Gender Bias in Diagnostic Radiology Resident Selection, Does it Exist?

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Rationale and Objectives: To investigate whether there is a bias in the residency selection process that influences the proportion of females entering diagnostic radiology residencies.

Materials and Methods: A total of 4117 applications to one diagnostic radiology residency program from 2008 to 2014 were analyzed. Invitations to interview were evaluated by each year, specifically looking at gender. Ranking of applicants, especially those placed in top 25% of the rank, was also assessed. Additional data analyzed included United States Medical Licensing Examination Step 1 board examination score (a proxy for academic performance), interview scores, and final position on rank list.

Results: Female applicants averaged 24% of the total applicant pool during the years studied, yet made up a disproportionately high percentage of applicants invited to interview (30%) and those ranked in top 25% (38%). It was found that female applicants had slightly higher mean interview scores and lower Step 1 scores than male applicants.

Conclusions: Our findings suggest that program directors in one program want to increase gender diversity by making strides to keep the female candidate pool and the proportion of female residents in the program at least stable. The pipeline of female medical students pursuing a career in radiology appears to be a limiting factor rather than a bias against women in the resident selection process. Identifying such trends is important as it provides a better understanding of the etiology for an overall lack of gender diversity within the field. Furthermore, it may lead to closing the gender gap in radiology.

Key Words: Education; Gender; Bias; Diversity; Radiology; Women; Resident.

INTRODUCTION

Although the percentage of women graduating from medical schools in the United States has increased significantly in the last few decades, reaching almost 50% in 2007, there has not been a parallel increase in gender composition of medical graduates pursuing diagnostic radiology residency programs (1). The proportion of women starting a career in radiology has remained remarkably stagnant since at least 1980, when 25.5% of all radiology residents were female (2). As of 2013, women made up just 26.8% of all the radiology residents, demonstrating only a 1.3% increase in more than 30 years (3). Conversely, the gender landscape in other specialties has changed significantly during this same period of time. In the 1980s and prior, female residents were concentrated in internal medicine, obstetrics and gynecology, pediatrics, and family medicine (4). Since then, women have redistributed throughout most other specialties, even those that are historically male predominant such as surgery and the various surgical subspecialties (3,4). Radiology has not benefitted from this redistribution of women in medicine, as evidenced by the fact that the proportion of women in the specialty has not significantly changed.

The reason women continue to be underrepresented in radiology has been studied at length, including baseline interest of medical students in radiology, factors influencing interest, and whether these factors differ between genders (5,6). Lifestyle factors and other characteristics that influence whether medical students choose radiology as a career, such as the amount of patient contact, salary, and competitiveness, have also been described in relationship to gender (7). The influence of female role models, program directors, and faculty in determining a female medical student's career path has also been investigated in several articles (5,8,9).

Diversity is celebrated as an important factor contributing to the success of companies and businesses. Increased diversity has been shown to correlate with increased sales revenue, greater market share, and higher profits (10). Large, successful companies recognize this and many make pointed efforts to enhance diversity within the workforce (10). A successful group, whether it be a business or a radiology residency training program, needs to be able to recruit and hold on to the most talented individuals available. This is not possible if almost half of the candidate pool (female medical students) is not even considering a career in radiology. There are also reasons more specific to the field of radiology. There have been shortages of mammographers and pediatric radiologists in recent years (11–14). It has been found that female radiologists are much more likely to pursue a career in these two subspecialties than

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males, and increasing the pool of female radiologists could lead to ending this shortage (11–14).

The presence of gender bias in academia and science is a current topic of interest. Despite an increasingly integrated workforce and education environment between men and women, many studies suggest that gender bias may persist in these communities (15). For example, a recent study demonstrated that unconscious bias favoring men exists in science faculty members' perception of students (16). As a testament to the potential significance of this finding, it has been shown that a small degree of bias in the assessment of job applicant performance correlates to large differences in the number of positions filled by different types of applicants (17). Despite the awareness of gender bias in scientific communities and the ongoing discussion about the lack of gender diversity in diagnostic radiology in the literature, a study has not been undertaken to discern if there is gender bias at the level of resident selection in United States radiology programs. Because women are not entering radiology residencies in a similar proportion to other specialties (3), we hypothesize that gender bias occurs at the level of radiology resident selection.

METHODS

This study is a retrospective cohort study investigating a total of 4117 applications to one diagnostic radiology residency program from 2008 to 2014. Data from these applications were obtained from the Electronic Residency Application Services (ERAS). All applications were analyzed anonymously to protect applicant privacy. The residency program of study is a large-sized, university program with a total of 36 residents and is located in the Southeast.

Data extracted from all applications included gender, United States Medical Licensing Examination (USMLE) Step 1 score, medical school type (international versus noninternational), and whether the applicant was invited to interview. USMLE Step 1 score was chosen as a proxy for overall academic performance as it has been shown to directly correlate with academic performance and because other metrics such as the number of honors/passes/fails or Alpha Omega Alpha status differ by medical school (18).

Additional data extracted from the applications of individuals invited to interview included mean interview score, whether the applicant was ranked, and final position on the rank list. Finally, to determine the consequence of any possible gender bias, the final match status of the applicants ranked was also investigated.

At our institution, all applications are initially reviewed by two members of the selection committee, the Program Director and the Assistant Program Director. Applicants are invited to interview based on grades in clinical clerkships, Medical Student Performance Evaluations (MSPEs), leadership experience, USMLE step 1 score, volunteer work, research, letters of recommendation, and significant life experiences.

The proportion of females to total applicants at the stages of invitation to interview, rank, rank in the top quartile, and match was determined for each year. Trends in these proportions over the years studied were analyzed using slopes tests. Threshold for statistical significance was set at $P < 0.05$ for all analyses. Slopes test was also used to analyze the trend in the proportion of total female applicants over the years studied.

We compared our local data to national data using a one-sample binomial test to assess whether our findings are mirrored on a larger scale. National data were obtained from publicly available ERAS data, which report applicant number by gender for all programs accredited by the Accreditation Council for Graduate Medical Education (19). The only ERAS years available for comparison were 2010–2014, and these are the only national data currently available that divide residency applicants by gender and by specialty. ERAS data are permissible to be reproduced and distributed with attribution for educational noncommercial purposes. We also compared trends in the proportion of female applicants to this radiology program with the proportion of female applicants to radiology programs nationwide utilizing the same ERAS data over time using a slopes test. A slopes test was also used to determine if there was a significant trend in the proportion of the females out of the total applicant pool nationwide over the years studied. Lastly, a slopes test was used for both national and local data to determine trends in the total number of applicants to programs for years 2010–2014 and years 2008–2014, respectively.

For each year individually, we compared the observed proportion of women invited to interview to the hypothesized proportion that would be expected to be invited to interview if the proportion of total female applicants was maintained with a one-sample binomial test. We also used a one-sample binomial test to compare the percentage of women ranked in the top 25% of the rank list to the hypothesized percentage that would be expected to be ranked in the top 25% if the proportion of female applicants invited to interview was maintained with a one-sample binomial test.

USMLE Step 1 score and mean interview score for each year separated by gender was also compared to determine whether differences in females from males at various stages in the match process is due to differences in qualifications (academic performance, interview performance) between genders or due to bias related to the applicant's gender. Mean interview score refers to the average of all scores an applicant received from each interviewer. The average of all male and female applicants' Step 1 scores and mean interview score was used for each year. Statistical significance ($P < 0.05$) for the difference between male and female mean interview scores and USMLE Step 1 scores was determined using Welch's unpaired *t* tests and also analysis of variance (ANOVA) tests. Post hoc comparisons were conducted using the Sidak method of correcting for multiple comparisons.

RESULTS

Female applicants made up an average of only 24% ($N = 993/4117$) of the total applicant pool during the years 2008–2014 (Table 1). However, females comprised 30%