OPEN

PRS GLOBAL OPEN

ORIGINAL ARTICLE
Education

Do Dedicated Research Years during Medical School Predict Academic Productivity during Residency?

Sarah A. Applebaum, MD, MS*†
Jenna R. Stoehr, BA*†
Jonathan T. Bacos, MD‡
Elbert E. Vaca, MD§
Joseph Lopez, MD, MBA¶
Yuyang Chu, BS†
ASPSRC Subspecialty Career Pathways Study Group
Arun K. Gosain, MD*†

Background: Evidence regarding whether medical school research portends resident research is limited. This information will provide program directors with data that may be useful for selecting applicants with a commitment to continued academic productivity.
Methods: A questionnaire distributed via the American Society of Plastic Surgeons Resident Council to residents in 44 plastic surgery training programs in May 2020 assessed participation in dedicated research years during medical school, the number of publications completed before residency, and the total number of publications by each resident at the time of the survey. One-way ANOVA and post hoc analysis determined significant associations between publication count and number of research years.
Results: Of the 256 included respondents, 203 did not complete a research year during medical school, 44 completed 1 research year, and nine completed 2 research years. Mean publications before residency were higher for participants who took 1 or 2 research years (9.88 and 27.60, respectively) compared with those who did not (4.83, $P < 0.001$). A comparison of total publications during residency similarly revealed increased productivity by individuals who took 1 or more research years; however, there was no difference between the number of publications completed during residency for individuals who took 1 versus 2 years ($P = 0.23$).
Conclusions: Residents with research experience during medical school continue to produce an increased number of publications during residency compared with those without, suggesting dedicated research years taken during medical school serve as a predictor of academic productivity in plastic surgery residents.
(Plast Reconstr Surg Glob Open 2021;9:e3849; doi: 10.1097/GOX.0000000000003849; Published online 19 October 2021.)

INTRODUCTION

Integrated plastic surgery residency is among the most competitive programs in the US national residency matching program. In 2021, 329 individuals applied for 187 integrated postgraduate year-1 (PGY1) positions, for an overall match rate of 76%.[1] A successful match has historically been predicated on competitive board scores, number of publications, AOA membership, and positive away rotation experiences.[2,3] In the face of the change of the USMLE Step 1 score reporting to pass/fail, programs may give even more consideration to the number and quality of research when determining which applicants have the most potential for success.

Prior studies and data from the national residency matching program indicate a rise in the mean number of publications authored by matched plastic surgery applicants from 3.4 in 2007 to 14.2 in 2018.[3–10] Due to this trend, dedicated research time during medical school has become more popular, as applicants seek to strengthen their credentials.[4,7] A survey of all plastic surgery applicants from 2013 to 2016 (n = 621) found that 25% of applicants participated in dedicated research time, and the match rate for those who completed a research fellowship

*From the *Division of Pediatric Plastic and Reconstructive Surgery, Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, Ill.; †Division of Plastic Surgery, Northwestern University Feinberg School of Medicine, Chicago, Ill.; ‡Department of Plastic Surgery, Medical College of Wisconsin, Milwaukee, Wis.; §Elbert Vaca Aesthetic Plastic Surgery, Boca Raton, Fla.; ¶Division of Plastic Surgery, Yale University, New Haven, Conn.*

Received for publication June 14, 2021; accepted August 2, 2021.

DOI: 10.1097/GOX.0000000000003849

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

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

was higher than the match rate for those who did not (97% versus 81%, respectively).[4]

It remains unclear as to whether applicants pursue dedicated research time during medical school to present a more competitive profile for the residency match, or whether this experience has a positive impact on academic productivity during residency. Although the Electronic Residency Application Service asks residents to demonstrate their publication record, and program directors pay particular attention to these data when ranking applicants, there is no evidence that dedicated time for research during medical school is correlated with continued research productivity during residency.[11] The present study seeks to evaluate the impact that dedicated research years taken during medical school have upon continued academic productivity of these individuals during plastic surgery residency. Our goal is to inform medical students of the potential academic impact of pursuing one or more dedicated research years during medical school, and to provide program directors with data that may be useful for selecting applicants with a commitment to continued academic productivity.

METHODS

In May 2020, an anonymous survey of 13–19 questions was distributed via the American Society of Plastic Surgeons Resident Council. (**See survey, Supplemental Digital Content 1,** which displays the survey distributed via American Society of Plastic Surgeons Resident Council. **http://links.lww.com/PRSGO/B797**.) A subset of American Society of Plastic Surgeons Resident Council representatives sent the survey to their respective programs, yielding a response from 39 of 44 accessible institutions. Of the 39 programs, 22 institutions had only integrated residency programs, four institutions had only independent, and 13 institutions had combined integrated/independent. The survey assessed (1) additional years taken for full-time research during medical school, (2) number of past publications before residency, and (3) total number of publications at the time of the survey. Start of residency consisted of the first residency following medical school, which was the pre-requisite surgical residency for independent plastic surgery residents. This research study was reviewed and found to be exempt by the Northwestern University IRB.

Data corresponding to reported past and total publications were stratified into three cohorts: (1) no dedicated time for research during medical school, (2) one dedicated research year during medical school, and (3) two dedicated research years during medical school. The average number of publications per year during residency (referred to as the "annual average") was obtained by calculating the difference between total publications and past publications and dividing by the reported PGY level for each response. Data were entered into RStudio (version 4.0.2 at www.R-project.org) to perform descriptive and inferential statistics.[12] Analyses of integrated and independent survey responses were performed separately due to inherent differences between these two groups. The number of past, total, and annual average publications were analyzed with unpaired t-tests for participants who did not complete a dedicated research fellowship and participants who completed 1 or 2 research years during medical school. Statistical significance was defined as a *P* value of 0.05 or less. If significant, a one-way ANOVA test compared the effect of research year length (no research year, 1 research year, 2 research years) on the publication means (past, total, and annual average). Post hoc analysis with Tukey's HSD test identified the significance of comparisons between the research year cohorts.

RESULTS

Of 593 potential respondents, 275 completed the survey and 256 were included in this study (46.5% response rate) (Table 1). Responses were excluded if the resident had taken time off to complete an additional degree during medical school (n = 16) or taken more than 2 years for dedicated research (n = 3). The majority of respondents were integrated residents (integrated 81.6%, independent 18.4%). Of the included residents, 203 (80%) did not take dedicated time off for research in medical school and 53 (20%) spent at least 1 additional year on research during medical school. With respect to PGY level, the majority of respondents were in their senior years (PGY4+) in the no research year group (59.2%) and in their junior years (PGY1–3) in the research group (51.3%). For the entire research cohort, 48 (90.6%) were integrated plastic surgery residents and five (9.4%) were independent plastic surgery residents. Of those who took additional research time, 44 (83%) completed 1 year of research (43 integrated residents, one independent resident), and nine (17%) completed 2 years of research (five integrated residents, four independent residents). Seventy-three percent of students taking time off for research were from institutions ranked in the top 50 medical schools, and 28.3% were from institutions in the top 10 medical schools based on the US News & World Report.[13]

Of the 44 participants who took 1 year off for research, 21 (47.7%) identified perceived competitiveness of the field as the driving factor (Table 2). Narrative responses describing "other" reasons for taking 1 year off included mentorship and outside opportunities (4.5%). In contrast, the majority of participants who completed 2 research years in medical school noted personal interest in research as their underlying motivation (18.2% for 1 year off versus 44.4% for 2 years off). Despite these subtle differences, the majority of both groups agree that research time was useful, and they would do it again if given the choice (77.3% for 1 year and 66.7% for 2 years).

Integrated residents without a research year reported an average of 4.83 (SD 6.60) past publications before residency, 10.77 (SD 11.45) total publications at the time of survey completion, and an annual average of 1.54 (SD 1.61) (Table 3) (Fig. 1). In comparison, participants who completed 1 or 2 research years authored on average 11.73 (SD 14.00) past, 23.58 (SD 20.86) total, and 3.61 (SD 3.16) average publications per year in residency ($P < 0.001$). When the responses were stratified by the

Table 1. Baseline Characteristics of Survey Participants: No Research Year versus Dedicated Research Year(s) (n = 256)

Characteristic		Research Year, No. (%)		P†
		No Research Year n = 203 (80)	Dedicated Research Year(s) n = 53 (20)	
Sex	Women	87 (42.8)	18 (33.9)	<0.001
	Men	116 (57.1)	35 (66.0)	
	Other	1 (0.5)	0 (0)	
Age	20–25	2 (0.9)	0 (0)	<0.001
	25–30	84 (41.3)	23 (43.4)	
	31–35	95 (46.8)	26 (49.0)	
	36–40	21 (10.3)	4 (7.5)	
	>40	1 (0.5)	0 (0)	
Type of residency	Integrated	161 (79.3)	48 (90.6)	<0.001
	Independent	42 (20.7)	5 (9.4)	
Current postgraduate year (PGY)	PGY1	33 (16.2)	9 (17.1)	<0.001
	PGY2	23 (11.3)	9 (17.1)	
	PGY3	27 (13.3)	9 (17.1)	
	PGY4	39 (19.2)	6 (11.3)	
	PGY5	17 (8.4)	7 (13.1)	
	PGY6	30 (14.8)	7 (13.1)	
	PGY7	12 (6)	3 (5.6)	
	PGY8+	22 (10.8)	3 (5.6)	
US News & World Report medical school ranking*	1–10	26 (12.8)	15 (28.3)	<0.001
	11–20	21 (10.3)	7 (13.2)	
	21–30	20 (9.8)	7 (13.2)	
	31–40	12 (6)	8 (15)	
	41–50	27 (13.3)	2 (3.7)	
	51+	73 (36)	12 (22.6)	
Medical school outside the US or Canada		24 (11.8)	2 (3.7)	<0.001

*Best Medical Schools (Research) Ranked in 2021—US News Rankings [Internet]. [cited 2020 Dec 7]. Available from: https://www.usnews.com/best-graduate-schools/top-medical-schools/research-rankings.
†By Pearson's chi-squared test.

number of research years, the mean numbers of past, total, and annual average publications were 9.88 (SD 12.92), 22.44 (SD 21.36), and 3.65 (SD 3.29), respectively, for 1 research year and 27.6 (SD 14.06), 33.40 (SD 13.68), and 3.26 (SD 1.79), respectively, for 2 research years ($P < 0.001$).

A one-way ANOVA determined a significant effect of the number of research years on past, total, and annual average publications with a P value less than 0.001 for integrated residents. Post hoc analysis confirmed that past, total, and annual average publications in the no-research group were significantly less than the 1 year group (past, $P = 0.001$; total, $P < 0.001$; annual average, $P < 0.001$) and the 2 year group at the level of past and total publications (past, $P < 0.001$; total, $P = 0.001$; annual average, $P = 0.92$) (Table 4). Past publications in the 1 year group were also significantly less than the 2 year group ($P < 0.001$); however, the number of total publications and annual average for the 1 year cohort did not differ significantly from the publications reported by the 2 year cohort at these time points ($P = 0.23$ and $P = 0.92$, respectively). Taken together, these results suggest research years are predictive of more initial and total publications; however, the differences between the number of publications for one versus 2 years even out over time.

Table 2. Primary Reason for Taking Time Off for Research and Opinion of the Research Experience (n = 53)

	Research Year, No. (%)	
	One Year 44 (83)	Two Years 9 (17)
What was the MAIN reason you took time off for research?		
a. Perceived competitiveness (increase chances of matching into program of choice)	21 (47.7)	3 (33.3)
b. Developed late interest in plastic surgery	12 (27.3)	2 (22.2)
c. Personal interest in research	8 (18.2)	4 (44.4)
d. Other	2 (4.5)	0 (0)
In retrospect, what is your opinion of the value of your dedicated research time?		
a. It was useful/would do it again if given the choice	34 (77.3)	6 (66.7)
b. I would consider doing it again if I had proper mentorship	4 (9.1)	1 (11.1)
c. Indifferent	2 (4.5)	0 (0)
d. I would not do it again if given the choice	4 (9.1)	2 (22.2)

In contrast, independent residents without a research year reported an average of 5.85 (SD 16.83) past publications, 12.80 (SD 18) total publications, and an annual average of 1.03 (SD 1.41) (Table 5). In comparison, participants who completed 1 or 2 research years during medical school authored on average 9.50 (SD 9.81) past, 26.75 (SD 21.55) total, and 12.83 (SD 24.26) publications per year in residency. No statistical significance was found at any time point ($P > 0.05$).

DISCUSSION

As plastic surgery is a field with both clinical expertise and innovation at its core, the role of research in furthering our mission cannot be overstated. Extending medical school to take additional years in pursuit of research is a noble commitment to this credence; however, it is a major investment in time and finances on the part of the students. We are not aware of prior analyses evaluating the relationship of this added research time to continued

Table 3. Publication Record of Integrated Residents (n = 209)

	Research Year, No. (%)					
Publications, Mean (SD)	**No. Research Year, n = 161 (77.03)**	**All Research Year(s), n = 48 (22.97)**	***P****	**One Research Year, n = 43 (20.57)**	**Two Research Years, n = 5 (2.40)**	***P*†**
Past	4.83 (6.60)	11.73 (14.00)	<0.001	9.88 (12.92)	27.60 (14.06)	<0.001
Total	10.77 (11.45)	23.58 (20.86)	<0.001	22.44 (21.36)	33.40 (13.68)	<0.001
Annual Average	1.54 (1.61)	3.61 (3.16)	<0.001	3.65 (3.29)	3.26 (1.79)	<0.001

"Past" represents publications before integrated plastic surgery residency; "total" represents total publications at the time of survey completion; "annual average" represents annual number of publications during residency.
*By two-sample *t*-test assuming unequal variances.
†By one-way ANOVA test.

academic productivity during plastic surgery residency. We believe this information to be essential both to the medical students who wish to make the investment in additional research years, and to the program directors who consider potential academic productivity to be a key criterion for matching into a plastic surgery training program. As expected, our results identified a positive correlation between dedicated research years during medical school and number of publications at the time of application. Furthermore, residents with research experience continued to produce an increased number of publications during residency with an average number of publications per year highest among those who spent 2 years conducting full-time research in medical school. Trends for total publications similarly revealed a higher average for residents who completed a dedicated research year during medical school, but there was no significant difference between 1 and 2 years of research over time.

While it is not entirely surprising that research experiences during medical school were correlated with higher academic productivity in residency, it does provide reassurance that the value of medical school research opportunities has the potential to transcend the original goal of improving the applicant's competitiveness for residency positions. Surveys of medical students have found that residency competitiveness is the most common motivating factor for taking a research year and many students interested in highly competitive specialties would not take one if it did not augment their application.[14] The results of the present study seemingly contradict these findings, as one would expect individuals not to continue to produce research in residency if they were only taking research years out of a desire to improve their applications. We hypothesize three possible explanations for this discrepancy. First, medical students who initially pursued research for the sake of their residency application may discover a passion for research and develop their skills during the research year, thus leading to continued engagement in research. Second, medical students who took a research year may be more likely to match into residency programs with higher expectations for resident research, thus creating an ongoing impetus for research productivity. Third, increased research productivity during residency may be partly due to subsequent completion of research projects commenced, but not completed, before residency.

Junior residents in our study (PGY1–3) were more likely to have dedicated additional time to research during medical school than their senior counterparts (PGY4+). One possible explanation for this dichotomy is that the PGY4+ cohort in our study included independent

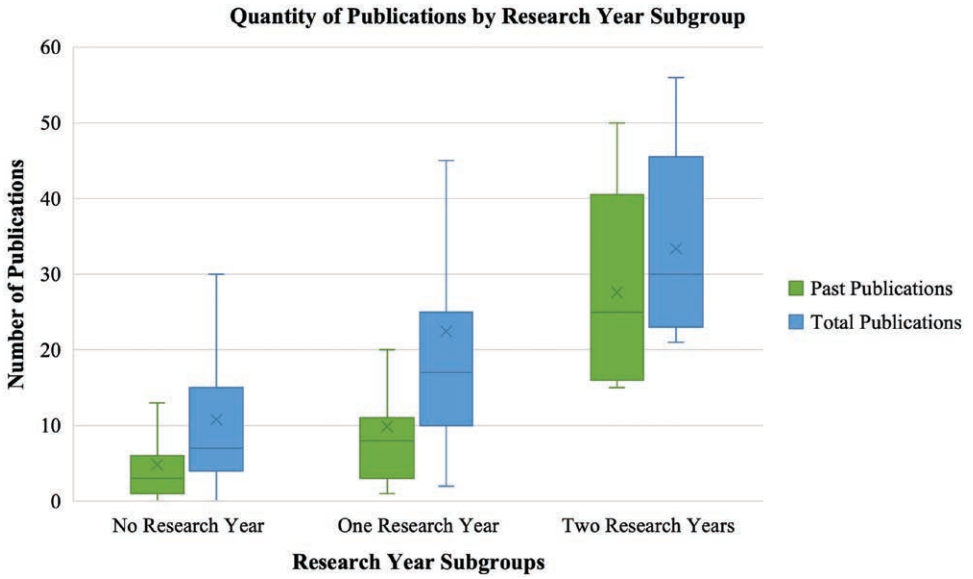

Fig. 1. Quantity of publications by research year subgroup.

Table 4. Publication Record of Integrated Residents—Post Hoc Analysis Using Tukey's HSD Test (n = 209)

		Past Publications			Total Publications			Annual Average		
		95% Confidence Interval			95% Confidence Interval			95% Confidence Interval		
		Lower Bound	Upper Bound	*P*	Lower Bound	Upper Bound	*P*	Lower Bound	Upper Bound	*P*
No Research Year	One Research Year	1.62	8.48	0.001	5.95	17.37	<0.001	1.27	2.95	<0.001
No Research Year	Two Research Years	13.68	31.85	<0.001	7.52	37.73	.001	–0.49	3.94	0.16
One Research Year	Two Research Years	8.26	27.16	<0.001	–4.76	26.67	.23	–2.71	1.92	.92

"Past" represents publications before integrated plastic surgery residency; "total" represents total publications at the time of survey completion; "annual average" represents annual number of publications during residency.

trainees, who typically do not conduct dedicated research before pre-requisite general surgery training.[15,16] Another plausible explanation for this finding may be related to the surge in applications to integrated plastic surgery residency over the last few years, making the field even more competitive and requiring applicants to excel in research to stand out.[4,9]

The average number of publications completed before residency identified in this study are in line with previous studies, which have reported a range from 3.4 to 14.2.[2,3,7–10] To account for publication delay and the impact, this phenomenon may have had on the total number of publications reported by junior residents; we divided our dataset into a junior (PGY1-3) and senior (PGY4+) cohort (Table 6). An analysis of past, total, and annual average publications per year for junior residents (n = 124) yielded 7.33, 10.86, and 1.9, respectively. The same analysis for the senior cohort (n = 151) identified 6.91, 17.44, and 2.24, respectively. Although the junior cohort began residency with a higher number of publications than the senior cohort (presumably due to the increasing popularity of a research fellowship amongst the junior cohort), the senior cohort's total and annual average publications per year exceeded that of the junior cohort, suggesting that publication lag from medical school research likely had little effect on the results.

We found that there was no significant difference in regard to long-term productivity between residents who had taken 1 versus 2 research years, even though students who took 2 years originally had more publications at the time of residency application. One possible explanation for this observed discrepancy is that students who dedicated either 1 or 2 years for research during medical school likely had similar motivations to conduct research (ie, competitiveness, academic interest), leading to similar output in residency. Another possible explanation is that the demands of residency may level the playing field, thereby impeding publication output for all residents. Of note, publications reported in this work may also include projects that were conducted to satisfy the American College of Graduate Medical Education's requirement for residency programs to engage in scholarly activities.[17] Although some residency programs may allocate additional time to research and others may require a specific number of publications, this is a universal requirement and as such, minor differences are irrelevant and will likely have little impact on the conclusions drawn herein.

Reassuringly, plastic surgery residents with medical school research in general (1 or 2 years) demonstrated a higher output than those residents without such experience. Nevertheless, we believe there may be additional value to 2 full-time research years during medical school. The extended time permits the student to embark on impactful basic science or translational research and to bring projects to fruition, thereby gaining an appreciation for all stages of the research process. Lastly, the number of publications at the time of application is still highly regarded as a metric of academic rigor and potential.[7,18–20] Based on our results, 2 years of full-time research would yield more publications at the time of residency application, and would therefore increase the applicant's chance of matching.

There are several limitations to this study. First, selection bias is a limitation inherent in the study design, as one would expect research-minded residents would be more likely to complete the survey. However, 80% of respondents did not pursue additional research years during medical school, suggesting that a breadth of residents did respond to the survey. Second, the majority of respondents attended a top 50 US News and World Report medical school where exposure to and emphasis on research

Table 5. Publication Record of Independent Residents (n = 47)

Publications, Mean (SD)	No Research Year, n = 42 (89.4)	All Research Year(s), n = 5 (10.6)	*P**
Past	5.85 (16.83)	9.50 (9.81)	0.67
Total	12.80 (18)	26.75 (21.55)	0.38
Annual average	1.03 (1.41)	12.83 (24.26)	0.34

"Past" represents publications before residency; "total" represents total publications at the time of survey completion; "annual average" represents annual number of publications during residency.
*By two-sample t-test assuming unequal variances.

Table 6. Publication Record by Junior (PGY1–3) and Senior (PGY4+) Residents (n = 256)

Publications, Mean (SD)	Junior Residents n = 110 (43)	Senior Residents n = 146 (57)	*P**
Past	6.91 (9.93)	5.90 (11.50)	0.45
Total	10.44 (12.89)	16.12 (17.20)	0.003
Annual average	1.94 (2.44)	2.16 (4.88)	0.64

"Past" represents publications before residency; "total" represents total publications at the time of survey completion; "annual average" represents annual number of publications during residency.
*By two-sample t-test assuming unequal variances.

are likely ingrained in the culture.[13] Although the anonymous nature of our survey did not link publication output to institution, plastic surgery applicants typically come from top tier medical schools, and our results may therefore reflect the plastic surgery residency cohort as a whole rather than a predisposition to these survey respondents.[9] Conversely, it is also possible that our population may include some individuals with less than optimal academic performance, as 48% of the 1 year cohort and 33% of the 2 year cohort undertook additional research time due to perceived competitiveness of the field. These individuals may have attempted to offset academic deficiencies with a robust research portfolio, and including their publication means in our analysis may have inflated the results. Nonetheless, our large sample size and high response rate offload some of these concerns related to selection bias, as the total respondents in our study outnumber any survey study of plastic surgery residents or applicants to date.[3,15,21,22]

Third, inherent in this survey, as well as the responses provided by plastic surgery applicants when completing their residency applications, is misinterpretation of the terms "peer-reviewed publications." The standard set by Electronic Residency Application Service for reporting publications includes peer-reviewed publications, non-peer-reviewed and invited publications, and published abstracts.[11] Therefore, the numbers reported in this and in prior studies are higher than one would find in rigorous review of peer-reviewed publications alone. Most of the medical students have not been directed as to which of their publications is peer-reviewed, and they often follow the Electronic Residency Application Service standard when reporting this number, inflating the self-reported number for peer-reviewed publications.[11] Future study could account for this issue by analyzing the Hirsch index (H-index), which considers publication number and citations to calculate a score that measures scholarly impact and not merely the academic output.[23]

Lastly, the window of academic productivity in this work may be insufficient to determine long-term academic productivity. Future investigations comparing academic productivity in medical school and residency to that of an attending surgeon are needed to determine if research as a trainee heralds a career of academic pursuit, as demonstrated in the urology literature, in which publications before medical school have been associated with likelihood of pursuing an academic career.[24]

CONCLUSIONS

Academic productivity has forever been a vital metric in the integrated plastic surgery residency application process. While it is self-evident that dedicated research time during medical school is predictive of more publications at the time of application, we also found an increased number of publications during residency for respondents who reported dedicated research time during medical school. Overall, these findings suggest that dedicated research years during medical school produce more efficient and research-minded residents. Our results may be useful for future medical students looking to improve their research skills and prepare for an academic career, and for program directors looking to improve resident recruitment. Further study is needed to determine the long-term impact of medical school research experiences on one's continued academic productivity following residency training.

Arun K. Gosain, MD
Division of Plastic Surgery
Ann & Robert H. Lurie Children's Hospital of Chicago
Northwestern University Feinberg School of Medicine
225 E. Chicago Ave., Box 93
Chicago, IL 60611
E-mail: argosain@luriechildrens.org

ACKNOWLEDGEMENTS

This article would not be possible without the assistance provided by the American Society of Plastic Surgeons Resident Council Subspecialty Career Pathways Study Group. We thank the following resident ambassadors of this study group:

Kristy Hamilton, Brendan Alleyne, Anna Carlson, Arman Serebrakian, Ben Schultz, David Hill, Ravi Bamba, Miguel Dorante, Ashley Howarth, Krishna Vyas, Alain Azzi, Matthew Fahrenkopf, Ara Salibian, Sofia Aronson, Lindsay Janes, Casey Kraft, Ersilia Anghel, Jordan Halsey, Zeshaan Maan, Shoichiro Tanaka, Adam Hauch, Rachel Lentz, Timothy Bruce, Suma Yalamanchili, Brian Starr, Doug Dembinski, Salih Colakoglu, Mathew Hagan, Jeffrey Lisiecki, Arya Akhavan, Said Azoury, Michael Hu, Walter Joseph, Ronald Brown, Erik Wolfswinkel, Shana Kalaria, Pablo Padilla, Jared Garlick, David Chi, Austin Ha, Katherine Carruthers, Spencer Anderson, Lauren Hutchinson, and Sam Golpanian.

REFERENCES

1. National Resident Matching Program, Results and Data: 2021 Main Residency Match®. National Resident Matching Program, Washington, DC. 2021. Available at https://mk0nrmp3oyqui6wqfm.kinstacdn.com/wp-content/uploads/2021/03/Advance-Data-Tables-2021_Final.pdf.
2. Claiborne JR, Crantford JC, Swett KR, et al. The plastic surgery match: predicting success and improving the process. *Ann Plast Surg.* 2013;70:698–703.
3. Rogers CR, Gutowski KA, Rio AM, et al. Integrated plastic surgery residency applicant survey: characteristics of successful applicants and feedback about the interview process. *Plast Reconstr Surg.* 2009;123:1607–1617.
4. Mehta K, Sinno S, Thanik V, et al. Matching into integrated plastic surgery: the value of research fellowships. *Plast Reconstr Surg.* 2019;143:640–645.
5. Borsting EA, Chim JH, Thaller SR. An updated view of the integrated plastic surgery match. *Ann Plast Surg.* 2015;75:556–559.
6. Schaverien MV. Selection for surgical training: an evidence-based review. *J Surg Educ.* 2016;73:721–729.
7. Tadisina KK, Orra S, Bassiri Gharb B, et al. Applying to integrated plastic surgery residency programs: trends in the past 5 years of the match. *Plast Reconstr Surg.* 2016;137:1344–1353.
8. Ngaage LM, Elegbede A, McGlone KL, et al. Integrated plastic surgery match: trends in research productivity of successful candidates. *Plast Reconstr Surg.* 2020;146:193–201.
9. Schultz KP, Shih L, Davis MJ, et al. Integrated plastic surgery applicant review: important factors and selection criteria. *Plast Reconstr Surg Glob Open.* 2020;8:e2892.

10. National Resident Matching Program, Charting Outcomes in the Match: U.S. Allopathic Seniors, 2018. National Resident Matching Program, Washington, DC 2018. https://www.nrmp.org/wp-content/uploads/2018/06/Charting-Outcomes-in-the-Match-2018-Seniors.pdf
11. AAMC. About ERAS. Available at https://students-residents.aamc.org/applying-residencies-eras/about-eras. Accessed June 1, 2021.
12. R: The R Project for Statistical Computing [Internet]. Available at https://www.r-project.org/. Accessed December 7, 2020.
13. Best Medical Schools (Research) Ranked in 2021 – US News Rankings [Internet]. Available at https://www.usnews.com/best-graduate-schools/top-medical-schools/research-rankings. Accessed December 7, 2020.
14. Pathipati AS, Taleghani N. Research in medical school: a survey evaluating why medical students take research years. *Cureus*. 2016;8:e741.
15. Hammoudeh ZS, Mostafa G, Saint-Cyr M, et al. The "independent" plastic surgery match: analysis of changes in recent years and applicant preferences. *J Surg Educ*. 2016;73:1039–1045.
16. Guo L, Friend J, Kim E, Lipsitz S, Orgill DP, Pribaz J. Comparison of quantitative educational metrics between integrated and independent plastic surgery residents. *Plast Reconstr Surg*. 2008;122:972–978; discussion 979.
17. Accreditation Council for Graduate Medical Education, ACGME Common Program Requirements (Residency). 2020. Available at https://www.acgme.org/Portals/0/PFAssets/ProgramRequirements/CPRResidency2020.pdf
18. DeLong MR, Hughes DB, Tandon VJ, et al. Factors influencing fellowship selection, career trajectory, and academic productivity among plastic surgeons. *Plast Reconstr Surg*. 2014;133:730–736.
19. Janis JE, Hatef DA. Resident selection protocols in plastic surgery: a national survey of plastic surgery program directors. *Plast Reconstr Surg*. 2008;122:1929–1939.
20. Nguyen AT, Janis JE. Resident selection protocols in plastic surgery: a national survey of plastic surgery independent program directors. *Plast Reconstr Surg*. 2012;130:459–469.
21. Lin LO, Makhoul AT, Hackenberger PN, et al. Implications of pass/fail step 1 scoring: plastic surgery program director and applicant perspective. *Plast Reconstr Surg Glob Open*. 2020;8:e3266.
22. Patel AA, Wong MS, Nguyen VT, et al. Analysis of reapplications to integrated and independent plastic surgery residency. *Plast Reconstr Surg Glob Open*. 2021;9:e3508.
23. Hirsch JE. An index to quantify an individual's scientific research output. *Proc Natl Acad Sci U S A*. 2005;102:16569–16572.
24. Thompson RH, Lohse CM, Husmann DA, et al. Predictors of scholarly productivity, pursuit of fellowship, and academic practice among urology residents using medical student application materials. *Urology*. 2018;120:49–55.