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Factors Influencing Graduate Program Choice Among Undergraduate Women

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ABSTRACT

Context: Despite equal enrollment proportions in MD and PhD programs, there are fewer women than men in MD-PhD programs and academic medicine. Factors important in degree program selection, including the perception of gender disparities, among undergraduate students were characterized.

Methods: In 2017, women pre-health students at four public North Carolina universities were invited to participate in an online survey regarding career plans, decision factors, and perceptions of gender disparities in MD, PhD and MD-PhD pathways. This study characterizes factors important to program selection, and evaluates the association of intended graduate program with perceived gender disparities using Fisher's exact tests.

Results: Among the n=186 female survey participants, most were white (54 %) and intended MD, PhD, and/or MD-PhD programs (52 %). Sixty percent had heard of MD-PhD programs, over half had no research experience, and half were considering but uncertain about pursuing a research career. The most common factors influencing degree program choice were perceived competitiveness as an applicant, desired future work environment, and desire for patient interaction. Twenty-five percent of students considering MD, PhD, and MD-PhD programs stated that perceived gender disparities during training for those degrees will influence their choice of program, however intended degree was not statistically associated with perceived gender disparities.

Discussion: Perceived gender disparities may influence choice of graduate training program but are not among the top factors. Perceived competitiveness as an applicant is an important career consideration among undergraduate women. Strategies to increase awareness of MD-PhD programs, to encourage women to consider all training paths for which they are qualified are needed.

What is known: Though men and women are nearly equally represented in MD-only and PhD-only programs, women are underrepresented in MD-PhD programs, which train physician-scientists. Prior studies have shown gender is not associated with rates of attrition from MD-PhD programs or differences in academic preparation, research interest, or research experience, suggesting enrollment differences by gender may be due to fewer women applying to MD-PhD programs. Gender parity in the physician-scientist workforce is critical to equitably serving a diverse patient population.

What this study adds: This study is the first to examine the role of gender disparities in the career choices of undergraduate women. Given the moderate familiarity with MD-PhD training and lack of research experience among respondents, increased awareness of MD-PhD programs and expanded research opportunities may help undergraduates make informed career choices. This may increase women MD-PhD applicants, creating a more balanced physician-scientist workforce to address the needs of patients from all backgrounds.

Keywords: Education, Graduate, Sexism, Career Choice, Biomedical Research/education, Female

INTRODUCTION

Women are underrepresented in academic medicine, particularly in high-ranking leadership positions,¹ as physician-scientists,² and in full-time clinical positions.³ The latest Physician -Scientist Workforce Report prepared by the National Institutes of Health (NIH) revealed that women represent just 22 % of MD-PhD research project grant awardees.⁴ Factors that differentially affect the career trajectories of women and men include, but are not limited to, a stated interest in a research-based career,⁵ participation in domestic and parenting responsibilities,⁵ available opportunities for mentorship,⁷ financial compensation,⁸ grant funding,⁹ and career attrition.¹⁰ Gender disparities, defined here as differences in the treatment of students who identify as female and students who identify as male, are the focus of ongoing dialogues among faculty in academic medicine but are also relevant to students entering the training pipeline at the university and graduate school levels.¹¹

Despite approximately equivalent representation of men and women in MD-only and PhD-only training programs, only 39% of students enrolled in combined MD-PhD programs in the United States in the 2017-2018 academic year are women.¹²⁻¹⁴ Among those interested or enrolled in MD-PhD programs, gender has not been associated with differences in academic preparation, interest or experience in

research,¹⁵ or in program attrition rates.¹⁶ The proportion of women compared to men among applicants and among matriculants are similar and both below gender parity of 50%,¹⁷ suggesting that programs have fewer women than men primarily because fewer women choose to apply to MD- PhD programs.

Faculty with both MD and PhD training represent 45% of the NIH-funded physician-scientist workforce even though dual degree students are a small minority of students pursuing MD degrees.¹⁸ Equalizing the gender balance in MD-PhD training programs and ultimately, in the physician-scientist workforce is a priority for the future^{11,19} and necessitates an examination of why women are currently underrepresented in MD-PhD programs. Goals for this study were to identify factors central to the selection of a graduate school program (MD, PhD, or MD-PhD) by women, to examine the association between perceived gender disparities and intended graduate school program, and to pinpoint opportunities for intervention that may encourage equivalent representation between men and women in MD-PhD programs. It is conceivable that the volume of discussion and media attention surrounding gender disparities in STEM fields may deter qualified candidates from applying to advanced degree programs that they would otherwise consider. Here, the authors consider the example of MD-PhD programs and hypothesize that female undergraduates' perception of gender disparities in graduate program training is negatively associated with their stated intention to matriculate to an MD-PhD program.

METHODS

Survey instrument

The 40-item survey was developed to assess the demographics, post-undergraduate training plans, and factors influencing choice of graduate program among undergraduate students (Appendix 1). Respondents who indicated interest in applying to MD, PhD, and/ or MD-PhD programs were asked questions about who discouraged or encouraged them to apply to the indicated program s and about factors impacting selection of programs and institutions. Some questions were adapted from the Summer Undergraduate Research Program at Icahn School of Medicine at Mount Sinai survey (2015).

All respondents who indicated interest in graduate training answered questions about their perception of gender disparities in MD, PhD, and MD-PhD training. "Gender disparities" were defined in the survey as "differences in the treatment of students who identify as female and students who identify as male." More specifically, specific aspects of training that may be differentially experienced by students who identify as female (e.g., differential treatment by faculty or peers, acceptance of having children, impact of length of training on family planning) were queried. Respondents were asked to rate their agreement with the statement "Gender disparities during training will play NO role in my decision about the type of degree-granting program(s) to which I will apply" with response options of true, false, or I don't know.

All respondents were asked demographic information, including whether they identified as an underrepresented minority, which institution they attend(ed), current year of study, and familiarity with MD-PhD programs. “Underrepresented minority” was defined using the American Association of Medical Colleges definition: “racial and ethnic populations that are underrepresented in the medical profession relative to their numbers in the general population.” Participants who indicated interest in MD, PhD, and/or MD-PhD programs were asked which program they would select if they had to pick one today; this single choice is referred to as the “intended” training program.

Survey distribution

The survey was hosted electronically via Qualtrics at UNC-Chapel Hill. Survey invitations were emailed to undergraduate listservs for students interested in health-related careers at UNC-Chapel Hill (UNC-CH; 4,000 subscribers), East Carolina University (ECU; 4,998), North Carolina State University (NCSU; 1,427), and UNC-Charlotte (UNC-C; 2150). Responses were not linked to the participant’s name or other identifying information. Participants could enter their email address in a separate, unlinked survey for a chance to win a \$10 Amazon gift card. The survey remained open for a minimum of two weeks at each institution.

Statistical analysis

All data were analyzed in SAS 9.4 (SAS Institute, Cary, North Carolina). Total respondents included participants who completed every page of the survey without missing demographic responses. Demographic data were summed and reported as percentages of total respondents. Due to a low number of men respondents, analyses feature only women respondents. Chi square tests ($\alpha = 0.05$) were used for two sets of categorical variables to evaluate the association of current institution with familiarity with MD-PhD programs, and of interest in a career in research with research experience. Factors influencing choice of graduate program and institution were reported as distributions across all women respondents and by type of program in which the respondent indicated interest. Participants could indicate interest in multiple programs and select all factors that apply, or write-in other factors.

Among participants interested in MD, PhD, and/or MD-PhD programs, using Fisher’s exact tests, the associations of intended degree program with the following were examined: perceived gender disparities in training programs and career success of MD, PhD, and MD-PhDs; and stated role of gender disparities in graduate program decision. Six questions about gender disparities in training and in success of MD, PhD and MD-PhDs were originally on a 5-point Likert scale ranging from “strongly disagree” to “strongly agree”, with an additional option “I don’t know.” Response patterns for “neutral” and “I don’t know” were examined via Fisher’s exact tests and were not meaningfully different, so they were grouped into one option (“neutral/I don’t know”) in analyses. “I don’t know” comprised approximately half of this group

RESULTS

In November 2017, a total of 186 women completed the survey. Responses were comparable between R1 (highest research activity) and R2/R3 (higher or moderate research activity) universities (1.4% and 1.8% of listserv subscribers, respectively). Most participants were white (54%), 41% identified as an underrepresented minority (Table 1). Most participants (92%) were currently completing their undergraduate degrees. Overall, 52% of participants were considering MD, PhD, and/or MD-PhD training. When asked to pick one program, most intended to pursue MD degrees (77%), followed by MD-PhD (15%) or PhD (8%) degrees (data not shown).

Table 1 Characteristics of female undergraduate student respondents in North Carolina in 2017

Total	186
Age (median, IQR)	20 (19, 21)
	N (%)
Ethnicity	
White	101 (54)
Black, African, AA	26 (14)
Hispanic or Latino	16 (9)
Asian or Pacific Islander	21 (11)
Multiple/Other/Do not wish to answer	22 (12)
Underrepresented minority	
Yes	76 (41)
No	109 (59)
Major	
Biological sciences	113 (61)
Public Health	19 (10)
Physical sciences and engineering	14 (8)
Psychology or Sociology	15 (8)
Other	25 (13)
Year in School	
Undergrad 1	38 (20)
Undergrad 2	53 (28)
Undergrad 3	41 (22)
Undergrad 4	39 (21)
Recent Graduate	11 (6)
Other	4 (2)
Programs considering	
MD, PhD, and/or MD-PhD	96 (52)
Other professional degree	48 (26)
Master's program	27 (15)
Undecided/multiple	15 (8)

Sixty percent of women indicated familiarity with MD-PhD training (Figure 1). However, familiarity

varied significantly by institution: students attending universities classified as R2 or R3 (ECU and UNC-Charlotte) were less familiar with MD-PhD training than students at R1 institutions (UNC-Chapel Hill and NCSU). About half of respondents (n=98, 53%) stated they were unsure of their interest in a career that involves research, and over half had no prior research experience (n=101, 54%). Overall, interest in a research career varied by experience with research (p=0.01), with lack of research experience most prevalent among those unsure of their interest in a research career (Figure 2).

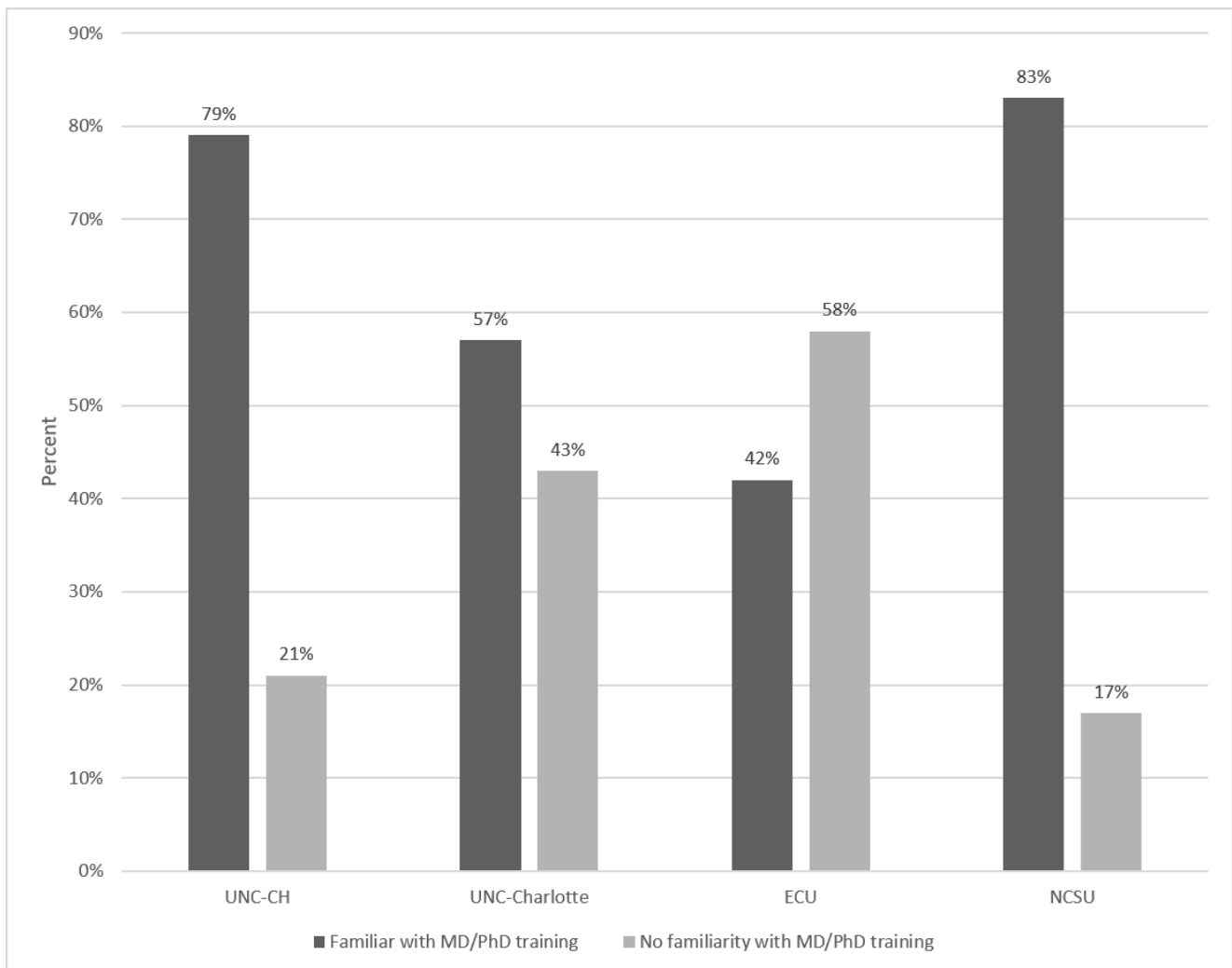


Figure 1 Familiarity with MD/PhD training program by institution. Proportion of respondents familiar was statistically significantly different by institution (p-value < 0.0001).

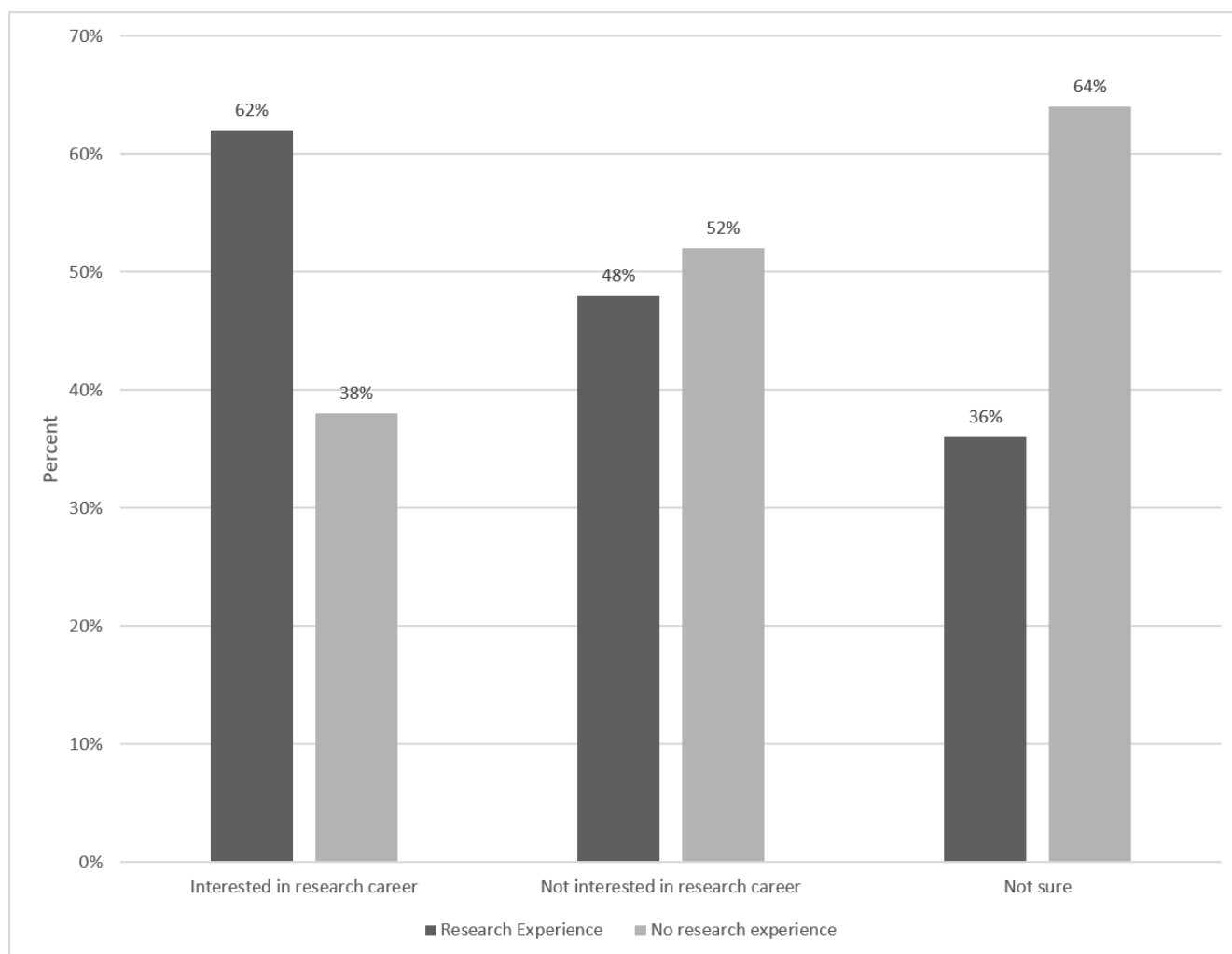


Figure 2 Percentage of respondents with research experience by interest in research career. Proportion of students with research experience was statistically significantly different by interest in research career (p -value = 0.01).

Among women interested in MD, PhD, and/or MD-PhD training ($n=96$), the top seven factors cited when selecting which degree-granting program to apply were : perceived competitiveness as an applicant (76%), desired future work environment (71%), desire for patient interaction (52%), funding during program/personal finances (50%), prestige of program (47%), length of training (46%), and perceived workload/stress during training (45%) (Table 2). Some women (15%) ranked gender barriers to success in career as a factor that influences their selection of a graduate program. When selecting an institution for training, the five most important considerations listed were location (58%), program funding (50%), prestige of institution (48%), perceived competitiveness as an applicant (33%), feeling of “fit” with current students (33%).

Table 2 Factors central to selection of academic training program and institutions among female undergraduate students in North Carolina in 2017 considering MD, PhD, and/or MD-PhD programs

Factors endorsed when selecting to which PROGRAM to apply a (% total)	
1. Perceived competitiveness as an applicant	76%
2. Desired future work environment	71%
3. Desire for patient interaction	52%
4. Funding during program/personal finances	50%
5. Prestige of program	47%
6. Length of training	46%
7. Perceived workload/stress during training	45%
8. Ability to balance life with training	40%
9. Income potential following training	38%
10. Role models	34%
11. Timeline for impact on society	31%
12. Gender barriers to success in career	15%
13. Emphasis on research	14%
14. Employment situation of spouse/partner	8%
15. Childcare resources during training	4%
Factors endorsed when selecting to which INSTITUTIONS to apply ^a (% total)	
1. Location	58%
2. Program funding	50%
3. Prestige of institution	48%
4. Perceived competitiveness as an applicant	33%
5. Feeling of “ fit ” with current students	33%
6. Size of program	22%
7. Friendliness of administration/program directors	20%
8. Proximity to family	15%
9. Representation of students of same ethnicity	8%
10. Representation of students of other ethnicities	6%
11. Acceptance of having children during training	3%
12. Employment situation of spouse/partner	2%
13. Resources for childcare	2%
14. Representation of students of same gender	1%
14. Representation of students of other genders	1%

^a Respondents could select all options that apply

There were no statistically significant differences in the selection of intended degree program across any gender disparity questions (Table 3). Collectively between all those intending an MD, PhD, or MD-PhD program, about half of participants agreed that there were gender barriers in training (range 43-60%) and to career success (range 42-53%) as an MD, PhD, or MD-PhD. While not significant, slightly more MD intending participants agreed that gender disparities exist in MD training (64%) and career success (57%) than in training and success as a PhD (53% and 43%, respectively) or as an MD-PhD (42% and 39%, respectively). Among participants intending to pursue an MD or a PhD program, the majority of women

(64% and 63%, respectively) agreed that there are gender disparities in their intended programs' training process, whereas a lower proportion of students intending an MD-PhD program endorsed "agree" (43%) that there are disparities in MD-PhD training, however, 43% of those intending an MD-PhD program answered "neutral/I don't know". Among students intending an MD-PhD program, about half agreed that gender disparities exist in training for an MD-PhD (43%), PhD (50%), and MD (50%). Students intending an MD-PhD agreed more often to the presence of gender disparities in the success of an MD-PhD career (50%) compared to in a career as a PhD (36%) or an MD (43%).

When explicitly asked, 57% of women said disparities would play no role in their choice of program, while 25% said disparities would play a role, and 18% were not sure (Table 3). Those intending MD training more frequently indicated that gender disparities would play no role in their choice of program compared to those intending a PhD or an MD-PhD (MD: 61%, PhD: 38%, MD-PhD: 50%) (Table 3). Uncertainty regarding whether gender disparities would influence their degree program decision was highest among those intending a PhD (50%), compared with only 14% of those intending an MD and 21% of those intending an MD-PhD. However, none of the differences reached statistical significance.

(Page Break for **Table 3** on the following page.)

Table 3 Distribution of perceived gender disparities among female undergraduates in North Carolina in 2017 by intended degree program

There are gender disparities:	Intended degree program				P-value ^b
	MD ^a %	PhD ^a %	MD-PhD ^a %	All degrees %	
In the MD training process					0.74
Agree	64	50	50	60	
Disagree	12	13	14	13	
Neutral/I don't know	24	38	36	27	
In the PhD training process					0.24
Agree	53	63	50	53	
Disagree	5	13	21	8	
Neutral/I don't know	42	25	29	39	
In the MD-PhD training process					0.36
Agree	42	50	43	43	
Disagree	4	13	14	6	
Neutral/I don't know	54	38	43	51	
That affect my ability to succeed as an MD					0.59
Agree	57	38	43	53	
Disagree	24	25	36	26	
Neutral/I don't know	19	38	21	21	
That affect my ability to succeed as a PhD					0.91
Agree	43	38	36	42	
Disagree	19	25	29	21	
Neutral/I don't know	38	38	36	37	
That affect my ability to succeed as an MD-PhD					0.39
Agree	39	50	50	42	
Disagree	16	25	29	19	
Neutral/I don't know	45	25	21	40	
Gender disparities will play NO role in my choice of program					0.17
True	61	38	50	57	
False	26	13	29	25	
I don't know	14	50	21	18	

^a Respondents who indicated if they had to choose one program today, they would choose MD, PhD, or MD-PhD training

^b Determined using Fisher's exact test with significance at alpha=0.05

DISCUSSION

In this population of women undergraduates at large, public universities in North Carolina, perceived gender disparities were not significantly associated with intended graduate degree. Women most commonly cited perceived competitiveness as an applicant and desired work environment as important to selecting a graduate degree program. Awareness of MD-PhD programs varied significantly by institution research intensity; overall 60% of respondents indicated familiarity with this training pathway.

The working hypothesis was that women undergraduates' perception of gender disparities in graduate program training is negatively associated with stated intention to matriculate to an MD-PhD program. Encouragingly, none of the gender disparity responses were significantly associated with intended degree program. However, multiple data points in this study's results suggest gender disparities are a concern for some aspiring biomedical professionals. When asked explicitly whether gender disparities would play a role in the participant's choice of degree program, 25% of those intending to pursue an MD, PhD or MD-PhD said disparities would influence their decision. Ideally, perceived gender disparities would never play a role in women's career decisions. Initiatives that facilitate undergraduate research experiences and help students learn about careers in research, such as integrated summer programs²³ or course-based undergraduate research experiences (CURES),²⁴⁻²⁶ may help eliminate the effect of perceived gender disparities in graduate training choices. It is important not only that these initiatives exist, but that they promote a culture that welcomes and values women, supports women as they make career decisions, and provide encounters with mentors that are supportive and relatable²⁷. Such initiatives and culture changes may strengthen the scientific identities and motivation of early undergraduate women, and could also serve to increase interest in MD-PhD training among women.²⁸

Over three-quarters of female participants considering MD, PhD, and/or MD-PhD programs stated that their perceived competitiveness as an applicant was a determining factor in their choice of graduate degree program. Women consistently underrate their competence, even at an early age.^{20,21} While not unique to MD-PhD training, women who consider MD-PhD training as the best way to achieve their career goals may inappropriately self-select out of the applicant pool because they perceive that they are underqualified to apply. Because attitudes and perceptions are internalized at an early age, it would be beneficial for all women — and especially those attracted to hyper-competitive careers and environments like academic medicine — to be able to accurately assess their competencies and apply with confidence to programs that match those qualifications. In addition to perceived competitiveness, other highly ranked factors concerned the nature of the work itself (work environment and patient interaction) and burden of training (financial support, stress, and duration of training). Encouragingly, these factors were endorsed more often than other reasons commonly thought to account for the gender disparity, including the desire for work-life balance, perceived gender barriers to success, and role models.¹¹ It is likely that experiences that allow women to assess their competencies and qualifications (i.e. undergraduate research initiatives, faculty mentorship) will also help them learn about the day-to-day mechanics and training pathways of different research careers.

Familiarity with MD-PhD training programs was lowest among students at R2 or R3 universities without affiliated MD-PhD programs. It is likely that awareness of MD-PhD programs and the physician-scientist career path is even lower in the general student population compared to this study's sample of pre-health

listserv subscribers, 60% of whom indicated knowledge of the joint degree pathway. Additionally, about half of the “neutral/I don’t know” responses in the questions about gender disparities in training and success for PhD and MD-PhD careers were originally coded as “I don’t know” and were from students who intended to pursue an MD, which indicates that many aspiring physicians are not sure about the presence or effect of gender disparities in more research-oriented training programs and careers. The data from the current study indicate an opportunity for an intervention to disseminate information about MD-PhD programs to both the student population as well as undergraduate research and pre-health advisers. Students at universities without MD-PhD programs may benefit from stronger collaborations between the MD-PhD program and undergraduates, or on-campus information sessions co-hosted by MD-PhD trainees at neighboring institutions.⁵ Furthermore, mentoring support from faculty members has been shown to strengthen the scientific identities and motivation of early undergraduate women, and a limitation of this study is that the authors do not know to which program students will ultimately apply, and their responses reflect their perceptions, rather than empirical experiences, with graduate programs.

Participants’ hypothetical choice one degree program at the time of the survey approximates their future path, but their decision may change over time. Strengths of this study include the participation of students from multiple universities as well as those who identified as underrepresented minorities.

In summary, undergraduate women’s perceptions of gender disparities in MD, PhD, and MD-PhD training programs; factors that influence their choice of degree program; and sources of encouragement or discouragement to pursue specific paths are presented. In the current study, one in four students intending to pursue an MD, PhD, or MD-PhD program stated that gender disparities during training will influence their choice of program. The most commonly cited factor influencing choice of degree program was perceived competitiveness as an applicant — a factor that women consistently underrate. Finally, self-rated understanding of MD-PhD programs varied significantly by institutional research intensity, and very few students were encouraged by pre-health advisers to pursue MD-PhD training. Altogether, there is room for increased dissemination of information about MD-PhD programs to both undergraduate students and pre-health advisers. Future research should evaluate whether such initiatives generate earlier interest in physician-scientist training and encourage women to apply for and remain in physician-scientist careers.

REFERENCES

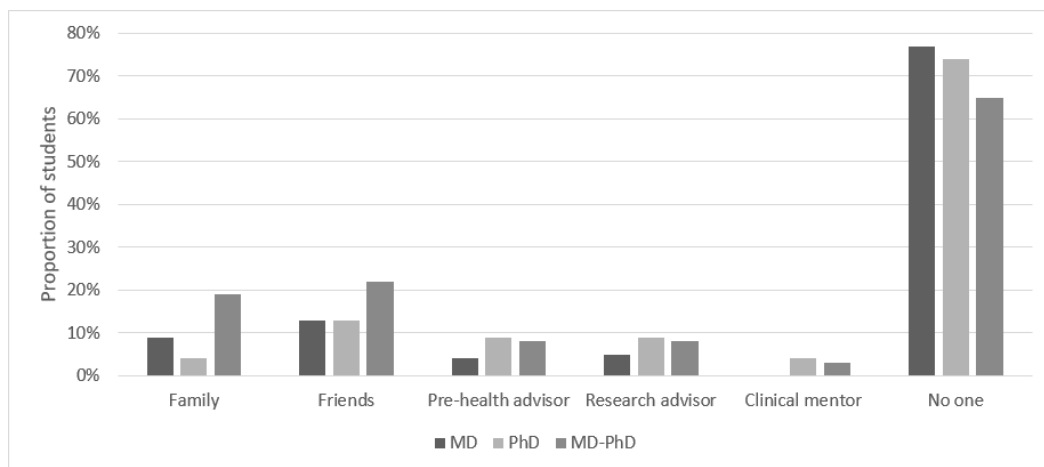
1. Carr PL, Raj A, Kaplan SE, Terrin N, Breeze JL, Freund KM. Gender Differences in Academic Medicine: Retention, Rank, and Leadership Comparisons From the National Faculty Survey. *Acad Med* 2018.
2. Ley TJ, Rosenberg LE. The physician-scientist career pipeline in 2005: build it, and they will come. *JAMA* 2005; **294**(11): 1343-51.
3. Darbar M, Emans SJ, Harris ZL, Brown NJ, Scott TA, Cooper WO. Part-time physician faculty in a pediatrics department: a study of equity in compensation and academic advancement. *Acad Med* 2011; **86**(8): 968-73.
4. National Institutes of Health. NIH Physician-scientist Workforce (PSW) Working Group Report 2014. http://acd.od.nih.gov/reports/PSW_Report_ACD_06042014.pdf Accessed October 2018.
5. Guelich JM, Singer BH, Castro MC, Rosenberg LE. A gender gap in the next generation of physician-scientists: medical student interest and participation in research. *J Investig Med* 2002; **50**(6): 412-8.
6. Jolly S, Griffith KA, DeCastro R, Stewart A, Ubel P, Jagsi R. Gender differences in time spent on parenting and domestic responsibilities by high-achieving young physician-researchers. *Ann Intern Med* 2014; **160**(5): 344-53.
7. Kong X, Chakraverty D, Jeffe DB, Andriole DA, Wathington HD, Tai RH. How Do Interaction Experiences Influence Doctoral Students' Academic Pursuits in Biomedical Research? *Bull Sci Technol Soc* 2013; **33**(3-4): 76-84.
8. Ash AS, Carr PL, Goldstein R, Friedman RH. Compensation and advancement of women in academic medicine: is there equity? *Ann Intern Med* 2004; **141**(3): 205-12.

9. Jeffe DB, Andriole DA. Prevalence and predictors of US medical graduates' federal F32, mentored-K, and R01 awards: a national cohort study. *J Investig Med* 2018; **66**(2): 340-50.
10. Ley TJ, Hamilton BH. Sociology. The gender gap in NIH grant applications. *Science* 2008; **322**(5907): 1472-4.
11. Andrews NC. The other physician-scientist problem: where have all the young girls gone? *Nat Med* 2002; **8**(5): 439-41.
12. AAMC. Table A-1: U.S. Medical School Applications and Matriculants by School, State of Legal Residence, and Sex, 2017-2018. <https://www.aamc.org/download/321442/data/factstablea1.pdf>.
13. NSF. Table 56. Statistical profile of doctorate recipients in life sciences fields, by sex and field of study: 2016. <https://www.nsf.gov/statistics/2018/nsf18304/data/tab56.pdf>.
14. AAMC. Table B-11.2: Total MD-PhD Enrollment by U.S. Medical School and Sex, 2013-2014 through 2017-2018. <https://www.aamc.org/download/321554/data/factstableb11-2.pdf>.
15. Jeffe DB, Andriole DA, Wathington HD, Tai RH. The emerging physician-scientist workforce: demographic, experiential, and attitudinal predictors of MD-PhD program enrollment. *Acad Med* 2014; **89**(10): 1398-407.
16. Jeffe DB, Andriole DA, Wathington HD, Tai RH. Educational outcomes for students enrolled in MD-PhD programs at medical school matriculation, 1995-2000: a national cohort study. *Acad Med* 2014; **89**(1): 84-93.
17. AAMC. Table B-8: U.S. Medical School MD-PhD Applications and Matriculants by School, In-State Status, and Sex, 2017-2018. <https://www.aamc.org/download/321544/data/factstableb8.pdf>.
18. NIH. Appendix IV: Physician-scientists Workforce Data Chapter 2 Main Data. https://www.report.nih.gov/Workforce/PSW/chapter_2_main_data.aspx.

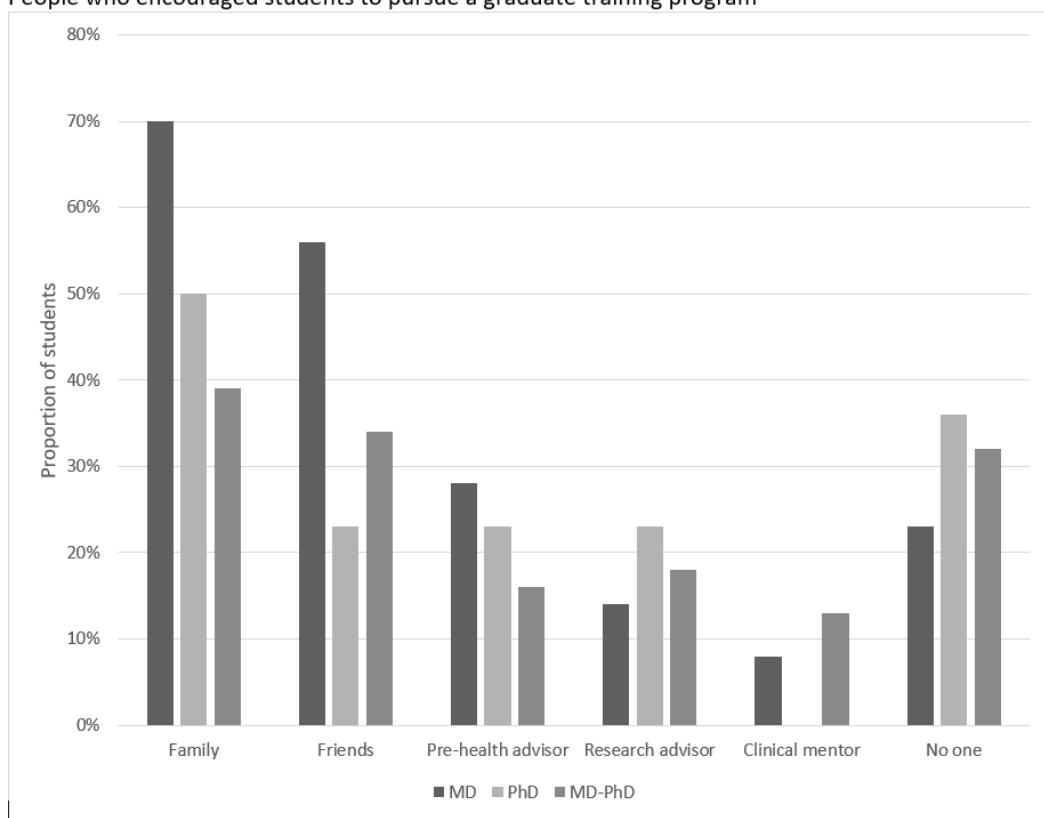
19. Harding CV, Akabas MH, Andersen OS. History and Outcomes of 50 Years of Physician-Scientist Training in Medical Scientist Training Programs. *Acad Med* 2017; **92**(10): 1390-8.
20. Eccles JS. Gender Roles and Women's Achievement-Related Decisions. *Psychol Women Q* 1987; **11**(2): 135-72.
21. Dunning D. Why People Fail to Recognize Their Own Incompetence. *Curr Dir Psychol Sci* 2003; **12**(3): 83-7.
22. Jeffe DB, Yan Y, Andriole DA. Do research activities during college, medical school, and residency mediate racial/ethnic disparities in full-time faculty appointments at U.S. Medical schools? *Acad Med* 2012; **87**(11): 1582-93.
23. Gotian R, Raymore JC, Rhooms SK, Liberman L, Andersen OS. Gateways to the Laboratory: How an MD-PhD Program Increased the Number of Minority Physician-Scientists. *Acad Med* 2017; **92**(5): 628-34.
24. Jansen DA, Jadack RA, Ayoola AB, et al. Embedding Research in Undergraduate Learning Opportunities. *West J Nurs Res* 2015; **37**(10): 1340-58.
25. Bangera G, Brownell SE. Course-based undergraduate research experiences can make scientific research more inclusive. *CBE Life Sci Educ* 2014; **13**(4): 602-6.
26. Auchincloss LC, Laursen SL, Branchaw JL, et al. Assessment of course-based undergraduate research experiences: a meeting report. *CBE Life Sci Educ* 2014; **13**(1): 29-40.
27. Cheryan S, Ziegler SA, Montoya AK, Jiang L. Why are some STEM fields more gender balanced than others?. *Psychological Bulletin*. 2017 Jan;143(1):1.
28. Hernandez PR, Bloodhart B, Barnes RT, et al. Promoting professional identity, motivation, and persistence: Benefits of an informal mentoring program for female undergraduate students. *PLoS One* 2017; **12**(11): e0187531.

29. Morales DX, Grineski SE, Collins TW. Influences on Faculty Willingness to Mentor Undergraduate Students from Another University as Part of an Interinstitutional Research Training Program. *CBE Life Sci Educ* 2016; **15**(3).

Supplemental Figure 3. Sources of encouragement or discouragement among female undergraduates in North Carolina in 2017 considering MD, PhD, and/or MD-PhD programs



People who encouraged students to pursue a graduate training program



People who discouraged students from pursuing a graduate training program