



Do Plastic Surgery Programs with Integrated Residencies or Subspecialty Fellowships Have Increased Academic Productivity?

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Background: The aim of this study was to evaluate the effect of different surgical training pathways on the academic performance of plastic surgical divisions.

Methods: Eighty-two academic parameters for 338 plastic surgeons (PS), 1737 general surgeons (GS), and 1689 specialist surgeons (SS) from the top 55 National Institutes of Health (NIH)-funded academic departments of surgery were examined using data gathered from websites, SCOPUS, and NIH Research Portfolio Online Reporting Tools.

Results: The median size of a PS division was 7 faculty members. PS faculty had lower median publications (P)/citations (C) (ie, P/C) than GS and SS (PS: 25/328, GS: 35/607, and SS: 40/713, $P < 0.05$). Publication and citation differences were observed at all ranks: assistant professor (PS: 11/101, GS: 13/169, and SS: 19/249), associate professor (PS: 33/342, GS: 40/691, and SS: 44/780), and professor (PS: 57/968, GS: 97/2451, and SS: 101/2376). PS had a lower percentage of faculty with current/former NIH funding (PS: 13.5%, GS: 22.8%, and SS: 25.1%, $P < 0.05$). Academic productivity for PS faculty was improved in integrated programs. P/C for PS faculty from divisions with traditional 3-year fellowships was 19/153, integrated 6-year residency was 25/329, and both traditional and 6-year programs were 27/344, $P < 0.05$. Craniofacial and hand fellowships increased productivity within the integrated residency programs. P/C for programs with a craniofacial fellowship were 32/364 and for those that additionally had a hand fellowship were 45/536. PS faculty at divisions with integrated training programs also had a higher frequency of NIH funding.

Conclusions: PS divisions vary in degree of academic productivity. Dramatically improved scholarly output is observed with integrated residency training programs and advanced specialty fellowships. (*Plast Reconstr Surg Glob Open* 2016;4:e614; doi: 10.1097/GOX.0000000000000596; Published online 10 February 2016.)

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Presented at ASPS, 2015, Boston, Mass.

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DOI: 10.1097/GOX.0000000000000596

Academic plastic surgery is a small cohort of individuals that aims to educate the next generation and further discover and innovate within the specialty. General success in academic medicine and surgery has historically been measured by number of publications, citations, and the amount of extramural research funding generated by an individual or department.^{1,2} A common, standardized measurement of academic productivity is the h-index,³ which has been shown to statistically correlate with academic rank.⁴ Moreover, metrics of

Disclosure: The authors have no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.

academic productivity are often used as part of the criteria for tenure or promotion across multiple specialties.⁵⁻⁸ Academic productivity has also been used as a criterion for salary bonus in a recent study of faculty recruitment and retention,⁹ making this an important fiscal issue as well.

Plastic surgery divisions and departments are no different in their use of metrics of academic productivity for promotion. Although the h-index has been shown to correlate with academic rank and has been reported to be higher in larger programs and those with integrated residencies,¹⁰ the specific impact of different combinations of traditional and integrated plastics programs on departmental productivity has not been determined. Also unknown is the influence of having an integrated training program on the level of National Institutes of Health (NIH) funding awarded to the plastic surgery division.

The introduction of the integrated training pathway, whereby the trainee fits into a 6-year clinical training program directly out of medical school, in addition to the independent model has had notable effects on academics in plastic surgery across the United States. It has been shown that the characteristics of residents more likely to enter academics include greater number of publications before residency, greater number of publications during residency, fellowship training, and graduating from an integrated residency.¹¹ The majority of recent graduates have chosen to enter private practice rather than academics. However, when comparing independent versus integrated program graduates, there is a significantly higher percentage of integrated graduates entering academia.¹² Subspecialty applicants in craniofacial and hand surgery are more likely to remain in academics 5 years after graduating if they have a greater number of publications at the time of application and have more publications compared with their colleagues who pursued private practice.¹³

The goal of this study is to better characterize the influence of subspecialty fellowships and integrated residency programs on plastic surgery department or division academic productivity. We hypothesized that the presence of an integrated program or subspecialty fellowship would increase the academic productivity within plastic surgery not only in terms of the numbers of publications and citations but also in terms of extramural funding for research.

METHODS

The methods used in this article have been described in detail in a previous study by the authors of this article¹⁴ and are described here briefly.

Data Collection

By using data from the Blue-Ridge Institute for Medical Research (<http://www.brimr.org/>), the top 50 university-based and 5 hospital-based departments of surgery based on the NIH funding were identified. The surgery departmental websites were queried for each of these institutions, and a list of 4015 surgical faculty members were then identified. For each of these faculty members, we collected data on demographic characteristics including academic rank, division, degrees, sex, and any leadership positions (defined as department or division chief and or program director). The SCOPUS database (<http://www.scopus.com/>) was used to determine scholarly output including total publications, total citations, 3-year citations, and h-index for each faculty member.

Metrics of Academic Output and NIH Funding

Initial analysis suggested that the majority of funding appeared to be derived from the NIH. As well, NIH funding by principal investigator is readily and reliably assessed through publically available online resources. Thus, NIH funding was the only metric of funding that was measured. Two independent sources of NIH funding information were used: the NIH Research Portfolio Online Reporting Tools database and the Grantome online database (<http://www.grantome.com/>). From these sources, all current or previous NIH grants, including the funding amount, years funded, and type of NIH award were collected. As has been described previously in detail,¹⁵ the NIH awards were categorized into 3 broad categories (1) NIH P01/R01/U01 awards, (2) nonmajor funding (eg, F32, K08, R00, R21, R43), and (3) no history of current/former NIH funding.

Data Quality and Statistical Analyses

The data were analyzed to identify faculty members with missing data resulting from variations of name spellings and other errors. A recheck of all data sources was performed for faculty members with any missing data ($n = 408$), and data were updated as available. To correct errors in data collection owing to the volume of data generated, a random data quality assurance was performed for 30% of the data, and <1% error rate was found and appropriately corrected.

Metrics of academic output were compared using *t* test of means. Multiple group comparisons were performed using analysis of variance as applicable. Multivariate logistic regressions were performed for publications, citations, and NIH funding. A $P \leq 0.05$ was considered statistically significant. All data warehousing and analyses were performed using SPSS

version 16 (SPSS Inc., Chicago, IL). This study was exempted from review by the institutional review board of Indiana University School of Medicine.

Subset Analysis

The entire dataset was divided into 3 subsets based on the divisions of the faculty members. Plastic surgery (PS) departments and divisions were identified as 1 group. General surgery (GS) and its subspecialties were defined as general surgery and included acute care surgery, surgical critical care, surgical oncology, and trauma surgery. All other specialties including cardiothoracic surgery, pediatric surgery, science/research divisions, and transplant were combined into a single category of “other surgical specialties (SS).” All statistical analyses and group comparisons were subsequently made among these subsets (PS vs GS and SS).

RESULTS

Demographics and Structuring of Plastic Surgical Departments Compared with General Surgery and Other Surgical Subspecialties

The median size of a PS division was 7 faculty members (Table 1). Overall, 39.6% of the plastic surgery faculty were assistant professors, 25% were associate professors, and 35.4% were full professors. GS faculty members were similarly distributed among the different ranks (assistant, associate, and full professors: 39.1%, 28.7%, and 32.2%, respectively). However, among SS, fewer faculty members were assistant professors (33.9%) and more were full professors (41.1%), $P < 0.05$.

The percentage of plastic surgery faculty members who were in leadership positions (department/division chair and/or program director) was between those from GS and from other surgical specialties. Twelve percent of the plastic surgical faculty members were in leadership positions. GS had the lowest percentage of faculty in some leadership position (8.7%), whereas faculty members in SS were approximately 2 times as likely as general surgical faculty to be represented among divisional or departmental leadership positions (15.9%).

Plastic surgery had the fewest PhDs and MD, PhDs. Overall 5% of the plastic surgery faculty had a PhD or MD, PhD compared with 13.4% among GS faculty and 10% among other surgical specialties ($P < 0.05$). However, the percentages of MD, PhDs were more similarly distributed among each of the 3 specialty subgroups. These data also demonstrated differences in the percentages of faculty members from each of the specialty subgroups that had current or past funding from the NIH. Overall 13.5%

Table 1. Overview of Plastic Surgery Productivity Compared With General Surgery and Surgical Specialties

Parameter	Plastic Surgery			General Surgery			All Other Surgical Specialties		
	n (%) Among Division	Total P ± SD	Total C ± SD	n (%) Among Division	Total P ± SD	Total C ± SD	n (%) Among Division	Total P ± SD	Total C ± SD
Overall	338 (100)	25±64	328±1343	1737 (100)	35±85	889±3049	1689 (100)	40±105	623±3128
Academic ranks									
Assistant professor	108 (39.6)	11±23	102±651	679 (39.1)	13±27	169±808	572 (33.9)	19±56	247±1277
Associate professor	54 (25)	33±32	342±860	499 (28.7)	40±39	690±1443	422 (25)	44±46	780±2179
Professor	101 (35.4)	57±92	968±1818	559 (32.2)	97±110	2451±4439	695 (41.1)	101±141	2374±4357
Division chief									
Division chief/director	40 (11.7)	54±124	779±1813	151 (8.7)	95±105	2228±4116	268 (15.9)	81±120	1881±3954
No title	223 (88.3)	22±49	324±1280	1586 (91.3)	33±80	552±3023	1421 (84.1)	37±104	661±3117
Academic credentials									
MD	250 (95.1)	23±64	327±1200	1504 (86.6)	34±81	530±3086	1521 (90.1)	38±101	629±3146
MD, PhD	8 (3.6)	29±57	119±1091	83 (4.8)	46±130	1056±4453	94 (5.6)	78±121	1510±3850
PhD	5 (3.0)	84±63	2250±1658	150 (8.6)	44±94	1369±2575	74 (4.3)	36±93	1194±2229
Current/former NIH funding									
NIH R01/U01/P01 grants	20 (2.7)	127±144	3221±2633	152 (8.8)	96±124	2480±4569	187 (11.1)	111±194	3302±5478
Non-R01 grants	36 (10.8)	28±97	697±1570	241 (13.9)	62±110	1601±4085	236 (14)	50±99	992±3256
No NIH funding	207 (86.5)	22±45	288±1077	1344 (77.2)	25±67	406±2450	1266 (74.9)	32±74	516±2216

of the plastic surgery faculty had current/former NIH funding compared with 22.7% of the GS faculty and 25.1% of other surgical specialties ($P < 0.05$). Of these, there were greater differences concerning the percentage of faculty with NIH R01/U01/P01 grants (PS: 2.5%, GS: 8.8%, and SS: 11.1%, $P < 0.05$)

Academic Output and NIH Funding in Plastic Surgery

Overall, PS faculty had lower median publications/citations (P/C) than general surgeons and surgical subspecialists. Median P/C for plastic surgery faculty was 25/328 when compared with 35/889 for GS faculty and 40/105 ($P < 0.05$) for faculty from SS. This difference was observed for each academic level. Median P/C by academic rank were as follows: assistant professor (PS: 11/102 vs GS: 13/169 and SS: 19/247, $P < 0.05$), associate professor (PS: 33/342 vs GS: 40/690 and SS: 44/780, $P < 0.05$), and professor (PS: 57/968 vs GS: 97/2451 and SS: 101/2374, $P < 0.05$). The median h-index for PS was 9; this was 12 for general surgery (GS) and 13 for other surgical specialties (SS; $P < 0.001$ when comparing PS with either GS or SS).

Advanced degrees and NIH funding among PS faculty members improved their academic output metrics to levels comparable with that of their peers in GS and SS divisions. The mean publications for PS faculty with PhDs and MD, PhDs was 50 publications compared with 45 publications for faculty members in GS and 55 publications in SS (derived from Table 1).

Several noteworthy points can be made regarding the academic output for faculty members analyzed by NIH funding. The academic output of the non-NIH funded PS (P/C: 22/288) faculty was only marginally lower compared with that of the GS (25/406) and SS (32/516) faculty. The considerably higher percentage, however, of non-NIH-funded faculty in PS (86.5%) compared with GS (77.2%) and SS (74.9%) lowered the median academic output of the aggregate PS faculty members. The impact of NIH funding consisting of smaller NIH grants (R21, R43, K08, etc.) on the academic output of all surgical faculty members was lowest for PS faculty (P/C for faculty members with small NIH grants, PS: 28/697 vs GS: 62/1601 and SS: 50/992, $P < 0.05$). Finally, among faculty members with large NIH grants (R01/U01/P01), PS faculty attained the highest levels of academic output (PS: 127/3221 vs GS: 96/2480 and SS: 111/3302, $P < 0.05$).

Influence of Integrated Training Programs and Advanced Fellowships on Academic Productivity and NIH Funding Among Plastic Surgery Divisions

Academic productivity for PS faculty was dramatically improved in integrated residency programs. P/C for PS faculty from divisions with traditional

3-year fellowships alone were 19/153, compared with those programs with integrated 6-year residency (27/329) and programs that combined both traditional and 6-year programs (26/364), $P < 0.05$.

Craniofacial and hand fellowships further increased productivity within the integrated residency fellowship programs. P/C for programs that also had a craniofacial reconstructive fellowship were 32/364 and for those that additionally had a hand fellowships were 45/536 ($P < 0.05$). Programs with a hand fellowship alone had fewer average publications but had higher citations (22/404, $P < 0.05$; Table 2)

PS programs with integrated residencies alone had higher productivity at all academic ranks compared with traditional 3-year fellowships (P/C assistant: 11/174 vs 5/34, associate: 39/325 vs 27/256, and full professor: 71/846 vs 56/547, $P < 0.05$).

PS faculty at divisions with integrated training programs also had a higher frequency of NIH funding (PS% with current/former NIH funding, 3-year fellowships: 5.8%, integrated 5-year residency: 7.9%, and both 5-year and 2-year programs: 18.7%). Number of RO1/U01/P01 grants were highest at programs with integrated residencies alone, followed by combined training programs and the lowest at traditional fellowships alone (128 vs 126 vs 0, respectively, $P < 0.05$). Nonmajor NIH grants followed a different pattern with integrated alone having the most followed by traditional fellowship and combined (69 vs 42 vs 23, respectively, $P < 0.05$) (Table 3).

DISCUSSION

Plastic surgery has a rich history of academicians, researchers, and innovators¹⁵; however, in this study, plastic surgery faculty were observed to be less academically productive than their counterparts in GS and SS by publications, citations, and NIH funding. Conversely, this data analysis also identified a number of extremely productive academic plastic surgeons. For such successful plastic surgical faculty, the balance between time for clinical activities and commitment to research is critical. A recent study showed that academic plastic surgeon income is similar to that of private practice plastic surgeons; however, this required more clinical volume measured in relative value unit to attain such an income.¹⁶ On top of this, clinical productivity can be slowed by intraoperative resident education in plastic surgery, costing operating room time.¹⁷ A recent survey found that 93% of respondents feel that academic plastic surgery practice as it is performed today will change in the future, although 50.7% felt that the job demands of academic plastic surgery are not feasible in a managed care environment.

Table 2. Overview of Plastic Surgery Faculty Productivity Between Institutions With Different Fellowship Training Paradigms

Parameter	Plastic Surgery			General Surgery			All Other Surgical Specialties		
	n (%) Among Division	Total P ± SD	Total C ± SD	n (%) Among Division	Total P ± SD	Total C ± SD	n (%) Among Division	Total P ± SD	Total C ± SD
Overall	338 (100)	25 ± 64	328 ± 1343	1737 (100)	35 ± 85	889 ± 3049	1689 (100)	40 ± 105	623 ± 3128
Plastic surgery training									
Traditional 3-y fellowship		19 ± 38	153 ± 725		33 ± 62	634 ± 1734		35 ± 98	633 ± 3031
Integrated 6-y program alone		27 ± 50	329 ± 1566		31 ± 96	414 ± 2965		33 ± 77	588 ± 2158
Both 3-y/6-y programs present		26 ± 75	364 ± 1371		35 ± 84	649 ± 3120		46 ± 114	780 ± 3500
Within combined tradition 3-y/integrated 6-y programs									
No advanced fellowships		27 ± 63	351 ± 1259		31 ± 84	583 ± 2979		39 ± 87	650 ± 3019
Hand fellowships		22 ± 114	404 ± 1773		48 ± 87	1033 ± 3081		62 ± 157	1090 ± 4507
Craniofacial fellowships		32 ± 54	364 ± 1079		32 ± 59	470 ± 2392		53 ± 141	973 ± 3900
Both hand/cranial fellowships		45 ± 67	536 ± 1483		52 ± 101	897 ± 4873		56 ± 83	994 ± 2179

However, 73% of respondents defined academic plastic surgeon as a teacher and a researcher,¹⁸ thus indicating that although plastic surgeons may have high academic potential as measured by numbers of publications and citations, they also face constraints in their clinical practice that may limit this inclination toward research.

Plastic surgery faculty members at institutions with an integrated residency have more publications and citations compared with those with a traditional fellowship. There could be multiple reasons for this. It has been previously shown that residents in the traditional plastic surgery fellowship are more likely to go directly into private practice and less likely to pursue additional fellowship training.¹⁹ Pursuing additional fellowship training was significantly correlated with entering academic practice, and integrated residents were more likely to obtain additional subspecialty fellowship training.¹⁹ A recent study comparing integrated program and the traditional fellowship program showed that integrated residents had higher preresidency publication scores and were more often MD/PhDs.²⁰ These characteristics carry over into residency training and likely contribute to increased publications among integrated residents and therefore their attending mentors. There is so much competition and drive for publications to obtain integrated residency positions, and there was concern that applicants may have been misrepresenting the number of publications they had in progress, but it was found that the great majority of applicants were truthful.²¹

Herein, we showed that craniofacial and hand subspecialty fellowships within plastic surgery programs increase the academic productivity of faculty. This may in part because of the characteristics of integrated residents and their increased likelihood to pursue additional subspecialty training. A recent survey by Gerety et al.²² found that practicing craniofacial surgeons were largely academic, with 69% in active academic practice. Of these, 54% were full professors.

There are fewer plastic surgeons in academic practice than other surgical specialties. The American College of Surgeons Health Policy Research Institute released a survey in 2010 that identified 6267 active plastic surgeons in 2008, of whom 0.41% participate in teaching and 0.26% participate in medical research.²³ These 2008 numbers showed a decrease in teaching and research by 25.7% and 23.8%, respectively, compared with 2004. This is in contrast to all other active surgeons of which there are a larger number (135,854) and proportionally more involved in medical teaching (0.77%) and research (0.48%).²⁴ These numbers are lower than expected; however, there is likely a response bias in this large, national survey. In addition to other surgeons being

Table 3. Overview of Plastic Surgery Faculty Productivity Among Institutions With Different Fellowship Training Paradigms

Parameter	Traditional 3-y Fellowships		Integrated 6-yr Residency Program		Both 3-y/6-y Training Programs	
	Total P ± SD	Total C ± SD	Total P ± SD	Total C ± SD	Total P ± SD	Total C ± SD
Overall						
Academic ranks						
Assistant professor	5 ± 15	34 ± 1047	11 ± 25	174 ± 378	15 ± 25	163 ± 570
Associate professor	27 ± 22	256 ± 539	39 ± 38	325 ± 920	33 ± 33	351 ± 953
Professor	56 ± 51	547 ± 465	71 ± 56	846 ± 2064	55 ± 119	1175 ± 1878
Division chief						
Division chief/director	26 ± 50	209 ± 693	55 ± 46	623 ± 780	53 ± 145	1021 ± 2070
No title	16 ± 37	153 ± 735	22 ± 52	329 ± 1703	23 ± 51	328 ± 1184
Current/former NIH funding						
NIH R01/U01/P01 grants	—	—	128	8352	126 ± 155	3162 ± 2132
Non-R01 grants	42 ± 19	1127 ± 19	69 ± 58	771 ± 1087	23 ± 109	461 ± 1739
No NIH funding	16 ± 40	149 ± 748	25 ± 49	325 ± 1360	24 ± 44	324 ± 999

active in research, general surgery programs are typically larger and, therefore, have more residents available to participate in research endeavors. This likely increases the academic productivity of general surgeons compared with plastic surgeons in academia, but further study is needed. In addition, general surgery academic productivity may be increased purely because there are more journals and therefore more publications and opportunity for citation.

It might be that economic pressures are decreasing plastic surgeon involvement in research as well. A 2001 study revealed that there was an increasing influence of managed care on academic plastic surgery, leading to an overall increase in time spent in clinical practice and decreased time spent on research endeavors.²⁴

NIH funding among plastic surgeons was lower than compared with GS and other surgical subspecialties. Within plastic surgery programs the highest amount of funding was with integrated residency programs alone. As mentioned earlier, the research track record of those programs with integrated residencies is significantly stronger. A study of academic otolaryngology revealed that h-index was highly predictive of NIH grant awards.²⁵ The higher numbers of residents at integrated residency positions who have a strong and early interest in academic research could potentially explain the considerably higher numbers of publications and citations and therefore larger extramural research funding from the NIH.

The authors of this study have previously provided a broad overview of the academic metrics of surgical departments and divisions^{14,26,27}; however, to the authors' best knowledge, this is the first study elucidating the increased academic productivity of plastic surgery faculty based on the presence of an integrated residency program and both craniofacial and hand surgery fellowships. Limitations of this study include its limitation to the top 55 NIH-funded

surgery departments, database inclusion criteria, research funding limited to NIH funding, publication impact factor, and number of residents within a program. A previous analysis of NIH funding and medical schools revealed that the top 10 ranked medical schools based on the NIH funding increased overall NIH funding during the course of a decade, whereas other schools showed a decrease.²⁸ The current analysis covered the top 50 NIH-funded surgery departments, which certainly captures the majority of highly funded research divisions, but it limits the applicability to all of academic surgery. Inclusion of programs with craniofacial and hand fellowships allowed for evaluating the impact of these programs on academic productivity; however, microsurgery, burn, and cosmetic fellowships were excluded from this study. Further research is needed to study the impact of fellowship programs on faculty academic productivity. Research funding in this study focused primarily on NIH grants. However, as NIH funding becomes increasingly competitive, faculty are able to secure funding from sources such as the Plastic Surgery Foundation. In fact, it was recently shown that a majority of plastics faculty obtaining federal funding first received grants from the Plastic Surgery Foundation.²⁹ This study does not account for the impact factor of studies published or significance of the research. Although programs with craniofacial fellowships showed the highest number of publications and citations within plastic surgery, recent data show that the quality of evidence in craniofacial research is low.³⁰ Finally, this study data set does not contain the number of residents in each program. It is possible that integrated programs and programs with hand and craniofacial fellowships may be more productive simply because there are more residents available for participation in research. There may also be differences in the ability

for integrated residents to publish research because their training program is longer than traditional fellows (6 vs 3 years), allowing them develop faculty mentorship, apply for funding, set up institutional review boards, design studies, acquire data, and submit papers. Future studies are needed to further discern the differences between training models and their relationship with academic productivity.

This study shows a clear difference in academic productivity among plastic surgery faculty. Plastic surgeons as a whole are less academically productive than their other surgical counterparts. Faculty productivity is increased with integrated programs and subspecialty fellowship in craniofacial and hand surgery. Residents and fellow trainees who are involved in research and publish before entering likely increase their faculty mentors' productivity. Recruiting those students and residents who wish to have active research involvement should be a priority for plastic surgery departments and divisions that wish to train the next generation of educators in plastic surgery.

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