



# Impact of Virtual Interviews on Pulmonary and Critical Care Fellowship Match

## An Analysis of National Data

Hamza Alzghoul<sup>1,2</sup>, Saqr Alsakarneh<sup>3</sup>, Saeed Abughazaleh<sup>4</sup>, Lauran Zeineddine<sup>5</sup>, Ariel Ruiz De Villa<sup>1,2</sup>, Raju Reddy<sup>6</sup>, Ibrahim Faruqi<sup>7</sup>, and Bashar Alzghoul<sup>7</sup>

<sup>1</sup>Graduate Medical Education, University of Central Florida College of Medicine, Orlando, Florida; <sup>2</sup>Internal Medicine Residency Program, North Florida Regional Medical Center, Gainesville, Florida; <sup>3</sup>University of Missouri–Kansas City, Kansas City, Missouri; <sup>4</sup>St. Elizabeth Medical Center, Tufts University School of Medicine, Brighton, Massachusetts; <sup>5</sup>Department of Internal Medicine, University of Florida Health, Gainesville, Florida; <sup>6</sup>Division of Pulmonary and Critical Care Medicine, Department of Internal Medicine, University of Texas at Austin, Austin, Texas; and <sup>7</sup>Division of Pulmonary, Critical Care, and Sleep Medicine, Department of Internal Medicine, University of Florida, Gainesville, Florida

ORCID IDs: 0000-0003-3123-2659 (H.A.); 0000-0002-4224-0892 (B.A.)

### ABSTRACT

**Background:** Internal Medicine residents have historically expressed hesitancy in pursuing a career in pulmonary and critical care medicine (PCCM). However, recent studies have demonstrated newfound competitiveness. The coronavirus disease (COVID-19) global outbreak prompted the implementation of a virtual interviewing model for PCCM fellowship match. The effect of this new paradigm on PCCM match results has not been studied previously.

**Objective:** With the shift to virtual interviewing, we aim to determine how this new method of interviewing may influence the selection of candidates for fellowship training programs.

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**Correspondence and requests for reprints should be addressed to** Bashar Alzghoul, M.D., Division of Pulmonary, Critical Care, and Sleep Medicine, Department of Medicine, University of Florida, 1600 SW Archer Road, Box 100277, Gainesville, FL 32610. E-mail: bashar.alzghoul@medicine.ufl.edu.

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**Methods:** We acquired data of 4,333 applicants ranking PCCM for the years 2017–2021 from the National Resident Matching Program and the Electronic Residency Application Service websites for the years 2017–2021. Chi-square ( $\chi^2$ ) analysis of the applicants' demographics and the percentage of applicants matching at their first choice versus those who matched at lower than their third-choice program before and after the implementation of virtual interviews season was performed.

**Results:** The matching probability for the U.S. Doctors of Osteopathic Medicine significantly increased after the implementation of virtual interviews compared with the years 2017–2020 ( $\chi^2 = 8.569$ ;  $P = 0.003$ ). The matching probability remained unchanged for U.S. Doctors of Medicine ( $\chi^2 = 2.448$ ;  $P = 0.118$ ). Overall, an applicant's probability of matching at their first choice has significantly decreased after the virtual interview format ( $\chi^2 = 4.14$ ;  $P = 0.04$ ). Conversely, the probability of matching at a program that is lower than the third choice has significantly increased ( $\chi^2 = 11.039$ ;  $P < 0.001$ ).

**Conclusion:** Our study provides evidence regarding the effect of the virtual interview format on PCCM match results. Strikingly, applicants are more likely to match at lower-ranked programs in their rank list after the implementation of the virtual interview process. These results can be helpful for both programs and applicants, to guide their future expectations and decisions while going through the interview process.

**Keywords:**

pulmonary and critical care medicine; fellowship; virtual interviews; match trends; coronavirus disease

Several studies have demonstrated that critical care services directed and delivered by physicians who received formal training in critical care medicine reduce intensive care unit (ICU) mortality and healthcare costs (1). Accordingly, multiple proposals intended to increase the number of intensivists and pulmonary and critical care medicine (PCCM) specialists in the United States were made, as many ICUs were not staffed by intensivists (2). Despite the growing importance of this field, previous studies have shown that internal medicine residents have historically been hesitant to pursue PCCM as a career choice (1, 2). However, more recent studies suggest that PCCM has become increasingly attractive to fellowship match applicants, with rising

competitiveness and an increasing number of unmatched applicants (3, 4). More recently, PCCM became the most competitive internal medicine subspecialty (6).

A crucial first step toward becoming a PCCM specialist is choosing an appropriate training program, beginning with the interview process. Traditionally, this involved in-person meetings between the applicants and programs. The site visit allows applicants to learn the program culture (7), meet existing trainees, evaluate training facilities, and interact with potential mentors (7), factors considered crucial in the ranking and matching process. However, the coronavirus disease (COVID-19) pandemic had a big impact on graduate medical education programs, particularly with the shift to the virtual

interview process, in which participants interacted with each other over a video-audio interface without physically being in the same room. The impact of virtual interviews has been varied. Although some studies found that applicants were able to understand the program adequately and represent themselves (8), other studies found that applicants had difficulty representing their personality (9). Given the paucity of data on the impact of virtual interviews on match results, we examined the trends in match results before and after the implementation of a virtual interview process brought about by the COVID-19 pandemic. In this study, using the National Resident Matching Program (NRMP), American Board of Internal Medicine (ABIM) data, and ancillary data from the Electronic Residency Application Service (ERAS), we investigated the changes in patterns of PCCM match results. The findings of this study could have important implications for both trainees and programs, particularly considering the continued uncertainty surrounding virtual interviewing. By examining the changes in patterns of matching after the implementation of virtual interviewing, we can better understand the impact of this shift on the selection of candidates for these specialties.

## METHODS

Publicly available data from the NRMP and the ABIM for PCCM match results for the years 2017–2021 were analyzed for the number of positions offered, the total number and percentage of applicants ranking the specialty, the number and percentage of applicants who applied to the specialty as a preferred specialty, the total number and percentage of filled and unfilled positions, and the total number and percentage of matched and

unmatched applicants (10, 11). In addition, data regarding the total number and percentage of females, U.S. Doctors of Medicine (U.S. MDs), International Medical Graduates (IMGs), and U.S. Doctors of Osteopathic Medicine (U.S. DOs) were obtained, and applicants were grouped into three groups (U.S. MDs, U.S. DOs, and IMG applicants) according to their degree status. Data for match results between 2017 and 2020 were obtained to establish a historical baseline as the pre-virtual interview match group and compared with results from the match year 2021, which served as the virtual interview group. The data were presented and tabulated for the years 2017–2021 and separately for every year. We also obtained the annual number and percentage of applicants matching at their first, second, third, and lower than third choice on their rank lists for each of the mentioned years from the NRMP website. Collateral data were obtained from the ERAS website (12). In all of the databases used, data from the 2021 match results represent the results of the first match season conducted through virtual interviews. In addition, “match year” in our study represents the year in which applicants will start their fellowship training; for example, match year 2021 represents the year for which applicants submitted their application in July 2020 and expected to start their training in July 2021. The pandemic started in the spring of 2020 and caused a switch to virtual interviews in the fall of 2020; this first virtual match season is represented throughout the manuscript as match year 2021, representing the year when matched applicants started their training, not when they did their interviews. Critical care medicine fellowship was excluded, as NRMP data are available for match year 2022 only. Our analysis did not include postgraduate

Year 4 residents in combined medicine–pediatric programs.

Multiple databases were used because of the limited availability of publicly accessible data in each database. All data points were obtained from the NRMP website, except for applicant sex information and the number of third-year internal medicine residency graduates eligible for fellowships, which were obtained from the ABIM website. In addition, collateral information about the average number of applications for the PCCM fellowship match sent by each applicant according to his status (U.S. MD, U.S. DO, and IMG) for each year was obtained from the ERAS website.

#### Statistical Analysis

Match rates for U.S. MDs, U.S. DOs, and IMG applicants and match rates for males and females in the pre–virtual interview match group (2017–2020) were compared with the virtual interview match group (2021) using chi-square ( $\chi^2$ ) testing. An additional analysis was done to examine if a significant change was seen in the percentage of applicants matching at their first, second, third, and lower than the third choice over the mentioned years. *P* values were then calculated to determine the significance of the association. All data analyses were performed using Microsoft Excel and PRISM Data Analysis Software version 8 (13). The  $\chi^2$  testing was used to compare the observed numbers and percentages of applicants or matched applicants in 2021 to the pre–virtual interview cohort of applicants or matched applicants from the years 2017–2020. A *P* value  $\leq 0.05$  was considered statistically significant.

The project did not receive any funding from any organizations. All information used in this study was freely available on

NRMP, ABIM, and ERAS websites. This study was conducted in accordance with the ethical principles of the declaration of Helsinki. The study was exempt from institutional review board evaluation, as the data used featured deidentified information.

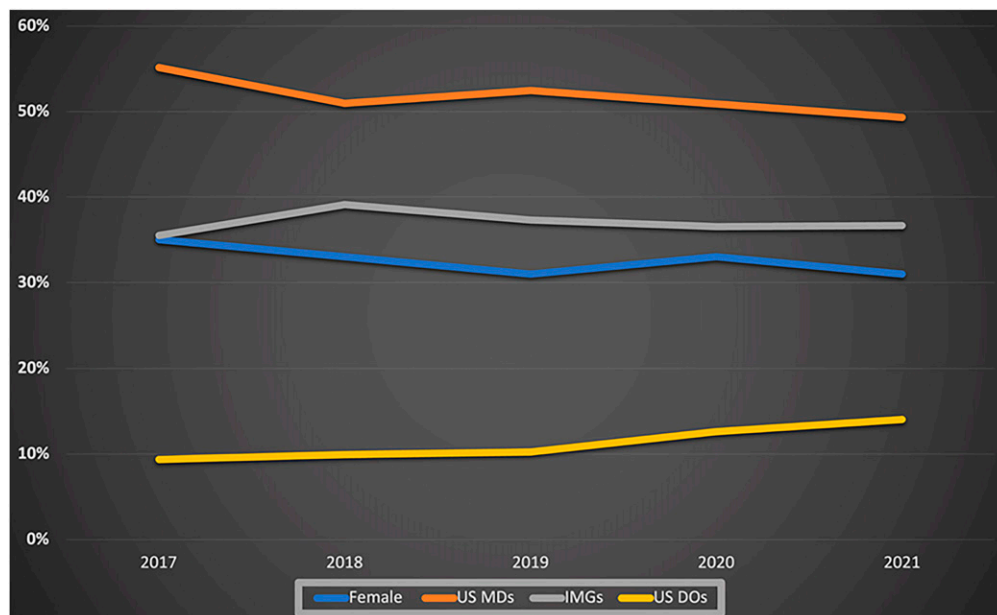
#### RESULTS

Data of 4,333 applicants ranking PCCM specialty and 2,966 successfully matched applicants were collected and analyzed for the years 2017–2021, with demographic information summarized in Table 1. Figure 1 shows the match trend for female candidates, U.S. MDs, U.S. DOs, and IMG applicants for the years 2017–2021. As shown in Table 2, the number of females and the number of IMG applicants matching into PCCM did not change significantly comparing the years 2017–2020 to year 2021. However, the number of matched U.S. DOs for the year 2021 has increased significantly after switching to the virtual interview format compared with the pre–virtual interview format between 2017 and 2020. Chi-square trend analysis comparing the percentage of applicants (U.S. MDs vs. U.S. DOs vs. IMGs) between the average of the 2017–2020 years versus 2021 showed that the percentage of U.S. MDs applying to PCCM decreased significantly in 2021 compared with 2017–2020 ( $\chi^2 = 6.432$ ; *P* = 0.01) (Table 3). However, the applicant match rate did not significantly change ( $\chi^2 = 2.448$ ; *P* = 0.118). The match probability for U.S. DOs was shown to have increased in 2021 when compared with the years 2017–2020 ( $\chi^2 = 8.569$ ; *P* = 0.003). There was no significant change in IMG applicants' match rates after the implementation of virtual interviews.

**Table 1.** Data including the total number and percentage of matched applicants per year according to them being women, US MDs, IMGs, and DOs

Match Year	Total No. of Applicants Ranking Specialty	U.S. MD Applicants		Non-U.S. MD Applicants		Total Positions		Matched U.S. MD		Matched IMGs		Matched DOs		Matched Female	
		n	% out of Total Applicants	n	% out of Total Applicants	n	%	n	% of U.S. MD Applicants	n	% of Non-U.S. MD Applicants	n	% of Non-U.S. MD Applicants	n	% of Filled Positions
2017	742	323	43.50	419	56.50	530	98.90	289	89.50	186	44.39	49	11.69	183	35.00
2018	789	320	40.60	469	59.40	568	99.50	288	90.00	221	47.12	56	11.94	186	33.00
2019	848	363	42.80	485	57.20	601	99.00	312	86.00	222	45.77	61	12.58	184	31.00
2020	931	374	40.20	557	59.80	629	99.70	319	85.30	229	41.11	79	14.18	207	33.00
2021	1,023	387	37.80	636	62.20	657	99.70	323	83.50	240	37.74	92	14.47	203	31.00

*Definition of abbreviations:* IMG = International Medical Graduate; U.S. DO = U.S. Doctor of Osteopathic Medicine; U.S. MD = U.S. Doctor of Medicine. Match year in our study represents the year in which applicants will start their fellowship training; for example, match year 2021 represents the year for which applicants submitted their application in July 2020 and expected to start their training in July 2021.



**Figure 1.** Percentage of applicants by their demographic group from 2017 to 2021. IMG = International Medical Graduate; U.S. DO = U.S. Doctor of Osteopathic Medicine; U.S. MD = U.S. Doctor of Medicine.

Strikingly, the overall applicants' probability of matching at their first choice has significantly decreased after the virtual interviews season ( $\chi^2 = 4.14$ ;  $P = 0.042$ ). The probability of matching at a program lower than their third choice has significantly increased ( $\chi^2 = 11.039$ ;  $P < 0.001$ ) (Table 3 and Figure 2). Both before and after 2021, 95% of applicants who applied to PCCM indicated it as their preferred specialty (Table 3).

## DISCUSSION

The NRMP and ABIM match data from 2017–2021 showed an overall increase in the number of applicants applying to PCCM, potentially indicating that PCCM is becoming a more attractive career choice for many applicants despite the COVID-19 pandemic. The reasons for this are multifactorial. Prior studies have demonstrated that shift work was associated with a reduction in burnout (14, 15) among ICU physicians. Other potential reasons include higher compensation than

several other internal medicine subspecialties (16). Finally, PCCM likely provides broad career opportunities for fellows in the future, given the shortage of intensivists in the United States (17). The increasing interest in PCCM is likely driven by the increasing number of U.S. DO and IMG applicants. The percentage of U.S. MD applicants increased by 19.8%, whereas the percentage of U.S. DOs and IMGs increased by 51.7% between 2017 and 2021. This is likely a reflection of the increasing number of U.S. DO graduates. Between 2011 and 2021, the number of U.S. DO graduates increased from 4,458 per year to 7,416 (18). We also found a large percentage of applicants to PCCM fellowship programs are IMGs. In fact, 36.6% of PCCM fellowship spots were filled by IMGs; this percentage did not significantly change between 2017 and 2021. According to Allman and colleagues, IMGs are the most viable solution to fill vacancies in the U.S. healthcare workforce, especially in underserved communities (19). In addition,

**Table 2.** Characteristics of pulmonary and critical care medicine matched applicants, 2017–2021 and 2017–2020

Match Year	Total Number of Matched Applicants	Sex out of Matched		Matched Applicant Status					
		Female	Male	U.S. MDs	Non-U.S. MDs	IMGs	Non-IMGs	U.S. DOs	Non-U.S. DOs
2017	524	183	341	289	235	186	338	49	475
2018	565	186	379	288	277	221	344	56	509
2019	595	184	411	312	283	222	373	61	534
2020	627	207	420	319	308	229	398	79	548
2021	655	203	452	323	332	240	415	92	563
2017–2021	—	0.2181	—	0.0748	—	0.9151	—	0.003	—
2017–2020	—	0.4096	—	0.2374	—	0.9362	—	0.0732	—
2017–2020 vs. 2021, <i>P</i> value	—	0.278	—	0.1	—	0.65	—	0.0034	—

For definition of abbreviations, see Table 1.

The data for the years 2017–2020 and 2017–2021 represents the average across these periods. The purpose was to investigate whether the exclusion of the year 2021 would lead to different results. It is crucial to note that, originally, the inclusion of the year 2021, characterized by virtual interviews, rendered a significant *P* value for the match of DOs. However, upon its exclusion, the *P* value became nonsignificant.

IMGs may provide diversity to the field, given the rapidly diversifying population in the United States (20).

An interesting finding in our study was the significant increase in the match rate of U.S. DOs with the implementation of virtual interviews. This is likely due to an increase in U.S. DO candidates entering the match. Another potential explanation is the increased opportunity to interview more broadly with the virtual interview process (21). A recent analysis of ERAS data found that the number of applications per applicant in PCCM increased between the years 2018 and 2021 (43.4 applications per applicant in 2018 compared with 54.4 applications per applicant in 2021) (22). In addition, five internal medicine fellowships reported a higher annual increase in the percentage of applications per applicant between 2020 and 2021 compared with prior years

(22). In addition, applicants estimated cost savings of \$3,000–\$5,000 each with the virtual interviews (23). The reduction in travel costs could have also prompted candidates to apply and interview more broadly.

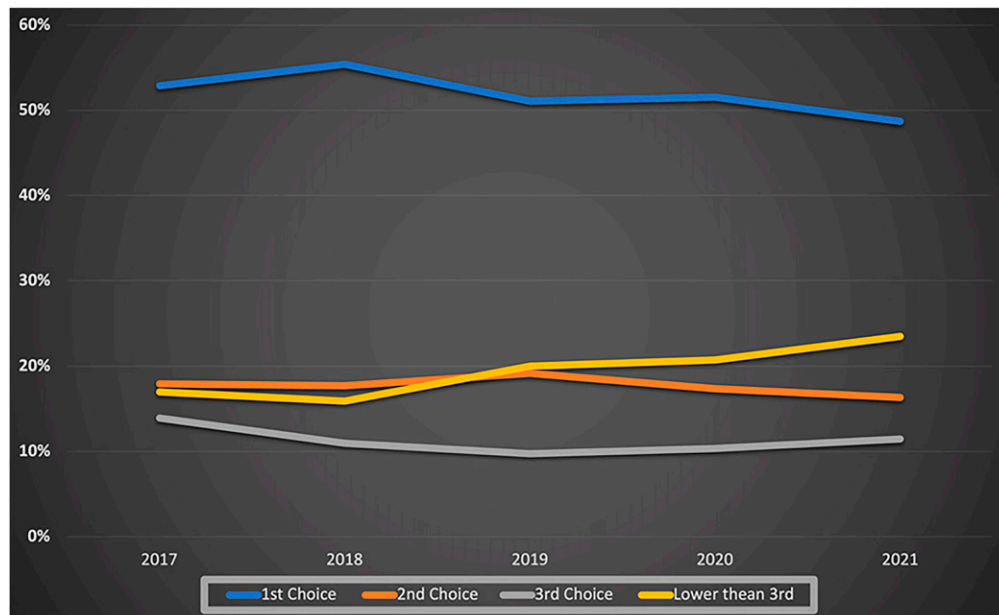
After the implementation of the virtual interviews season, we found that PCCM applicants are significantly more likely to match at a program ranked lower than third on their rank list. This observation could be explained by the increased number of applications each program received for the limited number of positions (22). As applicants are applying more broadly, this may have contributed to a higher number of interviews for each applicant (21). We also argue that virtual interviews might not give programs and applicants the best chance to connect on a professional level (24); it is hard to get a good sense of the applicant's demeanor

**Table 3.** Comparison of ranking choice of matched applicants in PCCM and the number of US MDs applying between 2017 and 2021

Match Year	Total No. of Matched Applicants		Applicants Matching at a Choice		Applicants Matching at a Choice Lower Than Their Third Choice		Total of Applicant Ranking Specialty		Applied to PCCM as the Preferred Specialty		U.S. MD Applicants	
	n	%	n	%	n	%	n	%	n	%	n	%
2017	524	53	277	53	89	17	742	708	95.4	323	43.5	
2018	565	55	313	55	90	16	789	752	95.3	320	40.6	
2019	595	51	304	51	119	20	848	804	94.8	363	42.8	
2020	627	52	323	52	130	21	931	889	95.5	374	40.2	
2021	655	49	319	49	154	24	1,023	975	95.3	387	37.8	
2017–2020 vs. 2021, P value	—	0.04	—	0.0089	—	—	—	—	—	—	0.01	

*Definition of abbreviations:* PCCM= pulmonary and critical care medicine; U.S. MD= U.S. Doctor of Medicine. Match year in our study represents the year in which applicants will start their fellowship training; for example, match year 2021 represents the year for which applicants submitted their application in July 2020 and expected to start their training in July 2021.





**Figure 2.** At which choice do applicants match?

and mannerisms and to assess a program's environment virtually (25). In a survey of applicants to the pediatric anesthesiology fellowship, more than 50% of applicants felt slightly worse or much worse on the representation of their personality (52.2%), communication skills (52.2%), demonstration of interest in the program (56.8%), and ability to convey "who I am" (60.9%) by virtual interviews (9). These factors could have potentially contributed to confusion and ambivalence during ranking by both programs and applicants. COVID-19 pandemic restrictions might have also limited some of the applicants' ability to do elective rotations at the programs they were interested in, removing a potential avenue for experiencing a program firsthand and interacting with faculty, staff, and other fellows (25).

### Limitations

The databases used in this study provide limited information about applicants or program characteristics. In particular, the individual separate number of IMG and U.S. DO applicants applying to PCCM

is not publicly available on the NRMP website, as U.S. DOs and IMGs are grouped together in the same group referred to as non-U.S. MDs. However, we reported our data using the number of matched applicants according to each group. It also did not give any information about applicants' future careers. In addition, some fellowship programs do not participate in the NRMP match.

In addition, this study does not provide sufficient data on how the pandemic affected internal medicine residents in making their career decisions. Last, our study did not include any data on the residency programs in which applicants were enrolled at the time they applied to the fellowship match. Therefore, we were unable to provide matching data on applicants for each cohort. Thus, other factors associated with the residency program (e.g., the presence of mentors) could have confounded our results, and this is a limitation of our study. Nevertheless, to our knowledge, this is the first study that compares match trends for PCCM before

and after the implementation of the virtual interview process.

### Conclusion

Our study provides evidence regarding the effect of the virtual interview process on PCCM match results. Strikingly, applicants are more likely to match at lower-ranked programs in their rank list after the implementation of the virtual interview process. The information found detailing the change in the applicants' backgrounds as well as the change in rates of matching at

preferred programs can be helpful for both programs and applicants, to guide their future expectations and decisions while going through the interview process.

Although this is a start, future studies are likely needed to further expand on the detailed demographics of applicants and potential changes seen after the shift in the interview paradigm as well as further information on the types of programs where applicants are matching.

**Author disclosures are available with the text of this article at [www.atsjournals.org](http://www.atsjournals.org).**

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