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Spine Surgery Education

Impacts of COVID-19 on orthopaedic surgery residency / spine trainee application trends<sup>☆</sup>Mursal Gardezi<sup>a</sup>, Harold G. Moore<sup>b</sup>, Adrienne R. Socci<sup>c</sup>, Jonathan N. Grauer<sup>c,\*</sup><sup>a</sup> Yale School of Medicine, New Haven, CT, USA<sup>b</sup> Weill Cornell Medical College, New York, NY, USA<sup>c</sup> Yale New Haven Hospital Department of Orthopaedics and Rehabilitation, New Haven, CT, USA

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## ABSTRACT

**Background:** The COVID-19 pandemic has had widespread impact across medical educational sectors, including cancellations and delays of board exams, interruptions in clinical rotations and electives, altered processes for away rotations, and conversion to virtual interviews. These changes, combined with applicant and program uncertainty, may affect the 2021 residency application cycle for competitive fields such as orthopaedic surgery. In consideration of spine trainees and the spine fellow application pipeline, the current study aims to evaluate for deviations in trends found in applications to an orthopaedic surgery residency program from the 2021 cycle compared to six years prior.

**Methods:** After institutional review board approval, applications to a single orthopaedic surgery residency program from application cycles 2015 to 2021 were evaluated in the Electronic Residency Application System (ERAS) and analyzed for trends. Supplementary information was taken from publicly available ERAS statistics.

**Results:** Compared to existing trends, the ERAS 2021 cycle had a greater number of applicants, more research items, and lower rates of USMLE Step 2 test administration. Of the 4,965 applications analyzed, no deviations in trends were found in number of female applicants, Black and Hispanic applicants, applicants from medical schools outside the US, DO applicants, applicants with interruptions in their training, or USMLE scores.

**Conclusions:** The orthopaedic surgery applicant pool increased amidst the COVID-19 pandemic and applicants had more research items than previous years. No significant deviations in the demographics of the applicant pool were noted. This is thought to be reassuring about the integrity of the orthopaedic residency application process / spine fellow application pipeline and should continue to be observed in the coming years.

## Background

The burden of the novel coronavirus disease 2019 (COVID-19) on hospital systems, in combination with efforts to slow the spread of disease, led to widespread changes in medical student education processes including limiting activities involving direct patient contact and in-person research [1], delays and cancellations of the United States Medical Licensing Exams (USMLE) [2,3], reduction and cancellation of electives [4], and rapid adoption of telehealth for routine clinic visits [3].

Concerns over what these changes might mean for residency applicants quickly mounted [3], especially for highly competitive fields such as orthopaedic surgery where applicants applied to 74.19 programs on average in 2019 [5]. That same year, 99.6% of the available orthopaedic

surgery residency positions were filled, leaving 19% of applicants unsuccessful in securing a match [6].

Orthopaedic spine surgery fellowship is an additional one-year program often pursued by those interested in gaining expertise in spine surgery after an orthopaedic surgery or neurosurgery residency. With over 90% of orthopaedic surgery residents pursuing fellowship training after residency [7], it is feasible to think that changes in the orthopaedic surgery residency applicant pool may have downstream effects on the orthopaedic spine surgery fellowship application pool.

With changes due to COVID-19, including adoption of remote interviews, it is difficult to predict what this may mean for residency applications. Existing literature studying effects of COVID-19 on the orthopaedic surgery residency application process have been primarily

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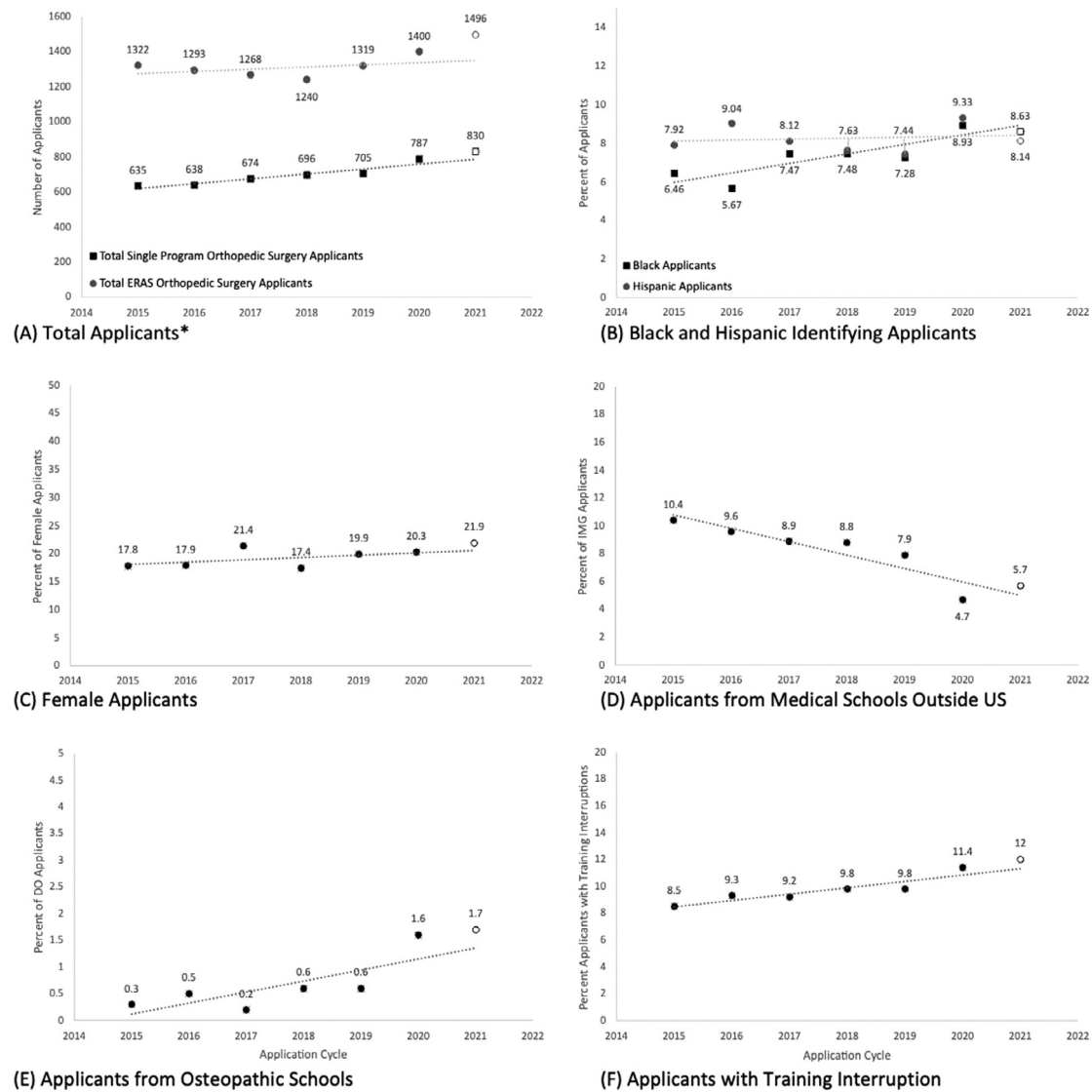
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**Fig. 1.** Trends in orthopedic surgery residency applications from 2015-2021 for (A) total applicants, (B) Black and Hispanic identifying applicants, (C) female applicants (D) applicant from medical schools outside US, (E) applicants from osteopathic medical schools, and (F) applicants with training interruptions are shown. Trendlines were created from 2015-2020 data only and \* signifies when 2021 data deviate greater than 2 standard deviations from the expected trendline.

limited to surveys and recommendations based on opinion/expert analysis [3,4,8,9].

The current study aims to use data from the electronic residency application system (ERAS) to evaluate trends from an orthopaedic surgery residency program from 2015-2021.

**Methods**

ERAS data from 2015-2021 was requested for a single urban Northeast academic orthopaedic surgery residency program following institutional review board (IRB) exemption and ERAS approval.

Data elements collected from ERAS included: applicant number, gender, race/ethnicity, medical school location, degree type, interrupted training, USMLE exam scores, USMLE Step 2 CS test administration rate, and research items (publications, book chapters, presentations, abstracts, scientific monoliths).

Total number of orthopaedic surgery residency applicants were obtained from the AAMC ERAS website [5]. Stata Version 13 was used to analyze data. Trendlines were created from ERAS 2015-2020 data. Points that deviated significantly were defined by greater than two stan-

dard deviations from the mean difference of predicted versus observed values from 2015-2020.

**Results**

*Number and demographics of orthopaedic surgery residency applicants*

Total orthopaedic surgery residency applications using the ERAS system increased from 1322 to 1496 from 2015-2021 and applicants to the sampled institution increased from 635 to 830 (Figure 1a). The ERAS 2021 cycle demonstrated a significant increase beyond the expected trend for applicants to orthopaedic surgery and the sampled institution.

Orthopaedic surgery is one of the least racially and gender diverse specialties, despite efforts to change this [10,11]. Among applicants to the sampled institution, 14.28% identified as Hispanic or Black in ERAS 2015 and 16.77% in ERAS 2021 (Figure 1b). Applicants identifying as Native American could not be assessed in this study due to sample size.

The number of female-identifying applicants saw an increase of 2.5% from 2015-2020 and 1.6% from 2020-2021 (Figure 1c).

From 2015-2021, applicants that are international medical graduates (IMGs) have decreased by over 50% (Figure 1d). ERAS 2021 represents

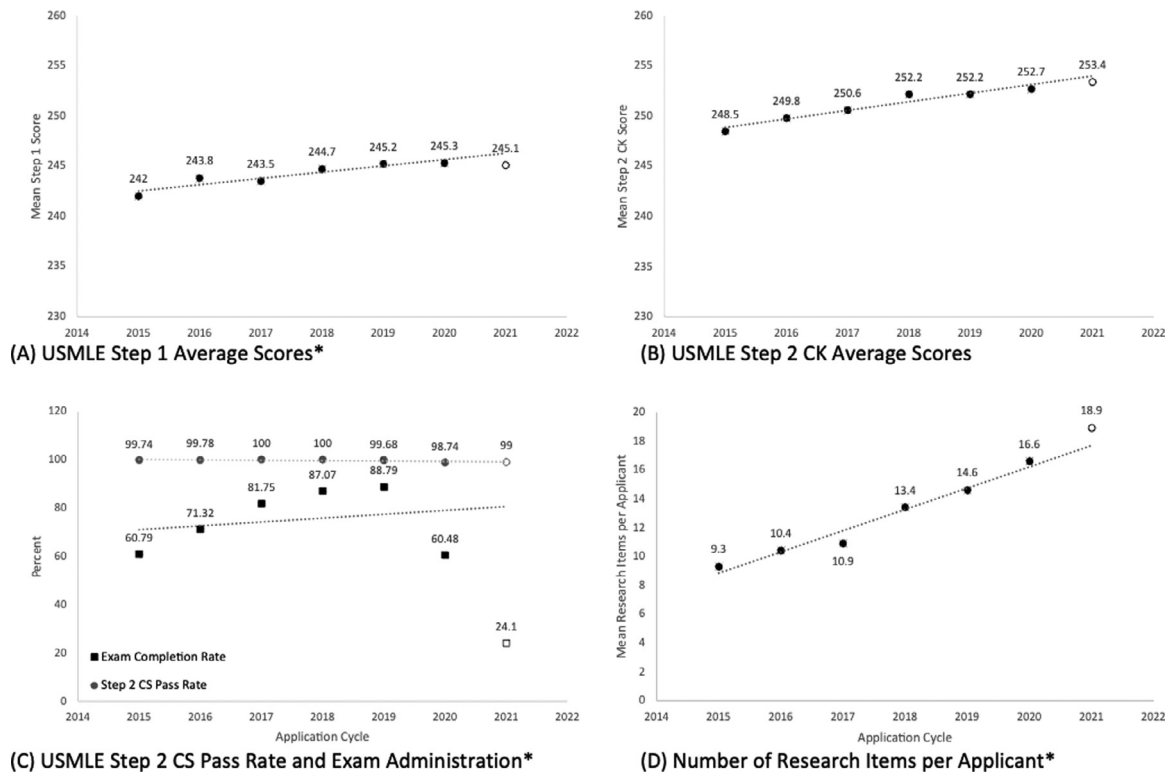


Fig. 2. Trends in orthopedic surgery residency applications from 2015-2021 for (A) USMLE Step 1 average scores, (B) USMLE Step 2 CK average scores, (C) USMLE Step 2 CS pass rate and exam administration, (D) number of research items per applicant are shown. Trendlines were created from 2015-2020 data only and \* signifies when 2021 data deviate greater than 2 standard deviations from the expected trendline.

the only year that had a relative increase compared to the year prior, but still followed the overall decreasing projected trend.

In contrast to the decrease in IMGs, there has been an increase in applications from osteopathic doctors (DOs). From 2015-2021, DO applicants increased 140%, with 2021 increasing along the projected trendline (Figure 1e).

Applicants with training interruptions did not deviate significantly from expected trends in ERAS 2021, increasing to 12% from 8.5% in ERAS 2015 (Figure 1f).

#### Board scores and research of orthopaedic surgery residency applicants

Average USMLE Step 1 score for the sampled institution was 242 in ERAS 2015 and increased to 245.1 in ERAS 2021 with a statistically significant decrease in ERAS 2021 (Figure 2a). Step 2 Clinical Knowledge (CK) scores increased from 248.5 to 253.4 from 2015-2021 and increased steadily yearly (Figure 2b).

Pass rates for USMLE Step 2 CS has been consistently high at over 98.5% since ERAS 2015 (Figure 2c). Score reporting prior to submitting ERAS for USMLE Step 2 CS increased from 2015 to 2019 from 60.79% to 88.79% followed by a decline in test administration to 60.48% in 2020 and 24.2% in ERAS 2021.

Research remains an important part of residency applications according to the NRMP Program Director Survey [12]. In ERAS 2015, the average number of research items per applicant was 9.3. Since then, research items more than doubled to 18.9, with a significant increase in ERAS 2021 (Figure 2d).

#### Discussion

The orthopaedic surgery residency application process is highly competitive [12] and the COVID-19 pandemic has contributed to applicant and program uncertainty. The current study thus explored trends to a

single Northeast orthopaedic surgery residency program over multiple years, with a focus on the recent cycle (2021).

The current study found no deviations in most of the expected trends projected for 2021. Significant deviations can be explained by changes due to COVID-19: the decrease in the USMLE Step 2 CS exam administration rate may be attributed to delays and subsequent permanent cancellation of this exam [2] and the increase in research items per applicant may be attributed to the popularity of dedicating part of the hiatus in clinical curriculum toward non-laboratory research endeavors as well as the transition to online research conferences. Although a statistically significant decrease in Step 1 scores were measured in 2021, the absolute change amounted to -0.2 points, which is likely not practically significant. Aside from the changes to the application cycle directly resulting from the COVID-19 pandemic, there were no other significant changes to the 2021 application cycle known to the authors of this paper, although it is possible that there may be other reasons not identified in this study that may contribute to the findings of the current study.

Prior to the application cycle, the American Orthopaedic Association Council of Orthopaedic Residency Directors (AOA/CORD) released guidelines for the 2021 cycle, including a recommendation to limit applications to no more than 60 programs per applicant [13]. From 2016-2020, the average applications per applicant were 75.51, 76.40, 75.93, 74.19, and 78.34 [5]. Perhaps unsurprisingly, preliminary data from 2021 suggest that AOA/CORD guidelines were not adhered to, with an average of 77.40 applications per applicant [5].

While most trends this year did not deviate significantly, we have yet to know the full effects of COVID-19 on residency and fellowship applications in the future. It would be interesting to see how trends continue to develop in subsequent years as this cohort goes on to apply to spine fellowship. The next few years bring additional challenges, namely USMLE Step 1 transitioning to binary pass/fail grading system [14], and residency programs should be aware of possible lasting effects of COVID-19 on the application pool. For instance, we did not see

deviations in training interruptions in 2021, but this trend may take additional years to materialize in applications. Similarly, many applicants from 2021 would have already taken some or all of their board exams before the pandemic and therefore these aspects of their applications would have been unaffected.

Similarly, COVID-19 may have affected recruitment efforts in orthopaedic surgery, especially those from underrepresented backgrounds, which may affect application pools in years to come. Orthopaedic spine surgery stands out as one of the least gender diverse subspecialties in orthopaedics, with only 3% of applicants being female [15]. Women comprise half of enrolled medical students, but only 21.9% of orthopaedic surgery residency applicants [16]. Compared to the estimated 31.9% of Black and Hispanic persons in the US, Black and Hispanic applicants to orthopaedic surgery residency comprise 16.77% of applicants in 2021 [17]. In order to combat this, efforts focused on promoting diversity and inclusion in orthopaedic surgery should not be forgotten during this time [18].

This study has some limitations. The study sample is limited to applicants to a single program and may not be representative of the entire applicant pool to orthopaedic surgery. Furthermore, this study did not evaluate all components of the ERAS application, like quality of research or recommendation letters, or include information regarding interview allocation or match rate, but acknowledges that these may also have been impacted by COVID-19.

## Conclusion

In conclusion, the current study of orthopaedic surgery residency applications demonstrates an increase in applicant number and research items per applicant, but reveals no other significant deviations in application trends in 2021 despite interruptions due to COVID-19. It may require several cycles before we see the full effects of COVID-19 on orthopaedic surgery residency and spine fellowship applications, but at present the orthopaedic spine trainee and spine fellow pipeline appears maintained.

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IRB: Our institutional review board (IRB) granted an exemption for this study.

## Informed Patient Consent

The authors declare that informed patient consent was taken from all the patients.

## Declaration of Competing Interest

The authors declare no conflict of interest.

## References

- [1] Catanese, A.W.J.P.G.Y.V.M., Guidance on medical students' clinical participation: Effective immediately. Association of American Medical Colleges. 2020.
- [2] USMLE Suspending Step 2 Clinical Skills Examination. 2020 [cited 2021 January 24]; Available from: <https://www.usmle.org/announcements/default.aspx?ContentId=284>.
- [3] Dooley JH, Bettin KA, Bettin CC. The Current State of the Residency Match. *Orthop Clin North Am* 2021;52(1):69–76.
- [4] Boyd CJ, et al. Impact of COVID-19 on Away Rotations in Surgical Fields. *J Surg Res* 2020;255:96–8.
- [5] AAMC. ERAS Statistics. 2021 [cited 2021 February 1].
- [6] Program NRM. Results and Data 2019 Main Residency Match. NRMP 2019.
- [7] Horst PK, et al. Graduates of orthopaedic residency training are increasingly subspecialized: a review of the american board of orthopaedic surgery part II database. *J Bone Joint Surg Am* 2015;97(10):869–75.
- [8] Richardson MA, Islam W, Magruder M. The evolving impact of COVID-19 on medical student orthopedic education: perspectives from medical students in different phases of the curriculum. *Geriatr Orthop Surg Rehabil* 2020;11:2151459320951721.
- [9] Aiyer AA, et al. The impact of COVID-19 on the orthopaedic surgery residency application process. *J Am Acad Orthop Surg* 2020;28(15):e633–41.
- [10] AAMC. Distribution of Residents by Specialty, 2005 Compared to 2015. 2016 [cited 2021 February 1]; Available from: <https://www.aamc.org/download/481180/data/2015Table2.pdf>.
- [11] AAMC. Residency Applicants from U.S. MD-Granting Medical Schools to ACGME-Accredited Programs by Specialty and Race/Ethnicity, 2019-2020. 2019 [cited 2021 February 1]; Available from: [https://www.aamc.org/system/files/2019-12/2019\\_FACTS\\_Table\\_C-5.pdf](https://www.aamc.org/system/files/2019-12/2019_FACTS_Table_C-5.pdf).
- [12] NRMP. Results of the 2020 NRMP Program Director Survey. 2020 [cited 2021 February 1]; Available from: <https://mk0nrmp3oyqui6wqfm.kinstadcn.com/wp-content/uploads/2020/08/2020-PD-Survey.pdf>.
- [13] AOA/CORD. Letter to Orthopaedic Surgery Residency Programs. 2020 [cited 2021 February 1]; Available from: [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwi7oLnzODuAhWDT98KHVPFCcIQFjAAegQIARAC&url=https%3A%2F%2Faamc-orange.global.ssl.fastly.net%2Fproduction%2Fmedia%2Ffiler\\_public%2F74%2F44%2F7444d6bc-5148-49b0-b240-cf90130b943a%2Faoacord\\_rec\\_guidelines\\_2021\\_application\\_seasonaamc.pdf&usq=AOvVaw0Zgle7K1L0VEUunuDRyJT2](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwi7oLnzODuAhWDT98KHVPFCcIQFjAAegQIARAC&url=https%3A%2F%2Faamc-orange.global.ssl.fastly.net%2Fproduction%2Fmedia%2Ffiler_public%2F74%2F44%2F7444d6bc-5148-49b0-b240-cf90130b943a%2Faoacord_rec_guidelines_2021_application_seasonaamc.pdf&usq=AOvVaw0Zgle7K1L0VEUunuDRyJT2).
- [14] InCUS, U., Change to pass/fail score reporting for Step 1. 2020: usmle.org.
- [15] Cannada LK. Women in orthopaedic fellowships: what is their match rate, and what specialties do they choose? *Clin Orthop Relat Res* 2016;474(9):1957–61.
- [16] AAMC. Table B-3: Total U.S. medical school enrollment by race/ethnicity (Alone) and Sex, 2016-2017 through 2020-2021. 2020 [cited 2021 February 1]; Available from: [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjPh8H94eHuAhWHXM0KHcJgCwgQFjALegQIGxAc&url=https%3A%2F%2Fwww.aamc.org%2Fmedia%2F6116%2Fdownload&usq=AOvVaw3OJL1\\_uQhHtQfbyIPNqMl](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjPh8H94eHuAhWHXM0KHcJgCwgQFjALegQIGxAc&url=https%3A%2F%2Fwww.aamc.org%2Fmedia%2F6116%2Fdownload&usq=AOvVaw3OJL1_uQhHtQfbyIPNqMl).
- [17] Bureau, U.S.C. QuickFacts United States. 2019 [cited 2021 February 1]; Population estimates, July 1, 2019, (V2019)]. Available from: <https://www.census.gov/quickfacts/fact/table/US/RHI725219#RHI725219>.
- [18] Gerull KM, et al. Striving for inclusive excellence in the recruitment of diverse surgical residents during COVID-19. *Acad Med* 2021;96(2):210–12.