



## AOA Critical Issues in Education

# Identification of Factors Associated with Orthopaedic Surgery Residency Programs That Preferentially Match Students Who Performed an Elective Rotation Before the Interview Process

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**Introduction:** The role of elective rotations in the orthopaedic residency selection process varies between programs. Our study aims to identify factors associated with residency programs that interview and match a greater proportion of applicants who have completed an elective rotation with their program.

**Methods:** Data were collected through the American Orthopaedic Association's Orthopaedic Residency Information Network database. Bivariate correlations and multivariate regression models were used to identify independent predictors of programs with a greater proportion of interviewees or residents who completed an elective rotation at the respective program.

**Results:** One hundred seventy-eight of the 218 existing residency programs were included in this study. Programs that offered fewer interviews and more away rotation positions per year were associated with a greater odds of its interviewees (OR = 0.36,  $p = 0.01$ ; OR = 4.55,  $p < 0.001$ , respectively) and residents (OR = 0.44,  $p = 0.04$ ; OR = 4.23,  $p < 0.001$ , respectively) having completed an elective rotation with the program. In addition, programs with fewer attendings (OR = 0.39,  $p = 0.03$ ) and in-person interviews (OR = 3.04,  $p = 0.04$ ) matched a greater proportion of their rotators. However, programs that interviewed applicants during the elective rotation were less likely to match their rotators (OR = 0.35,  $p = 0.04$ ).

**Conclusion:** Certain program characteristics independently predict the likelihood of a program interviewing and matching their rotators. These findings may provide information for applicants and programs regarding the rotation process.

**Level of Evidence:** III.

**Disclosure:** The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (<http://links.lww.com/JBJSOA/A624>).

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## Introduction

Orthopaedic surgery continues to be one of the most competitive residencies for graduating medical students<sup>1,2</sup>. In 2023, the orthopaedic surgery match rate was 63% among all applicants for postgraduate year one positions<sup>3</sup>. Programs have historically relied on factors such as class rank, clinical grades, Alpha Omega Alpha status, US Medical Licensing Examination (USMLE) scores, and research productivity to judge an applicant's competitiveness, with each program placing a varying degree of emphasis on different components of the application<sup>4</sup>.

Elective rotations have also been ranked by orthopaedic residency program directors (PDs) as one of the most influential factors when considering potential applicants<sup>5</sup>. PDs and students view the elective rotation as an opportunity to assess whether an applicant is a "good fit" for that program and as a means of differentiating themselves from other candidates with comparable objective profiles<sup>6,7</sup>. In a survey of 312 matched applicants, 60% reported matching at a program with which they had completed an orthopaedic rotation, indicating that students are 1.5 times more likely to match at a program they have rotated with<sup>8</sup>. The importance of the elective rotation is also expected to increase in the 2024 match with the recent transition of USMLE Step 1 to pass/fail<sup>9</sup>. However, the structure and emphasis of the elective rotation are variable between different orthopaedic residency programs<sup>7</sup>. For instance, some programs invite the majority of their rotators to interview, whereas other programs do not give rotators any increased preference<sup>6,7</sup>.

Despite this variability, no previous study has investigated program characteristics associated with an increased proportion of residents who had performed an elective rotation. Strengthening one's competitiveness to match at a desired program has been ranked as the most important factor by applicants in arranging their away rotations<sup>6</sup>. Thus, it is important for students to be aware of which programs are more likely to match residents who completed an elective rotation because this information may help students in allocating their rotation blocks and preference signals, as well as formulating their rank lists. Although each applicant is given 30 signals to indicate interest, selecting a program as one of their 2 to 4 possible away rotations is considered one of the strongest signals an applicant can convey<sup>10</sup>. In this study, we sought to identify the attributes of residency programs that match a greater proportion of their rotators, with the aim of helping to guide students during the rotation and residency application process.

## Materials and Methods

Data used in this study were gathered from the American Orthopaedic Association's Orthopaedic Residency Information Network (ORIN)<sup>11</sup>. This database provides deidentified residency program information sourced directly from program leadership of all Council of Orthopaedic Residency Directors member orthopaedic surgery residency programs within the United States, accounting for 82% of all existing programs. All extracted data are publicly available on the ORIN database, making our study exempt from institutional review board

approval. No funding source was provided for the completion of this study.

Data were extracted between February 20, 2023, and March 5, 2023, by 2 authors, independently, for each program within the ORIN database. The following data points were extracted to be used as estimates of a program's relative emphasis on rotations in the residency selection process: percent of residents who completed an elective rotation at the same program and percent of interviews granted to students who completed an elective rotation at the same program. Students completing an "elective rotation" included both away rotators and home rotators from the program's associated medical school because ORIN does not distinguish between the 2 for these dependent variables of interest. In addition, data were extracted for the following variables to be assessed as possible predictors of a program's relative emphasis on rotations: program location, number of residents, number of attendings, weeks allocated for dedicated research time during residency, percent of residents from associated medical school, number of applicants per year, number of interviews per year, number of away rotators per year, number of away rotators per rotation, number of months available for away rotations, if programs offered virtual or in-person interviews, and whether rotators were interviewed during the rotation. No programs were excluded from the study.

Variables were filled using the multiple imputation technique for missing data to allow for a robust multivariate regression analysis<sup>12</sup>. Bivariate Pearson correlation was first performed to assess for associations between continuous program attributes and the percent of interviewees or residents who were rotators. Student *t* tests and analysis of variance were used to compare categorical program attributes. Variables that were statistically significant in the bivariate analysis, as well as number of attendings and number of residents, were then included in a multivariate model. For regression analysis, all included continuous variables were grouped into dichotomous variables as greater or less than the respective median value. Multiple logistic regression was performed to evaluate the effect of various residency program attributes as an independent predictor of rotators comprising a greater proportion of interviewees or residents at a given program. Adjusted odds ratios were calculated to quantify the effect. All statistical analysis was conducted using IBM SPSS Statistics software (IBM, Version 27). A *p* value < 0.05 was set as the threshold for statistical significance.

## Results

### Program Attributes

A total of 178 of the 218 existing residency programs were reported within the ORIN database and included in this analysis. Among all included data points, there was a total of 16.3% missing values before imputation. The number of programs reporting each data point before multiple imputation is reported in Table I. The percentage of a program's interviewees who completed an elective rotation with the respective program ranged from 0% to 100%, with a median of 25.0%. The percentage of a program's residents who completed an elective

rotation with the respective program ranged from 0% to 100%, with a median of 46.0%. A complete description of all program attributes is available in Table I.

### Factors Associated with Proportion of Rotators Among Interviewees/Residents

The proportion of elective rotators among a program's interviewees was positively correlated with the number of rotator positions available per year and the number of away rotators per rotation ( $r = 0.32$ ,  $p < 0.001$ ;  $r = 0.27$ ,  $p < 0.001$ , respectively), but was negatively correlated with the number of applications received and interviews offered per year ( $r = -0.29$ ,  $p < 0.001$ ;  $r = -0.36$ ,  $p < 0.001$ , respectively) (Table II). Applicants who completed an elective rotation with a program

made up a significantly greater proportion of interviewees at programs offering in-person interviews (40.7% vs. 26.3%,  $p < 0.001$ ), whereas programs that completed interviews virtually or during the elective rotation had a significantly lower percentage of interviewees who rotated with their program (28.4% vs. 39.8%,  $p < 0.01$ ; 22.0% vs. 32.4%,  $p = 0.01$ , respectively). Among the 29 programs that interviewed applicants during their rotation, only 4 did not offer an interview to all their rotators. In addition, these programs performed an average of 18.5 more interviews per year compared with programs that did not interview during the rotation (76.5 vs. 58.0,  $p < 0.001$ ), explaining why rotators still comprised a lesser proportion of interviewees.

In regard to the percentage of a program's residents who rotated with the respective program, there was a positive correlation with the number of rotator positions available per year and the number of away rotators per rotation, as well as the percentage of residents from the associated medical school ( $r = 0.26$ ,  $p < 0.001$ ;  $r = 0.25$ ,  $p < 0.001$ ;  $r = 0.18$ ,  $p = 0.02$ , respectively). On the other hand, there was a negative correlation with the number of interviews that a program offered per year ( $r = -0.28$ ,  $p < 0.001$ ) (Table II). A program's residents were significantly more likely to have rotated with the institution at programs offering in-person interviews (55.5% vs. 43.5%,  $p < 0.01$ ), whereas rotators composed a lesser percentage of a program's residents when interviews were conducted virtually or during the elective rotation (44.0% vs. 55.5%,  $p = 0.01$ ; 36.9% vs. 48.5%,  $p = 0.01$ , respectively).

### Independent Predictors of Programs That Preferentially Interview/Match Rotators

After controlling for potential confounding program attributes from the bivariate analysis, programs allotting a greater proportion of interviews for rotators were independently predicted by fewer total interviews per year and more total rotator positions per year (OR = 0.36,  $p = 0.01$ ; OR = 4.55,  $p < 0.001$ , respectively). Programs that matched a greater percentage of their rotators were independently predicted by fewer number of attendings (OR = 0.39,  $p = 0.03$ ), fewer interviews offered per year (OR = 0.44,  $p = 0.04$ ), more rotator positions offered per year (OR = 4.23,  $p < 0.001$ ), in-person interviews (OR = 3.04,  $p = 0.04$ ), and interviews not conducted during the elective rotation (OR = 0.35,  $p = 0.04$ ) (Table III).

### Discussion

In this study, we identify the key attributes of orthopaedic surgery programs that are more likely to interview and match applicants who have completed a rotation at their program. Predictors of a program interviewing and matching a greater proportion of their rotators included more rotator positions offered per year and less interviews offered per year. Matching a greater percentage of rotators was also predicted by less attendings, offering in-person interviews, and interviews not being conducted during the rotation. Although ORIN does not distinguish between home vs. away elective rotations, these findings remained statistically significant after controlling for

**TABLE I** Descriptive Statistics of Included Program Attributes

	Programs Reported <sup>a</sup>	Median (Range)/N (%) <sup>b</sup>
Location	173	—
Midwest	—	45 (26.0%)
Northeast	—	49 (28.3%)
Southeast	—	36 (20.8%)
Southwest	—	18 (10.4%)
West	—	24 (13.9%)
Canada	—	1 (0.6%)
No. of attendings	166	26 (3-145)
No. of residents	178	21 (3-72)
Weeks of dedicated research time	141	8 (0-52)
% of residents from associated medical school	137	20 (0-100)
No. of interviews/yr	158	60 (4-130)
No. of applicants/yr	161	700 (30-1,000)
No. of away rotators/yr	139	20 (2-90)
No. of away rotators/rotation	140	4 (1-18)
No. of months available for rotations	134	5.5 (1-12)
Virtual interviews (Y/N)	148	120 (81.1%)
In-person interviews (Y/N)	148	45 (30.4%)
Interview during the rotation (Y/N)	167	29 (17.4%)
% of interviewees who completed an elective rotation at the same program	131	25 (0-100)
% of matched residents who completed an elective rotation at the same program	117	46 (0-100)

<sup>a</sup>Refers to number of programs in which variable was reported before multiple imputation. <sup>b</sup>Continuous variables described as median (range); categorical variables described as N (%).

TABLE II Pearson Correlation Analysis for Percent Interviewees/Matched Residents Having Rotated With the Program

	% of Interviewees Who Completed an Elective Rotation at the Same Program		% of Matched Residents Who Completed an Elective Rotation at the Same Program	
	Correlation Coefficient	p	Correlation Coefficient	p
Location	0.52	0.76	1.39	0.23
No. of attendings	0.06	0.44	-0.05	0.52
No. of residents	-0.07	0.39	-0.03	0.72
Weeks of dedicated research time	-0.05	0.54	0.15	0.05
% of residents from associated medical school	0.05	0.55	0.18	<b>0.02</b>
No. of interviews/yr	-0.36	<b>&lt;0.001</b>	-0.28	<b>&lt;0.001</b>
No. of Applicants/yr	-0.29	<b>&lt;0.001</b>	-0.10	0.17
No. of away rotators/yr	0.32	<b>&lt;0.001</b>	0.26	<b>&lt;0.001</b>
No. of away rotators/rotation	0.27	<b>&lt;0.001</b>	0.25	<b>&lt;0.001</b>
No. of months available for rotations	0.01	0.96	-0.04	0.57

Bold = statistically significant.

the percent of residents from the associated medical school in our regression model. Therefore, these findings are likely in fact predictive of programs that preferentially interview and match their away rotators. With PDs reporting that away rotations solely improve an applicant's competitiveness at the specific program where they complete the rotation, it is important for applicants to be strategic in selecting where to apply<sup>6</sup>. Behind a letter of intent, choice of away rotations are considered the strongest signal of interest an applicant can convey<sup>10</sup>. Thus, it is our hope that these findings may help to guide students in creating a more structured approach to allocating their away rotation applications. Our results may also provide strategies

for programs to better recruit rotators or nonrotators in accordance with their respective because experiences during the elective rotation have been listed as the most important factors for applicants when developing their rank lists<sup>13</sup>.

Residency programs with greater than 26 attendings or 60 interviews offered per year both negatively predicted the percentage of a program's residents who completed a rotation at the respective program. For programs offering more interviews per year, it is logical for rotators to comprise a smaller proportion of interviewees and residents because of there being a larger pool of applicants under significant consideration. On the other hand, programs with more attendings matching a lesser percentage of

TABLE III Multiple Logistic Regression Analysis for Percent Interviewees/Matched Residents Having Rotated with the Program

	% of Interviewees Who Completed an Elective Rotation at the Same Program		% of Matched Residents Who Completed an Elective Rotation at the Same Program	
	OR (95% CI)	p	OR (95% CI)	p
No. of attendings	1.10 (0.49-2.47)	0.82	0.39 (0.17-0.89)	<b>0.03</b>
No. of residents	0.87 (0.37-2.06)	0.75	1.10 (0.48-2.53)	0.83
% of residents from associated medical school	1.38 (0.70-2.74)	0.35	1.20 (0.61-2.36)	0.59
No. of interviews/yr	0.36 (0.16-0.80)	<b>0.01</b>	0.44 (0.20-0.96)	<b>0.04</b>
No. of applicants/yr	0.51 (0.24-1.09)	0.08	1.48 (0.71-3.08)	0.29
No. of away rotators/yr	4.55 (2.00-10.46)	<b>&lt;0.001</b>	4.23 (1.86-9.65)	<b>&lt;0.001</b>
No. of away rotators/rotation	2.26 (0.98-5.17)	0.06	1.42 (0.64-3.15)	0.40
Virtual interviews (Y/N)	1.17 (0.44-3.06)	0.76	1.26 (0.50-3.19)	0.62
In-person interviews (Y/N)	1.91 (0.66-5.51)	0.23	3.04 (1.08-8.57)	<b>0.04</b>
Interview during the rotation (Y/N)	0.43 (0.17-1.10)	0.08	0.35 (0.13-0.93)	<b>0.04</b>

CI = confidence interval, and OR = odds ratio. Bold = statistically significant.

rotators may be explained by limited interaction between rotators and the entirety of a program's department throughout the sub-internship. Evaluation of students' performance during the rotation is largely provided by the attendings and residents on service<sup>7</sup>. However, programs with a larger faculty may only allow for a subset of attending surgeons to gain first-hand assessment of the applicant. Therefore, it is possible that rotating at such programs may hold relatively less weight in the selection process. Interaction with a smaller proportion of a department's attendings may also limit the applicant's ability to assess fit and negatively affect where the program falls on their rank list. Programs seeking to better recruit their rotators may consider actively facilitating contact between students and as many faculty as possible.

Programs that offered a greater number of away rotator positions per year interviewed and matched a greater proportion of rotators. Although the availability of resources is a limiting factor in the number of away rotators a program can accept<sup>7</sup>, this finding remained significant despite our model accounting for differences in program size, as measured by the number of residents and attendings. It is possible that programs with more rotator positions available place greater consideration on the rotator experience and the ability to assess applicant qualities that are conveyed through direct interaction. Program leaders agree that in-person rotations provide the best opportunity to evaluate how an applicant would integrate in their program, as well as an applicant's work ethic, social skills, and "grit."<sup>6,7,14</sup> Therefore, an applicant may benefit the most from rotating at programs that have demonstrated an emphasis on the assessment of such self-discipline and interpersonal skills, through the creation of more in-person rotation opportunities.

Programs offering in-person interviews may be another indicator of the relative weight that a program places on such applicant characteristics. According to PDs, in-person interviews offer an opportunity to better assess subjective traits such as candidate fit/interest and commitment to orthopaedics<sup>15,16</sup>. Despite Association of American Medical Colleges (AAMC) guidelines to conduct virtual interviews for this past year's application cycle, 31.6% of PDs report the value of in-person interviews to be insurmountable and intend to continue offering interviews in-person<sup>16</sup>. Programs that elect to forgo the AAMC's guidelines likely place greater value in assessing applicants' character and social interaction, as well as the opportunity to demonstrate their program's culture to the applicant. In addition to in-person interviews, assessment of such interpersonal skills is most effectively done through clinical rotations<sup>17</sup>. Our study found that programs offering in-person interviews matched a greater percentage of their rotators. Therefore, it seems that programs creating more opportunities to interact with applicants face-to-face, through more rotation positions or in-person interviews, are those most likely to strongly consider applicants who have rotated with their program. Further development of away rotation scholarships may also help facilitate in-person interaction by alleviating the significant financial burden associated with away rotations<sup>18</sup>.

Interestingly, programs that conducted interviews during the elective rotation ultimately matched a lower percent of rotators. This could possibly be attributed to underperformance

during the interview because of having less time for preparation. Subsequently, rotators may also be deterred from ranking the program highly. From the rotator's perspective, 58% prefer to return to interview with all other applicants, whereas only 41.6% prefer to interview solely during their rotation<sup>19</sup>. This is also an important consideration for PDs seeking to modify their interview process to better recruit desirable rotators. Although returning to interview creates added costs<sup>8,20</sup>, applicants may prefer the opportunity to more suitably prepare for the interview after having time to learn about the program and debrief their experience. This also allows applicants to directly interact with more of the program's faculty and residents during the designated interview dates and remain fresh in the minds of the selection committee at the time of rank list formulation.

This study is not without limitations. First, the ORIN database is a self-reported database and is dependent on the information that programs elected to share. As a result, not all programs directly reported our variables of interest, which led to 16.3% of missing data. Statistical guidelines on managing missing data suggest that exclusion of missing values beyond 5% to 10% may bias results because of underestimation of effect size. Instead, use of multiple imputation, as performed in our study, is recommended to provide the most flexible valid analytic approach when the proportion of missing data does not exceed 40%<sup>12,21,22</sup>. However, it is important to consider the possibility that data may be missing not completely at random because of selective non-reporting by programs. For instance, programs that exclusively match rotators or do not match any rotators at all may elect to withhold this data because of concern of hindering interest in their program. Second, program information is not uniformly updated within the ORIN database, making it possible for certain data points to be outdated. This is especially important to consider with programs continuing to transition back to in-person interviews after the pandemic. As more programs begin to return to in-person interviewing, this may become a weaker metric for applicants to gauge a program's relative emphasis on rotations. Third, the ORIN does not distinguish between home and away elective rotations, which is important to consider given that these applicants may be uniquely compared in the match process. Although our analytic approach attempts to differentiate the 2 by controlling for percent of residents from the associated medical school, future study is needed to truly ascertain how these findings may vary for home vs. away rotators. Last, the dependent variables used in our study, percent interviewees and percent residents who rotated at the institution, are imperfect measurements of how highly a program values completing a rotation with them and should only be interpreted as estimates. For instance, these measures may be negatively skewed by poor performance of applicants during a rotation, despite a program highly valuing this component of the application. Similarly, applicants may learn that a program is not optimal for them after rotating and ultimately not rank the program highly.

## Conclusions

The findings of our study may help to serve as a baseline guide for students in determining which away rotations would

most significantly increase their likelihood of matching. However, when deciding where to rotate, it is important for applicants to think holistically and also consider if a program seems to be a good fit for them. The ORIN database offers a novel and robust data source that applicants should use to learn about programs and help guide them in making informed decisions of where to complete away rotations and allocate preference signals. ■

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