Research productivity and gender of research award recipients in international ophthalmology societies

Anne Xuan-Lan Nguyen, Dipti Satvi Venkatesh, Ankita Biyani, Sanyam Ratan, Gun Min Youn, Albert Y Wu

ABSTRACT

Purpose The purpose of this study is to assess the research productivity and gender of award recipients of ophthalmology research awards in international societies.

Methods This is a retrospective, observational study. The study population included award recipients of research awards from 36 ophthalmologic societies (listed on the International Council of Ophthalmology database) in 99 years (1922–2021). A gender-specific pronoun and a photograph of each award recipient were extracted from professional websites to assign their gender. Research productivity levels were retrieved from the Elsevier Scopus author database. The main outcome measures were gender distribution of award recipients per year, mean h-index per year, mean m-quotation per year, mean h-index by society, and mean m-quotation by society.

Results Out of 2506 recipients for 122 awards, 1897 (75.7%) were men and 609 (24.3%) were women. The proportion of woman recipients increased from 0% in 1922 to 41.0% in 2021. Compared with 2000–2010 (19.8%, 109 of 550), women received a greater proportion of awards (48.4%, 459 of 949) in the last decade, from 2011 to 2021. Furthermore, men more often had greater h-index scores and m-quotation scores.

Conclusions Women received awards (24.3%) at a lower rate than men (75.7%) while also exhibiting lower productivity, supporting the existence of a gender disparity. Our study found that women are under-represented in research awards, and further investigation into award selection processes and gender membership data is recommended.

INTRODUCTION

Medical societies are established to facilitate collaborative communication among healthcare practitioners in a particular area of expertise. In ophthalmology, multiple societies represent various geographic locations, subspecialties and practice types. Within most societies, there is an emphasis on academic achievement with recognition through research awards and grants. Supporting research in this manner is therefore essential to developing and discovering major advancements in vision science and ophthalmic practice.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Previous studies have found that women have lower publication productivity in fields such as gastroenterology, oncology and urology. As more women are entering the field of ophthalmology, it is important to identify disparities to create an equitable environment for all.

WHAT THIS STUDY ADDS

This study shows the existence of a gender disparity among men and woman research award recipients, as women received only 24.3% of the awards from 1922 to 2021 and woman awardees had generally lower h-index and m-quotation values compared with men.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

The implication of this study will contribute towards efforts to increase equity and remove bias to allow for a more significant number of deserving women to be recognised as equally as men by changing policies in ophthalmology societies and working towards a more diverse, inclusive workplace.
identify the causes of women’s decreased citation-related publication productivity.

To the best of our knowledge, no study has examined differences in research productivity of international ophthalmology research award recipients while accounting for variables such as society, affiliated country and award year. This study therefore aims to identify if there were gender differences in the productivity of research-specific awardees of ophthalmological societies.

METHODS

The study design is retrospective observational. The International Council of Ophthalmology (ICO) database (https://icoph.org/, Geneva, Switzerland) lists all societies. From this list, the award listings for each website were examined and award information (name, classification as research award and years) and the award recipient’s full name were extracted. Research awards are defined as awards given out for excellence in research which promote further work and contributions. If data could not be found on individual society websites, an email was sent to the contact information listed. Societies that did not list awardees or did not respond to email communication were not included in the dataset.

With the hypothesis that ophthalmology research awards are given to recognise high-impact research, we specifically examined research awards. While non-research awards (eg, medical education, leadership recognition) may be associated with higher research productivity, the criteria of these awards do not emphasise the requirement of publishing research. By excluding non-research awards, we therefore ensure an accurate dataset to compare research productivity between man and woman ophthalmologists recognised for their research. Research awards, under the umbrella of research recognition (eg, medical education, leadership recognition) may be associated with higher research productivity, the criteria of these awards do not emphasise the requirement of publishing research. By excluding non-research awards, we therefore ensure an accurate dataset to compare research productivity between man and woman ophthalmologists recognised for their research. Research awards, under the umbrella of the reward system, are also linked with higher productivity in general.10

Each award recipient’s gender was determined by performing a web search for pronouns or by reviewing the recipient’s picture. Gender identification was further verified by inputting name and country of origin into Gender API (https://gender-api.com/, Passau, Germany), a programme interface assigning gender with 98% accuracy.11

Elsevier Scopus (www.scopus.com, North Holland, the Netherlands) was used to extract research productivity metrics (number of publications, number of citations, h-index and first year active) and geographic location (affiliation, city, country/territory). Elsevier Scopus documents are primarily indexed serial publications from journals, trade journals, book series and conference materials with assigned International Standard Serial Numbers.12 If the awardee could not be found on Scopus, but maintained an online presence, 0 was entered for numerical values. M-quotient was calculated by dividing the h-index by the number of years active, the first year active subtracted from the data collection date (May 2022).

A study by Gasparyan et al showed that alternative metrics, such as Google Scholar and ResearchGate, have their own limitations such as multiple versions of the same item and an uneven distribution of profiles.13 The h-index has been endorsed since 2005 globally and is a highly cited metric. Along with being an appropriate indicator, another advantage of using h-index relates to the combined approach to quantifying publication and citation counts.

Statistical analyses were performed using STATA/IC V.16.1 (Stata Corp, College Station, Texas, USA). Mann-Whitney U (Wilcoxon rank sum) tests were conducted to compare research productivity metrics between men and women. Multiplicity adjustments were performed to take into account the different societies using the Bonferroni correction method. P values<0.05 were considered statistically significant.

RESULTS

Out of 253 total societies listed on ICO, 44 (17.4%) societies had research awards (online supplemental table 1) and 36 provided lists of award names. Of the 150 research awards identified, 122 (81.3%) awards have recipients featured on their website.

Out of 2506 recipients for 122 awards, 1897 (75.7%) were men and 609 (24.3%) were women. Gender was determined using Gender-API (mean accuracy=97.5% and SD=6.1%). The 2506 awardees were affiliated with institutions from 56 countries and territories, the top 4 being the USA (n=1502; 59.9%) with 19.2% women, Canada (n=184; 7.3%) with 30.4% women, the UK (n=101; 4.0%) with 22.8% women and Japan (n=91; 3.6%) with 18.7% women. Although most research award recipients received 1 award (n=1943; 77.5%), some recipients (n=563; 22.5%) received more than 1 award with 1 individual receiving up to 10 awards (n=1; 0.0%).

Most research awards were given by the American Academy of Ophthalmology (n=443; 17.7%), followed by the American Society of Ophthalmic Plastic and Reconstructive Surgery (n=392; 15.1%), the Association for Research in Vision and Ophthalmology (n=302; 12.1%), the Canadian Ophthalmological Society (n=181; 7.2%) and the Macula Society (n=164; 6.5%) (table 1). The remaining societies had less than 100 research awardees. In total, 33.0% of international award recipients were women (240 women out of 728 awardees) and 29.5% of domestic award recipients were women (369 women out of 1278 US society awardees).

Awards were given out over a 99-year period from 1922 to 2021 (figure 1). The proportion of awardees increased from 0% in 1922–1948 to 8.7% in 2021, with the highest proportion occurring in 2020 with 13.1%. The proportion of women recipients increased from 0% in 1922 to 41.0% in 2021. Compared with 2000–2010 (19.8%, 109 of 550), women received a greater proportion of awards (48.4%, 459 of 949) in the last decade, from 2011 to 2021. The mean h-index for women changed from null in 1922 to 12.8 in 2021.
Research productivity metrics

Overall, men had a significantly higher mean number of publications ($\bar{x}=158.3$, $SD=191.6$) than women ($\bar{x}=86.9$, $SD=189.4$), adjusted $p<0.001$. Men had a significantly higher mean number of citations ($\bar{x}=6526.9$, $SD=108500.2$) than women ($\bar{x}=3919.9$, $SD=8945.1$), adjusted $p<0.001$. Men had a significantly higher mean number of years active ($\bar{x}=25.6$, $SD=11.6$) than women ($\bar{x}=17.1$, $SD=10.9$), adjusted $p<0.001$.

Men had a significantly higher mean h-index ($\bar{x}=30.9$, $SD=25.8$) than women ($\bar{x}=18.4$, $SD=23.4$), adjusted $p<0.001$. Men had a significantly higher mean m-quotient ($\bar{x}=1.2$, $SD=0.8$) than women ($\bar{x}=1.0$, $SD=0.8$), adjusted $p<0.001$. Mean h-index and m-quotient trends per gender and per year are presented in figure 2.

The highest total mean h-index per society was 69.8 (Association of University Professors of Ophthalmology), 60.0 (Macula Society), 57.7 (International Society for Eye Research) and 50.7 (American Society of Retina Specialists). Men had a significantly higher mean h-index than women in six societies: European Society of Ophthalmic Plastic and Reconstructive Surgery ($p<0.001$),

Table 1

<table>
<thead>
<tr>
<th>Continent</th>
<th>Society name</th>
<th>Years</th>
<th>Number of woman award recipients/number of award recipients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>Egyptian Ophthalmological Society</td>
<td>2013</td>
<td>3/12 (25.00%)</td>
</tr>
<tr>
<td>Asia</td>
<td>Japanese Ophthalmological Society</td>
<td>2011–2021</td>
<td>10/60 (16.67%)</td>
</tr>
<tr>
<td>Asia</td>
<td>Malaysian Society of Ophthalmology</td>
<td>2001–2020</td>
<td>3/13 (23.08%)</td>
</tr>
<tr>
<td>Asia</td>
<td>Oculoplastics Association of India</td>
<td>2012–2018</td>
<td>8/17 (47.06%)</td>
</tr>
<tr>
<td>Asia</td>
<td>Saudi Ophthalmological Society</td>
<td>2014–2016</td>
<td>2/9 (22.22%)</td>
</tr>
<tr>
<td>Asia</td>
<td>Vitreo Retinal Society of India</td>
<td>2001–2019</td>
<td>3/30 (10.00%)</td>
</tr>
<tr>
<td>Asia</td>
<td>Young Ophthalmologists Society of India</td>
<td>2019</td>
<td>0/1 (0.00%)</td>
</tr>
<tr>
<td>Europe</td>
<td>Academia Ophthalmologica Internationalis</td>
<td>1998–2018</td>
<td>0/6 (0.00%)</td>
</tr>
<tr>
<td>Europe</td>
<td>Bulgarian Society of Ophthalmology</td>
<td>1996–1998</td>
<td>1/2 (50.00%)</td>
</tr>
<tr>
<td>Europe</td>
<td>Deutschsprachige Gesellschaft fur Intraokularlinsen-Implantation und Refraktive Chirurgie</td>
<td>2009–2019</td>
<td>1/1 (9.09%)</td>
</tr>
<tr>
<td>Europe</td>
<td>Estonian Ophthalmological Society</td>
<td>2006–2021</td>
<td>16/26 (61.54%)</td>
</tr>
<tr>
<td>Europe</td>
<td>European Board of Ophthalmology</td>
<td>2011–2021</td>
<td>5/16 (31.25%)</td>
</tr>
<tr>
<td>Europe</td>
<td>European Contact Lens Society of Ophthalmologists</td>
<td>1983–2018</td>
<td>3/19 (15.79%)</td>
</tr>
<tr>
<td>Europe</td>
<td>European Pediatric Ophthalmological Society</td>
<td>2003–2020</td>
<td>44/58 (75.86%)</td>
</tr>
<tr>
<td>Europe</td>
<td>European Society of Cataract and Refractive Surgeons</td>
<td>2012–2020</td>
<td>1/10 (10.00%)</td>
</tr>
<tr>
<td>Europe</td>
<td>European Society of Ophthalmic Plastic and Reconstructive Surgery</td>
<td>1993–2021</td>
<td>7/20 (35.00%)</td>
</tr>
<tr>
<td>Europe</td>
<td>European Society of Retina Specialists</td>
<td>2019–2021</td>
<td>0/6 (0.00%)</td>
</tr>
<tr>
<td>Europe</td>
<td>International Society for Clinical Electrophysiology of Vision</td>
<td>1996–2020</td>
<td>20/68 (29.41%)</td>
</tr>
<tr>
<td>Europe</td>
<td>Italian Ophthalmological Society</td>
<td>2005–2020</td>
<td>39/57 (68.42%)</td>
</tr>
<tr>
<td>Europe</td>
<td>Netherlands Ophthalmological Society</td>
<td>1983–2021</td>
<td>7/36 (19.44%)</td>
</tr>
<tr>
<td>Europe</td>
<td>World Glaucoma Association</td>
<td>2009–2021</td>
<td>1/3 (3.03%)</td>
</tr>
<tr>
<td>North America</td>
<td>American Academy of Ophthalmology</td>
<td>1992–2021</td>
<td>164/443 (37.02%)</td>
</tr>
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<td>North America</td>
<td>American Association for Pediatric Ophthalmology and Strabismus</td>
<td>1974–2021</td>
<td>16/94 (17.02%)</td>
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<tr>
<td>North America</td>
<td>American Ophthalmological Society</td>
<td>1922–2021</td>
<td>5/8 (5.75%)</td>
</tr>
<tr>
<td>North America</td>
<td>American Society of Cataract and Refractive Surgery</td>
<td>1975–2021</td>
<td>3/8 (3.75%)</td>
</tr>
<tr>
<td>North America</td>
<td>American Society of Retina Specialists</td>
<td>1995–2021</td>
<td>11/63 (17.46%)</td>
</tr>
<tr>
<td>North America</td>
<td>Association of University Professors of Ophthalmology</td>
<td>2018–2021</td>
<td>1/4 (25.00%)</td>
</tr>
<tr>
<td>North America</td>
<td>Canadian Glaucoma Society</td>
<td>2013–2020</td>
<td>11/37 (29.73%)</td>
</tr>
<tr>
<td>North America</td>
<td>Canadian Ophthalmological Society</td>
<td>1995–2021</td>
<td>55/181 (30.39%)</td>
</tr>
<tr>
<td>North America</td>
<td>Chinese American Ophthalmological Society</td>
<td>1994–2021</td>
<td>9/37 (24.32%)</td>
</tr>
<tr>
<td>North America</td>
<td>Cornea Society</td>
<td>1975–2020</td>
<td>8/60 (13.33%)</td>
</tr>
<tr>
<td>North America</td>
<td>Eye Bank Association of America</td>
<td>1982–2021</td>
<td>2/4 (5.00%)</td>
</tr>
<tr>
<td>North America</td>
<td>International Society for Eye Research</td>
<td>1982–2020</td>
<td>13/75 (17.33%)</td>
</tr>
<tr>
<td>North America</td>
<td>Macula Society</td>
<td>1987–2020</td>
<td>33/164 (20.12%)</td>
</tr>
</tbody>
</table>
International Society for Clinical Electrophysiology of Vision (p=0.03), American Academy of Ophthalmology (p=0.001), American Society of Ophthalmic Plastic and Reconstructive Surgery (p<0.001), Canadian Glaucoma Society (p=0.03) and Canadian Ophthalmological Society (p<0.001) (figure 3). Women had a significantly higher mean h-index than men in three societies: Malaysian Society of Ophthalmology (p=0.02), European Contact Lens Society of Ophthalmologists (p=0.02) and American Society of Retina Specialists (p=0.007) (figure 3). Men also had significantly higher mean m-quotient than women in five societies: European Society of Ophthalmic Plastic and Reconstructive Surgery (p=0.005), International Society for Clinical Electrophysiology of Vision (p=0.04), American Society of Ophthalmic Plastic and Reconstructive Surgery (p=0.009), Canadian Glaucoma Society (p=0.03) and Canadian Ophthalmological Society (p=0.02) (figure 3). Women had a significantly higher mean m-quotient than men in two societies: European Contact Lens Society of Ophthalmologists (p=0.04) and American Society of Retina Specialists (p=0.005) (figure 3). More details regarding the research.
productivity trends per gender and per society are presented in figure 3 and online supplemental table 2.

DISCUSSION

During the past decades, the representation of women in ophthalmology has increased, as approximately 25.0%–30.0% of ophthalmologists are women. Prior work has shown growth in the representation of women publishing in ophthalmology journals and working in academic centres. Even so, woman ophthalmologists are under-represented in ophthalmic journal editorial and society board leadership positions, as well as in other award categories in the USA.

In our study assessing ophthalmology research award recipients’ productivity by gender over the past 99 years, we found that overall, woman awardees had significantly lower research productivity than men when examining the h-index and the number of documents and number of citations separately. Men were found to have a significantly greater number of years active than women. Even when considering the number of years active, the research productivity measured using m-quotient was still significantly lower overall for women compared with men.

The number of woman physicians in the past century and their productivity levels are essential to understand why there are more woman award recipients in recent years. Just over 10% of women entered medical school in 1970. Therefore, not many women could be nominated for award positions, as shown by the low numbers of woman awardees in figure 1 up to 1970. After Title IX, which prohibits sex-based discrimination in schools or education programmes that received federal funding, there was an increase in the number of women pursuing medicine. In 1974, 22% of new medical students were women. The number of woman physicians has quadrupled in the last 20 years.

Furthermore, there was a shift toward women after 1989 in first authorship in ophthalmology journals such as: Ophthalmology (1969, 4.6%; 1979, 5.4%; 1989, 12.3%; and 1999, 20.2%), Archives of Ophthalmology (1969, 6.6%; 1979, 5.1%; 1989, 15.6%; and 1999, 28.6%) and American Journal of Ophthalmology (1969, 5.6%; 1979, 4.2%; 1989, 9.2%; and 1999, 23.9%). The increase in woman first authorship during the five decades parallels the increase in American woman physicians. This explains the increase and frequency of woman awardees from the early 1980s to late 2000s in figure 1.

By 2004, women made up 34% of members in training in ophthalmology. In addition, from 2000 to 2009, when ophthalmology journals such as the American Journal of Ophthalmology, Archives of Ophthalmology and Ophthalmology were considered together in a study done by Shah et al, there was a notable increase in the percentage of woman first authors (21% in 2000 to 34.2% in 2009) and last authors (18.5% in 2000 to 20.5% in 2009).
correlates to the increase in woman awardees from the early 2000s, as reflected in figure 1.

In 2017–2019, the number of women entering medical school outnumbered the number of men. Additionally, in a study done by Gertig et al, first and senior authors in ophthalmology review journals: Progress in Retinal and Eye Research, Survey of Ophthalmology and Current Opinion in Ophthalmology were evaluated. In 2019, the frequency of women authorship rose to 44% for first authors and 29% for senior authors. Also, the proportion of reviews with women being the first or senior author did not vary by country of origin (p=0.887 and p=0.520, respectively). Therefore, this explains the majority spikes of woman award recipients seen during the later 2010s in figure 1.

Although a near equal h-index value for man and woman award recipients is expected, overall, woman awardees generally had a lower h-index than their man counterparts. However, as shown in figure 3A, most societies had no significant differences in h-index between genders. Only six societies had a significantly higher mean h-index for man awardees and three societies had a significantly higher mean h-index for woman awardees (figure 3A). In the past 40 years, the mean h-index of man award recipients has predominantly stayed higher than that of woman awardees (figure 2A). Higher mean h-index for women occurred in 1993, 1994, 2001 and 2002 due to the low sample size of women (n=2, n=5, n=5, n=8) having higher h-indices than those of men although the number of man award recipients is higher (n=18, n=23, n=36, n=35) (figure 1). This can be attributed to the greater number of man award recipients and repeat awardees, although in recent years the proportion of woman award recipients has increased (figure 1). Evidence supports the continued existence of a gender disparity among societies throughout the years.

With m-quotient being a relatively more accurate measurement of productivity due to the consideration of years active, an equal m-quotient value is expected, especially in the past decade. Over the 40-year period, man awardees have generally maintained a higher mean m-quotient, although the number of woman award recipients has been increasing (figure 2B). Similar to the h-indices, higher mean m-quotient for women occurred in 1993, 1994 and 2002 due to the low sample size of women (n=2, n=5, n=8) having higher m-quotients due to lower number of years active and higher h-indices than those of men, although the number of man award recipients is higher (n=18, n=23, n=35) (figure 1). Men maintained a significantly higher mean m-quotient in five societies, while women had a significantly higher mean m-quotient in two societies (figure 3B).

There are limitations of the h-index. The h-index is shifting, and values reflect values at the time of collection only. The h-index is based on long-term observations, which disadvantages newcomers and people who change their names (women more often than men). Moreover, h-index fails to consider the information contained in authorship rank (first, middle, last). However, despite this limitation, the h-index does not show decay in a scientist’s career and measures long-term performance.

Limitations of m-quotient involve the instability of the statistic when considering the authorships of researchers with relatively short careers, as small changes in h-index lead to dramatic fluctuations in m-quotient. It also does not consider whether the academic has sustained productivity, again mostly for newer academics whose first papers would be minor contributions. Furthermore, m-quotient is not a fair metric when considering part-time researchers and those with career suspensions (eg, parental leaves traditionally affecting women more than men).

Possible factors resulting in our findings include implicit gender association and bias, disparities in available funding and productivity association with academic rank and collaboration with those of the same gender, impacting author positions. Implicit gender bias occurs when authors of one gender exclude authors of the opposite gender, which leads to a lower woman research productivity and a lower chance of being awarded a research award, causing the gender disparity between man and woman research award recipients. Implicit biases are concealed from conscious awareness; these are the attitudes that one does not realise are impacting their understanding and actions. Implicit bias awareness and education should be implemented more to avoid gender disparity.

Woman investigators receive less funding than men in the research field and area. One study that explored gender differences in Canadian Institutes of Health Research awards found that less favourable assessments of women as principal investigators drove lower award rates, rather than the quality of their proposals. Such biases may contribute to barriers women face in progressing in their medical careers, including reduced opportunities.

A Hong Kong-based study showed that women received more funding from their institutions, but men were more likely to receive public research funding, showing that man academics access a more comprehensive range of external funding. Less access to funding or less funding for women means that it is less likely the research will be completed as proposed and can lower the productivity levels of women.

Studies also show that from assistant professor through professor, the h-index increases with subsequent academic rank. However, women are often under-represented in positions of high rank in ophthalmology societies and are not being promoted to positions of professorship or faculty at the same rate as men or women in other specialties.

Quantifying differences between genders in award recognition and examining potential underlying factors (research productivity metrics, award year, country of affiliated institution, society itself), explaining these disparities are the first steps to achieve equitable representation between genders. Although some ophthalmic societies are more gender balanced than others, men...
tend to have greater representation among research awards. These men also have significantly higher mean h-index and m-quotient values than their woman counterparts. However, it is important to note that research productivity metrics can have limitations and negative biases towards women. It is therefore not recommended to choose award recipients solely on these potentially discriminatory metrics.

Selection of research awardees within societies is often a multistep process, ranging from nomination of candidates from a pool of society members, review of their accomplishments (including research productivity) and final selection by a select jury. At each step of this process, there are opportunities to increase equity and remove bias to allow for more deserving women to be recognised equally.34 Societies have a role in assessing the gender distribution of the members of under-represented groups (whether it is through mentorship or broader membership inclusion). Second, review of candidates’ research accomplishments should consider research productivity and other research impact that can sometimes be difficult to quantify, including leadership within research organisations, mentorship of research trainees and role in science communication. Lastly, the jury itself should be composed of diverse members to represent a variety of perspectives in selecting the award recipients.

In conclusion, there are multiple factors contributing to research productivity differences between men and women research awardees. Further investigation into award selection processes and gender membership data is required to further understand why women are under-represented among ophthalmic research award recipients.15

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Competing interests None declared.

Patient and public involvement The patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Patient consent for publication Not applicable.

Ethics approval This study was exempted by the Stanford University Ethics Committee (eProtocol: 57659-IRB 7: registration 5136). The described research adhered to the tenets of the Declaration of Helsinki.

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