First-generation physician-scientists are under-represented and need better support:

First-generation students, whose parents do not have baccalaureate degrees, are less likely to apply to MD-PhD programs than to MD programs, which has led to a worrying lack of diversity among physician-scientists.

Briana Christophers[1,✉], **Briana Macedo**[2], **Edwin Nieblas-Bedolla**[3], **Mollie Marr**[4], **Olaf S. Andersen**[1], **Catharine Boothroyd**[1]

[1]Weill Cornell–Rockefeller–Sloan Kettering Tri-Institutional MD–PhD Program, New York, NY, USA

[2]Princeton University, Princeton, NJ, USA

[3]University of Washington School of Medicine, Seattle, WA, USA

[4]Oregon Health & Science University Medical Scientist Training Program, Portland, OR, USA

Physician-scientists occupy a unique and important space that bridges scientific research and medical practice, and many have expressed concern that physician-scientists are an endangered species, with a dwindling pool of interested future researchers[1–4]. Indeed, the number of MD-PhD applicants in the USA has remained stagnant from 2012, when there were 1,853 applicants, to 2020, when there were 1,825. Meanwhile, applications to medical school have steadily increased during the same time period, from 45,266 to 53,030 (refs.[5,6]). Is this because the traditional pool of applicants—those who have adequate advising and probably do not come from minority identities—has reached saturation? If so, there is a pressing need to recruit students who do not fit the traditional mold into the physician-scientist career path.

People who identify as the first in their family to receive a baccalaureate degree— also known as 'first-generation' students— remain under-represented in MD-PhD programs in the USA. The experience of first-generation physician-scientists in training has been excluded from conversations about diversity and inclusion, since first-generation status often intersects with other under-represented identities. The needs and barriers faced by first-generation MD-PhD applicants and trainees probably overlap those faced by first-generation undergraduate, medical and graduate students, but due to a lack of research, some specific needs and barriers are unknown and will require future study.

Given that first-generation MD-PhD students come from a background currently under-represented in medicine, they may be more likely to focus on important but under-investigated problems pertaining to the nation's health. For example, it was not until the US National Institutes of Health had its first female director, in the early 1990s, that it was mandated that women be included in clinical trials for diseases that affected more than just men[7]. Similarly, a 2018 study showed a 19% decrease in cardiac mortality in Black men when they were treated by a Black male physician[8]. People from lower socioeconomic backgrounds and certain races or ethnic groups have higher levels of COVID-19 vaccine hesitancy and refusal[9]. Research has shown that teams with a variety of backgrounds tend to be more creative and focus on problems that reach a greater network of people[10–13]. There is therefore a need to increase the number and diversity of physician-scientists, which makes it important to better understand the barriers first-generation students face in becoming physician-scientists. With this understanding, it will be possible to recruit a larger, and more-representative, student body to reap the benefits that stem from the unique characteristics and perspectives of these first-generation students.

Credit: erhui1979 / DigitalVision Vectors/ Getty

Lack of representation

According to data from the Association of American Medical Colleges, a total of 666 first-generation students matriculated into MD-PhD programs between 2012 and 2020, compared with a total of 5,461 matriculants during this period[5]. The total enrollment increased from 5,010 to 5,830, while the representation of first-generation applicants and matriculants remained unchanged across the same 9-year period[14,15]. The 'first-generation indicator', a more recent designation created by the Association of American Medical Colleges in 2018 to identify applications by first-generation students, was used by 11% of MD-PhD program applicants and 8% of matriculants in the 2020–2021 academic year[16,17]. The gap between applicants and matriculants was greatest for first-generation students, relative to that of students whose parents have degrees. We conclude that first-generation students are under-represented among applicants to MD-PhD programs, and that these students do less well during admissions, as evident by the applicant-to-matriculant ratio (Fig. 1).

In contrast, for medical-school matriculants, the percentage of first-generation enrollees is double that for MD-PhD enrollees, and a lower proportion of students have parents with

graduate degrees[18]. Differences between MD-PhD and MD-only applicants and matriculants suggest there are real and perceived barriers to matriculation into MD-PhD program, relative to those for MD programs, that exacerbate the under-representation of first-generation students among MD-PhD trainees.

The observations noted above are best understood in the context of intersecting identities. First-generation status often converges with other identities under-represented in science and medicine, including minority race and ethnicity and lower socioeconomic status[19,20]. These identities are also under-represented in MD-PhD programs. 64% of MD-PhD applicants and 71% of matriculants in 2020 had parents with a master's degree or higher[5]. Over 40% of matriculants in the past 9 years have had at least one parent with a doctoral degree[5]. Nationwide, the majority of medical students came from households with incomes in the top quintile (greater than $120,000 per year), and over 20% of the students' households had incomes in the top 5% (ref. [21]). Among MD-PhD students, 41% of applicants and 49% of matriculants came from families with a household income of $100,000 or greater, with no substantial changes between 2014 and 2020. Only 9% of applicants and 6% of matriculants had childhood household incomes in the lowest quintile (less than $25,000 per year)[22].

The disadvantages faced by first-generation MD-PhD students before they apply have not been studied and are therefore largely unknown. However, we expect that the barriers overlap those faced by first-generation pre-medical and pre-graduate students. The disadvantages most frequently cited for first-generation pre-medical and pre-graduate students are a lack of social, cultural and financial capital and the benefits that flow from that capital[19,23] (Fig. 2).

Social capital

Social capital refers to the social networks to which a person has access[23,24]. For first-generation students, social capital can be limited, because their families are unlikely to be able to provide the same guidance or have the same professional networks as those of traditional students[25]. This can manifest as a scarcity of mentors and advisors throughout undergraduate studies, during the application process and during training[25–27]. The lack of social capital is also reflected in limited access to the research opportunities and clinical experiences that are considered necessary experiences for successful MD-PhD applicants.

Financial capital

First-generation students may also face barriers because of their limited financial capital. Many first-generation students have additional financial responsibilities while attending college, which requires them to make time for jobs, take out larger loans and save money for the high cost of applying to medical school[28]. Part-time jobs may limit time that could be invested in college courses, preparation for the Medical College Admission Test, extracurricular activities (including laboratory research) and clinical experiences. Paid positions unrelated to science may take priority over unpaid research experiences, which are considered critical in the evaluation of MD-PhD applicants. Part-time jobs may also limit the time available for building social and professional networks and may thereby stifle

acquisition of the social capital deemed valuable by admissions committees[24]. Furthermore, the delay in achieving a stable income due to the doubled time to degree for MD-PhD trainees relative to that for MD students may pose additional concern for those facing financial hardship. If entering the job market becomes an urgent concern, the additional years of training may dissuade applicants. Although a student is fully funded while matriculated, these programs restrict employment opportunities and access to educational loans, which affects those in difficult financial situations. Students paying off undergraduate loans, financially supporting families or facing unexpected expenses during their program may struggle to balance those costs with the additional expenses of medical education, such as board-preparatory materials and national board exams. The high financial costs of applying for and training in MD-PhD programs should be reevaluated with first-generation and low-income students in mind, in addition to finding ways to more clearly explain to potential applicants the benefits of pursuing such training.

Cultural capital

Mentorship is often critical in providing first-generation students with the cultural capital needed to successfully navigate academic spaces[19]. This cultural capital includes knowledge and skills passed down through families and communities, to which first-generation students do not have access. First-generation students may also miss out on critical feedback and encouragement to continue on the path toward becoming physician-scientists[26].

For example, as mentioned above, finding the first research opportunity is of vital importance for future physician-scientists. First-generation undergraduate students may struggle in their search for a research opportunity due to a lack of understanding of the culture of the research setting and the expectations of MD-PhD programs' admissions committees. The extensive research experience necessary to be a competitive MD-PhD applicant often proves to be a barrier to those who are unaware of these expectations at an early stage in their undergraduate or even post-baccalaureate education.

Students who are not first generation may have parents and mentors working in science and medicine who relay information about the careers of physician-scientists—information that may not be as readily available to first-generation students. Moreover, first-generation students may feel that their applications are lacking if they did not start research early or were unable to invest substantial time in research because of their lack of social, cultural and financial capital early in their undergraduate training. This is a barrier more relevant to MD-PhD programs than to MD programs, which may explain some of the discrepancies in first-generation representation.

Moving forward

The lack of first-generation applicants cannot be explained by a lack of interest in MD-PhD programs. First-generation students show an interest in healthcare professions but often suffer from imposter syndrome or may not have the social connections necessary for medical school[25]. Given the considerable expense of applying to medical school, first-generation applicants may be more risk-averse in applying or reapplying, especially if they do not feel

confident in their abilities. Moreover, if they are not accepted the first time they apply, they may find that family and advisors encourage them to consider an alternate career path due to the high cost of applying, or they may choose to skip an application cycle in order to save money for the application, which will further delay their entry into the job market.

The barriers faced by first-generation students who are interested in pursuing the physician-scientist career path help to explain the small number of applicants[2,3]. The unique needs of first-generation students from application to completion must be recognized, characterized and addressed in order to ensure success of these people along the physician-scientist pathway. New opportunities for training physician-scientists will also require an expansion of MD-PhD programs[29]. Given the lack of growth in the number of applicants to MD-PhD programs, growing the physician-scientist community will require supporting students from a wide range of backgrounds for the collective benefit of science and medicine. Accomplishing this will require understanding and removal of the barriers faced by this diverse group of applicants, so that they can develop into the next generation of physician-scientists, ☐

Acknowledgements

References

1. Sarma GP, Levey A & Faundez V Nat. Med 26, 461–462 (2020). [PubMed: 32273602]

2. Rosenberg L Science 283, 331–332 (1999). [PubMed: 9925491]

3. Schafer AI Transl Res. 155, 1–2 (2010). [PubMed: 20004354]

4. Jain MK et al. N. Engl. J. Med 381, 399–402 (2019). [PubMed: 31365796]

5. Association of American Medical Colleges. MD-PhD Applicants and MD-PhD Matriculants to U.S. Medical Schools by Highest Parental Educational Level, 2012–2013 through 2020–2021 (Association of American Medical Colleges, 2020).

6. Association of American Medical Colleges. https://www.aamc.org/media/6006/download (2020).

7. Shalala DE Science 333, 1836 (2011). [PubMed: 21960620]

8. Alsan M, Garrick O & Graziani G Am. Econ. Rev 109, 4071–4111 (2019).

9. Bertoncello C et al. Vaccines (Basel) 8, 276 (2020).

10. Swartz TH, Palermo A-GS, Masur SK & Aberg JA J. Infect. Dis 220, S33–S41 (2019). [PubMed: 31430380]

11. Freeman RB & Huang W Nature 513, 305 (2014). [PubMed: 25230634]

12. Patterson ME & Williams DR J. Environ. Psychol 25, 361–380 (2005).

13. Vogel EK & Awh E Curr. Dir. Psychol. Sci 17, 171–176 (2008).

14. Association of American Medical Colleges. https://www.aamc.org/media/6156/download (2020).

15. Association of American Medical Colleges. https://www.aamc.org/media/6161/download (2020).

16. Association of American Medical Colleges. MD-PhD Applicants and MD-PhD Matriculants to U.S. Medical Schools by First Generation Status, 2018–2019 through 2020–2021 (Association of American Medical Colleges, 2020).

17. Association of American Medical Colleges. https://students-residents.aamc.org/media/10906/download (2017).

18. Grbic D, Garrison G & Jolly P Association of American Medical Colleges https://www.aamc.org/media/5871/download (2010).

19. Romero R, Miotto K, Casillas A & Sanford J Acad. Psychiatry 44, 467–470 (2020). [PubMed: 32399837]

20. Nguyen T-H & Nguyen BMD Rev. Res. Educ 42, 146–176 (2018).

21. Youngclaus J & Roskovensky L Association of American Medical Colleges https://www.aamc.org/data-reports/analysis-brief/report/updated-look-economic-diversity-us-medical-students (2018).

22. Association of American Medical Colleges. MD-PhD Applicants and MD-PhD Matriculants to U.S. Medical Schools by Childhood Household Income, 2014–2015 through 2020–2021 (Association of American Medical Colleges, 2020).

23. Nicholson S & Cleland JA Adv. Health Sci. Educ. Theory Pract 22, 477–490 (2017). [PubMed: 27844179]

24. Cleland J, Alexander K & Nicholson S in Selection and Recruitment in the Healthcare Professions: Research, Theory and Practice (eds. Patterson F & Zibarras L) 249–274 (Springer International Publishing, 2018).

25. Dewsbury BM, Taylor C, Reid A & Viamonte CJ Microbiol. Biol. Educ 20, 20.3.51 (2019).

26. Hébert TP Gift. Child Q 62, 96–110 (2018).

27. Ball R, Alexander K & Cleland J Perspect. Med. Educ 9, 147–156 (2020). [PubMed: 32323114]

28. Furquim F, Glasener KM, Oster M, McCall BP & DesJardins SL Ann. Am. Acad. Pol. Soc. Sci 671, 69–91 (2017).

29. Kirp DL The New York Times https://www.nytimes.com/2021/04/06/opinion/stanford-admissions-campus.html (2021).
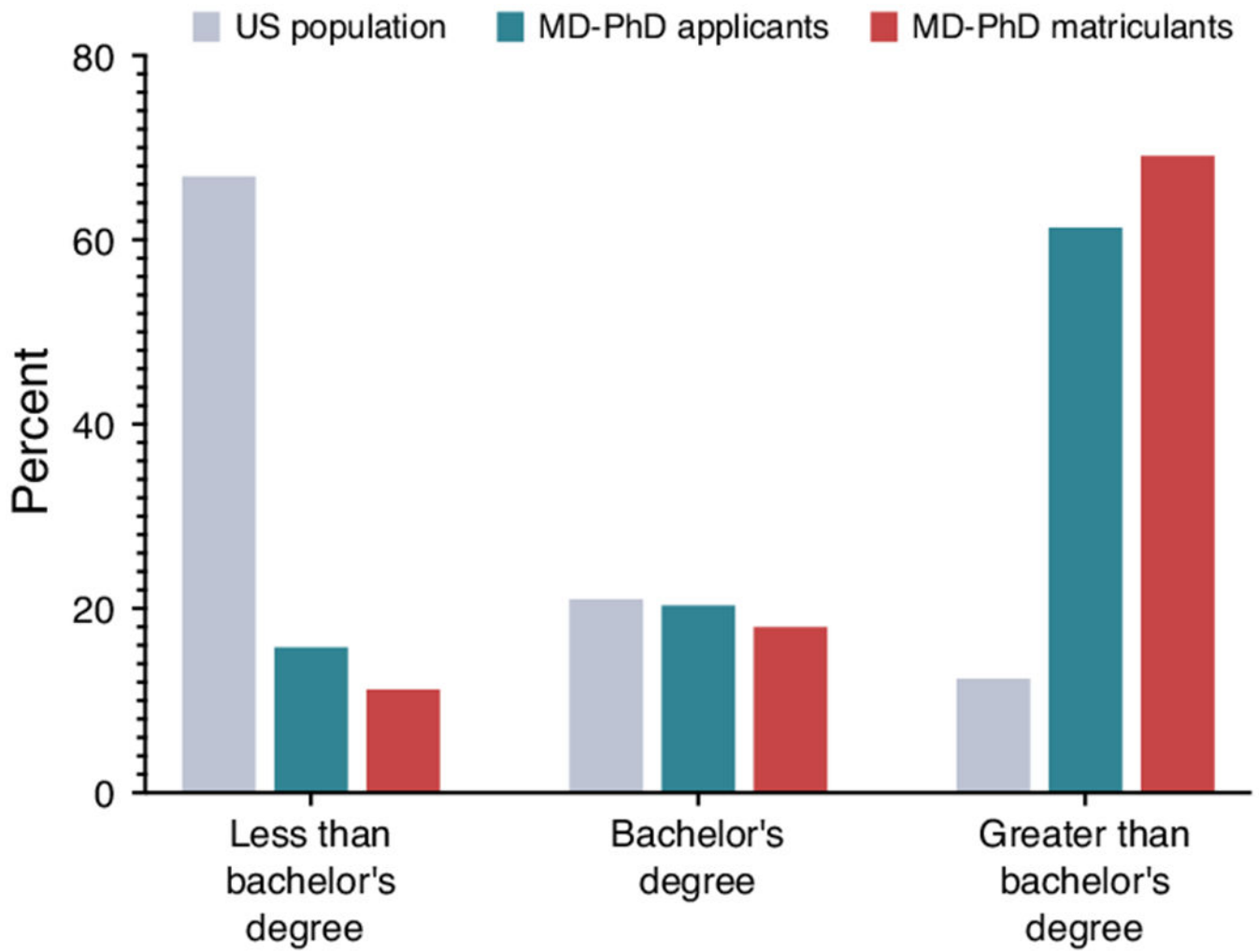
Fig. 1 |.
Parental educational attainment of applicants and matriculants to MD-PhD programs (2012-2020) versus that of the US general population.

	Barriers	Possible solutions
Social	• Networking • Shadowing • Mentorship • Research opportunities	• Linking undergraduate institutions and medical/research centers • Mentorship programs • Paid research opportunities • Interactive sessions with physician-scientists
Financial	• Need to work • Financial stress • Loan repayments • Study resources, tutoring • MCAT costs • Application fees	• Flexible scheduling for research, office hours • New loan-repayment options • Free/low-cost study resources, tutoring • Fee waivers (MCAT, applications)
Cultural	• Encouragement • External expectations • Navigating academia • Advising	• Identify/address implicit bias • Ask about student resources/needs • Provide clear written guidance on navigating academia

Fig. 2 |. Possible solutions to social, financial, and cultural barriers faced by first-generation students interested in pursuing the MD-PhD career path.
MCAT, Medical College Admission Test.