Gender Differences in Promotion and Scholarly Impact: An Analysis of 1460 Academic Ophthalmologists

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OBJECTIVES: In recent years, gender differences in academic promotion have been documented within surgical fields. To the best of our knowledge, gender discrepancies in association with scholarly productivity have not been well assessed among academic ophthalmologists. Because research productivity is strongly associated with academic career advancement, we sought to determine whether gender differences in scholarly impact, measured by the *h-index*, exist among academic ophthalmologists.

DESIGN: Academic rank and gender were determined using faculty listings from academic ophthalmology departments. *h-index* and publication experience (in years) of faculty members were determined using the Scopus database.

SETTING: Academic medical center.

RESULTS: From assistant professor through professor, the *h-index* increased with subsequent academic rank ($p < 0.001$), although between chairpersons and professors no statistical difference was found ($p > 0.05$). Overall, men had higher *h-indices* ($h = 10.4 \pm 0.34$ standard error of mean) than women ($h = 6.0 \pm 0.38$ standard error of mean), a finding that was only statistically significant among assistant professors in a subgroup analysis. Women were generally underrepresented among senior positions. When controlling for publication range (i.e., length of time publishing), men had higher *h-indices* among those with 1 to 10 years of publication experience ($p < 0.0001$), whereas women had scholarly impact equivalent to and even exceeding that of men later in their careers.

CONCLUSION: Women in academic ophthalmology continue to be underrepresented among senior faculty. Although women surpass men in scholarly productivity during the later stages of their careers, low scholarly impact during the earlier stages may impede academic advancement and partly explain the gender disparity in senior academic positions. (J Surg 71:851-859. © 2014 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: *h-index*, gender disparities, academic promotion, academic ophthalmologists

COMPETENCIES: Professionalism, Practice-Based Learning and Improvement, Systems-Based Practice

INTRODUCTION

The disparity between men and women in senior academic ranks within various medical fields has been well documented.[1] Despite the increase in the number of women in medicine throughout the past 2 decades, they remain significantly underrepresented in these senior ranks in many specialties, particularly surgical disciplines.[2-4] This lack of representation may be partly because of the failure of academic medicine to produce an adequate number of women in senior faculty positions, as such role models are often necessary for the academic mentorship integral to career choice.[5-10] For example, a recent study among academic otolaryngologists noted that only 4 of 103 chairpersons were women.[11] Various factors may explain the paucity of academic female physicians in leadership positions, such as the reluctance of female physicians to undergo and continue subspecialty training combined with their disproportionate entry into primary care and nonsurgical careers.[12,13]

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Hiring and promotion committees within academic medicine generally take into account contributions to medical education, clinical performance, and scholarly activity when evaluating faculty for academic advancement.[14,15] Nevertheless, a candidate's research productivity is usually the factor of principal importance when being considered for promotion.[1] In the evaluation of research productivity, promotion metrics may focus on the candidate's total number of publications, the total citations attributed to the candidate's publications, grant awards, and academic recognitions.[16] A physician's research output can be measured by the total number of publications achieved (attempting to measure the quantity of research), or alternatively, by the total number of citations attributed to the author's publications (attempting to measure the significance of an investigator's work). Each of these bibliometrics alone, however, fails to completely capture the total scholarly impact of a physician's publication history. In this regard, an author's apparent scholarly influence can be adjusted for both quantity and importance by using the *h-index*. An author's *h-index* expresses the number of published articles (*h*) that have attained at least *h* citations each, excluding any articles cited fewer than *h* times.[17] The *h-index* may be valuable for quantifying the quantity and significance of an author's work, and its use has been studied in numerous medical fields.[4,18-47] Furthermore, there is a strong correlation between *h-index* and successive academic rank among academic physicians in a variety of surgical specialties, including ophthalmology.[4] To our knowledge, there has not been an in-depth analysis of academic ophthalmologists' *h-index* associated with their departmental rank and gender. One potential reason for the gender disparity in senior academic positions may be differences in scholarly impact, as research productivity is generally an integral component for academic promotion. The primary objective of this analysis is to characterize scholarly impact among male and female academic ophthalmologists using the *h-index* and correlate their scholarly impact with academic position.

MATERIALS AND METHODS

The American Medical Association's FREIDA database was searched for ophthalmology training programs in the United States. Online listings from the individual website of each academic department were searched for information regarding faculty, including academic rank. Division chiefs from institutions where ophthalmology was not an independent academic department were counted in the "chairperson" category for the purposes of this analysis. Faculty were also organized by gender, determined independently using names and photographs from online profiles by P.F.S., S.A.L., and J.A.E. Nonphysician, nonacademic, and part-time faculty were excluded from this analysis. Additionally, any faculty for which academic rank could not be determined from their online profile, and faculty from institutions whose websites did not contain pertinent information, were also excluded from this analysis.

Of 117 programs from the initial FREIDA search, 14 lacked online faculty listings or did not report academic rank, and 3 other programs only noted a departmental chairperson and did not report other faculty designations. After application of exclusion criteria, 1460 academic ophthalmologists from 100 departments (plus 3 departmental leaders) were included.

The Scopus database (www.scopus.com) was used for calculation of each individual's *h-index* as well as publication range (i.e., the publication experience, in years). This database covers more than 40 million publication records from 18,500 peer-reviewed venues and has been valuable in previous analyses of the *h-index* covering a wide variety of medical fields and topics.[4,18,28-34,48-50] Other available *h-index* calculators include those found on Google Scholar, ISI Web of Knowledge, and Publish or Perish; a recent analysis of the impact of the *h-index* on academic neurosurgeons revealed a strong correlation between results from Google Scholar and Scopus.[49] On initial search for each individual, multiple results may appear, especially if the individual has a common last name. Departmental affiliations as listed on Scopus, previous positions with other departments, and the presence (or absence) of ophthalmology or ophthalmology-related journals were used to ensure that the *h-index* and publication range obtained for each author was related to the appropriate individual. Data collection was completed in March 2013.

Statistical Analysis

Mann-Whitney *U* tests and Kruskal-Wallis tests were used for comparison of continuous variables as appropriate and Pearson chi-square for comparison of categorical variables, with threshold for significance set at $p < 0.05$. SPSS version 20 (an IBM Company, Chicago, IL) was used for statistical calculation.

RESULTS

The *h-index* of academic ophthalmologists increased with successive academic rank from assistant professor through professor (Fig. 1) ($p < 0.001$), although no statistical difference was noted among chairpersons and other practitioners at the rank of professor ($p > 0.05$). Women constituted 419 (29.3%) ophthalmologists and 271 (43.8%) assistant professors in this sample (Fig. 2A). They were less represented among more senior academic ranks and positions (Fig. 2A). When considered by gender, academic rank representation differed ($p < 0.0001$) (Fig. 2B), as a larger proportion of men were serving at more senior positions.

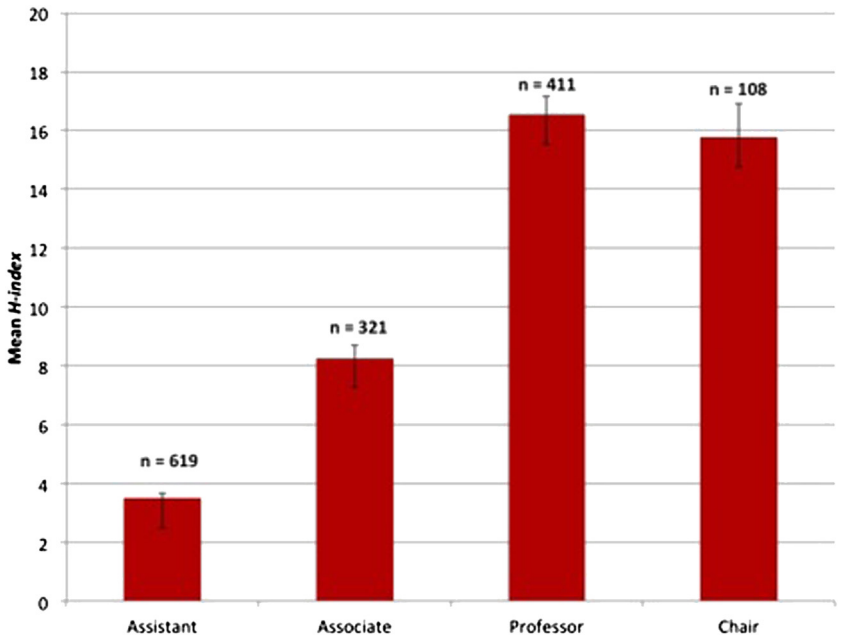

FIGURE 1. Mean *h-index* organized by academic rank among 1460 academic ophthalmologists. Practitioners in the "Chair" category were not counted in the "Professor" category to avoid double counting. *n* represents sample size, and error bars represent standard error of mean.

Men had higher scholarly impact as measured by the *h-index* ($h = 10.4 \pm 0.34$ standard error of mean) than their female colleagues ($h = 6.0 \pm 0.38$ standard error of mean) (Fig. 3) ($p < 0.0001$). On controlling for academic rank, a gender difference was noted only among assistant professors ($p = 0.03$) (Fig. 4). A gender difference in

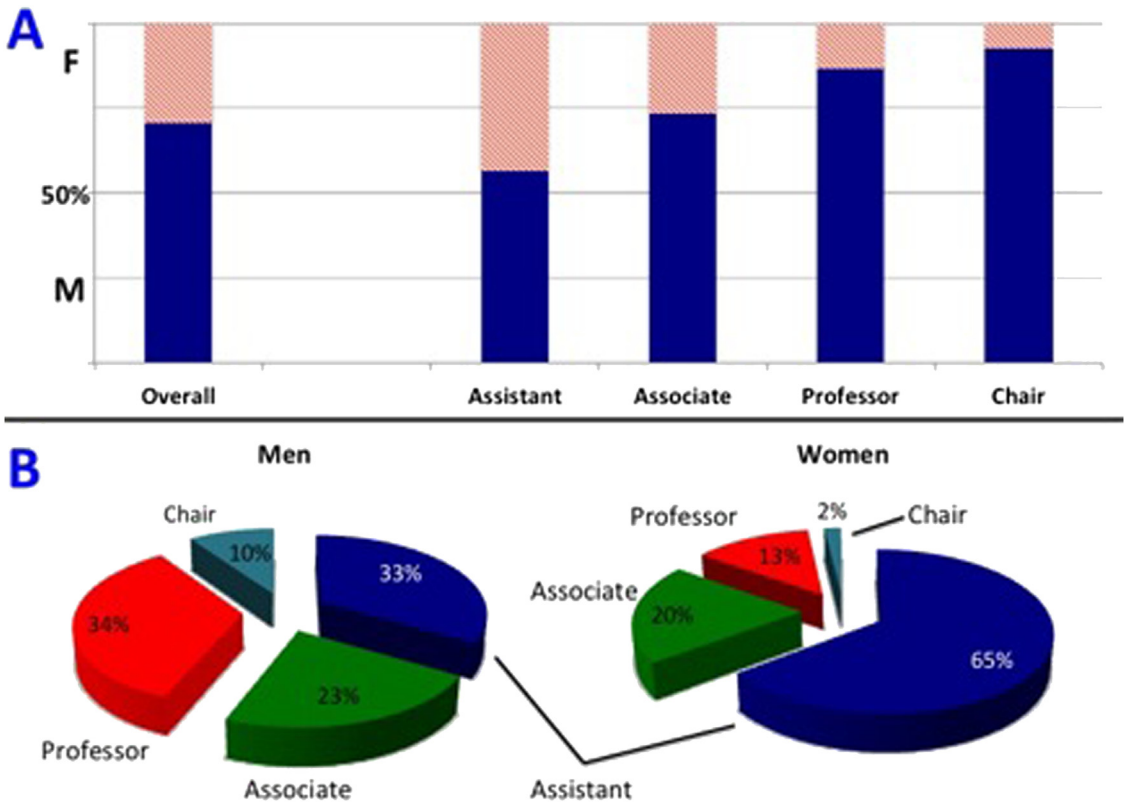

FIGURE 2. (A) Academic rank representation. Bottom (solid) bars represent male ophthalmologists, and top (diagonally striped) bars represent female ophthalmologists. (B) Academic rank representation by gender.

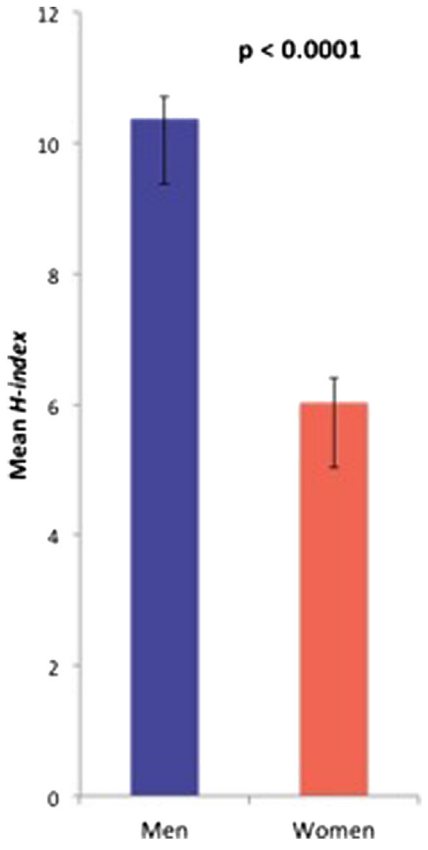

FIGURE 3. Mean *h-index* of academic ophthalmologists organized by gender. Error bars represent standard errors of mean.

scholarly productivity was noted after controlling for publication range (in years) (Fig. 5). Men had higher *h-indices* among the cohort with 1 to 20 years of publication experience ($p < 0.0001$), while there was no difference noted among academic ophthalmologists with 21 to 40 years of experience ($p = 0.95$). On consideration by decade of career, there was no difference in *h-index* among those with 1 to 10 years of publication experience ($p = 0.76$), while men had a higher trending *h-index* among those with 11 to 20 years of experience ($h = 9.6$ vs. $h = 8.1$), although this did not reach statistical significance ($p = 0.10$). Women had a higher scholarly impact among practitioners with 31 to 40 years of publication experience ($h = 15.7$ for men vs. $h = 20.4$ for women), a result that bordered on statistical significance ($p = 0.05$). No comparison of practitioners with beyond 40 years of experience was noted in Figure 5, as there were only 4 such female practitioners in this study's sample.

DISCUSSION

Gender Discrepancies in Medicine

Gender inequality in the workplace in the United States, especially in medicine, has been an issue that is extensively debated and evaluated.[2,13] Within the past 20 years, there has been an increase in the proportion of female medical students in the United States, and not surprisingly, an increase in the number of woman physicians entering several fields of medicine during that period.[2] These observations, however, are not consonant with the recent findings of several studies indicating the presence of gender disparity in academic promotion among the highest echelons of medicine, specifically in senior faculty roles.[2,4] Women are underrepresented in senior leadership roles in competitive fields such as radiology, ophthalmology, and otolaryngology.[4,51-53] In addition, women represent less than one-fifth of all editorial board members in major medical journals.[54] This lack of female role models in leadership positions may act as an obstacle facing young female faculty members and hinder their advancement.[55] The creation of mentoring programs for junior female faculty as well female medical students in several institutions across the United States is an attempt to address these findings by employing the traditional model of guidance that has worked for men.[56] However, such short-term initiatives have reportedly failed to close the gender gap facing academic medicine.[57]

Underrepresentation of women in senior faculty roles may be partly because of a discrepancy in scholarly productivity between male and female physicians seeking promotion.[58] For example, recent studies have reported fewer National Institute of Health funding awards for women than men in otolaryngology and ophthalmology.[53,59] It has been well documented within academic medicine that research productivity and scholarly impact are of paramount importance in making advancement and promotion decisions.[16,18,22,28,29,58,60-64] Another potential reason for the underrepresentation of women in senior academic ranks may be that the number of women in academic medicine has only recently increased, and that there are fewer women in academic medicine with the experience necessary for promotion. If this point is true, then the gender gap in senior faculty positions may be expected to diminish with time.

Women Had Lower Research Productivity and Academic Rank in Ophthalmology

Our study's primary objective was to elucidate possible correlations between ophthalmologists' *h-index,* gender, and successive academic rank, which might help to explain the underrepresentation of woman in senior academic positions.[4] Previous findings have shown strong associations between higher *h-index* and sequential academic rank, confirming the importance of scholarly impact and research productivity on career advancement.[4,18,20-22,28-30,32-34,64] Our study is consistent with these findings as ophthalmologists with higher *h-indices* occupied more senior ranks (Fig. 1), such as professor or chair, among 100

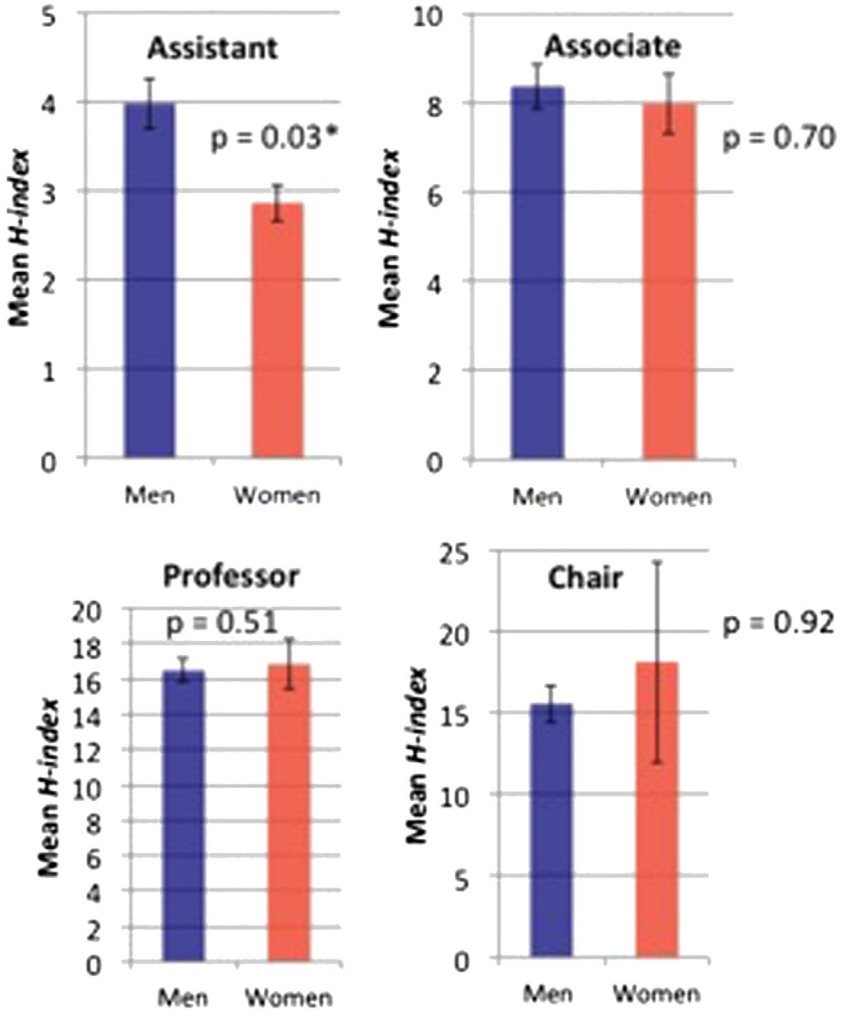

FIGURE 4. Gender differences in *h-index* organized by academic rank. Practitioners in the "Chair" category were not counted in the "Professor" category to avoid double counting. Error bars represent standard error of mean.

ophthalmology departments nationwide. Among the cohort of 1460 academic ophthalmologists included in this study, regardless of rank or research productivity, women constituted far less than half of the total number of practitioners (Fig. 2A). Thus, although women are increasingly entering more competitive medical fields in recent years,[2] a gender gap in academic ophthalmology still persists. In agreement with a previous study documenting fewer women in leadership roles in academic medicine,[4] our study found a higher proportion of men serving at senior faculty positions than women (Fig. 2B).

Several recent studies have found female academic physicians attaining higher scholarly impact later, as opposed to earlier, in their careers.[1,29] Our study validates these results (Fig. 5) in the field of ophthalmology by finding men to have greater scholarly impact in the beginning of their careers as compared with women, but subsequently being surpassed by their female colleagues in the later stages of their careers. This trend is demonstrated by the slopes of Figure 5 representing the *h-index* levels as a function of publication years. This trend of late-career women ascendancy regarding scholarly impact is also supported by our data showing a gender difference in *h-index* levels only at the rank of assistant professor (Fig. 4). Familial obligations, such as childbearing and child rearing, which are disproportionately borne by women early in their careers, may possibly explain the relatively higher productivity rates at later stages of women's careers.[1,4,29,57,58,65-70]

Limitations

The use of the *h-index* has become both beneficial and controversial in the judgment of an author's potential research impact in promotion considerations.[24] The *h-index* has been correlated with success in obtaining academic promotions as well as predicting future research productivity rates in a multitude of medical fields. The attractiveness of the *h-index* comes from its potential ability

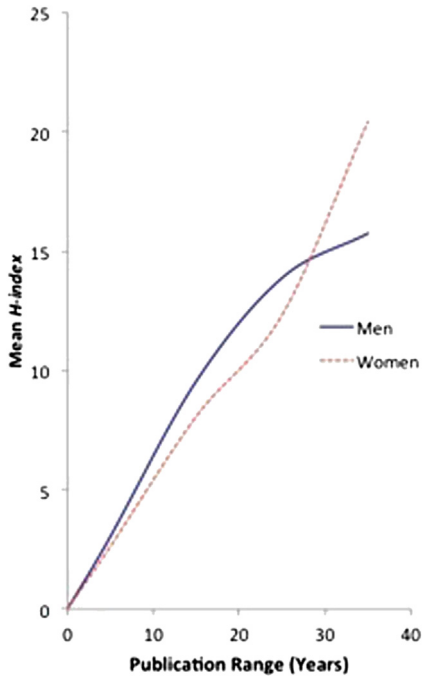

FIGURE 5. Scholarly impact measured by *h-index* over an author's publication experience (in years). The slopes of the graphs indicate the rate of change of *h-index* over time. Although the *h-index* in men tends to increase rapidly earlier in their career (creating a difference in *h-index* between men and women ie greatest at approximately 20 years), the *h-index* in women rises faster than men at approximately 23 years and surpasses men at approximately 29 years.

to quantify the influence of an author's work in his or her field in an objective fashion. Controversy over the use of the *h-index* arises from criticism about strategies that may erroneously inflate a particular author's *h-index*.[71] Such strategies involve deliberate self-citation[72] to achieve more articles cited *h* times, as articles cited less than *h* times are not included.[72] This mechanism may be especially advantageous if authors cite their works that are at the verge of counting for their *h-index*; however, such a strategy is unsustainable as authors with considerable *h-index* levels may already have their articles cited by many authors.[73] Furthermore, the *h-index* fails to take into account the order in which an author is enumerated in an article nor does it account for being just one of several authors (or perhaps the lead author) on an extremely important study.[74,75] Finally, the *h-index* is unable to take into account the career phase of a particular author[74]; such information may be relevant when authors with modest *h-index* levels seek promotion. Although it is not widely employed, Hirsch[17] proposed a value, *m*, which would take into account this information by dividing an authors *h-index* with the scientist's years of activity.

CONCLUSION

A gender discrepancy in senior academic positions continues to be prevalent in competitive medical fields, including ophthalmology. Our study of academic productivity as measured by the *h-index* has revealed a gender difference concerning scholarly impact. Although male ophthalmologists had higher overall academic impact as measured by this value, academic scholarly impact tended to vary throughout different stages of the careers of men and women. Specifically, when compared with men, women ophthalmologists had lower academic productivity rates early in their careers as measured by the *h-index*, but later in their careers, their scholarly impact increased, and eventually their *h-index* levels surpassed those of their male colleagues.

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