THE ORTHOPAEDIC FORUM

A Comparison of Matched and Unmatched Orthopaedic Surgery Residency Applicants from 2006 to 2014: Data from the National Resident Matching Program

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Background: The Association of American Medical Colleges publishes residency match data and reports through the National Resident Matching Program (NRMP) every year. The purpose of this study was to analyze trends in orthopaedic surgery residency matching data and characteristics of successful applicants to counsel medical students with regard to their chances of matching.

Methods: The annual reports of the NRMP were searched annually from 2006 to 2014 to determine the number of orthopaedic surgery residency positions available, the number of applicants, and the match rate among applicants. Comparisons were performed between matched applicants and unmatched applicants with regard to the number of contiguous ranks and distinct specialties, United States Medical Licensing Examination (USMLE) scores, number of research experiences and research products (abstracts, presentations, posters, publications), and proportion of Alpha Omega Alpha (AOA) Honor Medical Society members and students at a top-40, National Institutes of Health (NIH)-funded medical school.

Results: The number of orthopaedic surgery positions available and number of applicants increased at a mean rate of 9 positions and 65 applicants per year ($p = 0.11$). The mean number of contiguous ranks for U.S. senior medical students was 11.5 for those who matched and 5.5 for those who did not match ($p < 0.0001$). The USMLE scores for applicants who matched were significantly greater than for those who did not match in each category: Step-1 scores for U.S. seniors ($p < 0.001$) and independent applicants ($p = 0.039$), and Step-2 scores for U.S. seniors ($p < 0.01$) and independent applicants ($p = 0.026$). The mean number of research products was significantly greater for matched U.S. seniors compared with unmatched U.S. seniors ($p = 0.035$). A significantly higher proportion of matched U.S. seniors compared with unmatched U.S. seniors were AOA members and students at a top-40, NIH-funded medical school (both $p < 0.0001$).

continued

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Conclusions: Successful applicants in the Match for orthopaedic surgery residency have higher USMLE Step-1 and 2 scores, number of research experiences and research products, and contiguous ranks. A higher proportion of successful applicants are AOA members and students at a top-40, NIH-funded medical school.

The Association of American Medical Colleges (AAMC) publishes residency match data and reports through the National Resident Matching Program (NRMP) every year. Orthopaedic surgery is one of the most competitive subspecialties for residency applicants[1-6]. Multiple studies have determined the most important attributes for successfully matching into orthopaedic surgery residency programs[6-9]. In one study, Karnes et al.[10] hypothesized that the increased competition is a misconception likely based on the increased importance of objective criteria in selecting candidates for interviews because of an increased number of applications per candidate. Other studies[11-13] have analyzed how well orthopaedic surgery residency applicants are screened and are selected. Rinard and Mahabir[6] studied the effect that various factors had on applicants' Match success using data from the 2007 and 2009 Matches. The current study builds on the former study with data from the 2011 and 2014 Matches and provides a statistical analysis to rank the importance of the number of contiguous ranks, number of ranked distinct specialties, and additional degrees held by applicants. In addition, this study provides information on important differences between matched and unmatched U.S. seniors compared with independent applicants. The purpose of this study was to analyze trends in orthopaedic surgery residency matching data and characteristics of successful applicants to counsel medical students with regard to their chances of matching.

Materials and Methods

The NRMP publishes annual reports of main Match data. There have been five editions of Charting Outcomes in these Match reports that provide characteristics and qualifications of applicants who matched to their preferred specialty published in 2006, 2007, 2009, 2011, and 2014. The data categorized in the 2006 edition were organized differently than in later editions and therefore were not included in our analysis. These data are publicly available (http://www.nrmp.org/match-data/nrmp-historical-reports/). The annual reports of the NRMP were searched each year from 2006 to 2014 to determine the number of orthopaedic surgery programs available, the number of applicants, and the Match rate among applicants. These reports include separate data on U.S. senior medical students and independent applicants. Independent applicants were defined as any non-U.S. senior allopathic medical student applicant at the time of application submission. This may have included foreign applicants, U.S. citizens graduating from a foreign medical

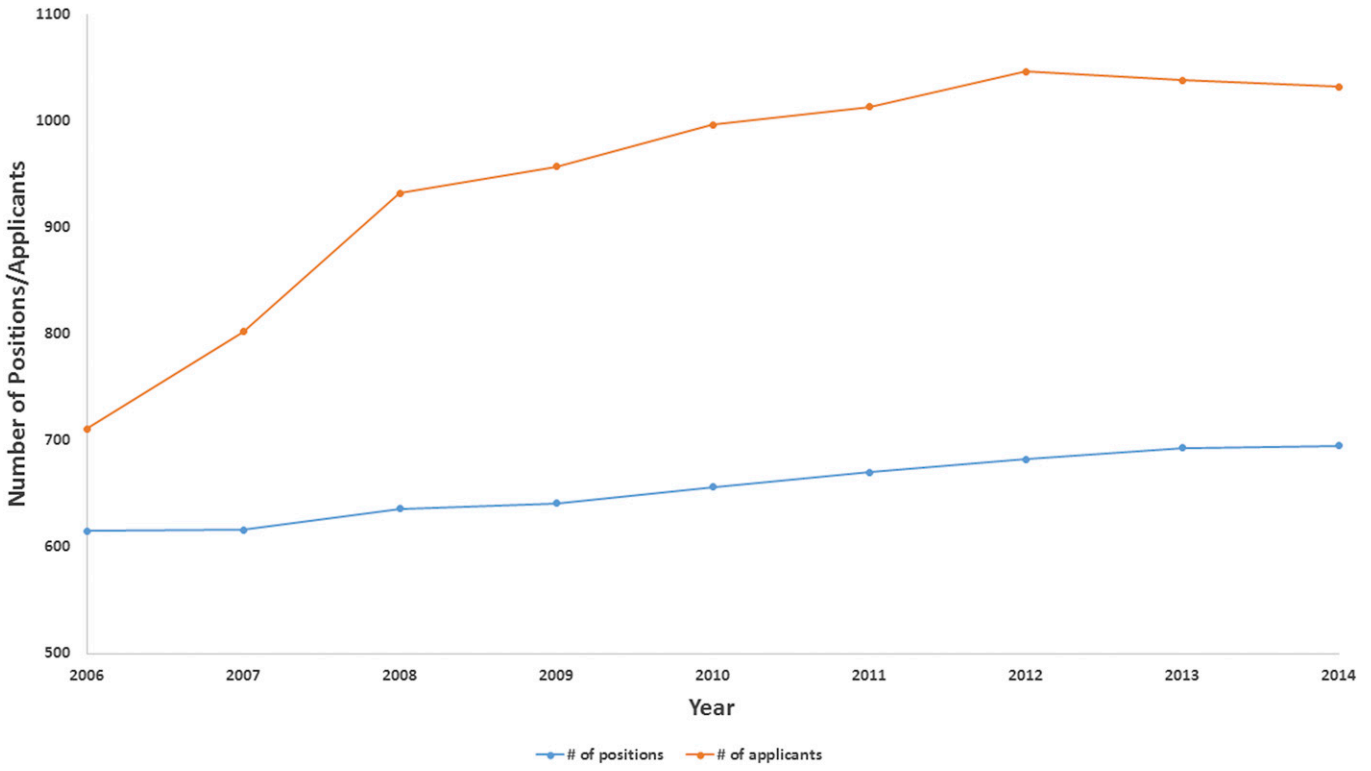

Fig. 1
The number of PGY-1 orthopaedic surgery residency positions available and the total number of applicants from 2006 to 2014.

school, students at an osteopathic medical school, and U.S. medical school graduates who either had not matched the year prior or had been residents in another specialty (e.g., preliminary surgery) at the time of application submission.

Applicants who matched were compared with those who did not match with regard to the number of contiguous ranks, distinct specialties to which an applicant applied, United States Medical Licensing Examination (USMLE) Step-1 and Step-2 scores, research experiences, work experiences, volunteer experiences, number of research products (abstracts, presentations, posters, and publications), as well as proportion of Alpha Omega Alpha (AOA) Honor Medical Society members, doctoral (PhD) degree holders, and graduates of a top-40, National Institutes of Health (NIH)-funded medical school. Each research experience was defined as a unique experience conducting clinical or basic science research. Research products were defined as the total number of abstracts, presentations, posters, and publications by an applicant. Contiguous ranks were defined as the number of programs ranked within one specialty by an applicant. Distinct specialties are defined as the number of different specialties ranked by a single applicant (e.g., 2 for an applicant who lists both orthopaedic surgery and general surgery programs on the rank list).

Chi-square tests were used to determine significant differences in dichotomous variables and paired t tests were used to determine significant differences in continuous variables between applicants who matched and those who did not match. A paired t test was used to determine a significant difference between the change in the number of applicants each year compared with the change in the number of postgraduate year-1 (PGY-1) positions available, as well as to compare differences in Step-1 and Step-2 scores between orthopaedic surgery applicants and all specialties combined.

Results

The number of orthopaedic surgery residency PGY-1 positions available increased every year, and the number of applicants increased every year from 2006 to 2012 and then decreased in 2013 and 2014 (Fig. 1). The number of positions available increased at a mean rate of 9 positions per year, and the number of applicants increased at a mean rate of 65 applicants per year ($p = 0.11$).

USMLE Scores

During the years in which Charting Outcomes of the Match were available (2007, 2009, 2011, and 2014), the mean USMLE Step-1 score (and standard deviation) for matched U.S. seniors (239 ± 4.6 points) was significantly greater ($p < 0.001$) than that of unmatched U.S. seniors (223 ± 6.3 points) (Fig. 2). The mean USMLE Step-1 score of matched U.S. seniors increased each time the Charting Outcomes of the Match were published: 234 points in 2007, 238 points in 2009, 240 points in 2011, and 245 points in 2014. The mean Step-1 score was 227 ± 7.0 points for matched independent applicants compared with 220 ± 5.7 points for unmatched independent applicants ($p = 0.039$). The mean Step-1 scores for matched U.S. seniors were significantly greater than scores for matched independent applicants ($p < 0.01$) and unmatched independent applicants ($p < 0.001$).

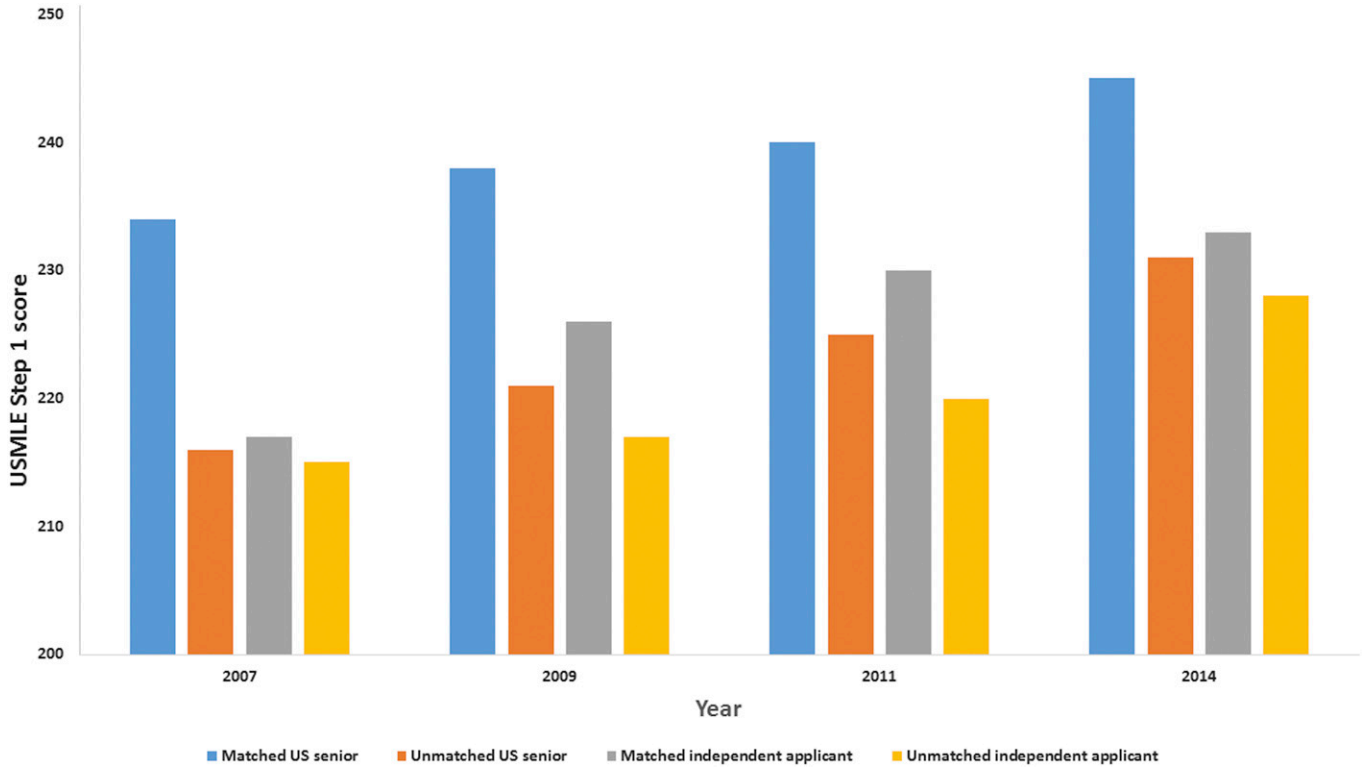

Fig. 2

The mean USMLE Step-1 scores for matched and unmatched U.S. seniors and independent applicants. Significant differences were found between matched and unmatched U.S. seniors ($p < 0.001$), matched and unmatched independent applicants ($p = 0.039$), matched U.S. seniors and independent applicants ($p < 0.01$), unmatched U.S. seniors and independent applicants ($p = 0.032$), and matched U.S. seniors and unmatched independent applicants ($p < 0.001$).

The mean USMLE Step-2 scores were significantly greater for matched U.S. seniors and independent applicants when compared with unmatched U.S. seniors ($p < 0.01$) and independent applicants ($p = 0.026$). The mean USMLE Step-2 scores rose each time the Charting Outcomes of the Match were published for each group, except for unmatched independent applicants between 2007 and 2009 (Fig. 3). The mean Step-2 scores for matched U.S. seniors were higher than scores for matched independent applicants ($p < 0.01$) and unmatched independent applicants ($p < 0.01$). Matched independent applicants had higher Step-2 scores than unmatched U.S. seniors ($p = 0.031$).

Contiguous Ranks and Distinct Specialties

The mean number of contiguous ranks for a U.S. senior matching into an orthopaedic surgery residency program was 11.5 compared with 5.5 for an unmatched U.S. senior ($p < 0.0001$). The mean number of contiguous ranks for matched U.S. seniors increased from 11.0 in 2007 to 12.1 in 2014. The mean number of contiguous ranks was 4.9 for a matched independent applicant compared with 2.8 for an unmatched independent applicant ($p < 0.01$).

The mean number of ranked distinct specialties was 1.1 for matched U.S. seniors and 1.3 for unmatched U.S. seniors ($p < 0.01$). The mean number of distinct specialties listed was 1.3 for matched independent applicants and 2.9 for unmatched independent applicants ($p = 0.043$).

Research

The mean number of research products (abstracts, presentations, posters, and publications) was significantly greater for matched U.S. seniors than for unmatched U.S. seniors ($p = 0.035$) (Fig. 4). A nonsignificant difference was seen with regard to research products between matched and unmatched independent applicants ($p = 0.20$). Unmatched U.S. seniors had fewer research products than unmatched independent applicants ($p = 0.035$). Matched U.S. seniors and matched independent applicants had more research experiences when compared with unmatched U.S. seniors ($p = 0.010$) and unmatched independent applicants ($p = 0.027$).

Other Factors

Overall, the most important factors for determining Match success among U.S. seniors were AOA membership, graduation from a top-40, NIH-funded medical school, number of contiguous ranks, and USMLE Step-1 score (Table I). The number of contiguous ranks, USMLE Step-2 score, and number of research experiences were the most important determinants for independent applicants.

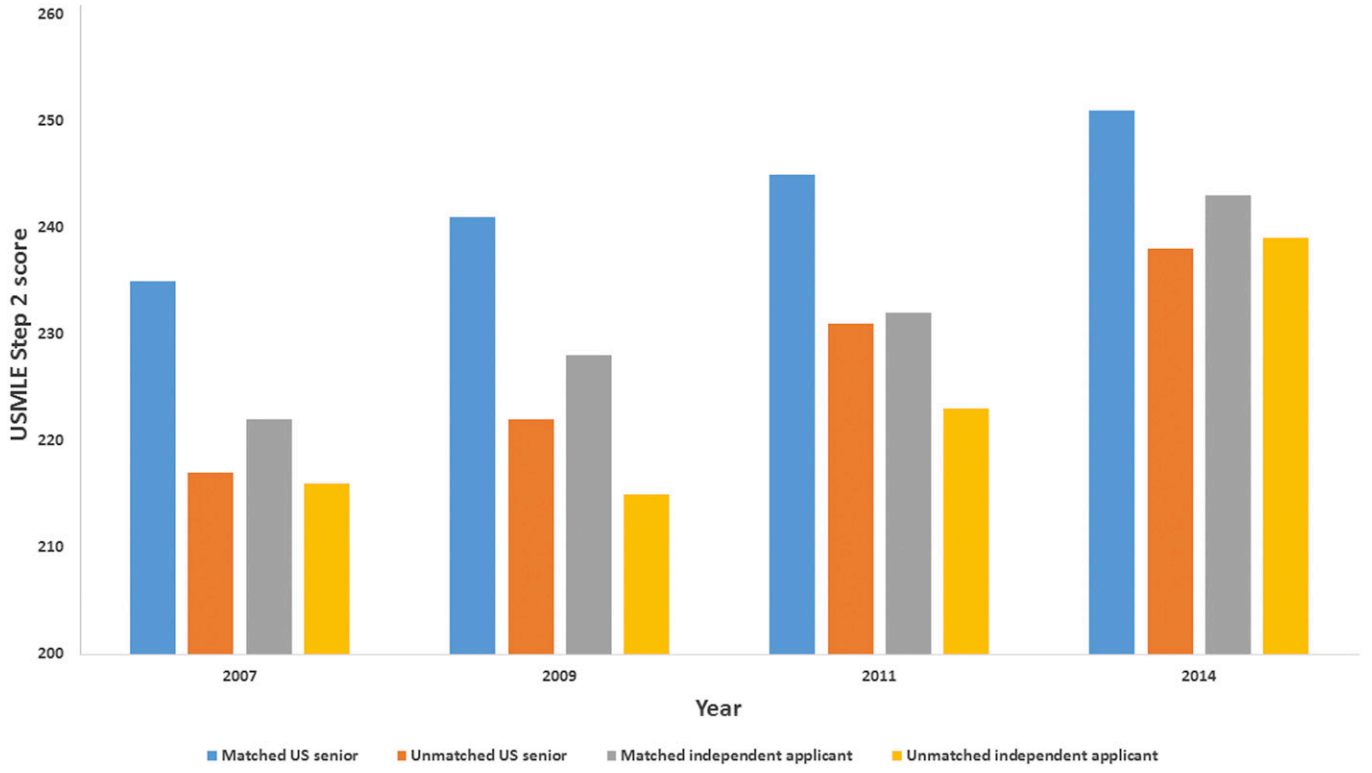

Fig. 3

The mean USMLE Step-2 scores for matched and unmatched U.S. seniors and independent applicants. Significant differences were found between matched and unmatched U.S. seniors ($p < 0.01$), matched and unmatched independent applicants ($p = 0.026$), matched U.S. seniors and independent applicants ($p < 0.01$), matched U.S. seniors and unmatched independent applicants ($p < 0.01$), and unmatched U.S. seniors and matched independent applicants ($p = 0.031$).

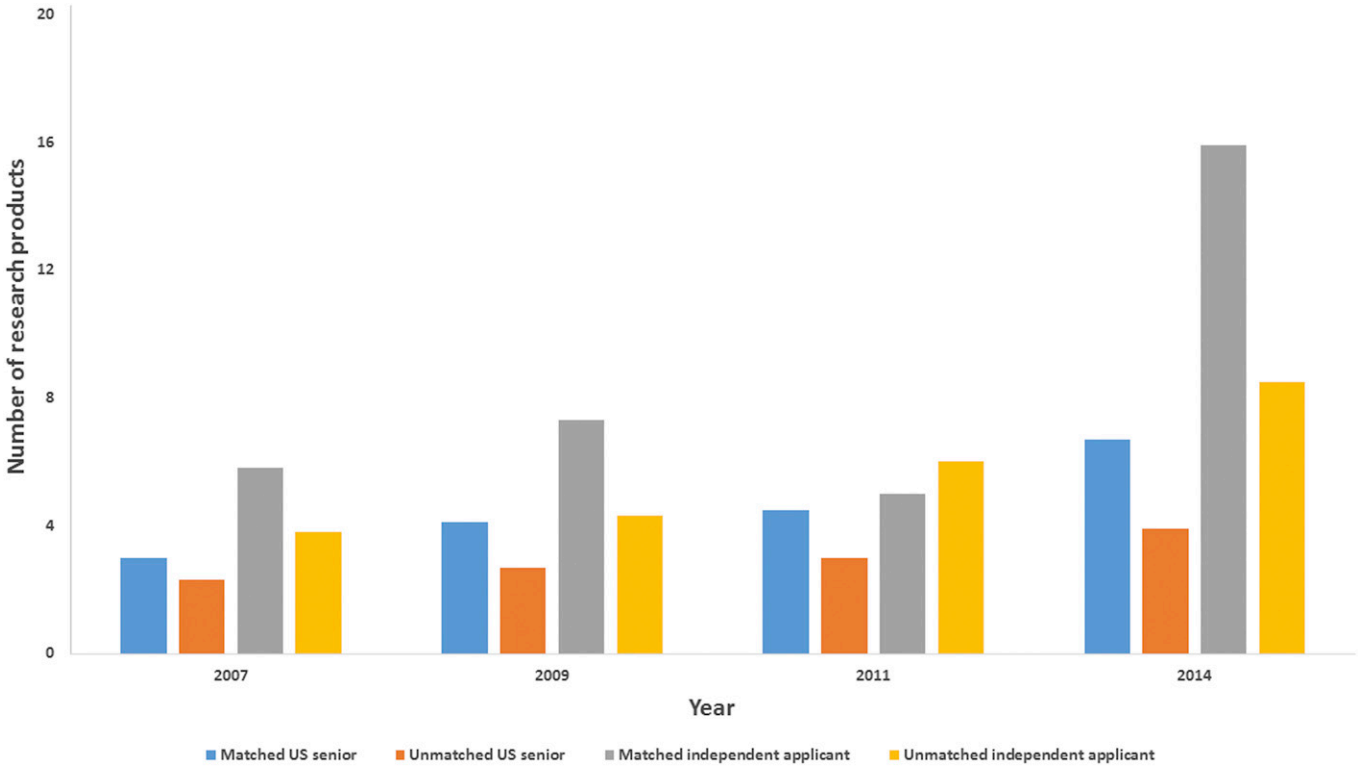

Fig. 4

The mean number of research products for matched and unmatched U.S. seniors and independent applicants. Significant differences were found between matched and unmatched U.S. seniors ($p = 0.035$) and between unmatched U.S. seniors and independent applicants ($p = 0.035$).

Twenty-nine percent of matched U.S. seniors were AOA members compared with 4.9% of unmatched U.S. seniors ($p < 0.0001$). Doctoral degrees were held by 2.2% of matched U.S. seniors and 1.3% of unmatched U.S. seniors ($p = 0.18$). Twelve percent of matched U.S. seniors and 17% of unmatched U.S. seniors held a degree other than a PhD ($p < 0.01$).

TABLE I Factors Determining Match Success for U.S. Seniors and Independent Applicants from 2007 to 2014

Factors Determining Match Success	Matched U.S. Senior	Unmatched U.S. Senior	P Value	Matched Independent	Unmatched Independent	P Value
AOA membership	29%	4.9%	<0.0001*	NA†	NA†	NA†
Graduation from a top-40, NIH-funded medical school	37%	25%	<0.0001*	NA†	NA†	NA†
No. of contiguous ranks	11.5	5.5	<0.0001*	4.9	2.8	0.01*
Mean USMLE Step-1 score *(points)*	239	223	<0.001*	227	220	0.039*
Other degree (non-PhD)	12%	17%	<0.01*	NA†	NA†	NA†
Mean USMLE Step-2 score *(points)*	243	227	<0.01*	231	223	0.026*
Mean no. of distinct specialties ranked	1.1	1.3	<0.01*	1.3	2.9	0.043*
Mean no. of research experiences	3.1	2.9	0.010*	3.4	2.4	0.027*
Mean no. of research products	4.6	3.0	0.035*	8.5	5.7	0.20
PhD degree	2.2%	1.3%	0.18	NA†	NA†	NA†
Mean no. of work experiences‡	2.7	2.8	0.84	3.4	3.2	0.32
Mean no. of volunteer experiences‡	6.4	6.5	0.90	5.3	4.4	0.037*

*These differences were significant. †NA = not available. ‡These experiences were calculated on the basis of the 2009, 2011, and 2014 Charting Outcomes in the Match data.

Across all specialties, USMLE Step-1 and Step-2 scores increased for matched U.S. seniors from 2007 to 2014. These scores were significantly higher for U.S. seniors who matched into orthopaedic surgery residencies when compared with matched U.S. seniors in all specialties combined ($p < 0.0001$ for Step-1 scores and $p < 0.001$ for Step-2 scores), although the rate of increase in scores between these two groups during the study period was not significantly different ($p = 0.18$ for Step-1 scores and $p = 0.74$ for Step-2 scores).

Discussion

Competition for orthopaedic surgery residency PGY-1 positions has increased over the last 10 years. Despite an increase in the number of applicants every year from 2006 to 2012, the number of applicants decreased in 2013 and 2014. This is possibly due to the known competitiveness of applying to orthopaedic surgery programs or due to its perception as a lifestyle-unfriendly specialty when compared with ROAD (radiology, ophthalmology, anesthesiology, and dermatology) specialties[4], which may dissuade some medical students who are initially interested in orthopaedics. Karnes et al.[10] studied intercandidate competition for orthopaedic PGY-1 positions and attributed the perceived increase in competition to an increased number of applications submitted per candidate, resulting in greater relative importance placed on objective criteria when programs select applicants for interviews. Indeed, the increased competition among orthopaedic surgery applicants is not due to a higher rate of increase in USMLE Step-1 and Step-2 scores compared with applicants across all specialties, although Step-1 and Step-2 scores have been increasing among orthopaedic surgery applicants for several years.

In the current study, the most important features for determining Match success were AOA membership, graduation from a top-40, NIH-funded medical school, number of contiguous ranks, and USMLE Step-1 score. These characteristics tend to be closely linked; strong undergraduate students apply to and are admitted to competitive medical schools, then students who receive high scores on board examinations and are among the top students in their class are objectively more competitive applicants for residency interviews, thus leading to more contiguous ranks. Other important factors in Match success were USMLE Step-2 scores, research experience, and research products. USMLE Step-2 scores are not always available when programs offer interview invitations to applicants, which may explain its apparent reduced importance in Match success compared with Step-1 scores. Work and volunteer experiences did not differ between matched and unmatched U.S. seniors or independent applicants.

Using data from the 2007 and 2009 Matches, Rinard and Mahabir[6] studied the effect that various factors had on Match success among applicants to various surgical specialties, including orthopaedic surgery. The authors concluded that students with higher USMLE Step-1 and Step-2 scores, AOA membership, research experience, and graduation from a top-40, NIH-funded medical school increased applicants' success in the Match[6]. The current study confirms this trend, but also builds upon Rinard and Mahabir's study with data from the 2011 and 2014 Matches and adds analysis on number of contiguous ranks, number of ranked distinct specialties, additional degrees, and differences between U.S. seniors and independent applicants.

There was a significant difference between the mean number of contiguous ranks for matched U.S. seniors (11.5) and unmatched U.S. seniors (5.5) and for matched independent applicants (4.9) and unmatched independent applicants (2.8). Green et al.[5] studied selection criteria for residency by surveying 1,201 program directors across all specialties. After compiling the responses and averaging across all specialties, the top-5 selection criteria were grades in required clerkships, USMLE Step-1 and 2 scores, grades in senior electives in the students' desired specialties, and number of Honors grades. This confirms the conclusion by Karnes et al.[10] that there is a greater importance on objective criteria when applicants are selected for an interview. In 2004, Bajaj and Carmichael[7] sent anonymous questionnaires to faculty orthopaedists at teaching institutions to study important attributes for orthopaedic residency selection. The authors reported that the most important attributes for obtaining an orthopaedic surgery residency position were performance on a local rotation, class rank, and interview performance[7].

Baldwin et al.[8] studied the effect of the number of away rotations on the odds of a student matching into orthopaedic surgery residency positions and found that students who performed ≥2 away rotations had better odds of matching. The authors also noted that students who did exactly 2 away rotations tended to be stronger academically (AOA membership, top 10% of class, and higher USMLE Step-1 scores) than those who did ≥3 away rotations[8].

The current study found that the mean total number of abstracts, presentations, posters, and publications (research products) for matched U.S. seniors increased over time and was significantly greater than for unmatched U.S. seniors. Interestingly, the mean number of research products for matched independent applicants was 15.9 in 2014, more than double that of matched U.S. seniors. One possible explanation for this trend is a need for independent applicants to compensate for lacking in other application components, such as USMLE scores or number of Honors grades. On the basis of the results of this study, matched independent applicants had significantly lower USMLE Step-1 and Step-2 scores when compared with matched U.S. seniors, which is likely an important reason as to why an independent applicant may not have matched during the previous application cycle. However, independent applicants can supplement their application with research experience and research products to improve their chances of success in the Match.

We found that applicants with additional non-PhD degrees (e.g., Master of Science [MS]) do not have an increased rate of matching into orthopaedic surgery residencies, as 12% of matched U.S. seniors held an additional non-PhD degree compared with 17% of unmatched U.S. seniors. We hypothesize that some of these students were marginal medical school applicants and obtained a master's or other non-PhD degree to increase their chances of acceptance into medical school. These

students were likely less competitive within their medical school class and thus were less likely to match into orthopaedic surgery.

In the current study, AOA members tended to be more successful in the Match than non-AOA members. AOA membership is determined by academic achievement, leadership, service, professionalism, and promise of future success in medicine. Grayson et al.[4] studied specialty selection trends by AOA members and non-AOA members. The authors found an increase in the selection of orthopaedic surgery by AOA members compared with non-AOA members[4].

The current study specifically analyzed factors published by the NRMP, and it should be noted that there are other factors that determine the success of an applicant matching into an orthopaedic surgery residency. Bernstein et al.[14] conducted a survey of orthopaedic surgery program directors in 2003. According to their study, the three most important residency selection criteria were a rotation at the program director's institution, USMLE Step-1 score, and rank in medical school[14]. Factors such as formality or politeness during an interview, personal appearance of the candidate, performance on ethical questions during an interview, and letter of recommendation by an orthopaedic surgeon were deemed more important than AOA membership and medical school reputation[14].

Dirschl et al.[15] studied resident selection factors and their ability to predict resident performance. In their study, academic performance in clinical clerkships in medical school was the most predictive of subsequent overall performance as an orthopaedic resident, followed by AOA membership[15]. Honors grades are one of multiple important resident selection factors that are not included in the NRMP data.

There were limitations to this study. Some of the data analyzed in this study (e.g., research products and volunteer experiences) came from applicants' responses in their residency applications, and therefore the accuracy of these outcomes was dependent on the honesty of these responses. Only two categories, graduation from a top-40, NIH-funded medical school and number of contiguous ranks, were not self-reported by the applicant. In addition, the NRMP stated that only 75% of USMLE Step-1 scores and 71% of USMLE Step-2 scores were verified or were corrected in 2014. In addition, there were other factors not listed in the NRMP data, including class rank, number of Honors grades, the completion of away rotations, and strong letters of recommendation, that are important in the resident-selection process.

In conclusion, U.S. senior medical students and independent applicants who successfully match into orthopaedic surgery residency positions have increasingly higher USMLE Step-1 and 2 scores, number of research experiences and research products, and number of contiguous ranks. Additional, non-PhD degrees do not improve an applicant's success rate in the Match. ■

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