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Featured Article

The Association of Women Surgeons research grant: An analysis of the first 25 years

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ABSTRACT

Background: The impact of the Association of Women Surgeons (AWS) Research Grant on academic productivity is unknown.
Methods: Grant applications were obtained from AWS archives. Applicant bibliometrics and National Institutes of Health (NIH) grants were identified via public databases.
Results: Twenty-four recipients between 1996 and 2020 and 68 nonrecipients between 2012 and 2017 were identified. $596,700 was awarded over the 25 years. Twenty-five percent of recipients subsequently acquired NIH funding amounting to $6,611,927.00, an 885–1008% return on investment. Compared to nonrecipients, grant recipients produced a greater mean number of publications (50.6 versus 36.4; $p = 0.05$), had a higher h-index (15.92 versus 10.7; $p = 0.01$), and were cited in higher impact factor journals (6.32 versus 3.9; $p = 0.02$).
Conclusions: Overall, previous AWS Research Grant recipients were more likely to become more impactful surgeon-scientists, as indicated by a higher post-award rate of NIH funding, total number of publications, and h-index than nonrecipients.

Introduction

Surgeon-scientists are invaluable to society given their intellectual curiosity, creativity, and commitment to the advancement of medicine and surgery. The training and development of surgeon-scientists, however, is a substantial undertaking, requiring a vast amount of time and resources including continued institutional and mentor support, protected research time, and (arguably the most concerning given the current trend of federal research funding) a sustained source of funding. The procurement of research funds is indicative of career progression and is a metric by which the success of a surgeon-scientist can be measured.[1] Recent trends in the awarding of federal research funds have been disappointing,[2,3] and the inability to secure research funds is often identified by surgeon-scientists as a significant impediment to conducting research.[4] This difficulty is even more pronounced in women surgeons with studies showing that they received fewer payments and smaller dollar value payments from industry sponsors.[5,6] This was the case even after controlling for factors such as academic positions and years since residency.[7] The disparity between men and women surgeons was also present in first-time principal investigators receiving funding from the National Institutes of Health (NIH).[8] As a result, the pipeline of surgeon-scientists is progressively diminishing.[9]

Considering the aforementioned challenges, the cultivation, advancement, and preservation of surgeon-scientists should be a top priority for all surgical organizations. Consistent with the

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Association of Women Surgeons (AWS) strategic plan and goal of promoting professional and personal development for surgeons by creating and enhancing resources and programs, the Fellowship Grant program was introduced in 1996.[10] The AWS Foundation (AWSF), in conjunction with Ethicon, Inc., have been awarding research grants for original and innovative research to outstanding women surgeon-scientists who are initiating or expanding their research portfolios irrespective of age or career stage.[11]

Selection of the AWS Research Grant recipient involves review of applications by AWS Grants and Fellowship Committee members, independent of any industry oversight or influence, using a scoring system. Committee recommendations are subsequently sent for approval by both the AWS Council and the AWSF representative. The grant is disbursed in two payments during a one-year period. As a condition of the grant, recipients are required to devote at least 10% of their professional efforts and time to their research and must deliver a 10-min podium presentation of their findings during the annual AWS meeting which is held in conjunction with the American College of Surgeons (ACS).

Periodic review of grant programs is recommended to assess the value and success of the grant program and to identify potential areas for improvement in the applicant selection process given that resources are limited. Celebrating 25 years of existence, the Grants and Fellowship Committee of the AWS sought to review the success of the research grant program by evaluating the applicants' ability to procure federal research funds, produce high-impact publications, and obtain a high Hirsch index (h-index), which is often used as a surrogate for academic success.[12] This study will also serve as a post-hoc analysis of the quality of the selection of awardees by comparing grant recipients to nonrecipients. We hypothesized that recipients of the AWS Research Grant would have experienced accelerated career growth in terms of increases in monies secured, publications, and h-index.

Material and methods

This study was determined to be exempt from review by the principal investigator's Institutional Review Board. AWS Research Grant applications of applicants between the years 1996 and 2020 were obtained from the AWS archives. Grant applications from a second grant sponsored by Genomic Health, Inc. were excluded due to differing award amounts and a smaller subset of recipients. Applicants for whom full applications could not be retrieved were not included in the analysis. Applicant credentials, year of application, academic appointment (at the time of application and current), institution affiliation (at the time of application and current), number of publications at the time of application, and any active or prior research support in which the applicant was the principal investigator or co-principal investigator were extracted. In the event of missing information, applicants were contacted via email. The first application was used for all analyses for applicants who applied or won more than once. Institutional profiles were used to determine current institution affiliations and academic appointments. Professional networking platforms Doximity® (https://www.doximity.com/) and LinkedIn® (https://www.linkedin.com/) were used to cross check information.

The h-index is a metric by which an individual's contribution to research can be measured; it is determined by the number of publications, h, which have been cited $\geq h$ times.[13] The SCOPUS database (http://www.scopus.com) was used to search for the number and list of publications, article citation counts, and the h-index for each applicant. Of note, the h-index at the time of application was not available as it requires the total number of citations for each manuscript to be known at the time of grant application. This cannot accurately be recreated in a retrospective nature, thus comparison of pre- and post-grant cannot reliably be performed. The National Center for Biotechnology Information (https://www.ncbi.nlm.nih.gov/myncbi/) bibliographies, when referenced by an applicant in their grant application, was also used to assure the most accurate information was obtained. Each applicant's list of publications was examined and the three highest cited articles in which the applicant was the first or last author was extracted along with the name of the journal. Current journal impact factors were obtained from the official journal websites.

NIH grant recipients were identified via the NIH Research Portfolio Online Reporting Tools Expenditures and Results (RePORTER) database (http://www.report.nih.gov/).[14] We queried the database for all available years (i.e., 1985–2020). Only grants in which the applicant was the principal investigator or co-principal investigator were considered. The grant type, amount, year of award, and time since application were extracted. A return on investment analysis was conducted taking into account the total amount of AWS funds awarded as well as the amount of NIH funds received following AWS Research Grant receipt. Given the time it takes to prepare a grant application we cannot definitively state that receipt of the AWS Research Grant was disclosed on the NIH applications. As such, we conducted a second return on investment analysis excluding NIH grants which were awarded to applicants the same year as the AWS Research Grant to give a lower bound of impact.

Statistical analysis

Data was collected via Microsoft Excel (V16.13.1). Statistical analyses were completed utilizing R, version 3.5.1 of R Core Team (R Foundation for Statistical Computing, Vienna, Austria, 2018). Descriptive statistics were summarized as frequencies with percentages for categorical variables and compared with chi-squared analysis. Comparisons between continuous variables were performed with Student's t-test (means) and one-way ANOVA tests. Statistical significance was declared for p-values < 0.05.

Results

Twenty-four unique grant recipients were identified between the years 1996 and 2020; one applicant was a grant recipient for two non-consecutive years. Sixty-eight nonrecipients were identified between the years 2012 and 2017. At the time of application, 29% (n = 7) of grant recipients had a graduate degree in addition to their MD: PhD 17% (n = 4); MPH 12.5% (n = 3) while 43% (n = 29) of nonrecipients had another degree in addition to their MD: PhD 10% (n = 7) or a Masters degree 37% (n = 25, p = 0.20). Two of the nonrecipients had more than one Masters degree.

A total of $596,700 was awarded in grant funding over the 25 years (Table 1). Only one grant recipient had prior NIH funding at the time of application. Twenty-five percent of grant recipients were successful at acquiring federal NIH funding afterwards compared to 10.3% of nonrecipients (p = 0.005, Table 2), with individual grant amounts ranging from $56,957.00 to $2,478,720.00 for grant recipients and $101,851.00 to $1,980,479.00 for nonrecipients (p = 0.448). Collectively, the NIH awards subsequently acquired by grant recipients amounted to $6,611,927.00, resulting in a 1008% return on investment. Excluding NIH grants which were awarded to recipients the same year as their AWS Research Grant, the return on investment was 885%. Seventeen percent (n = 4) of grant recipients were awarded K grants and 13% (n = 3) were awarded R grants; one recipient received both K and R grants with a conversion rate of two years. NIH grant types procured by the recipients included M01, R01, R03, R21, K07, K08, and K22. The mean time to funding from application to NIH grant procurement was

Table 1
Association of Women Surgeons (AWS) Research Grant funding and corresponding funding awarded from the National Institutes of Health (NIH). Total return on investment (ROI) was 1008%.

Year of Application	AWS Award Amount	Years from AWS Grant to NIH Funding	NIH Grant Awarded	NIH Grant Amount
1996	$25,000	6	R03	$298,040
1997	$25,000			
1998	$25,000			
1999	$25,000			
2000	$25,000			
2001	$25,000			
2002[a]	$25,000	9	K07	$818,100
2003	$25,000	3	R21	$260,068
		10	R01	$1,967,819
2004	$25,000	4	M01	$56,957
2005	$15,000			
2006	$16,700			
2007	$25,000			
2008	$25,000			
2009	$25,000			
2010	$25,000	0	K22	$561,431
		2	R01	$2,478,720
2011[a]	$25,000	0	K07	$818,100
2012	$25,000			
2013	$25,000			
2014	$25,000			
2015	$25,000			
2016	$27,500			
2017	$27,500			
2018	$27,500			
2019	$27,500	0	K08	$170,792
2020	$27,500			
Unused funds	*-$22,500*			
AWS Total Amount Invested:	**$596,700**		**Total Amount of NIH Grants:**	**$6,611,927**
			Total ROI	**1008%**

[a] Same applicant.

3.14 years with a mean of 3 years to K award acquisition and 3.7 years until R award acquisition.

Compared to nonrecipients, grant recipients produced a greater mean number of publications (50.6 versus 36.4; $p = 0.05$), ranging from 2 to 220 publications, and were cited in higher impact factor journals (6.32 versus 3.9; $p = 0.02$), as determined by the impact factors of the three highest cited journal articles by the author as the first or last author (Table 3). Grant recipients also had a higher h-index than nonrecipients (15.92 versus 10.7; $p = 0.01$). Considering the academic position for grant recipients, the mean h-index for assistant professors, associate professors, and professors was 15.5, 14, and 36, respectively. Nonrecipients followed a similar trend with a mean h-index of 9, 12, and 35 for assistant professors, associate professors, and professors, respectively.

Discussion

Advancements in academia are largely influenced by the ability to attain research funds,[1] yet federal funding for surgeon-scientists has been steadily declining with investigators reporting a 19% decline from the year 2003–2013[15] or a decrease of three million dollars per year between the years 2007 and 2016.[16,17] While surgeon-scientists have made remarkable contributions to the scientific community, they have historically been less successful at obtaining federal funding compared to physician-scientists[17] and PhD-scientists.[15] Further, women surgeons are less likely to receive funding than their male counterparts, irrespective of their academic rank or experience.[7] In a study of academic orthopedic surgeons receiving industry payments, Forrester et al. found that the median payments for men and women were $1027.00 and $177.00, respectively ($p < 0.001$).[7] Women surgeons are also underrepresented in surgical[18] and medical journals, with less than one-third as first or last authors.[19]

Numerous national medical and surgical organizations such as the American Association of Plastic Surgeons, the Society for Vascular Surgery, and the Society of University Surgeons have published the results of their research grant programs.[9,20–32] Many of these organizations sought to determine whether grant recipients subsequently received extramural funding from the NIH. Typically, the journey from inexperienced researcher to independent surgeon-scientist involves applying for a K-Series Grant, i.e., mentored career development award that support researchers in

Table 2
Comparison of National Institutes of Health (NIH) Funding Success between the number of Association of Women Surgeons (AWS) Grant recipients and nonrecipients. Analysis performed using the chi-squared test.

	Recipients (n = 24)	Nonrecipients (n = 68)	*p*-value
Any NIH funding history	6 (25%)	12 (17.6%)	0.49
Post-award/Post-application NIH funding	6 (25%)	7 (10.3%)	0.005
K-series grant	3 (12.5%)	3 (4.4%)	0.17
R-series grant	3 (12.5%)	3 (4.4%)	0.17
Other (e.g., F32, M01, P30)	1 (4.2%)	3 (4.4%)	0.96
Multiple NIH Grants	2 (8.3%)	2 (2.9%)	0.27

Table 3
Characteristics and comparison of outcomes by academic status. Analysis performed using the [a]Student's t-test and [b]chi-squared test.

Variable	Recipients (n = 24)	Nonrecipients (n = 68)	*p*-value
h-index (mean)[a]			
All	15.92	10.7	0.01
Assistant Professor	15.5	9	0.007
Associate Professor	14	12	0.31
Professor	36	35	0.47
Publications (mean)[a]			
All	50.6	36.4	0.05
Assistant Professor	46.3	28.4	0.06
Associate Professor	39.3	45.6	0.31
Professor	137.3	118.8	0.34
Journal Impact Factor (mean)[a]			
All	6.32	3.9	0.02
Assistant Professor	4.27	3.73	0.29
Associate Professor	8.15	4.35	0.15
Professor	10.3	7.71	0.27
Credentials[b]			
MD only	18 (75%)	39 (57.3%)	0.13
MD and Masters	2 (8.3%)	25 (36.8%)	0.009
MD and PhD	4 (16.7%)	7 (10.3%)	0.41

the early stages of their academic careers.[32,33] The Mentored Clinical Scientist Research Career Development Award (K08) and the Mentored Patient-Oriented Research Career Development Award (K23) are the most common K-Series Grants. Surgeon-scientists may also apply for R-Grants such as the R01 which is available for researchers during all stages of their academic careers.[32] Grant recipients of federal NIH and National Heart, Lung, and Blood Institute (NHLBI) grants have also been evaluated to determine award impact.[33–38]

We found that being awarded the AWS Research Grant correlated with receiving federal grant funding as compared to nonrecipients with between 885% and 1008% return on investment. Similarly, Safdar et al. reported 78% of Society for Academic Emergency Medicine Research Training Grant recipients were successful at obtaining federal funding while only 40% of nonrecipients shared the same success.[24] Likewise, Zarzaur et al. found that acute care surgery research scholarship recipients were more likely to receive NIH funding compared to nonrecipients (33% versus 11%, $p < 0.05$).[12]

In assessing scholarly impact, AWS Research Grant recipients had a higher h-index, produced more publications, and published in higher impact factor journals than nonrecipients. These findings are also consistent with the current published literature. In the presented data, grant recipients had an average h-index of 15.9 whereas Kibbe et al. reported an average h-index of 19.0 for vascular surgeon-scientists.[9] In a study evaluating outcomes of scholarship recipients by rank, assistant professors, associate professors, and professors all produced an increased median number of publications than nonrecipients. Not surprisingly, the authors found that the median number of publications, number of citations, and h-index for both recipients and nonrecipients increased with academic rank.[12] Overall, the results of our study also followed a similar trend.

Kim et al. found that pediatric urologists with advanced degrees enjoyed greater success at obtaining federal grants.[2] We could not conclude the same as we discovered that 29% of grant recipients and 43% of nonrecipients had advanced degrees in addition to their medical degrees. Protopsaltis et al. similarly found that having an advanced degree (i.e., MD/PhD) was not associated with an increased chance of obtaining a R01 grant compared to individuals with a MD degree alone.[38]

Our study has several limitations. We conducted a retrospective review of grant applicants which is limited due to its retrospective nature. Unlike other similar studies, we chose not to conduct a survey in an attempt to avoid responder bias. Additionally, the use of the h-index to determine scholarly impact is imperfect and has been extensively debated in the literature due to its shortcomings in assessing academic success for young scientists. The use of SCOPUS is also a limitation as it may not list all publications for authors. As such, there is some variability in the number of publications and the h-index among different search engines and databases. Further, our scope in determining extramural funding only from the NIH and not taking into account other sources of funding such as institutional and foundation grants was limited. Also, we only took into account funding in which the applicant was the principal investigator or co-principal investigator and not a co-investigator thereby possibly underestimating the amount and types of federal funds procured. Moreover, two of the grant recipients received NIH grants the same year as their AWS award and the timing of which application was submitted first was unknown. Finally, we had a relatively small sample size as this specific grant has only been awarded for the last 25 years and also because we were not able to obtain many applications from earlier years for the nonrecipients.

Conclusions

The Association of Women Surgeons has been extremely successful in achieving its goals and mission of supporting women surgeons during all stages of their training. AWS Research Grant recipients were more likely to become more impactful surgeon-scientists, as indicated by a higher post-award rate of NIH funding, total number of publications, and h-index compared to nonrecipients. Given the deteriorating federal funding awarded to surgeon-scientists, surgical societies play an instrumental role in inspiring, motivating, and cultivating future surgeon-scientists.

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