

Trends in the research profile of matched independent plastic surgery fellows

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Abstract

The independent plastic surgery pathway recruits candidates with 5 years of surgical training who are typically more advanced in research than their integrated counterparts. Research productivity helps to discriminate between applicants. However, no studies exist detailing the academic attributes of matched independent plastic surgery candidates.

We performed a cohort study of 161 independent plastic surgery fellows from accredited residency programs from the 2015 to 2017 application cycles. We performed a bibliometric analysis utilizing Scopus, PubMed, and Google Scholar to identify research output measures at the time of application.

The cohort was predominantly men (66%) with a median of 3 articles and a *H*-index of 1 at the time of application. Interestingly, 16% of successful candidates had no published articles at the time of application, and this did not change significantly over time ($P=.0740$). Although the *H*-index remained stable ($R\ 0.13$, $P=.1095$), the number of published journal articles per candidate significantly decreased over 3 consecutive application cycles ($R\ -0.16$, $P=.0484$). Analysis of article types demonstrated a significant increase in basic science articles ($R\ 0.18$, $P=.0366$) and a concurrent decrease in editorial-type publications ($R=-0.18$, $P=.0374$).

Despite the decline in publication volume of matched independent plastic surgery fellows, the quality of their research portfolio has remained constant. Matched applicants appear to be shifting focus from faster-to-publish articles to longer but higher impact projects. In selecting a training route, applicants must weigh the highly competitive integrated path against the dwindling number of independent positions.

Abbreviations: ACGME = Council for Graduate Medical Education, FMG = foreign medical graduate, NRMP = National Residency Matching Program, SF = San Francisco.

Keywords: academic, bibliometrics, *H*-index, publications, research, residency

1. Introduction

In the United States, there are currently 2 routes into plastic surgery residency training. The independent pathway, previously

known as the plastic surgery fellowship, recruits trainees who have already completed 5 years of surgical training, in disciplines such as, general surgery, orthopedics, and otolaryngology. In contrast, the integrated pathway recruits trainees immediately after completion of postgraduate medical education. As such, although not always the case, the residents in the independent pathway are typically believed to be more advanced with respect to technical ability and research.^[1] Research productivity of the candidate at the time of application helps to discriminate between candidates, serving as a predictive measure of academic rigor and sustained productivity.^[2–5]

However, the available positions for independent applicants at academic institutions have decreased significantly.^[6] As the number of independent programs have declined, so has the applicant pool. Due to this declining applicant pool, recent studies have raised concerns about reduced quality of candidates that apply through the independent pathway over recent cycles.^[7] It is unknown whether this has led to a shift in research qualifications of matched independent candidates. Currently, the San Francisco (SF) Match does not publish any data detailing the academic attributes of successful candidates. Although National Residency Matching Program (NRMP) publishes data for integrated applicants, it is self-reported data which may be inaccurate^[8] and may be outdated when compared with the research credentials of a general surgery resident. Therefore, independent candidates cannot accurately assess the strength of their application relative to the pool of applicants.

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In this study, we sought to quantify and detect trends of the research qualifications held by matched independent plastic surgery fellows at the time of their application. Furthermore, we investigated trends in first-authorship, article relatedness to plastic surgery, and article type over 3 consecutive application cycles. Our purpose is to provide accurate data on the research portfolio of matched independent plastic surgery applicants in order to better inform general surgery residents, program directors, and faculty mentors.

2. Methods

2.1. Study population

This study was reviewed by and received ethical approval from the University of Maryland Institutional Review Board. We identified residents of all independent plastic surgery residency programs listed by the Accreditation Council for Graduate Medical Education (ACGME) website for the academic years 2016 to 2018 (<https://www.acgme.org/>). We then collected details on sex, postgraduate year, additional degrees, and medical school information from the official websites of each residency training program and Doximity (<https://www.doximity.com/>). We ascribed sex based on name, posted photograph, and the program website's use of gendered pronouns. We excluded all residents whose postgraduate year could not be ascertained ($n=2$) or who applied prior to 2015 ($n=4$).

2.2. Academic productivity

We utilised Scopus (<https://www.scopus.com>), PubMed (<https://www.ncbi.nlm.nih.gov/pubmed/>), and Google Scholar (<https://scholar.google.com/>) to identify the articles published by each candidate. To account for publication lag, all the publications up to September of the first year of residency were included to reflect the information that would have been available in the match applications. For example, candidates who started the independent plastic surgery residency training in July 2017 would have all publications up to September 2017 included. This was done in an attempt to reflect the information that would have been available in the match applications and be inclusive of articles listed as "accepted" as part of the application.

All publication details were collected by 2 investigators (KLM and BJK) then reviewed by a third investigator (LMN). We collected the following research details: total number of research articles published; type of research article, that is: original research articles (clinical and basic science investigations), review articles (literature reviews, systematic reviews, and meta-analyses), case reports, editorials (book chapters, letters to the editors, commentaries, and editorials); number of first authored papers; number of plastic surgery-related articles; and *H*-index. Book chapters were included within the editorials group because only 5% of matched applicants had authored a book chapter at the time of application. Errata were excluded from publication counts. Plastic surgery-relatedness of the study was determined based on the speciality of the publishing journal, the speciality of the senior author, and our review of the abstract. We manually calculated the *H*-index at the time of application. The *H*-index considers publication number and citations to calculate a score that measures the individual's scholarly impact.^[9] The *H* value is equal to the numbers of articles, "H," that have been cited at least "H" times. For example, an author with 2 publications that have 3 and 8 citations, respectively, will have a *H*-index of 2.

2.3. Data analysis

Composite data were stored and analyzed in Microsoft Excel (Microsoft 2016, Redmond, WA). Kolmogorov-Smirnov testing revealed that number of publications, number of first authorships, number of each publication type, and *H*-index, did not follow a normal distribution. Therefore, median values and interquartile ranges are reported for these variables. Differences in continuous data between the groups were evaluated with the nonparametric Kruskal Wallis test. The chi-squared test was used to test for differences between categorical data. Linear regression was utilized to analyze temporal trends in research output measures. Statistical significance was defined as a 2-tailed value of $P \leq .05$.

3. Results

3.1. Overall productivity

We identified 161 independent plastic surgery residents (Table 1). The cohort was predominantly men (66%). At the time of application, independent candidates had published a median of 3 papers [IQR: 1–8] and a median *H*-index of 1 [IQR: 0–3]. Only 84% ($n=136$) of matched candidates had published one or more papers at the point of application. Of those with published journal articles at application, 3 quarters (74%, $n=100$) possessed one or more first authorships. On average, 39% of all articles were first-authored by the candidate, and one-third of the articles were related to plastic surgery (34%).

3.2. Article types:

Three quarters (75%) of the publications were original research articles while 13% were case reports and 9% were review articles. Editorial-type articles including book chapters, commentaries, editorials, and letters were the least prevalent article type (3%). The majority of original research articles were related to clinical outcomes ($n=636$, 80%) while the remaining 20% were basic science studies.

3.3. Foreign medical graduates (FMGs)

Foreign medical graduates (FMGs) demonstrated greater academic productivity (total number of publications: 5 [IQR: 1–13.5] vs 3 [IQR: 1–6], $P=.1141$), and a greater scholarly impact

Table 1

Characteristics of successful independent plastic surgery applicants.

| | Applicants |
|--------------------------------|--------------|
| Total | 161 |
| Gender | |
| Male | 107 (66%) |
| Female | 54 (34%) |
| Number of applicants per year | |
| 2015 | 62 |
| 2016 | 53 |
| 2017 | 46 |
| International medical graduate | 27 (17%) |
| Additional graduate degree | 17 (11%) |
| Median number of publications | 3 [IQR: 1–8] |
| Median <i>H</i> -index | 1 [IQR: 0–3] |

IQR=interquartile range.

(*H*-index: 2 [IQR: 0–2] vs 1 [IQR: 0–2], *P*=.2713) than US medical school graduates but this did not reach significance.

3.4. Advanced degrees:

Successful independent candidates with advanced degrees did not have significantly more publications (3 [IQR: 1–7.5] vs 3 [IQR: 1–6.5], *P*=.3222) and had a similar *H*-index (2 [IQR: 0.5–4] vs 1 [IQR: 0–2], *P*=.2501) compared with candidates without additional graduate degrees.

3.5. Temporal analysis of publications

We sought to identify trends across application cycles. Specifically, we analyzed the data for the 3 consecutive application cycles to determine whether there were changes in the numbers of publications, types of publications, or the *H*-indices of the candidates that were successful in the match, at the time of their application.

For every consecutive application cycle (from 2015 to 2017), there was a decrease in the number of published articles per candidate (*R* = -0.16, *P* = .0484) (Fig. 1A). However, there was no change in *H*-index over the same period (*R* = 0.13, *P* = .1095) (Fig. 1B). Furthermore, the proportion of matched candidates who had ≥1 published article (81% vs 80%, *P* = .0740) (Table 2) and the proportion who published ≥1 first-authored article (63% vs 58%, *P* = .8958) did not change. Amongst those with at least 1 publication, one-third of the articles were first authored by the candidate and this did not change significantly over time (*R* = 0.14, *P* = .1050). The percentage of articles focused on plastic surgery subjects also remained constant over time (*R* = 0.09, *P* = .2930).

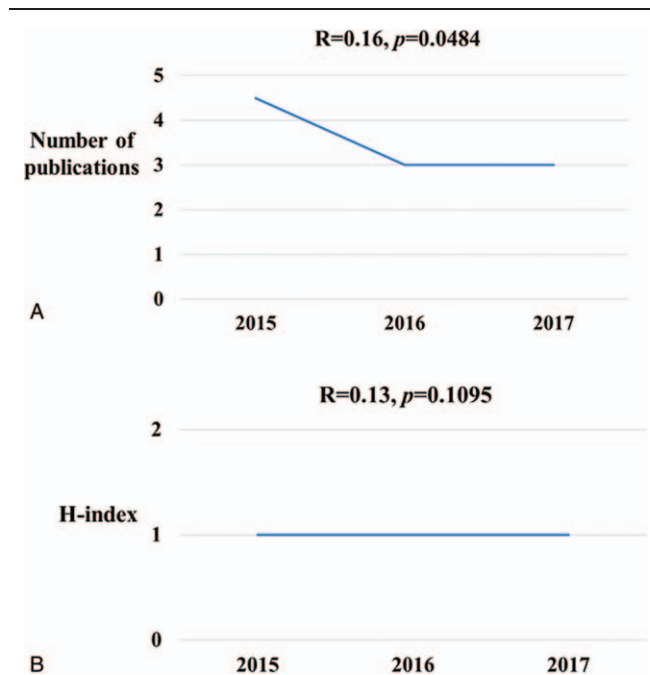


Figure 1. Measures of academic productivity over time for successful plastic surgery applicants. (A) The distribution of academic publications of successful independent plastic surgery applicants over time. (B) The distribution of *H*-indices of successful integrated plastic surgery applicants over time.

Table 2
Mean percentage of papers published by successful independent plastic surgery applicants with one or more publications.

| Application year | Number of applicants with ≥1 publication | Number of applicants with ≥1 first authorship | Publications with first authorship | Publications related to plastic surgery |
|------------------|--|---|------------------------------------|---|
| 2015 | 50 (81%) | 39 (63%) | 43% | 42% |
| 2016 | 49 (92%) | 33 (62%) | 34% | 33% |
| 2017 | 37 (80%) | 27 (58%) | 32% | 34% |

The number of original research articles published by candidates significantly increased (*R* = 0.20, *P* = .0178), while there was a significant decline in the number of editorial-type publications (*R* = -0.18, *P* = .0374) (Fig. 2) over this period. In contrast, the number of review articles (*R* = 0.10, *P* = .2639) and case reports (*R* = 0.01, *P* = .9373) per candidate remained stable.

We sought to identify whether the increase in the number of original research articles over the consecutive application cycles was attributable to basic science and/or clinical studies. Our analysis revealed that the number of basic science articles significantly increased (*R* = 0.18, *P* = .0366) while the number of clinical articles did not significantly change (*R* = 0.17, *P* = .0522).

4. Discussion

Over the last decade, since the duration increase of the independent plastic surgery training program from 2 years to 3 years, independent plastic surgery applicants and program participation in the SF Match have decreased, with significantly fewer positions available than the integrated match.^{16,10} Our results demonstrate that there has been a decline in the average number of publications per candidate over 3 consecutive application cycles. However, there is a concomitant increase in the number of basic science studies published over the same period while the overall scholarly impact (*H*-index) remained stable. This suggests that matched applicants appear to be shifting focus from faster-to-publish articles to longer but higher impact projects.

The quantity of academic publications held by successful independent plastic surgery candidates has shown a downward trend in recent years. However, this has not affected the quality, as demonstrated by the stable *H*-index. This may be due to the decline in editorial-type articles with a concurrent increase in the number of basic science articles. It is well known that basic science studies tend to result in fewer publications and take a longer time to publish compared with the majority of clinical studies in our specialty. If more matched fellows are engaged in basic science studies, there may be an increase in the basic science articles published by candidates but a parallel decrease in the total number of published articles, as our data suggest. Alternatively, the declining number of independent applicants¹¹ may result in less competition and candidates are not pressured to publish multiple faster-to-publish low impact studies (e.g., commentaries, letters, and editorials) to pad their application.

The shift in article types may also be due to changing program preferences or the evolving applicant pool. It is possible that independent residency programs preferentially select candidates who are involved in basic science research. On the other hand, we speculate that the academic profile of independent candidates may simply be sequelae of their general residency training. The

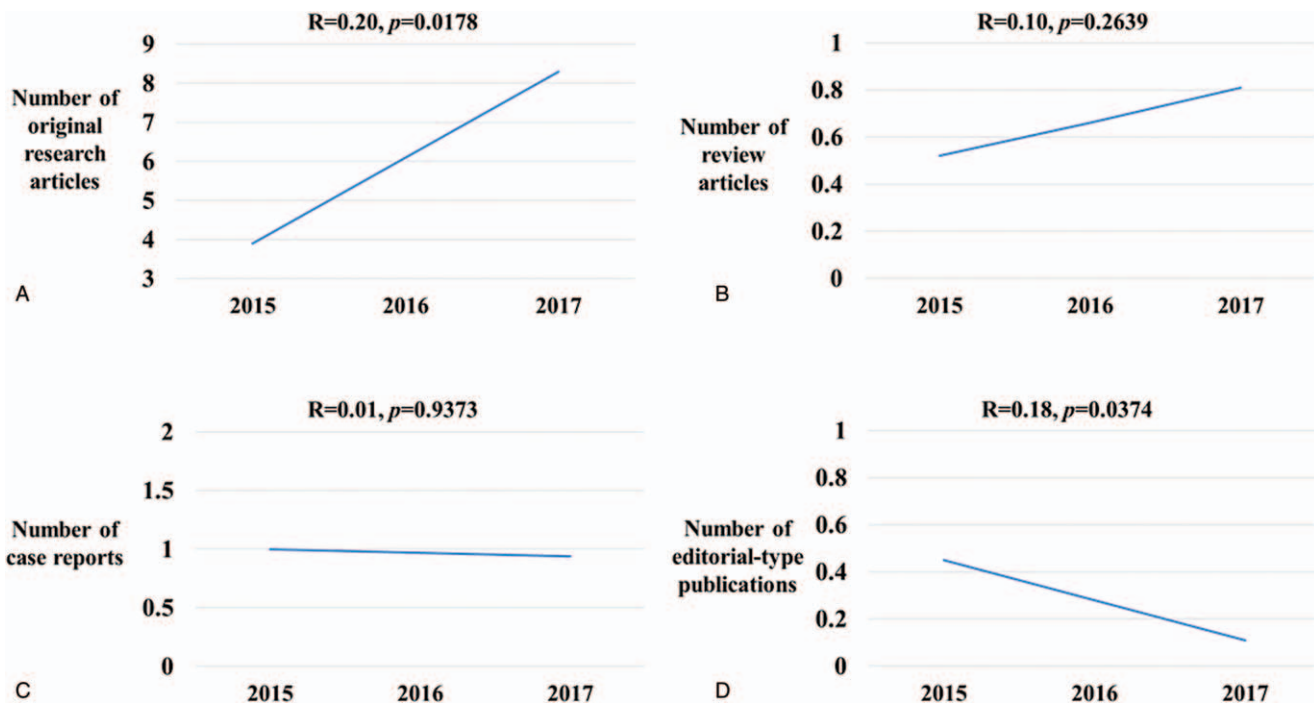


Figure 2. Number of each publication type held by successful independent plastic surgery candidates at the time of application. (A) Original articles, (B) reviews, (C) case reports, and (D) editorial-type publications.

work schedule for surgical residents is notoriously packed, with little time available for scholarly pursuits without protected time in the form of research years.^[12,13] General surgery residents who participate in research years often join a basic science laboratory which often comes with external salary support.^[14] This may account for the increase in basic science studies. Nonetheless, future research evaluating the research profile of all general surgery residents at the point of graduation are warranted to assess whether this trend persists for those not applying for plastic surgery fellowship.

Our results contrast reports on academic productivity of integrated plastic surgery applicants^[15] which demonstrate increasing academic qualifications.^[4,16] Since 2010, the participation of both independent plastic surgery applicants and programs in the SF Match has decreased^[6,11] and the match rate has increased.^[17] Whereas the integrated path has seen increased applicant and program participation and a corresponding increase in competition for places.^[18,19] Some suggest that these trends demonstrate decreased competition in the independent SF match^[7] resulting from the increased uptake of integrated plastic surgery programs. Alternatively, these temporal trends may also be due to the other inherent differences between the 2 candidate pools. Independent candidates have evidence of clinical capabilities and operative skills which may lead to a lesser reliance on research productivity. Moreover, the reported decreased competition in the SF Match may allow independent applicants to have more choice in project selection without the same pressure to inflate academic productivity seen in the integrated plastic surgery match. When we compare these results to trends in the integrated match,^[4,15,18–20] integrated applicants have less productivity at the time of plastic surgery residency applications but stronger post-medical school credentials than their independent counterparts at the same timepoint. Given the

differing academic trends between independent and integrated candidates, applicants interested in becoming plastic surgeons should critically evaluate their application and consider the most feasible route. The highly competitive integrated pathway must be weighed against the dwindling number of independent plastic surgery positions.

Unlike previous studies,^[15,21] FMG status and possession of an advanced degree were not associated with a significant increase in academic productivity to independent plastic surgery applicants as it does for integrated candidates. This may reflect the effects of participation in a surgical residency program. FMGs are able to demonstrate competency in US healthcare system through completion of a surgical residency so are less reliant on publications to gain entry to the system. Additionally, independent plastic surgery fellows spend additional years in training where they can be academically productive so are able to match the productivity of those who took time out for research endeavors.

We acknowledge the limitations to this study. First, data on unmatched independent plastic surgery candidates are not available so we were unable to compare these 2 groups. Future investigations comparing the research productivity and characteristics of successful and unsuccessful candidates are warranted to evaluate the true impact of research on SF match success. Second, we utilized online resources to collect data. Websites may have been outdated or included an incomplete list of residents. However, our data include 161 fellows which represents 72% of current independent plastic surgery residents.^[22] A third limitation is the lack of data on abstracts and presentations, both of which form part of the research profile of a plastic surgery applicant. Fourth, the *H*-index can be falsely elevated by self-citation. However, reports show that this effect is limited in plastic surgery.^[23] Lastly, previous studies have noted incon-

sistencies in reported measures of academic productivity with individual scholarly databases.^[24] We used multiple and large databases to address this concern. Furthermore, to account for publication lag, we included articles published for up to a year after the residency application. Nevertheless, it has been reported that some plastic surgery journals may take longer than 1 year from acceptance to print publication.^[25]

However, this study has many strengths. To our knowledge, we are the first study to quantify the research productivity of candidates who matched into accredited independent plastic surgery training programs, and analyze trends in research achievements. Furthermore, we utilized robust citation databases to identify candidates' publications and their *H*-indices at the time of their application.

5. Conclusion

There has been a decline in the average number of publications per independent plastic surgery candidate over 3 consecutive application cycles. However, the scholarly impact has remained constant suggesting that matched independent plastic surgery fellows are shifting focus to higher impact projects. Applicants interested in becoming plastic surgeons should critically evaluate their application and consider the most feasible route—the highly competitive integrated pathway must be weighed against the dwindling number of independent plastic surgery positions.

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