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Nationwide Bibliometric Analysis of Integrated Plastic Surgery Program Directors

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Background: Studies have linked bibliometric indices with the academic level of plastic surgeons, but this relationship has not been explored with residency program directors (PDs). As teachers of the next generation, PDs' academic performance is an important component of residency program success. We sought to identify distinguishing characteristics of integrated plastic surgery programs, focusing on their PD bibliometric indices.

Methods: We identified plastic surgery programs based on 2021 Doximity reputation and research output rankings, respectively, and then divided them into four quartiles (Q1–Q4). PD academic history and bibliometric indices (h-index, the number of publications, and citations) were collected through Doximity profiles and program websites: PubMed, Scopus, Google Scholar, American Society of Plastic Surgeons, and Accreditation Council for Graduate Medical Education.

Results: Eighty-four programs were identified. There was a significant positive relationship between h-index, the number of publications, and type of research with reputation ranking ($P < 0.05$). After adjusting for years of experience post-training, h-index (OR = 1.24; $P < 0.001$) and the number of publications (OR = 1.05, $P < 0.001$) were significantly associated with reputation ranking. There was a statistically significant relationship between PD research fellowship completion and research output ranking ($P < 0.01$). After adjusting for years of experience post-training, h-index (OR = 1.05; $P = 0.047$) and the number of publications (OR = 1.01; $P = 0.04$) were significantly associated with research output ranking.

Conclusion: Higher ranked programs tend to have PDs who have a strong record of scholarly activity, as evidenced by certain bibliometric indices. *(Plast Reconstr Surg Glob Open 2023; 11:e4711; doi: 10.1097/GOX.0000000000004711; Published online 10 January 2023.)*

INTRODUCTION

Plastic surgery is one of the most competitive specialties in medicine due to the limited availability of residency program positions in the United States as well as the popularity of the specialty. Program directors (PDs) play a critical role in setting the tone and culture for each individual program, and are critical in training the next generation of physicians and surgeons.[1] While the residency application process and selection methods used by PDs have been thoroughly studied,[2–4] little is available in the literature with regard to the attributes of the PDs themselves. Many applicants state that important factors when ranking a program in the match process include perceived resident happiness, high operative volume, faculty mentorship, and strong research infrastructure.[5] Undoubtedly, the PD influences these factors and represents the program for prospective applicants.

Because PDs have such an impact on the education of future plastic surgeons, it is sensible to evaluate them on their own academic performance. Importantly, this does not equate to analyzing their scores on standardized examinations; rather, a multitude of factors including training, leadership, clinical volume, and research productivity should be taken into account.[6,7] Although efforts exist to include all of these attributes in the evaluation of faculty members,[8] research performance remains the central determinant of academic standing.[6,7] Simple quantitative measures of a faculty member's publications and citations have traditionally been used to evaluate

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research performance. However, bibliometric indices are increasing in popularity due to the more comprehensive, unbiased evaluation they provide.[9,10] The Hirsch index (h-index), introduced in 2005, is one of the most frequently used bibliometric indices in the literature and has been used for professional evaluation of plastic surgeons in the past.[11–13] Many studies have linked bibliometric indices with the academic achievement of plastic surgeons, but this relationship has not been explored at the level of plastic surgery PDs.[6,7,14–16]

In this study, we aim to investigate the distinguishing characteristics of integrated plastic surgery program PDs, focusing on the correlation between academic, research indices, and residency program ranking. We hypothesize that PD bibliometric values are positively correlated with higher ranked programs.

Takeaways

Question: Does academic achievement (based on h-index, the number of publications, and the number of citations) of integrated plastic surgery program directors (PDs) correlate with higher Doximity residency rankings?

Findings: After adjusting for years of experience post-training, higher h-index and number of publications were associated with higher Doximity reputation ranking and Doximity research ranking.

Meaning: PDs passionate about research may instill those values in their residents, potentially bolstering the academic rank of their respective programs.

METHODS

This study was approved by the institutional review board of Rush University Medical Center. Data were gathered using the Accreditation Council for Graduate Medical Education and Doximity database of integrated plastic surgery residency programs. Only full-time PDs of active integrated programs were included in the study. Bibliometric indices were evaluated using a subscription bibliographic citation database (Scopus; Reed Elsevier, London, United Kingdom), cross-referencing the data with Google Scholar (http://scholar.google.com) and PubMed/National Center for Biotechnology Information (http://www.ncbi.nlm.nih.gov). All 2021 PD curriculum vitaes and biographies available on their Doximity profiles and respective program websites were reviewed for additional data.

Bibliometric indices measured included h-index (the number of publications h that are cited $\geq h$ times),[13] the total number of publications, the total number of citations, and the number of publications per year. Personal characteristics evaluated included gender, years of experience post-training, number of years as PD, and type of research (basic science, clinical, or both) conducted. We identified programs and PDs from the 2021 Doximity reputation and research output rankings, then divided them into four quartiles (Q1–Q4) following the study design established by Zhang et al.[17]

Statistical analysis and graphics were produced using R.[18] One-way analysis of variance and the Fisher exact test were used to evaluate the association between each bibliometric measure and program rankings. Welch two-sample t test was used to compare the mean PD h-indices based on the type of research they conducted. Program ranking lists were divided into quartiles: Q1–Q4. Multinomial logistic regression analysis was used to compare each quartile against the top Q1 quartile. These results were then used to correlate PD h-index, the number of peer-reviewed publications, and the number of citations with the Doximity reputation and research output rankings. These analyses were undertaken after adjusting for years in practice post-training. Linear regression analysis of h-index and years of experience post-training as well as the number of publications and years of experience post-training were completed for both research and reputation ranking. In all analyses, separate models for each variable were performed to avoid collinearity. A P value less than 0.05 was considered statistically significant.

RESULTS

A total of 84 active integrated plastic surgery programs and PDs were identified. The following descriptive statistics, as well as the exact breakdown of PD clinical fellowships are summarized in Table 1. Among the 84 PDs, 19.05% (n = 16) were women and 80.95% (n = 68) were men. Among all PDs, mean h-index was 13.86 (SD, ±9.53; range, 0–44), and mean number of publications was 47.21 (SD, ±45.35; range, 0–251). Mean years of experience post-training was 16.43 (SD, ±9.46; range, 3–44). In terms of the type of research conducted, 82.14% (n = 69) had conducted both clinical and basic science research, 16.67% (n = 14) conducted only clinical research, and 1.19% (n = 1) had conducted neither type of research. There

Table 1. Summary Statistics

Characteristic	N = 84
Gender, n (%)	
Female	16 (19.05)
Male	68 (80.95)
H-index, mean (±SD)	13.86 (±9.53)
Number of publications, mean (±SD)	47.21 (±45.35)
Type of research, n (%)	
Both	69 (82.14)
Clinical	14 (16.67)
Neither	1 (1.19)
Clinical fellowships, n (%)	67 (79.76)
Type of clinical fellowship, n (%)	
Burn	1 (1.49)
Burn/critical care	1 (1.49)
Cosmetic	1 (1.49)
Craniofacial	15 (22.39)
Hand	24 (35.82)
Head and neck	2 (2.99)
Microsurgery	15 (22.39)
Molecular pathology	1 (1.49)
Pediatric	3 (4.48)
Pediatric craniofacial	3 (4.48)
Surgical critical care	1 (1.49)
Missing information	17
Research fellowships, n (%)	9 (10.71)
Years of experience post-training, mean (±SD)	16.43 (±9.46)

Table 2. Mean H-index Based on Type of Research Conducted by the PD (Clinical or Both Basic Science and Clinical)

Characteristic	Both, N = 69	Clinical, N = 14	*P*
H-index, mean (±SD)	16.10 (±8.98)	3.79 (±2.64)	<0.001*

There was a statistically significant difference in mean h-index based on the type of research conducted.
*Statistical significance.

Table 3. Logistic Regression Analysis

Characteristic	OR	95% CI	*P*
H-index	1.24	1.13–1.38	<0.001*
Years of experience post-training	0.92	0.86–0.97	0.01*
Number of publications	1.05	1.03–1.07	<0.001*
Years of experience post-training	0.95	0.89–1.00	0.07

After adjusting for years of experience post-training, both h-index and the number of publications were found to be positively associated with reputation ranking (Q1 and Q2 versus Q3 and Q4).
*Statistical significance.

was a statistically significant difference in mean h-index based on the type of research conducted ($P < 0.001$), with the mean PD h-index for those who had done both clinical and basic science research being 16.10 (SD, ±8.98), while PDs who had only conducted clinical research had a mean h-index of 3.79 (SD, ±2.64) (Table 2). Of the 84 PDs, 79.76% (n = 67) completed some type of clinical fellowship, while 10.71% (n = 9) had completed some type of research fellowship.

The association between h-index and the number of publications with reputation rankings (Tables 3–7) and research rankings (Tables 8–12) was adjusted for years in practice post-training and analyzed separately. Based on logistic regression analysis, both h-index (OR = 1.24; $P < 0.001$) and the number of publications (OR = 1.05; $P < 0.001$) were found to be positively associated with reputation ranking (Table 3). On multinomial logistic regression analysis, higher h-index was found to be negatively associated with Q3 and Q4 reputation ranking; however, higher h-index was not significantly associated with the difference between Q2 and Q1 reputation ranking (Table 4). The same relationship applied to the number of publications, as a greater number of publications were found to be negatively associated with Q3 and Q4 reputation ranking; meanwhile, a greater number of publications was not significantly associated with Q2 versus Q1 reputation ranking (Table 5). Based on linear regression analysis, both h-index ($P < 0.001$) and the number of publications ($P < 0.001$) were significantly associated with years of experience post-training (Tables 6, 7).

Based on logistic regression analysis, both h-index (OR = 1.05; $P < 0.047$) and the number of publications (OR = 1.01; $P < 0.04$) were found to be positively associated with research ranking (Table 8). On multinomial logistic regression analysis, higher h-index was found to be negatively associated with Q2 and Q4 reputation ranking; however, higher h-index was not significantly associated with Q3 ranking at all (Table 9). A greater number of publications were negatively associated with Q4 ranking, while it was not significantly associated with Q2 nor Q3 ranking at all (Table 10). Finally, based on linear regression analysis, both h-index (p = 0.003) and the number of publications ($P = 0.01$) were significantly associated with the years of experience post-training (Tables 11, 12).

Table 4. Multinomial Logistic Regression Analysis

Characteristic	OR	95% CI	*P*
Q2			
H-index	0.98	0.92–1.05	0.6
Years of experience post-training	1.07	0.99–1.15	0.11
Q3			
H-index	0.83	0.75–0.93	0.001*
Years of experience post-training	1.13	1.03–1.23	0.01*
Q4			
H-index	0.75	0.66–0.86	<0.001*
Years of experience post-training	1.14	1.03–1.25	0.01*

After adjusting for years of experience post-training, higher h-index was found to be negatively associated with Q3 and Q4 reputation ranking. Meanwhile, higher h-index was not significantly associated with the difference between Q2 and Q1 reputation ranking (Q2, Q3, and Q4 versus Q1).
*Statistical Significance.

Table 5. Multinomial Logistic Regression Analysis

Characteristic	OR	95% CI	*P*
Q2			
Number of publications	1.00	0.99–1.01	0.8
Years of experience post-training	1.06	0.98–1.15	0.12
Q3			
Number of publications	0.97	0.94–0.99	0.01*
Years of experience post-training	1.10	1.01–1.19	0.03*
Q4			
Number of publications	0.94	0.90–0.97	<0.001*
Years of experience post-training	1.09	1.00–1.19	0.045*

After adjusting for years of experience post-training, a greater number of publications were found to be negatively associated with Q3 and Q4 reputation ranking. Meanwhile, a greater number of publications were not significantly associated with Q2 versus Q1 reputation ranking (Q2, Q3, and Q4 versus Q1).
*Statistical significance.

Table 6. Linear Regression Analysis of H-index and Years of Experience Post-training Based on Reputation Ranking

Characteristic	Beta	95% CI	*P*
H-index	–1.3	–1.8 to –0.85	<0.001*
Years of experience post-training	0.70	0.21–1.2	0.01*

*Statistical significance.

Table 7. Linear Regression Analysis of the Number of Publications and Years of Experience Post-training Based on Reputation Ranking

Characteristic	Beta	95% CI	*P*
Number of publications	–0.23	–0.33 to –0.12	<0.001*
Years of experience post-training	0.52	0.01–1.0	0.047*

*Statistical significance.

Table 8. Logistic Regression Analysis

Characteristic	OR	95% CI	*P*
H-index	1.05	1.00–1.12	0.047*
Years of experience post-training	0.97	0.92–1.02	0.2
Number of publications	1.01	1.00–1.03	0.04*
Years of experience post-training	0.98	0.93–1.02	0.3

After adjusting for years of experience post-training, higher h-index was found to be positively associated with higher research output ranking (Q1 and Q2 versus Q3 and Q4).
*Statistical significance.

Table 9. Multinomial Logistic Regression

Characteristic	OR	95% CI	*P*
Q2			
H-index	0.94	0.87–1.00	0.07*
Years of experience post-training	1.09	1.00–1.18	0.04*
Q3			
H-index	0.93	0.87–1.00	0.06
Years of experience post-training	1.08	0.99–1.17	0.08
Q4			
H-index	0.90	0.83–0.98	0.01*
Years of experience post-training	1.09	1.01–1.19	0.04*

After adjusting for years of experience post-training, higher h-index was negatively associated with Q2 and Q4 ranking, while it was not significantly associated with Q3 ranking at all (Q2, Q3, and Q4 versus Q1).
*Statistical significance.

Table 10. Multinomial Logistic Regression

Characteristic	OR	95% CI	*P*
Q2			
Number of publications	0.99	0.98–1.00	0.2
Years of experience post-training	1.08	1.00–1.17	0.06
Q3			
Number of publications	0.99	0.97–1.00	0.10
Years of experience post-training	1.07	0.99–1.15	0.11
Q4			
Number of publications	0.98	0.96–1.00	0.02*
Years of experience post-training	1.08	1.00–1.17	0.06

After adjusting for years of experience post-training, the number of publications was negatively associated with Q4 ranking, while it was not significantly associated with Q2 nor Q3 ranking at all (Q2, Q3, and Q4 versus Q1).
*Statistical significance.

Table 11. Linear Regression Analysis of H-index and Years of Experience Post-training Based on Research Output Ranking

Characteristic	Beta	95% CI	*P*
H-index	−0.83	−1.4 to −0.29	0.003*
Years of experience post-training	0.53	−0.02 to 1.1	0.06

*Statistical significance.

Table 12. Linear Regression Analysis of the Number of Publications and Years of Experience Post-training Based on Research Output Ranking

Characteristic	Beta	95% CI	*P*
Number of publications	-0.15	−0.26 to −0.03	0.01*
Years of experience post-training	0.42	−0.12 to 1.0	0.13

*Statistical significance.

DISCUSSION

The purpose of this study was to evaluate distinguishing characteristics of integrated plastic surgery program PDs—with a focus on their bibliometric indices—to investigate how these characteristics might impact the program rank. Our results supported the hypothesis that PD scholarly activity is associated with program rank, although there were some differences between the research output and reputation rankings. Higher h-index and the number of publications were positively correlated with both higher reputation and research output ranks. Notably, higher mean h-index was also significantly associated with PD participation in basic science research, further highlighting the relationship between PD scholarly activity and their respective program's ranking.[19]

The Doximity reputation classification rank order has been shown to influence fourth-year medical student residency rankings in other specialties outside of plastic surgery.[20,21] This rank order is derived from a survey of over 53,000 eligible physician nominations of residency programs that they believe offer the best clinical training.[22] Of note, this survey does not ask any questions regarding scholarly works by the institution or the PD. However, our analysis found that PD scholarly activity is often positively correlated with program rankings on Doximity.

Interestingly, for both research output and reputation rankings, higher h-index and the number of publications were most strongly correlated with higher rankings. These findings imply that reputation is strongly influenced by research funding. According to Silvestre et al,[23] the top five National Institutes of Health-funded plastic surgery departments in the United States in 2015 were Stanford University, University of Michigan, Washington University in St. Louis, University of Pittsburgh, and Harvard University. These programs currently rank 10, 3, 13, 1, and 8 with respect to reputation, as well as 7, 1, 25, 5, and 45 with respect to research output, respectively.[22] Thus, while research funding likely plays a role in subjective perceptions of programs, it does not fully explain the extent of our findings. The question becomes whether PDs with high scholarly activity effectively increase the rankings of the program or conversely if high-ranking programs prioritize scholarly activity as an attribute of the PD. Longitudinal data analysis is warranted to decipher this classic "chicken-or-egg" paradigm.

The mean PD h-index in our study was 13.86, which is higher than values found in studies focusing on the general population of academic plastic surgeons. When studying academic plastic surgeons, Gast et al,[24] Paik et al,[25] and Susarla et al[6] found mean h-index values of 7, 8.6, and 10.2, respectively. These differences could be attributed to different methods for obtaining the h-index, which have been reported variably in different databases.[26,27] Alternatively, these differences could also indicate that PDs on average have higher academic productivity than the general plastic surgery population. Given that PDs are at the forefront of academic surgery, this theory is intuitive. Furthermore, studies in plastic surgery and other medical fields have found that the h-index is positively correlated with academic rank.[12,28–31] Our nationwide study of integrated plastic surgery PDs confirms that research productivity is one of many important factors in becoming a PD in plastic surgery—particularly in highly ranked programs.

Some studies suggest that surgeon-specific factors, such as time since completion of plastic surgery training, subspecialty training, gender, and type of fellowship, may influence academic promotion.[8,27] We found that while clinical fellowship training had no statistically significant correlation with program rank, PD completion of a research fellowship was associated with higher research output ranking. In a similar study of 90 plastic surgery residency programs (including both independent and integrated), Fishman et al[32] found that 45% of the plastic surgery PDs are male hand specialists. Our findings are

consistent with those of previously reported data, given that a substantial number (n = 24, 35.82%) of PDs completed a dedicated hand fellowship. Given that our study also found that a vast majority (around 81%) of PDs are male, our findings support the conclusions of more recent publications such as that of Reghunathan et al[33] and Chen et al[34], who have identified a concerning lack of female representation throughout various levels of training and leadership in plastic surgery.

The discussion regarding potential consequences of generation gap between faculty and trainees has been brought to attention during the past two decades.[1,35,36] As a result, it is possible that higher ranked programs have an increased tendency to choose PDs who completed training more recently, as they would be more in tune with the current state of residency training.

The main limitation of our study is the use of the Doximity ranking system as a proxy for residency program rankings; which it is not. According to the Doximity Residency Navigator research methodology, reputation ranks were derived from nomination survey responses limited to board-certified physicians in a given specialty, while the research output ranks were calculated based on a combination of the collective h-index of publications authored by alumni graduating within the past 10 years, the ratio of current residents and recent graduates publishing, and research grants awarded and participation in clinical trials.[22] Thus, these rankings, especially the reputation ranks, can be subject to significant bias and should be interpreted with a certain degree of caution. However, it is a resource used extensively by prospective applicants across the country, and to our knowledge, the nomination survey model used by Doximity is one of the most comprehensive ranking systems currently available for American residency programs.[22] A gold-standard ranking system for residency programs—and plastic surgery programs, in particular—has yet to be created.[37,38] Furthermore, some of the statistical analysis conducted for this study may not appear immediately sensible due to our inherently limited sample size of just 84 total integrated programs. For example, we found that h-index and the number of publications were significantly associated with research output ranking. At first glance, it may seem baffling that an OR of 1.01 or 1.05 could be found significant, given that an OR of 1 represents no association at all between independent and dependent variables. However, in the context of our descriptive statistics, the numbers are substantially different, with the size of the OR likely related to the scaling of the variable. Thus, for ease of interpretation, an OR of 1.01 can be thought of as one additional publication increasing the odds of higher output rank by 1%. It would not be expected that one PD publication would make a 10% difference in program rank.

Another possible limitation of our study is that we used bibliometric indices to assess academic productivity. Despite the various advantages of bibliometric indices, multiple studies have raised concerns regarding their limitations. For example, it is possible that some indices may be distorted by self-citation.[6,15] However, one study in 2012 among academic radiologists showed that the effect of self-citation is negligible, with an only 2% increase in cumulative citations and unaffected h-index after inclusion of self-citations.[39] Swanson et al[40] recently performed an analogous study in the field of plastic surgery and similarly concluded that self-citation has a minor impact on common bibliometric measures in academic plastic and reconstructive surgery. An additional limitation of our study is that we did not include PD grant funding in our analysis. Continued research on other key characteristics of plastic surgery PDs is required to produce a more thorough understanding of their academic performance and its impact on the perception of their institution.

CONCLUSIONS

We have identified characteristics of various plastic surgery residency PDs and compared them based on program ranking. Our study demonstrates that certain PD bibliometric indices, such as h-index and the number of publications, are positively correlated with their program ranking. These findings highlight the significant influence that PDs' academic endeavors have on the culture and ranking of residency programs in the field of plastic surgery.

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