

Collaboration Metrics Among Female and Male Researchers: A 5-Year Review of Publications in Major Radiology Journals

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Rationale and Objectives: Women are under-represented in radiology, but the implications of this under-representation are poorly understood. Therefore, the purpose of this study was to determine if articles published by women in major radiology journals were more collaborative.

Materials and Methods: Following an institutional review board exemption, we reviewed all original research articles in *Radiology*, in the *American Journal of Roentgenology*, and in *Academic Radiology* from 2011 to 2015. For each article, the gender of the first and the last authors and proxy measures of collaboration were recorded, including the total number of authors, female authors, departments, and institutions. Nominal logistic regression analysis was used to test for associations while controlling for confounders.

Results: There were 1934 articles analyzed. Female first and last authors represented 30.2% (585 of 1934) and 24.4% (473 of 1934) of the articles, respectively. A female first author was associated with more female last authors (36% vs 20%, $P < .001$), total female authors (2.9 vs 1.2, $P < .001$), and departments (3.3 vs 3.0, $P < .001$). Similarly, a female last author was associated with more female first authors (44% vs 26%, $P = .001$), total female authors (3.1 vs 1.2, $P < .001$), departments (3.5 vs 3.0 $P < .001$), and institutions (2.3 vs 1.9, $P = .006$). Each additional female author increased the mean number of institutions by 0.33 and departments by 0.46 on linear regression. First- or last-author gender was not associated with total authors ($P = .17$).

Conclusions: Original research articles published with a female first or last author were associated with more departments and institutions, but not with the total number of authors, suggesting that women engage in some metrics of more collaborative research.

Key Words: Gender; journals; collaboration; publications; women.

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INTRODUCTION

Women are under-represented in radiology despite near-equal medical school graduation rates (1–5). Improving diversity is an avowed goal of the American College of Radiology, but there is little objective research on the implications of gender inequality specifically for radiology (5–7). Extrapolations can be made from the social sciences literature, which has demonstrated multiple benefits of more diverse teams and organizations. Female team members have been shown to increase a team's collective intelligence beyond the average of the individual team members or even the smartest team member (8). Women have been shown to improve group communications, group processes, and overall collaborations (7,9,10). Multiple studies have, in

turn, demonstrated that compared to individual research efforts, collaborative teams produce a greater number of research publications that yield more frequent citations and higher impact (10–12). Radiology is very different from the corporate world and distinct from the other scientific fields in which the benefits of diversity have been tested, and so it is important to test whether these benefits also apply to radiology.

Therefore, the purpose of the present study was to determine if female radiology researchers were more collaborative than their male counterparts in research articles published in major radiology journals.

METHODS

Following an institutional review board exemption, we reviewed all articles published from January 2011 to December 2015 in *Radiology*, in the *American Journal of Roentgenology (AJR)*, and in *Academic Radiology*. These journals were chosen as they are the highest impact factor scientific journals aimed at a general radiology audience based in the United States with a primary focus on original research. Only original research articles published in the journals were eligible for review. As a result, article

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types such as opinion pieces, letters to the editor, editorials, review articles, case reports, and pictorial essays were not included. Only investigations originating from the United States—defined as articles having a senior author associated with a US institution—were included in the investigation, given that the gender distribution of radiologists varies by country, the gender discrepancy is greatest in the United States, and the included journals are all US based (13).

For each article, the gender of the first and the last authors was recorded, as was the total number of female authors. If the gender was not apparent from the name, then a review of the authors' departmental or practice group website was performed. Proxy measures of collaboration for each article were recorded, including the total number of authors, departments, and institutions. These variables were chosen as they were publicly available and signified work outside the immediate environment (ie, same department and institution). A department was characterized by the specific geographic location, such that two authors from diagnostic radiology departments at different institutions would be classified as two departments and two institutions. Furthermore, authors not in clinical practice, such as those affiliated with a company, were counted as being part of an institution but not a department. Thus, there is a notable overlap between departments and institutions, but collectively, these departments and institutions represent collaboration with individuals outside the immediate environment.

The genders of the first and the last authors were tested against the measures of collaboration on univariate analysis. Those variables significant at univariate analysis ($P < .05$) were included in a nominal logistic regression model to test for the effect of confounders. Exploratory univariate analysis was also performed on subgroups of variables. A final P value of .05 was considered statistically significant. Statistical analysis was performed using JMP Pro (version 13.0; SAS Institute, Cary, NC).

RESULTS

There were 1934 articles included for analysis. The distribution of variables is shown in Table 1. First-author gender was associated with all collaborative variables ($P < .05$) at univariate analysis except for the total number of authors ($P = .17$). On nominal logistic regression, female first-author gender was associated with a higher percentage of female last authors (36%

TABLE 1. Distribution of Variables Among Research Articles From January 2011 to December 2015

Variable	n (%) / Mean ± SD
Total	1934 (100)
Journal	
<i>American Journal of Roentgenology</i>	889 (46)
<i>Radiology</i>	552 (29)
<i>Academic Radiology</i>	493 (25)
First-author gender	
Male	1349 (70)
Female	585 (30)
Last-author gender	
Male	1461 (76)
Female	473 (24)
Female first and last authors	210 (11)
Mean number of female authors	1.7 ± 1.7
Mean number of authors	6.0 ± 2.8
Mean percentage of female authors	28% (95% CI: 27%–29%)
Mean number of departments	3.1 ± 2.1
Mean number of institutions	2.0 ± 1.7

CI, confidence interval; SD, standard deviation.

vs 20%, $P < .001$), greater total number of female authors (2.9 vs 1.2, $P < .001$), and more collaborating departments (3.3 vs 3, $P < .001$) (Table 2). The difference in the mean number of collaborating institutions was not statistically significant (2.3 vs 2.0, $P = .20$) at multiple regression, in part, because of the strong correlation between institutions and departments ($r = 0.80$). The unadjusted odds ratio of a female first author and a female senior author was 2.3 ($\chi^2 = 59.3$). Notably, there was a weak correlation between total authors and number of female authors ($r = 0.45$), as well as institutions ($r = 0.43$), and a moderate correlation between total authors and number of departments ($r = 0.58$). On univariate analysis, there was no association between first-author gender and year of publication ($P = .57$), but there was an association with journal ($P = .016$). *AJR* had a higher percentage of female first authors (33.5%) than *Academic Radiology* (27.2%) or *Radiology* (27.8%).

TABLE 2. Distribution of Variables Based on First-author Gender

Variables	Male First Author	Female First Author	P Value
Mean number of authors	6.0 ± 2.9	6.1 ± 2.6	.17
Percentage of female last authors (%)	20	36	<.001
Mean number of female authors	1.2 ± 1.3	2.9 ± 1.8	<.001
Mean number of departments	3.0 ± 2.0	3.3 ± 2.4	<.001
Mean number of institutions	2.0 ± 1.5	2.3 ± 2.0	.20

P values refer to the results of the nominal logistic regression.

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