

Increasing Clinician–Scientist Workforce Diversity through the National Institute of General Medical Sciences’ Medical Scientist Training Program

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ABSTRACT

The National Institute of General Medical Sciences Medical Scientist Training Program (MSTP) has been successful in producing clinician-scientists, with a majority of graduates pursuing research-related careers. However, there are a number of areas of continuing concern for the program. In particular, women and individuals from certain racial and ethnic backgrounds remain persistently underrepresented in MSTPs relative to the average college-aged U.S. population and to students receiving life sciences bachelor’s degrees. The authors, who include leaders of NIGMS, identify a number of challenges and opportunities for enhancing diversity, equity and inclusion in the MSTPs and suggest strategies for addressing them.

Keywords:

clinician-scientist; diversity; inclusion; education; M.D.-Ph.D.

The National Institute of General Medical Sciences (NIGMS), a component of the National Institutes of Health (NIH), manages the Medical Scientist Training

Program (MSTP). The MSTP provides training grants to institutions to allow support for students pursuing dual clinical and research doctorates such as joint M.D.

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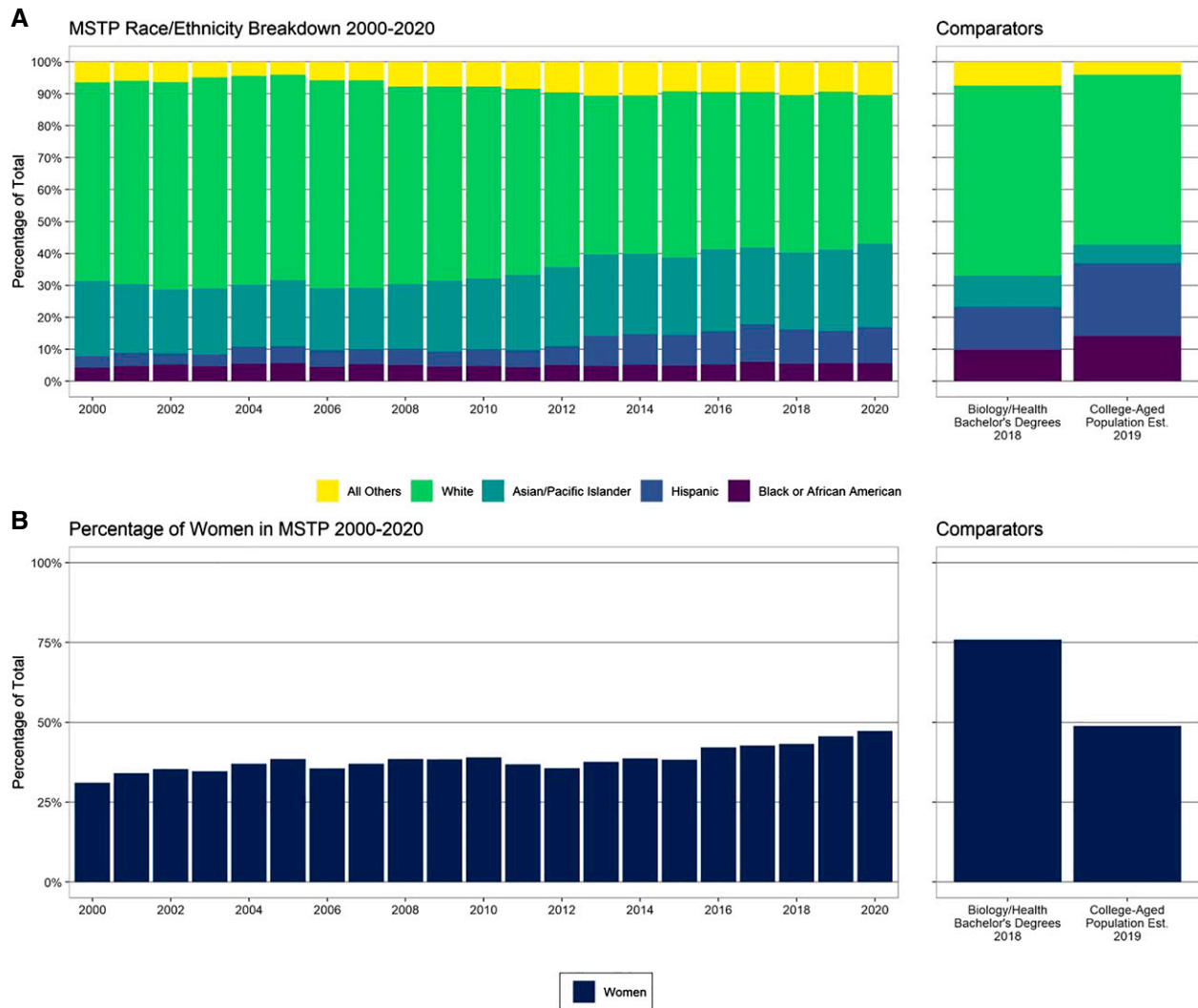


Figure 1. Medical Scientist Training Program (MSTP) trainee demographics compared with the U.S. population and students receiving bachelor’s degrees in life sciences fields. (A) Race/ethnicity breakdown, 2000–2020. The figure shows the demographic data over time for Black/African American (dark purple), Hispanic (lighter purple), Asian/Pacific Islander (teal), White (light green), and all others (yellow). The bars are shown as a percentage of the total. The left panel has the demographic information for the MSTP trainees (source: NIH internal data), and the right panels are the comparators, including those earning a bachelor’s degree in biology/health sciences in 2018 (Source: National Science Foundation) and the college-aged population (Source: U.S. Census) (4–6). (B) Percentage of women, 2000–2020. The graph shows the percentage of women in the MSTP (left panel) and the comparators described above (right panel).

and Ph.D. degrees. In 2021, NIGMS funded 53 programs that supported 1,132 dual-degree students. Institutions receiving MSTP training grants generally contribute additional resources to the programs, and mentors’ research grants often support trainees during part of their Ph.D. studies. The combination of NIH and institutional support provides most dual-degree students in MSTPs with full tuition and stipend during their clinical and research

doctoral studies. Since 1975, the NIGMS MSTP has supported more than 14,000 clinician-scientist trainees.

UNDERREPRESENTATION OF WOMEN AND SOME RACIAL AND ETHNIC GROUPS IN MSTPS

Overall Enrollment Demographics

Although the program has been successful in producing clinician-scientists, with a majority of graduates pursuing

research-related careers (1, 2), there are a number of areas of continuing concern. In particular, women and individuals from certain racial and ethnic backgrounds remain persistently underrepresented in MSTPs relative to the average college-aged (18–24 yr old) U.S. population and relative to students receiving life sciences bachelor’s degrees (Figure 1; note that throughout this paper, data related to the MSTPs are from the NIH, whereas data referring to U.S. medical schools and

M.D.-Ph.D. programs overall are from the Association of American Medical Colleges [AAMC]). From 2006 to 2020, the proportions of certain underrepresented groups increased, including women (from 36% to 47%), Asian (from 19% to 26%), and Hispanic (from 5% to 11%), whereas the proportion of students identifying as Black/African American (B/AA) has not grown appreciably (4.4% in 2006 and 5.5% in 2020) (Figure 1). When compared with U.S. M.D.-granting medical schools

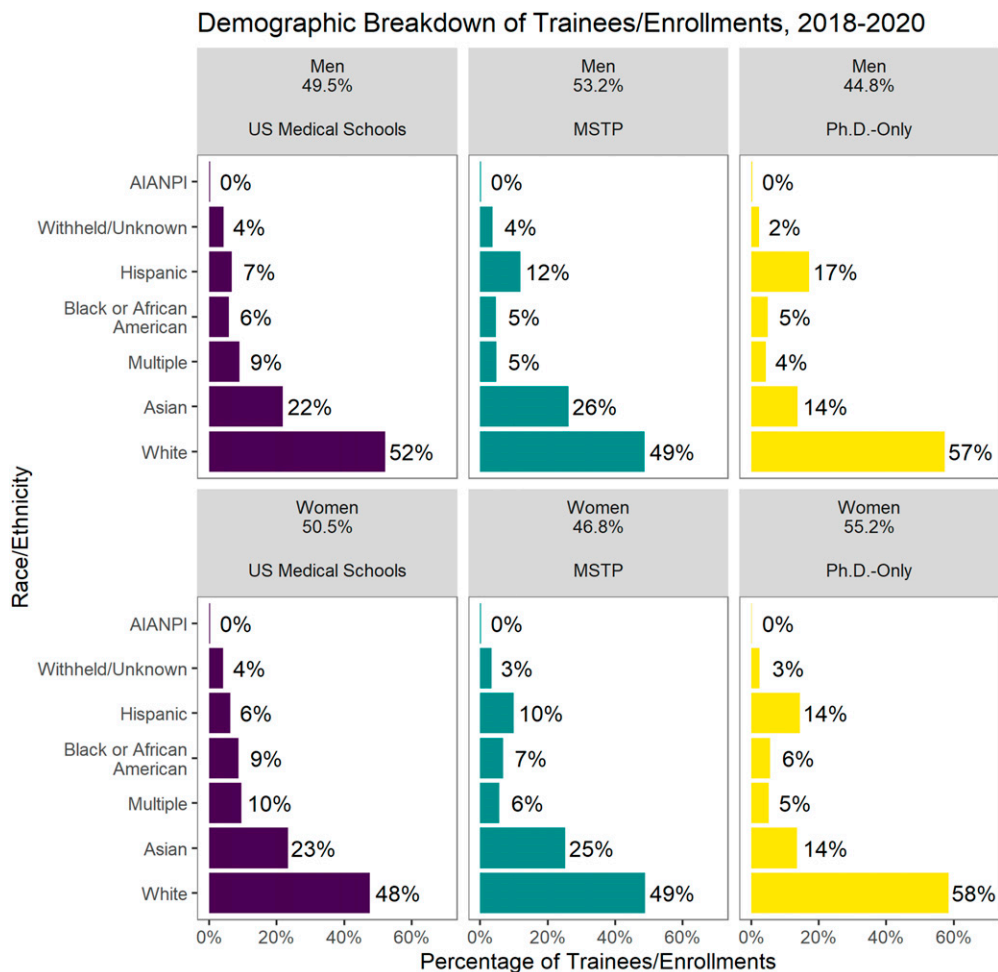


Figure 2. Medical Scientist Training Program (MSTP) trainee demographics compared to students enrolled in U.S. medical schools or National Institute of General Medical Sciences (NIGMS)-funded basic biomedical predoctoral training programs from 2018 to 2020. The race/ethnicity in MSTPs (middle panels, teal) compared with U.S. medical schools (left panels, purple) and NIGMS-funded basic biomedical predoctoral (Ph.D.-only, right panels, yellow) programs are shown as a percentage of trainees/enrollments. Men are shown in the top panels, and women are shown in the bottom panels. MSTP and Ph.D.-only data source: NIH internal data; U.S. medical school data source: Association of American Medical Colleges 2020 FACTS Table B-3, accessed May 2021 (4). AIANPI = American Indian/Alaska Native/Pacific Islander.

(U.S. medical schools) as a whole and NIGMS-funded basic biomedical predoctoral programs (Ph.D. only), MSTPs have a higher proportion of Hispanic students than U.S. medical schools but a lower proportion than the Ph.D.-only programs (Figure 2). Because the NIH and AAMC do not report ethnicity data in the same way, the apparent difference in Hispanic representation between U.S. medical schools and the NIGMS Ph.D. and MSTPs might not be significant. Both MSTPs and Ph.D. programs have a lower proportion of B/AA students than do U.S. medical schools. In all cases, the numbers of American

Indian/Alaska Native (AI/AN) and Native Hawaiian/Pacific Islander students are too small to provide reliable data on differences among the programs. Although we do not provide data for the intersection between race/ethnicity and sex in MSTP demographics, in U.S. medical schools overall, representation of men identifying as B/AA or AI/AN has actually decreased since 1980 (3), indicating that MSTPs should also pay close attention to intersectional disparities in enrollment.

There is significant heterogeneity in the representation of B/AA students among the current MSTPs (Figure 3). For the

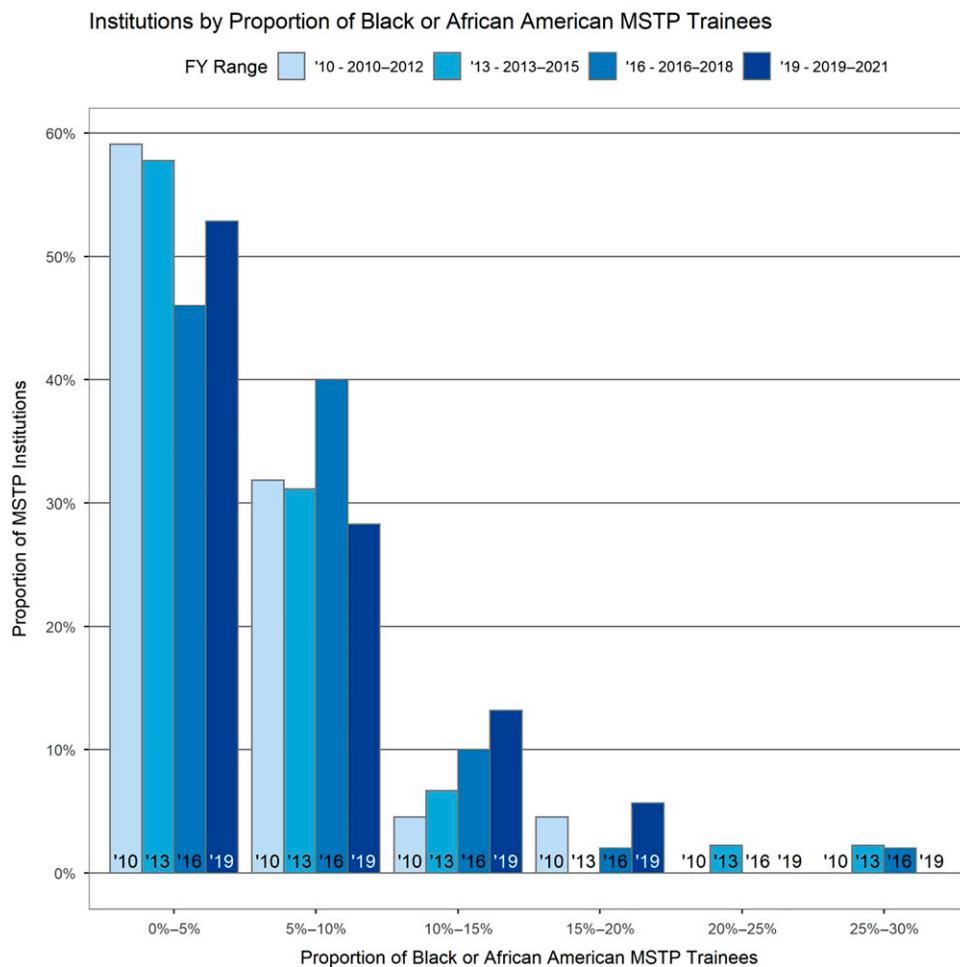
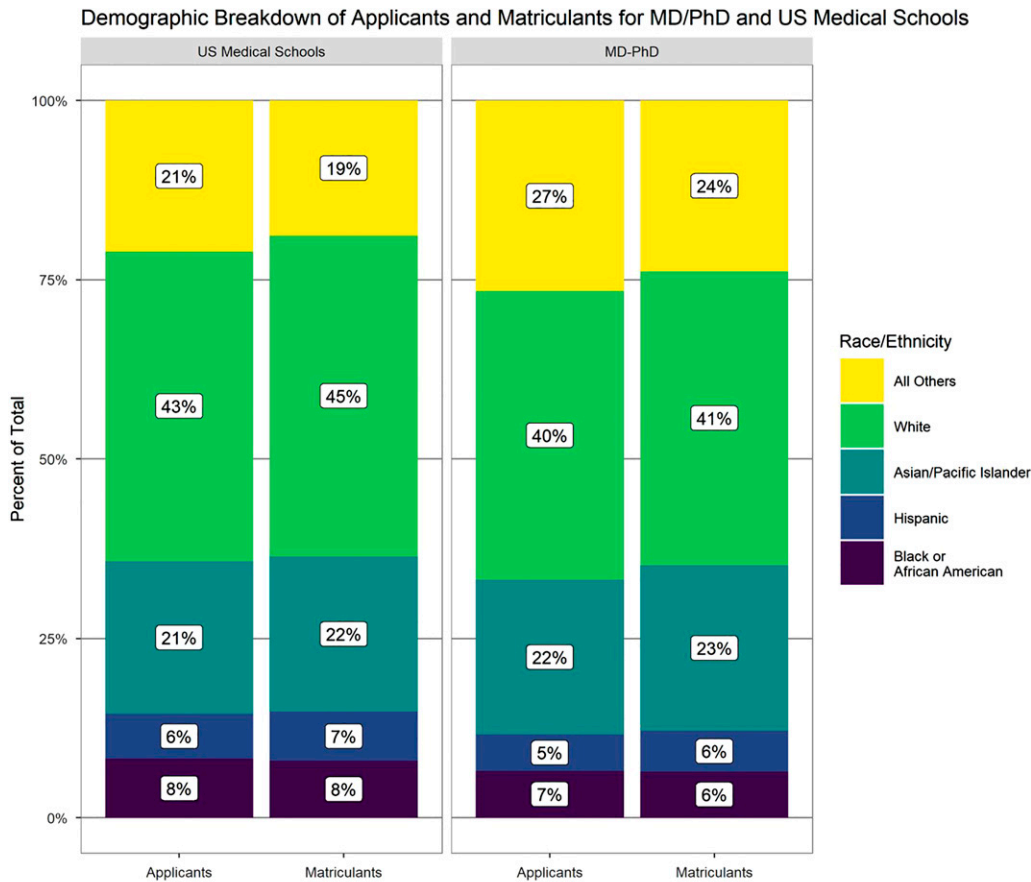


Figure 3. Institutions by the proportion of Black/African American Medical Scientist Training Program (MSTP) trainees from 2010 to 2021. The figure shows the proportion of programs with 0–5%, 5–10%, 10–15%, 20–25%, and 20–30% of Black/African American MSTP trainees. The color legend is shown on the top of the graph for the years in increasingly dark shades of blue by 3-year increments from 2010 to 2012 ('10), 2013 to 2015 ('13), 2016 to 2018 ('16), and 2019 to 2021 ('19). Source: NIH internal data.



Source: AAMC 2020 FACTS Tables A-10, A-11, B-7, and B-9; accessed May 5, 2021

Figure 4. Demographic breakdown of applicants and matriculants in U.S. medical schools and M.D.-Ph.D. programs (2020–2021). The graph shows the Association of American Medical Colleges data on applicants and matriculants to U.S. medical schools for Black/African American (dark purple), Hispanic (lighter purple), Asian/Pacific Islander (teal), White (light green), and all others (yellow) for U.S. medical schools and M.D.-Ph.D. programs (includes both MSTP and non-MSTP M.D.-Ph.D. programs). Source: Association of American Medical Colleges 2020 FACTS Tables A-10, A-11, B-7, and B-9, accessed May 2021 (4).

past 10 years, on average, 80–90% of MSTPs have proportions of B/AA students <15%, and, on average, >50% of MSTPs have enrollments with ≤5% B/AA students. Overall, a significant majority of programs have low enrollments of B/AA MSTP trainees, and this has not changed over time.

Applications, Admissions, and Matriculation

It is important to understand whether the low representation of certain groups in the MSTP is due to lower application

numbers and/or matriculation rates (Figure 4). The data show that, overall, for U.S. medical schools and M.D.-Ph.D. programs, there is not a significant drop in percentages between applicants and matriculants among B/AA, Hispanic, or Asian/Pacific Islander racial/ethnic groups. However, the percentages of B/AA and Hispanic applicants relative to the demographics of both the college-aged U.S. population and of life sciences college graduates are an area of concern (e.g., 6.5% of M.D.-Ph.D. program applicants self-reported as B/AA in 2020–2021 vs.

Table 1. Medical Scientist Training Program demographics of dual-degree completion rates and average time to degrees

Racial/Ethnic Group	Degree Completion Rate	Average Time to Degrees (yr)
American Indian/Alaska Native	56%	9.4
Asian	80%	8.0
Black or African American	83%	8.1
Hispanic	80%	7.9
Multiple	88%	8.0
Other/Pacific Islander	83%	8.4
Unknown	85%	7.4
White	84%	8.0
Withheld	77%	7.4

14.1% of the college-aged population and 9.8% of those awarded life sciences bachelor's degrees in 2018; data from 4–6).

Degree Completion

In addition to admission and matriculation rates, degree completion rates must be considered. Because of the extensive training, a significant investment of time is required for students to graduate with a dual degree. Looking at trainees who started between 2000 and 2020 and are no longer in training, an analysis of the NIH-funded MSTPs shows the time to earning the dual degree is similar across most racial/ethnic groups (~8 yr), with the exception of AI/AN students, who, on average, take 9.4 years (Table 1). Likewise, graduation rates are similar across groups (~85%), except for AI/AN students, who graduate at a lower rate (56%). However, it should be noted that the small number of AI/AN students enrolled in MSTPs means that the averages may be influenced by a few individuals.

Overall, the data indicate that, on average, the main disparity among groups

across M.D.-Ph.D. programs is at the level of application rates rather than admission, matriculation, or graduation. It is important to note, however, that because there is considerable heterogeneity among the programs, at the level of individual schools, admissions or degree completion might still be problematic. In addition, the low application numbers from underrepresented groups could be masking inherent disparities at other stages, such as admissions, that could become more evident if application numbers increase.

Career Choices

A majority of MSTP graduates appear to go on to pursue careers involving research (1, 2). A recent study of M.D.-Ph.D. graduates indicated that women were somewhat less likely than men to pursue research-intensive careers (7). Data from the NIH Clinician Scientist Workforce Report showed that from 2008 to 2012, the percentages of women with M.D.-Ph.D. degrees (22%) who had received NIH research project grants was lower than for women with M.D.s (29%)

or Ph.D.s (36%) alone (8). In the same time period, only 51 B/AA M.D.-Ph.D. recipients had research project grants, a number that had not increased for a decade. These data underscore the need to increase both the numbers of women and underrepresented minorities graduating with M.D.-Ph.D. degrees, as well as ensuring their interest and persistence in research careers.

POTENTIAL SOURCES OF ENROLLMENT DISPARITIES IN MSTPS AND APPROACHES FOR MITIGATING THEM

A vibrant and productive clinician-scientist workforce must reflect the diversity of our country, and because the MSTP provides an important pathway to build this workforce, enhancing the diversity in these programs is a critical goal. Lower application percentages appear to be the major contributor to the disparities in MSTP enrollment for students from underrepresented racial/ethnic groups. The following section explores potential reasons for these lower percentages of applicants from underrepresented groups and potential ways to increase their enrollment. The barriers and potential mitigation strategies are shown in Table 2.

Barriers to Applying: Lack of Financial Stability and Student Debt Burden

The decision to pursue dual clinical doctorate and Ph.D. degrees represents a major commitment of time on the part of trainees. As shown in Table 1, on average, it takes students more than 8 years to complete M.D.-Ph.D. programs, and this time is generally followed by additional training in residency programs and postdoctoral fellowships. During this extended period

of training, trainees receive relatively low pay. In addition, during part of the training period, trainees may be required to start paying back student debt (e.g., during residency). Data from the AAMC show that medical students from groups underrepresented in the biomedical sciences have much higher undergraduate debt burdens, on average, than do students from well-represented groups (9). Nationwide, B/AA undergraduates and graduate students carry significantly more student debt than counterparts from other groups. For instance, 40.5% of B/AA trainees had \$25,000 or more in student debt as compared with 18.7% for White trainees and 11.3% for Asian trainees (10–12). In addition, the costs for all the standardized tests, primary and secondary application fees, and travel required to apply to medical school represent a significant barrier for students with limited financial resources (13).

Financial stresses, including student debt, have been shown to be significant contributors to student career decisions (14–16), making it seem likely that the debt disparity, coupled with related economic strains such as lack of family financial “safety nets,” makes the application costs followed by the long low-income training pathway required for MSTP students very difficult to overcome for many from underrepresented groups. High student debt has also been associated with decreased likelihood of M.D.-Ph.D. graduates pursuing careers as faculty members (17).

To help counteract these effects, as recommended by the NIH Advisory Committee to the Director’s report on the physician-scientist workforce (8), the NIH and its stakeholders should find ways to increase awareness and use of the NIH Loan Repayment Program to make

Table 2. Barriers to application and admittance and potential mitigation strategies

Barriers to Application and Admittance	Potential Mitigation Strategies
Financial insecurity: Student debt burden is higher for students from certain underrepresented groups	<ul style="list-style-type: none"> • Increase awareness of loan repayment programs (e.g., NIH's) • Advertise that most clinician-scientist programs cover tuition and pay a stipend • Engage philanthropic sources to help relieve student debt • Offer admissions fee waivers or direct students to fee assistance programs
MSTPs have the reputation of only taking “the best of the best”; this can discourage women and individuals from underrepresented groups from applying	<ul style="list-style-type: none"> • Change the way MSTPs are advertised to be more inclusive and welcoming of students with a variety of backgrounds; move away from “elitism” messaging • Employ innovative outreach methods (e.g., recruit at national meetings for students from underrepresented groups, form relationships with individuals at minority-serving institutions and who run programs to increase persistence in pursuing a biomedical research career)
Admissions: Grades and standardized test scores can be biased	<ul style="list-style-type: none"> • Consider applicants across a broad range of grade point averages and standardized test scores
Admissions: Recommendation letters can be biased	<ul style="list-style-type: none"> • Provide guidance to letter writers for mitigating implicit biases • Use highly structured assessment forms and structured rubrics • Require training for admissions committee members to recognize and mitigate biased decisions • Mask the identity and institution of the letter writer
Admissions: Personal statements are not always predictive and can vary according to how many resources are available to the applicant	<ul style="list-style-type: none"> • Ensure that the statement prompts are culturally inclusive and not inadvertently introducing biases • Employ a standard rubric and scoring system for evaluating personal statements • Require evaluators to justify their scoring of the statements in writing • Provide bias mitigation training for evaluators • Provide writing prompts regarding the broader impacts of the individual’s career aspirations (e.g., community engagement, health equity, and diversity building)
Admissions: Judgments about the quality of applicants’ research experiences can be biased	<ul style="list-style-type: none"> • Ensure that access to research opportunities is taken into consideration when evaluating the quality of the research experiences
Admissions: In-person interviews can be biased and expensive	<ul style="list-style-type: none"> • Use structured formats in which all candidates are asked the same questions and are assessed using a standard rubric • Provide implicit bias mitigation training for interviewers • Employ video interviews to allow a larger pool of applicants to be considered • Require written explanations to justify interview scores and have a trained group review these explanations to ensure they used predefined standards
Admissions: lack of evaluation of decision patterns that may detect bias	<ul style="list-style-type: none"> • Conduct and publish retrospective, quantitative analyses of the evaluation patterns in the review process
Admissions: lack of diversity on the review panels	<ul style="list-style-type: none"> • Include students and/or alumni from diverse backgrounds on the admissions committee
Admissions: perception of biases in the review process	<ul style="list-style-type: none"> • Advertise any significant changes that have been made to the admissions process to make it more equitable • Conduct targeted outreach to explain the process and how bias mitigation is being implemented

Definition of abbreviations: MSTP = Medical Scientist Training Program; NIH = National Institutes of Health.

clinical doctorate-Ph.D. dual-degree programs more tenable options for students with high debt burdens. To reduce potential applicants' concerns about their abilities to pay back their student debt if they choose to enroll in a dual-degree program, MSTPs could include in their recruiting materials information about the NIH Loan Repayment Program as a potential path for reducing debt after completion of M.D.-Ph.D. degrees for students who continue in research careers. In addition, MSTPs should ensure that potential applicants from underrepresented groups are aware that they will receive tuition remission and stipends to cover living expenses if they enroll in an MSTP. This sort of information is often not common knowledge and should be broadly disseminated in recruitment materials (18). Clearly laying out the financial implications and benefits of joining an MSTP and of following a career in biomedical research could be a useful tool in reducing information asymmetries and increasing applications from members of underrepresented groups (19, 20). Finally, there is an opportunity for philanthropy to engage, such as by creating awards to pay back student debt. Finally, offering fee waivers or making individuals aware of application fee assistance programs may help to remove the financial burden of applying to MSTPs.

Barriers to Applying: Reputation for Enrolling “the Best of the Best” Elitism

Admission to M.D.-Ph.D. programs is highly competitive, with mean grade point averages and standardized test scores for matriculated students even higher than those for U.S. medical school students (Figure 5) and with matriculation rates lower for M.D.-Ph.D. programs than for U.S. medical schools as a whole (38% vs. 42% in 2020–2021) (21, 22). MSTPs are

frequently viewed as among the most elite education programs in the country, and phrases such as “the best of the best” and “cream of the crop” are often used to describe admitted students as well as the programs themselves. The rarefied admissions expectations of the MSTPs and the elitist lexicon used to describe the programs can discourage applicants from applying who are not from historically well-connected academic and/or high socioeconomic status (SES) backgrounds (18). A recent study of sex differences in MSTP application patterns showed strikingly opposite correlations between the likelihood of men and women applying to the programs and the US News rankings of the corresponding medical schools (23): Women's likelihood of applying to a program diminished markedly and linearly as the medical schools became better ranked, whereas men's likelihood of applying increased linearly with better rankings. Interestingly, the trends were much more pronounced for MSTPs than for M.D.-only applicants. The authors suggest that the effect may be due in part to women's lower self-efficacy. Women might also perceive that more highly ranked schools are less likely to provide supportive training environments.

We encourage MSTPs to evaluate how they describe and promote themselves, both externally and internally, and to develop strategies to create and communicate more inclusive and supportive educational and research environments. In addition to new communication strategies, meeting this goal will likely require changes to institutional structures, policies, and culture, as described below.

An additional means of counteracting the factors that may be discouraging promising applicants from

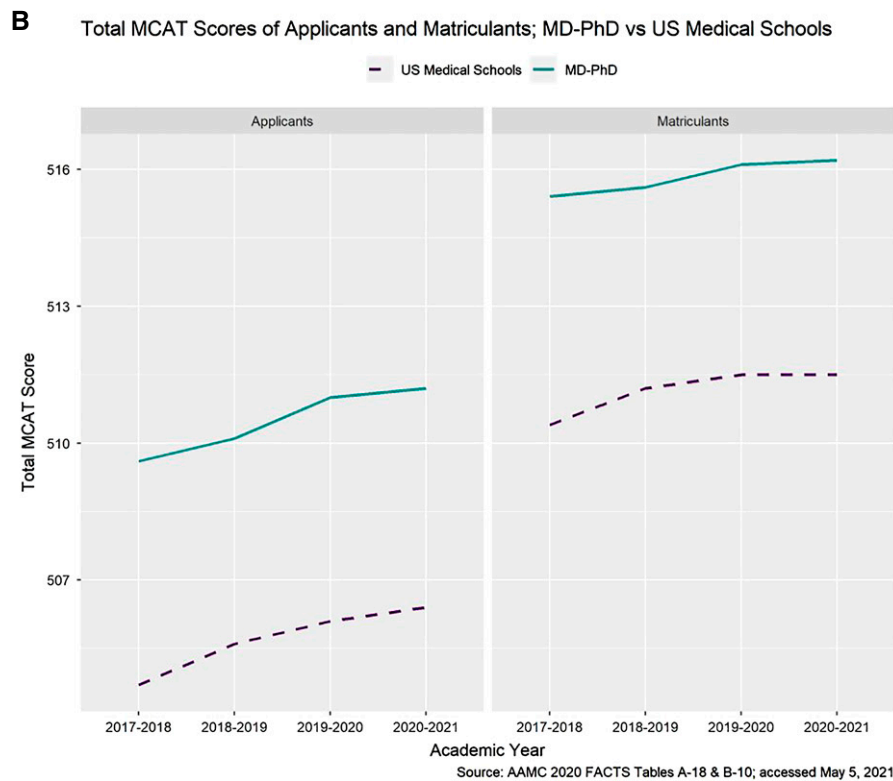
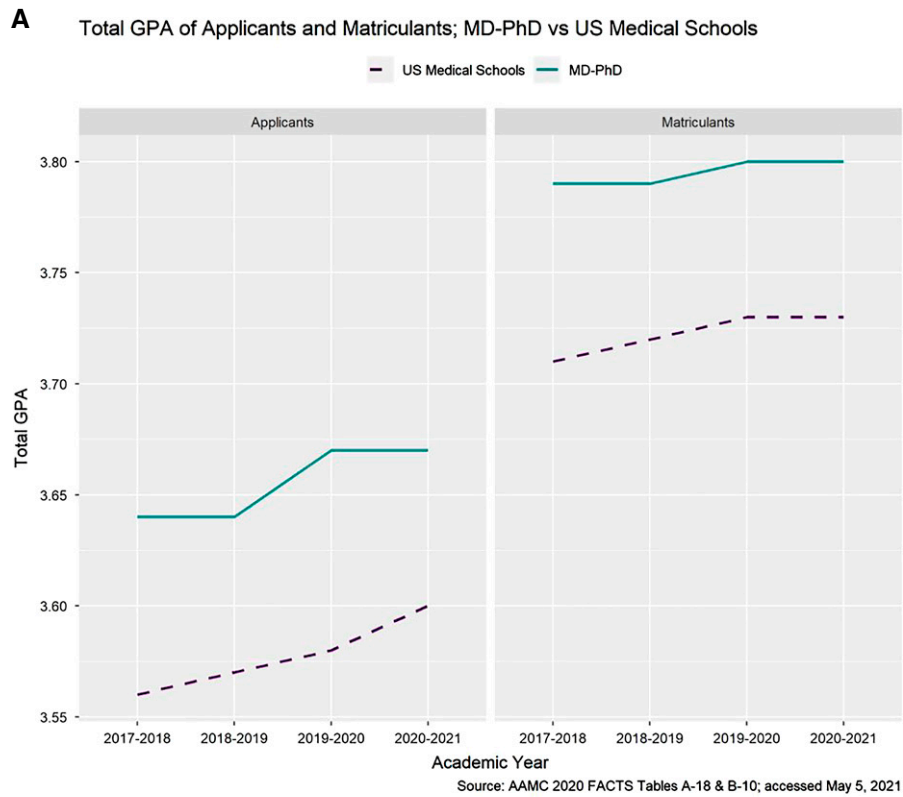


Figure 5. Grade point averages and Medical College Admissions Test (MCAT) scores of applicants and matriculants, M.D.-Ph.D. compared with U.S. medical schools, 2017–2021. (A) Grade point averages (GPAs) of applicants (right graph) and matriculants (left graph) for M.D.-Ph.D. (green bars) and U.S. medical schools (dashed line) are shown over time from 2017 to 2021. (B) MCAT scores of applicants (right graph) and matriculants (left graph) for M.D.-Ph.D. (green bars) and U.S. medical schools (dashed line) are shown over time from 2017 to 2021. Source: Association of American Medical Colleges 2020 FACTS Tables A-18 and B-10, accessed May 2021 (4).

underrepresented groups from applying to MSTPs is to actively encourage them to apply (18). This can be done in a variety of ways, including those outlined on the webpage listing NIGMS resources for enhancing diversity in training programs. Some activities include reaching out to students at meetings and summer programs that focus on undergraduate scientists from underrepresented backgrounds (e.g., Annual Biomedical Research Conference for Minority Students, the Society for Advancing Chicanos/Hispanics and Native Americans in Science National Diversity in STEM Conference, and the Centers for Disease Control and Prevention Undergraduate Public Health Scholars program); building sustained, mutually beneficial relationships with minority-serving institutions (e.g., historically black colleges and universities, Hispanic-serving institutions, tribal colleges and universities) and with undergraduate and postbaccalaureate programs aimed at enhancing biomedical research workforce diversity (e.g., NIGMS Bridges to the Baccalaureate, Maximizing Access to Research Careers, Undergraduate Research Training Initiative for Student Enhancement, Postbaccalaureate Research Education Program); and hosting summer students in research laboratories through diversity supplements for NIH grants. Active recruitment strategies that emphasize a commitment to diversity, equity, and inclusion have been shown to increase applications from members of underrepresented groups to corporate searches (24), and it seems likely that similar strategies will have positive effects for competitive academic programs such as MSTPs (25).

Barriers to Admittance

As noted above, admission into MSTPs is an extraordinarily competitive process. Making these admissions decisions usually

begins with the screening of applications using criteria such as grades, standardized test scores, and assessments of applicants' personal statements, research, clinical and service experiences, and letters of recommendation. Typically, candidate applications are vetted through a series of reviews and discussions, leading to a group of finalists who are invited to interview. Final acceptance decisions are made after these interviews. Each of the inputs in this process is susceptible to biases and can perpetuate inequities.

Grades and test scores. Overemphasis on grades and standardized test scores has been shown in a variety of settings to discriminate against members of underrepresented groups or those from low SES backgrounds (26, 27). Although undergraduate grades and standardized test scores correlate with performance in the first year of medical school for U.S. medical school students (28), Medical College Admission Test (MCAT) scores were only weakly to moderately predictive of student performance on medical licensure examinations (29). At least one study indicated that this correlation does not hold for assessments of clinical examination skills or for evaluations of clinical performance in the first year of residency (30), and another found only weak and inconsistent associations between standardized test scores and a variety of outcome measures (31). In addition, a number of studies have indicated that undergraduate grades and standardized test scores do not predict performance in graduate school in the biomedical sciences (32–35). Notably, the AAMC, which administers MCAT, recently studied the predictive performance of the test (36) and concluded (28) that students in the top and middle thirds of MCAT scores were

similarly successful in advancing from the first to the second year of medical school. Because there are more students from underrepresented backgrounds in the middle third of scores, AAMC suggested that “schools hoping to increase diversity are well served to look in that middle third.”

It is also noteworthy that the United States Medical Licensing Examination recently changed the scoring of its step 1 test from a three-digit numeric score to pass-fail (37) to “help reduce some of the current overemphasis on United States Medical Licensing Examination performance.”

Given the above factors, it would seem worthwhile for MSTPs to consider applicants with a broader range of grade point averages and MCAT scores when making admissions decisions. Focusing only on students with the very top grades and scores is likely to select for people who have had the advantages needed to excel at these metrics of success and will miss many highly promising students who have not had these advantages.

Recommendation letters. Letters of recommendation, long a cornerstone of admissions, hiring, and promotion evaluations in academia, can perpetuate a number of systemic biases (38–43). For example, letter writers’ implicit biases can be embedded in the language used in recommendation letters, and readers of these letters often have a natural tendency to place a higher value on letters from people they know (or know of) relative to letters from people who are unfamiliar to them, especially if the writers are at institutions that are not considered prestigious by the reader. Because of these potential biases, students at minority-serving or lesser-resourced undergraduate

schools may be at an inherent disadvantage, even when their professors write them highly supportive recommendation letters. In addition, first-generation college students might be less likely than students from backgrounds with a knowledge of academia to have been advised by parents and others of the importance of developing relationships with faculty members and other mentors who can recommend them to graduate admissions committees. Finally, “evaluation inflation,” or the tendency to write letters with only subtle gradations of high praise and superlatives and lacking any critical assessments, can mean that letters written by those who know the system and its norms may be more effective than those written by people who are not as familiar with current expectations (44). One study of letters of recommendation concluded that their predictive value in terms of class rank at graduation was low, with the only significant positive variables being if the student was described as “the best” and if the letter was written by a supervisor, whereas negative comments in letters correlated with poorer class ranks (45).

Methods to reduce possible biases in writing and reading letters of recommendation might include directing letter writers to resources for mitigating implicit biases when letters are requested, using highly structured assessment forms with multiple criteria in which high ratings require additional written explanations, using structured rubrics to evaluate letters of recommendation, and requiring training for admissions committee members in how to recognize sources of bias in recommendation letters and in minimizing their own biases when evaluating them (46, 47). It might also be worth testing the effects of blinding the identity and institution of the letter writer.

Personal statements. Personal statements have long been another cornerstone of admissions processes. In theory, these essays provide applicants with a chance to explain to the admissions committee their motivations for applying to the program, how they would benefit from being in the program, how the program would benefit from having them in it, and what the applicants will do with the training they receive. Applicants can also describe challenges they have faced during their lives that could be relevant considerations. A meta-analysis of the utility of personal statements in admissions decisions indicated that, in general, they provide low predictive value for a variety of student outcomes (48). Regardless of their potential utility, and despite the possibility that personal statements can allow students to make a case for themselves, they also open the door to additional sources of bias and disparity. For example, applicants who have access to family members, mentors, and others who are well versed in writing these types of essays and can help the applicants hone their statements will have an advantage over applicants who do not have this type of help. Thus, applicants from affluent backgrounds might enjoy an advantage over those from lower SES backgrounds and those who are first-generation college students. In addition, because assessing personal statements and deciding how to use those assessments in admissions decisions have significant subjective components, reviewer biases can easily creep into the process.

Possible approaches for mitigating the potential for bias in evaluating personal statements might include ensuring that the questions/prompts used for the statements are culturally inclusive and not inadvertently introducing biases, employing a standard rubric and scoring

system for evaluating personal statements, requiring evaluators to justify their scoring of the statements in writing, and providing bias mitigation training for evaluators.

Programs might also ask for a statement describing applicants' goals for how their careers will have a broader impact on society as part of the application process. Asking all students for such a statement would elevate the importance of goals that go beyond laboratory work such as community engagement, health equity, and diversity building, which might have historically been underappreciated by MSTP admissions committees.

Research experience. Even evaluation of applicants' research experience, which seems essential for programs that focus on research training, should be approached cautiously. Although it is reasonable to expect that students entering MSTPs should have had sufficient research experience to be confident that they want to pursue careers in biomedical research, making judgments about the "quality" of their experiences can lead to biases and inequities. Students from disadvantaged backgrounds or students graduating from lesser-resourced schools may not have the opportunities to conduct research to the extent typically expected for admission to MSTPs (49, 50). Thus, overly weighting research outcomes such as publications or presentations at conferences could unfairly favor students with access to intensive research experiences over those with less access. Context is important in assessing research experiences. For example, if a student began doing research in high school, it likely shows a strong interest in and commitment to science, but it would be even more impressive for a first-generation college student who grew up in a low SES household, who would have had to work much harder to find and take

advantage of these opportunities, than for a student from an affluent background. Although a number of programs exist to give students from diverse backgrounds research experiences before, during, and after college, not all students have access to these programs, and sometimes personal situations (e.g., family care responsibilities that will not allow the student to leave home for a summer research program) can prevent participation in them. If one student has less research experience than another, it might be more a reflection of opportunity than of interest or commitment. We are also concerned that postbaccalaureate research experience programs are increasingly being used by students who already had ample opportunity to conduct research to burnish their applications, which has created an “arms race” of sorts and may be leading students who could really benefit from such experiences to be unable to have them. Open discussions of these issues among admissions committee members might help to ensure that the appropriate factors are considered when assessing research experiences and prevent amplification of prior inequities or creation of new ones.

Interviews. Interviews can also be sources of bias in the admissions process. One recent study of interviews for graduate school admissions reported a negative correlation between applicant body mass index and likelihood of an offer of admission, especially for female students (51). Another study gave an implicit bias test to all members of a medical school admissions committee before conducting candidate evaluations (27). They found that all groups tested displayed significant implicit bias in favor of White individuals and that a majority of those who took the test believed it might be useful in mitigating bias during admissions deliberations. An analysis of a

natural experiment that took place at the University of Texas Medical School at Houston in the late 1970s, in which a cohort of students who were initially rejected were subsequently admitted, concluded that most of the variance between admitted students and those who originally missed the cutoff resulted from interviews and that these interview-based decisions had little predictive value (52). Strategies for reducing bias in interviews might include using structured formats in which all candidates are asked the same questions and are assessed using a standard rubric, implicit bias mitigation training for interviewers, use of video interviews to allow a larger pool of applicants to be considered, requiring written explanations to justify interview scores, and having a trained group review these explanations to ensure they used predefined standards (53–56).

Overall considerations in the application process. Programs should conduct retrospective, quantitative analyses of the evaluation patterns in the review process to identify trends that might suggest biases. Programs that do not already do so should consider including students and/or alumni from diverse backgrounds on the admissions committee to provide additional perspectives and input.

Students are more likely to apply to a program if they believe they will be treated fairly and equitably by the admissions committee and that they have a reasonable chance of being accepted. Thus, ensuring that admissions processes are as equitable and free of bias as they can be and that admissions expectations encompass as many promising candidates as possible will likely pay additional dividends by increasing application rates of students from underrepresented groups. This effect could be enhanced by

emphasizing in outreach and recruiting materials any significant changes that have been made to the admissions process to make it equitable. In addition, MSTPs should work with minority-serving and lesser-resourced undergraduate institutions to make them aware of realistic expectations for students applying to their programs and advise the institutions on how best to help their students meet these expectations.

INSTITUTIONAL CHANGES TO PROMOTE DIVERSITY, EQUITY, AND INCLUSION

Changes to institutional culture, policies, and priorities will be required to support improvements in diversity, equity, and inclusion in MSTPs. For example, some of the changes to admissions processes proposed above, particularly reducing emphasis on top grades and standardized test scores and considering a broader swath of applicants, could negatively affect schools' rankings as determined by various organizations. Universities might need to decide on their priorities in terms of issues such as diversity and culture versus school ranking and set their policies accordingly. For its part, the NIH should work to reduce unintended institutional biases in its processes, such as implicit consideration of institutional prestige during peer review or in making funding decisions, so that institutions are not penalized if their rankings drop as a consequence of increased focus on diversity, equity, and inclusion.

The goal of the MSTP is to use didactic, research, mentoring, and career development elements to prepare diverse groups of promising trainees for careers as clinician-scientists. It is not to select and recruit only students who are already extremely well prepared for medical and graduate school and will need little

guidance or external help to thrive in these academic and research environments. In addition to designing recruiting and admissions processes with these goals in mind, institutions should ensure that educational, mentoring, career development, and student support services are optimized to promote the success of all the trainees, regardless of their backgrounds. "Sink or swim" models of training, in which students are expected to learn on their own with minimal guidance or support, are not appropriate for NIGMS funding. In accordance with these principles, desired program outcomes should center on the degree to which students' efficacy and skill levels have been increased rather than on raw outputs such as the number of papers published or licensure examination scores. MSTPs should explore putting in place initiatives to support student success and transitions, including those that address psychosocial factors such as impostor phenomenon and feelings of not belonging, as well as cultural ones such as hostile or unsupportive learning and research environments (57, 58). These goals and principles are now clearly articulated in the NIGMS MSTP funding opportunity announcement and are assessed during peer review of applications.

Program and institutional cultures are also critical to student development and success. A recent study showed that science, technology, engineering, and mathematics (STEM) students are more motivated by and achieve more in the classes of professors who have a "growth mindset" (i.e., believing that student talent can be developed) than in the classes of professors who believe that student talent is fixed (i.e., intrinsic) (59). This effect was even more pronounced for underrepresented minority students than for majority students and was independent

of faculty age, sex, and race/ethnicity. Thus, programs not only should ensure faculty members use evidence-informed approaches to education, they also should make sure the faculty who engage with students understand their roles in supporting the development of students' skills.

The skills and styles of mentors have also been shown to be important for student development and success, as well as for increasing diversity and inclusion (60–63). Programs should develop evidence-informed, culturally aware mentor and clinical preceptor training (61, 64–68), methods for assessing mentor and preceptor performance (69–71), and remediating or removing those who perform below expectations. To further incentivize the development of a culture of effective mentoring, institutions might consider including assessments of mentoring in promotion decisions and create awards for mentoring achievements that promote diversity and inclusion. Students might also benefit from explicit training in how to develop and sustain productive mentoring relationships (67, 72). In addition, near-peer mentoring programs can provide the dual benefits of building mentoring skills in senior students while providing additional support networks for more junior ones (73).

Faculty diversity in terms of backgrounds and research interests is also critically important for attracting and retaining a diverse and vibrant pool of students to MSTPs. Programs such as Maximizing Opportunities for Scientific and Academic Independent Careers can serve as sources for outstanding early career faculty candidates from a wide variety of backgrounds and with scientific interests spanning most of NIH's mission.

Including research areas such as minority health, health equity, and the biomedical behavioral and social sciences in MSTPs

will also provide a broader catchment for student interests and will help build important fields of research in need of clinician-scientists.

Finally, student support and wellness services are critical aspects of creating more inclusive and equitable cultures. The long training time required for MSTPs can be a particular disincentive to women because it generally spans typical childbearing years. The NIH has started an initiative to provide graduate students and postdoctoral fellows supported by National Research Service Awards, including those funded by MSTP T32 training grants, with \$2,500 supplements to help pay for childcare costs (NOT-OD-21-177). The hope is that universities will also contribute to supporting trainees who have children to enable more women to follow clinician-scientist and other biomedical research career paths. In addition, institutions should examine student wellness and mental health services because stress, anxiety, and other behavioral and mental health issues have been shown to have major negative effects on student success and persistence (74, 75).

These negative effects may have an even greater impact on women and members of underrepresented groups (76).

The pandemic necessitated that institutions experiment with new strategies for student admissions, education, and services in areas ranging from virtual interviews and learning to expectations for research experiences. We expect that lessons learned from these experiments will help institutions change their practices, policies, and cultures to better support all their trainees and promote diversity, equity, and inclusion.

Additional research is needed to understand the factors that positively and negatively influence students from

different backgrounds regarding application to MSTPs, that affect their success while in the program, and that alter their interests in ultimately pursuing research-focused careers. To support such research, NIGMS offers grants through its Research on Interventions that Promote the Careers of Individuals in the Biomedical Research Enterprise program.

CONCLUSIONS

A particular problem that MSTPs have in changing their policies and culture is that they have to navigate these changes across both the clinical and scientific parts of their institutions. This process will require buy-in from many different departments and stakeholders. Accordingly, having the support of institutional leadership in making the required changes will be essential. As universities increasingly declare that diversity, equity, and inclusion are core values and incorporate these goals into their mission statements and strategic plans, there is an opportunity to leverage institutional interest into a commitment to promoting the needed reforms that will allow MSTPs to significantly increase their

efficacy in diversifying the clinician-scientist workforce and acting as agents of positive change in biomedical research, patient care, and health equity. The new emphasis placed on diversity, equity, and inclusion in NIGMS's MSTP funding opportunity announcement and in the review of applications for the program should also help internal champions promote the needed institutional changes to meet these critical goals. Finally, NIH as a whole must continue to strengthen its support for researchers from diverse backgrounds at all career stages through initiatives such as UNITE (77).

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