INTRODUCTION

This application cycle presents academic leadership with an unprecedented challenge: how to virtually match applicants to mutually beneficial programs. The authors sought to refer to previous years’ data, specifically geographic trends, to better inform both program directors and applicants. The authors hypothesized that geography, as it pertains to the transition from medical school to residency, impacts match patterns.

Methods: The study was designed as a cross-sectional analysis including all current integrated plastic surgery residents. The independent websites of all accredited integrated plastic surgery programs were then queried for the desired demographic resident information. Additionally, as an illustrative endpoint, geospatial heat maps were generated to better understand geographic trends.

Results: All (n = 78) integrated plastic surgery programs and 953 residents were included in the study. Nearly half (47.2%) of current residents remain in the same geographic region in which they obtained their medical degree, with 26% and 17% remaining in the same state and institution, respectively. Students within all regions (North, South, Midwest, West) were more likely to stay within that region for residency (OR 2.59, 2.39, 2.09, 3.80, respectively). Students attending medical schools with affiliated integrated plastic surgery residencies have matched to programs with significantly higher Doximity rankings ($p < 0.0001$).

Conclusions: Matched integrated plastic surgery applicants are more likely to continue their training at institutions in closer geographic proximity to their medical schools. Students graduating from medical schools without affiliated integrated plastic surgery programs appear to be at a disadvantage during the match process.

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trends and better inform both program leadership and applicants.

METHODS

Study Design

Institutional review board exempt status was obtained for this study before data collection. The study was designed as a cross-sectional review of current integrated plastic surgery residents. At the time of data collection (April 2020), a list of accredited integrated plastic surgery programs was obtained from the American Council of Academic Plastic Surgeons. Each programs’ independent website was then queried for the desired demographic information of each resident; variables collected included sex, postgraduate year of training, institution where the resident is currently training, institution where the residents’ prior medical degree was obtained, geographic region (as defined by the 2020 United States census) of the current training program and prior medical school, U.S. News and World Report (New York, N.Y.) ranking of the residents’ prior medical school, and the Doximity (San Francisco, Calif.) ranking of the residents’ current residency program. (See figure, Supplemental Digital Content 1, which displays graphic representation of the United States geographic delineation, as outlined from the United States Census Bureau, and used to define regions in this article. http://links.lww.com/PRSGO/B642.)

Residents who graduated from medical programs outside the United States were excluded due to the differing schooling patterns and lack of conformity. These data were then securely stored within a REDCap database (Nashville, Tenn.). The primary endpoint of the study was obtaining sufficient objective data to design and create geographic heat maps that explain current geographic trends as they pertain to the transition from medical school to integrated plastic surgery residency. Secondarily, the data collected in this study were used to explore how gender representation within the integrated plastic surgery residents has evolved over the past 6 years.

Data Analysis

Demographic characteristics were summarized with numbers and percentages for categorical variables and mean (SD) for continuous variables. Statistical significance of categorical and continuous variables was determined using chi-squared tests, odds ratios, and 2-sample t-tests. Analysis was performed using Microsoft Excel (Redmond, Wash.) and JMP (version 13; SAS Institute Inc., Cary, N.C.).

Heat maps were generated by obtaining institutions’ precise geographic coordinates from Google Maps (Mountain View, Calif.) (Figs. 2–4). The coordinates were then analyzed through Heatmapper (University of Alberta, Edmonton, Canada), which was used to generate heat maps. Individual data points were smoothed using a Gaussian function incorporating a weighted density of values; the Gaussian radius multiplier was consistently set to 0.5 for all heat maps presented within this article.10

RESULTS

All 78 integrated plastic surgery programs (as of April 2020) were included in this study. Within those 78 programs, 953 resident profiles were input into the centralized database. Overall, 541 (56.7%) residents identified themselves as men, 405 (42.3%) were identified as women, and 7 residents did not identify. Treating each sequential postgraduate year as an independent class, it was determined that the proportion of men to women in integrated plastic surgery residency has not significantly changed over the past 6 years ($\chi^2 = 3.5$; $P = 0.62$; Table 1).

As designated by U.S. Census region, a roughly even number of residents currently train in each region (Fig. 1). However, a higher proportion of total residents obtained their medical degree in the Southern region (37%), with proportionately less residents having obtained their medical degree in the West (10%). Notably, 4% of current integrated plastic surgery residents obtained their medical degree outside the United States.

Heat maps generated from geographic coordinate system data illustrate the locations of medical schools attended by current integrated plastic surgery residents (Fig. 2). Data were then broken down to show the pattern of medical school location by each geographic region where integrated plastic surgery residents are currently training (South, North, Midwest, and West) (Fig. 3). Figure 4 demonstrates the geographic distribution of medical schools for residents currently training in the top twenty residency programs, as ranked by reputation in Doximity.

Nearly half ($n = 447, 47.2\%$) of the current integrated plastic surgery residents are training in the same geographic region that they attended medical school. Roughly one-quarter ($n = 242; 25.5\%$) of the current residents are training in the same state that they obtained their medical degree. Also, 17.2 ($n = 163$) of residents are currently training at the same institution they obtained their medical degree from.

Further analysis with odds ratios (ORs) demonstrated that, for those students who matched, medical students in each region were significantly more likely to attend an integrated plastic surgery program within that same region; the extent of this likelihood varied depending on which region the medical school was in. ORs predicting the likelihood for students within a given region to stay within that region for training were calculated as follows: Midwest OR = 2.09 (95% CI 1.17–3.74), South OR = 2.39 (95% CI 1.39–4.11), North OR = 2.59 (95% CI 1.42–4.71).

Table 1. Distribution of Gender amongst Current Integrated Plastic Surgery Residents

| Postgraduate Year [PGY] (Year of Match) | Female Residents (%) | Male Residents (%) |
|----------------------------------------|----------------------|-------------------|
| PGY-1 (2019)                           | 77 (47%)             | 88 (55%)          |
| PGY-2 (2018)                           | 75 (45%)             | 90 (55%)          |
| PGY-3 (2017)                           | 75 (45%)             | 91 (55%)          |
| PGY-4 (2016)                           | 65 (39%)             | 100 (61%)         |
| PGY-5 (2015)                           | 68 (43%)             | 91 (57%)          |
| PGY-6 (2014)                           | 51 (43%)             | 81 (57%)          |
| Total                                  | 405 (43%)            | 541 (57%)         |

The proportion of men/women in integrated plastic surgery residency has not significantly changed over the past 6 years ($P = 0.62$).
and West OR = 3.80 (95% CI 1.67–8.68) (Table 2). Additionally, the proportion of incoming integrated plastic surgery residents that attended medical school within the same geographic region did not change over the 6 years of data this study captured ($\chi^2 = 3.8; P = 0.58$).

The data showed that, among current integrated plastic surgery residents, attending medical school at an institution with an affiliated integrated plastic surgery residency did correlate with matching into a residency program with a higher Doximity ranking ($P < 0.0001$).
Respectively, 68.5% (n = 649) and 31.5% (n = 297) of residents attended a medical school with and without an affiliated integrated plastic surgery program. Those who attended a medical school with an affiliated plastic surgery training program matched into programs with an average Doximity ranking of 29.8 compared with those without an affiliated training program who matched into programs with an average ranking of 36.8 (P < 0.0001). Additionally, incoming plastic surgery residents whose home affiliated program had a Doximity ranking in the top 20 were no more likely to have matriculated into their home residency program (18%) than students with home programs outside the Doximity top 20 (17%) (χ² = 0.098; P = 0.754).

**DISCUSSION**

This cross-sectional geographic analysis of the plastic surgery match offers both academic leadership and prospective applicants valuable insight into recent trends within the match process. There is a roughly even geographic distribution of residency positions while a high proportion of matriculating medical school seniors come from the Southern region. Additionally, over the last 6 years, matriculating seniors have stayed in close proximity to their medical schools for training, with nearly half of them remaining in the same region and almost a quarter remaining within the same state. Importantly, the region of origin for the applicant seems to have a significant impact on where the student matriculates for residency. This was particularly true for those who went to medical school in the West (OR 3.80). This is the first time the regional impact of medical school on residency matriculation has been quantified in the form of odds ratios.

Further, the rates at which applicants are remaining within the same region appear to be similar to those found in earlier publications, lending legitimacy to the trends discussed above. In comparison with Silvestre et al, this study includes updated data, which are particularly important considering the dramatic increase in integrated plastic surgery residency spots since 2015 (148–180 in 2015–2020, respectively). Additionally, this study separates itself within the literature, as it provides illustrative data in the form of odds ratios and heat maps, respectively, which gives actionable information to both program directors and applying medical students. Finally, we show that, of the students who matched into integrated plastic surgery, those coming from institutions with home training programs matriculated into higher-ranked training programs—although not necessarily unilaterally causal, this is a relationship that, to our knowledge, has not been previously published within the body of literature.

As this year’s match brings challenges to both academic leadership and applicants, both parties should take into account the geographic trends presented in this article. The authors anticipated an increased number of interview spots offered nationally, as the normal constraints of
travel, cost, and logistics will be somewhat ameliorated by virtual interviews. However, this may also mean that both program leadership and applicants will be burdened with a significant increase in applicants and programs to consider, respectively. In an attempt to identify the highest yield opportunities for both parties, it would behoove academic leadership to thoroughly consider applicants coming from medical schools within their region and, most certainly, state or institution. For applicants, we believe the same considerations should be made regarding the selection of interviews and the creation of the final rank list. Although the authors do not feel that geographic constraints should be a primary decision-maker for either party, these data offer clarity through a difficult upcoming application cycle.

This study also underlined that successfully matched students coming from institutions with established integrated plastic surgery residency programs match into higher-ranked programs than those whose institutions have no affiliated programs. Although the reasoning behind this trend cannot be definitively described, the authors postulate that students’ increased exposure to the field, more research opportunities, and more direct access to mentors may contribute. While the authors were limited to using Doximity rankings (a combined subjective and objective measure) to analyze this trend, the observed disparity remains concerning. Specifically, the authors feel that this gap may be widened during the upcoming application cycle due to the lack of visiting sub-internships and in-person networking at local, regional, and national meetings, all of which traditionally offered students without a home program an avenue to gain experience and connections within the field. To this end, we assert that program leadership should remain vigilant when assessing applications from institutions without significant ties to academic plastic surgery, specifically toward those applicants within their respective geographic region or state.

**Fig. 4.** Heat map demonstrating the geographic locations and densities of where current integrated plastic surgery residents in the top 20 Doximity attended medical school, divided by U.S. census region. Each blue dot represents an individual data point, with higher and lower densities denoted by hues of red and yellow, respectively, and on a continuous spectrum. The heat map was generated using latitude/longitude data points of the residents’ medical schools and the Gaussian radius multiplier was set at 0.5. The maps were generated with the assistance of Heatmapper.

**Table 2. A Numeric Representation, by Region, Depicting the Distribution of How Many Current Integrated Plastic Surgery Residents Are Training within the Same Geographic That They Attended Medical School**

| United States Census Region | Matched within Same Region as Medical School (%) | Matched to a Different Region than Medical School (%) | Odds Ratio of Residency in Same Region as Medical School (95% CI) | Total |
|-----------------------------|-----------------------------------------------|-----------------------------------------------------|---------------------------------------------------------------|-------|
| Midwest                     | 110 (48%)                                     | 119 (52%)                                           | 2.09                                                          | 229   |
| North                       | 120 (50%)                                     | 121 (50%)                                           | 2.59                                                          | 241   |
| South                       | 160 (41%)                                     | 186 (59%)                                           | 2.39                                                          | 346   |
| West                        | 55 (58%)                                      | 39 (42%)                                            | 3.80                                                          | 94    |
| Total                       | 445 (49%)                                     | 465 (51%)                                           | 910                                                           |       |
Gender disparity amongst matriculants into surgical subspecialties, including plastic surgery, is an issue that has recently been under deservedly intense scrutiny.\textsuperscript{1,11-13} Although not a primary endpoint of this study, patterns in gender representation within integrated plastic surgery residency were also examined. As a cross-sectional review of all current integrated plastic surgery residents, this study showed that 42% of residents were women. Moreover, this proportion was stable over the past 6 sequential resident classes (range: 39%–46%). These results show that, in plastic surgery, women have more appropriate representation in residency than in other comparable integrated surgical subspecialties (percentage of current female resident representation in orthopedics, neurosurgery, and cardiothoracic were recently found to be 15.4%, 17.5%, and 21.8%, respectively).\textsuperscript{14} While there certainly remains much to accomplish regarding gender equity in plastic surgery, the recent increase in literature regarding the topic may explain the improving gender equity; however, additional dedicated studies would be beneficial in further examining these trends.\textsuperscript{15-17}

Although this study offers many valuable insights, it is not without limitations. Most significantly, this study only examines trends among students who successfully matched into integrated plastic surgery; therefore, the data and trends reported within this study are by no means representative of all students that applied. This inherent form of selection bias could not be avoided, as applicants who did not successfully match have no transition from medical school to residency from which to analyze geographic impact. Although these data certainly illustrate trends within the plastic surgery match, they should not serve as predictive models for prospective applicants and/or program leadership.

Secondly, applicants’ proclivity to match in close geographic proximity to where they went to medical school is undoubtedly complex and multifaceted. There are innumerable co-variables that were not included in multivariate analysis that could have theoretically influenced outcomes. This being said, the authors believe regional data should not be evaluated in isolation by applicants or program leadership; however, when taken as a generalized trend with nearly 1000 residents over 6 years, understanding geographic implications is powerful. Additionally, the accuracy of the data collected is dependent upon the accuracy of the data made available by each institution; when ambiguities or voids were identified, program coordinators were directly contacted for clarification. The use of Doximity rankings as a surrogate for programs’ reputation may also be limiting as the ranking protocols can be opaque; however, this remains the most commonly cited ranking system for integrated plastic surgery. Finally, international medical graduates were not included in this study as there was too much variability in schooling patterns. The exclusion of international medical graduates does diminish the impact of the study is relatively minimal.\textsuperscript{18}

The authors feel this article highlights 2 key variables in the plastic surgery match: geographic implications and the disparity for applicants coming from institutions with no affiliated home program. No simple solution exists to these complex problems; however, this study offers data to navigate these obstacles. We highlight how difficult it may be for applicants to match at programs geographically isolated from their medical schools. Thus, we believe applicants with interest in geographically distinct areas from their medical school would greatly benefit from expressing explicit interest in such regions. This interest may come in the form of networking (in-person at conferences or online), away rotations (appreciating the current ACAPS stance on rotating students), and letters of recommendation from faculty within regions of interest. Regarding applicants graduating from schools without affiliated plastic surgery programs, the authors recommend they seek mentorship from local community plastic surgeons and consider completing additional away rotations, specifically at programs geographically closest to their medical school. Moreover, we would implore program leadership to consider such applicants, as it is apparent they are not as represented within high-ranking plastic surgery programs.

CONCLUSIONS

Although integrated plastic surgery applicants come from around the country, those who successfully match are more likely to continue their training at institutions in closer geographic proximity to their medical schools. Matriculating students graduating from medical schools without affiliated integrated plastic surgery programs seem to be at a disadvantage during the match process. We strongly believe that this study offers program leadership and prospective applicants data regarding the recent trends within the plastic surgery match. We hope this will allow both parties to make informed and efficient decisions, especially during the difficult impending application cycle.

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