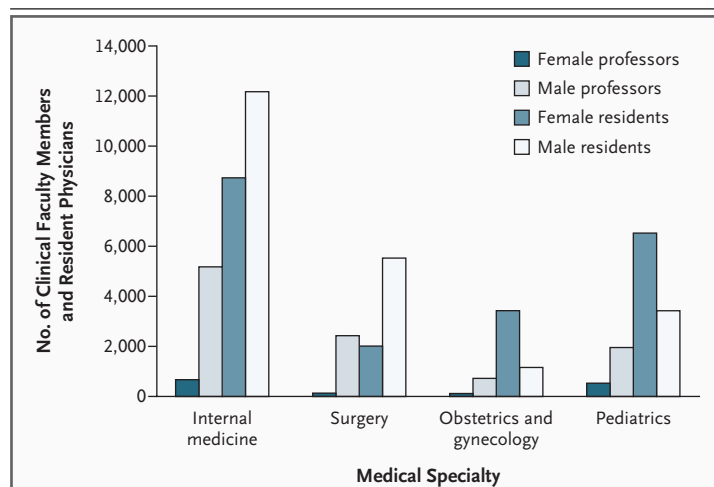


Figure 1. Sex Distribution of Clinical Faculty Members and Resident Physicians in Medical Specialties, 2004.

Data from the Association of American Medical Colleges indicate that a relatively small absolute number of female faculty members serve as professors and role models for the large number of both male and female residents in the main medical specialties.

site and performing Internet searches with the use of the Google search engine.

Also included and separately identified in the study were guest editorials in the two nonspecialty journals, *NEJM* and *JAMA*. Only editorials authored by persons other than editorial-board members were considered for analysis. In the rare cases in which editorials were written by more than two authors, our analysis included just the first and last authors.

STATISTICAL ANALYSIS

Our analysis was restricted to investigators from U.S. institutions who held an M.D. degree. The tabulated data were stored in a Microsoft Access database and analyzed (with the use of SAS software, version 9.1) to determine the sex distributions of the first and senior (last listed) authors of original articles for each journal and the sex distributions of authors of guest editorials in *NEJM* and *JAMA*. The Cochran–Armitage trend test was used to test for the trend over time. Reported P values pertain to the significance of trends over time in these data.

RESULTS

AUTHORSHIP OF ORIGINAL RESEARCH

A total of 7249 authors of original articles who held M.D. degrees and were from U.S. institutions were identified in the six journals during the years studied; 3872 were first authors, and 3377 were senior authors. The sex of the author was determined for 98.5 percent. Overall, 15.9 percent of the first authors and 10.3 percent of the senior authors were women. An analysis of the data according to year demonstrated significant gains by female physician-investigators since 1970 (Fig. 2). The proportion of women serving as first authors of published original research in these journals increased from 5.9 percent to 29.3 percent, and the proportion of women serving as senior authors increased from 3.7 percent to 19.3 percent. The data also suggested that this momentum may be reaching a plateau.

Significant trends of increased female representation were evident for each of the six journals during the 35-year period (Table 1). The proportions of first and senior authors who were women increased most sharply in the specialty journals of obstetrics and pediatrics and remained low in the journal having to do with surgery. In

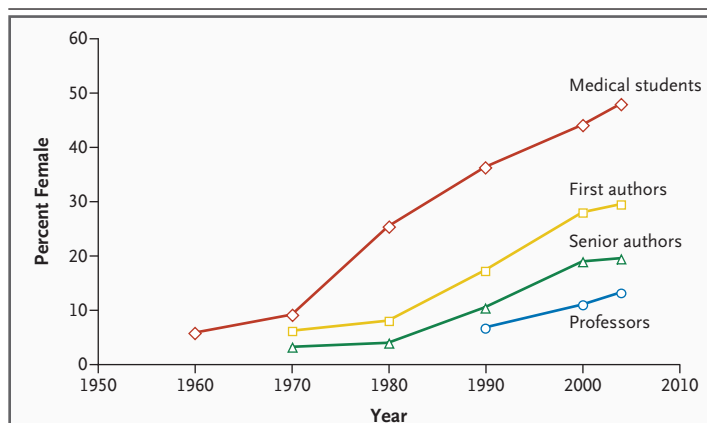


Figure 2. Female Physician-Investigators Who Were First and Senior Authors of Published Original Research.

In the six journals studied, the representation of women among first and senior authors of published original research increased during the past four decades. The cumulative trends over time are depicted by curves showing female representation among students enrolled in medical school and among professors on medical school faculties (data on faculty rank according to sex were not available from the Association of American Medical Colleges for 1980, 1970, or 1960).

2004, in the three general medical journals (*Ann Intern Med*, *NEJM*, and *JAMA*) collectively, female physicians made up 23.2 percent of the first authors and 12.7 percent of the senior authors of original research articles.

Of the U.S. authors in the years studied, 181 first authors held both M.D. and Ph.D. degrees and 236 senior authors held both M.D. and Ph.D. degrees. In this subgroup, the sex distribution over time was similar to that in the overall data set. Among the first authors holding both M.D. and Ph.D. degrees, 7.7 percent were female in 1970, 6.7 percent in 1980, 10.0 percent in 1990, 20.0 percent in 2000, and 17.9 percent in 2004 (P for trend=0.05). Of the senior authors holding both M.D. and Ph.D. degrees, 3.7 percent were female in 1970, 0 percent in 1980, 12.5 percent in 1990, 22.9 percent in 2000, and 9.3 percent in 2004 (P for trend=0.02).

SEX OF AUTHORS OF GUEST EDITORIALS

We determined the sex of 99.6 percent of the 808 U.S. investigators with an M.D. degree who served as first or senior (last listed) authors of guest editorials in *NEJM* and *JAMA* during the years studied. During this period, of the 514 authors of guest editorials in *NEJM*, women made up 8.8 percent overall and 1.5 percent in 1970, 2.4 percent in 1980, 9.7 percent in 1990, 20.4 percent in 2000, and 11.4

Table 1. Representation of Female Physician-Investigators among First and Senior Authors of Published Original Research in Six U.S. Journals.*

Variable	1970	1980	1990	2000	2004	P Value
	<i>number/total number (percent)</i>					
Overall						
First author	58/982 (5.9)	67/810 (8.3)	137/814 (16.8)	169/614 (27.5)	178/607 (29.3)	<0.001
Senior author	29/783 (3.7)	25/692 (3.6)	69/681 (10.1)	106/578 (18.3)	112/580 (19.3)	<0.001
<i>NEJM</i>						
First author	8/188 (4.3)	14/117 (12.0)	23/143 (16.1)	23/110 (20.9)	13/92 (14.1)	<0.001
Senior author	6/153 (3.9)	3/108 (2.8)	11/122 (9.0)	13/106 (12.3)	11/97 (11.3)	<0.001
<i>JAMA</i>						
First author	13/227 (5.7)	7/151 (4.6)	25/125 (20.0)	26/121 (21.5)	30/113 (26.5)	<0.001
Senior author	5/173 (2.9)	3/128 (2.3)	13/102 (12.7)	19/115 (16.5)	16/118 (13.6)	<0.001
<i>Ann Intern Med</i>						
First author	5/107 (4.7)	8/126 (6.3)	13/106 (12.3)	15/44 (34.1)	17/54 (31.5)	<0.001
Senior author	5/93 (5.4)	4/115 (3.5)	4/92 (4.3)	11/43 (25.6)	7/52 (13.5)	0.009
<i>Ann Surg</i>						
First author	4/175 (2.3)	7/168 (4.2)	7/135 (5.2)	13/110 (11.8)	15/90 (16.7)	<0.001
Senior author	1/153 (0.7)	1/149 (0.7)	1/117 (0.9)	2/101 (2.0)	6/89 (6.7)	0.034
<i>Obstet Gynecol</i>						
First author	12/178 (6.7)	13/161 (8.1)	45/227 (19.8)	62/164 (37.8)	61/150 (40.7)	<0.001
Senior author	8/117 (6.8)	6/116 (5.2)	29/185 (15.7)	41/140 (29.3)	37/132 (28.0)	<0.001
<i>J Pediatr</i>						
First author	16/107 (15.0)	18/87 (20.7)	24/78 (30.8)	30/65 (46.2)	42/108 (38.9)	<0.001
Senior author	4/94 (4.3)	8/76 (10.5)	11/63 (17.5)	20/73 (27.4)	35/92 (38.0)	<0.001

* The analysis was restricted to authors from U.S. institutions holding an M.D. degree or equivalent for whom sex could be determined.

percent in 2004 (P for trend <0.001). Sex was determined for 291 of the 294 U.S. authors of guest editorials with M.D. degrees in *JAMA* during the years studied. Of these 291 authors, women made up 10 percent overall and 0 percent in 1970, 2.0 percent in 1980, 7.4 percent in 1990, 10.0 percent in 2000, and 18.8 percent in 2004 (P for trend <0.001).

DISCUSSION

Advancement in academic medicine is largely contingent on productivity and the measured external influence of one's scholarly work. Objective measures of the effect of one's work include the publication of original research in prominent journals and invitations by editors to provide scientific opinions on the published research of others. In this study, we focused on six medical jour-

nals chosen specifically for their prominence and high visibility to medical students, residents, and fellows. We found that from 1970 to 2004, the proportion of women among the U.S. physician-authors of original research in these journals increased from 5.9 percent to 29.3 percent of first authors and from 3.7 percent to 19.3 percent of senior authors. The magnitude of change for both groups was highest for *J Pediatr* and *Obstet Gynecol* and lowest for *Ann Surg*; these findings may have reflected, at least in part, the numbers of women entering these fields.

Despite these positive overall findings, the results also raise potential areas of concern. Although the proportion of women among authors has increased over time, the data suggest a possible lack of continued momentum among both first authors and senior authors in 2004 as compared with 2000. The data also suggest that a gender

Table 2. Academic Rank of Clinical Faculty in Main Specialties, According to Sex.*

Variable	1990	1995	2000	2005
	<i>% women</i>			
Overall				
Medical students	36	39	43	47
Instructors	38	44	46	—
Assistant professors	27	32	35	38
Associate professors	16	20	23	27
Professor	7	9	11	14
Internal Medicine				
Instructors	33	37	41	—
Assistant professor	23	29	33	36
Associate professor	11	17	20	24
Professor	5	6	9	12
Obstetrics and gynecology				
Instructor	56	65	66	—
Assistant professor	34	43	47	53
Associate professor	14	21	27	34
Professor	7	9	12	16
Pediatrics				
Instructor	55	60	64	—
Assistant professor	41	48	51	53
Associate professor	26	32	34	40
Professor	15	17	19	22
Surgery				
Instructor	21	29	31	—
Assistant professor	12	15	17	21
Associate professor	6	8	9	12
Professor	2	3	4	6

* Data are from the Association of American Medical Colleges.^{4,8,22-24} Bold face values reflect a superimposed 20-year pipeline to full professor from an estimated year of graduation from medical school of 1985. Thirty percent of graduates from U.S. medical schools in 1985 were women. Data on instructor-level appointments according to sex were available in the Association of American Medical Colleges Data Books for 1990, 1995, and 2000, but not 2005.

gap in authorship remains, particularly among senior authors and editorial commentators.

Of the many possible explanations for our findings, one factor that probably explains at least some of the gender gap observed is that the pool of female faculty members who are eligible to serve as senior authors or editorial commentators remains limited. Nonnemaker examined the rates of academic advancement of men and women among different cohorts of U.S. medical school faculties from 1979 through 1997.⁷ The study revealed that the numbers of women advancing to the ranks of associate and full professor were sig-

nificantly lower than expected. Longitudinal data from the American Association of Medical Colleges seem to reaffirm this finding (Table 2).^{4,8,22-24} In 2004, women made up only 19 percent of associate and full professors on the clinical faculties of medical schools.⁹ The low overall percentage of female senior authors in 2004 — 19 percent in the six journals studied — may reflect this smaller pool of senior faculty members who are women. Similarly, the low percentage of women among authors of guest editorials may indicate that there is a limited pool of women who have achieved sufficient international recognition and expertise to

merit these invitations. Since the pool is limited, senior women may also be inundated with academic activities and may find it necessary to decline invitations more often, notwithstanding the potential for prestige and influence.

Several studies have explored the basis for the gender gap in academic medicine. In a study by Yedidia and Bickel,²⁵ three important barriers to the academic advancement of women were identified from interviews of department chairs — the constraints of traditional sex roles, manifestations of sexism in the medical environment, and lack of effective mentors. Carr et al. reported that female faculty members who had children published less and had less institutional support than did male colleagues who had children.²⁶ In addition, a study of female faculty members in the School of Science at the Massachusetts Institute of Technology found unanticipated patterns of inequity relative to the allocation of resources, space, salary, outside professional activities, and positions of influence.²⁷

Some of the gap observed may also stem from career choices made by men and women. Studies have documented differences in career preferences between male and female medical students,^{28,29} and women may devote more of their working time to teaching and clinical activity than to research.³⁰ Some have also speculated that women may have different priorities regarding the balance between work and other pursuits,³¹⁻³³ although recent studies have suggested that a balance between work and other activities is as important to men as it is to women, at least among younger physicians.³⁴⁻³⁶ Ultimately, Nonnemaker found that fewer women were choosing academic career paths in the late 1990s.⁷

Finally, it has been suggested that the most productive period of women's careers is delayed,

and this delay conflicts with traditional tenure clocks.³⁷ Strategies like the National Institutes of Health supplements to promote reentry into biomedical and behavioral research careers are grounded in the assumption that measures that help women to address these issues of timing may promote their more equal participation in academic medicine. On the basis of a similar logic, it may also be appropriate to consider making awards for career development independent of the number of years since medical school or since one's first faculty appointment.

Given the design of our study, we were unable to assess the contribution of productivity, career choice, or other possible factors to the gender gap in authorship in the journals we studied. Future research should explore these questions, since it is only through analysis of the underlying forces that this gap in academic medicine may be understood. Faculty diversity is valuable in promoting new insights into and approaches to medical research, so efforts to increase the representation of women in academic medicine should be grounded in rigorous, evidence-based analysis.

Our findings validate the perception that although women have made substantial strides in the past four decades, a gender gap remains among the authors of original articles in prestigious academic medical journals. Further investigation is necessary to understand more fully the causes for this gap, including the possibility that certain barriers may impede women's participation as authors early in their careers and in turn may diminish the pool of female senior faculty members who may serve in prominent authorship positions.

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