Gender Differences in Successful National Institutes of Health Funding in Ophthalmology

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OBJECTIVE: To determine whether gender differences in individual National Institutes of Health (NIH) awards and in funding totals exist in ophthalmology, and to further characterize whether factors such as experience, academic rank, and terminal degree play a role.

DESIGN: A retrospective review of awards granted to primary investigators (PIs) in ophthalmology departments from 2011 through the present was conducted. PIs were classified by gender, degree, experience, and academic position. The NIH funding database was used to gather award data.

SETTING: Academic medical center.

RESULTS: Men had higher mean NIH awards ($418,605) than their female colleagues ($353,170; $p = 0.005$) and had higher total funding per PI ($p = 0.004$). Men had statistically higher awards at the level of assistant professor than their female counterparts ($p < 0.05$). A gender difference was statistically significant and most marked among researchers holding an MD (or equivalent) degree. When controlled for publication experience, men had higher NIH awards throughout their careers, although this difference only reached statistical significance on comparison of faculty with 10 or fewer years of experience.

CONCLUSIONS: Male PIs receiving grants since 2011 had higher awards than their female colleagues did, most markedly among PIs in the earlier portions of their career. Differences in gender representation among senior faculty and in positions of leadership in academic ophthalmology may be partially a result of disparities in research output, as scholarly productivity is an important component of the academic advancement process in ophthalmology. (J Surg 71:680-688. © 2014 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: gender, NIH funding, gender disparity, NIH funding gender disparity, academic promotion, NIH RePORTER

COMPETENCIES: Professionalism, Interpersonal and Communication Skills, Practice-Based Learning and Improvement

INTRODUCTION

Numerous studies have documented the increasing representation of women in academic medicine. In 2012, females constituted 47.8% of US medical school graduates, an increase from 44.3% in 2001.[1] Similarly, women accounted for 43.1% of ophthalmology residents in 2011. Significant differences in gender representation, however, do persist among senior faculty and in positions of leadership. Of the nearly 120 ophthalmology departments in the United States, only 3 have a female chairperson, while only 34% of residency program directors are women.[2]

Differences in scholarly productivity may play a role in the underrepresentation of women in these positions. Along with other factors such as clinical performance and contributions to medical education, research output is an important component of the academic appointment and promotion process.[3-13] A review of ophthalmic peer-reviewed publications from 2009 noted that 29.2% of first authors, only 12.5% of assistant editors, and none of the editors in chief of ophthalmic scientific journals were

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women.[14] Similarly, a study of 60 peer-reviewed journals across specialties published in 2011 found that 17.5% of 4112 editorial board members were women, whereas only 15.9% of editors in chief were women. Consistent with the previously mentioned analysis from 2009, no women held the position of editor in chief of any journals dedicated to ophthalmology.[15]

Several measures commonly used to assess scholarly productivity may be integral to academic advancement at many institutions. Research output as measured by total number of publications in the peer-reviewed literature, and measures of scholarly relevance such as the *h-index* are both objective and easily calculable measures.[5-7,16-22] Successful procurement of research grants may also be used to assess faculty, as such awards (1) increase research output, and consequently, the impact of an institution on discourse within a field; (2) decrease financial pressures on institutions to support research via internal mechanisms; and (3) potentially affect the reputation of institutions and departments.[5,20,23,24]

Grants awarded by the National Institutes of Health (NIH) are often regarded as the gold standard in biomedical research, as the NIH is the largest supporter of biomedical research in the US.[5,20,23,24] Although gender disparities in research productivity have been described in other specialties and with other measures of scholarly impact,[3,6,22,25-27] there has been no examination of whether any such differences exist in the funding of primary investigators (PIs) in academic ophthalmology departments. The objectives of this analysis are to determine whether gender differences in individual NIH awards and funding totals exist, and further characterize whether factors such as years of experience, academic rank, and terminal degree play a role in the disparity.

MATERIALS AND METHODS

The NIH Research Portfolio Online Reporting Tool Expenditures and Results (RePORTER) site (http://projectreporter.nih.gov/reporter.cfm) was used to obtain a list of the 590 NIH grants awarded to ophthalmology departments listed online as of February 2013, ranging from fiscal year 2011 to 2013. Although the effect of gender has not been previously examined in ophthalmology, this online database has proven valuable in analyses of NIH funding trends in radiology, urology, and otolaryngology.[5,20,24] The 590 NIH grants were awarded to 408 unique PIs, as many had multiple awards. In this analysis, both individual NIH awards as well as the NIH funding totals per each PI (i.e., the aggregate of individual awards to a PI) were considered.

Online faculty listings from the home institutions of PIs on this database were searched for information regarding academic rank (assistant professor, associate professor, professor, or nonfaculty positions, including postdoctoral fellows, research fellows, and research associates) and terminal degree (MD, MD-PhD, PhD, or other doctorate). PIs were further organized by gender, determined independently by 2 authors (P.F.S. and A.A.P.) using both names and photographs from online listings.

The Scopus database (www.scopus.com) was used to determine the publication experience (in years) of all PIs, as well as the *h-index* of all PIs. Although this database comprehensively details sources from more than 18,000 peer-reviewed journals[28] and has been of value in previous bibliometric analyses,[7,8,21,25-27,29-44] multiple search results can arise when common names are searched.[22] Previous and current departmental affiliations as well as source history were used to ensure that the publication range obtained for each author was referring to the appropriate PI.

Statistical Analysis

Mann-Whitney *U* tests were performed for comparison of continuous variables as appropriate, with threshold for significance set at $p < 0.05$. SPSS version 20 (IBM Company, Chicago, IL) was used for statistical calculations.

RESULTS

Of 590 NIH grants included in this analysis, 433 (73.4%) were awarded to male PIs and 157 (26.6%) to female PIs. The mean grant awarded to male PIs ($418,605) was significantly higher than the mean awarded to female PIs ($353,170) (Fig. 1A, $p = 0.005$). This gender disparity persisted when accounting for PIs with multiple grants and examining total NIH funding per individual (Fig. 1B).

When controlled for by academic rank, a gender difference in NIH awards reached significance at the level of assistant professor (Fig. 2A, $p = 0.046$). Male PIs had higher mean NIH awards among associate professors, professors, and nonfaculty members (Fig. 2A and B), although this difference did not reach statistical significance ($p = 0.14$ and 0.06, respectively). On organization by terminal degree, male MDs had statistically higher NIH awards than their female colleagues (Fig. 3, $p = 0.03$). The smallest gender difference was noted among PIs with PhDs, for which awards to men were greater by only an average of $22,452 ($p = 0.16$).

Men had higher NIH awards than their female colleagues throughout nearly all years of publication experience, although this difference only reached significance on comparison of PIs with 0 to 10 years of experience ($272,360 vs $192,067; $p = 0.03$) (Fig. 4). There was a nearly equivalent breakdown of types of grants awarded between genders. The only series of grants for which a statistical difference was noted in mean awards were R-series grants; the mean R-grant to male PIs was $408,934, statistically higher than those awarded to women ($359,212; $p = 0.03$). R-series grants comprised 75.0% of NIH awards to men and 75.1%

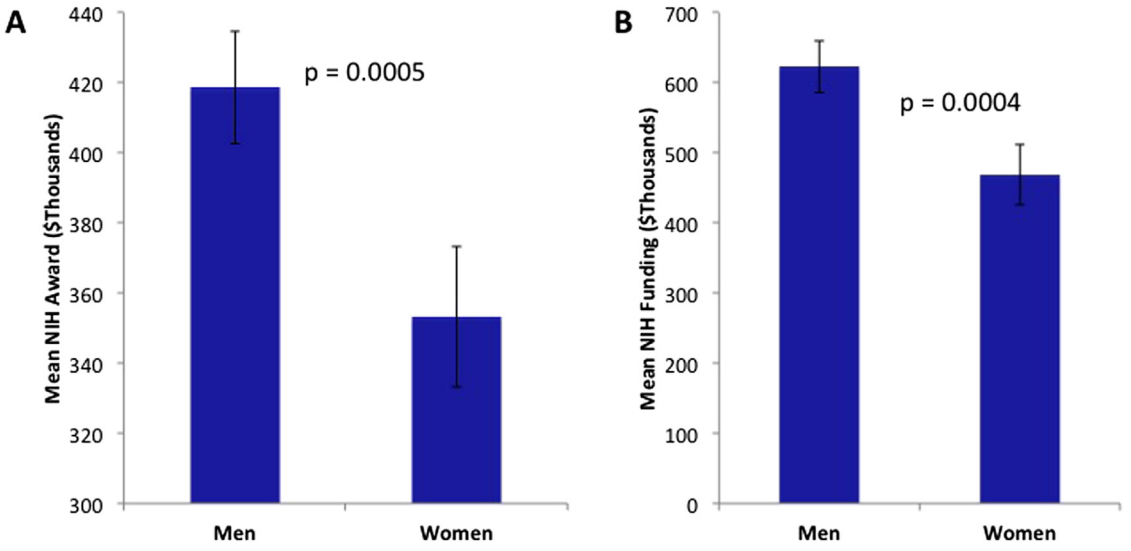

FIGURE 1. (A) Mean NIH awards to faculty in ophthalmology departments. (B) Mean total NIH funding per PI. The p values were derived from Mann-Whitney *U* test, and error bars represent standard error of mean.

of those to women. Scholarly impact, as measured by the *h-index*, was measured among the cohorts included in this analysis and showed that overall, men had a higher *h-index* ($H = 21.1 \pm 0.51$ standard error of mean) than women ($H = 17.3 \pm 0.87$ standard error of mean) ($p < 0.0001$).

DISCUSSION

The representation of women among US graduating physicians has only recently approached 50%.[22,45-47] According to the Association of American Medical Colleges, women comprised 54.3% of family medicine residents and 70.3% of pediatric residents in 2011.[1] In contrast, women are considerably underrepresented in many surgical specialties, accounting for 37.1% of residents in general surgery, 15.4% in neurological surgery, and 13.6% in orthopedic surgery.

As previously noted, differences in gender representation are smaller among ophthalmology residents than in other surgical specialties. According to the Association of American Medical Colleges, during the 10-year period

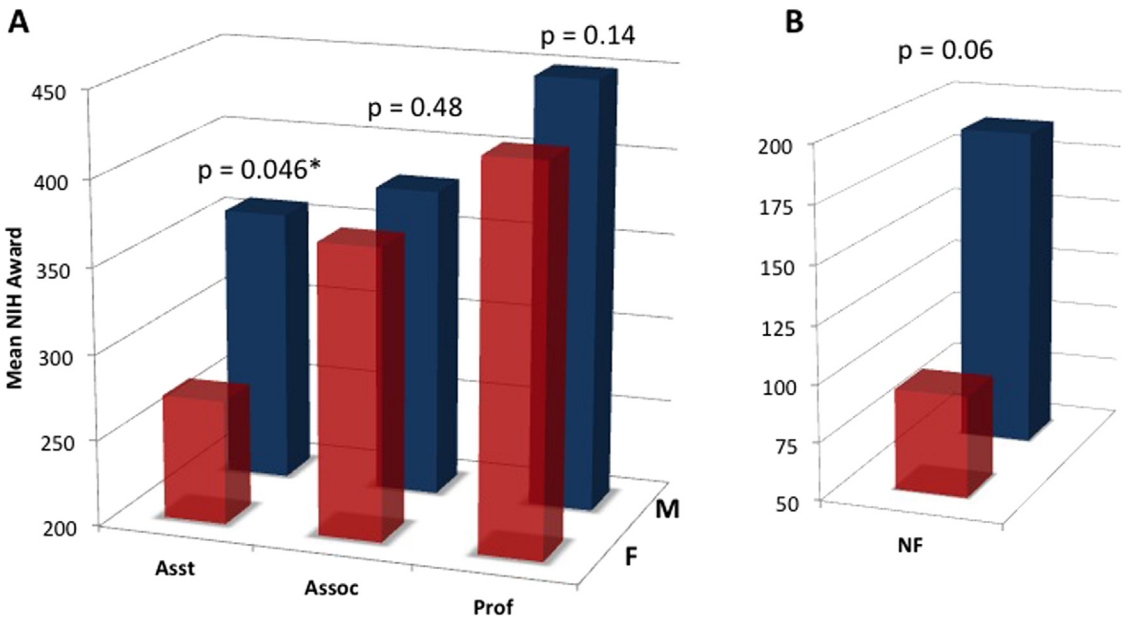

FIGURE 2. Mean NIH awards broken down by gender and academic rank. (A) Faculty in ophthalmology departments receiving NIH awards. (B) Nonfaculty PIs in ophthalmology departments receiving NIH awards, including research fellows, postdoctoral fellows, and research associates. The p values were derived from Mann-Whitney *U* tests. Asst, assistant professor; Assoc, associate professor; Prof, professor; M, males; F, females.

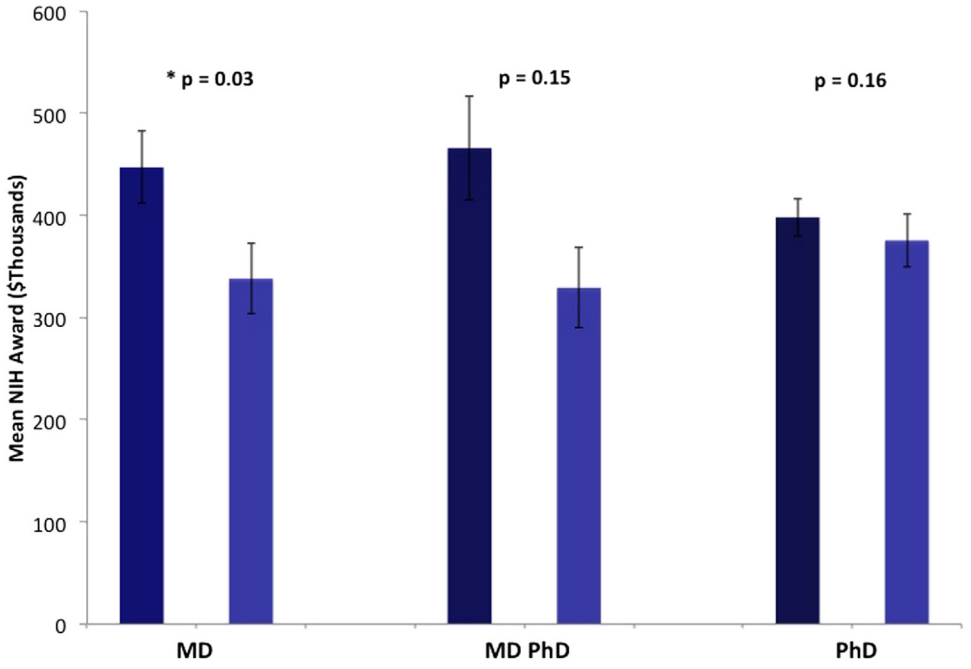

FIGURE 3. Gender differences in NIH awards organized by terminal degree. PhD cohort represents PhDs and other non-MD/MD-equivalent doctorates. The p values were derived from Mann-Whitney *U* tests, and error bars represent standard error of mean.

between 2001 and 2011, the proportion of female residents in ophthalmology training programs increased from 32.1% to 43.1%.[1] On the contrary, female ophthalmologists are underrepresented as attending physicians, particularly in academic medicine, constituting 31% of full-time faculty in 2012. This relative underrepresentation increases with successive academic rank.[1] As the number of women in ophthalmology has not increased until relatively recently, many recently trained female ophthalmologists may have not yet attained the credentials necessary for academic advancement.

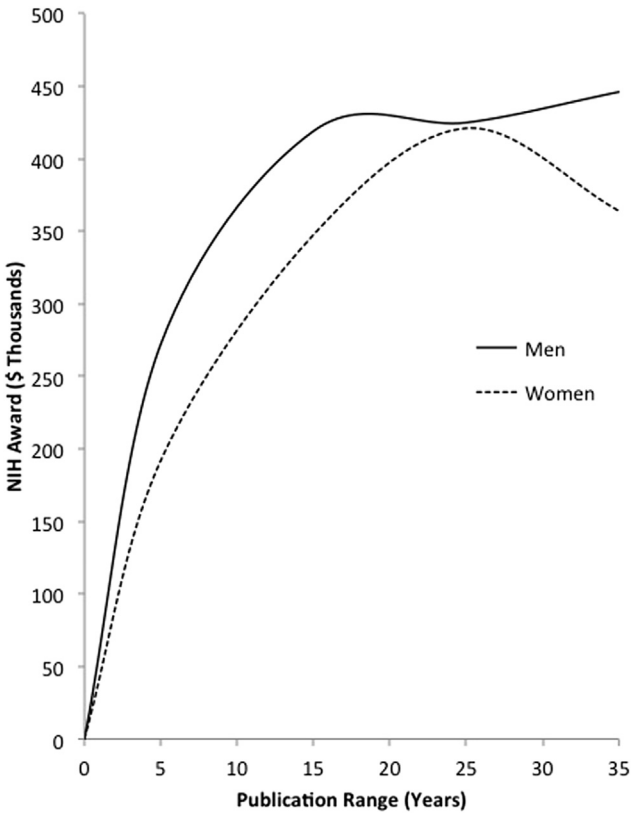

FIGURE 4. NIH awards organized by publication experience (in years).

Several reasons have been offered for the historical underrepresentation of women in surgical specialties relative to other fields. Concerns about workload in ophthalmology and other surgical specialties and its effects on family responsibilities have been widely studied and cited as a potential reason.[48-56] Across all professions, women are more likely to be the primary caregiver for dependents and have more limited geographic mobility secondary to this role, increasing their time away from academic and career pursuits.[55,57,58] Female physicians with children have been reported to have lower publication rates, less institutional support, slower perceived career progress, and lower reported career satisfaction when compared with their male counterparts with children.[55] Female physicians may also take more time off from work for childbirth or adoption, whereas male physicians in general work more hours per week.[59]

Partially related to this issue are adverse consequences associated with pregnancy during a surgical residency; increased work hours and maternal age may potentially increase complications such as preterm delivery and inadequate birth weight.[60-63] Analyses have noted that female academic physicians agree with the perception that family

responsibilities have postponed academic promotion.[55,64] These differences have been noted to disproportionately affect women in the earlier part of their careers, an observation consistent with findings in the present analysis. Notably, overall gender differences noted were statistically significant and most marked at the level of assistant professor (Fig. 2A), as well as on comparison of faculty members with less than 10 years of experience (Fig. 4).

Multiple analyses have previously noted an early-career gender disparity among academic physicians. A single-institution analysis of faculty from the Mayo clinic reported that although men had higher overall publication rates, female research productivity exceeded that of their male colleagues later in their careers.[3] Another analysis of scholarly impact among academic otolaryngologists similarly reported that although men had higher overall research output, women demonstrated a disparate productivity curve in which their scholarly productivity equaled and surpassed that of their male colleagues in the later parts of their academic careers.[22] In our analysis, overall differences in NIH funding between genders, noted in Figure 1, diminished when controlled for academic rank (Fig. 2). However, further research is needed to elucidate the reasons for this finding. In other words, it is not clear whether women are promoted in fewer numbers because of a failure to attract sizeable grants or owing to failure to attract grants hurts promotion opportunities.

Although family considerations have been previously studied, some have noted that women are just as motivated as men to pursue leadership opportunities in academic surgery.[57] The role of family responsibilities in academic advancement may in fact be overemphasized. Several studies have failed to support this conclusion,[58,65,66] and in one study, male physicians perceived greater delays in their career advancement because of family responsibilities than women did.[59] Aside from the controversial question of family responsibilities, other potential reasons for the underrepresentation of women in surgical specialties and positions of leadership include sexism, increased clinical and educational responsibilities, and a lack of female mentors.[6,22,56,67,68] Effective mentorship plays an important role in career choice and development.[6,22,52,69,70] As women have only recently increased their numbers in surgical specialties and ophthalmology, there may not yet be a substantial amount of senior female mentors.[6,22,57,71,72] Furthermore, women may not aspire to career goals at the same rate as men. Female academic physicians spend significantly more time in teaching and patient care than their male counterparts do, especially early in their careers.[59] Moreover, although female medical school graduates have entered academic medicine at higher rate than men, they failed to advance at the same pace, perhaps because their academic interests are more focused on teaching than research, which tends to have a negative effect on academic advancement.[73]

A possible explanation for the gender discrepancy in NIH awards could be owing to differences in scholarly impact. Prior analyses have noted a statistically higher *h-index* in male academic physicians, and a variety of factors may be responsible for this, all of which are speculative.[6] Even within the cohort in our present analysis of NIH-funded faculty in ophthalmology departments, we detected a difference in *h-index* as noted in the results, suggesting that this may partly explain differences detected. Analysis of unsuccessful applicants would have significantly enhanced this study, as we could have examined whether this difference persisted or was even greater among those applicants. However, this information is not publically available and represents a limitation of our analysis.

Although purely speculative, another potential reason for calculated discrepancies may be that successful female grant seekers simply applied for less funding on average than their male counterparts, and those applying for higher totals had less success. There are myriad reasons beyond the scope of this analysis that could potentially explain this, including possible differences in travel budgets if women were less likely to include time away from their home institutions in research plans. A future survey-based analysis as well as access to information regarding unsuccessful applicants may provide insight into this issue.

Although only 36.1% of PIs included in this analysis had MD degrees (or MD equivalents), many of the gender issues affecting academic advancement certainly affect nonphysician faculty. A recent analysis focusing on women and underrepresented minorities suggested that limited research contact and mentorship between faculty and these groups during the undergraduate years may perpetuate their underrepresentation in science.[74] However, as in clinical medicine, progress has been made: the proportion of doctorates awarded to women in the sciences has increased to nearly 50% in 2005 from 20% in the 1970s.[75] This trend, however, has not been mirrored by an increase of women in academic science positions. As in clinical medicine, issues surrounding family responsibilities and child rearing have been cited as important factors hindering research productivity.[75]

Although this is the first analysis to comprehensively delineate gender differences in successful NIH funding among ophthalmology faculty, there are several limitations. The NIH RePORTER system only reports awarded grants and does not provide information regarding unsuccessful grant applications. Consequently, our examination indicates nothing about whether gender differences in successful grant application rates exist. One possible reason men may have had higher awards totals may simply be that they apply for higher funding totals. An analysis of research grant support among faculty from Harvard Medical School found no differences among successful grant acquisition when controlling for academic rank, but did note that differences in grant application requests among junior faculty

contributed to a gender disparity in grant funding.[76] This finding may certainly be consistent with the findings in the present analysis. However, the current analysis was not designed or able to investigate grant application success rates using the publically available NIH RePORTER system, making it impossible to draw any conclusions regarding whether this is the case in academic ophthalmology.

CONCLUSIONS

Although the proportion of female ophthalmologists has been increasing in recent years, previous analyses have noted a continued underrepresentation of women at senior academic ranks and in positions of leadership. Scholarly productivity is an important component of the academic appointment and promotion process. Consequently, differences in gender representation may potentially be related to disparities in research output. Male PIs in ophthalmology departments receiving grants from the NIH had statistically higher awards than their female colleagues did, a result most pronounced among junior faculty, particularly those in the first decade of their career. Although concerns specific to early-career female faculty may need to be taken into account in the academic advancement process, some of these differences may diminish as the recently trained cohort of female ophthalmology resident progresses through their careers and attain the credentials necessary for promotion.

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