



# Evaluation of Predictors for Successful Residency Match in General Surgery

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**OBJECTIVE:** To determine predictive factors for a successful residency match among general surgery applicants from 2018 to 2021.

**DESIGN:** A retrospective cross-sectional study of general surgery applicants who matched and went unmatched in match years 2018 to 2021. Applicant characteristics, geographic connections to a program, and away rotations were compared among matched and unmatched applicants.

**SETTING:** Data were sourced from the Texas Seeking Transparency in Applications to Residency initiative for general surgery applicants.

**PARTICIPANTS:** All fourth-year medical students applying in the 2018 to 2021 cycles at participating U.S. medical schools were eligible to respond to the Texas Seeking Transparency in Applications to Residency survey. This study included a total of 1,425 general surgery applicants.

**RESULTS:** Of 1,425 general surgery applicants, 88% matched and 12% went unmatched. Significant predictors for a successful match included Step 1 Score  $\geq 237$  (odds ratio (OR) 1.59 [95% CI 1.15-2.19];  $p = 0.005$ ); Step 2 CK Score  $\geq 252$  (OR 1.88 [95% CI 1.36-2.60];  $p < 0.001$ );  $\geq 3$  Honored Clerkships (OR 1.84 [95% CI 1.33-2.53];  $p < 0.001$ ); Honors in General Surgery Clerkship (OR 1.73 [95% CI 1.33-2.53];  $p = 0.001$ ); AOA membership (OR 2.14 [95% CI 1.34-3.42];  $p = 0.001$ );  $\geq 4$  abstracts, posters, or publications (OR 1.66 [95% CI

1.20-2.30];  $p = 0.002$ ); and  $\geq 1$  peer-reviewed publications (OR 1.52 [95% CI 1.09-2.12];  $p = 0.014$ ). On average, matched applicants completed more away rotations than unmatched applicants ( $p = 0.004$ ). Overall, 36% of matched applicants reported a geographic connection to the program where they matched.

**CONCLUSIONS:** We found that Step 2 CK score, research productivity, honored clerkships, AOA status, and away rotations are significant predictors for successfully matching into general surgery residency. Medical schools can encourage students to prepare a holistic application incorporating variables quantified in this study in preparation for the Step 1 reporting change. (J Surg Ed 79:579–586. © 2021 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

**KEY WORDS:** surgery, general surgery, residency, match, medical education

**COMPETENCIES:** Medical Knowledge, Interpersonal and Communication Skills, Professionalism, Practice-Based Learning and Improvement

## INTRODUCTION

The January 2022 change in the United States Medical Licensing Examination (USMLE) Step 1 score reporting from a 3-digit score to pass/fail brings uncertainty to medical students and residency programs. Previously, the numeric Step 1 score impacted medical student learning and well-being, and it widened disparities, especially for marginalized students.<sup>1-3</sup> While the reporting change may help address some of these issues, it has also stirred anxieties among students.<sup>4,5</sup> In addition, residency program directors have expressed concern with

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the change due to loss of objective measures historically important to the residency selection process.<sup>6-8</sup> Programs and applicants may need to adjust expectations, priorities, and preparations in lieu of the Step 1 reporting change. A better understanding of the relative importance of each component in a successful residency application may help students and programs prioritize certain experiences when Step 1 scores can no longer stratify candidates.

In this study, we explore predictive factors for a successful residency match among general surgery residency applicants from match year 2018 to 2021. We analyzed self-reported standardized test scores, clerkship grades including honors in general surgery, honors society membership, and extracurricular experiences such as research, volunteering, and leadership. Additionally, we examined pre-existing connections applicants had with the general surgery residency programs at which they matched, including away rotations and geographic ties. We hypothesized that USMLE Step 1 and Step 2 Clinical Knowledge scores mattered most for a successful match, with research experiences following.

## MATERIAL AND METHODS

Data were obtained from the Texas Seeking Transparency in Applications to Residency (STAR) initiative at the University of Texas Southwestern Medical Center, which includes surveys to recently matched fourth-year medical students at participating U.S. medical schools. The study was reviewed by the Institutional Review Board at the University of North Carolina at Chapel Hill and was determined to be nonhuman subjects research.

### Participants

All categorical general surgery residency applicants during the 2018-2021 application cycles at participating U.S. medical schools were eligible to respond to the Texas STAR survey. Fourth-year medical students received the Texas STAR survey from their student affairs dean and could submit responses between match day and April 10<sup>th</sup> of the same year. Specific medical schools were not disclosed for applicant confidentiality.

In 2018, 2019, 2020, and 2021, the medical student response rates were 46% (4802/10,431 students at 78 participating schools), 40.8% (6127/15,404 students at 108 participating schools), 46% (7265/15,783 students at 115 participating schools), and 40% (6,912/17,179 students at 123 participating schools) respectively. Among applicants who responded to the Texas STAR survey, there were 1,425 general surgery residency applicants over the 4-year period with 264 respondents in 2018, 362 in 2019, 414 in 2020, and 385 in 2021. Respondents

matching into preliminary positions in general surgery were excluded from our analysis. Because the survey was only distributed to U.S. medical students, respondents who were classified as international medical graduates (IMG) were also excluded. Only a few osteopathic medical schools in the U.S. participated in the Texas STAR survey.

The Texas STAR sample slightly overrepresents matched applicants relative to the national average according to the National Resident Matching Program (NRMP) data. The rate of unmatched U.S. M.D. applicants to general surgery reported by NRMP was 6.9% in 2018, 9.5% in 2019, 10.5% in 2020, and 10.6% in 2021. The rate of unmatched U.S. D.O. applicants to general surgery reported by NRMP was 50.0% in 2018, 49.0% in 2019 (this estimate included previous U.S. graduates and Canadian, Osteopathic, and Fifth Pathway applicants), 24.7% in 2020, and 23.9% in 2021, however the STAR database has few participating D.O. schools compared to M.D. schools.<sup>9-13</sup> The total number of categorical general surgery applicants from U.S. medical schools was 2,477 in 2018, 2,430 in 2019, and 2,713 in 2020.<sup>14</sup> Thus, our sample represents approximately 10% to 15% of these general surgery applicants during this time period.

### Survey Instrument and Data

General surgery applicants completed the Texas STAR online survey after match results were released for the years 2018, 2019, 2020, and 2021. The survey requested that responses be provided as they were reported in Electronic Residency Application Service (ERAS) of that same cycle. Questions included: (1) 3-digit USMLE Step 1 score; (2) Step 2 CK scores; (3) total number of honors in clerkship; (4) honors in general surgery; (5) Alpha Omega Alpha (AOA) membership; (6) Gold Humanism Honor Society (GHHS) membership; (7) research year; (8) number of research experiences; (9) number of abstracts, posters, or presentations; (10) number of peer-reviewed publications; (11) volunteer experiences; (12) leadership positions; (13) couples match; (14) total number of away rotations; (15) number of interviews attended; (16) medical student geographic region defined by Association of American Medical College (AAMC) Group of Student Affairs (GSA) regions as Northeast, South, West, and Central and; (17) second degree. Participants were presented a matrix with all possible residency programs and asked to check if they "had a geographic connection to the area," completed an interview at that program, completed an away rotation at that program, applied to that program, were invited to an interview, and/or whether they matched at that program.

All variables were examined for missing observations. Data on applicant connections to matched programs

was missing for 16.1% of matched applicants for both away rotations and geographic connections. All other variables were missing <5% of observations.

## Statistical Analysis

Descriptive statistics were used to examine baseline characteristics in matched vs. unmatched general surgery applicants. Bivariate testing methods included two-sided t-tests, Chi-square tests, and Fisher's exact test. Predictors of match success were examined using univariate logistic regression models, and continuous variables were dichotomized at their median values for the sample. A subset analysis was performed among matched applicants to examine percentage of applicants who matched at a program with a geographic connection or away rotation. Applicants in the 2020 to 2021 cycle (n = 385) were excluded from the away rotation analysis due to COVID-19 related cancellations. Statistical significance was set at p < 0.05 for all analyses. Stata 16.0 (StataCorp LP, College Station, TX) was used for all analyses.

## RESULTS

### Baseline Characteristics by Match Success

We reviewed responses from 1,425 general surgery applicants who responded to the Texas STAR survey between 2018 and 2021. Of these applicants, 88.0%

(1,254 applicants) successfully matched into a general surgery residency program and 12.0% (171 applicants) did not match. Characteristics of matched vs. unmatched applicants are summarized in [Table 1](#).

Compared to unmatched applicants, students who matched into a general surgery residency program were more likely to have a greater number of honored clerkships (mean (SD), 3.5 (2.3) vs. 2.6 (2.3); p < 0.001); have honors in general surgery clerkship (63.4% vs. 50.0%; p = 0.001); be Alpha Omega Alpha (AOA) members (25.2% vs. 13.6%; p = 0.001); have a higher Step 1 (mean (SD), 236.6 (14.6) vs. 230.8 (15.7); p < 0.001) and Step 2 CK score (mean (SD), 250.7 (11.8) vs. 244.8 (13.0); p < 0.001); have more abstracts, posters, or presentations (mean (SD), 4.7 (3.5) vs. 4.1 (3.7); p < 0.048); and a greater number of interviews attended (mean (SD), 13.7 (5.4) vs. 10.1 (5.9); p < 0.001). There were no significant differences in Gold Humanism Honor Society (GHHS) membership, couples match, additional advanced degrees, research year, number of research experiences, number of peer-reviewed publications, volunteer experiences, or leadership positions ([Table 1](#)).

### Predictors of Match Success

To assess predictors for a successful residency match in general surgery, univariate logistic regression models were used, and results are summarized in [Table 2](#) and [Figure 1](#). Statistically significant predictors were Step 1

**TABLE 1.** Characteristics of Matched vs. Unmatched Applicants

	Matched (n = 1,254)	Unmatched (n = 171)	Total (n = 1,425)	p-value
# Honored Clerkships (mean, SD)	3.5 (2.3)	2.6 (2.3)	3.4 (2.3)	<0.001
Honors in General Surgery Clerkship	763 (63.4%)	84 (50.0%)	847 (61.8%)	0.001
AOA	303 (25.2%)	22 (13.6%)	325 (23.8%)	0.001
GHHS	225 (18.6%)	26 (15.4%)	252 (18.2%)	0.313
Step 1 score, centered (mean, SD)	236.6 (14.6)	230.8 (15.7)	235.9 (14.8)	<0.001
Step 2 CK, centered (mean, SD)	250.7 (11.8)	244.8 (13.0)	250.0 (12.1)	<0.001
Couples Match	89 (7.1%)	6 (3.5%)	95 (6.7%)	0.078
Second Degree	286 (22.8%)	49 (28.7%)	335 (23.5%)	0.091
Research Year	73 (5.8%)	11 (6.4%)	84 (5.9%)	0.750
Number of Research Experiences (mean, SD)	4.1 (2.5)	4.1 (2.9)	4.1 (2.5)	0.981
Number of Abstracts, Posters, or Presentations (mean, SD)	4.7 (3.5)	4.1 (3.7)	4.6 (3.5)	0.048
Number of Peer-Reviewed Publications (mean, SD)	2.3 (2.7)	2.0 (2.8)	2.3 (2.7)	0.098
Volunteer Experiences (mean, SD)	6.9 (2.9)	6.7 (3.1)	6.9 (3.0)	0.301
Leadership Positions (mean, SD)	4.2 (2.7)	4.0 (2.8)	4.2 (2.7)	0.385
Number of interviews attended (mean, SD)	13.7 (5.4)	10.1 (5.9)	13.3 (5.6)	<0.001
Geographic Region				0.462
Central	298 (24.1%)	37 (21.9%)	335 (23.8%)	
Northeast	325 (26.2%)	39 (23.1%)	364 (25.6%)	
South	485 (39.1%)	77 (45.6%)	562 (39.9%)	
West	131 (10.6%)	16 (9.5%)	147 (10.4%)	

**TABLE 2.** Univariate Logistic Regression Model for Predictors of Matching

	OR and 95% CI	p-value
Step 1 Score 237 or greater*	1.59 (1.15-2.19)	0.005
Step 2 CK Score 252 or greater	1.88 (1.36-2.60)	<0.001
3 or more Honored Clerkships	1.84 (1.33-2.53)	<0.001
Honors in General Surgery Clerkship	1.73 (1.25-2.40)	0.001
AOA	2.14 (1.34-3.42)	0.001
GHHS	1.26 (0.81-1.95)	0.314
Couples Match	2.10 (0.90-4.88)	0.084
Second Degree	0.74 (0.51-1.05)	0.092
Research Year	0.90 (0.47-1.73)	0.750
4 or more Research Experiences	1.19 (0.86-1.63)	0.293
4 or more Abstracts, Posters, or Publications	1.66 (1.20-2.30)	0.002
1 or more Peer-Reviewed Publications	1.52 (1.09-2.12)	0.014
7 or more Volunteer Experiences	1.20 (0.87-1.66)	0.267
4 or more Leadership Positions	1.32 (0.95-1.83)	0.096

\*All continuous variables were dichotomized at their median value for the sample

score 237 or greater (OR 1.59 [95% CI 1.15-2.19];  $p = 0.005$ ); Step 2 CK score 252 or greater (OR 1.88 [95% CI 1.36-2.60];  $p < 0.001$ ); 3 or more Honored Clerkships (OR 1.84 [95% CI 1.33-2.53];  $p < 0.001$ ); Honors in General Surgery Clerkship (OR 1.73 [95% CI 1.33-2.53];  $p = 0.001$ ); AOA membership (OR 2.14 [95%

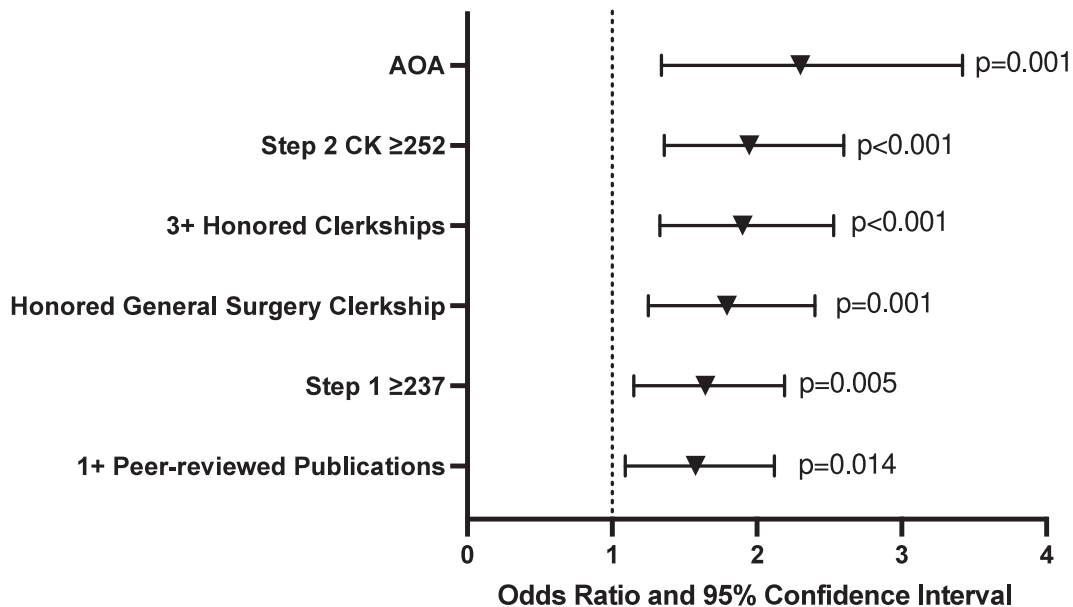
CI 1.34-3.42];  $p = 0.001$ ); 4 or more abstracts, posters, or publications (OR 1.66 [95% CI 1.20-2.30];  $p = 0.002$ ); and 1 or more peer-reviewed publications (OR 1.52 [95% CI 1.09-2.12];  $p = 0.014$ ).

A stepwise analysis was used to further assess the impact of Step 1 and Step 2 CK scores on match success by evaluating scores by quartile. In this sample, Step 1 scores of 227, 237, 247, and 267 constituted the 25th, 50th, 75th, and 99th percentiles, respectively. Step 2 CK scores of 242, 252, 257, and 279 constituted the 25th, 50th, 75th, and 99th percentiles, respectively. Compared to applicants with Step 1 scores in the 1st to 25th percentile, those in the 26th to 50th percentile had a non-significant difference in odds of match success (OR 1.24 [95% CI 0.83-1.84];  $p = 0.289$ ); those in the 50th to 75th percentiles (OR 1.73 [95% CI 1.11-2.69];  $p = 0.015$ ) and 75th to 99th percentiles (OR 2.32 [95% CI 1.37-3.96];  $p = 0.002$ ) had significantly increased odds of match success.

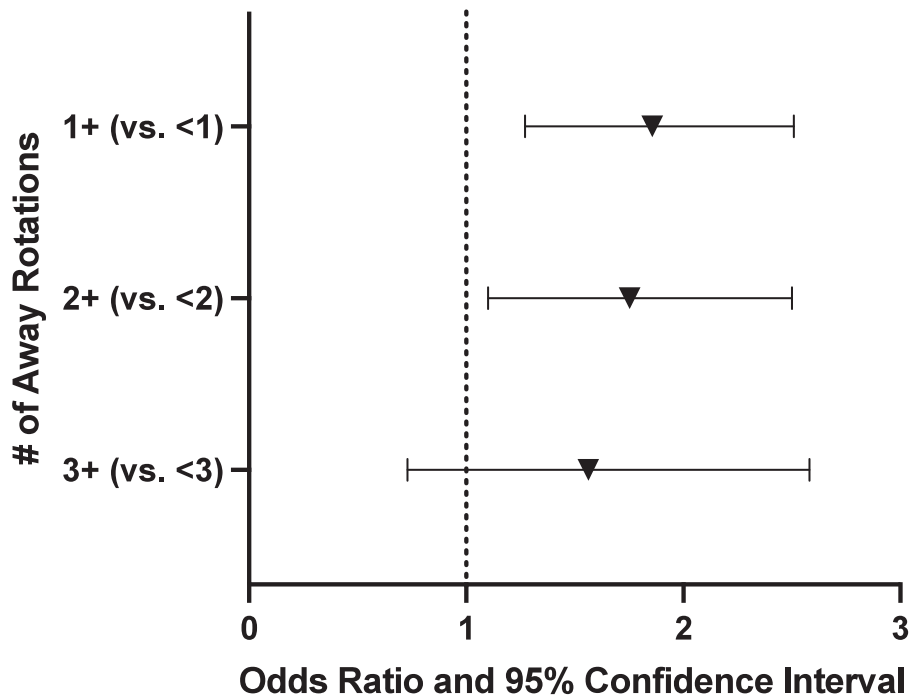
Compared to applicants with Step 2 CK scores in the 1st to 25th percentile, those in the 26th to 50th percentile had a non-significant difference in odds of match success (OR 1.43 [95% CI 0.98-2.08];  $p = 0.065$ ); those in the 50th to 75th percentiles (OR 1.81 [95% CI 1.11-2.95];  $p = 0.018$ ) and 75th to 99th percentiles (OR 3.30 [95% CI 1.93-5.66];  $p < 0.001$ ) had significantly increased odds of match success.

### Secondary Measurement Outcomes

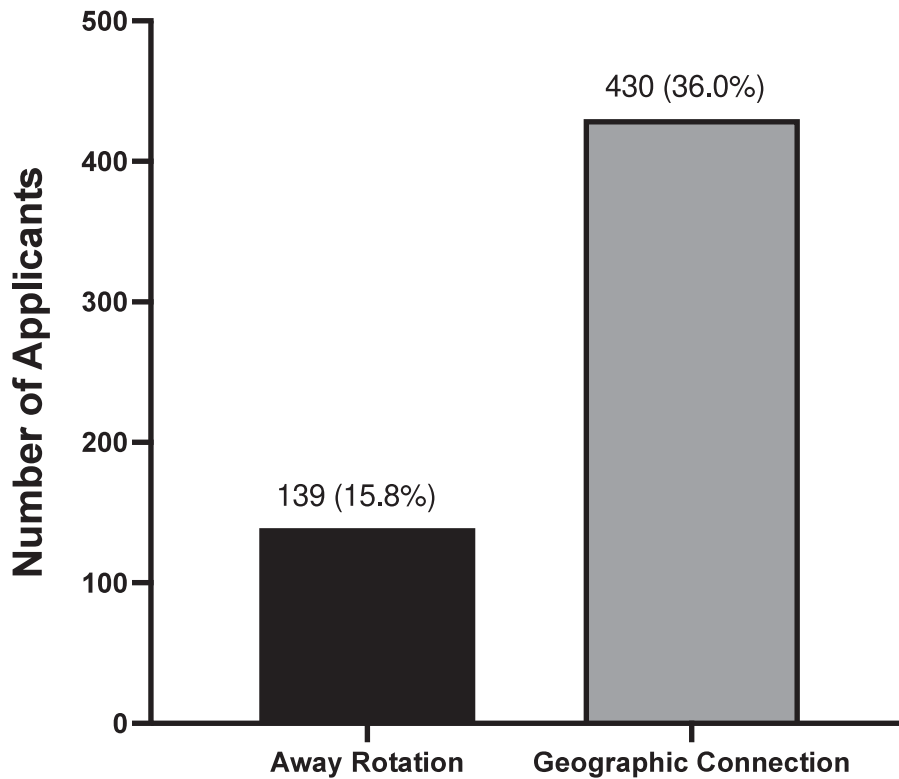
On average, matched applicants completed more away rotations than unmatched applicants (mean (SD), 1.0 (1.1) vs. 0.7 (1.0);  $p = 0.004$ ), summarized



**FIGURE 1.** Forest Plot showing Odds Ratios and 95% CI for Significant Predictors of Match Success.



**FIGURE 2.** Stepwise Logistic Regression Model for the Odds of Match Success with Number of Away Rotations.



**FIGURE 3.** Matched Applicant Connections with Programs at which they Matched. \*Away rotation data available for 881 applicants (2021 excluded), geographic connection data available for 1,196 applicants.

in [Figure 2](#). When using a stepwise univariate logistic regression model, the odds of matching into a general surgery residency program were higher when completing 1 rotation compared to none (OR 1.79 [95% CI 1.27-2.51];  $p=0.001$ ) or 2 away rotations compared to  $<2$  (OR 1.66 [95% CI 1.10-2.50];  $p=0.015$ ). However, increasing number of away rotations beyond 3 programs was not associated with increased odds of match success (OR 1.38 [95% CI 0.73-2.58];  $p=0.318$ ).

Applicant-reported geographic connections to the programs at which they matched were also examined. Overall, 36% of matched applicants reported a geographic connection to the program at which they matched, and 15.8% of matched applicants reported an away rotation at their matched program ([Fig. 3](#)).

## DISCUSSION

In this study, we analyzed predictors for a successful general surgery residency match. Contrary to our hypothesis, the variables most strongly associated with a successful match were AOA membership, Step 2 CK scores, and honored clerkships (both the number of honored clerkships and honors specifically in General Surgery). Although Step 1 score and research output were significantly associated with match success, the associations were not as strong as we had hypothesized. With the new Step 1 pass/fail reporting, Step 2 CK will become the sole standardized test score that programs receive. Number of honored clerkships, especially in general surgery, can be expected to play a larger role in determining an applicant's academic profile, however, not all medical schools have honors grading.

We found that doing at least one or two away rotations was a significant predictor for successfully matching into general surgery, and 15.8% of applicants matched at a program where they completed an away rotation. Away rotations have not historically been emphasized for general surgery applicants compared to specialties like neurosurgery and orthopedic surgery.<sup>15,16</sup> However, a recent survey study found that 54% of general surgery program directors reported assessing a medical student's fit for their residency program as the second most important purpose of subinternships, with 39% reporting a letter of recommendation from the faculty mentor was the most important criteria for offering students an interview.<sup>17</sup> Additionally, we found that 36% of applicants reported a geographic connection to the program at which they matched. However, it is yet to be determined if the transition of Step 1 to pass/fail reporting changes the relative importance of factors such as geographic connections or away rotations.

## Limitations

There are several limitations of this retrospective analysis using the Texas STAR data. The data may be subject to recall bias because applicants were asked to report information submitted in ERAS applications but completed the survey several months after the ERAS submission deadline. We were also unable to differentiate between those who did not respond for honors in general surgery (3.8% of respondents) and total number of honored clerkships (2.3% of respondents) from those for whom it was not applicable due to clerkships being pass/fail. Furthermore, we were unable to differentiate between those who did not report honors society membership and for those whom it was not applicable due to no home chapter. These were 4.9% of respondents for AOA status and 3.2% of respondents for GHHS status.

Additionally, data on demographic characteristics such as race, ethnicity, and gender, and program affiliation were not available. These characteristics have been shown to add challenges to the residency application process, especially for minority students.<sup>18-20</sup> In the Texas STAR survey, "geographic connection" is not clearly defined, thus, students may be differentially disclosing or not disclosing regional ties. There was also the potential for selection bias in survey response, with matched applicants more likely to respond. The match rate for this dataset was 88.0%, compared to 82.3% in 2020 for U.S. M.D. Seniors according to the NRMP Charting Outcomes report.<sup>21</sup>

Our data may also be skewed because the Texas STAR survey was not distributed to IMGs. IMGs make up approximately one third of general surgery applicants and often experience significant barriers to matching despite producing more scholarly work.<sup>14,22,23</sup> Exclusion of IMGs from the Texas STAR survey not only produces selection bias, but also limits the generalizability of our study. Similarly, our sample size represents only about 10-15% of general surgery applicants from U.S. medical schools from 2018 to 2021, which creates additional potential for selection bias and limits the overall generalizability of our findings. Additional studies are warranted to verify our findings and evaluate match outcomes among IMGs.

Finally, the residency application is a complex process with many factors involved that were not measured in this dataset, including but not limited to an applicant's medical school reputation, mentor connections, letters of recommendation, personal statements, interviews, and other personal ties to a program. Disparities in access and equity are likely contributing to additional known and unknown barriers for students from marginalized backgrounds and identities which are not captured in the data.<sup>18-20</sup>

## CONCLUSION

As Step 1 transitions to pass/fail reporting, general surgery applicants may seek other ways to showcase their candidacy for residency. This study suggests that Step 2 CK score, research productivity, honored clerkships, AOA status, and away rotations are significant predictors for successfully matching into general surgery residency. These findings can help inform applicants about which objective factors may matter most to general surgery programs as the match evolves towards more holistic review in the future.

## CONFLICT OF INTEREST

None of the other authors has any relevant conflicts of interest to disclose.

## STATEMENT ON DUPLICATE AND PREPRINT PUBLICATION

This work has not been published previously and is not under consideration for publication elsewhere.

## AUTHOR CONTRIBUTIONS

Iwai, Lenze, Stitzenberg: Concept and design. All authors: Acquisition, analysis, or interpretation of data; Critical revision of the manuscript for important intellectual content; Final approval of the version submitted. Iwai, Lenze: Drafting of the manuscript. All authors. Lenze: Statistical analysis. Stitzenberg: Supervision.

## MEETING PRESENTATION

The contents of this manuscript will not be presented at any meetings.

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