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Effect of the COVID-19 pandemic on the residency match among surgical specialties

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ABSTRACT

Background: Despite unprecedented changes to undergraduate medical education and the residency selection process during the COVID-19 pandemic, there is little objective evidence on how the pandemic affected match outcomes such as matched applicant characteristics, interview distribution, geographic clustering, and associated costs. We investigated COVID-19's impact on the residency match by comparing surgery applicants' characteristics, interview distribution, and related costs from 2018 to 2020 to 2021.

Methods: Data from the Texas Seeking Transparency in Applications to Residency initiative were analyzed. Descriptive statistics, bivariate testing, and sensitivity analysis were performed to compare matched applicants in surgical specialties from 2018–2020 to 2021.

Results: This study included 5,258 applicants who matched into 10 surgical specialties from 2018 to 2021. In 2021, there was a decrease in proportion of students who reported a geographic connection to their matched program (38.4% vs 42.1%; $P = .021$) and no significant difference in number of interviews attended (mean [SD], 13.1 [6.2] vs 13.3 [4.7]; $P = .136$) compared to prior years. Applicants in 2021 had more research experiences and fewer honored clerkships (both $P < .001$), and these associations persisted in sensitivity analysis. Matched applicants in 2021 reported significantly lower total costs associated with the residency application process compared to 2018 to 2020 (mean [SD] \$1,959 [1,275] vs \$6,756 [4,081]; $P < .001$).

Conclusion: Although COVID-19 appeared to result in a reduction in number of honored clerkships, it may have provided more opportunities for students to engage in research. Overall, the adoption of virtual interviews and away rotations may have successfully mitigated some of the adverse consequences of the pandemic on the residency match for surgical specialties.

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Background

The coronavirus 2019 (COVID-19) pandemic has had a profound impact on the transition from medical school to residency. In March 2020, the American Association of Medical Colleges (AAMC)

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advised that all medical student clinical experiences be halted to enforce community safety standards and address personal protective equipment (PPE) shortages.^{1,2} Subinternships and away rotations have been key for matching into competitive specialties, including neurosurgery, orthopedic surgery, and plastic surgery.^{3–5} In light of the AAMC's recommendations against direct clinical activities due to COVID-19, programs offered virtual away rotations for candidates applying into surgical specialties,^{6–8} in addition to virtual interviews that were implemented for all specialties.^{9,10}

Some programs have reported these initiatives as opportunities for increasing diversity and equity and offsetting the financial burden of interview travel and associated expenses.^{11–13} However, students have raised concerns about the effect of COVID-19 on the

quality of their surgical education and their success in the residency match.^{14–16} Despite the changes caused by the COVID-19 pandemic and concerns among applicants, there is little objective evidence about how the pandemic actually impacted the residency match among surgical specialties. These data could inform how students and programs prepare for ongoing challenges with the residency selection process during and after the pandemic.

In this study, we compared characteristics of matched applicants in surgical specialties from 2018 to 2020 to matched applicants in 2021. We assessed applicant-reported geographic connections to programs given the widespread cancellation of in-person away rotations in the 2020–2021 application cycle. In addition, we examined traditional metrics such as United States Medical Licensing Exam Step 1 and Step 2 Clinical Knowledge scores, clerkship grades, research experience, and honors society membership. We then analyzed the distribution of interview invitations and interviews attended in the 2020–2021 cycle compared to prior cycles given concerns for “interview hoarding” (some candidates interviewing at more programs than necessary, leaving fewer interview opportunities for candidates who receive fewer offers to begin with) in the virtual application cycle.^{17,18} Finally, we analyzed applicant-reported costs associated with the residency application process, including total costs, interview costs, application costs, and other costs.

We hypothesized that with the lack of in-person away rotations due to COVID-19, geographic connections to a program would play a larger role in the match for surgical specialties. We also hypothesized that the number of interviews attended per applicant in the 2020–2021 cycle would exceed prior cycles given the potential for applicants to attend more interviews in the virtual setting due to decreased travel costs associated with interviewing. Finally, we hypothesized that in 2021, students' applications would be reviewed more holistically than in prior years, with research, volunteering, and leadership given more weight.

Methods

Data were acquired from the University of Texas Southwestern Medical School's Texas Seeking Transparency in Applications to Residency (STAR) initiative. This study was reviewed and determined to be nonhuman subjects research by the Institutional Review Board at the University of North Carolina at Chapel Hill.

Participants

Texas STAR distributes surveys to fourth-year medical students who have recently applied to residency programs from US allopathic and osteopathic medical schools. Surveys were disseminated by the student affairs dean at each participating school, and medical students had between match day and April 10 of the same application cycle to submit their responses. Student demographics, including race, ethnicity, or gender, were not collected, and medical school affiliations were not disclosed for confidentiality reasons. Medical student response rates were 46% in 2018 (4802/10,431 students at 78 participating schools), 40.8% in 2019 (6127/15,404 students at 108 participating schools), 46% in 2020 (7265/15,783 students at 115 participating schools), and 40% in 2021 (6,912/17,179 students at 123 participating schools).

All medical students who matched into surgical residency programs from 2018 to 2021 and responded to the Texas STAR survey were included in this study. The 10 surgical specialties analyzed were: general surgery (categorical), neurosurgery, obstetrics and gynecology (OB-GYN), ophthalmology, orthopedic surgery, otolaryngology, plastic surgery, thoracic surgery, urology, and vascular

surgery. The survey was only sent to participating US medical schools, so international medical graduates were excluded from this study. In addition, only a few US osteopathic medical schools participated in the Texas STAR survey.

Survey instrument

The Texas STAR survey requested students complete the online questionnaire with the same information that was submitted in the Electronic Residency Application Service (ERAS) application. Questions included United States Medical Licensing Exam Step 1 and Step 2 Clinical Knowledge scores (reported in a 5-digit range for confidentiality), extracurricular experiences (including research activities, peer-reviewed publications, leadership positions, volunteer experiences), and honors society membership (Alpha Omega Alpha and Gold Humanism Honor Society). The survey also collected information on whether students did an away rotation at their matched institution and whether they had a geographic connection to the matched institution using AAMC's regional categories: Northeast, South, West, and Central.

Statistical analysis

Descriptive statistics were used to examine baseline characteristics in applicants who matched in 2021 compared to applicants who matched from 2018 to 2020. Bivariate testing methods included 2-sided *t* tests and χ^2 tests. The distribution of interviews attended was compared for matched applicants in 2021 versus 2018–2020 using histograms and descriptive statistics (mean, maximum, skewness, and kurtosis). Two-sided *t* tests were used to compare geographic connections and costs for applicants in 2021 versus 2018–2020. Stratified analyses were performed to examine percentages of matched applicants with a geographic connection or away rotation at their program by year for each surgical specialty. The 2020–2021 application cycle was excluded from the away rotation analysis due to COVID-19-related cancellations. A sensitivity analysis was performed to examine annual changes in matched applicants' characteristics from 2018 to 2021 to determine if significant variables in the bivariate analysis were related to a broader trend. All variables were found to have <5% missing observations. Statistical significance was set at $P < .05$ of all analyses. Stata 16.0 (StataCorp LP, College Station, TX) was used for all analyses.

Results

Surgical residency applicant characteristics

Data from 5,258 students who successfully matched into 10 surgical specialties between 2018 and 2021 were included. A total of 5,258 matched respondents were analyzed: 1,006 respondents in 2018, 1,224 in 2019, 1,516 in 2020, and 1,512 in 2021. Among these respondents over the 4-year period, there were 1,254 general surgery (categorical) respondents, 192 neurosurgery respondents, 1,536 OB-GYN respondents, 443 ophthalmology respondents, 796 orthopedic surgery respondents, 386 otolaryngology respondents, 198 plastic surgery respondents, 52 thoracic surgery respondents, 342 urology respondents, and 59 vascular surgery respondents. Surgical specialties were combined to analyze trends in matched applicant characteristics for years 2018 to 2020 versus 2021.

Main measurement outcomes

Differences in characteristics of successfully matched applicants from 2018 to 2020 and 2021 are summarized in [Table 1](#). Students

Table 1
Characteristics of matched applicants in 2021 versus 2018 to 2020

| | 2018 to 2020 (N = 3,746) | 2021 (N = 1,512) | P value |
|--|--------------------------|------------------|---------|
| # Honored clerkships (mean, SD) | 4.0 (2.4) | 3.8 (2.3) | <.001 |
| Honors in clerkship of specialty choice | 2,636 (79.1%) | 1,054 (80.2%) | .409 |
| Alpha Omega Alpha | 1,188 (33.1%) | 488 (35.3%) | .150 |
| Gold Humanism Honors Society | 661 (18.3%) | 264 (18.5%) | .808 |
| Step 1 score, centered (mean, SD) | 240.8 (14.9) | 240.6 (14.6) | .625 |
| Step 2 Clinical Knowledge, centered (mean, SD) | 252.0 (11.8) | 253.0 (11.4) | .004 |
| Second degree | 764 (20.4%) | 346 (22.9%) | .045 |
| Research year | 348 (9.3%) | 159 (10.5%) | .175 |
| Number of research experiences (mean, SD) | 4.6 (2.7) | 5.3 (2.8) | <.001 |
| Number of abstracts, posters, or presentations | 5.3 (3.7) | 6.1 (3.7) | <.001 |
| Number of peer-reviewed publications | 2.8 (3.0) | 3.7 (3.4) | <.001 |
| Volunteer experiences | 6.9 (3.0) | 7.5 (2.9) | <.001 |
| Leadership positions | 4.3 (2.7) | 4.8 (2.8) | <.001 |

The bold values are statistically significant.

who matched into surgical specialties in 2021 had fewer number of honored clerkships compared to students who matched in 2018–2020, (mean [SD], 3.8 [2.3] vs 4.0 [2.4], respectively; $P < .001$), but higher Step 2 Clinical Knowledge scores (mean [SD], 253.0 [11.4] vs 252.0 [11.8]; $P = .004$); more second degrees (22.9% vs 20.4%; $P = .045$); more research experiences (mean [SD], 5.3 [2.8] vs 4.6 [2.7]; $P < .001$); more abstracts, posters, or presentations (mean [SD], 6.1 [3.7] vs 5.3 [3.7]; $P < .001$); more peer-reviewed publications (mean [SD], 3.7 [3.4] vs 2.8 [3.0]; $P < .001$); more volunteer experiences (mean [SD], 7.5 [2.9] vs 6.9 [3.0]; $P < .001$); and more leadership positions (mean [SD], 4.8 [2.8] vs 4.3 [2.7]; $P < .001$). There were no significant differences between 2018 to 2020 and 2021 applicants for honors in clerkship of specialty choice, Alpha Omega Alpha membership, Gold Humanism Honors Society membership, Step 1 score, or completion of a research year (Table 1).

A sensitivity analysis was performed for significant variables in Table 1 to assess if the changes were uniquely observed in the 2020–2021 cycle or were part of a broader trend (see Supplementary Materials). After sensitivity analysis, only number of honored clerkships ($P = .001$) and number of research experiences ($P < .001$) demonstrated statistically significant change unique to the 2021 cycle.

We also compared interview invitations and number of interviews attended for students who applied to surgical residency programs in 2018–2020 versus 2021, summarized in Figure 1. Applicants reported fewer interview offers in the 2020–2021 cycle compared to prior years (mean [SD], 14.8 [9.1] vs 16.7 [9.6]; $P < .001$), but there was no significant difference in number of interviews attended (mean [SD], 13.1 [6.2] vs 13.3 [4.7]; $P = .136$) (Figure 1).

Secondary measurement outcomes

Data on geographic connections to matched programs were analyzed. The proportion of students who matched into a surgical specialty where they had a geographic connection was 40.5% (407 out of 1,006 respondents) in 2018, 39.5% (483 out of 1,224 respondents) in 2019, 45.3% (686 out of 1,516 respondents) in 2020, and 38.4% (495 out of 1,289 respondents) in 2021 (Figure 2, A). Overall, there was a statistically significant decrease in proportion of students who reported a geographic connection to their matched surgery program in the 2020–2021 cycle compared to prior cycles (38.4% vs 42.1%; $P = .021$).

Data regarding away rotations were analyzed for application cycles 2018 to 2020. Among all surgical specialties, the proportion of applicants who reported matching at a program where they did

an away rotation was 24.7% (248 out of 1,006 respondents) in 2018, 25.4% (311 out of 1,224 respondents) in 2019, and 28.6% (433 out of 1,516 respondents) in 2020 (Figure 2, A).

Next, we examined away rotations and geographic connections stratified by each surgical specialty (Figure 2, B–J). Overall, general surgery (17.1% in 2018, 14.9% in 2019, and 15.7% in 2020; Figure 2, B) and OB-GYN (14.5% in 2018, 15.6% in 2019, and 16.6% in 2020; Figure 2, D) applicants had the lowest proportion of students who did an away rotation at the program where they matched. In comparison, orthopedic surgery applicants had the highest proportion of students who did an away rotation at the program where they matched (45.8% in 2018, 53.6% in 2019, and 54.1% in 2020; Figure 2, F), with plastic surgery following (47.4% in 2018, 32.4% in 2019, 49.2% in 2020; Figure 2, H). For geographic connections to a surgery program, OB-GYN (40.9% in 2018, 43.4% in 2019, 51.7% in 2020, and 43.6% in 2021; Figure 2, D) and orthopedic surgery (45.8% in 2018, 48.6% in 2019, 48.1% in 2020, 44.6% in 2021; Figure 2, F) applicants had the highest proportion of students with a reported connection.

Finally, we examined applicant-reported costs associated with the residency application process, including total costs, interview costs, application costs, and other costs. Applicants from the 2020 to 2021 cycle reported significantly lower total costs (mean [SD] \$1,959 [1,275] vs \$6,756 [4,081]; $P < .001$), interview costs (mean [SD] \$74 [70] vs \$3,426 [2,603]; $P < .001$), and other costs (mean [SD] \$645 [899] vs \$2,178 [1,960]; $P < .001$). There was no significant difference in applicant-reported application costs between the 2020 to 2021 cycle and prior years (mean [SD] \$1,486 [818] vs \$1,505 [786]; $P = .440$).

Discussion

In this study, we compared characteristics of successfully matched residency applicants in surgical specialties from 2018 to 2020 with the 2021 application cycle. Applicants who matched into surgical specialties in 2021 reported more research experiences and lower number of honored clerkships compared to prior cycles. Sensitivity analysis suggested that these findings were related specifically to the 2020 to 2021 application cycle rather than being part of a broader trend. In contrast to our hypotheses, there was no significant increase in the percentage of matched applicants with a geographic connection to their program or mean number of interviews attended in the 2020 to 2021 cycle. Overall, these findings can be used to help inform future residency application cycles and decisions regarding virtual interviews, even beyond the COVID-19 pandemic.

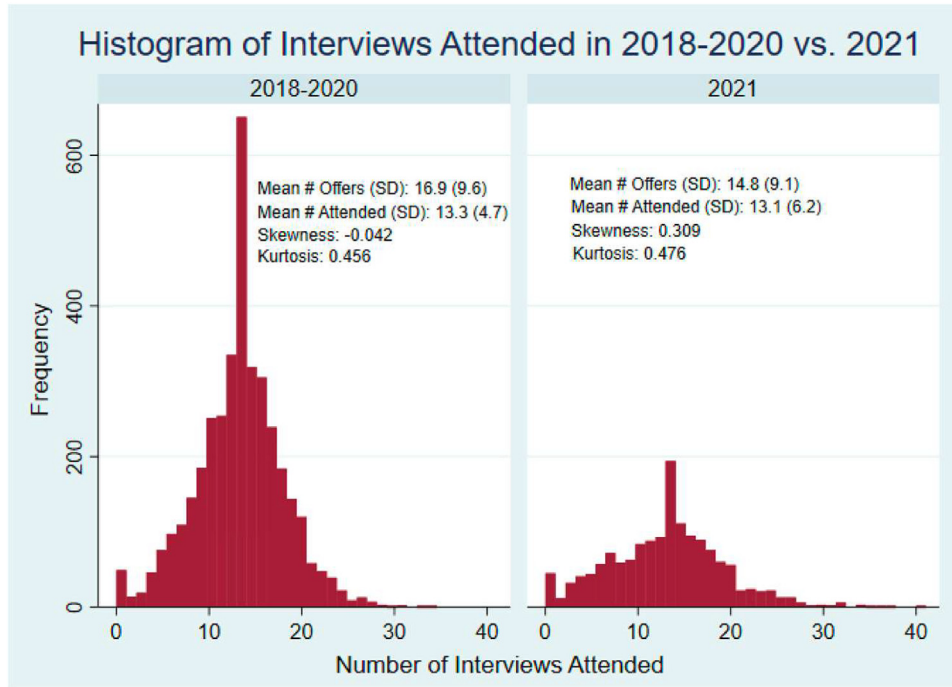


Figure 1. Histogram showing the distribution of interviews attended by matched applicants in 2021 compared to 2018 to 2020 (mean [SD]: 13.1 [6.2] vs 13.3 [4.7]; $P = .136$).

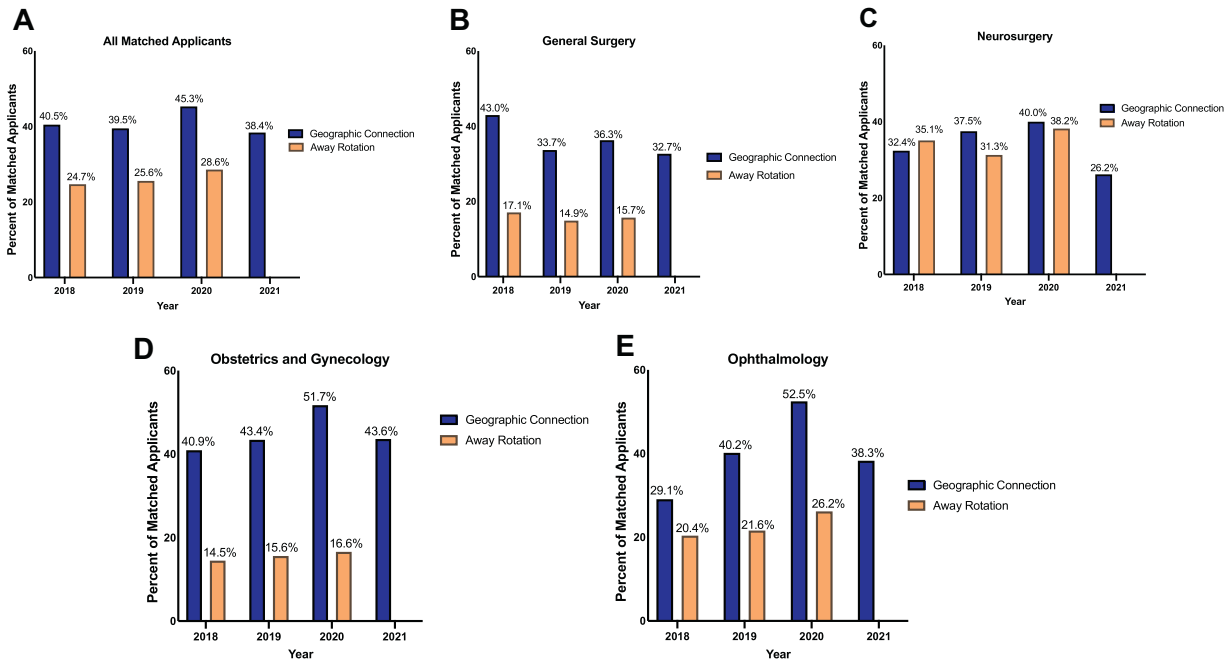


Figure 2. (A) Bar graph showing the percentage of applicants matching at a program where they did an away rotation or had a geographic connection by year. (B) General surgery applicants' connections to programs at which they matched. (C) Neurosurgery applicants' connections to programs at which they matched. (D) Obstetrics and gynecology applicants' connections to programs at which they matched. (E) Ophthalmology applicants' connections to programs at which they matched. (F) Orthopedic surgery applicants' connections to programs at which they matched. (G) Otolaryngology applicants' connections to programs at which they matched. (H) Plastic surgery applicants' connections to programs at which they matched. (I) Urology applicants' connections to programs at which they matched. (J) Vascular surgery applicants' connections to programs at which they matched.

We had hypothesized that with the lack of in-person away rotations due to COVID-19, applicants in the 2020 to 2021 cycle would be more likely to match at a program where they had a geographic connection. However, our analysis revealed that there was an

overall decrease in the number of applicants who reported a geographic tie to the program at which they matched. The inability of applicants to connect with new programs via in-person away rotations may have been partially mitigated by increased

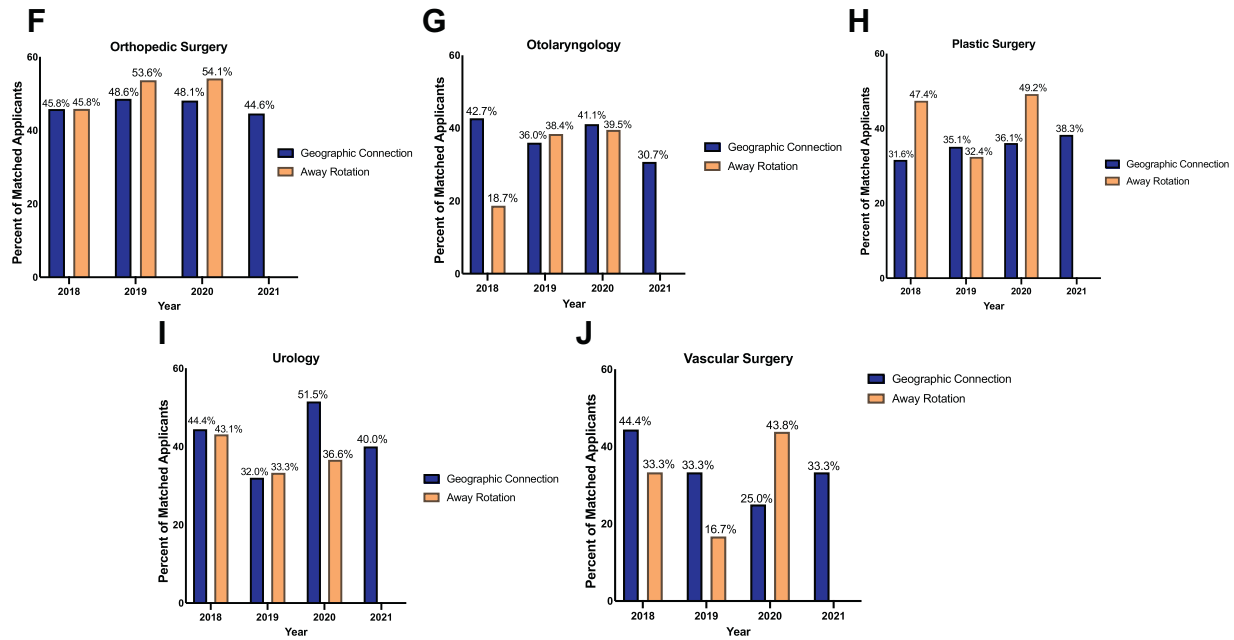


Figure 2. Continued

opportunities from virtual interviews and virtual away rotations. Traveling for residency interviews and away rotations are known to be financially taxing for many students. Some students report canceling interviews because of the financial burden.^{19–21} It is possible that students who could not have attended interviews in previous years were able to interview at geographically distant programs more readily.

The finding that there were less geographic connections between applicants and the programs at which they matched may have important implications for future cycles. The Coalition for Physician Accountability recommended virtual interviews for the 2021–2022 residency application cycle,²² and a recent National Residency Matching Program survey of more than 1,000 program directors found that 60% intended to rely on the virtual environment for future application cycles.²³ Applicants can be reassured that the continuation of virtual interviews and, potentially, lack of in-person away rotations may not limit their geographic options in the residency match. The extent to which virtual away rotations may have contributed to this finding by facilitating applicant connections with geographically distant programs is unknown. More research is warranted to determine the drivers of this finding from both an applicant and program perspective.

We suspect that the finding of more research experiences among matched applicants in 2021 may be partially explained by the increased time afforded to some medical students to engage in remote research activities due to the cancellation or shortening of clinical and clerkship rotations. Likewise, the decrease in number of honored clerkships may be explained by cancellations in clinical rotations, changes in graduation requirements, or transitions to pass/fail grading in response to the COVID-19 pandemic. However, the difference in average number of honored clerkships going from 4.0 to 3.8 is functionally not very different, despite statistical significance in our analysis.

Our findings also showed that in 2021, matched applicants had higher Step 2 Clinical Knowledge scores, more abstracts, posters, or presentations, more peer-reviewed publications, more volunteer

experiences, and more leadership experiences compared to applicants in prior cycles. However, sensitivity analysis suggested that these findings were part of a broader trend rather than a result of the pandemic given the evidence of incremental increases in these metrics from 2018 to 2021. This may reflect an increasing competitiveness of matching into surgical specialties in the United States. Additionally, some of these differences among matched and unmatched applicants, such as Step 2 Clinical Knowledge score (253.0 vs 252.0), second degrees (22.9% vs 20.4%), and leadership positions (4.8 vs 4.3), were statistically significant but may not be functionally significant differences.

Another concern during the 2020 to 2021 application cycle was the potential for “interview hoarding” due to the significant alleviation of interview-associated expenses and travel logistics. We found a statistically significant decrease in the mean number of interviews offered in the 2020 to 2021 cycle compared to prior years (14.8 vs 16.7), and yet no change in the average number of interviews attended by students (13.1 vs 13.3). Because there was no concomitant decrease in the number of interviews attended, it is possible that some applicants attended relatively more interviews than they would have in past years. This is illustrated by the histogram in Figure 1, showing that the 2021 distribution of interviews had more outliers of students attending a higher number of interviews. It is important to note that although the change in interview offers was statistically significant, a difference of 2 interviews may not be practically meaningful. The important takeaway from these findings is that there was not a significant increase in number of interviews attended with the COVID-19 pandemic to suggest interview hoarding as we had hypothesized.

Finally, applicants reported significantly lower costs associated with the residency application process in the 2020 to 2021 cycle. This finding is presumably due to the lack of in-person away rotations and the absence of typical travel expenses required for in-person interviews. Decreased costs is one of the advantages of virtual interviews, and to our knowledge this is the first study to quantify this difference.

Limitations

There are several limitations to this study using the Texas STAR database. The data come from self-reported surveys, which may be subject to recall bias. Selection bias is also a possibility because matched applicants were more likely to respond to the survey. The National Resident Matching Program reported an 82.3% match rate in 2020, whereas 88.0% of respondents to the Texas STAR reported matching.²⁴ Additionally, the Texas STAR data was deidentified by applicants' medical schools despite known associations between a medical school's curriculum and/or affiliated health system's impact on resources and readiness of students going into surgery.^{25,26} Further, no data were available on demographics (eg, race, ethnicity, gender, or socioeconomic status), which can all impact an applicant's access, interest, sense of belonging, and success in matching into surgical specialties.^{27–29} "Geographic ties" was also not clearly defined in the Texas STAR survey, so students may have interpreted whether they had a connection or not in different ways.

Despite our sensitivity analysis, it is difficult to parse out whether our findings were driven by the COVID-19 pandemic, an increasing competitiveness of matching into surgical specialties, or other unmeasured confounders. Additionally, we combined surgical specialties in this exploratory analysis to maximize our statistical power and assess broad trends in the 2020 to 2021 application cycle. However, we recognize that there are important differences across the surgical specialties that may not have been captured in our study. Further studies may be warranted to verify these findings among individual surgical specialties.

Our study included only matched surgery applicants due to limited sample size and incomplete data for unmatched applicants. However, to understand the full picture of "interview hoarding" and cost saving with virtual interviews, our analysis would have benefited from data on unmatched applicants for each surgical specialty. We also did not capture the qualitative side of cost saving associated with virtual interviews. Despite decreases in costs, students may have had preferences for in-person interviews based on the limited capacity for interaction with program faculty, current residents, and other interviewees in the virtual setting. Additional analysis of the quality of virtual interviewing may help contextualize the benefits of virtual interviews.

In conclusion, although the COVID-19 pandemic appeared to negatively impact the number of honored clinical clerkships, it may have provided more time and flexibility for students to engage in research experiences. Overall, the adoption of virtual interviews and virtual away rotations may have successfully mitigated some of the adverse consequences of the pandemic, without significant sequela such as "interview hoarding." The decrease in proportion of applicants matching at programs with a geographic connection also suggests that virtual interviews can create opportunities for students to train at programs they may not have had access to otherwise. Finally, the virtual interview format resulted in significant cost savings for applicants. These data can help inform future research and decisions regarding the residency selection process.

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Conflict of interest/Disclosure

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

Supplementary Materials

Supplementary material associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.surg.2021.11.013>.

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