



# Pediatric Pulmonary Fellowship Program Size Effect on Recruitment and Workforce Distribution

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## ABSTRACT

**Background:** Concerns about the pediatric pulmonology workforce suggest a need to improve fellowship recruitment. Program size is related to the financial health and recruitment success of pediatric subspecialty education programs, but there are few data on how program size impacts recruitment and workforce in pediatric pulmonology.

**Objective:** Assess the impact of program size in pediatric pulmonology through examination of the distribution of applicants matching into pediatric pulmonology training programs over time and relationships to workforce distribution.

**Methods:** Data from the National Residency Match Program from 2010 to 2022 were extracted from published documents. Positions offered, positioned filled, and match rates were calculated for each appointment year. Statewide statistics for the number of fellows matched were analyzed relative to the number of pediatric pulmonologists per capita using data from the American Board of Pediatrics.

**Results:** From 2010 to 2018, the size and distribution of programs in pediatric pulmonology were stable, with most fellows (82.4%) matching into programs with one or two positions per cycle. Starting in 2019, programs offering three or more positions

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steadily increased in number and aggregate positions offered. This change was associated with an increase in total filled positions ( $38.9 \pm 7.3$  in 2010–2018 vs.  $50.5 \pm 8.7$  in 2019–2022;  $P < 0.03$ ) and an increased fraction who matched into larger programs (17.6% in 2010–2018 vs. 36.9% in 2019–2022;  $P < 0.001$ ). Among states with fellowship programs, the number of fellows matched over the past 5 years correlated with the number of practicing pediatric pulmonologists per capita ( $r = 0.78$ ;  $P < 0.001$ ).

**Conclusion:** The period 2019–2022 saw a marked shift of pediatric pulmonary trainees matching into a relatively small number of larger programs. This shift was associated with overall growth in the number of trainees but may have implications on geographical distribution of practicing pediatric pulmonologists.

**Keywords:**

fellow; match; applicants; positions

Since joining the National Residency Match Program (NRMP) for the 2010 appointment year, pediatric pulmonology has always had more available training positions than applicants. Failure to fill all offered positions has raised concerns about the future of the workforce (1–5), and although current match rates appear sufficient to maintain and even grow the number of actively practicing pediatric pulmonologists (1), it is unclear if these numbers will be sufficient to meet the growing clinical need (4, 5). Several studies have evaluated the factors that underlie successful recruitment into training programs, with program size linked to greater financial security in pediatric subspecialties in general (6) and pediatric pulmonology in particular (7). Program size has also been associated with higher match rates in other fellowship training programs (8, 9).

Pediatric pulmonology training programs have historically been relatively small, with the vast majority accepting only one or two trainees per year. However, recent data from the NRMP indicate a growing number of larger pediatric pulmonology training programs offering three or more positions annually (10). To determine the

influence of this increase in the number of larger programs on the total number and distribution of trainees, we analyzed NRMP data for pediatric pulmonology from 2010 to the 2022 appointment year and explored relationships between fellowship positions filled and active pediatric pulmonologists. Because some pediatric pulmonology fellows find positions outside of the match (5, 11), we also used data from the American Board of Pediatrics (ABP) on total number of first-year fellows per year.

## METHODS

NRMP data were extracted from three documents: NRMP Program Results 2018–2022 Specialties Matching Service, NRMP Program Results 2014–2018 Specialties Matching Service, and NRMP Program Results 2010–2014 Specialties Matching Service available online (10). Each document was exported to a spreadsheet and data extracted for pediatric pulmonology programs. All exported data were reviewed manually, and data from overlapping years among the documents were used to validate data extraction. Publicly available data from the ABP were

used to assess the total number of fellows in pediatric pulmonology training programs (12), which accounts for fellows who secured positions via the match as well as outside the match. The ABP data were also used to assess the number of children and number of practicing pediatric pulmonologists per state (13). Match rates per capita were determined by dividing the total number of applicants matched from 2018 to 2022 in each state (combining program data for states with multiple programs) by the total number of children in the state. For statistical analyses, between-group comparisons between programs over different time intervals were made using Student's *t* test, and comparisons among programs of different size within a time interval were performed by analysis of variance, with Dunnett's *post hoc* test comparisons. Correlations were performed by linear regression.

## RESULTS

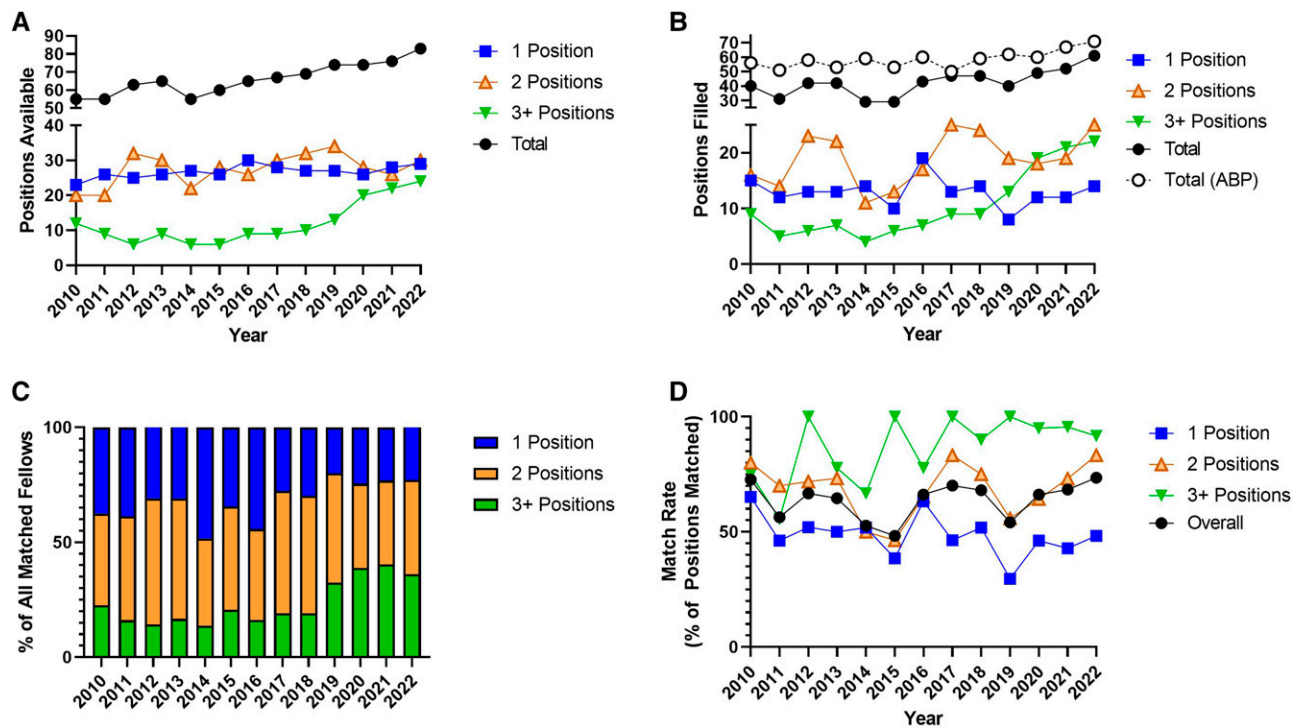
### Trend of Total Positions Offered by Program Size

Using NRMP data, we assessed the match statistics of training programs segregated by size based on the number of positions offered in each cycle. Between 2010 and 2018, the distribution of positions offered by program size was stable (Figure 1). Programs offering one or two positions per cycle represented the bulk of available training positions, collectively offering an average of  $26.4 \pm 1.9$  and  $26.7 \pm 4.9$  positions per cycle, respectively (Table 1). In this interval, no more than three programs offered three or more positions per cycle, and these larger programs collectively offered significantly fewer aggregate positions, with an average of  $8.4 \pm 2.1$  positions per cycle. However, starting in 2019, the number of aggregate positions offered by programs with three

or more positions increased significantly (Figure 1A), and from 2019 to 2022 the total number of positions these programs offered per cycle more than doubled to  $19.8 \pm 4.8$  positions per cycle ( $P < 0.001$  vs. 2010–2018 interval). In contrast, the total number of positions from programs offering one or two positions per cycle were not statistically different between the two intervals (Table 1).

### Trend of Match Rate and Proportion of Total Matched Applicants by Program Size

The change in distribution of available training positions within the NRMP had a significant impact on the distribution of matched applicants among different-sized programs. The number of applicants matched into the largest programs that offered three or more slots per cycle increased from  $6.9 \pm 1.8$  per cycle (17.6% of the total) during 2010–2018 to  $18.8 \pm 4.0$  applicants per cycle (36.9% of total) during 2019–2022 ( $P < 0.001$ ) (Table 1 and Figures 1B and 1C). In contrast, the number of applicants who matched into the smallest programs with only one slot per year was  $13.7 \pm 2.4$  in 2010–2018 and  $11.5 \pm 2.5$  in 2019–2022 ( $P = 0.072$ ) (Figure 1B), which represented a decreased share from  $35.8 \pm 7.0\%$  to  $22.6 \pm 1.9\%$  of all applicants ( $P < 0.005$ ; Figure 1C). The number of applicants matching into programs offering two positions was  $18.3 \pm 5.2$  from 2010 to 2018 and  $20.3 \pm 3.2$  from 2019 to 2022 (Table 1 and Figure 1C), which was not a statistically significant difference ( $P = 0.127$ ). The increase in matched positions within the programs offering three or more slots was sufficient to increase the total number of matched applicants from  $38.9 \pm 7.3$  in 2010–2018 to  $50.5 \pm 8.7$  in 2019–2022 ( $P = 0.029$ ). There was a similar increase in the total



**Figure 1.** Pediatric pulmonology training and program size. (A) Number of National Residency Match Program (NRMP) positions offered per year for programs segregated by program size, defined by the number of training positions offered in that match year (one, two, or three or more positions). (B) Number of positions filled per year by program size. Also shown are total for all positions matched by the NRMP and total number of first-year fellows for that year by ABP. (C) Distribution of all matched fellows per year by program size. (D) Match rate (percentage of NRMP positions matched) per year by program size. ABP = American Board of Pediatrics

number of first-year pediatric pulmonology fellows as tracked by ABP (Table 1 and Figure 1B). Match rates (percentage of offered positions that matched) varied considerably by program size and were significantly higher in programs offering two positions or three or more positions relative to those offering one position over both intervals (Table 1 and Figure 1D).

#### Training Program Size and Geographic Distribution of Pediatric Pulmonologists

Of the 56 programs that offered positions in any year from 2019 to 2022, 9 programs in eight states offered three or more positions for at least one cycle. Each program was located in a major metropolitan region, and all were located in states that were at or above the median number of pediatric pulmonologists of 1.3

per 100,000 children. The average number of pediatric pulmonologists in the eight states with these larger programs was significantly higher than in states that only had programs that offered one or two positions annually ( $2.4 \pm 1.0$  vs.  $1.7 \pm 0.5$ ;  $P = 0.031$ ). To assess the relationship between fellowship match rates and availability of pediatric pulmonologists, we compared the total number of pediatric pulmonology fellows matched over the past 5 years within each state that had at least one training program to the number of pediatric pulmonologists currently practicing in that state. On a per capita basis (per 100,000 children), the total number of fellows matched per state significantly correlated with the number of active pediatric pulmonologists (Figure 2).

**Table 1.** Pediatric pulmonology match data over the intervals 2010–2018 and 2019–2022 by program size

	Interval	Program Size (Positions Offered per Cycle)			Total
		1 Position	2 Positions	≥3 Positions	
NRMP programs	2010–2018	26.4 ± 1.9	13.3 ± 2.4	<b>2.8 ± 0.7</b>	<b>42.6 ± 3.3</b>
	2019–2022	27.5 ± 1.3	14.8 ± 1.7	<b>6.0 ± 1.4</b>	<b>48.3 ± 2.1</b>
	<i>P</i> value*	0.347	0.322	<b>&lt;0.001</b>	<b>0.010</b>
NRMP positions available	2010–2018	26.4 ± 1.9	26.7 ± 4.9	<b>8.4 ± 2.1<sup>†</sup></b>	<b>61.6 ± 5.5</b>
	2019–2022	27.5 ± 1.3	29.5 ± 3.4	<b>19.8 ± 4.8<sup>†</sup></b>	<b>76.8 ± 4.3</b>
	<i>P</i> value*	0.347	0.322	<b>&lt;0.001</b>	<b>&lt;0.001</b>
NRMP positions filled	2010–2018	13.7 ± 2.4	18.3 ± 5.2 <sup>†</sup>	<b>6.9 ± 1.8<sup>‡</sup></b>	<b>38.9 ± 7.3</b>
	2019–2022	11.5 ± 2.5	20.3 ± 3.2 <sup>§</sup>	<b>18.8 ± 4.0<sup>†</sup></b>	<b>50.5 ± 8.7</b>
	<i>P</i> value*	0.172	0.518	<b>&lt;0.001</b>	<b>0.029</b>
ABP first-year fellows	2010–2018	—	—	—	<b>55.4 ± 3.8</b>
	2019–2022	—	—	—	<b>65.0 ± 5.0</b>
	<i>P</i> value*	—	—	—	<b>0.003</b>
Match rate (% of NRMP positions matched)	2010–2018	51.7 ± 8.3	68.4 ± 12.6 <sup>†</sup>	82.5 ± 16.0 <sup>‡</sup>	62.9 ± 8.4
	2019–2022	41.7 ± 8.4	69.1 ± 11.8 <sup>§</sup>	95.5 ± 3.4 <sup>†</sup>	65.5 ± 8.2
	<i>P</i> value*	0.072	0.919	0.145	0.605
% of all NRMP matched fellows	2010–2018	<b>35.8 ± 7.0</b>	46.5 ± 6.5 <sup>§</sup>	<b>17.6 ± 2.9<sup>‡</sup></b>	100
	2019–2022	<b>22.6 ± 1.9</b>	40.4 ± 5.1 <sup>†</sup>	<b>36.9 ± 3.5<sup>‡</sup></b>	100
	<i>P</i> value*	<b>0.004</b>	0.127	<b>&lt;0.001</b>	—

*Definition of abbreviations:* ABP = American Board of Pediatrics; NRMP = National Residency Match Program.

Values that are significantly different ( $P < 0.05$ ) are highlighted in bold.

\* $P$  value for 2010–2018 versus 2019–2022 by Student's  $t$  test.

<sup>†</sup> $P < 0.05$  vs. programs with one position by analysis of variance across program size with Dunnett's multiple comparisons *post hoc* test.

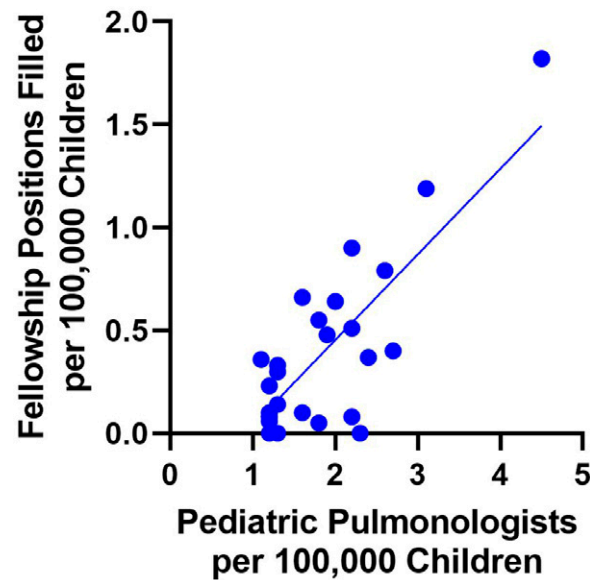
<sup>‡</sup> $P < 0.001$  vs. programs with one position by analysis of variance across program size with Dunnett's multiple comparisons *post hoc* test.

<sup>§</sup> $P < 0.01$  vs. programs with one position by analysis of variance across program size with Dunnett's multiple comparisons *post hoc* test.

## DISCUSSION

Data from the NRMP demonstrate a clear shift in the size distribution of pediatric pulmonology programs over time. Since 2019, the number of programs offering three or more training positions has grown significantly, with a greater fraction of all trainees concentrated into this relatively small number of large programs. Even accounting for fellows who find positions outside of the match using ABP

data, these large programs now train nearly a third of new pediatric pulmonologists, significantly more than those who matched into the smallest programs, even though the latter collectively offer more positions through the match. The shift toward a greater fraction of fellows in larger programs is a reversal from patterns present from 2010 to 2018, in which >80% of fellows matched into smaller programs



**Figure 2.** Relationship between recent training and number of pediatric pulmonologists. A significant linear correlation ( $r=0.78$ ;  $P<0.001$ ) was observed between the number of pediatric pulmonologists per 100,000 children and the number of pediatric pulmonology fellowship positions matched per 100,000 children over the past 5 years in each state with a pediatric pulmonology training program. States without pediatric pulmonology training programs were excluded from the analysis.

offering only one or two positions per cycle.

Essentially all of the growth in the total number of trainees since 2019 reflects increased matching into larger programs, with the number of fellows matching into programs with one or two positions not changing significantly over these intervals. Although prior studies have focused on the roles of early exposure and mentoring (14, 15), social media presence (8, 9), and national reputation (9) in attracting more trainees to underfilled specialties, our findings raise the question of whether increasing the number of larger programs may also improve recruitment. We have not established a cause-and-effect relationship or reasons why increasing the number of larger programs would attract more residents into a specialty. Program size is strongly related to match rates across other subspecialties (8, 9), although, at least in nephrology, size was less of a factor when national reputation and social

media presence were taken into account (9). Larger programs have better funding and financial security in pediatric subspecialties in aggregate (6) and in pediatric pulmonology specifically (7), which gives them the means to expand, offer more resources, and attract more applicants. There are few data to inform reasons why larger programs are more successful with the match. Future qualitative studies could help to explain this trend and assess if factors such as camaraderie and social aspects of larger programs are playing a role, which will allow for informed recommendations regarding strategies to improve recruitment and workforce distribution.

Although increasing the number of pediatric pulmonologists being trained could help address longstanding concerns about the future of the workforce (4, 5), there are some potential negative effects associated with the shift toward concentrating more trainees into a

relatively small number of larger programs. Although we did not observe statistically significant changes in fill rates of the smallest programs over the interval 2019–2022, there were concerning trends that could become more significant over longer time frames than we measured in our study. Furthermore, the larger pediatric pulmonology programs are all located in metropolitan areas, and many are within states that are well above the median values of currently active pediatric pulmonologists per capita. Location of training has been postulated to influence location of practice (16, 17), and the correlation between matched trainees and active pediatric pulmonologists per state observed in this study is consistent with this hypothesis. Although the factors underlying the geographical disparities in access to pediatric pulmonary care are complex (18) and may involve factors unrelated to training, such as lifetime earning potential (19), it is possible that a shift of more fellows into larger programs could contribute to these geographic disparities. Moving providers from the cities where they train to underserved areas will be important in terms of access to care.

### Limitations

One limitation to this study is that data from the last 2 years were from recruitment cycles that were virtual because of the coronavirus disease (COVID-19) pandemic. Although we cannot rule out that virtual recruitment favored larger programs and contributed to our findings, the trends we observed predated the pandemic and are unlikely to be entirely due to the switch away from in-person recruiting. Virtual interviews seem likely to remain a significant part of recruitment as a means to promote equity among applicants, some of whom may have financial or logistical barriers to

in-person visits (20). Regardless, the impact of virtual recruiting on training decisions deserves further investigation.

Another limitation to this study is that the analysis of positions offered and filled were derived from the NRMP. A substantial fraction of fellows enter programs outside of the match (11), and the ABP does not publicly report detailed data on the number of fellows per program needed to evaluate the influence of program size or number of fellows by state. Given the high match rates in larger programs, it seems likely that many trainees who did find positions outside the match did so within smaller programs, although it is unclear if they filled unmatched positions or took positions that were never offered as part of the NRMP. Although our reliance on NRMP data may overestimate discrepancies between large and small programs, we do not believe that accounting for these positions would meaningfully alter our main conclusions relating to the increase in number of trainees, growth of larger programs, and relationships between state-specific pediatric pulmonologists and trainees.

### Conclusions

We identified a recent shift in pediatric pulmonary training in which more applicants were matching into larger programs offering three or more slots per year. Future studies can explore reasons trainees are attracted to larger programs and the impact of increasing the number of large programs on overall recruitment. At the same time, we must evaluate the impact this trend may have on smaller programs and/or geographical disparities in access to care.

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

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