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BRIEF COMMUNICATION

# Match Outcomes for Cardiovascular Disease Fellowship Training: 2010 to 2021

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**BACKGROUND:** This study elucidates recent trends in application and match rates in the Cardiovascular Disease Fellowship Match. We hypothesized that (1) match rates have increased with time; (2) match rates are highest for US allopathic graduates; and (3) most candidates match at 1 of their top 3 ranked fellowship choices.

**METHODS AND RESULTS:** This was a retrospective cohort study of all applicants in the Cardiovascular Disease Fellowship Match from 2010 to 2021 (n=14 674). Chi-square tests were used to compare trends over time and match rates by applicant archetype (US allopathic graduates and non-US allopathic graduates). The annual number of applicants increased from 1184 to 1575 (33% increase) while training positions increased 718 to 1045 (46% increase) over the study period. The percentage of applicants that matched increased from 61% in 2010 to 66% in 2021 ($P$=0.090). The average match rate was 70% over the study period. During each year, US allopathic graduates had higher match rates than non-US allopathic graduates ($P$<0.001), but this disparity narrowed with time (83% versus 41% in 2010 and 83% versus 54% in 2021). Most applicants matched at 1 of their top 3 choices (first, 37%; second, 12%; third, 7%). Applicants matching at 1 of their top 3 choices decreased from 51% in 2010 to 48% in 2021 ($P$=0.704).

**CONCLUSIONS:** The Cardiovascular Disease Fellowship Match has remained equally competitive over the past decade. US allopathic graduates have an advantage over non-US allopathic graduates. Most applicants match at 1 of their top 3 ranked fellowship choices.

**Key Words:** ACGME ■ cardiology ■ cardiovascular ■ fellowship ■ match ■ training

Cardiovascular disease is the largest subspecialty for internal medicine by number of training positions, yet remains among the most competitive for applicants.[1,2] This perception of increasing competition in the Cardiovascular Disease Fellowship Match (CDFM) can present unique challenges to both applicants and programs especially in the era of virtual interviews post COVID-19.[3] Objective data on recent match outcomes in the CDFM can help applicants, mentors, and faculty anticipate match outcomes and potentially improve match efficiency, which is an important area of ongoing research, debate, and discussion.[4]

In 2018, successfully matched US allopathic graduates ranked on average 9 Cardiovascular Disease Fellowship training programs in the CDFM.[5] Virtual and in-person interviews require clinical coverage and the potential for significant travel costs. While data for CDFM interview expenses are lacking in the literature, surgical residents most frequently attend between 8 and 12 fellowship interviews and most spend over $4000 on the interview process.[6] For the time being, virtual interviews have become the new normal given the impact of the COVID-19 pandemic.[7] Currently, few studies exist that provide objective data to guide future CDFM applicants.[8]

Each year, the National Resident Matching Program releases match outcomes data,[2,5] which demonstrate longitudinal trends in match rates and levels of competitiveness for each specialty. On the basis of insights generated from these reports, we generated 3 primary

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hypotheses: (1) match rates have increased over the past decade; (2) match rates are higher for US allopathic graduates versus non-US allopathic graduates; and (3) most candidates match at 1 of their top 3 ranked fellowship choices.

## METHODS

We designed a retrospective cohort study of all applicants in the CDFM from 2010 to 2021. The National Resident Matching Program provided data on match outcomes from the CDFM.[9] This study received exemption status from the Institutional Review Board given the deidentified nature of all data. The data that support the findings of this study are available from the corresponding author upon reasonable request. All eligible Cardiovascular Disease Fellowships were accredited by the Accreditation Council for Graduate Medical Education.

Data attributes amenable to statistical analysis included number of applicants, number of available training positions, and number of unfilled positions. These data were provided by match year and applicant archetype (US allopathic graduates and non-US allopathic graduates). Match rates were calculated as percentages and compared over time. Match years were defined by the National Resident Matching Program and preceded the year of training appointment. US allopathic graduates were previous students of US medical schools accredited by the Liaison Committee on Medical Education. Non-US allopathic graduates encompassed other applicants including international medical graduates. The National Resident Matching Program provided data on the number of applicants matching at their first, second, third, and fourth choice or higher.

Temporal trends were analyzed with Cochran-Armitage tests for trend. The percentage of applicants matching at their first choice, second choice, third choice, and fourth choice or higher were also calculated and trended over time. Successful match rates were compared by applicant archetype (US allopathic graduates versus non-US allopathic graduates) with Chi-square tests. Statistical tests were 2-tailed and calculated on GraphPad Prism (San Diego, CA). *P* values of <0.05 were considered statistically significant.

## RESULTS

### Number of Applicants, Programs, and Match Rates

The total number of available fellowship positions increased from 718 in 2010 to 1045 in 2021 (46% increase). The total number of fellowship applicants increased from 1184 in 2010 to 1575 in 2021 (33% increase). The increase in fellowship applicants was driven primarily by non-US allopathic graduates, which increased from 642 in 2010 to 914 in 2021 (42% increase). The percentage of applicants that matched to a Cardiovascular Disease Fellowship program increased from 61% (718/1184) in 2010 to 66% (1045/1575) in 2021 (*P*=0.090, Figure 1),

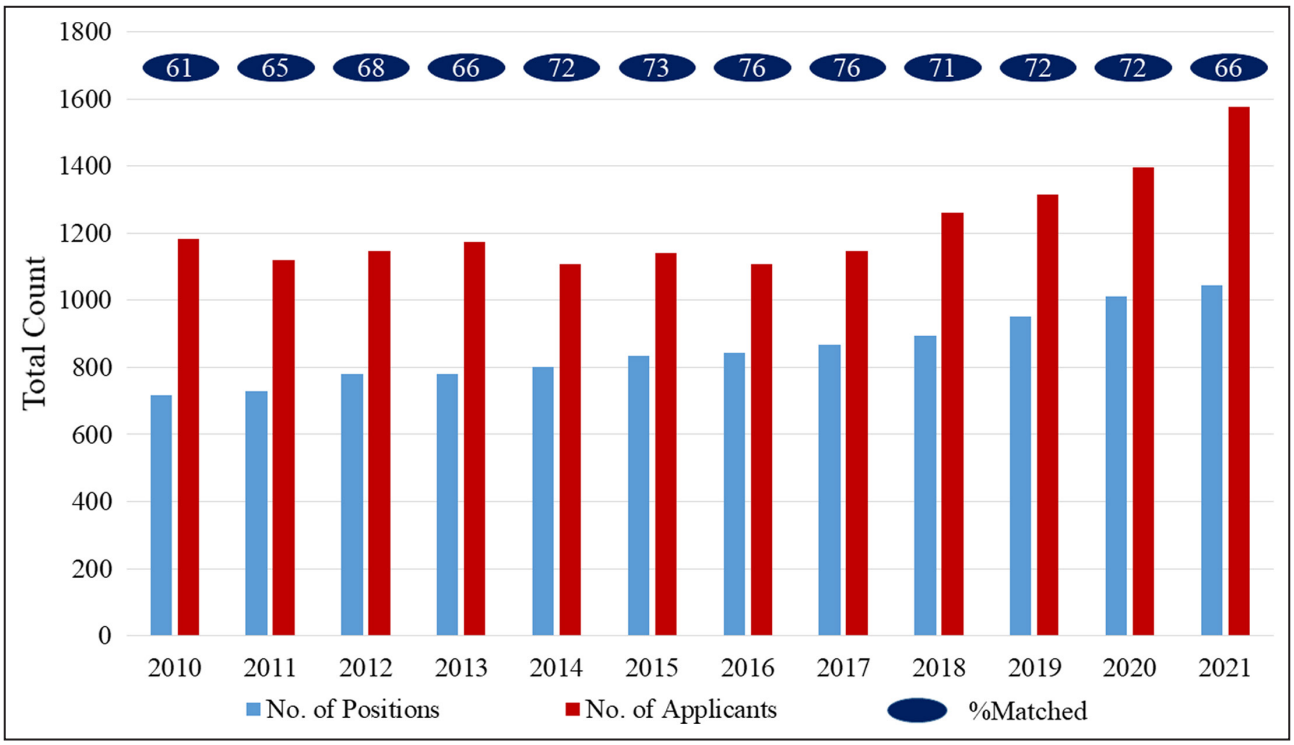


**Figure 1. Number of applicants and programs in the Cardiovascular Disease Fellowship Match.**

but this increase did not reach statistical significance. The annual match rate peaked in 2016 (76% [844/1108]) and 2017 (76% [866/1147]), which appeared to be driven by a steadily decreasing number of applicants with an increasing number of training positions (Figure 1). Over the study period, the average annual match rate was 70% (10252/14674).

## Comparison of Match Rates Between US Allopathic and Non-US Allopathic Graduates

US allopathic graduates had higher match rates than non-US allopathic graduates during each year ($P<0.001$), but this disparity narrowed over time (Figure 2). In 2010, there was nearly a 2-fold difference in match rates between US allopathic and non-US allopathic graduates (83% [450/542] versus 41% [263/642]; $P<0.001$), which decreased to 1.5-fold in 2021 (83% [549/661] versus 54% [493/914]; $P<0.001$). Over the study period, there was a significant increase in the annual match rate for non-US allopathic graduates ($P=0.003$) but was not significant for US allopathic graduates ($P=0.968$, Figure 2).

## Percentage of Applicants Matching at Their Top Ranked Programs

Over the study period, most applicants (56% [8279/14674]) matched at 1 of their top 3 ranked fellowship choices (first choice, 37% [5422/14674]; second choice, 12% [1771/14674]; third choice, 7% [1086/14674]). The percentage of applicants that matched at programs at their fourth choice and below was 13% (1889/14674). Applicants matching at 1 of their top 3 choices decreased from 52% (605/1184) in 2010 to 48% (754/1575) in 2021 ($P=0.704$, Figure 3).

## Number of Unmatched Positions in the CDFM

Every year, there was a certain number of training positions that did not match a fellow (Table S1). This percentage varied from 1.4% (11/779) in 2012 to 0.2% (2/1010) in 2020. There was a significant trend towards fewer available training positions that went unmatched over the study period ($P=0.016$).

# DISCUSSION

Overall, results from this study demonstrate consistently competitive match rates in the CDFM over the past decade. Match rates have increased significantly for non-US allopathic graduates, but US allopathic graduates retain a competitive advantage each year. In 2020, the first match year after the COVID-19 outbreak, match rates remained consistent with those from the prior year. However, in 2021, there was an increase in applications, which resulted in lower match rates for that year. Furthermore, match rates appeared to peak in 2016 and 2017 driven by a stagnating

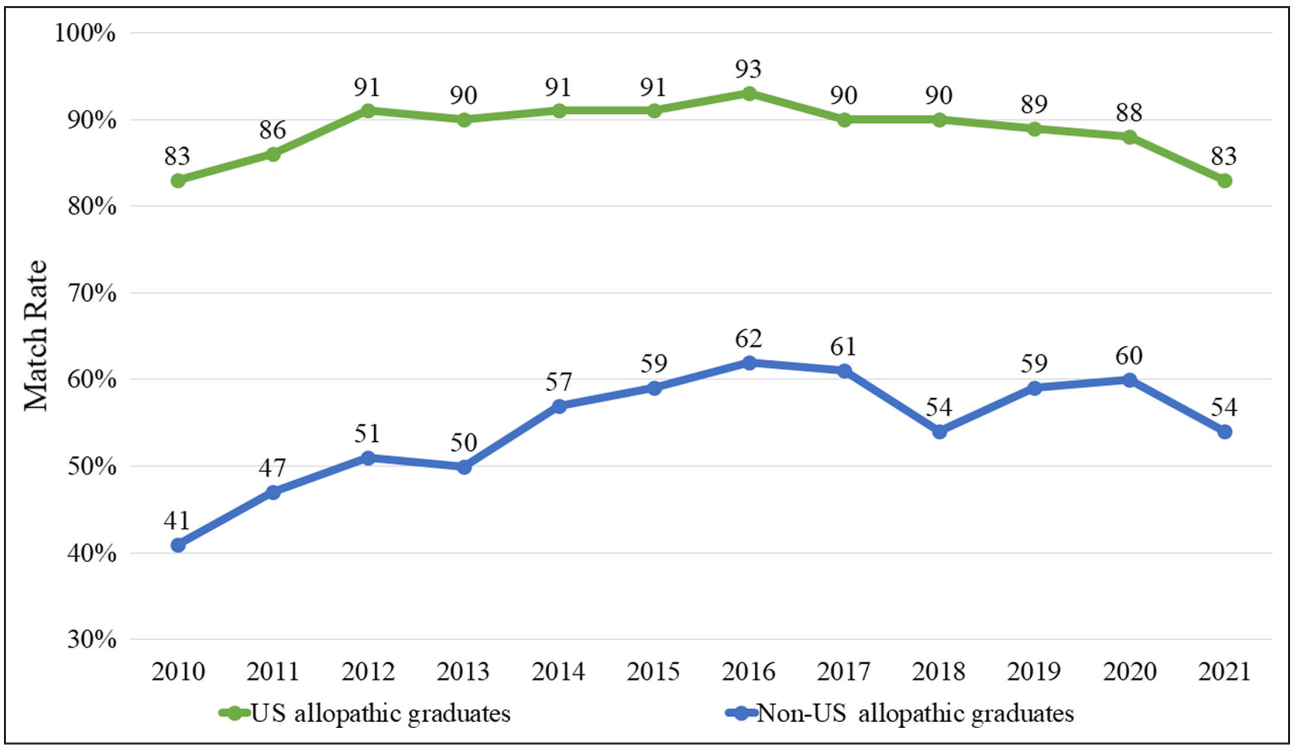


**Figure 2. Match rates in the Cardiovascular Disease Fellowship Match.**

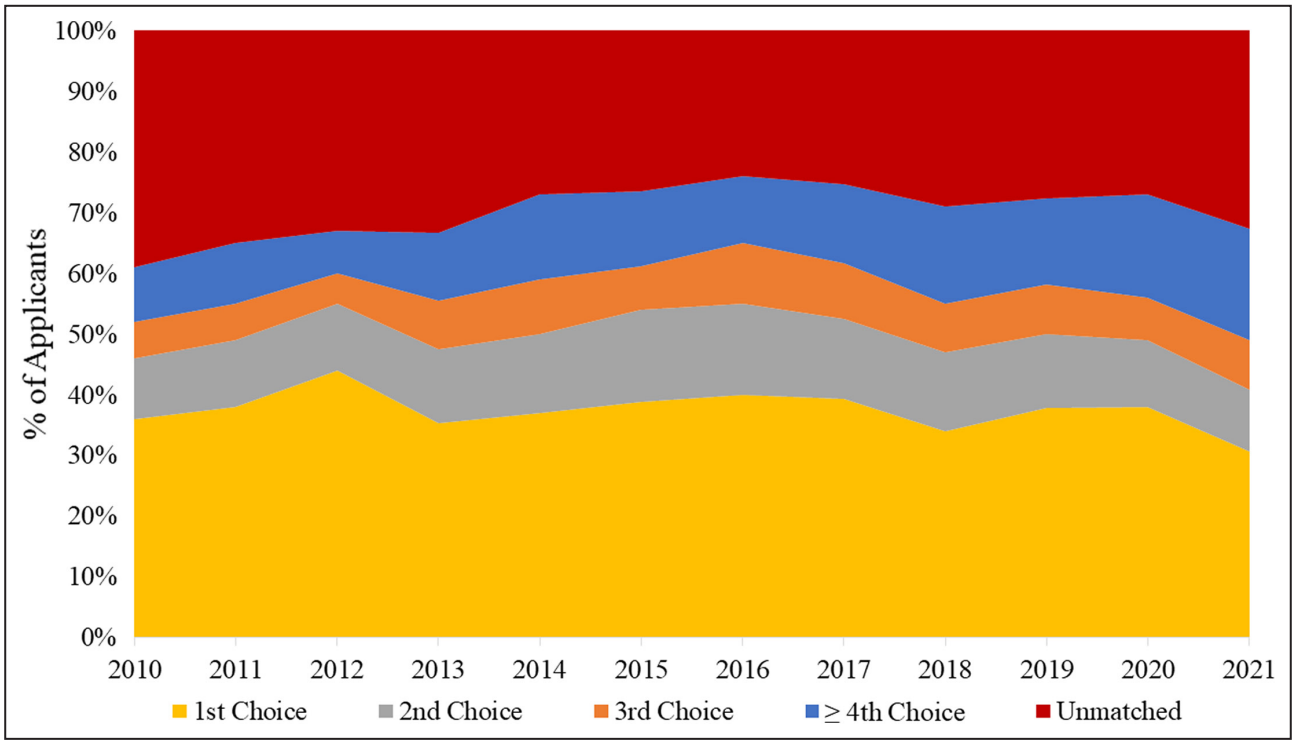


**Figure 3. Proportion of applicants matching at their top ranked choices in the Cardiovascular Disease Fellowship Match.**

number of applicants and consistently increasing number of training positions. Reasons for the rising interest in Cardiovascular Disease Fellowship training remain unknown and are likely complex and multifactorial. Future research is needed to understand the factors that compel trainees to pursue Cardiovascular Disease Fellowship training including personal experiences, anticipated work-life balance, and mentorship. Given trends from prior years, conclusions on the impact of COVID-19 on match rates should be interpreted with caution. Ultimately, these data can be used by prospective applicants and faculty to anticipate outcomes in the CDFM.

A recent single-center study elucidated academic qualifications associated with a successful match outcome in the CDFM, including >3 research manuscripts during residency, high performance on the cardiovascular component of the in-training examination, completion of a cardiovascular elective rotation, and declaration of a career intention in cardiovascular disease.[10] Data from a national level corroborate these findings in that successfully matched applicants have higher mean board exam scores, number of research experiences, and number of publications.[5] Analysis of academic accomplishments of matched versus unmatched applicants consistently demonstrate that Cardiovascular Disease Fellowship training remains among the most competitive for internal medicine residents.[2] Results from our study demonstrate the competitiveness of the CDFM with an aggregate match rate of 70% over the past decade. It may be reasonable for non-US allopathic graduates to apply to a greater number of programs given their lower match rates.

There were several limitations to this study. First, we provide a snapshot of match outcomes from 2010 to 2021. While trends are instructive, they should be understood as indicative of the past and not necessarily the future. Second, fellowship applicant demographics and characteristics were not available for study including the number of fellowship program applications and interview invitations. It would be interesting to see how race and sex impact match outcomes given increased efforts to promote diversity and inclusion in the cardiovascular disease workforce.[11,12] Future studies should elucidate those applicant accomplishments that are most associated with successful match outcomes in the CDFM. Third, the impact of residency program rank and other training variables remain unknown. There are many confounding variables that influence match rates to highly ranked programs (eg, geography, personal preferences) as well as match rates by training background (ie, allopathic graduate) which should be the focus of future research. Future surveys can provide insight into how these variables impact the CDFM, with the goal of selecting future cardiovascular disease fellows in an evidence-based manner.[13,14] Lastly, future studies are needed to better understand the future demand for cardiologists as the US population ages and cardiovascular disease becomes more prevalent.[15] Results from the present study demonstrate an

increasing number of applicants for Cardiovascular Disease Fellowship training that could be leveraged for future workforce planning in the United States.

In summary, match rates in the CDFM have remained stable over the past decade. While match rates for non-US allopathic graduates have increased, US allopathic graduates maintain a competitive advantage. The majority of applicants match at 1 of their top 3 ranked fellowship programs. This analysis can help prospective applicants and programs to anticipate outcomes and potentially improve the efficiency of the match process. More research is needed to understand disparities in match rates by applicant variables including demographic and training factors.

## ARTICLE INFORMATION

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### Disclosures

None.

### Supplemental Material

Table S1

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# SUPPLEMENTAL MATERIAL

**Table S1. Analysis of Unmatched Positions in the Cardiovascular Disease Fellowship Match.**

| Match Year | Number of Available Positions | Number of Unmatched Positions | % of Unmatched Positions |
|---|---|---|---|
| 2010 | 718 | 4 | 0.6 |
| 2011 | 729 | 7 | 1.0 |
| 2012 | 779 | 11 | 1.4 |
| 2013 | 781 | 4 | 0.5 |
| 2014 | 800 | 3 | 0.4 |
| 2015 | 835 | 8 | 1.0 |
| 2016 | 844 | 7 | 0.8 |
| 2017 | 866 | 7 | 0.8 |
| 2018 | 894 | 5 | 0.6 |
| 2019 | 961 | 5 | 0.5 |
| 2020 | 1,010 | 2 | 0.2 |
| 2021 | 1,045 | 3 | 0.3 |
| Total | 10,262 | 66 | 0.6 |

*Data refer to the number of available positions that did not match a Cardiovascular Disease Fellow; Cochran-Armitage test for trend gives p=0.016