Pediatric Radiology (2023) 53:487–492
https://doi.org/10.1007/s00247-022-05547-9

ORIGINAL ARTICLE

Gender disparity in academic advancement: exploring differences among adult and pediatric radiologists

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Received: 29 May 2022 / Revised: 13 October 2022 / Accepted: 8 November 2022 / Published online: 29 November 2022
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Abstract

Background Gender imbalance in research output and academic rank in academic radiology is well-documented and long-standing. Less is known regarding this imbalance among pediatric radiologists.

Objective To characterize gender differences for academic rank and scholarly productivity of pediatric radiologists relative to adult radiologists.

Materials and methods During summer 2021, faculty data for the top 10 U.S. News & World Report ranked adult radiology programs and the top 12 largest pediatric hospital radiology departments were collected. Information regarding self-reported gender, age, years of practice and academic rank was accessed from institutional websites and public provider databases. The h-index and the number of publications were acquired via Scopus. Group comparisons were performed using Mann–Whitney and chi-square tests.

Results Three hundred and sixty-four (160 women) pediatric and 1,170 (468 women) adult radiologists were included. Compared to adult radiologists, there were significantly fewer pediatric radiologists in advanced ranks (associate or full professor) ($P=0.024$), driven by differences between male ($P=0.033$) but not female radiologists ($P=0.67$). Among pediatric radiologists, there was no significant difference in years in practice ($P=0.29$) between males and females. There also was no significant difference in academic rank by gender ($P=0.37$), different from adult radiology where men outnumber women in advanced ranks ($P<0.001$). Male pediatric radiologists displayed higher academic productivity (h-index: 9.0 vs. 7.0; $P=0.01$ and number of publications: 31 vs. 18; $P=0.003$) than their female colleagues.

Conclusion Academic pediatric radiology seems to have more equitable academic advancement than academic adult radiology. Despite similar time in the workforce, academic output among female pediatric radiologists lags that of their male colleagues.

Keywords Academic advancement · Adult · Gender · Pediatric radiology · Publications

Introduction

Gender diversity in workplace leadership and management contributes to enhanced resourcefulness, improved efficiency and higher collective intelligence among teams [1]. In the medical field, physicians are often responsible for leading health care teams. Medical school admissions have made strides toward equal gender representation and, in 2020, the majority of graduating medical students were women [2]. Nonetheless, radiology remains a male-dominated workforce. More specifically, women have accounted for less than 27% of radiologic residency positions over the last 12 years [3], which has translated to a workforce consisting of 23% female radiologists as of 2019 [4].

Upon graduation from medical school, women are more likely than men to pursue a career in academia [5, 6], an

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environment that values collaboration and productivity. Despite this, the unequal promotion of women within academic medicine in general has been widely demonstrated [5–7] and the yearly proportion of women in advanced academic ranks and in leadership positions decreased between 2006 and 2017 [8]. Similar trends exist in academic radiology where women account for 34% of full-time faculty members and only held 26% of full professor positions in a 2021 analysis [9]. Continuing to work on these trends can be important to improve diversity in academic department, which can help produce higher quality research, with bigger impact and more citations [10–12].

Although a number of factors influence professional advancement in academic medicine, one important factor is scholarly productivity and research output [13]. While female-first and senior authorship in medical imaging journals has gradually risen between 1978 and 2013 [14], women in academic radiology still lag men in these important publication metrics [15], a trend exacerbated by the coronavirus disease 2019 (COVID-19) pandemic [15, 16]. A recent study of authorship trends in *Pediatric Radiology* inclusive of the COVID-19 pandemic showed female senior authorship was significantly lower in the early phase of the pandemic compared to the previous year [17].

Academic pediatric radiology is one of the few subspecialties in radiology with a more equal gender distribution among full-time faculty members with women comprising around 45% of the workforce [9, 18]. However, gender trends of academic advancement and scholarly productivity in this subspecialty are less well understood. Understanding these trends in academic pediatric radiology and how they differ from academic adult radiology presents an opportunity to define pathways toward gender equity in academic radiology. Therefore, the purpose of this study is to characterize gender differences for academic rank and scholarly productivity of pediatric radiologists relative to adult radiologists.

Materials and methods

Following review by the local Institutional Review Board, this study was determined to be exempt as all data were collected from publicly available sources. Between July and August 2021, information was gathered for the 2021 top 10 U.S. News & World Report ranked adult radiology programs [19] and the top 12 largest pediatric hospital radiology departments (by number of faculty) were determined via personal correspondence from the Society of Chiefs of Radiology at Children's Hospitals (SCORCH) in 2022 (Table 1). A larger cohort of pediatric hospitals was included in analysis as a means to improve the power of this study due to the smaller sample sizes of faculty within pediatric radiology departments. Each included institution had an Accreditation Council for Graduate Medical Education (ACGME)-accredited training program in diagnostic radiology at the time of data collection. Emeritus professors, adjunct faculty, visiting radiologists and volunteer professors were excluded from the final faculty sample as were residents or fellows listed as in training. Otherwise, each faculty radiologist holding a Doctor of Medicine (MD), Doctor of Osteopathic Medicine (DO) or an international equivalent medical degree who appeared on the institutional websites of hospitals meeting inclusion criteria were included.

Information pertaining to each faculty member within the adult and pediatric radiology cohorts was accessed by one author (S.M.S., a medical student) from institutional websites, Doximity (www.doximity.com) and the Centers for Medicare and Medicaid Services (CMS) National Plan and Provider Enumeration System (NPPES) National Provider Identifier (NPI) registry. Collected data included self-reported gender, age, years of practice and academic rank. Years of practice were defined as the number of years since completing their most recent fellowship at the time of data collection. Individuals were further categorized as early

Table 1 Included pediatric and adult radiology departments

Pediatric radiology departments	Adult radiology departments
Boston Children's Hospital	Duke University
Children's Hospital of Colorado	Johns Hopkins
Children's Hospital of Philadelphia	Massachusetts General Hospital
Cincinnati Children's Hospital Medical Center	Mayo Clinic (Rochester)
Lucile Packard Children's Hospital	New York University
Lurie Children's Hospital	Stanford University
Mercy Children's Hospital	University of California – San Francisco
Nationwide Children's Hospital	University of Michigan
Seattle Children's Hospital	University of Pennsylvania
Texas Children's Hospital	Washington University
University of Pittsburgh Children's Hospital	
University of Texas Southwestern Children's Hospital	

career (≤ 10 years), mid-career (11–20 years) and late career (≥ 21 years) based on years of practice. Academic rank was classified as instructor, assistant professor, associate professor or professor. If a faculty member held multiple titles within different clinical or academic departments, only the position held within the radiology department was included for analysis. Any radiologist with an affiliation at both a large university hospital and a children's hospital, such as a radiologist with an affiliation at both Stanford University and Lucile Packard Children's Hospital, was only included in the pediatric radiology cohort. Accuracy of the information was verified with spot checking by the senior author (R.S.A., a pediatric radiologist with 8 years of experience).

Scholarly productivity was defined as academic output, which can be measured by the h-index and number of publications per individual. The authorship database maintained through Scopus (Elsevier, Amsterdam, Netherlands) was used to gather metrics on scholarly activity. The author profile of all radiologists in the sample was retrieved through the Scopus search function to view the h-index and number of publications. If a radiologist had more than one author profile, Scopus' merge author function was employed to obtain a combined count of the author's metrics of interest.

Statistical analysis was performed using GraphPad Prism (v9.3.1; GraphPad Software, LLC, San Diego, CA). Descriptive statistics including counts, percentages, medians and interquartile ranges (IQR) were used to summarize the study sample. Group comparisons were achieved with Mann–Whitney tests for continuous variables and chi-squared tests for categorical variables. Mixed effects modeling was used to test for interactions between genders and years in practice as predictors of academic productivity. A P-value of < 0.05 was considered statistically significant for all inference testing.

Table 2 Characteristics of pediatric radiologists

	Total	Female	Male	P-value
Age (years)		48 (42, 55)	46.5 (42, 55.75)	0.74
Years in practice		14 (8, 20)	12 (7, 20)	0.29
Academic rank (n, %)				0.37
Instructor	18	10 (56%)	8 (44%)	
Assistant	179	84 (47%)	95 (53%)	
Associate	103	42 (41%)	61 (59%)	
Professor	64	24 (38%)	40 (62%)	
Academic productivity				
H-index		7 (3, 14.75)	9 (4, 20)	0.01
Total publications		18 (6, 50.5)	31 (11, 75)	0.03

P-values reflect comparisons between men and women

Results are presented as medians and interquartile ranges or as counts and percentages

Table 3 Characteristics of adult radiologists

	Total	Female	Male	P-value
Age (years)		47 (39, 57)	48 (41, 59)	0.07
Years in practice		14 (5, 23)	13 (6, 24)	0.44
Academic rank (n, %)				0.0004
Instructor	68	22 (32%)	46 (68%)	
Assistant	529	222 (42%)	307 (58%)	
Associate	283	98 (35%)	185 (65%)	
Professor	290	79 (27%)	211 (73%)	
Academic productivity				
H-index		8 (3, 16)	15 (6, 29)	< 0.0001
Total publications		20 (6, 51.5)	45 (15, 108.8)	< 0.0001

P-values reflect comparisons between men and women

Results are presented as medians and interquartile ranges or as counts and percentages

Results

Three hundred and sixty-four (44% [$n = 160$] women) pediatric radiologists were included in the final sample. Women comprised the majority only among instructors ($n = 10/18$, 56%), while occupying less than 50% of roles in other academic ranks, a difference compared to men that was not statistically significant ($P = 0.37$) (Table 2). Male pediatric radiologists had significantly higher h-indexes ($P < 0.02$) and numbers of publications ($P < 0.01$) compared to their female counterparts (Table 2). There was no significant difference in age ($P = 0.74$) or years in practice ($P = 0.29$) between male and female pediatric radiologists (Table 2).

Across the 10 adult radiology departments analyzed, 1,170 (36% [$n = 421$] women) radiologists were included in the final sample. Men significantly outnumbered women in all academic ranks ($P < 0.001$), holding 68% of instructor roles, 58% of assistant professor roles, 65% of associate professor roles and 73% of professor roles (Table 3). Male adult radiologists had significantly higher h-indexes ($P < 0.0001$) and numbers of publications ($P < 0.0001$) compared to their female counterparts (Table 3). There was no significant difference in age ($P = 0.07$) or years in practice ($P = 0.44$) between male and female adult radiologists (Table 3).

There was no significant difference in median age (pediatric: 47 [IQR: 42, 55] years; adult: 47 [IQR: 40, 58] years; $P = 0.84$) or median years in practice (pediatric: 13 [IQR: 7, 20] years; adult: 13 [IQR: 6, 24] years; $P = 0.60$) between pediatric and adult radiologists. However, compared to adult radiologists, there were significantly fewer pediatric radiologists in advanced ranks (associate or full professor) (167/364

vs. 573/1,170; $P=0.02$). This difference was significant for men (101/204 vs. 396/749; $P=0.03$) but not for women (66/160 vs. 177/421; $P=0.67$). There was no statistically significant difference among women in pediatric or adult groups for publications or h-index ($P=0.25$ and $P=0.11$, respectively).

Among pediatric radiologists, time in career and male gender were each statistically significant independent factors associated with more publications ($P<0.0001$, $P=0.001$), higher h-index ($P<0.0001$, $P=0.0032$), and advanced rank (associate or full professor) ($P<0.0001$, $P=0.007$), respectively. However, when gender and years in practice were assessed together, there was no statistically significant effect on publications ($P=0.66$), h-index ($P=0.81$) or advanced rank ($P=0.65$).

Discussion

Diverse teams foster collaboration and innovation [1, 20, 21], yet academic radiology has historically struggled with a gender imbalance in staffing and promotion [9, 22]. As a subspecialty, pediatric radiology has more equal gender representation among radiologists than other radiology subspecialties [9, 18]. How this interacts with academic rank and scholarly productivity metrics relevant to academic rank is not well understood. In our sample that included the largest academic pediatric radiology departments and highest ranked adult radiology departments, the proportion of female faculty members was relatively similar between pediatric and adult radiology departments (44% and 36%, respectively). However, women had more equal representation in advanced ranks in pediatric radiology departments than in adult departments where women were significantly underrepresented across all ranks, but particularly in the advanced ranks. Despite this, women in both pediatric and adult radiology departments displayed lower academic productivity compared to their male counterparts.

It is well known that gender discrepancies exist in adult radiology departments. The most recent workforce survey by the American College of Radiology from 2019 showed an enduring predominance of male and no significant change in the proportion of female faculty (23%) since 2012 [4]. In our sample of the top 10 U.S. News & World Report ranked adult academic radiology departments, the gender gap appears less wide than previously reported [9, 22], a discrepancy that may relate to sample differences or could represent real improvement in equitable gender advancement efforts. Possible sources of improved gender balance in academic radiology include more women graduating medical school [2] alongside the greater preference women have for choosing to pursue an academic career relative to men [5, 6]. Early participation in research, professional goals and interests, and work-life balance are all thought to contribute to this decision to enter academia [9, 23, 24].

Although our sample demonstrates a similar proportion of women in academic adult radiology departments to previous work, our results continue to show disproportionately low representation of women in advanced academic ranks in adult radiology departments, particularly the full professor rank (73% men). This finding aligns with a 2016 study showing that only 16% of women in adult academic radiology held the title of full professor compared to 26% of men [25] and a more recent study in 2021 reporting that only 26% of all full professor titles in adult academic radiology belonged to women [9]. These findings all suggest that while the gender gap may be narrowing for representation in academic radiology faculty, the gender gap in academic advancement has not yet caught up.

Pediatric radiology is one of the radiologic subspecialties with more equal gender distribution among full-time radiologists [18], a trend that holds true in academic pediatric radiology as shown in our study (44% women) and previous studies (45–46% women) [9, 26]. Despite this, previous studies suggest there is a gender gap in academic rank in academic pediatric radiology departments, mirroring adult radiology departments. Specifically, a 2020 study of pediatric radiologists in the United States and Canada showed a minority of senior faculty members (associate professors and full professors) to be women (34% and 29%, respectively) [26]. Among assistant professors in the aforementioned study, however, women held a small majority (55%) [26]. In our sample, women were the minority in all advanced ranks, but there was no statistically significant difference in rank by gender. This discrepancy in results may speak to differences in sample populations given that our study did not include Canadian radiology departments. Alternatively, this might signify a recent movement toward more equitable promoting practices, particularly in the largest academic pediatric radiology departments in the United States. While such a shift would indicate progress, work remains to achieve and promote equity in academic advancement. Disproportionate career development between genders in academia is thought to be multifactorial with perhaps inconsistent standards even within individual institutions [27]. Earlier work has acknowledged scholarly productivity levels, faculty-chosen track, a lack of oversight in promotion procedures, poor retention of women, an unequal burden of family responsibilities and imbalanced resource allocation as possible causes of gender inequity in promotion [5, 6, 25, 27].

When comparing pediatric to adult radiology departments, our results show lower frequencies of advanced academic rank among pediatric compared to adult radiologists despite no difference in age or years in practice. This appears to be driven by a significant difference between male radiologists, but not female radiologists. This suggests two things:

1) male adult radiologists appear to progress to advanced ranks faster than male pediatric radiologists; and 2) female radiologists are equally underrepresented at advanced ranks in both adult and pediatric departments despite no difference in age or years in practice from their male counterparts. While the cause of the overall lower frequency of pediatric associate or full professors is unknown, one possible explanation is that pediatric radiologists are not afforded, or are not seeking, promotion in their departments at the same rate as their adult radiology counterparts.

In academic medicine, scholarly productivity is the factor that tends to have the greatest influence on promotion [9, 13]. Our results show that women in academic pediatric and adult radiology lag their male colleagues in scholarly productivity as indicated by lower h-indices and a smaller number of publications in peer-reviewed imaging journals. This is despite no significant difference in age or years in practice between genders, which is concordant with previous reports [9, 14, 15, 17]. Our study was not designed to define the causes for this discrepancy, but there are a number of barriers known to limit scholarly achievement and therefore hinder the opportunity for promotion. Female radiologists have been shown to be less likely to receive National Institutes of Health grants compared to men and, compounding the inequity, the amount awarded to women was lower compared to their male counterparts [28, 29]. Additionally, faculty members with mentors tend to have a higher number of publications [30], yet women in medicine often lack access to mentors [31]. Lastly, childcare responsibilities and work-life balance preferences may impact research output and have been identified as barriers to professional development by women in academic radiology [32].

This study is not without limitations. First, faculty track (tenure versus nontenure; educator versus academic), part-time status and length of employment at each faculty member's current institution (versus overall years in practice) were not included in analyses as these data were not consistently publicly available. Similarly, institution-specific promotion guidelines/criteria are also not publicly available and could not be included in analyses. Second, although all data were obtained over a 2-month period, the majority of institutional websites did not display when faculty lists had been updated making the data in this study dependent on the frequency of individual departmental updating practices. Furthermore, given that Scopus is continuously updated according to journal publishing, author h-indices and publication counts will not be identical if a similar study were to use the Scopus database in the future. Third, if an individual had changed their name, such as after marriage, so that it differed from — or was not merged with — an earlier Scopus profile, their scholarly productivity metrics would have been underestimated. Fourth, the calculation of a faculty member's total years of practice did not account for any career pauses or disruptions, such as obtaining advanced degrees or parental/medical leave, which would lead to an overestimation of this metric. Finally, it is not possible to know the degree of similarity or difference between institutions within this study sample in terms of characteristics that might be relevant to scholarly productivity of faculty.

Conclusion

Although academic pediatric radiology appears to have more equitable advancement to higher academic rank between genders as compared to adult radiology, women still hold a minority of senior academic ranks overall. Women in pediatric radiology also continue to have lower academic output relative to men despite similar time in practice. These findings show a continued need for initiatives that both support women in academic radiology and remove barriers to productivity and promotion, in addition to a critical assessment of promotion criteria differences among pediatric and adult radiology departments.

Declarations

Conflicts of interest None

References

1. Dwyer S, Richard OC, Chadwick K (2003) Gender diversity in management and firm performance: the influence of growth orientation and organizational culture. J Bus Res 56:1009–1019
2. Association of American Medical Colleges (2021) Total U.S. medical school enrollment by race/ethnicity and sex, 2017–2018 through 2021–2022. Washington, DC
3. Adham S, Rybicki FJ, Mahoney MC et al (2022) Analysis of gender disparity in US and Canadian radiology residency programs. Curr Probl Diagn Radiol 51:21–24
4. Bender CE, Bansal S, Wolfman D, Parikh JR (2020) 2019 ACR Commission on Human Resources Workforce Survey. J Am Coll Radiol 17:673–675
5. Nonnemaker L (2000) Women physicians in academic medicine — new insights from cohort studies. N Engl J Med 342:399–405
6. Richter KP, Clark L, Wick JA et al (2020) Women physicians and promotion in academic medicine. N Engl J Med 383:2148–2157
7. Jena AB, Khullar D, Ho O et al (2015) Sex differences in academic rank in US medical schools in 2014. JAMA 314:1149–1158
8. Niu BT, Nicolaou S, Levine D et al (2020) Trends in gender and racial profiles of US academic radiology faculty. J Am Coll Radiol 17:1337–1343
9. Goswami AK, Kokabi N, Khaja MS et al (2021) Academic radiology in the United States: defining gender disparities in faculty leadership and academic rank. Acad Radiol 29:714–725
10. Campbell LG, Mehtani S, Dozier ME, Rinehart J (2013) Gender-heterogeneous working groups produce higher quality science. PLoS ONE 8:e79147
11. Freeman RB, Huang W (2014) Collaboration: strength in diversity. Nature 513:305

12. National Research Council (2015) Enhancing the effectiveness of team science. National Academies Press, Washington, DC
13. Rice DB, Raffoul H, Ioannidis JPA, Moher D (2020) Academic criteria for promotion and tenure in biomedical sciences faculties: cross sectional analysis of international sample of universities. BMJ 369:m2081
14. Piper CL, Scheel JR, Lee CI, Forman HP (2015) Gender trends in radiology authorship: a 35-year analysis. AJR Am J Roentgenol 206:3–7
15. Quak E, Girault G, Thenint MA et al (2021) Author gender inequality in medical imaging journals and the COVID-19 pandemic. Radiology 300:E301–E307
16. Mogensen MA, Lee CI, Carlos RC (2021) The impact of the COVID-19 pandemic on journal scholarly activity among female contributors. J Am Coll Radiol 18:1044–1047
17. Ayyala RS, Trout AT (2021) Gender trends in authorship of Pediatric Radiology publications and impact of the COVID-19 pandemic. Pediatr Radiol 52:868–873
18. Pfeifer CM, Gokli A, Reid JR (2020) Advancing from gender equity to women in leadership in pediatric radiology. Pediatric Radiol 50:631–633
19. No authors listed (2021) Best radiology programs. In: U.S. News & World Report. Accessed 26 Jun 2021
20. Østergaard CR, Timmermans B, Kristinsson K (2011) Does a different view create something new? The effect of employee diversity on innovation. Res Policy 40:500–509
21. Williams AW, Chabris CF, Pentland A et al (2010) Evidence for a collective intelligence factor in the performance of human groups. Science 330:686–688
22. Grimm LJ, Ngo J, Pisano ED, Yoon S (2016) Men (and women) in academic radiology: how can we reduce the gender discrepancy? AJR Am J Roentgenol 206:678–680
23. Edmunds LD, Ovseiko PV, Shepperd S et al (2016) Why do women choose or reject careers in academic medicine? A narrative review of empirical evidence. Lancet 388:2948–2958
24. Andriole DA, Jeffe DB, Hageman HL et al (2010) Variables associated with full-time faculty appointment among contemporary U.S. Medical school graduates: implications for academic medicine workforce diversity. Acad Med 85:1250–1257
25. Kapoor N, Blumenthal DM, Smith SE et al (2016) Gender differences in academic rank of radiologists in U.S. medical schools. Radiology 283:140–147
26. Counter WB, Khurshid K, Jalal S et al (2020) Gender differences among academic pediatric radiology faculty in the United States and Canada. Acad Radiol 27:575–581
27. Murphy M, Callander JK, Dohan D, Grandis JR (2021) Women's experiences of promotion and tenure in academic medicine and potential implications for gender disparities in career advancement: a qualitative analysis. JAMA Netw Open 4:e2125843–e2125843
28. Jutras M, Malekafzali L, Jung S et al (2020) National Institutes of Health: gender differences in radiology funding. Acad Radiol 29:748–754
29. Franceschi AM, Rosenkrantz AB (2017) Patterns of recent National Institutes of Health (NIH) funding to diagnostic radiology departments: analysis using the NIH RePORTER System. Acad Radiol 24:1162–1168
30. Sambunjak D, Straus SE, Marušić A (2006) Mentoring in academic medicine: a systematic review. JAMA 296:1103–1115
31. Bredella MA, Fessell D, Thrall JH (2019) Mentorship in academic radiology: why it matters. Insights Imaging 10:107
32. Piltch-Loeb R, Rosenkrantz AB, Merdjanoff AA (2020) Identifying barriers and facilitators of success for female radiology researchers: an analysis of in-depth interviews with nationally recognized leaders of the field. J Am Coll Radiol 17:1344–1351

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