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Defining Predictors of Future Academic Productivity in Plastic Surgery Residency

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Background: Research is a valued component of applications to plastic surgery residency. No prior studies have explored factors associated with increased resident research productivity. This study aims to compare the academic productivity levels of plastic surgery residency graduates based on their pre- and postresidency experiences.

Methods: Residents graduating in 2019 and 2020 were identified from integrated programs. Metrics collected included the number of publications in medical school and residency. Descriptive statistics were completed along with linear regressions to evaluate the impact of these on academic productivity.

Results: A total of 221 residents from the classes of 2019 and 2020 were included. Most residents completed fellowship (75.9%) although less than half went on to academic practice (42.3%). Approximately one in five residents obtained secondary degrees (17.4%). Subjects averaged 3.15 (N = 208, SD = 4.51) publications while in medical school and 8.1 publications during residency (N = 209, SD = 10.0). For *h*-index calculated at the end of residency, having dedicated medical school research time was the only statistically significant factor (coefficient = 2.96, $P = 0.002$).

Conclusions: Plastic surgery residents published more often as first authors and overall during residency than medical school, indicating increased research involvement and leadership. The present study builds upon prior studies by confirming the importance of dedicated medical school research time and its lasting impact. Understanding the associations of academic factors with increased research productivity in residency is relevant for both applicants and programs evaluating residency candidates. *(Plast Reconstr Surg Glob Open 2023; 11:e5358; doi: 10.1097/GOX.0000000000005358; Published online 16 October 2023.)*

INTRODUCTION

Plastic surgery as a field values innovation and creativity in patient care and focuses on recruiting exceptional residency candidates with high academic productivity. Thus, plastic surgery residency program directors value research highly when considering interview candidates. With the step 1 examination and many medical school rotations transitioning to a pass/fail scoring system, it is likely that the importance of research experience will only increase.[1,2] Plastic surgery remains one of the most competitive residencies in the match each year.[3,4] As the match becomes more competitive each year, integrated plastic surgery applicants have reported an increasing number of research experiences, with over half reporting completion of a research fellowship with the goal of strengthening their application.[5,6] These fellowships may include additional costs to plastic surgery applicants but have been shown to be associated with an increased likelihood of matching and increased number of publications during residency.[5,7] Given the desire for programs to match highly productive residents and applicants to showcase their propensity for success in training, we sought to further characterize the impact of medical school and residency experiences as well as career goals on the academic productivity of residents.

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Prior studies have described the relevance of these variables to academic productivity either in isolation or at one timepoint in training.[8–10] Currently, the literature focuses on either quantity of publications or quality of publications using the number of publications or *h*-index, respectively, but there is a paucity of studies examining them together. Although the number of publications, including the number of first and last author publications, indicates research involvement, the *h*-index has been used in a variety of specialties to assess the overall impact of an author's academic contributions.[8] Joint consideration of *h*-index and number of publications provides a more comprehensive measurement of academic productivity over quantity of publications alone. Within plastic surgery, prior studies have demonstrated that applicants with higher *h*-indices have a higher likelihood of matching into a program with higher rank and higher NIH funding[9,10] but do not characterize this impact on long-term productivity after the match.

Several institutional characteristics in undergraduate and graduate medical education may influence residency academic productivity but have not been explored before this study. Trends in access to research time, for example, are especially relevant as nearly half of all medical schools have a research requirement and many are in the process of condensing their preclinical time in favor of offering more flexible time according to a report by the Association of American Medical Colleges.[11] Many plastic surgery residencies also offer designated research time, ranging from month-long rotations to dedicated years outside of the clinical curriculum. In addition to designated research time, the impact of factors on academic productivity that span multiple stages of training, such as choosing to stay at the same institution for residency and intending to complete a fellowship, remains unclear.

This study aims to assess predictors of academic productivity in residency, including medical school academic productivity, graduate institutional characteristics, and career intentions. Through the use of bibliometric variables over the course of training and regression analyses, this study builds upon prior literature by offering a comprehensive understanding of the individual and institutional influences on academic productivity across residency. The results of this study are particularly valuable to residency programs that are invested in developing future academicians and to the larger discussion about the value of additional research time during medical school.

Takeaways

Question: This study aims to compare the academic productivity levels of plastic surgery residency graduates based on their pre- and postresidency experiences.

Findings: There were no significant differences in the productivity of residents based on the ultimate choice to pursue a fellowship or an academic faculty position. Dedicated time for research during medical school was noted to have a significant impact on the quantity and quality of publications.

Meaning: There is a significant effect of dedicated research time in medical school on academic productivity in residency, which is pertinent for both medical student planning and the program's application review.

METHODS

Participants and Study Design

This study utilizes a retrospective correlational study design to examine associations between academic history and research productivity during residency for chief residents of 2019 and 2020 of integrated plastic and reconstructive surgery programs. Librarians were consulted to develop a methodology for collecting bibliometric data. Programs were identified through the American Council of Academic Plastic Surgeons. Chief integrated plastic surgery residents of 2019 and 2020 were identified through a review of program websites, published program data, emailing program coordinators, and publicly available online profiles. All residents in the graduating classes were searched but were only included for analysis if data for variables of interest were identified.

VARIABLES OF INTEREST

Variables of interest were determined based on prior literature and author opinion. The following background characteristics were collected for each resident: medical school, dedicated research time during medical school and residency, gap year after medical school, completion of other degrees, residency program, length of residency program, completion of fellowship, and academia versus private practice. The following variables were collected as measures of productivity: overall number of publications during medical school, number of medical school publications as first or last author, overall number of publications during residency, number of residency publications as first or last author, and *h*-index.

A gap year was defined as an additional year after completing medical school. The number of publications was calculated by checking SCOPUS and Web of Science databases. The start date for including publications for medical school was January 1 of their first year, and the end date was December 31 of their graduation year. The start date for including publications for residency was January 1 of their first year, and the end date was December 31 of their graduation year. For example, someone who started medical school in August 2010 and then proceeded to a 6-year residency would have medical school publications counted from January 2011 to December 2014, and residency publications counted from January 2015 to December 2020. The *h*-index was collected through an existing SCOPUS tool that could be adjusted to a specific date range.

ANALYSES

Descriptive statistics were generated pertaining to demographics. Two linear regressions were conducted to assess the predictive impact of variables from medical

school, residency, and fellowship on *h*-index and the number of publications at the end of residency. In the first regression, the dependent variable was the number of publications at the end of residency, and the independent variables included practice type, fellowship, attendance at the same institution for residency and medical school, dedicated medical school research time, dedicated residency research time, and secondary degrees. In the second regression, the dependent variable was calculated *h*-index at the end of residency, and the independent variables were the same as above. Independent variables again included practice type, fellowship, attendance at the same institution for residency and medical school, dedicated medical school and residency research time, and secondary degrees. All statistical analyses were performed using R Statistical Software (Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Participant Characteristics

Overall, there were 221 graduates with complete data available, 95 (82.6% of graduates) of which were class of 2019 and 126 (92% of graduates) of which were class of 2020. Approximately one in five residents had secondary degrees (n = 39, 17.4%), such as a PhD, MPH, MBA, or JD. There were 36 (16.8%) residents who attended the same institution for residency and medical school. Approximately three-fourths of residents completed the fellowship (n = 161, 75.9%). Regarding access to dedicated research time during medical school, 79 (36.2%) subjects had no time, 87 (39.9%) subjects had optional time, and 52 (23.9%) subjects had mandatory time. Regarding access to dedicated research time during residency, 31.8% had dedicated time built into their residency program curriculum, whereas the remaining 68.2% did not. On average, subjects averaged 3.15 (N = 208, SD = 4.51) publications while in medical school and 8.1 publications during residency (N = 209, SD = 10.0). For postgraduate careers, 42% entered academics, whereas 39% entered private practice, and 18% could not be determined. Complete demographics of each class of subjects are described in Supplemental Digital Content 1. (**See table, Supplemental Digital Content 1**, which displays the demographics by graduation class, including class of 2019 and 2020, **http://links.lww.com/PRSGO/C825**.)

Overall Academic Productivity

The number of publications while in medical school was positively related to dedicated research time in medical school (coefficient = 0.74, *P* = 0.000), and this achieved statistical significance. (**See table, Supplemental Digital Content 2**, which displays the regression analysis of independent factors and their association with total number of publications and *h*-index at the end of residency, **http://links.lww.com/PRSGO/C826**.)

Other variables, including dedicated research time in residency (coefficient = 0.13, *P* = 0.369), were not statistically significant (*P* = 0.05). With regard to *h*-index calculated at the end of residency, having dedicated medical school research time was again positively related and statistically significant (coefficient = 2.96, *P* = 0.002) (**Supplemental Digital Content 2, http://links.lww.com/PRSGO/C826**). In addition, having a secondary degree was found to have a significant positive impact (coefficient = 1.88, *P* = 0.035) on *h*-index, although it did not have an impact on the total number of publications. This analysis again demonstrated that dedicated research time in residency was not associated with a higher *h*-index in a statistically significant way (coefficient = 0.94, *P* = 0.202).

Change in Productivity during Residency

For the third linear regression that was conducted to assess which factors were related to the difference between the number of publications during the first 3 years and the last 3 years in residency, no factors were statistically significant. [**See table, Supplemental Digital Content 3**, which displays the regression analysis of independent factors and association with a difference in number of publications over time in residency (second half of residency compared with first half), **http://links.lww.com/PRSGO/C827**.]

DISCUSSION

Our findings demonstrate that dedicated research time during medical school was an independent predictor of the number of publications and *h*-index by the end of plastic surgery residency. Although prior studies have individually assessed the impact of factors such as publications during medical school on later academic productivity, often utilizing univariate analyses and self-reported data, our study was able to confirm the importance of dedicated medical research time through robust analyses, including multivariable models. Additionally, our bibliometric methodology provides systematic data collection that reduces biases seen in previous self-reported data. Finally, this study includes novel, longitudinal covariates that may impact residency productivity from medical school to postfellowship. Collective assessment of these factors using multiple, multivariate linear regressions demonstrates the relative predictive significance of dedicated research time during medical school on academic productivity in the context of other factors from medical training and career choice.

Dedicated medical school research time was significantly associated with both quantity (number of publications) and quality (*h*-index) of academic productivity which increases confidence in this finding. Based on our regression data, mandatory dedicated research time in medical school is expected to increase the total number of publications by 101% and increase the *h*-index of a resident by 2.96 (average *h*-index 5.31, SD = 5.09). A secondary degree is expected to increase the *h*-index by 1.88 points in comparison. Notably, this finding did not apply to optional research time in medical school or dedicated research time during residency. Other factors such as the number of publications in medical school seem to not necessarily predict future productivity and may instead be more closely related to medical students

pursuing publications for their perceived importance in the application process. An additional finding was that there were no identified factors associated with a change in productivity from the first 3 years to the last 3 years of residency. These factors, to the authors' surprise, included the pursuit of fellowship and academic practice. Jinka et al showed previously that decision to pursue fellowship was significantly associated with the number of intraresidency publications,[11] but their cohort graduating from 1998 to 2009 had a mean preresidency publication of 0.59 publications compared with 3.15 in our cohort, a trend that has been described in the literature.[12] This change to a negative finding in our cohort may be representative of a trend toward earlier and more consistent research productivity expectations in training over time. The negative finding may also be due to variation in the current cohort regarding when residents solidify their career interests and intentions during the course of plastic surgery residency.

The findings of this study have implications for stakeholders at the premedical, undergraduate, and graduate medical education levels. Prospective medical students may prioritize attending schools with dedicated research time, especially if they are considering a competitive specialty. Both the positive and negative findings are relevant to how residency programs assess research potential in prospective applicants. Prior studies have indicated that residency programs highly value the number of publications when considering applicants,[3–5] but the findings of the present study indicate that the number of publications during medical school is not an independent predictor of end-of-residency productivity. Furthermore, our study finds that dedicated research time included in the mandatory curriculum showed an impact, whereas optional research time did not. This is the first study to distinguish between mandatory and optional research opportunities. Many medical students are now taking additional, optional, research-related gap years. Our findings reflect that there is a benefit of dedicated research time that is not solely encapsulated by the number of research publications, potentially including structured education in the research process and mentorship from a clinician-scientist. This underscores the importance of increasing accessibility of funded and structured opportunities for students whose institutions do not offer dedicated research time so that they may build skills that are valuable in plastic and reconstructive surgery. The cost accrued through increasing debt during unpaid research time or delaying an attending-level salary may be prohibitive for some students seeking access to additional research time during medical school. Furthermore, without a structured research curriculum as a mandatory part of the educational design for both medical students and residents, it may not be as impactful. Academic development during dedicated research time may be an undervalued component of the research period to promote continued high-quality research over time.[13]

Limitations

Bibliometric collection poses certain limitations that are important to address. Publicly available databases have been shown to be inconsistent across platforms,[14,15] although this study used multiple platforms to circumvent this. Online information may not capture cultural patterns, such as unofficial research time during electives or summer vacation, when students are highly encouraged to complete research, and thus, may impact the estimated effect of our covariates. Our ability to classify whether faculty were considered to pursue an academic career postresidency was complicated by the fact that some may serve as adjunct faculty or clinical faculty, and this may not be reflected in their profiles and thus could have led to us misestimating the effect. Similarly, for students taking an additional year in medical school, it was not always possible to determine if the additional year was due to research or due to needing additional time. As a result, we cannot definitively conclude the role of taking a research year in end-of-residency productivity. Finally, bibliometric analyses preclude our ability to assess the influence of individual qualities, such as motivation and interest in academic plastic surgery, on end-of-residency productivity. Although we did not include undergraduate research in our analyses, for example, it is probable that students who are the most competitive would select schools with dedicated research time and eventually be the most competitive at the end of residency due to their personal qualities. For this specific source of potential bias, we note that dedicated research time is offered by nearly 50% of medical schools across ranks, indicating that undergraduates who are less academically competitive attend schools with dedicated research time.[16] Although bibliometric collection can be biased by these factors, it is important to note that it may still be less biased than collecting subjective data on academic motivation from students directly. An added benefit is that the variables utilized in our regression can be independently found by stakeholders in the application process.

Additional limitations of our study relate to the regression and variables used. Although we were able to capture a majority of residents from the graduating classes of 2019 and 2020, those with incomplete data were excluded, which is a limitation of our data set. Furthermore, given data availability, it was necessary to retrospectively assess graduating chiefs' undergraduate and graduate medical training over the previous 10 years and these findings may not reflect current evolving trends. To avoid the risk of complicating our interpretation of the results given the number of covariates, we did not assess for all possible interactions between covariates. An example is that it is possible that students may be more likely to take additional time in medical school if their institution does not offer research time. Although excluding interactions simplifies our model, missing important interactions may lead to under- or overestimating the effects of covariates. There is also a potential limitation from the choice of a 6-month timepoint by which publications would be part of one stage of training or another. Regarding the time it takes for publication to occur from submission, one study demonstrated that high-impact work takes approximately 150 days, and low- to medium-impact work takes approximately 100 days.[17] This timeline has also slowed in recent years following the COVID-19 pandemic.[18] Considering that our cohort was graduating in the spring of 2020, and it would be less common to start new projects in the last

year of training, we think 6 months is a reasonable lag time. However, this may be a limitation of our data and needs to be lengthened in future studies. It is important to note that dedicated medical school research time may not align at some institutions with cycles of productivity for the research teams at that institution, limiting the impact on medical school productivity. Whether having more dedicated research time to account for these cycles improves end-of-residency productivity warrants further exploration. Finally, as an outcome measure, *h*-index poses limitations due to its dependence on time. The impact of a publication earlier in one's career may increase *h*-index more than a publication later in one's career because of the amount of time it has had to be cited and not because it is necessarily more impactful in the long term. As a result, using *h*-index as an outcome measure biases our results to favor earlier career variables over later ones. We support the usage of the *h*-index as an outcome variable because of its prevalence in academic productivity research to assess impact,[8,19,20] and we also used number of publications as an outcome measure because it does not share the same limitations.

Research continues to be a highly valued component of medical training at all levels. Our study shows that required, dedicated time for early research in medical school has a significant impact on future productivity not matched by optional or later experiences. This study informs both trainees and programs of the relevant timing and structure of a period of dedicated research or secondary degree. Future directions may include assessing how residents' and graduates' subjective prioritization of research over time aligns with their productivity in addition to the variables chosen for this specific study.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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