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# Gender, race-ethnicity and postdoctoral hiring in STEMM fields☆

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ABSTRACT

As postdoctoral training has become a requirement in many STEMM fields the influence of postdoc hiring on STEMM labor force inclusion and diversity has increased, yet postdoc hiring processes have received only limited attention from researchers. Drawing on status theory and data for 769 postdoctoral recruitments, we systematically analyze the relationship between gender, race-ethnicity, and postdoctoral hiring. The findings show: (1) differences by gender and race-ethnicity in application rates, and in whether an applicant is seriously considered, interviewed, and offered the postdoc position; (2) hiring disparities correlate with between-group differences in applicants' network connections, referrer prestige, and academic human capital; (3) between-group differences in network connections have the greatest power to account for hiring disparities; and (4) hiring processes may differ by applicant gender or race-ethnicity, the female representation in the STEMM field and the race of the search committee chair. We discuss competing interpretations of the results and highlight directions for future research.

## 1. Introduction

Postdoctoral appointments are an established part of professional training in many fields of science and engineering and are increasingly common in the social sciences and humanities (Åkerlind, 2005; Conti and Liu, 2015; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2014; Nerad and Cerny, 1999). The population of postdoctoral researchers has expanded steadily to more than double in size since the 1980s, and attaining a postdoc is a "virtual prerequisite" for advancement into research careers in industry, government, and the nonprofit sector (Cantwell and Taylor, 2015; Denton et al., 2022; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2000; 2014). In the pipeline for faculty positions in the science, technology, engineering, mathematical and medical (STEMM) fields, the postdoc stage has become a critical filter, a "proving ground for academic excellence, scientific entrepreneurship, and ultimate intellectual independence" (Nerad and Cerny, 1999:1533). This is especially true for tenure-track positions at research universities where new assistant professors are, almost universally, recent postdoctoral scholars trained at prominent research-intensive universities (Herschberg et al., 2018; Sheltzer and Smith, 2014).

The population of postdoctoral researchers also accounts for a sizeable and essential segment of the science, technology, engineering, mathematics, and medical (STEMM) workforce (Conti and Liu, 2015; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2014) despite the fact that postdoc appointments are usually temporary and that doctorates

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spend only 2–5 years in postdoc positions (Andalib et al., 2018; Kahn and Ginther, 2017). Postdoctoral scholars are highly skilled, and with the rise of team-based research they have become integral to the conduct of research, its dissemination, and efforts to secure the funding that dictates its future direction (Blaney et al., 2020; Cantwell, 2011a, 2011b; Herschberg et al., 2018; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2014; Pavlidis et al., 2014; Stephan, 2015). Postdoctoral scholars also act as direct supervisors for students in research labs and may be more observable and accessible role models than faculty, particularly for racially/ethnically minoritized students (Blaney et al., 2020). The postdoc population, therefore, not only defines the pool of potential STEMM faculty, it also directly impacts the science conducted and its potential for innovation, as well as the cultivation of the next generation of scientists.

Given the influence that postdoctoral training has on both individual careers and the conduct of research nationally, ensuring equal and inclusive access to, experience during, and placement after postdoctoral positions is key to achieving equity and innovation in STEMM (Garrison et al., 2016; Herschberg et al., 2018; Knaub et al., 2018; Koning et al., 2021; Wei et al., 2012). Yet the processes that affect participation in postdoctoral training have received little attention from researchers, institutional administrators, and policy makers. Federal funding agencies, research universities, and professional associations currently lack explicit and consistent policy related to postdoctoral hiring (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2000; 2014; National Science Foundation, 2018; University of California Office of the President, 2020) and tend to defer to funded researchers to determine how postdocs will be recruited (Huynh and Shauman, 2021). The lack of structure and oversight may increase the likelihood of bias in postdoc recruitment while also making inequities difficult to detect and address. Indeed, the dearth of research on postdoc hiring is largely attributable to the informality and decentralized structure of the postdoc market, both of which inhibit systematic investigation and data collection.

We use a unique set of administrative data to examine the magnitude, hiring process timing, and the correlates of disparities by race and gender in postdoctoral hiring in STEMM fields. Drawing on status theory (Correll and Ridgeway, 2006; Ridgeway, 2014) we investigate if the observed differences in hiring are attributable to disparities by race and gender in (1) the distribution of applicant resources that correlate with hiring outcomes, and (2) in how the resources affect those outcomes. We focus on three categories of applicant-level resources: the applicants' network connections, the prestige of their referrers, and their academic human capital. We also test if the representation of sex and race-ethnicity in the organizational context of postdoc recruitment – measured at the field, department, and search committee levels – affect disparities in applicants' hiring outcomes.

## 2. Characteristics of the market for postdoctoral scholars

Studies of the postdoc labor market emphasize its precarity, low pay, decentralization, and reliance on informal networks (Cantwell, 2011a; Herschberg et al., 2018; Kahn and Ginther, 2017; Knaub et al., 2018; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2000). While the total supply of postdoctoral positions includes well-known, established, and often prestigious fellowships, the number of these positions has remained constant since 1980 (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2014). Growth in the supply of postdoctoral positions has been driven by postdoctoral positions created as part of research grants and "other non-Federal sources" (National Academy of Sciences, 2014). According to a report by the National Academy of Sciences, this sector accounted for over 90% of postdoc positions in 2009 (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2014: Figs. 2–1). This part of the postdoc market lacks centralized systems for advertising available positions, collecting application materials, facilitating the review of applicants, and tracking who is hired. The market relies on informal networks and recruitment processes (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2014), and most postdoctoral scholars are hired through personal connections and direct contact with potential advisors (Knaub et al., 2018; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2000).

## 3. Status theory and hiring discrimination

We draw on status theory to frame our investigation of disparities in postdoctoral hiring. Status theory articulates how status, as a force that is independent from material resources and power, drives the cultural construction of distinct social groups (Lamont, 2012; Tilly, 1998), causes the unequal distribution of material resources between those groups, and then becomes a direct cause of material inequalities between people (Ridgeway, 2014). The resulting group-level disparities in resources feed perceptions of group-based differences in competence and worthiness that coalesce into status beliefs, i.e., the normative beliefs that a status characteristic itself indicates who is "better," "more competent," or "worthy" of esteem, privileged positions, and a disproportionate share of valued resources. These status-esteem conflations are especially likely and durable when they align with socially salient, observable categories, such as those defined by gender and race (Ridgeway, 2011, 2019; Ridgeway and Correll, 2006; Ridgeway and Erickson, 2000; Tilly, 1998). And status-based differences in esteem translate into disparities in material resources through three types of micro-level social-relational processes: status biases in judgments and behavior, associational preference biases, and reactions to status challenges (Ridgeway, 2014, 2019).

Status theory conceptualizes hiring as a "gateway" interaction – an interpersonal process that takes place in an organizational context – that mediates people's access to jobs (Ridgeway, 2014; Ridgeway and Fisk, 2012) and thereby generates and reinforces group-based inequality in access to material resources. From the perspective of status theory, persistent disparities by gender and race-ethnicity in hiring processes (e.g., Bertrand and Mullainathan, 2004; Fernandez and Sosa, 2005; Goldin and Rouse, 2000; Gorman, 2005; Moss-Racusin et al., 2012; Pager and Shepherd, 2008; Phelan et al., 2008; Quillian and Midtbøen, 2021) result from two primary causes: between-group disparities in the distribution of resources and qualifications relevant to the job, and between-group differences in the evaluation of applicants with equal resources and qualifications.

### 3.1. Status processes and the unequal distributions of resources in STEMM

Status theory predicts that status processes create unequal access to resources and opportunities that accumulate into consequential between-group differences in the distribution of resources, and that these disparities both cause and justify group-level inequities in hiring outcomes (Ridgeway, 2019). A growing body of research documents how resources that are directly related to success in STEMM careers are affected by race- and gender-based biases. The segregation of science teams by gender and race generates disparities in access to training opportunities (e.g., Buffington et al., 2016; Freeman and Huang, 2015; Karimi et al., 2018; Koput and Gutek, 2010; Sheltzer and Smith, 2014), and bias generates inequities in the awarding of grants and fellowships (e.g., Carnes et al., 2005; Dutt et al., 2016; Ginther et al., 2011; Wenneras and Wold, 1997), in the allocation of authorship on multi-author papers (West et al., 2013; Zuckerman, 1968), and in the publishing process (e.g., Card et al., 2020; Fox and Paine, 2019; Hengel, 2017). Studies also show that gendered and racialized citation patterns build disparities into citation counts, which are often used as indicators of scholarly quality and impact (Fox and Paine, 2019; King et al., 2017; Maliniak et al., 2013). These biases accumulate to produce significant disparities in the observable metrics and characteristics that are commonly used in hiring decisions, and they thereby provide seemingly objective grounds to favor males and whites in hiring decisions.

In educational and employment settings, status beliefs and associational biases produce segregated networks that perpetuate status inequalities in multiple ways. In addition to reinforcing disparities in access to information and opportunities for skill development, they also reproduce hierarchies of prestige by reinforcing group differences in access to elite institutions and influential mentors (Lamont, 2009; Sheltzer and Smith, 2014). In hiring processes, access to elite networks is consequential because the relative prestige of an applicant's personal and institutional affiliations is a common proxy measures of their "quality" or cultural "fit" with a job or organization above and beyond their human capital qualifications. Studies have shown that institutional connections, e.g., where one attained a degree, are interpreted as signals of applicant quality in both academic (Allison and Long, 1987; Barbezat, 1992; Burris, 2004; Correll et al., 2017; Hargens and Hagstrom, 1967) and non-academic job markets (Bedeian et al., 2010; Rivera, 2011, 2015). Others have documented that prestigious interpersonal connections, such as having a prominent reference, affect hiring decisions net of applicant characteristics and qualifications (Castilla et al., 2013; Correll et al., 2017; Hadani et al., 2012; Judge et al., 2004; Reskin, 1979; Yakubovich and Lup, 2006). The advantage of elite institutional affiliations is reflected in the homophily of PhD hiring networks (Clauset et al., 2015) and in the extreme homogeneity that characterizes the institutional origins of university faculty (Wapman et al., 2022).

### 3.2. Status processes and evaluation bias in STEMM

Status theory also predicts that status characteristics, such as gender or race, affect hiring outcomes because they cause bias in evaluation and preferences for affiliation even when there are no between-group differences in job applicants' qualifications (Ridgeway, 2014). A large body of research in social psychology demonstrates that status beliefs cause evaluators to shift, redefine, or apply altogether distinct standards for evaluations of merit depending on the gender or race-ethnicity of the evaluation subjects (Biernat, 2003; Biernat et al., 2009; Biernat and Fuegen, 2001; Biernat and Krobrynowicz, 1997; Biernat and Manis, 1994; Fiske, 2000; Fiske et al., 2002; Glick et al., 1995, 2000, 2004; Phelan et al., 2008). Studies show that women and members of minoritized racial-ethnic groups are held to higher standards than are men and Whites (Biernat et al., 1989; Biernat and Fuegen, 2001; Foschi, 1996, 2009; Foschi and Valenzuela, 2008; Linville and Jones, 1980), that negative characteristics have a lesser impact on the employment outcomes of men and whites (Pager, 2003; Pager et al., 2009), and that evidence of actual achievement is required for women while evidence of potential achievement is sufficient for men (Huang, 2009; Lunbeck, 2005).

Despite the cultural dominance of the norms of universalism and meritocracy (Cole and Cole, 1973; Lamont, 2009; Long and Fox, 1995; Merton, 1942), there is evidence of gender and race-based bias in many academic processes and STEMM fields (Settles et al., 2020). Analyses of recommendation letters (Dutt et al., 2016) and quantitative ratings (Wenneras and Wold, 1997) of applicants for postdoctoral fellowships indicate that women's qualifications are under-rated compared to men's, and that women must demonstrate greater levels of scientific productivity to be considered as competent as men. Similarly, applicants for lab positions and postdoctoral positions who are female, Latinx or Black receive the lower hireability ratings than other candidates despite having identical qualifications (Eaton et al., 2019; Moss-Racusin et al., 2012). Documented disparities in the peer-review process, editorial decision-making (e.g., Card et al., 2020; Fox and Paine, 2019; Hengel, 2017) and in the valuation of collaborative work (Sarsons, 2017) reflect the operation of group-specific, as opposed to universal, standards for achievement.

In sum, status theory and the available research suggests that gender- and race-based differences in postdoctoral hiring are affected by between-group differences in the *distribution* of the applicants' characteristics, and in *how relevant characteristics are evaluated* in the hiring process. We therefore test the following hypotheses.

**Hypothesis 1**. *Disparate Resources Hypothesis*: Differences by gender and race-ethnicity in STEMM postdoctoral hiring outcomes are accounted for by between-group differences in the distribution of three types of resources that are valued in STEMM hiring: network connections, affiliation prestige, and human capital.

**Hypothesis 2**. *Biased Evaluation Hypothesis*: The association between applicant hiring outcomes and applicant-level resources, i.e., network connections, affiliation prestige, and human capital, varies by applicant gender and race-ethnicity.

### 3.3. Organization-level status processes

A central tenet of status theory is that status-based inequalities become embedded in the structure of social institutions, and that these structures then reinforce status beliefs and the status processes that generate inequalities (Ridgeway, 2009, 2014, 2019). With respect to employment processes and gender inequality, for example, a range of studies demonstrate how gender-based status biases and association preferences, are "written into" (Ridgeway, 2011) the labor market, the organization of jobs and work schedules, pay structures, and hiring and promotion processes (Acker, 1990; Charles and Grusky, 2004; England, 1992; England et al., 2020; Nelson and Bridges, 1999; Petersen and Morgan, 1995; Reskin et al., 1999). Once status-based organizational processes are established, they normalize the prevailing status beliefs (e.g., the assumption that masculine-typed characteristics indicate leadership potential) and status processes (e.g., relying on interpersonal networks to recruit job applicants) that reinforce and perpetuate group-based inequalities (Heilman, 1979; Kanter, 1977a, 1977b). The organizational context then comes to embody the status beliefs that generated it, continuously reinforcing implicit biases about which types of people are suitable for inclusion and which are unlikely to "fit" or succeed in that context.

If group representation signals and reinforces status beliefs about who "belongs," "fits," or is the most "competent" for a particular job, as status theory predicts, we expect that group representation in organizational settings will moderate the gender- and race-specific outcomes of applicants for postdoc positions. We measure group-representation in the hiring context at three levels: within the specific STEMM field targeting by the recruitment, within the department associated with the postdoctoral appointment, and among the chairs of the hiring committees. We expect the representation of women in a field, hiring department, or hiring committee to improve the hiring outcomes of female applicants, and that the same interaction effect will be observed between applicant race-ethnicity and the race-ethnic composition of the hiring field or department.

**Hypothesis 3**. (*Demographic Context Hypothesis)*: Differences by gender and race-ethnicity in STEMM postdoctoral hiring outcomes will depend on the demographics of the hiring context. The contextual influence may operate through the demographics of the STEMM field of the recruitment, the department that hosts the recruitment, or the chair of the recruitment committee.

## 4. Data

We test each of our hypotheses using data from the *Evaluating Equity in Faculty Recruitment* (EEFR) study. EEFR compiles data from the administrative records of the online faculty recruitment management system used by all campuses of a public research university system in the United States. Our analytic sample includes 22,098 applications submitted to 769 postdoctoral recruitments in 59 specific STEMM fields[1] conducted at 9 university campuses from 2013 through 2021. We include postdoctoral recruitments in 7 broad STEMM fields – agriculture and environmental science; engineering; biological and biomedical sciences; math, statistics, and computer science; physical science; social science; and health science. The EEFR data include information about the recruitments and search committees, as well as individual-level information about the scholars who applied for each position. It also includes the curricula vitae submitted by each applicant, from which we code measures of achievement.

The breadth and detail of the EEFR data are unprecedented and provide a rare opportunity to investigate the correlates of postdoctoral hiring, but these data are limited in ways that constrain the interpretation of results derived from them. First, it is important to note that since the EEFR data are neither a census nor a random sample of postdoc recruitments or applicants, and since they are drawn from a single university system, the generalizability of results based on these data to another university system or to the national patterns of postdoctoral hiring is unclear. Second, these data exist only because the recruitment management system was used to collect applications, and some of the recruitments may have used other systematized hiring processes, e.g., publicly posting of the job, requiring formal applications, recording decisions about each applicant, etc. These recruitment characteristics have at least two implications for this analysis. First, the results may not generalize to postdoc recruitments that use informal hiring practices. Second, since formal recruitment processes are associated with greater equity in hiring, our findings may provide conservative estimates of disparities by gender and race-ethnicity.

### 4.1. Recruitment characteristics

Our analysis controls for multiple recruitment-level characteristics that may be correlated with postdoc hiring patterns in general, and with gender- and race-specific hiring outcomes in particular. These include the academic year of the job posting, the campus (anonymized) where the recruitment took place, the STEMM field of the postdoc position, the NRC ranking of the hiring department, the size of the recruitment committee, and the number of applications each recruitment received. The demographic context of each postdoc hire is measured within the STEMM field targeted by the recruitment, the department hosting the postdoc, and committee

[1] The target fields of each EEFR recruitment are drawn from the 334 SED degree fields and identified by the departmental staff who post the job advertisement. This direct linkage between the SED and EEFR data provides a reliable operationalization of the demographics of recent doctorates in the recruitment fields.

**Table 1**
Percent distribution of applicants by the characteristics of the postdoctoral recruitments.

| | % or mean | (std. dev.) |
|---|---|---|
| Total number of recruitments = 769 | | |
| **Recruitment characteristics** | | |
| Number of applications received | 26.82 | (27.06) |
| Academic year of the recruitment | | |
| 2013-14 | 4.29 | |
| 2014-15 | 9.62 | |
| 2015-16 | 12.22 | |
| 2016-17 | 12.09 | |
| 2017-18 | 13.78 | |
| 2018-19 | 14.30 | |
| 2019-20 | 16.91 | |
| 2020-21 | 16.78 | |
| University hosting postdoc job recruitment | | |
| A | 58.91 | |
| B | 15.99 | |
| C | 7.15 | |
| D | 7.28 | |
| E | 3.38 | |
| F | 3.12 | |
| G | 2.99 | |
| H | 0.65 | |
| I | 0.52 | |
| STEM field | | |
| Agriculture and Environmental Science | 7.15 | |
| Engineering | 21.72 | |
| Biological and Biomedical Science | 26.92 | |
| Math, Statistics, or Computer Science | 8.06 | |
| Physical Science | 23.15 | |
| Social Science | 5.59 | |
| Health Professions | 7.41 | |
| Representation of gender*race groups among recent doctorates in recruitment field | | |
| % Female & Black, Latinx, or Native American | 4.49 | (3.23) |
| % Male & Black, Latinx, or Native American | 5.49 | (1.60) |
| % Female & Asian | 12.13 | (4.58) |
| % Male & Asian | 20.18 | (9.91) |
| % Female & White | 18.70 | (9.63) |
| % Male & White | 29.52 | (7.48) |
| **Hiring department characteristics** | | |
| NRC rank of hiring department | | |
| Unranked | 23.41 | |
| 1st-50th percentile (lower 50% of ranked depts.) | 10.27 | |
| 50th-75th percentile | 32.51 | |
| 75th-90th percentile | 18.47 | |
| 90th-100th percentile (top 10%) | 15.34 | |
| Gender and race-ethnic group representation among hiring department faculty | | |
| % Female | 38.31 | (23.42) |
| % Black, Latinx, or Native American | 8.25 | (7.65) |
| % Asian | 21.49 | (12.88) |
| | 18.99 | |

(*continued on next page*)

**Table 1** (*continued*)

| | % or mean | (std. dev.) |
|---|---|---|
| Missing faculty demographics | | |
| **Hiring committee characteristics** | | |
| No committee info | 6.76 | |
| 1 member | 42.13 | |
| 2–3 members | 38.75 | |
| 4+ members | 12.35 | |
| Gender and race-ethnicity of search committee chairs | | |
| Female | 30.69 | |
| Black, Latinx, or Native American | 5.33 | |
| Asian | 19.77 | |

managing the search. We use *Survey of Earned Doctorates* (SED) data to measure the relative representation of doctorates in the specific field of each postdoc recruitment by gender and race-ethnicity. To obtain reliable estimates, we use the detailed classification of STEMM fields employed by the SED and aggregate the data across the 5 years preceding each recruitment. Department-level demographic context is operationalized with three continuous variables measuring the representation of faculty in the hiring department who identify as female (of any race-ethnicity), as Asian, and as Black, Latinx or Native American (BLNA). Hiring committee demographics are captured by indicators of the gender and the race-ethnicity of the committee chair. Table 1 presents the operationalization of each measure and the distribution of the recruitments by each characteristic.

The recruitments included in this study are slightly skewed toward recent academic years and are heavily concentrated at a single campus.[2] The recruitments are also concentrated in the three STEMM fields that account for the majority of postdoctoral positions nationally (Denton et al., 2022; Huynh and Shauman, 2021; Kahn and Ginther, 2017): the physical sciences, the biological and biomedical sciences, and engineering. Most of the recruitments were conducted by departments that are ranked in the upper half of NRC-rated programs in their field, and 15 percent were in the 90th percentile. On average, the recruitments received about 27 applications, but the count varied widely, and the distribution is highly skewed: the median application count is 18 but it ranges from 4 to 200.

The STEMM fields targeted by the postdoc recruitments are, on average, 30 percent white and male, 19 percent white and female, 20 percent Asian and male, 12 percent Asian and female, 5.5 percent BLNA and male, and 4.5 percent BLNA and female. Faculty members in the hiring departments were, on average, 38 percent female, 8.3 percent BLNA, and 21.5 percent Asian. The recruitments varied in whether a committee managed the search and the number of faculty members included. Almost half of the recruitments did not have committees: forty-two percent of searches were managed by 1-person and 6.8 percent lacked any information on committee membership. Committees with 2–3 members were the most common, accounting for 38.8 percent of recruitments, while 12 percent had committees of 4 or more faculty members. The representation of women and faculty of color among the search committee chairs parallels the hiring departments faculty demographics: 30.7 percent of committee chairs were women, 19.8 percent were Asian, and 5.3 percent were BLNA.

### *4.2. Dependent variable: Applicant outcomes in the postdoctoral hiring process*

The hiring process includes a sequence of evaluation and selection steps that culminate in a limited number of job offers, and each step may be subject to different influences and potential inequities. We examine the applicants' outcomes across three steps in the hiring process: whether an applicant is seriously considered, interviewed, and offered the postdoctoral position. The pool of applicants eligible for each outcome is increasingly selective: all applicants have a chance of serious consideration, but only those who are seriously considered have a non-zero probability of being interviewed, and only those who are interviewed may be offered the position. This sequential approach (Mare, 1980, 1981) empirically parallels the hiring process and allows for more accurate estimation of disparities in the process and their correlates.

### *4.3. Applicant characteristics*

Our analysis focuses on the association between a job applicant's gender and race, their hiring outcomes, and three categories of applicant characteristics: their network connections, referrer prestige, and academic human capital. Table 2 presents the distribution

[2] Campuses A and B differ in size but both actively encourage or require use of the online recruitment system (that is the source of the EEFR data) for postdoctoral recruitments while it is used less consistently on other campuses. We compared the EEFR postdoc recruitment data to the population of STEMM postdocs – estimated from personnel data pooled across all campuses in the university system – to assess the representativeness by field. The distribution of postdoc recruitments included in the EEFR data generally tracks the distribution of all postdoctoral hires, although physical sciences and math, statistics, and computer science are slightly overrepresented, and the other fields are slightly underrepresented in our sample. The recruitments included in the EEFR data are overrepresented among fields with moderate gender diversity and those with low rates of racial-ethnic diversity while underrepresented among fields with high levels of gender and racial-ethnic diversity.

**Table 2**
Distribution of variables measuring applicant-level resources by applicant *Gender*Race-ethnicity*.

| | Total | Female & Black, Latinx or Native American | Male & Black, Latinx, or Native American | Female & Asian or Asian American | Male & Asian or Asian American | Female & White | Male & White | Gender and/or Race-ethnicity not reported | ANOVA *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| N | 22,098 | 631 | 1405 | 3286 | 7757 | 2659 | 4935 | 1425 | |
| Percent | | 2.86 | 6.36 | 14.87 | 35.10 | 12.03 | 22.33 | 6.45 | |
| Number of recruitments applied to in an academic year | | | | | | | | | |
| 1 | 89.80 | 89.70 | 91.74 | 87.55 | 89.47 | 88.79 | 90.86 | 93.05 | 0.00 |
| 2 | 7.10 | 5.55 | 5.91 | 7.82 | 7.44 | 7.78 | 6.81 | 5.19 | 0.00 |
| 3+ | 3.10 | 4.75 | 2.35 | 4.63 | 3.09 | 3.42 | 2.33 | 1.75 | 0.00 |
| **Indicators of network connection** | | | | | | | | | |
| Domestic or International Ph.D. | | | | | | | | | |
| US Ph.D. | 41.49 | 47.23 | 42.07 | 41.02 | 33.76 | 48.39 | 48.89 | 41.69 | 0.00 |
| International Ph.D. | 48.43 | 47.37 | 43.20 | 48.30 | 55.40 | 44.95 | 43.01 | 47.37 | 0.00 |
| Missing | 10.08 | 11.41 | 14.73 | 10.68 | 10.84 | 6.66 | 8.11 | 12.63 | 0.00 |
| Applicant affiliation with hiring university | | | | | | | | | |
| Earned doctorate from hiring institution | 1.54 | 3.49 | 1.64 | 1.46 | 0.59 | 2.44 | 2.07 | 2.39 | 0.00 |
| Missing | 12.38 | 15.37 | 13.38 | 13.91 | 13.64 | 9.78 | 9.73 | 13.68 | 0.00 |
| Where the applicant learned of the postdoc position | | | | | | | | | |
| Hiring campus website | 29.46 | 24.72 | 26.98 | 36.70 | 36.61 | 22.38 | 22.23 | 16.63 | 0.00 |
| Professional associations | 24.34 | 21.55 | 25.41 | 23.28 | 22.28 | 27.72 | 28.90 | 16.14 | 0.00 |
| Higher education media | 11.92 | 9.83 | 14.73 | 11.08 | 11.96 | 11.81 | 12.62 | 9.54 | 0.00 |
| Personal network | 6.15 | 11.25 | 6.48 | 4.35 | 2.99 | 11.32 | 8.90 | 5.68 | 0.00 |
| Declined to state; unknown; missing | 28.13 | 32.65 | 26.41 | 24.59 | 26.16 | 26.78 | 27.36 | 52.00 | 0.00 |
| **Indicators of the prestige and prominence of the applicants' referrers** | | | | | | | | | |
| Rank of referrers' institutional affiliation | | | | | | | | | |
| International (unranked) | 26.68 | 25.99 | 26.41 | 28.00 | 27.10 | 26.18 | 25.15 | 28.14 | 0.07 |
| Unranked U.S. affiliation | 10.22 | 11.41 | 9.75 | 9.40 | 8.26 | 13.92 | 11.94 | 9.82 | 0.00 |
| 1st-50th percentile (lower 50%) | 36.07 | 31.38 | 36.23 | 38.56 | 41.54 | 29.18 | 29.99 | 36.42 | 0.00 |
| 50th-75th percentile | 15.17 | 17.12 | 15.02 | 14.30 | 14.35 | 15.80 | 16.94 | 13.68 | 0.00 |
| 75th-90th percentile | 7.01 | 7.61 | 7.76 | 5.93 | 5.76 | 8.42 | 8.73 | 6.60 | 0.00 |
| 90th-100th percentile (top 10%) | 4.86 | 6.50 | 4.84 | 3.80 | 2.99 | 6.51 | 7.25 | 5.33 | 0.00 |
| Maximum h-index among referrers | 38.22 | 35.24 | 34.68 | 36.40 | 36.79 | 40.57 | 41.24 | 39.07 | 0.00 |
| | (25.40) | (24.49) | (25.00) | (24.10) | (24.11) | (25.77) | (27.33) | (26.25) | |

(*continued on next page*)

**Table 2** (*continued*)

| | Total | Female & Black, Latinx or Native American | Male & Black, Latinx, or Native American | Female & Asian or Asian American | Male & Asian or Asian American | Female & White | Male & White | Gender and/or Race-ethnicity not reported | ANOVA *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| Mean citation count among referrers | 29.95 | 26.85 | 27.20 | 26.82 | 27.11 | 32.79 | 34.24 | 35.10 | 0.00 |
| | (45.71) | (44.60) | (45.17) | (38.26) | (41.97) | (49.46) | (50.31) | (53.44) | |
| **Indicators of the applicants' human capital** | | | | | | | | | |
| Years since doctorate | 2.61 | 2.43 | 2.55 | 2.49 | 2.51 | 2.53 | 2.91 | 2.71 | 0.00 |
| | (3.57) | (3.28) | (3.21) | (3.36) | (3.43) | (3.30) | (4.15) | (3.42) | |
| Current position | | | | | | | | | |
| Postdoc | 21.63 | 20.13 | 20.00 | 18.84 | 23.72 | 20.65 | 22.03 | 19.37 | 0.00 |
| Professor | 7.02 | 4.91 | 5.48 | 7.76 | 9.05 | 2.93 | 6.12 | 7.51 | 0.00 |
| Adjunct or visiting professor, lecturer | 7.24 | 11.89 | 13.38 | 5.54 | 5.25 | 8.16 | 8.53 | 7.65 | 0.00 |
| Research or Teaching Fellow | 4.01 | 1.43 | 2.49 | 3.93 | 5.98 | 2.52 | 2.33 | 4.70 | 0.00 |
| Graduate student | 25.22 | 25.67 | 23.35 | 24.16 | 19.35 | 34.60 | 30.52 | 25.47 | 0.00 |
| Researcher | 19.52 | 15.69 | 18.51 | 19.26 | 22.61 | 16.70 | 16.98 | 20.00 | 0.00 |
| Other | 14.54 | 18.70 | 16.30 | 19.17 | 13.27 | 13.76 | 12.79 | 14.74 | 0.00 |
| Missing | 0.82 | 1.58 | 0.50 | 1.34 | 0.77 | 0.68 | 0.71 | 0.56 | 0.00 |
| CV lists at least one grant or fellowship | 1.97 | 1.87 | 1.58 | 1.24 | 0.89 | 3.39 | 3.23 | 2.92 | 0.00 |
| CV lists at least one publication | 80.97 | 70.41 | 77.89 | 84.55 | 83.47 | 79.76 | 77.89 | 79.53 | 0.00 |
| Citation count (for those with ≥1 publication) | 10.19 | 10.37 | 7.64 | 10.00 | 9.99 | 10.30 | 11.25 | 10.41 | 0.00 |
| | (21.80) | (45.15) | (13.43) | (15.38) | (14.26) | (22.91) | (32.03) | (19.77) | |
| Journal impact factor percentile (for those with ≥1 publication) | 68.76 | 68.42 | 66.63 | 68.50 | 68.05 | 71.31 | 69.34 | 69.63 | 0.00 |
| | (19.12) | (20.89) | (21.05) | (19.70) | (18.38) | (18.63) | (19.56) | (18.73) | |
| CV data missing | 9.81 | 15.37 | 10.18 | 11.93 | 8.43 | 10.27 | 9.10 | 11.23 | 0.00 |

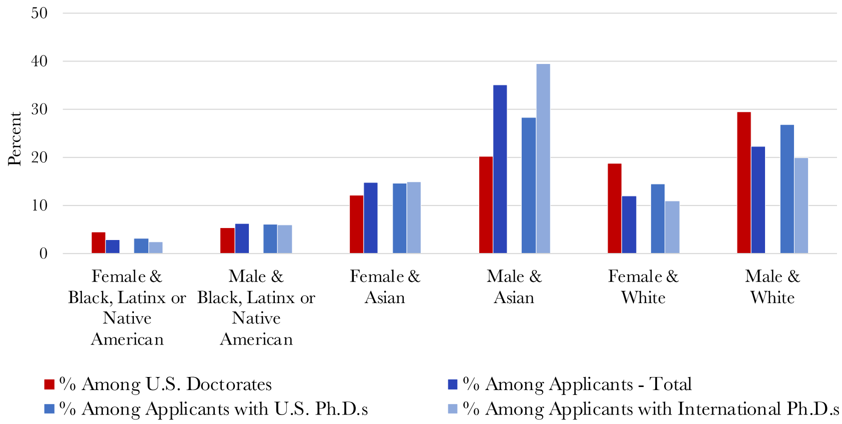


**Fig. 1.** Representation of doctorates by *Gender*Race-ethnicity* among recent U.S. doctorates in the STEMM field of the postdoc, and among applicants for the postdoc positions, in total and separately for those with U.S. vs. international Ph.D.s.

of applicant characteristics for the full population and separately by applicant gender and race-ethnicity.

#### 4.3.1. Gender*Race-ethnicity

Based on insights from intersectional theory (Collins, 2015; Crenshaw, 1990) and studies that document the intersectional effects of gender and race-ethnicity in STEMM (Alegria, 2020; Cole, 2009; Eaton et al., 2019; Haynes et al., 2020; Núñez et al., 2020) we examine the effects of gender within race-ethnic categories throughout this study. While our study can only approximate a qualitatively nuanced intersectional analysis (Núñez et al., 2020), our data include sufficient sample sizes to reveal disparities (López et al., 2018) that may result from the combined effects of racial and gender biases (Ong et al., 2011).

We use a 7-category variable, *Gender*Race-ethnicity*, that distinguishes applicants who identify as female or male within each of 3 race-ethnicity groups: Black, Latinx, or Native American (BLNA),[3] white, and Asian.[4] The variable also includes a category that aggregates those who do not specifically identify their gender, their race-ethnicity, or both.[5] The majority of the applicants for postdoc positions (see Table 2) are men who identify as either white (22.3 percent) or Asian (35.1 percent), while men who identify as BLNA account for only 6.4 percent of applicants. In comparison, 12.0 percent of applicants identify as white women, 14.9 percent identify as Asian women, and 2.7 percent identify as BLNA women. About 6.5 percent of applicants did not identify their race-ethnicity or their gender. Althought all *Gender*Race-ethnic* groups are included in our analyses,[6] we focus on the 6 groups with identified gender and race-ethnicity in our presentation and discussion of the results.

To contextualize the representation of *Gender*Race-ethnic* groups among the postdoctoral job applicants, Fig. 1 presents the applicant demographics among all applicants, and separately for those who earned their doctorates from U.S. and international institutions, relative to the population of recent doctorates in the specific fields targeted by each recruitment.[7] This benchmarking exercise shows that white men, white women, and BLNA women are underrepresented in the postdoc applicant pools relative to the field-specific representation of these groups among U.S. doctorates. In contrast, Asian women and BLNA men are slightly overrepresented, and Asian men are significantly overrepresented among the job applicants. Asian men account for 20.18 percent of all

[3] The EEFR data include a relatively small sample of applicants identifying as "Black or African American," "Hispanic or Latino," "Native American or Alaska Native," or "Native Hawaiian or Other Pacific Islander." Rather than omitting these important groups, our analyses preserve statistical power by combining these categories into a single group that is collectively referred to as "Black, Latinx, or Native American" in this study.

[4] Because the applicant survey does not collect detailed information about ethnicity, we are unable to disaggregate the data for applicants reporting Asian ancestry. Instead, we aggregate multiple Asian ethnic groups into a single "Asian" category despite their vastly different academic and employment experiences in the U.S.

[5] This category includes applicants who indicate multiple racial-ethnic categories, those who indicate a non-binary or "other" gender identity, as well as those who "decline to state" either their gender or their race-ethnicity. This aggregation is necessary because of the small numbers of applicants who identify as multiracial and/or multiethnic, who "decline to state," or who do not respond to these items on the demographic survey. While far from ideal, this aggregation allows us to include all applicants in the analysis.

[6] By retaining the applicants who are aggregated into the "not reported" category of the 7-category *Gender*Race-ethnicity* classification we reduce the potential for bias that can result from listwise deletion of cases from an analysis. Their inclusion in the analyses also acknowledges the small but growing prevalence of individuals who refuse to identify their gender or race-ethnicity (e.g., because refusal accurately reflects their identity, or because they perceive a strategic advantage in withholding the information) or who cannot be definitively categorized (e.g., those who identify as multiracial). But given the small counts of each that these types of non-identification and the heterogeneity generated by their aggregation, the results for the "not reported" category of *Gender*Race-ethnicity* are not interpretable.

[7] The relative representation of *Gender*Race-ethnic* groups in the population of doctorates is measured with data from the SED and include all U.S. citizens, permanent residents, and temporary visa holders who completed their degree during the 5 years prior to the year the postdoc job was posted. The figures are based on the detailed STEMM fields (see Appendix Table 1) identified as the target for each postdoc recruitment.

doctorates from U.S. institutions, but they represent 35.1% of all applicants for the postdoc positions; their overrepresentation among applicants is driven by a disproportionately high rate of application among both domestic and international PhDs. Asian men account for 28.32 percent of applicants with U.S. doctorates and 39.4 percent of applicants with international PhDs. This level of overrepresentation is unique to Asian men. In comparison, Asian women are overrepresented among all applicants but to a lesser degree – they account for 14.9 percent of applicants compared to 12.13 percent of doctorates from U.S. institutions – and they are equally represented among applicants with domestic (14.98 percent) and international PhDs (14.6 percent).

#### *4.3.2. Applicant-level control: Number of applications submitted*

To increase their odds of obtaining a position, scholars may apply for multiple postdoctoral recruitments in a given year. This behavior is observed but not common in our postdoc recruitment data. Almost 90 percent of the applicants applied to only one postdoctoral recruitment, 7 percent applied to two searches, and only 3 percent of applicants applied to 3 or more of the postdoctoral positions included in the EEFR data. The maximum number of applications submitted by a single applicant is 18. Although only a small proportion of applicants appear multiple times in our data, we employ two approaches to limit the potential biasing impact of this source of non-independence. We use multilevel models with random effects at the recruitment and field levels (described in Section 5), which accounts for the clustering of applicants within recruitment, and all models control for the number of applications associated with each applicant within each academic year.

#### *4.3.3. Applicant network connections*

We measure the applicants' self-reported network connections with three variables: an indicator of whether their doctorate was received from a U.S. or an international institution[8]; an indicator of whether an applicant has an alma mater connection with the hiring institution, i.e., if they earned their doctorate from the hiring institution; and a multi-category indicator of how the applicant learned about the postdoctoral position.

International doctorates account for about 48.4 percent of all postdoc applicants, but their representation is greatest (55.5 percent) among Asian males. Domestic doctorates, who account for 41.5 percent of all applicants, are somewhat overrepresented among whites and BLNA women. Only 1.5 percent of applicants earned their doctorate at the hiring university, and that percentage is significantly higher among BLNA women (3.5), white women (2.4 percent), and white men (2.1 percent). Among Asian applicants only 1.5 percent of females and 0.6 percent of males have an alma mater connection with the hiring university.

On average, most applicants learned about the postdoc position from the hiring campus website (29.5 percent) or through a professional association (24.3 percent), while 11.9 percent of applicants learned of the position through higher education media outlets such as *The Chronicle of Higher Education*, *Inside Higher Ed*, or a Higher Education Recruitment Consortium. Only 6.2 percent of all applicants reported learning of the position through their personal networks. There are differences by *Gender*Race-ethnicity* in the distribution in each of these categories, but the most important disparity for this study is in who had access through their personal networks. The applicants most likely to have learned of the position through personal networks or "word of mouth" are white men (8.9 percent), white women (11.3 percent), and women who identify as BLNA (11.3 percent). In contrast, women and men who identify as Asian (4.4 and 3.0 percent respectively) were the least likely to have been alerted to the job posting through their word-of-mouth networks. Asian applicants were much more likely (36.6 percent) than the average (29.5 percent) to have learned of the position from the hiring university website, which is the most publicly available and least "connected" source of the information.

#### *4.3.4. Indicators of applicants' referrer prestige*

To measure the status of the applicants' referrers, we use the National Research Council (NRC) ranking of the referrers' institutional affiliation[9] and their h-index values, a common bibliometric indicator of their scholarly impact and prominence. These metrics are limited and subject to bias,[10] and we use them as heuristic measures of the referrer's relative visibility and prestige within their field, not as indicators of the quality of their scholarship or mentorship skill. Because each job applicant has an average of 2.7 referrers, we use the maximum institutional ranking and the highest h-index value among each applicant's multiple referrers to capture the prominence of the applicants' professional affiliations.[11] The NRC rankings are operationalized as percentiles within academic

[8] Institutional affiliation is coded from applicants' self-reported "institution where they earned their highest degree." The variable is created from the unstructured text for applicants whose highest degree is a doctorate and is coded using a combination of hand-coding and string-matching to the institution id numbers of the NSF Institution Codes Names and Locations (2016 version). Those that are not matchable to specific institutions are matched to a country code if possible. The "missing" category of this variable includes both non-response and un-codable strings. We note that a rigorous analysis of the how international status affects postdoc hiring outcomes and how the postdoc market is influenced by international applicants is beyond the scope of this study. Our measure of international status is incomplete since we are unable to identify international scholars who earned their doctorate from a U.S. institution.

[9] Referrers' institutional affiliation is coded from the applicants' report of the referrer's institutional affiliation. The variable is created from the unstructured text using a combination of hand-coding and string-matching to the institution id numbers of the NSF Institution Codes Names and Locations (2016 version).

[10] The NRC rankings are limited to a subset of U.S. institutions. The h-index has been criticized as unreliable because it is sensitive to a scholar's age, to field differences in multi-authorship norms, disparities in self-citation rates, and to publication platform, e.g., open access vs. proprietary journals (Ferrara and Romero, 2013; Koltun and Hafner, 2021).

[11] Alternative operationalizations of referrer prestige based on the mean and the median h-index values yield results that are consistent with those reported here.

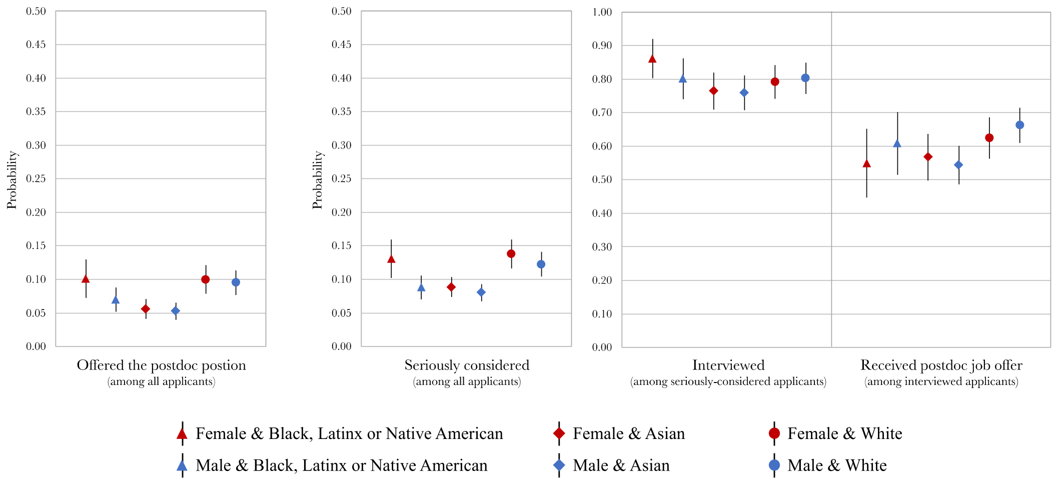


**Fig. 2.** Overall probability of being offered a postdoc position, and probability of success at each step in the hiring process, by *Gender*Race-ethnicity*, controlling for recruitment-level characteristics.

discipline so they are comparable across fields, and then grouped into 6 categories that distinguish applicants whose referrers are only affiliated with international institutions[12] or with unranked U.S. institutions, from applicants whose highest ranking referrer-affiliation is with a program ranked in the 1st-50th, 50th-75th, 75th-90th percentiles, or above the 90th percentile.

Disparities by *Gender*Race-ethnicity* in the distribution of prestige indicators are small, but it is notable that white applicants have the highest average maximum referrer h-index, while BLNA applicants have the lowest average referrer h-index values. White applicants also have the greatest likelihood of having referrers from highly ranked institutions, and only BLNA women share this level of affiliation prestige. Among all applicants, 4.9 percent have at least one referrer associated with an institution in the top 10th percentile of the NRC rankings, but 7.3 percent of white men and 6.5 percent of both BLNA and white women have at least one referrer affiliated with a top-ranked institution. It is also notable that men and women who identify as Asian are not more likely than average to have internationally affiliated referrers, but they are more likely to have referrers from programs ranked below the median in their field.

#### *4.3.5. Indicators of applicants' academic human capital*

We include multiple indicators of the applicants' academic human capital: the recentness or "age" of the applicant's doctorate; a multicategory classification of their position at the time of application; and multiple bibliometric indicators coded from the CV they submitted as part of their application.[13]

On average, applicants completed their doctorate 2.6 years prior to applying for the postdoc position, and this "degree age" is relatively consistent across *Gender*Race-ethnic* groups. A quarter of applicants are graduate students when they apply for the postdoc position, another 21.6 percent are currently postdocs, 19.5 percent are researchers, while about 14 percent have professorial titles or are lecturers. Asian males are overrepresented among applicants who are in postdoc, researcher, or professor positions, while white men and white women are overrepresented among the graduate student applicants. Scholars who identify as BLNA are overrepresented among applicants who are lecturers, adjunct or visiting professors.

Very few applicants have grants or fellowships listed on their CV, but white applicants are the most likely to have at least one grant or fellowship while Asian men are the least likely. Over 80 percent of applicants list at least one publication on their CV, although the percentage ranges from a low of 70 percent for BLNA women to 84 among Asian applicants. Citation counts and journal impact factor percentiles, which are tabulated only for the applicants who have at least one publication, are relatively high for white men and white women, but are relatively low for BLNA applicants.

In sum, the descriptive results are consistent with status theory: there are significant disparities by *Gender*Race-ethnicity* in the distribution of the network connections, referrer prestige, and human capital that we expect to be positively associated with the attainment of a postdoctoral position. These characteristics include holding a U.S. doctorate, earning a doctorate from the hiring institution, having referrers with high h-index values who tend to be affiliated with highly ranked institutions, being a very recent doctoral recipient, being a graduate student at the time of application (i.e., seeking a first post-doctorate position rather than a second

[12] International institutions are categorized separately but not ranked because the NRC ranks U.S. institutions only.

[13] The scholarly achievement of each applicant is coded from the "Education," "Publications" and "Grants" sections of their uploaded CV with an automated tool that uses text-recognition utilities to identify, extract and structure the textual data. The extracted publication entries are linked to open-source Digital Object Identifier (DOI) registries and proprietary (e.g., Scopus) bibliometric databases to obtain publication-specific measures of citation counts, journal impact factors, and other bibliometric information.

or third), attaining a grant or fellowship, and having at least one publication that appears in a relatively high-impact journal and has accumulated citations. Among our sample of applicants, white women and white men tend to be relatively advantaged in the distribution of these resources, Asian men and women tend to be relatively disadvantaged, and BLNA applicants are advantaged in some resources and disadvantaged in others.

## 5. Methodology

We investigate how status processes affect gender- and race-based differences in postdoctoral hiring with a series of three-level random effects binary logit models that account for the clustering of applicants within recruitments, which are clustered within 59 discrete STEMM disciplines (Appendix Table 1 presents the distribution of recruitments across the discipline categories). The multi-level model relaxes the assumption of conditional independence of applicants within recruitment and field, and provides reliable estimates of the association between the applicants' *Gender*Race-ethnicity* and their outcomes in the postdoc hiring process. We use a random-slopes specification that allows the intercepts to vary by recruitment and field but estimates a single population-average effect of each recruitment- and applicant-level covariate. We fit a set of models for each of the three hiring outcomes – serious consideration, interview, and received job offer – based on sequentially selective subpopulations: the probability that an applicant is seriously considered is estimated for all applicants; the probability of being interviewed is estimated only for the applicants who are selected for serious consideration; and the probability that an applicant is offered a job is estimated only for the subsample of applicants who are interviewed.[14]

Model 1 estimates the probability of a positive hiring outcome, $P(Y_{ijk} = 1)$, for each applicant, *i*, in recruitment, *j*, in field *k*, controlling for all recruitment-level characteristics (*RC*) and the number of jobs to which each applicant applied:

$$P(Y_{ijk}) = \beta_0 + \beta_1 \text{Gender*Race-ethnicity}_{ijk} + \beta_2 \text{Jobs\_Applied}_{ijk} + \beta_3 \text{RC}_{jk} + u_{0jk}^{(2)} + u_{0k}^{(3)} \quad (1)$$

where $\beta_1$ represents a vector of coefficients for the included categories of *Gender*Race-ethnicity*, $\beta_2$ is the coefficient for the number of applications submitted, $\beta_3$ represents a vector of fixed-effect coefficients for the recruitment-level variables, and $u_{0jk}^{(2)}$ and $u_{0k}^{(3)}$ are the recruitment (level 2) and STEMM discipline (level 3) random effects, respectively. This model provides the baseline test for disparities by *Gender*Race-ethnicity* in hiring outcomes.

The *Disparate Resources Hypothesis* (Hypothesis 1) predicts that equalizing applicants' resources – their network connections (NC), referrers' prestige (RP), and academic human capital (HC) – will attenuate the *Gender*Race-ethnicity* disparities in the hiring outcome, estimated by $\beta_1$, relative to the Model 1 estimates. To test Hypothesis 1, we estimate 3 reduced-form models, each of which adds controls for one set of applicant-level resources, NC, RP, and HC, to Model 1:

$$P(Y_{ijk}) = \text{Model 1} + \beta_{4a}\text{NC}_{ijk} \quad (2a)$$

$$P(Y_{ijk}) = \text{Model 1} + \beta_{4b}\text{RP}_{ijk} \quad (2b)$$

$$P(Y_{ijk}) = \text{Model 1} + \beta_{4c}\text{HC}_{ijk} \quad (2c)$$

The complete additive model, Model 3, includes all recruitment- and applicant-level variables:

$$P(Y_{ijk}) = \text{Model 1} + \beta_{4a}\text{NC}_{ijk} + \beta_{4b}\text{RP}_{ijk} + \beta_{4c}\text{HC}_{ijk} \quad (3)$$

Estimates from Models 2a-c measure the extent to which disparities by *Gender*Race-ethnicity* in hiring outcomes are associated with the unequal distribution of each type of resource, and Model 3 estimates the combined effect of those disparities. Appendix Table 2 presents the coefficients for Models 1–3.

We use Model 3 to investigate Hypotheses 2 and 3 by testing if the addition of interactions between *Gender*Race-ethnicity* and relevant applicant- and recruitment-level measures significantly improve the model fit. The *Biased Evaluation Hypothesis* (Hypothesis 2) predicts differences by gender and race-ethnicity in the association between applicant characteristics and their hiring outcomes. We test this hypothesis for each hiring outcome with interactions between *Gender*Race-ethnicity* and each measure of the applicants' network connections, referrer prestige, and human capital. To test the *Demographic Context Hypothesis* (Hypothesis 3) we test the significance of interactions between *Gender*Race-ethnicity* and the measures of gender and race-ethnic representation among doctorates in the hiring field, faculty in the hiring department, and search committee chairs.

## 6. Results

### 6.1. Observed disparities in hiring outcomes by gender and race-ethnicity

Fig. 2 presents the overall probability that an applicant is offered the postdoctoral position they apply for, and the probability of

[14] We used Stata 16 for all analyses. The models were estimated using the melogit command and predicted probabilities by Gender*Race-ethnicity for each model specification are estimated using the margins command with all other covariates in the models set to their population mean values.

**Table 3**
Estimated hiring outcome probabilities, P($Y_{ijk}$), by *Gender*Race-ethnicity*, between-group variance, and percent change associated with each set of applicant resource variables.

| | Estimated P($Y_{ijk}$) | | | Percent change in estimated P($Y_{ijk}$) relative to baseline model | | |
|---|---|---|---|---|---|---|
| | Seriously Considered | Interviewed | Offered the job | Seriously Considered | Interviewed | Offered the job |
| **Model 1 + All recruitment characteristics + multiple applications indicator** | | | | | | |
| Female & Black, Latinx or Native American | 0.120 | 0.865 | 0.569 | | | |
| Male & Black, Latinx, or Native America | 0.081 | 0.792 | 0.618 | | | |
| Female & Asian or Asian American | 0.081 | 0.756 | 0.572 | | | |
| Male & Asian or Asian American | 0.074 | 0.748 | 0.542 | | | |
| Female & White | 0.128 | 0.785 | 0.630 | | | |
| Male & White | 0.113 | 0.792 | 0.663 | | | |
| ***Between-group variance*** | ***0.0004*** | ***0.0007*** | ***0.0024*** | | | |
| **Model 2a:** Model 1 + **Indicators of network connection** | | | | | | |
| Female & Black, Latinx or Native American | 0.099 | 0.866 | 0.559 | −18.04 | 0.06 | −1.61 |
| Male & Black, Latinx, or Native America | 0.074 | 0.796 | 0.618 | −8.71 | 0.46 | 0.03 |
| Female & Asian or Asian American | 0.077 | 0.764 | 0.582 | −4.98 | 1.08 | 1.71 |
| Male & Asian or Asian American | 0.074 | 0.759 | 0.558 | −0.36 | 1.43 | 2.79 |
| Female & White | 0.107 | 0.782 | 0.631 | −16.40 | −0.30 | 0.02 |
| Male & White | 0.096 | 0.788 | 0.654 | −15.57 | −0.55 | −1.24 |
| ***Between-group variance*** | ***0.0002*** | ***0.0005*** | ***0.0016*** | ***−64.34*** | ***−29.40*** | ***−31.04*** |
| **Model 2b:** Model 1 + **Indicators of the prestige of the applicants' referrers** | | | | | | |
| Female & Black, Latinx or Native American | 0.112 | 0.863 | 0.568 | −7.09 | −0.27 | −0.04 |
| Male & Black, Latinx, or Native America | 0.079 | 0.796 | 0.621 | −2.10 | 0.55 | 0.57 |
| Female & Asian or Asian American | 0.076 | 0.755 | 0.574 | −6.23 | −0.16 | 0.43 |
| Male & Asian or Asian American | 0.072 | 0.749 | 0.544 | −3.41 | 0.11 | 0.23 |
| Female & White | 0.116 | 0.780 | 0.627 | −9.41 | −0.61 | −0.52 |
| Male & White | 0.104 | 0.787 | 0.663 | −8.75 | −0.66 | 0.01 |
| ***Between-group variance*** | ***0.0003*** | ***0.0007*** | ***0.0023*** | ***−32.15*** | ***−9.42*** | ***−3.70*** |
| **Model 2c:** Model 1 + **Indicators of the applicants' human capital** | | | | | | |
| Female & Black, Latinx or Native American | 0.137 | 0.876 | 0.601 | 13.64 | 1.17 | 5.74 |
| Male & Black, Latinx, or Native America | 0.098 | 0.814 | 0.648 | 20.44 | 2.76 | 4.95 |
| Female & Asian or Asian American | 0.095 | 0.776 | 0.615 | 16.45 | 2.71 | 7.59 |
| Male & Asian or Asian American | 0.087 | 0.765 | 0.586 | 17.39 | 2.26 | 8.07 |
| Female & White | 0.139 | 0.799 | 0.666 | 8.92 | 1.79 | 5.56 |
| Male & White | 0.129 | 0.807 | 0.696 | 14.12 | 1.90 | 5.05 |
| ***Between-group variance*** | ***0.0005*** | ***0.0007*** | ***0.0020*** | ***3.59*** | ***−11.05*** | ***−16.33*** |
| **Model 3:** Model 2 + **All applicant characteristic indicators** | | | | | | |
| Female & Black, Latinx or Native American | 0.116 | 0.873 | 0.591 | −3.53 | 0.89 | 3.92 |
| Male & Black, Latinx, or Native America | 0.091 | 0.817 | 0.647 | 11.71 | 3.18 | 4.72 |
| Female & Asian or Asian American | 0.091 | 0.780 | 0.621 | 11.43 | 3.14 | 8.61 |
| Male & Asian or Asian American | 0.087 | 0.773 | 0.595 | 16.67 | 3.33 | 9.62 |
| Female & White | 0.120 | 0.794 | 0.660 | −5.88 | 1.24 | 4.68 |
| Male & White | 0.111 | 0.798 | 0.685 | −2.42 | 0.81 | 3.38 |
| ***Between-group variance*** | ***0.0002*** | ***0.0005*** | ***0.0014*** | ***−60.96*** | ***−36.84*** | ***−40.91*** |

success at each stage in the hiring process, by *Gender*Race-ethnicity* based on Model 1, i.e., the probabilities are adjusted for the distribution of all recruitment-level characteristics and applicant-level controls. Among all applicants, the probability of receiving a postdoc job offer is 0.071, but it varies by *Gender*Race-ethnic* groups. White women (0.100), BLNA women (0.101), and white men (0.095) are the most likely to receive a postdoc offer and their advantage is statistically significant compared to BLNA men (0.067), and Asian men (0.052) and women (0.056).

The probability of success varies across the stages of the hiring process, however. On average, only 0.092, of applicants are seriously considered while the probability that a seriously considered applicant is interviewed is 0.776, and the probability that an interviewed applicant is offered the postdoctoral position is 0.605. It is clear from the estimates that the first step in the hiring process is the most selective and that the probability an applicant is seriously considered differs by both gender and race-ethnicity. Focusing only on race-ethnicity, white applicants have the highest probability of serious consideration, followed by BLNA applicants, while Asian applicants have the lowest likelihood of being selected for serious consideration. Focusing only on gender, women are more likely than men to be selected for serious consideration, and the gender gap is significant among both BLNA and white applicants. From the intersectional perspective, white women have the highest probability of serious consideration (0.128), followed by women who identify as BLNA (0.120), and white men (0.113). For all other applicants the probability of serious consideration is significantly lower: it is 0.081 for BLNA men and Asian women, and 0.074 for Asian men.

Among the applicants selected for serious consideration (n = 3186), there are significant differences in the probability of interview. Race differences are most evident at this stage of the hiring process, but gender affects the probability of interview for BLNA applicants. Among the applicants selected for serious consideration, the probability of interview is 0.82 for BLNA scholars, 0.79 for whites, and 0.76 for Asian applicants.[15] More specifically, BLNA women have the highest probability of interview (0.87), and their advantage is statistically significant relative to all *Gender*Race-ethnicity* groups. The probability of interview among white applicants is significantly greater than the interview probabilities for all Asian applicants and for BLNA male applicants.

The applicants who are interviewed are a select group, but even among this small subpopulation (n = 2060) there are differences by race and gender in the probability that an applicant receives a job offer. White applicants have the highest job-offer probability, and their advantage relative to Asian applicants is statistically significant. The job-offer probabilities for BLNA and Asian applicants are similar and low relative to those for Whites, but it is notable that the probability of job offer for BLNA women is among the lowest across all groups and their disadvantage is significant compared to white men. This contrasts with the earlier steps in the hiring process where BLNA women have some of the highest probabilities of selection compared to all the *Gender*Race-ethnicity* groups. It also contrasts with the pattern of outcomes for whites, who experience relatively high rates of success across all the hiring stages.

Four patterns characterize the hiring outcome probabilities presented in Fig. 2. First, applicants who identify as Asian tend to have the lowest probability of advancing at each stage of the hiring process. Second, applicants who identify as white are relatively advantaged throughout the hiring process. Third, BLNA women are the only group for whom we observe a dramatic shift in the pattern of relative success across the three steps of the hiring process: they have relatively high probabilities of serious consideration and interview but their probability of being offered the position is among the lowest. Fourth, gender differences within race-ethnicity are generally not significant, except among applicants who identify as BLNA; compared to men in this racial-ethnic group, women are much more likely to be seriously considered and interviewed, but they are not more likely to be offered the job.

### 6.2. *The relationships between applicant resources and hiring outcomes*

The estimated coefficients for Models 1–3 are presented in Appendix Table 2. The complete additive model (Model 3) provides the best estimates of the effects of the applicants' characteristics on their outcomes in the typical postdoc recruitment included in the EEFR data. The results show that hiring outcomes are associated with the applicants' network connections, referrer prestige, and academic human capital. We briefly describe the relationships before examining if between-group differences in the applicants' network, prestige, and human capital characteristics account for the disparities by *Gender*Race-ethnicity* in hiring outcomes.

#### 6.2.1. *Applicant network connections and hiring outcomes*

Postdoc job applicant outcomes are strongly associated with the network connections we measure. The odds an applicant is seriously considered improves significantly if they earned their PhD from a U.S. institution or learned about the position through a professional association, but these effects do not extend beyond the first stage of the hiring process. In contrast, having a proximate connection to the recruitment – here measured as having a doctorate from the hiring institution or learning about the postdoc position through personal networks – significantly enhances an applicants' chances of a positive outcome at each stage of the recruitment.

#### 6.2.2. *Referrer prestige and hiring outcomes*

The visibility or prestige of an applicant's referrers is positively associated with an applicant's probability of serious consideration and interview. More specifically, having referrers who are affiliated with U.S. institutions provides an advantage in the first two stages of the hiring process, and the ranking of the referrers' institutions and their h-index are all positively associated with an applicant's likelihood of being seriously considered and interviewed for a postdoc position.

#### 6.2.3. *Applicant human capital and hiring outcomes*

The applicants' degree year and their current job title have a significant influence on their outcomes in the hiring process, but the bibliometric indicators of their academic achievements generally do not when all other applicant characteristics are controlled. Each additional year after degree attainment significantly reduces an applicants' chances of serious consideration and interview. Graduate students and applicants who are already postdocs have the greatest likelihood of being seriously considered for a postdoc position. Applicants currently in all other position types have significantly lower odds of serious consideration, and those who are currently in "researcher" positions have the lowest probability of being interviewed even if they are seriously considered. In contrast, neither publication nor having a fellowship or grant is associated with any step in postdoctoral hiring process. Among those who have published at least one paper, the average impact factor of their publications is positively associated with the probability of serious consideration, but their average citation count is not.

### 6.3. *Do resources disparities account for Gender*Race-ethnic differences in hiring outcomes?*

The *Disparate Resources Hypothesis* predicts that the observed differences in hiring outcomes (see Fig. 2) are attributable to differences in the applicants' network connections, referrer prestige, and human capital. To address this question, we estimate Models 2a,

[15] The between-group differences by race-ethnicity are statistically significant in an alternative model specification that includes separate variables for race-ethnicity and gender.

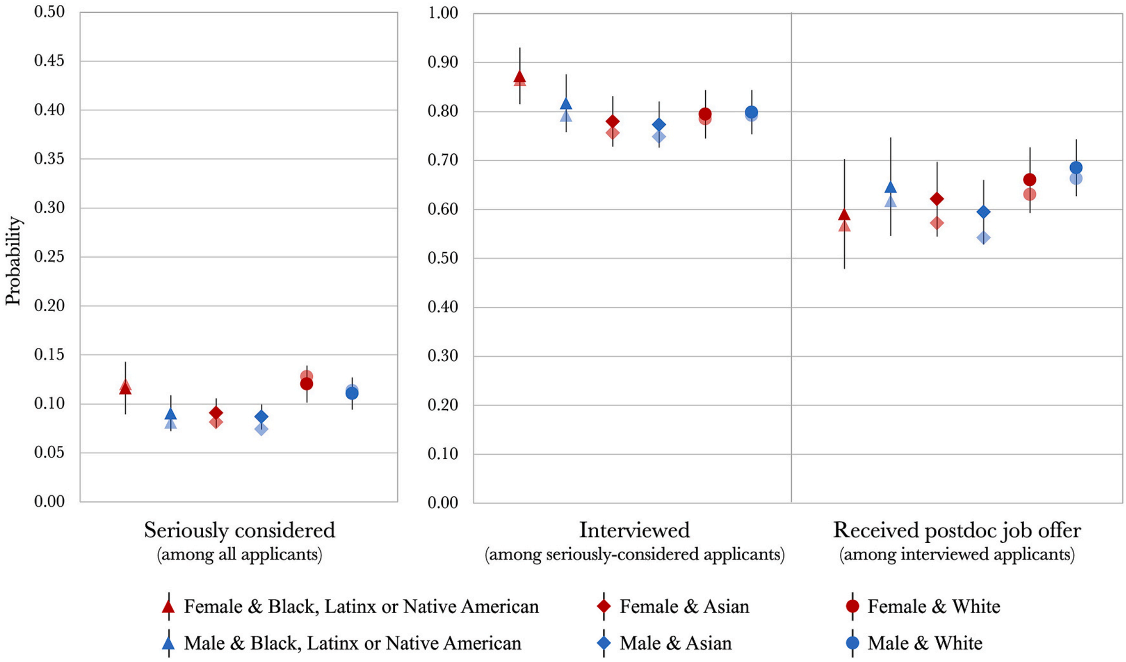


**Fig. 3.** Estimated hiring outcome probabilities (with 95% confidence interval) by *Gender*Race-ethnicity*, controlling for recruitment-level characteristics only (shaded symbols) and all indicators of applicant-level resources (solid symbols).

2 b and 2c (see Appendix Table 2 for the coefficients for each model) and use these models to generate predicted hiring outcome probabilities, $P(Y_{ijk})$, for each *Gender*Race-ethnicity* group. We then compare the Model 2 estimated probabilities to those based on Model 1, i.e., the probabilities that are not adjusted for differences in the distribution of applicant resources.

Table 3 presents the estimated $P(Y_{ijk})$ by *Gender*Race-ethnicity* based on each model specification, the between-group variance in the estimated outcome probabilities, and the percent change in each of those estimates for each model specification relative to Model 1. A positive change in a group-specific probability indicates that the members of that *Gender*Race-ethnicity* group are relatively *disadvantaged* in the distribution of the resources measured by the added covariates, so controlling for the covariates – which empirically imposes the counterfactual of equality in the distribution of the resources – increases the probability of a positive hiring outcome for that group. In contrast, a negative change in the group-specific probability indicates that the members of that group are relatively *advantaged* by the existing distribution of the influential characteristic(s), so controlling for those variables will reduce their predicted probability of the hiring outcome – it will counterfactually deprive the member of that group of an advantage they benefit from in reality.

The results are consistent with the *Disparate Resources Hypothesis*: controlling for differences in the distribution of resources across applicants attenuates the observed differences by gender and race in hiring outcomes. The results related to this hypothesis are summarized by the percent change in the between-group variance[16] for each Model 2 specification. This percent-change value measures the degree to which differences in $P(Y_{ijk})$ between the *Gender*Race-ethnic* groups would be attenuated (or expanded) if disparities in each type of applicant resource were eliminated.

Compared across the panels and columns of Table 3, the estimated changes in between-group variance reveals two patterns related to the disparate distribution of resources across applicants. First, the largest declines in the between-group variance are found for this first step in the hiring process. This indicates that the first step in the hiring process – whether an applicant is seriously considered – is the step that is most affected by *Gender*Race-ethnic* disparities in the distribution of resources. Second, the results show that disparities in the distribution of applicants' network connections have the greatest power to explain *Gender*Race-ethnic* differences in hiring outcomes. Controlling for network resources mitigates the between-group variance for all hiring outcomes and affects the greatest declines in between-group variance. In comparison, controlling for disparities in referrer prestige and applicant human capital generate smaller changes in between-group variance that are more limited to specific steps in the hiring process.

[16] Between-group variance is calculated as the weighted average of the squared difference between each group-specific probability and the pooled probability. The probabilities are estimated using each model specification, and the weights are the number of applicants within each *Gender*Race-ethnicity* group.

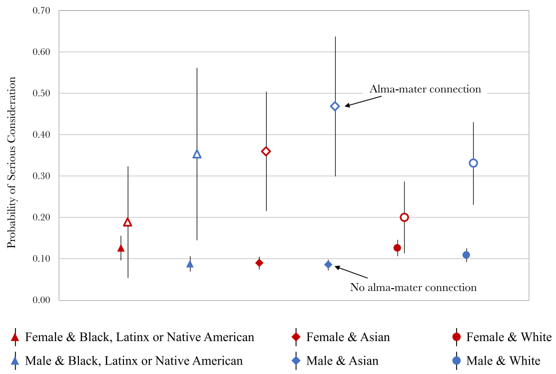


**Fig. 4.** Estimated probability of serious consideration by applicant *Gender*Race-ethnicity* separately for applicant who have an alma-mater connection (open-centered symbols) and those who do not (solid-centered symbols) to the hiring university.

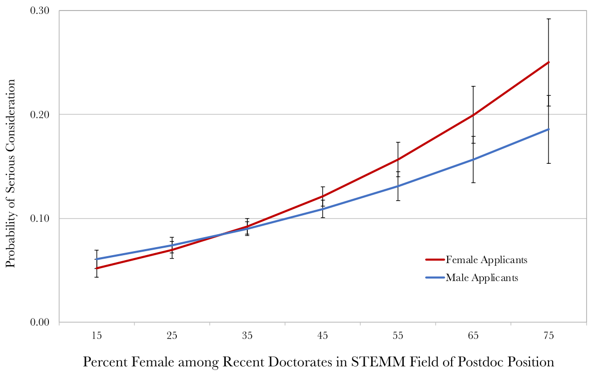


**Fig. 5.** Estimated probability of serious consideration by percent female in the postdoc STEMM field separately for female and male applicants, controlling for all recruitment-level characteristics and all indicators of applicant-level resources.

#### 6.3.1. Network connections and hiring outcomes by Gender*Race-ethnicity

The network connection indicators included in this analysis are significantly associated with disparities by gender and race-ethnicity at each step in postdoctoral hiring process. We estimate that equalizing the distribution of network connections (Model 2a) would result in a 64 percent decline in *Gender*Race-ethnic* variance in the probability of serious consideration, a 29 percent decline in the between-group variance in the probability of interview, and a 31 percent decline in the variance in the probability of job offer.

The percent change in each group-specific P($Y_{ijk}$) shows how disparities in the distribution of network connections affect *Gender*Race-ethnic* differences at each hiring stage. Equalizing the distribution of network connections would reduce the advantage conferred by the unequal distribution of this resource by 16 percent for whites and 18 percent for BLNA women, but by only 8 percent for BLNA men and 5 percent for Asian women, and it would have no effect for Asian men. These results suggests that white women, white men, and BLNA women have relatively high rates of success in the first stage of the hiring process (see Fig. 2) in part because of their advantage in the distribution of network connections. This advantage persists, but with less strength, to the interview stage for white applicants and to the job offer stage for white men and BLNA women. For all other groups, and particularly for Asian men and women, the results highlight their disadvantage in the distribution of network connections and indicate that equalizing those resources would slightly improve their odds of interview and job offer.

#### 6.3.2. Referrer prestige and hiring outcomes by Gender*Race-ethnicity

Between-group differences in the probability of serious consideration and interview are associated with between-group disparities in the prestige of the applicants' referrers. Based on the Model 2b estimates, equalizing the distribution of referrer prestige across all *Gender*Race-ethnicity* groups would reduce the observed disparities in the probability of serious consideration by 32 percent, but it would reduce the variance in interview probabilities by only 9.4 percent. The group-specific estimates indicate that the hiring outcomes of BLNA women, white women and men, and Asian women are enhanced by their advantage in the distribution of referrer prestige. Equalizing that distribution may reduce the probability of serious consideration for applicants in these *Gender*Race-ethnicity* groups by 6–9 percent, while the impact on the probability of interview for each group is less than 1 percent.

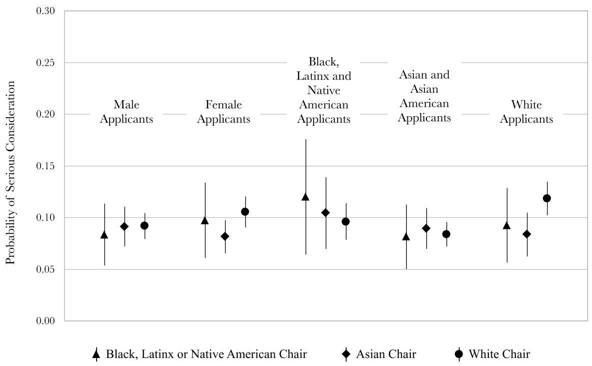


**Fig. 6.** Estimated probability of serious consideration by search committee chair race-ethnicity separately by applicant gender and applicant race-ethnicity, controlling for all recruitment-level characteristics and all indicators of applicant-level resources.

#### *6.3.3. Applicant human capital and hiring outcomes by Gender*Race-ethnicity*

The Model 2c results suggest that between-group differences in applicant human capital have the potential to explain disparities in the probability of interview and job offer only. Equalizing the distribution of the human capital indicators would reduce the observed *Gender*Race-ethnicity* gaps in the odds of interview by 11 percent and disparities in the odds of job offer by 16 percent. Human capital parity would increase the probability of interview and job offer for all *Gender*Race-ethnicity* groups, but the groups who are disadvantaged in the distribution of these variables – including BLNA men and Asian applicants of both genders – would benefit the most.

#### *6.3.4. Cumulative effects of resource disparities on hiring outcomes by Gender*Race-ethnicity*

The bottom panel of Table 3 reports the combined influence of disparities in all three types of resources – network connections, referrer prestige, and human capital – on the applicants' outcomes in STEMM postdoctoral hiring. Fig. 3 illustrates these results by presenting the outcome probabilities for each *Gender*Race-ethnicity* group, how those probabilities change when the distributions of all applicant-level resources are equalized, and how that counterfactual exercise affects the between-group differences in the postdoc hiring process. Controlling for all the applicant resource indicators accounts for 61 percent of the variance between *Gender*Race-ethnicity* groups in the probability of serious consideration, 37 percent of the between-group variance in the probability of interview, and 41 percent of the between-group variance in the probability an applicant receives the job offer. The results show that equalizing the distribution of resources would increase the odds of positive outcomes for applicants in the relatively disadvantaged groups, i.e., Asian women, Asian men, and BLNA men, while it would reduce, or produce smaller increases to, the odds of positive hiring outcomes for the advantaged groups, i.e., whites and BLNA women. The greater success observed among the advantaged *Gender*Race-ethnicity* groups therefore is partially associated with their relative advantage in the distribution of network connections, referrer prestige, and academic human capital.

While the results are consistent with the *Disparate Resources Hypothesis*, significant *Gender*Race-ethnic* differences in postdoc hiring remain even when all the applicant-level resource indicators are controlled. Applications from white women, white men and BLNA women remain more likely to be seriously considered than all other groups. Female BLNA applicants remain significantly more likely to be interviewed than all other groups but not to receive the job offer, while white men and women continue to have the highest job-offer probabilities. In addition, BLNA women continue to be among the least likely to receive a job offer even after controlling all the applicant characteristics we measure. The relative disadvantage of BLNA women relative to most other *Gender*Race-ethnicity* groups at the last step in the hiring process is not statistically significant but it is conspicuous when compared both to the relative advantage BLNA women experience in the early steps, and to the consistent pattern of relative advantage observed for whites. This finding indicates that BLNA women may lack resources that are specifically relevant to the job offer decision, resources that are not measured in this analysis, or that gender and race-ethnicity affect the job-offer decision directly.

### *6.4. Does Gender*Race-ethnicity affect the association between applicant resources and outcomes?*

The *Biased Evaluation Hypothesis* predicts that the effects of applicant-level resources will vary by gender and race-ethnicity. We investigate this hypothesis by testing for significant interactions between *Gender*Race-ethnicity* and each indicator of the applicants' network connections, referrer prestige, and human capital for each hiring outcome. Using the 7-category *Gender*Race-ethnicity* variable to test for interactions is especially exacting, however, and is unlikely to attain significance because of the large number of degrees of freedom each interaction uses. Therefore, we also tested this hypothesis using separate *Gender* and *Race-ethnicity* variables, i.

e., we tested for interactions by gender averaged across all race-ethnic groups, and by race-ethnicity averaged across gender.[17]

We find strong evidence that one type of network effect – the "alma mater" effect – varies by applicant *Gender*Race-ethnicity* at the first stage of the hiring process. This, however, is the only result that supports the *Biased Evaluation Hypothesis*. For all other indicators of the applicants' network connections, referrer prestige and human capital, the estimated effects on hiring outcomes do not vary by gender or race-ethnicity.

Fig. 4 illustrates that for the postdoc recruitments included in this study, the odds of serious consideration are much greater for applicants who earned their doctorate from the hiring institution, but only for BLNA men, white men, and Asian applicants of both genders. The positive "alma mater" effect is *not* found for the applicants who are most likely to have this connection – women applicants who identify as BLNA or white. And conversely, the largest positive effects are found for the groups who are least likely to have this connection – BLNA men and Asian applicants. For applicants in those *Gender*Race-ethnicity* groups, the alma-mater connection increases the likelihood of serious consideration by 300–500 percent. The results for white men indicate a two-fold advantage: they are both likely to have an alma-mater connection and to receive a significant boost to their likelihood of serious consideration because of that connection.

We interpret these results as evidence of bias in applicant evaluation because they show that the effect of an alma-mater connection depends on gender and race-ethnicity. BLNA men and Asian applicants, i.e., the groups with the lowest odds of serious consideration, are much more likely to be seriously considered when their doctorate is "home-grown" at the hiring institution. This implies that the alma mater connection may be necessary to put their chances of serious consideration on par with those of white and BLNA women. The results also show that white men receive an additional boost from an alma-mater connection, even as their odds of serious consideration are relatively high without that connection. The absence of a significant alma-mater effect for BLNA women and white women (the two group most likely to have an alma mater connection) highlights the advantage white men appear to have when they seek a postdoc position at their doctoral institution.

### *6.5. Does the demographic context influence hiring outcomes?*

To investigate the *Demographic Context Hypothesis* we test if the association between gender and/or race-ethnicity and each hiring outcome is influenced by the representation of gender or race-ethnicity in the hiring field, department or search committee. Using the intersectional *Gender*Race-ethnicity* variable, we do not find significant interactions for any of the demographic context measures across all 3 hiring outcomes. We further investigated this hypothesis using separate *Gender* and *Race-ethnicity* variables, and separate (rather than intersectional) measures of the gender and race-ethnic representation in the STEMM hiring field. Using the simplified model specification, we find that field-level gender representation and committee chair race-ethnicity both moderate the effect of applicant gender and race-ethnicity in the hiring process.

Fig. 5 illustrates the influence of the female representation in the STEMM field of the hire on the probability that an applicant is seriously considered. As the percent female in the STEMM field increases, the probability of serious consideration increases for all applicants, but the positive association is amplified for female applicants. This indicates that women are marginally more likely than men to be given serious consideration for postdoc appointments in the most female-dominated fields, even after controlling for the fact that those recruitments tend to have a greater proportion of all applicants selected for serious consideration. This interaction effect is consistent with the demographic context hypothesis, but the underlying mechanisms that produce it cannot be identified by our data. The result may reflect gender bias in associational preferences or the use of gender as a proxy for an applicant's job qualifications, but they also may reflect the combined effects of specialty matching and gender segregation of research specialties. Each postdoc recruitment targets a specific area of research but may receive applicants with expertise in a broad range of areas. If gender segregation across research areas is substantial, the selection of applicants based on field-specific research expertise will manifest as selection based on gender in analyses (such as this one) that lack reliable measures of the applicants' field of expertise.

Fig. 6 illustrates how committee chair race-ethnicity interacts with applicant gender and race-ethnicity at the first stage of the hiring process. For both whites and women, the probability of serious consideration is significantly higher in recruitments with white committee chairs, while it is significantly lower in recruitments with Asian committee chairs. For women applicants, the average probability of consideration is 0.106 when the committee chair is white compared to 0.082 when the committee chair is Asian or Asian American. For white applicants, the conditioning effect of chair race-ethnicity is even greater: 11.9 percent of white applicants are selected for serious consideration by committees chaired by whites compared to 8.4 percent for recruitments with Asian committee chairs. Committee chair race-ethnicity does not affect the probability of serious consideration for male applicants, and the positive effect of applicant-chair race matching observed for whites is not found for Asians or BLNA scholars. The results may reflect associational preferences among white scholars, i.e., one of the primary micro-level mechanisms identified by status theory, but the underlying mechanisms that produce the interaction effects cannot be identified by our data.

[17] We use the Akaike Information Criterion (AIC) to evaluate if the addition of each interaction, improves the fit of the model relative to Model 3. This metric penalizes models which use more independent variables and can indicate when a model is over-fitting the data. If the addition of the interaction between a covariate and *Gender*Race-ethnicity* reduces the AIC by 2 units or more, the model that includes the interaction is considered significantly better than Model 3.

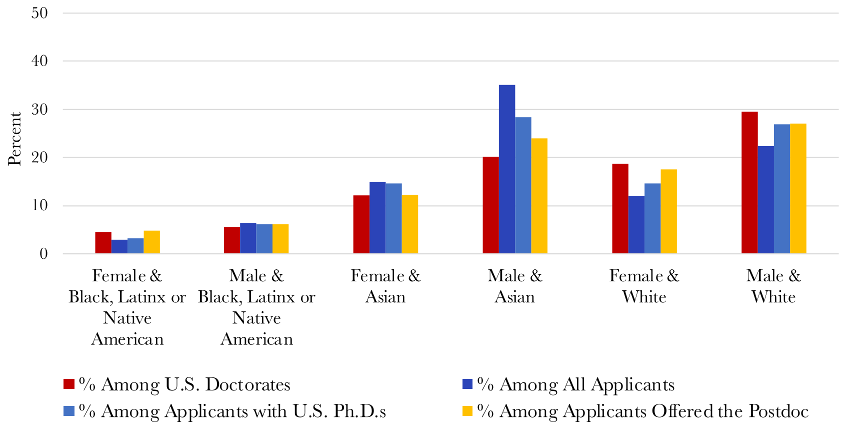


**Fig. 7.** Representation of doctorates by *Gender*Race-ethnicity* among recent doctorates in the recruitment fields, among applicants (in total and among those with U.S. Ph.D.s), and among those offered a postdoc position.

### *6.6. Additional analyses*

We conducted additional analyses to test the robustness of our results and their sensitivity to the characteristics of the postdoctoral recruitments and applicants included in the EEFR data. First, to test if the results are biased by the inclusion of applicants who apply for multiple postdoc positions, i.e., by non-independence within the pool of applications, we replicated the analysis using only the applicants who applied to one postdoc recruitment. This sample restriction affects the estimates for the first and second steps of the hiring process but does not alter the pattern of between-group differences that we find using the full population of applicants, so the results we report above do not appear to be driven by the multi-application applicants. Second, we test if the results are sensitive to the relative representation of the types of recruitments that appear in the EEFR data, we tested the interactions between *Gender*Race-ethnicity* and each recruitment-level characteristic not already included in the main analyses presented above. The results we report above are adjusted for the additive effects of the measured recruitment characteristics, but the estimated between-group differences will not be reliable if the estimated effect of *Gender*Race-ethnicity* varies by recruitment characteristics. We found no significant interactions with the year, campus,[18] the broad STEMM field of the recruitment, or whether the recruitment was managed by a committee or a single scholar. The estimated overall between-group differences we report above are therefore reliable for all the recruitments included in this study.

## 7. Discussion

Thousands of doctorates are hired annually into postdoctoral positions at research universities. These scholars are an essential part of the STEMM workforce, and they make up the population from which are drawn the future university faculty and leading researchers in STEMM. This study provides a window into the recruitments that shape this part of the STEMM labor force, and an opportunity to examine if status processes contribute to gender and race-ethnic disparities in access to postdoc positions. The results are consistent with the central predictions of status theory: between-group disparities in job applicants' resources and in how applicants are evaluated help to explain differences in hiring outcomes. But our findings also suggest that who applies for postdoctoral positions varies significantly by both the gender and race-ethnicity, and that this selectivity affects who is hired into postdoctoral positions.

We find that white women, white men, and BLNA women have the highest probability of being hired for postdoc positions, while Asian men and Asian women have the lowest probability of obtaining the postdocs they apply for. The *Gender*Race-ethnicity* disparities in postdoc hiring are established at the first step in the hiring process, i.e., in the selection of applicants for serious consideration, and these disparities are reinforced by the significant advantage BLNA women have in the probability of interview, and that whites have in the probability of receiving the job offer. As predicted by status theory these disparities are associated with between-group differences in the distribution of resources: the *Gender*Race-ethnicity* groups most likely to be seriously considered and interviewed are those who have the most favorable network connections, prestigious referrers, and recognizable markers of academic human capital. Network resources are the most important for understanding disparities in postdoc hiring outcomes, followed by referrer prestige. Network connections correlate with success at every step in the hiring process, so a large portion of the between-group differences can be attributed to differences by gender and race-ethnicity in the applicants' network connections. Disparities in referrer prestige have a more limited impact but they help to explain between-group differences in whether an applicant is selected for serious consideration and, to a lesser extent, for an interview. In comparison, the indicators of the applicants' human capital have relatively modest effects on between-group differences and only for the interview and job-offer stages of the hiring process, i.e., after the majority of applicants have been excluded.

[18] We tested interactions using the 9-category campus variable and simplified versions that collapsed the campuses that had few recruitments.

The limited explanatory power of the human capital indicators may accurately reflect the relatively marginal importance of applicant human capital for postdoc hiring. Most applicants for postdoc positions are early in their research careers and therefore have few distinct achievements that reliably indicate their skill and promise. When interpreted in relation to the comparatively strong explanatory power of the network and referrer prestige indicators, the limited impact of the human capital measures is consistent with theories of how status advantage operates in processes that are ostensibly meritocratic (Correll et al., 2017): because the normative indicators of scholarly aptitude may be unreliable or vary little across early-career applicants, decision-makers may rely more heavily on prestige or affiliation indicators, which are more variable across applicants, to inform their evaluation of applicant "quality" and their hiring decisions. Reducing the reliance on indicators of prestige will require hiring committees to identify the specific skills and experience they seek for the position, and to solicit application materials that allow the evaluation of applicants relative to those requirements.

We also find evidence that hiring decisions may be affected by the applicant's gender or race-ethnicity, the demographics of the field, and the race-ethnicity of the search committee chair. Specifically, we find that all *Gender*Race-ethnicity* groups except for BLNA and white women groups benefit from having earned their doctorate at the hiring institution, that female applicants may be advantaged in the most female-dominated STEMM fields, and that white committee chairs may prefer white applicants and female applicants. These results are consistent with the types of affiliation preferences in hiring that status theory predicts – for "home grown" doctorates, for women in female-dominated fields, and for white applicants among white committee chairs. And while the interaction effects we detect are not large in magnitude, they may be consequential because they are specific to the first step of the hiring process, i.e., they affect whether or not an applicant is selected for serious consideration. The probability of selection at this early stage is very low and applies to all applicants, so small differences in the group-specific probabilities can significantly alter the gender and race-ethnic composition of the applicants considered at each subsequent stage of the hiring process.

Although the results of our analysis are consistent with the processes that status theory identifies as the drivers of gender- and race-based disparities in hiring (Ridgeway, 2014, 2019), the indicators of applicant-level resources we include in this analysis do not account for observed *Gender*Race-ethnic* differences in postdoc hiring. A more complete explanation of disparities in the attainment of postdoc positions will require measures of applicant-level resources that are not included in this analysis, along with more precise measures of the applicant characteristics this analysis identifies as important. Furthermore, the observational nature and cross-sectional aspect of the EEFR data do not allow us to identify the causal mechanisms underlying the covariate-outcome associations or the interaction effects we observe. As noted above, the interaction effect may reflect bias in how applicants are evaluated, but our observational data cannot rule out alternative explanations. The limits of our analysis make clear the need for studies of postdoctoral hiring that reliably measure the characteristics of the postdoctoral recruitments and the scholars who apply to them, and that can identify the causal connections between those characteristics and the hiring outcomes.

Finally, this study illustrates the importance of the pre-application influences on the postdoc market and hiring outcomes. We observe consequential between-group differences in application rates and in the characteristics of the scholars who do apply, both of which are associated with disparities by gender and race in postdoctoral hiring. But because they are outside of the scope of our data, we can neither identify the causes of those disparities nor disentangle how they may be related. This highlights the need for studies that focus on selection into the various career tracks available to STEMM doctorates. In particular, the absence of data linking doctorates to job applicant pools – for postdoctoral positions, faculty positions, industry, and government jobs, etc. – prevents the investigation of this key juncture in the STEMM career trajectory and limits our understanding of the forces that perpetuate *Gender*Race-ethnicity* inequality in STEMM careers.

The direct impact of disparities in application rates is obvious: only those who apply have any chance of attaining a postdoctoral position and disparities in application behavior constrain the potential for diversity among postdocs and each STEMM career path into which the population of postdocs flows. Fig. 7 illustrates the association between disparities in application rates and *Gender*Race-ethnic* representation among the applicants who are offered the postdoc positions. We find that white women, white men, and BLNA women have the greatest probability of success in the postdoc hiring process, but because they are underrepresented among applicants, their representation among those offered the postdoc positions remains below (for whites) or just meets (for BLNA women) their representation among U.S. doctorates in their STEMM fields. In contrast, Asian men are the least likely to have the characteristics associated with postdoc attainment and have the lowest probability of selection at each step in the hiring process, yet they are the only group that is overrepresented among the hired postdocs, relative to their representation among the field-specific U.S. doctorates (including doctorates earned by temporary-visa holders). This outcome is driven by the significant overrepresentation of Asian men among applicants. The same process occurs for Asian women and BLNA men, although to a lesser extent. Both Asian women and BLNA men are disadvantaged in the distribution of relevant network, prestige, and human capital resources and in the probability of selection at most steps in the hiring process, but because they are overrepresented among applicants their representation among hired postdocs is on par with their field-specific representation among recent doctorates.

The between-group differences in application rates and in the characteristics of the scholars who do apply indicate that there are significant differences in whether and how doctorates enter the market for postdoctoral positions at research universities. Specifically, the results indicate that BLNA women and whites are positively selected into applying, i.e., that those who are most qualified are most likely to apply. In contrast, the overrepresentation of Asians and BLNA men, coupled with their relative disadvantage in the distribution of resources, indicate the absence of such selectivity. These between-group differences may reflect inequities in mentorship and experience during doctoral training, or in access to postdoctoral opportunities outside of the market we observe, e.g., in industry. They also may reflect differences in how doctorates approach the market for postdoctoral positions. In particular, the overrepresentation of Asian males among applicants, especially among those with international doctorates, may reveal the strategic targeting of university-based postdoctoral positions as an entry point into the STEMM labor force in the U.S.

The need for more extensive research on postdoc hiring and related processes is highlighted by this study's uniqueness and is underscored by the important part the postdoc career stage plays in both the cultivation of the STEMM labor force and the advancement of individual careers in STEMM fields. Analyses of mentorship during graduate school, of career decision-making at the conclusion of doctoral training, and of application behavior are needed to identify the processes that generate inequalities in who applies for postdoc positions and how they engage with the application process. Studies that compare STEMM fields, types of postdocs, and different hiring processes can help to identify both the causes of inequities and promising approaches to equalizing access to postdoctoral positions. And given the substantial presence of international scholars in the postdoc market, more research is needed to understand both the impact of that supply on how the market operates, and on how international status affects individual hiring outcomes and postdoctoral experiences. Addressing this broad research agenda requires a level of researcher access and data collection that will not be possible without a major shift toward transparency in the culture of postdoctoral training. That culture shift can be facilitated by increased oversight from funding agencies, professional associations, and research universities and by changes to the policies that govern how postdoctoral scholars are hired, managed, and mentored.

## Appendix

**Appendix Table 1**
Distribution of postdoctoral recruitments and applicants by detailed STEMM field

| STEMM Discipline | Recruitments | | Applicants | |
|---|---|---|---|---|
| | Count | Percent | Count | Percent |
| Viticulture and Enology | 3 | 0.39 | 52 | 0.24 |
| Animal Sciences, General | 1 | 0.13 | 21 | 0.10 |
| Food Science | 1 | 0.13 | 27 | 0.12 |
| Plant Sciences, General | 2 | 0.26 | 67 | 0.30 |
| Natural Resources/Conservation, General | 36 | 4.68 | 1476 | 6.68 |
| Environmental Studies | 12 | 1.56 | 321 | 1.45 |
| Information Science/Studies | 18 | 2.34 | 900 | 4.07 |
| Computer Science | 10 | 1.30 | 80 | 0.36 |
| Engineering, General | 22 | 2.86 | 993 | 4.49 |
| Bioengineering and Biomedical Engineering | 25 | 3.25 | 513 | 2.32 |
| Chemical Engineering | 22 | 2.86 | 342 | 1.55 |
| Civil Engineering, General | 41 | 5.33 | 994 | 4.50 |
| Computer Engineering, General | 18 | 2.34 | 631 | 2.86 |
| Materials Engineering | 20 | 2.60 | 775 | 3.51 |
| Mechanical Engineering | 16 | 2.08 | 588 | 2.66 |
| Nuclear Engineering | 3 | 0.39 | 51 | 0.23 |
| Biology/Biological Sciences, General | 2 | 0.26 | 50 | 0.23 |
| Biochemistry | 10 | 1.30 | 361 | 1.63 |
| Biochemistry and Molecular Biology | 17 | 2.21 | 486 | 2.20 |
| Plant Pathology/Phytopathology | 4 | 0.52 | 118 | 0.53 |
| Botany/Plant Biology, Other | 15 | 1.95 | 916 | 4.15 |
| Cell/Cellular and Molecular Biology | 28 | 3.64 | 741 | 3.35 |
| Microbiology, General | 15 | 1.95 | 332 | 1.50 |
| Microbiology and Immunology | 4 | 0.52 | 43 | 0.19 |
| Entomology | 6 | 0.78 | 129 | 0.58 |
| Zoology/Animal Biology, Other | 3 | 0.39 | 27 | 0.12 |
| Physiology, Pathology and Related Sciences | 16 | 2.08 | 172 | 0.78 |
| Pharmacology | 3 | 0.39 | 27 | 0.12 |
| Molecular Pharmacology | 2 | 0.26 | 30 | 0.14 |
| Environmental Toxicology | 1 | 0.13 | 17 | 0.08 |
| Biotechnology | 4 | 0.52 | 38 | 0.17 |
| Epidemiology | 2 | 0.26 | 34 | 0.15 |
| Ecology and Evolutionary Biology | 22 | 2.86 | 573 | 2.59 |
| Ecology, Evolution, Systematics and Population Biology | 4 | 0.52 | 42 | 0.19 |
| Neurobiology and Anatomy | 20 | 2.60 | 320 | 1.45 |
| Neurobiology and Behavior | 17 | 2.21 | 341 | 1.54 |
| Biology/Biological Sciences, Other | 12 | 1.56 | 234 | 1.06 |

(*continued on next page*)

**Appendix Table 1** (*continued*)

| STEMM Discipline | Recruitments | | Applicants | |
|---|---|---|---|---|
| | Count | Percent | Count | Percent |
| Mathematics, General | 17 | 2.21 | 624 | 2.82 |
| Applied Mathematics, General | 4 | 0.52 | 98 | 0.44 |
| Statistics, General | 13 | 1.69 | 197 | 0.89 |
| Physical Sciences | 1 | 0.13 | 13 | 0.06 |
| Astronomy | 16 | 2.08 | 801 | 3.62 |
| Astrophysics | 3 | 0.39 | 447 | 2.02 |
| Chemistry, General | 64 | 8.32 | 2657 | 12.02 |
| Chemistry, Other | 3 | 0.39 | 99 | 0.45 |
| Geology/Earth Science, General | 20 | 2.60 | 398 | 1.80 |
| Physics, General | 71 | 9.23 | 1902 | 8.61 |
| Psychology, General | 13 | 1.69 | 194 | 0.88 |
| Social Sciences, General | 3 | 0.39 | 91 | 0.41 |
| Anthropology | 7 | 0.91 | 77 | 0.35 |
| Criminology | 2 | 0.26 | 58 | 0.26 |
| Economics, General | 6 | 0.78 | 263 | 1.19 |
| Geography | 5 | 0.65 | 73 | 0.33 |
| Political Science and Government, General | 5 | 0.65 | 93 | 0.42 |
| Sociology | 2 | 0.26 | 32 | 0.14 |
| Medicine | 25 | 3.25 | 520 | 2.35 |
| Pharmacy | 13 | 1.69 | 357 | 1.62 |
| Public Health, General | 16 | 2.08 | 205 | 0.93 |
| Veterinary Biomedical and Clinical Science | 3 | 0.39 | 37 | 0.17 |
| Total | 769 | | 22,098 | |

## Appendix Table 2

Estimated coefficients from random effects logit models of postdoctoral hiring outcomes.

| | Model 1: Controls + Recruitment characteristics | | | Model 2a: Recruitment characteristics + Indicators of network connection | | | Model 2b: Recruitment characteristics + Indicators of referrers' prestige | | | Model 2c: Recruitment characteristics + Indicators of applicant human capital | | | Model 3: Complete additive model | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seriously Considered | Interviewed | Offered the job | Seriously Considered | Interviewed | Offered the job | Seriously Considered | Interviewed | Offered the job | Seriously Considered | Interviewed | Offered the job | Seriously Considered | Interviewed | Offered the job |
| **Gender*Race-ethnicity** | | | | | | | | | | | | | | | |
| Female & Black, Latinx or Native American | 0.072 | 0.827* | -0.501 | 0.036 | 0.882* | -0.494 | 0.093 | 0.855* | -0.502 | 0.070 | 0.798* | -0.522 | 0.059 | 0.860* | -0.503 |
| Male & Black, Latinx, or Native America | -0.392*** | -0.001 | -0.245 | -0.298** | 0.080 | -0.195 | -0.310** | 0.096 | -0.226 | -0.341*** | 0.070 | -0.271 | -0.241* | 0.194 | -0.211 |
| Female & Asian | -0.388*** | -0.348 | -0.485* | -0.248** | -0.229 | -0.382 | -0.355*** | -0.311 | -0.471* | -0.376*** | -0.303 | -0.449* | -0.239** | -0.186 | -0.347 |
| Male & Asian | -0.490*** | -0.419* | -0.635*** | -0.297*** | -0.278 | -0.504** | -0.424*** | -0.363* | -0.628*** | -0.473*** | -0.409* | -0.601*** | -0.292*** | -0.248 | -0.484** |
| Female & White | 0.144* | -0.074 | -0.176 | 0.130 | -0.054 | -0.127 | 0.134 | -0.070 | -0.194 | 0.091 | -0.086 | -0.175 | 0.102 | -0.042 | -0.139 |
| Male & White | | reference category | | | reference category | | | reference category | | | reference category | | | reference category | |
| Gender and/or Race-ethnicity not reported | -0.081 | -0.158 | -0.223 | -0.101 | -0.248 | -0.159 | -0.045 | -0.171 | -0.264 | -0.063 | -0.158 | -0.184 | -0.096 | -0.226 | -0.170 |
| **Controls** | | | | | | | | | | | | | | | |
| Number of recruitments applicant applied to | | | | | | | | | | | | | | | |
| 1 | | reference category | | | reference category | | | reference category | | | reference category | | | reference category | |
| 2 | -0.955*** | -0.615 | -0.049 | -0.844*** | -0.605 | -0.008 | -0.972*** | -0.676* | -0.056 | -0.961*** | -0.655* | -0.084 | -0.854*** | -0.647 | -0.031 |
| 3+ | -1.714*** | -1.982** | -1.478 | -1.442*** | -1.858** | -1.226 | -1.773*** | -1.939** | -1.531 | -1.627*** | -1.731* | -1.362 | -1.407*** | -1.648* | -1.229 |
| **Recruitment characteristics** | | | | | | | | | | | | | | | |
| Number of applications received | -0.036*** | -0.022* | -0.005 | -0.037*** | -0.022 | -0.005 | -0.037*** | -0.025* | -0.005 | -0.037*** | -0.024* | -0.007 | -0.038*** | -0.026* | -0.006 |
| quadratic term | 0.000*** | 0.000 | 0.000 | 0.000*** | 0.000 | 0.000 | 0.000*** | 0.000 | 0.000 | 0.000*** | 0.000 | 0.000 | 0.000*** | 0.000 | 0.000 |
| Academic year of the recruitment | | | | | | | | | | | | | | | |
| 2013-14 | | reference category | | | reference category | | | reference category | | | reference category | | | reference category | |
| 2014-15 | 0.685** | -2.591** | -0.023 | 0.814*** | -2.517** | 0.084 | 0.826*** | -2.388** | 0.035 | 0.772*** | -2.583** | -0.001 | 0.932*** | -2.398** | 0.134 |
| 2015-16 | 0.584** | -1.547 | 0.238 | 0.658** | -1.502 | 0.297 | 0.682** | -1.388 | 0.326 | 0.688** | -1.536 | 0.204 | 0.763** | -1.437 | 0.345 |
| 2016-17 | 0.382 | -1.200 | 0.560 | 0.444 | -1.203 | 0.657 | 0.440 | -1.108 | 0.679 | 0.469 | -1.186 | 0.519 | 0.521* | -1.145 | 0.717 |
| 2017-18 | 0.324 | -0.918 | 0.617 | 0.439 | -0.875 | 0.705 | 0.386 | -0.853 | 0.750 | 0.383 | -0.935 | 0.702 | 0.485 | -0.881 | 0.902* |
| 2018-19 | 0.272 | -0.564 | -0.244 | 0.404 | -0.506 | -0.168 | 0.563* | -0.113 | -0.215 | 0.441 | -0.423 | -0.188 | 0.629* | -0.044 | -0.125 |
| 2019-20 | 0.476* | -1.312 | -0.046 | 0.600* | -1.319 | -0.006 | 0.579* | -1.249 | 0.089 | 0.714** | -1.036 | 0.058 | 0.748** | -1.088 | 0.191 |
| 2020-21 | 0.538* | -1.861* | -0.048 | 0.596* | -1.911* | -0.043 | 0.595* | -1.818* | 0.068 | 0.695** | -1.657 | 0.031 | 0.675 | -1.734 | 0.133 |
| University hosting postdoc job recruitment | | | | | | | | | | | | | | | |
| A | | reference category | | | reference category | | | reference category | | | reference category | | | reference category | |
| B | -0.310 | 0.267 | -1.178*** | -0.436* | 0.156 | -1.214*** | -0.386* | 0.195 | -1.146*** | -0.262 | 0.269 | -1.163*** | -0.397* | 0.135 | -1.168*** |
| C | -0.505** | -1.051 | -0.568 | -0.687*** | -1.196* | -0.598 | -0.625** | -1.027 | -0.581 | -0.494* | -1.018 | -0.552 | -0.714*** | -1.082 | -0.566 |
| D | -0.685** | -0.935 | 0.331 | -0.882*** | -1.048 | 0.254 | -0.605* | -0.851 | 0.272 | -0.531* | -0.743 | 0.404 | -0.674* | -0.730 | 0.283 |
| E | -0.739*** | 2.077** | -1.026* | -0.815*** | 2.003** | -1.078** | -0.579** | 2.255** | -0.947* | -0.691** | 2.075** | -0.926* | -0.655** | 2.157** | -0.967* |
| F | 0.203 | -0.860 | -2.377 | -0.065 | -0.810 | -2.503* | -0.061 | -1.193 | -2.562* | 0.050 | -1.029 | -2.401 | -0.317 | -1.100 | -2.621* |
| G | 0.068 | 0.021 | -1.326* | 0.083 | 0.076 | -1.327* | 0.024 | -0.030 | -1.342* | 0.101 | 0.031 | -1.420** | 0.090 | -0.028 | -1.423** |
| H | -0.048 | -1.148 | -2.192*** | -0.088 | -1.110 | -2.114*** | -0.185 | -1.202 | -2.161*** | 0.032 | -0.907 | -2.083*** | -0.119 | -0.996 | -1.980 |
| I | -0.150 | -1.437 | 0.340 | -0.080 | -1.446 | 0.414 | 0.089 | -1.176 | 0.270 | -0.149 | -1.395 | 0.367 | 0.018 | -1.136 | 0.367 |
| STEMM field | | | | | | | | | | | | | | | |
| Agriculture or environmental sciences | | reference category | | | reference category | | | reference category | | | reference category | | | reference category | |
| Engineering fields | -0.033 | -3.170*** | 0.099 | -0.037 | -3.269*** | 0.053 | -0.018 | -3.280*** | 0.146 | -0.046 | -3.186*** | 0.118 | -0.057 | -3.332*** | 0.127 |
| Biological and biomedical sciences | 0.221 | -1.299* | 0.150 | 0.225 | -1.353* | 0.116 | 0.233 | -1.332* | 0.184 | 0.220 | -1.399* | 0.110 | 0.172 | -1.480* | 0.111 |
| Math, statistics, or computer science | 0.567* | -3.138*** | -0.391 | 0.410 | -3.236*** | -0.435 | 0.600* | -3.209*** | -0.325 | 0.544* | -3.229*** | -0.392 | 0.473 | -3.297*** | -0.315 |
| Physical sciences | 0.689** | -3.007*** | -0.446 | 0.625** | -3.121*** | -0.514 | 0.511* | -3.240*** | -0.441 | 0.610* | -3.183*** | -0.475 | 0.422 | -3.437*** | -0.496 |
| Social sciences | 0.500* | -2.722*** | -0.992* | 0.185 | -2.912*** | -1.080* | 0.648* | -2.715*** | -0.976 | 0.569* | -2.748*** | -0.981 | 0.449 | -2.826*** | -0.995 |
| Health professions | 0.178 | 0.852 | -0.887 | 0.178 | 0.932 | -0.884* | 0.455 | 1.247 | -1.016* | 0.304 | 0.748 | -1.092* | 0.403 | 1.141 | -1.119* |
| NRC rank of hiring department | | | | | | | | | | | | | | | |
| Unranked | | reference category | | | reference category | | | reference category | | | reference category | | | reference category | |
| 1st-50th percentile (lower 50% of ranked depts.) | -0.194 | 1.391* | -0.217 | -0.134 | 1.423* | -0.268 | -0.264 | 1.319* | -0.123 | -0.213 | 1.283* | -0.213 | -0.175 | 1.253* | -0.205 |
| 50th-75th percentile | -0.277 | 0.127 | -0.152 | -0.245 | 0.177 | -0.104 | -0.363* | 0.007 | -0.036 | -0.298 | 0.080 | -0.092 | -0.304 | 0.004 | 0.017 |
| 75th-90th percentile | -0.243 | 0.459 | -0.320 | -0.140 | 0.539 | -0.252 | -0.284 | 0.400 | -0.252 | -0.271 | 0.441 | -0.271 | -0.207 | 0.409 | -0.171 |
| 90th-100th percentile (top 10%) | -0.218 | 0.507 | -0.860* | -0.201 | 0.602 | -0.774* | -0.301 | 0.421 | -0.823* | -0.337 | 0.452 | -0.811* | -0.334 | 0.482 | -0.723* |
| Demographics of recent doctorates in recruitment fields | | | | | | | | | | | | | | | |
| % Female & Black, Latinx, or Native American | 0.019 | -0.120 | 0.022 | 0.027 | -0.125 | 0.020 | 0.024 | -0.129 | 0.021 | 0.029 | -0.118 | 0.027 | 0.035 | -0.126 | 0.024 |
| % Male & Black, Latinx, or Native American | 0.055 | -0.154 | -0.115* | 0.043 | -0.155 | -0.118* | 0.067* | -0.156 | -0.116* | 0.065* | -0.144 | -0.110 | 0.065* | -0.148 | -0.111 |
| % Female & Asian or Asian-American | 0.028** | -0.118*** | -0.013 | 0.035** | -0.118*** | -0.013 | 0.047*** | -0.106** | -0.008 | 0.029** | -0.117*** | -0.014 | 0.045*** | -0.109** | -0.011 |
| % Male & Asian of Asian-American | 0.007 | -0.044 | 0.001 | 0.011 | -0.049 | 0.000 | 0.011 | -0.045 | -0.002 | 0.016 | -0.038 | 0.003 | 0.020 | -0.043 | -0.001 |
| % Female & White | 0.030** | -0.104** | -0.022 | 0.033** | -0.105** | -0.022 | 0.032** | -0.104** | -0.022 | 0.034** | -0.099** | -0.020 | 0.039*** | -0.099** | -0.021 |
| **Hiring department faculty demographics** | | | | | | | | | | | | | | | |
| % Female | 0.035 | -0.170 | -0.173 | 0.046 | -0.166 | -0.187 | 0.057 | -0.145 | -0.178 | 0.048 | -0.155 | -0.173 | 0.069 | -0.140 | -0.187 |
| % Black, Latinx, or Native American | -0.076 | 0.199 | 0.063 | -0.109* | 0.174 | 0.057 | -0.103* | 0.201 | 0.057 | -0.085 | 0.182 | 0.045 | -0.121* | 0.159 | 0.043 |
| % Asian/Asian-American | -0.110* | 0.337* | 0.198 | -0.097 | 0.349* | 0.213* | -0.133* | 0.351* | 0.210* | -0.095 | 0.332* | 0.211* | -0.105 | 0.341* | 0.224* |
| **Hiring committee characteristics** | | | | | | | | | | | | | | | |
| No committee information | | reference category | | | reference category | | | reference category | | | reference category | | | reference category | |
| 1 member | -0.480** | -1.166* | -1.294*** | -0.412* | -1.073 | -1.150** | -0.535** | -1.353* | -1.276*** | -0.498** | -1.153* | -1.242*** | -0.470* | -1.258* | -1.098** |
| 2-3 members | -0.503** | -1.176 | -1.315*** | -0.462* | -1.096 | -1.181** | -0.624*** | -1.418* | -1.294*** | -0.512** | -1.127 | -1.206** | -0.548** | -1.280* | -1.072** |
| 4+ members | -0.382* | -1.202 | -0.858* | -0.505* | -1.255 | -0.819* | -0.519** | -1.448* | -0.855* | -0.459* | -1.238 | -0.802* | -0.600** | -1.447* | -0.745 |
| Gender and race-ethnicity of search committee chairs | | | | | | | | | | | | | | | |
| Female chair | -0.106 | 0.117 | -0.411* | -0.115 | 0.093 | -0.410* | -0.112 | 0.132 | -0.401* | -0.114 | 0.127 | -0.413* | -0.407* | -0.129 | 0.124 |
| Asian/Asian-American chair | -0.152 | -0.239 | 0.043 | -0.102 | -0.146 | 0.105 | -0.148 | -0.232 | 0.021 | -0.153 | -0.200 | 0.010 | 0.079 | -0.106 | -0.120 |
| Black, Latinx, or Native American chair | -0.031 | 0.555 | -0.614 | -0.079 | 0.656 | -0.581 | -0.019 | 0.589 | -0.657 | -0.054 | 0.562 | -0.665 | -0.615 | -0.076 | 0.700 |
| **Indicators of network connection** | | | | | | | | | | | | | | | |
| Domestic or International Ph.D. | | | | | | | | | | | | | | | |
| International Ph.D. | | | | | reference category | | | | | | | | | reference category | |
| US Ph.D. | | | | 0.695*** | 0.210 | 0.227 | | | | | | | 0.358*** | -0.147 | 0.154 |
| Where the applicant learned of the postdoc position | | | | | | | | | | | | | | | |
| Hiring campus website | | | | | reference category | | | | | | | | | reference category | |
| Professional associations | | | | 0.399*** | 0.208 | 0.240 | | | | | | | 0.350*** | 0.194 | 0.215 |
| Higher education media | | | | 0.066 | 0.090 | -0.001 | | | | | | | 0.141 | 0.077 | -0.080 |
| Personal network | | | | 1.531*** | 0.981*** | 0.627** | | | | | | | 1.388*** | 0.829*** | 0.559* |
| Applicant affiliation with hiring university | | | | | | | | | | | | | | | |
| Earned doctorate from hiring institution | | | | 1.566*** | 1.229*** | 1.094*** | | | | | | | 1.417*** | 1.096** | 1.073*** |
| **Indicators of the prestige and prominence of the applicants' referrers** | | | | | | | | | | | | | | | |
| Rank of referrers' institutional affiliation | | | | | | | | | | | | | | | |
| International affiliation (unranked) | | | | | | | | reference category | | | | | | reference category | |
| Unranked U.S. affiliation | | | | | | | 0.267** | 0.746** | 0.385 | | | | -0.096 | 0.767** | 0.308 |
| 1st-50th percentile (lower 50%) | | | | | | | -0.109 | 0.274 | 0.000 | | | | -0.132 | 0.372 | -0.006 |
| 50th-75th percentile | | | | | | | 0.325*** | 0.717** | 0.163 | | | | 0.072 | 0.680* | 0.037 |
| 75th-90th percentile | | | | | | | 0.681*** | 0.592* | 0.499 | | | | 0.366** | 0.517 | 0.338 |
| 90th-100th percentile (top 10%) | | | | | | | 0.920*** | 1.282*** | 0.382 | | | | 0.528*** | 1.185*** | 0.200 |
| Maximum h-index among referrers (logged) | | | | | | | 0.563*** | 0.406*** | 0.188*** | | | | 0.414*** | 0.332** | 0.156 |
| **Indicators of the applicants' human capital** | | | | | | | | | | | | | | | |
| Years since doctorate | | | | | | | | | | -0.139*** | -0.132** | -0.036 | -0.121*** | -0.126* | -0.004 |
| Quadratic term | | | | | | | | | | -0.120*** | -0.078* | -0.089* | -0.118*** | -0.072 | -0.074* |
| Current position | | | | | | | | | | | | | | | |
| Postdoc | | | | | | | | | | -0.391*** | -0.188 | -0.273 | -0.224** | -0.143 | -0.177 |
| Professor | | | | | | | | | | -1.915*** | -1.002* | -0.655 | -1.493*** | -0.837 | -0.490 |
| Adjunct or visiting professor, lecturer | | | | | | | | | | -1.027*** | -0.331 | -0.506 | -0.765*** | -0.200 | -0.445 |
| Research or Teaching Fellow | | | | | | | | | | -0.918*** | -0.186 | 0.230 | -0.631*** | -0.082 | 0.372 |
| Graduate student | | | | | | | | | | | reference category | | | reference category | |
| Researcher | | | | | | | | | | -0.707*** | -0.544** | -0.284 | -0.492*** | -0.395* | -0.172 |
| Other | | | | | | | | | | -1.121*** | -0.470* | -0.408 | -0.830*** | -0.315 | -0.266 |
| Has at least one publication | | | | | | | | | | -0.015 | 0.360 | -0.008 | -0.024 | 0.254 | 0.061 |
| Has at least one grant or fellowship | | | | | | | | | | 0.569*** | 0.505 | 0.458 | 0.242 | 0.247 | 0.367 |
| Citation count (for those with ≥1 publication) | | | | | | | | | | 0.113*** | 0.187** | 0.039 | 0.043 | 0.130 | 0.031 |
| Journal impact factor percentile | | | | | | | | | | 0.019*** | 0.011* | 0.008 | 0.014*** | 0.009 | 0.007 |
| CV data missing | | | | | | | | | | 0.019 | -0.041 | 0.400 | 0.011 | 0.009 | 0.228 |
| **Model fit statistics:** | | | | | | | | | | | | | | | |
| Sample size | 22,098 | 3,186 | 2,060 | 22,098 | 3,186 | 2,060 | 22,098 | 3,186 | 2,060 | 22,098 | 3,186 | 2,060 | 22,098 | 3,186 | 2,060 |
| AIC | 15896.74 | 2704.48 | 2428.49 | 14942.81 | 2664.46 | 2406.47 | 15376.27 | 2665.28 | 2429.08 | 15082.87 | 2691.81 | 2438.57 | 14267.66 | 2646.04 | 2427.17 |
| BIC | 16328.91 | 3032.07 | 2732.54 | 15439.01 | 3040.58 | 2755.56 | 15864.47 | 3035.34 | 2772.54 | 15651.10 | 3122.53 | 2838.34 | 14955.94 | 3167.76 | 2911.38 |
| *df* | 54 | 54 | 54 | 62 | 62 | 62 | 61 | 61 | 61 | 71 | 71 | 71 | 86 | 86 | 86 |

*$p \le 0.05$, **$p \le 0.01$, ***$p \le 0.001$

Note: All models include random intercepts for the STEMM discipline targeted for the postdoc position and recruitment. Models include indicators for missing values on the following variables: domestic vs. international Ph.D.; where the applicant learned of the postdoc position; maximum h-index among referrers; years since completing doctorate; has at least one publication; citation count; journal impact factor percentile; earned doctorate from hiring institution.

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