



## AOA Critical Issues in Education

# Effects of COVID-19 on Geographical Trends in the Orthopaedic Surgery Residency Match

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**BACKGROUND:** Historically, medical students often match within the same geographic location or to an orthopaedic surgery residency program affiliated with their medical school. The objective of this investigation was to determine differences in geographic trends between orthopaedic residents matching before and during the Coronavirus-19 (COVID-19) pandemic.

**METHODS:** This study analyzed 2 groups of orthopaedic residents: Pre-COVID cohort (years 2016-2020) and COVID-impacted cohort (year 2021). A list of accredited orthopaedic surgery residency programs ( $n = 202$ ) was obtained. Orthopaedic residency program webpages were located (region [ $n = 4$ ], division [ $n = 9$ ], state [ $n = 50$ ]). For each resident, their medical school and year of postgraduate training were recorded. Year 2021 resident information was obtained from the orthopaedic residency program webpages, social media accounts, and medical school match lists. Residency programs affiliated with a medical school were also assigned. Descriptive statistics were performed. Two sample Student  $t$  tests with Bonferroni correction applied to  $p$ -values ( $\alpha < 0.05$  significant) were performed.

**RESULTS:** There were 4,832 residents analyzed (4,074 in Pre-COVID cohort; 758 in COVID-impacted cohort [758/868 of all positions in 2021 Match]). Statistically significant differences were detected between the COVID-impacted cohort (39.6%,  $p < 0.001$ ) matching in the same state as their medical school (Pre-COVID 33.1%) and the COVID-impacted cohort (28.0%,  $p < 0.001$ ) matching to a residency program affiliated with their medical school (Pre-COVID 21.2%). In the COVID-impacted cohort, students who matched in state matched to their home program more frequently (69.3%) compared with the Pre-COVID cohort (60.5%). Geographically, there was a difference in the COVID-impacted cohort (52.5%,  $p < 0.011$ ) matching in the same division (Pre-COVID 47.5%). No statistically significant differences were identified for residents matching to the same region as their medical school (Pre-COVID 60.1%; COVID-impacted 61%,  $p = 0.968$ ).

**CONCLUSION:** Residents matching in the same state, in the same division, and to a residency program affiliated with their medical school increased significantly in the COVID-impacted cohort. There was no difference between cohorts matching in the same region as their medical school.

**Level of Evidence:** Observational/Cross-Sectional

**Disclosure:** The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (<http://links.lww.com/JBJSOA/A404>).

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## Introduction

On May 11, 2020, the Association of American Medical Colleges (AAMC) issued recommendations that discouraged away rotations and transitioned interviews to a virtual format because of the Coronavirus-19 (COVID-19) pandemic<sup>1</sup>. The away rotation is important in orthopaedic resident selection with 2.4 rotations completed per student<sup>2,3</sup>. Prospective 2020 to 2021 applicants were able to perform rotations with their home institutions to build rapport and enhance their orthopaedic surgery knowledge. However, applicants were left without a critical way to maximize exposure to nonlocal programs<sup>2,8</sup>. Applicants use away rotation(s) to increase the probability of matching somewhere that is not their home institution, which may be in a geographical area away from their home institution<sup>2-8</sup>.

The COVID-19 pandemic created a challenge for applicants who hoped to match to a program in a different region or geographical location than their medical school. Medical student exposure to orthopaedic surgery as a specialty was limited. Therefore, applicants sought alternative methods, such as social media, online meet-and-greet events, and virtual rotations<sup>9-11</sup>. Applicants reported that social media content posted by residencies influenced their interest in programs<sup>9</sup>. Residency programs found social media to be more helpful than previous years and placed importance on virtual rotations during resident recruitment<sup>11</sup>. The authors believe that a lack of away rotations would lead to an observable difference in both geographic and affiliated program matching during the COVID-impacted match cycle because these virtual engagement opportunities were not universally adopted or sufficient to prevent programs and applicants from matching to programs they were most familiar with.

In this study, we analyze orthopaedic surgery residents matching in the same geographical location as their preresidency training and to residencies affiliated with their preresidency training by separating orthopaedic surgery residents into 2 groups: Pre-COVID and COVID-impacted. The purposes of this study were to (1) determine whether a difference existed between the groups when analyzing matching in the same geographic location (region, division, and state) as their medical school and (2) determine whether a difference existed between the groups when analyzing matching to residency programs affiliated with their preresidency training. The authors hypothesized (1) residencies in the same geographical areas as preresidency training would have an increased geographical (matching in same region, division, or state) match rate in the COVID-impacted cohort and (2) residents matching to a residency program affiliated with their preresidency training would match to home programs more frequently in the COVID-impacted cohort.

## Methods

### Study Design

This study was performed through collection and analysis of publicly available and deidentified information. Therefore, no Institutional Review Board approval was necessary. We obtained a list of accredited orthopaedic surgery residency programs from Doximity (n = 202)<sup>12</sup>. Doximity is a free social networking website for healthcare professionals that provides

tools to explore residency programs. Orthopaedic surgery residents were classified broadly into 2 categories based on their match year: Pre-Coronavirus-19 cohort (Pre-COVID, years 2016-2020) and COVID-impacted cohort (COVID-impacted, year 2021). The cohorts were chosen to compare residents matching under traditional circumstances (Pre-COVID) with those in nontraditional circumstances. Two inclusion criteria were required: residents attended medical school and matched to an orthopaedic surgery residency. To obtain Pre-COVID resident information, each orthopaedic residency program webpage was located. Eighty-six percent of the residency programs (174/202) had information available on their residency program website. Fourteen percent (28/202) did not have an available residency program website or residency roster or was not located. For each resident, medical school name and year of postgraduate training were recorded. Some program websites provided only the name of a resident and year in training. If a resident's medical school was not provided on the program website, their names were searched on Google, Doximity, or LinkedIn and used if available. COVID-impacted resident information was obtained similarly. The orthopaedic residency program webpages, social media accounts (residency program's Facebook, Twitter, and Instagram), and medical school match lists were all located. Their medical school and residency program were recorded. A medical school match list is sometimes provided by a medical school to report their newly matched fourth year medical students' training locations. Residency program webpages are usually not updated until a resident begins their training with an institution. The authors noted that residency program social media pages, largely a result of the 2021 Match, posted announcements regarding their incoming class. Excluded residents were those without verification of the attending medical school, without an identifiable location of their medical school, and graduates of international medical schools.

After data collection, each resident was assigned 1 of 4 regions, 1 of 9 divisions, and 1 of 50 states based on the US Census designation<sup>13</sup>. During data collection, it was noted that some medical schools have multiple campuses with locations in multiple states. Those attending a school in this category were also queried using Google, Doximity, or LinkedIn to identify campus location.

### Geographical Data Designations

Using the US Census Bureau geographical boundaries (region, division, and state), regions were assigned as follows: Northeast, Midwest, South, and West. The US Census Bureau sub-categorized regions into divisions. The Northeast region was divided into the New England and Middle Atlantic divisions. The Midwest region was divided into the East North Central and West North Central divisions. The South region was divided into the South Atlantic, East South Central, and West South Central divisions. The West region was divided into Pacific and Mountain divisions (Appendix A).

After geographical designations were assigned, each resident was assessed for same region, same division, same state

match. In other words, this means that the location of their residency program was the same location as their medical school (i.e., region, division, and state).

#### *Affiliated Program Match Designation*

We determined whether a hospital with an orthopaedic surgery residency program had an affiliated medical school. Hospital's educational affiliations were located, determined, and analyzed. Residents matching to a residency program sharing hospital affiliation with their medical school were designated. A match to an affiliated program acted as a surrogate for "home program."

#### *Statistical Analysis*

All data analyses were performed using Microsoft Excel. Descriptive statistics were performed. Two-tailed Student *t* tests were performed between the 2 groups. A Bonferroni adjustment was performed to account for multiple comparisons with all  $\alpha < 0.05$  considered significant.

#### **Results**

There were 4,832 residents analyzed (4,074 in Pre-COVID cohort; 758 in COVID-impacted cohort). Greater than 87% of all offered positions (758/868) in the 2021 Match were included and analyzed<sup>14</sup>. Thirteen percent of the offered positions (110/868) were not included because the information was unobtainable.

#### *Same Region Match*

In the Pre-COVID cohort, 61% of the students matched in a residency program in the same region as their medical school, which was not different ( $p = 0.532$ ) from the COVID-impacted cohort (62.1%).

#### *Same Division Match*

In the Pre-COVID cohort, 47.5% of the students matched in a residency program in the same division as their medical school, which was significantly less ( $p = 0.011$ ) than the COVID-impacted cohort (52.5%).

#### *Same State Match*

In the COVID-impacted cohort, significantly more students (39.6%;  $p < 0.001$ ) matched to a residency program in the same state as their medical school than the Pre-COVID cohort (33.1%).

The greatest increases in matching to a residency in the same state as their medical school were as follows: Wisconsin (40%), Colorado (25.9%), Alabama (21.9%), Oregon, (20%), Rhode Island (20%), Georgia (19.6%), Texas (18.9%), Missouri (16.3%), and Washington (14.8%) (Fig. 1).

#### *Affiliated Program Match*

In the COVID-impacted cohort, significantly more students (28.0%;  $p < 0.001$ ) matched to a residency program that is affiliated with their medical school than the Pre-COVID cohort (21.2%).

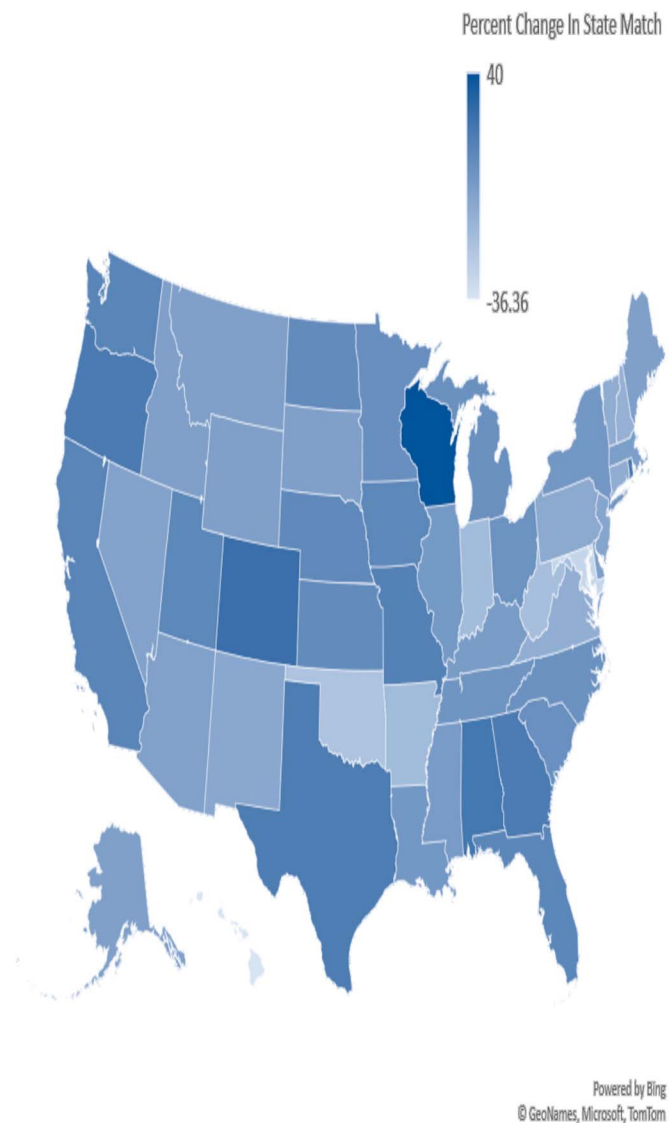


Fig. 1  
Orthopaedic surgery residents matching to the same state (percent change) between Pre-COVID (2016-2020) and COVID-impacted (2021) cohorts.

In the COVID-impacted cohort, students who stayed in the state matched to their home program more frequently (69.3%) compared with the Pre-COVID cohort (60.5%).

#### **Discussion**

The most important finding of this investigation is that orthopaedic surgery residency applicants in the COVID-impacted cohort were statistically significantly more likely to match into a residency program affiliated with their preresidency training. The hypothesis presented was valid for residents matching to a residency program in the same state and division as their preresidency training and to a residency program affiliated with their preresidency training. However, the hypothesis was false when evaluating matching to a program in the same region as the preresidency training of a resident. This investigation suggests that

online adaptations (virtual meet and greet, social media utilization, and virtual away rotations) are not a substitute for the in-person away rotation because the COVID-impacted cohort had significant increases in the same state, same division, and affiliated program match rate.

Novel relationship-building opportunities such as virtual open houses, residency recruitment through social media applications, and virtual away rotations have been identified by other studies during the 2021 recruitment cycle<sup>9-11,15,16</sup>. Brueggeman et al.<sup>15</sup> surveyed 2021 residency candidates and program directors to evaluate the impact of virtual recruitment and interviewing on the residency matching process. Program directors reported that residency candidate fit, social skills, clinical skills, surgical skills, and genuine interest in their specific program (i.e., applicant assessment) were more difficult to assess because of the lack of virtual recruitment and virtual interview process. Residency candidates (81%) and program directors (79%) both reported that in-person interviews were their preference over the virtual format. Although the lack of in-person relationship building opportunities may be viewed as a negative to applicants and residency programs, a small benefit of this change was identified by both Brueggeman et al.<sup>15</sup> and Gordon et al.<sup>16</sup>. These investigations identified monetary savings for residency applicants because of the newly implemented virtual format and lack of away rotations<sup>15,16</sup>. It is unclear which changes are “here to stay” and which will be discontinued when the COVID-19 pandemic does not necessitate alterations in resident recruitment.

Several other highly competitive specialties, including plastic surgery, otolaryngology, and dermatology, where away rotations were commonplace identified similar increases in home program match outcomes<sup>17-19</sup>. Asadourian et al.<sup>17</sup> investigated geographic trends of plastic surgery residency match during the COVID-19 pandemic categorizing their cohorts the same (2016-2020 compared with 2021) as the presented investigation. They identified a statistically significant increase in home program matching from 24.1% in their Pre-COVID cohort to 36% in their COVID-impacted cohort. They noted a statistically significant increase in applicants matching in the same region as their preresidency training in the COVID-impacted cohort (61.1% in COVID-impacted, 50.2% in Pre-COVID). This difference was statistically insignificant after removing applicants who matched to their home program. They did not identify a statistically significant difference for applicants who matched into the same state as their preresidency training. Their team attributed the observed difference to a lack of in-person opportunities outside of the applicant's home program. Bernstein et al.<sup>18</sup> investigated geographic trends and home program match trends of otolaryngology during the COVID-19 pandemic and identified a statistically significant increase from the 2020 match to the 2021 match (22% in 2020 to 30% in their COVID-impacted group). Their study did not identify any geographic differences in matching between the cohorts. Mulligan et al.<sup>19</sup> compared dermatology home program and same region match trends from different years spanning from 2007 through 2018 to compare with the 2021

dermatology match. A statistically significant increase from 29.8% in the Pre-COVID group to 38.2% in the COVID-impacted group was identified when examining matching to a home program, but no statistically significant difference was identified when matching within the same region. When comparing with this investigation, otolaryngology represents a specialty that had the most similar home program match outcomes before and during the COVID-19 pandemic. Plastic surgery seems to have had the greatest increase in percentage of students matching to a home program. The studies failed to identify consistent differences at the geographic level when comparing COVID-impacted groups with applicants in previous matches. All 3 studies concluded that lack of face-to-face interaction, such as virtual interviews and lack of away rotations, may have played a role in their observed findings. Although correlation does not equal causation, statistically significant increases in residency applicants matching to a home institution were observed in multiple fields (dermatology, otolaryngology, plastic surgery, and orthopaedic surgery) that are traditionally competitive with the loss of the traditional away rotation format in the year 2021<sup>17-19</sup>.

Although it was beyond the scope of this study to investigate the reasons behind the differences in the reported results of this investigation, there are several factors to be considered from both applicant and program perspectives. One major difference between the cohorts in this investigation was a lack of away rotations with the pandemic. Away rotations are an opportunity for applicants to express interest in a program and a way for programs to evaluate visiting students and how they fit with their program<sup>2,3</sup>. Applicants of competitive specialties, such as orthopaedic surgery, traditionally completed at least 1 away rotation. One assumption is that without away rotations, applicants were no longer able to more closely examine programs other than their home program, limiting the likelihood of ranking outside programs as highly as their own. It is also possible that residency programs ranked students from their own institution higher because they were able to evaluate those students on their services. Another possible factor is the impact of virtual interviews. In-person interviews give applicants an opportunity to tour the hospital and observe interactions between the residents and the faculty, both of which are a shortcoming of virtual interviews. This could potentially lead to a difference in how programs are ranked by applicants and vice versa. This rationale, although unable to be proven by the presented investigations, would make it more likely to match students in the same program, state, and division.


A limitation of this observational study is a lack of complete data for all matched students in orthopaedic surgery and program websites that reflect the medical school of current residents. A previous study in 2018 evaluated geographic trends in matching within the same geographical designations and reported a same state match rate of 31% and affiliated program match rate of 21%<sup>6</sup>. When compared with this investigation's pre-COVID data, similar same state and affiliated program match rates (33.1% and 21.2%) were identified. There is also

only 1 year of information available for COVID-impacted data. In addition, there is a paucity of information regarding the impact of virtual interviewing on the orthopaedic surgery match process during 2020 to 2021<sup>10,11,18,19</sup>. Even if such data existed, the extreme variability in the structure of each virtual rotation would require further analysis based on offerings of the rotation. This study is unable to determine whether these quantifiable differences are due to residency program or applicant preferences in the match process (i.e., whether either an applicant or residency program changed how they ranked based on the changes in the COVID-impacted match cycle). In addition, the authors were unable to identify studies investigating a phenomenon known as “interview hoarding,” where the virtual interview format allows top tier applicants accept all interviews.

### Conclusion

This study determined that orthopaedic surgery residency applicants during the COVID-impacted cycle were more likely to match to their home state, division, and program than applicants pre-COVID. Further research is warranted to determine the reasons for this change because it could benefit both applicants and residency programs.

### Appendix

 Supporting material provided by the authors is posted with the online version of this article as a data supplement at [jbjs.org \(http://links.lww.com/JBJSOA/A405\)](http://links.lww.com/JBJSOA/A405). This content was not copyedited or verified by JBJS. ■

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