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Disparities in publication patterns by gender, race and ethnicity based on a survey of a random sample of authors

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Abstract Gender and racial disparities have greatly diminished in academia over the last 30 years, but attrition rates among women and minority faculty still remain high. In this paper we examine gender and racial disparities in publishing, an activity that is important for career advancement, but has not been incorporated adequately into the debate on faculty attrition. We surveyed a random sample of 1,065 authors who contributed a peer-reviewed journal article indexed in the Web of Science (WoS) in 2005 and at least one other article during the period of 2001–2004 in four academic disciplines representing natural sciences (biochemistry and water resources) and social sciences (anthropology and economics). We then report on the relationships between demographic variables (gender and race/ethnicity) and career-related variables (academic rank, discipline, and h-index) of these authors. Our findings show that at every career level and within each discipline, women were under-represented in academic positions compared to men and an even lower percentage of women published at each academic level than were employed at that level. Further, we found that women had lower h-indices than men in all four disciplines surveyed. Societal and biological constraints may reduce women's ability to obtain research intensive positions and contribute to these gender disparities. Hispanics and blacks were underrepresented among individuals awarded with doctoral degrees, doctorate recipients employed in academia, and academics publishing in WoS as compared to their representation in the population. Whites, Asians, and Native Americans and Pacific Islanders

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were adequately or over-represented in each category. Additionally, blacks had lower h-indices than the other ethnic groups across the disciplines surveyed. Compared to women, attrition among blacks and Hispanics appears to occur earlier in their career development. Cumulative experiences with discrimination and stereotypes may partly explain higher attrition and lower publication productivity among blacks and Hispanics.

Keywords Academic attrition · Publication productivity · Gender disparities · Racial and ethnic disparities

Introduction

Motivation and objectives

Gender, racial and ethnic disparities are recognized to exist among faculty, especially at the higher professional ranks, among highly productive scientists, and in leadership positions in academic institutions (Simonton 1992; Trower and Chait 2002; Handelsman et al. 2005; Nelson 2005; Feist 2006). Women and minorities receive lower salaries (Trower and Chait 2002; Umbach 2007), fewer grants and less grant money (Hosek et al. 2005; OER 2005), and hold fewer leadership positions, such as department chairs, deans in medical schools (AAMC 2005) and chief editor of top ranked journals (CMPWASE 2007). External factors, such as organizational constraints, differences in family demands, implicit and explicit biases, and the underrepresentation of women in decision-making positions, have been identified as major contributors to the gender disparity that exists in academia (CMPWASE 2007). Based on this research, the US National Science Foundation (NSF) and higher education institutions have taken steps to combat the underrepresentation of women and minorities through the creation and encouragement of participation in programs, such as ADVANCE, the Minority Postdoctoral Research Fellowship and Follow-up Research Starter Grants, Minority Graduate Education Activity, and Louis Stokes Alliances for Minority Participation (NSF 2009a).The goals of many of these programs are to support projects that help create a more equitable environment for women and minority faculty and to increase their representation and advancement in academic science and engineering careers (NSF 2009a).

Academic productivity, in the form of peer-reviewed journal articles, is evaluated more heavily than any other area of an academic's career when decisions regarding career advancement are made by more senior members of academia (Skolnik 2000). Publishing is important because it is the primary means by which scientists communicate their research results. Individual productivity of academic scientists is most heavily weighted by their publication record, whereas other activities of academics such as teaching, mentorship, and administrative activities are only secondarily considered in academic job acquisition, tenure, promotion, and salary increases. The important role of publishing in career advancement coupled with observed gender, racial and ethnic disparities in the academic faculty suggests that there may be discernible differences in publication rates between men and women and people of different races and ethnicities.

Several earlier studies have found lower publication rates for women than men (Helmreich et al. 1980; Cole and Zuckerman 1984; Long 1992). However, longitudinal data from 1969 to 1993 showed that the gender disparity in academic faculty decreased during that period (Xie and Shauman 1998). The literature on productivity disparities has largely focused on the gender gap and very few studies have looked at publication rates of minorities (see Pearson 1985 for an exception).

In addition, the relationship between publication practice differences in the social and natural sciences and the distribution of gender and ethnicity in these broad disciplinary categories have been largely ignored. For example, books have traditionally been the most valued form of research output in many social science disciplines. Citation practices also have been influenced by this tradition, as evidenced by social scientists primarily citing books instead of articles (Larivière et al. 2006). Over the last 20 years however, this preference has slowly been changing to more closely reflect the article-focused practices in the natural sciences (Kyvik 2003; Wallace et al. 2009). Even though publishing practices are changing in social science as a whole, the culture of publishing, including co-authorship practices, definitions of what constitutes an original scientific article, article acceptance rates, the number of journals, and the degree of paradigmatic development continue to vary between disciplines and have a major impact on productivity (Biglan 1973; Zuckerman and Merton 1973; Braxton and Hargens 1996; Dundar and Lewis 1998; Becher and Trowler 2001). The natural sciences continue to exhibit higher rates of article publication and citation than the social sciences (Lee and Bozeman 2005; Batista et al. 2006; Iglesias and Pecharromán 2007).

In this paper we illuminate gender, ethnic and racial disparities in productivity with the intention that it will contribute to the literature on attrition in academia. Our overall hypothesis is that gender, ethnic and racial disparities in productivity are the critical factors contributing towards disparities observed in attrition in academia. Throughout our study we take into consideration disciplinary differences. We use a survey approach by randomly selecting authors from four academic disciplines indexed in the Web of Science (WoS). To test for variation in publishing practices between the natural and social sciences we selected two disciplines from the WoS Journal Citation Report science (water resources and biochemistry) and social science (economics and anthropology) editions. Our survey approach allows us to infer results to each of these four disciplines. We integrated demographic data with publication statistics compiled from the WoS to highlight gender, ethnic and racial disparities in publishing. The use of objective productivity measures such as the number of articles and Hirsch indices to explain the dearth of women in academic science is one of the major contributions of this study.

Attrition in academia

Nearly 60 % of those pursuing a graduate degree in the sciences want to enter academia (Nettles and Millett 2006), but only 30 % of those who receive PhDs in the sciences are actually employed in universities and 4-year colleges (NSF 2009b). There are gender and racial disparities in attrition rates at major transition points along career paths with fewer women and minorities choosing to continue to pursue a career in academic sciences at each point (CMPWASE 2007).

The representation of women and minorities has improved at the doctoral level over the last 20 years, but disparities in academic positions remain greater in some disciplines than others. For example, the Committee on Maximizing the Potential of Women in Academic Science and Engineering (CMPWASE 2007) found that women in 2003 were hired into assistant professor positions at research institutions in the physical and social sciences in greater proportions than their representation in the PhD pool (received doctorate 0–6 years prior to 2003), as opposed to the life sciences, computer science, mathematics, and psychology where women remain underrepresented compared to the PhD pool. The proportion of women who graduated with doctorate degrees 0 to 6 years prior to 2003 and received faculty positions by 2003 was approximately equal in chemistry and economics. However, among tenure-track engineering, science, and social science faculty in 1995 and 2001, men were more likely to receive tenure than women and of those who did not receive tenure, more men sought non-academic jobs while more women switched to non-tenure track positions within academia. Like women, minorities who did not receive tenure were also more likely to change to adjunct positions than leave academia altogether. Women are slightly less likely to get tenure than men, especially in the social sciences. Minorities are less likely to get tenure than non-minorities, especially in tenure cases that are determined after 4–6 years compared to those that are made within the first 2 years. A wide variety of reasons impact an individual's decision to leave academia before going through the tenure process, including excessive time commitments (Barnes et al. 1998; Zhou and Volkwein 2004), limited sense of community (Barnes et al. 1998), lack of unionization, low seniority and lack of tenure, unsatisfactory compensation, lack of job security, inadequate access to resources, and lack of extrinsic rewards (Zhou and Volkwein 2004). These factors would impact men and women in different ways leading to their different attrition rates.

Among those who achieve tenure, gender and ethnic disparities continue to vary by discipline at different ranks. At the associate professor level in research universities in 2003, women were adequately or overrepresented in chemistry, physical sciences, mathematics, and social sciences based on the proportion of women in the PhD pool during the probable years of hire (received doctorate 7–15 years prior to 2003) (CMPWASE 2007). Conversely, women are underrepresented in life sciences, computer science, psychology, and economics. At the full professor level in 2003 women were underrepresented in all disciplines as compared to the proportion of women in the PhD pool (received doctorate 16 or more years prior to 2003). The promotion process is typically slower for women and minorities and fewer reach the highest tenure level as compared to men and whites, especially in research-oriented institutions. Potential explanations for these differences are that the standards of promotion for women and minorities are higher and their judgment regarding their preparedness to apply for a promotion is altered by gender and ethnic biases.

Also, the reasons for attrition often vary between people of different genders and races and ethnicities. Salary is an especially critical factor in retention. Women are often paid less than men (MIT 1999; Callister 2006) and more frequently report dissatisfaction with their pay (Hemmasi et al. 1992; Trower and Bleak 2004). Closely linked to issues of salary is the tenure process, which men have been found to have a clearer understanding of and an easier time navigating (Trower and Bleak 2004). Conflicts between personal and professional life are another important reason for attrition of women. Women report less satisfaction with the interaction between their personal and professional life (Trower and Bleak 2004), greater challenges with juggling starting a family and advancing a career (Trower and Bleak 2004), and greater concern for spouse employment opportunities (CU-Boulder 2001) than men. Job satisfaction, including availability of support, mentoring and collaboration, which varies greatly based on the tenure-status, gender, and race and ethnicity of the faculty members, profoundly impacts faculty intentions to leave an institution (Holder and Vaux 1998; Niemann and Dovidio 1998; Jena 1999; Rosser 2004a, b; Callister 2006). A lack of respect and excessive scrutiny from male colleagues and administrators and a lack of inclusion in department decision-making also influence female faculty members' decisions to leave a university (Astin and Sax 1996; Chiliwniak 1997; Wenzel and Hollenshead 1998; Rutgers 2001; Preston 2004; Rosser 2004a, b).

Publication disparities in academia

Many studies have shown that women were less scientifically productive than men (Cole and Zuckerman 1984; Helmreich et al. 1980; Long 1992), however this association appears to be moderated by a host of personal, structural, and family-related factors. Gender disparity in productivity has been attributed to differences in family obligations (Reskin 1978; Long 1990), although some studies have found that levels of family responsibility have no direct effect on scientific productivity (Cole and Zuckerman 1984; Cole and Zuckerman 1987; Sax et al. 2002; Stack 2004) and still others identified a positive relationship (Fox and Faver 1985) depending on if the marriage is the first or subsequent and the age of the children (Fox 2005). Kyvik and Teigen (1996) found that greater levels of family obligation combined with less research collaboration are associated with lower productivity levels among women. Other studies have focused on the relationship between institutional affiliation, rank, discipline and productivity. Xie and Shauman (1998) found a strong association between the gender gap in publication rates and variables such as type of institution, rank, teaching load, funding level, and research assistance. Ramsden (1994) also found no association between gender and productivity after controlling for rank. Blackburn and colleagues (1978) noted that gender differences in productivity are explained by the tendency of women to be less interested in research, graduate from less prestigious schools, work in less prestigious and non-research focused institutions, hold lower rank and un-tenured positions, teach more lower level courses, and work in the humanities. In a subsequent publication, Blackburn and other colleagues (1991) reported that self-valuations related to self-competence and motivation to perform research explained variation in scientific productivity whereas gender failed to explain any of the variation. In a study of seven Norwegian universities, Smeby and Try (2005) found that the negative association between gender and productivity was explained by contextual variables such as discipline, age, and characteristics of the department, including quality.

The limited research on the association between race and ethnicity and scientific productivity has garnered mixed results. Judy Jackson (2004) found that Black and Hispanic engineers did not differ in levels of research productivity as compared to whites, whereas Asians had greater levels of productivity. In contrast Jerlando Jackson (2008) determined that African American male academics were found to publish less than their white counterparts. After controlling for gender, education, experience, instructional and research activities, and institutional type, Nettles and Perna (1995) found that Hispanics were more productive than faculty of other ethnicities.

Methods

We conducted a global survey of attitudes and practices related to publishing among randomly selected authors from four academic disciplines indexed in the WoS. We began the process of sampling the authors by downloading separately the citation information associated with all articles from all journals associated with each of the four disciplines published in 2005 indexed on the WoS. Unique authors were identified by parsing the dataset into author name and associated institutional affiliation and duplicates removed. In order to ensure that authors could report accurately on the publishing culture of their discipline we required at least one additional article published in the discipline during the period of 2001–2004. Randomly selected authors from each discipline were solicited by email in 2006 to participate in a web-based survey. Listed in Table 1 for each of the

Table 1 Sample selection from Web of Science in 2005

WoS category	Number of associated journals	Number of article authors	Number of solicitations sent	Number of respondents
Water resources	56	17,596	1,371	263
Biochemistry	260	215,968	1,504	232
Economics	174	14,612	1,322	272
Anthropology	50	3,478	1,223	298

selected disciplines are the number of associated journals, the number of unique authors based on our criteria described above, the number of solicitations sent for this study, and the number of respondents. The overall response rate was 19.6 %, which is consistent with other recent web-based surveys (e.g., Kaplowitz et al. 2012). Because of the relative evenness of the response rate for the different disciplines (between 15.4 and 24.3 %), we do not suspect any systematic differences by discipline. Given the sample frame, we are limited to the information in the Web of Science regarding the characteristics of the non-respondents and we therefore have no demographic information about them.

We calculated the percentage and standard error of authors by gender and race/ethnicity, and field of employment for each survey respondent. We also determined Hirsch's (2005) h-index ('h' signifies 'high impact') as a measure of their scientific impact throughout their career. Although there are several commonly used indicators of individual scientific impact, we decided to use the h-index because it combines two of the most common measures, number of publications and number of citations per article, into a single measure by determining the number of papers authored by a scientist that have been cited at least *h* times. In addition, Hirsch suggests that after adjusting the index threshold to accommodate scientists at different points in their career the h-index could be used for making decisions about tenure and promotion. This application makes the h-index an important measurement for comparison of demographic differences in publication and promotion patterns. He does caution that h-index patterns will differ across discipline, as will become apparent from our results, owing to the differences in disciplinary cultures of publishing.

Since publications and individual scientific impact are often reported as an important factor in hiring, promotion, and tenure, we compared the publishing trends we observed in our data with promotional trends for career academics obtained from NSF. We used two sources of information from NSF: the Survey of Earned Doctorates (SED) and the Survey of Doctorate Recipients (SDR). The annual SED reports on the number and characteristics of all US research doctorate graduates (NSF 2010a, b). The data from the SED used in our analysis was made available in the NSF *Women, Minorities, and Persons with Disabilities in Science and Engineering* report, which presented the number of graduates by field, gender (females in Table F-2 and males in Table F-3), and ethnicity (Table F-6) from 1999 to 2006 (NSF 2009b). For 2006 we calculated the percentage and standard error of the total graduates by gender and ethnicity.

The biennial SDR is longitudinal and follows recipients of research doctorates in a science, engineering or health field from a US institution throughout their career (NSF 2010a, b). Since the focus of our study is on academics, we used the data from the same report as the SED on the number of science and engineering doctorate holders employed in universities and 4-year colleges broken down by broad occupational category, gender, ethnicity, and faculty rank for the year 2006 (Table H-25) (NSF 2009b). Using these data we calculated the percentage and standard error of males and females and individuals of different ethnicities at non-tenure track, assistant, associate, and full professor career levels. The level of representation of different genders and ethnicities were determined for each academic rank and discipline by subtracting the percentage of representation of each gender and ethnic group from their percentage of representation in the population. Over and under representations are expressed as positive and negative percentages, respectively. The margin of error (ME) is included in the text for each value and in each figure the ME is represented by error bars. The ME is equal to the square root of $p(1-p)/n$, where n is the sample size and p is the proportion of the sample with the characteristic of interest multiplied by 1.96 (the z-value for a confidence interval of 95 %).

The outcomes of our comparison between the WoS data we collected and the NSF data are dependent on our ability to match variables between those two data sources. The disciplinary categories in the NSF data did not exactly map onto the disciplines represented in the WoS data, but we strove to match them as closely as possible. We matched the data from the earth, atmospheric, and ocean sciences category in the SED data and the physical sciences category in the SRD data to the water resources data from the WoS. The biochemistry data from WoS was matched to the biological sciences category in the SED and SRD data. The WoS data from water resources and biochemistry were combined to represent the broad disciplinary category of natural sciences as well as the data from the corresponding disciplinary categories in the SED and SRD. The WoS disciplinary category of anthropology was matched with the SED and SRD category of social sciences, as was the WoS disciplinary category of economics. The data from the WoS categories of anthropology and economics were combined to represent the broad disciplinary category of social sciences; this process was repeated for the corresponding data from SED to SRD. Our data suggest that the disciplines represented in the WoS data adequately represent the range of publishing practices in the social and natural sciences (Figs. 1, 2).

The variable of gender was closely matched between WoS and NSF data. In the SED the participants were given the option of marking male or female for their gender (NORC 2006). The same gender options in the SED were provided in the WoS survey, in addition to 'not available', which is the equivalent of the respondent choosing to not respond to the question on the SED.

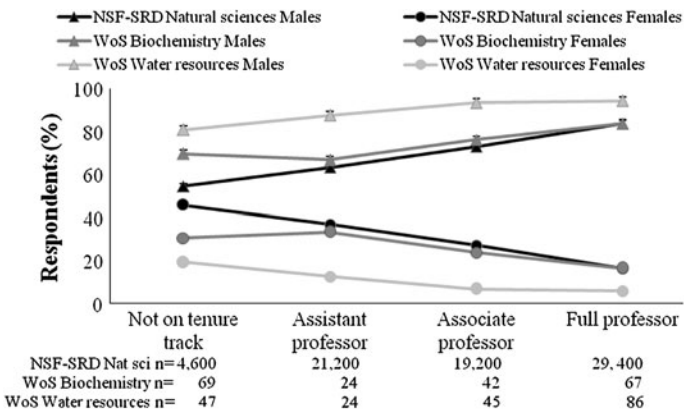

Fig. 1 Trends in the natural science data from NSF (2009b) as compared to our findings from WoS data for biochemistry and water resources. Margin of *error bars* are included. The sample size (n) corresponds to the academic level above each value

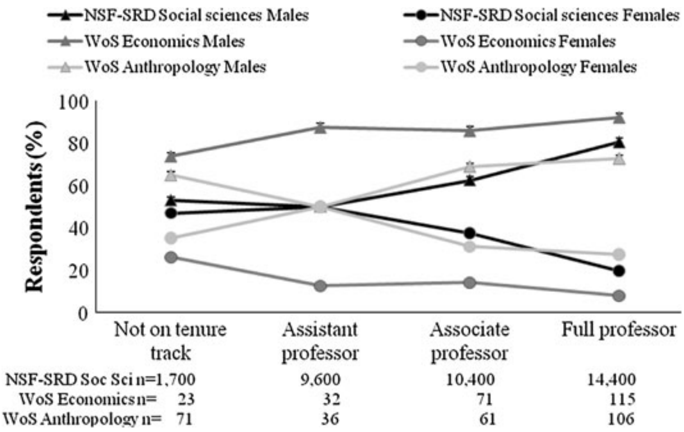

Fig. 2 Trends in the social science data from NSF (2009b) as compared to our findings from the WoS data for economics and anthropology. Margin of *error bars* are included. The sample size (*n*) corresponds to the academic level above each value

Variation in the collection and reporting of ethnicity and racial data poses several additional problems. First, the naming of subpopulations was slightly different across questionnaires. In the SED, as in the WoS survey, respondents were asked if they are Hispanic (NORC 2006). In both the surveys the respondents were given the option of responding affirmatively or negatively. The options for the racial background of the SED respondents were American Indian or Alaska Native and Native Hawaiian or other Pacific Islander, which we collapsed into one category and compared with the WoS other category. Additional racial categories of Asian, black or African American, and white were on both surveys. For both the ethnicity and race questions WOS survey respondents were allowed to report that they 'did not know' or 'not available', which was considered missing data and not included in the analysis as were non-responses for associated SED questions. The gender, racial, and ethnicity data included in the results from the SDR were based on what was reported by the respondent in the SED at the time of their graduation with their doctorate.

A second issue is that the reliability of data based on self-identification can vary by subgroups. For example, because our survey was global we found that people from Spain to Latin America are confused by the Hispanic/non-Hispanic ethnic distinction; 59.4 % of the 32 respondents living in Spain self-identified as Hispanic, 31.3 % as non-Hispanic, and 9.4 % as not available. Of the 19 respondents living in Latin America 42.1 % self-identified as Hispanic, 36.8 % as non-Hispanic, and 21.1 % as not unknown or not available. Although it is not ideal to have so much variation in conceptualization of the variable, it is probable that the respondents to the SED and SDR were equally likely to be confused by this distinction allowing us to make comparisons between the different datasets.

Third, when we only use a single statistic to describe racial or ethnic subgroups or by lumping non-whites together into the category of minorities we are undoubtedly missing aspects of heterogeneity within these groups. For example, we chose to include Asians with all other minority groups, as was done by NSF for comparison purposes; however their publishing behavior is generally much more similar to whites than to the other minority groups.

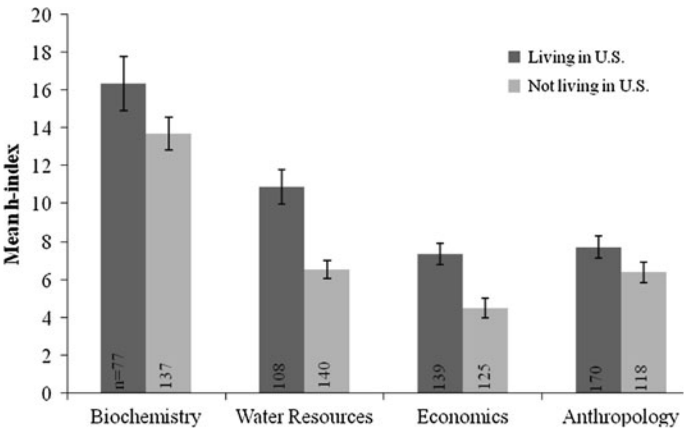

Fig. 3 The mean h-index of scientists living in the US and in other countries who published in the WoS in 2005 in the disciplines of water resources, biochemistry, economics, and anthropology. Margin of error and sample size (*n*) are included for each *bar*

The last challenge with ethnicity and race data are that several of the subgroups are small making it difficult to obtain accurate measures from a sample of the population. This is particularly problematic with the black and other subgroups. In cases where less than 100 individuals responded to a question on the SED and SDR, NSF suppressed the responses for confidentiality purposes. However, they did identify if there were 50–100 respondents or less than 50 respondents. The cases pertinent to this study were identified as between 50 and 100 and for those we assumed a value of 75.

In addition to the previously mentioned variables, we also analyzed the distribution of WoS authors by geographical location. Slightly more than half of the WoS authors were living in places other than the US. This impressive level of internationalization of WoS provides another potential challenge to comparing this population with the NSF survey data which focuses on scientists who received their doctorates and taught in US-based academic institutions. We assessed the potential impact of variation in geographical location by comparing h-indices of scientists living in the US to scientists living elsewhere in the world for each of the four disciplines of interest (Fig. 3). We found that the variation in h-indices was minimal when comparing the US to non-US counterparts. We also suspect that many of the non-US based scientists received training from US based institutions and would be included in the SED.

Findings

Data on the relationship between demographic variables (gender and race/ethnicity) and career related variables (academic rank, discipline, and h-index) are presented in this section. For clarity, the data are divided into two subsections based on the two demographic variables of interest.

Gender

In the year 2006, one-half of the US population from the age of 18–64 was composed of women (Table 2). During the same year women were only slightly underrepresented (−

Table 2 Percentage of people of different genders, ethnicities and races in the US General population, doctoral degree recipients from US Universities, doctoral recipients employed in US Universities, and academics publishing in WoS in the year 2006

Demographic variables	Annual population estimate of the age group 18–64 (US Census)	Awarded doctoral degree (SED)	All doctorate recipients in academia at all career levels (SRD)	Publishing from all different career levels (WoS Survey, this study)
Females	50.0	47.1	29.1	20.7
Males	50.0	52.9	70.9	79.3
Hispanic	14.3	5.38	3.93	5.07
White	66.9	76.3	81.0	81.7
Black	12.1	4.63	3.68	0.48
Asian	4.68	9.77	9.62	10.6
Other	1.98	3.91	1.75	2.17

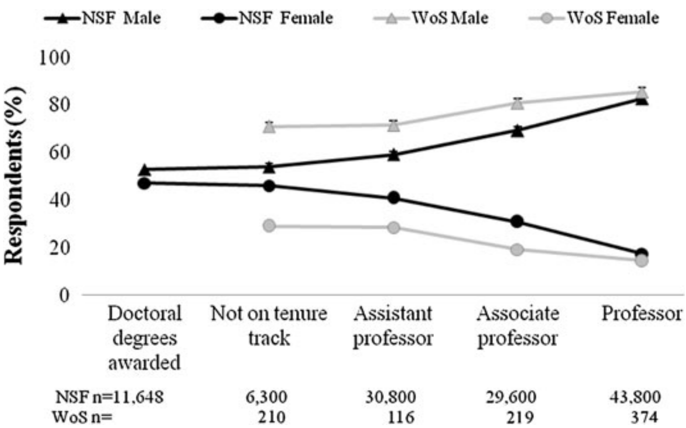

Fig. 4 Comparison of data from NSF (2009b) and this work of the percentage of people of different genders publishing in the WoS at different career levels. Margin of *error bars* are included. The sample size (n) corresponds to the academic level above each value

2.9 %) among doctoral graduates at US universities (NSF 2009b). However, they were greatly underrepresented in academic positions (−20.9 %) with less than one-third (29.1 %, ME = 0.27) of the positions being filled by women (NSF 2009b). We found that their representation as authors in WoS was even less (−29.3 %) with only one-fifth (20.7 %, ME = 2.62) of the authors being women. In comparing gender representation at different career levels, the NSF data show a trend towards less female representation at each career level with 46.0 % (ME = 1.33) of the scholars at the non-tenure track level self-identified as women, 40.9 % (ME = 1.25) at the assistant professor level, 30.7 % (ME = 1.09) at the associate professor level and 17.4 % (ME = 0.82) at the full professor level (Fig. 4). We found that an even lower percentage of women published at each academic level than are employed at that level. Of the scientists publishing at the following career levels, women represented 29.1 % (ME = 1.05) of non-tenure track employees, 28.5 % (ME = 1.04) of assistant professors, 19.2 % (ME = 0.86) of associate professors, and 14.4 % (ME = 0.74) of full professors. The gap between percentage of women employed at different career levels and the percentage of women publishing at the corresponding level decreased with an increase in rank.

In addition to variation in the gender representation by rank, our data also exhibit variation by broad disciplinary category. Compared to their equal representation with men in the US population, women make up only a third of the social scientists (34.1 %, ME = 1.14) and even less of the natural scientists (26.8 %, ME = 1.01) (NSF 2009b; Fig. 5). We found a similar trend in authorship of publications in WoS with 23.0 % (ME = 0.94) of women authoring papers in the social sciences and 17.6 % (ME = 0.82) in the natural sciences. Thus, the gap between percent hired and percent publishing is similar in the natural and social sciences (~11 % in social sciences and 9 % in natural sciences). In both the natural and social sciences a greater percentage of men published

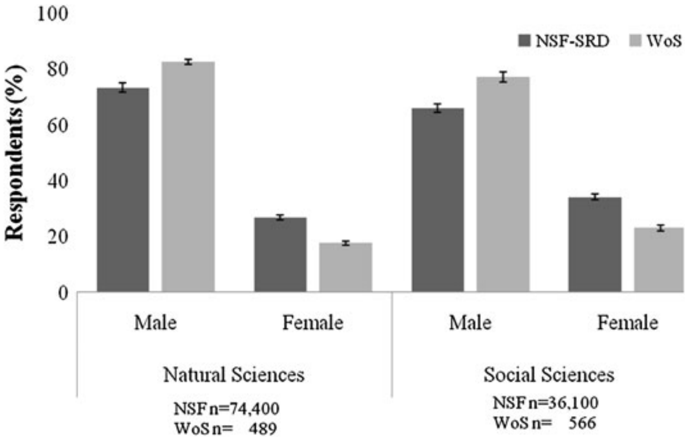

Fig. 5 Percentage of scientists in academia in 2006 by gender (NSF 2009b) compared to our findings of gender representation of authors in the WoS in 2005, grouped into cohorts by broad disciplinary category. Margin of *error bars* are included. The sample size (*n*) corresponds to the broad disciplinary category above each value

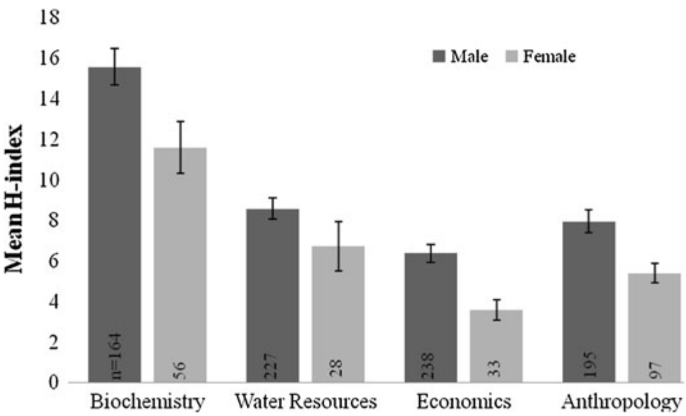

Fig. 6 The mean h-index of the scientists who published in WoS in 2005 in the disciplines of water resources, biochemistry, economics, and anthropology. Margin of error and sample size (*n*) are included for each *bar*

papers than the percentage employed in that same disciplinary category as compared to women.

We found that h-indices also vary by gender with men exhibiting higher values in all four disciplines surveyed. The mean h-index for women was only 56, 68, 78, and 74 % that of men in economics (h-index = 6.4, ME = 0.44), anthropology (h-index = 8.0, ME = 0.55), water resources (h-index = 8.6, ME = 0.53), and biochemistry (h-index = 15.6, ME = 0.88), respectively (Fig. 6). Economics had the lowest overall mean h-index (combined male and female scholars) of 6.0 (ME = 0.39), and the largest proportionate gender gap in publication impact (44 %). Anthropology had the next lowest combined mean h-index of 7.1 (ME = 0.41), and the next largest gender gap in h-index (32 %). Water resources and biochemistry had the two highest combined mean h-indices (8.4, ME = 0.49 and 14.5, ME = 0.74), and the two lowest gender gaps in h-index (22 % and 26 %).

Race and ethnicity

The largest ethnic group in the US in 2006 were whites (66.9 %) followed by Hispanics (14.3 %), blacks (12.1 %), Asians (4.7 %), and Native Americans and Pacific Islanders (2.0 %) (NSF 2009b; Table 2). Caucasians were overrepresented by +9.4 % in doctoral degrees received, and more so in academic positions (+14.1 %) (NSF 2009b; Table 2). We found similar over-representation in publication in WoS (+14.7 %). Asian scientists were almost equally overrepresented in all categories, including doctoral degrees received (+5.1 %), academic position (+5.0 %), and authoring of articles in WoS (+6.0 %). Native American or Pacific Islanders were, like Asians, overrepresented in doctoral degrees awarded (+1.9 %), and almost equally represented in the population, academia (−0.2 %) and as producers of articles in WoS (+0.2 %). Hispanics and blacks were underrepresented in doctoral degrees received (−8.9 and −7.5 %), positions in academia (−10.4 and −8.4 %), and authorship of articles in WoS (−9.2 and −11.6 %).

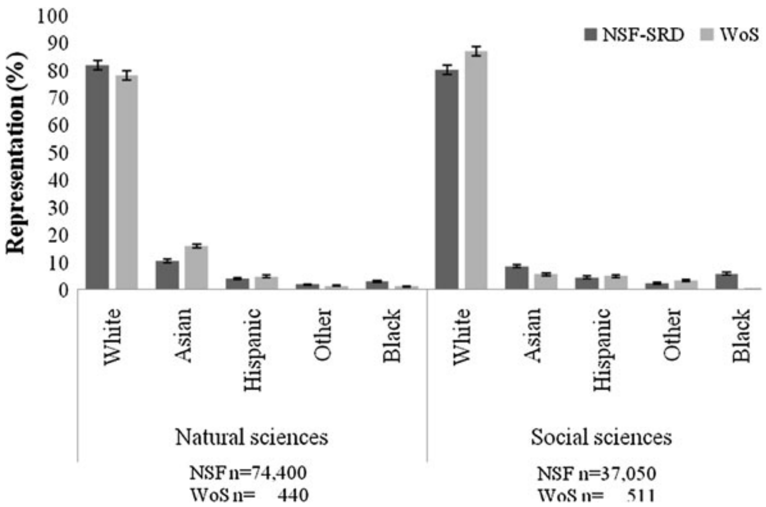

Fig. 7 The percentage of scientists of different races and ethnicities who held an academic position in 2006 (NSF 2009b) compared to our findings for representation among published authors in WoS in 2005, grouped into cohorts by broad disciplinary category. Margin of *error bars* are included. The sample size (*n*) corresponds to the broad disciplinary category above each value

Through comparing cohorts based on broad disciplinary categories, variation in prevalence of different ethnic groups is revealed. An almost equal percentage of people employed in the natural sciences and social sciences are white (81.6 %, ME = 1.77 and 79.9 %, ME = 1.75, respectively) (NSF 2009b; Fig. 7). The same trend is found among Hispanics (3.8 %, ME = 0.38 in the natural sciences and 4.3 %, ME = 0.40 in the social sciences) and Native Americans and Pacific Islanders (1.6 %, ME = 0.25 in the natural sciences and 2.0 %, ME = 0.28 in the social sciences). More blacks are employed in the social sciences (5.5 %, ME = 0.46) than the natural sciences (2.8 %, ME = 0.33) and the trend was the reverse for Asians (10.3 %, ME = 0.63 in natural sciences and only 8.3 %, ME = 0.56 in the social sciences).

We found that authors publishing in the social sciences indexed in the WoS were disproportionately white (86.7 %), or +6.8 % greater than their representation in social science academic employment (NSF 2009b). Hispanic and Native American and Pacific Islander authors of social science articles (4.7 %, ME = 0.42 and 3.0 %, ME = 0.34) were represented roughly equal with their employment in these disciplines (4.25 %, ME = 0.40 and 2.02 %, ME = 0.28), while Asians and blacks were represented less in publishing (5.3 %, ME = 0.45 and 0.4 %, ME = 0.12) than in employment (8.30 %, ME = 0.56 and 5.53 %, ME = 0.46). White, Asian, and Hispanic, and Native American and Pacific Islander authors publishing in the natural sciences (77.7 %, ME = 1.72; 15.7 %, ME = 0.78; 4.55 %, ME = 0.42; 1.14 %, ME = 0.21) were distributed approximately equal to their representation in academic positions (77.7 %, ME = 1.72; 15.7 %, ME = 0.78; 4.6 %, ME = 0.42; 1.1 %, ME = 0.21). Black authors were the only group whose representation in the WoS (0.9 %, ME = 0.19) was noticeably less (−1.9 %) than in academic positions (2.8 %, ME = 0.33).

The mean h-indices varied considerably by race and ethnicity, and discipline (Fig. 8). In water resources Asians had the highest mean h-index (10.4, ME = 1.66); the mean h-index of whites, Hispanics, Native Americans and Pacific Islanders was only 83, 51, 67, 29 % that of Asians (Fig. 8). In biochemistry whites had an average h-index of 15.7 (ME = 0.89) followed closely by Hispanics and Asians with 89 and 67 % that of whites.

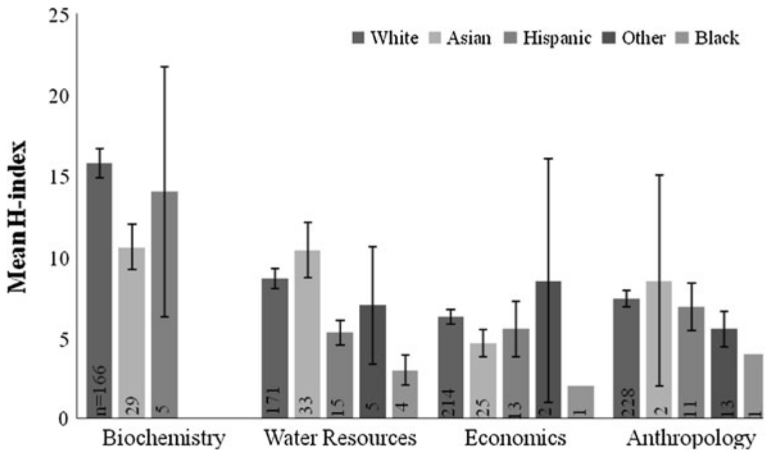

Fig. 8 The mean h-index of scientists of different races and ethnicities who published in the disciplines of water resources, biochemistry, economics, and anthropology in WoS during 2005. Margin of error and sample size are included for each *bar*

There were no blacks or Native Americans and Pacific Islanders in the sample who published in WoS within the discipline of biochemistry. Native Americans and Pacific Islanders had the highest average h-index in economics at 8.5 (ME = 7.50); whites, Hispanics, Asians, and blacks followed with 74, 65, 55, 24 % that of the Native Americans and Pacific Islanders. In anthropology Asians led the group (8.5, ME = 6.50) then came whites with an average h-index 87 % that of Asians, followed by Hispanics (81 %), Native Americans and Pacific Islanders (65 %), and blacks (47 %). The gap in average h-indices between ethnicities was least in biochemistry at 33 %, followed by anthropology at (53 %), then water resources (71 %) and was greatest in economics (76 %).

Discussion and conclusion

Gender and racial disparities have greatly diminished in academia over the last 30 years, but attrition rates among women and minority faculty still remain high. In this paper we examine gender and racial disparities in publishing, an activity that is arguably the most important predictor of career advancement, but has not been incorporated adequately into the debate on faculty attrition. We believe that in order to adequately address demographic disparities and attrition in academia, it is critical to understand the pattern of gender and ethnic disparities in publications and to explore possible explanations for these differences. Determining plausible explanations and testing them in future research are necessary steps in the creation of information that can be used in the development of new programs and policies geared towards reducing disparities in academia.

The study is conducted by taking a random sample of authors who contributed a peer-reviewed journal article indexed in the Web of Science (WoS) in 2005 and at least one other article during the period of 2001–2004 in four academic disciplines representing natural sciences (biochemistry and water resources) and social sciences (anthropology and economics). We then report on the relationships between demographic variables (gender and race/ethnicity) and career-related variables (academic rank, discipline, and h-index) of these authors.

Gender disparities have been found to be almost non-existent at the level of earning a doctoral degree, but our data show that the disparity increases along the academic pipeline with increases in rank, which is consistent with independent findings from other studies (CMPWASE 2007). The percentage of women publishing at each career level (our data) was less than the percentage of women employed in academic positions at each career level (NSF data). However, the gap between percent publishing and percent employed decreased with increase in the academic rank. This is similar to the findings of Ramsden (1994), who reported that the gap between percentage of women employed and percentage with publications in WoS narrows with an increase in career level, suggesting that those women who moved up the ladder were those who sought out research intensive positions and made publication a priority.

Disciplinary differences in publication practices are an unlikely explanation for the gender disparities because the difference between the percentage of women hired and the percentage publishing was approximately equal in the natural and social sciences. Disciplinary differences were however found to be critical in the overall publication impact (as measured by h-index), with women lagging behind men in all disciplines, but the gap was larger in the social sciences compared to the natural sciences. In contrast to our findings, Smeby and Try (2005) found that discipline was a critical factor in production disparity. They suggest that a greater proportion of women in humanities departments resulted in increased research time and scientific publishing among these same women. This may be due to the greater sharing of teaching and service responsibilities among female colleagues in these departments as compared to the social and natural sciences departments surveyed in this study.

Unlike gender disparities, underrepresentation among blacks and Hispanics was evident at the level of doctoral recipients. Hispanics and blacks were even less represented in academe and as authors of publications than they were as graduates of doctoral degrees. Caucasians, Asians and Native Americans and Pacific Islanders, were over represented as doctoral degree graduates and as authors of publications. As with gender disparities, disciplinary differences in publications do not appear to explain racial disparities. The discrepancy between the percentage of authors from each group and those employed in academia was minimal in both the natural and social sciences with the exception of blacks who were slightly more prevalent in the social than the natural sciences and Asians who were more slightly prevalent in the natural than the social sciences. In addition, in all disciplines the publication and citation impact of blacks were lower than their colleagues of other ethnicities, which is consistent with Jackson's (2008) more limited finding among engineers. Asians and Hispanics had similar levels of productivity (mean h-indices) as whites in the social sciences. In water resources Hispanics were significantly less productive than Asians and whites, and in biochemistry Asians were significantly less productive than Hispanics and whites. Our findings complement Jackson's (2004) finding among engineers of higher productivity for Asians, and comparable productivity for Hispanics and whites. The existence of ethnic disparities among doctoral degree graduates suggest that attrition among blacks and Hispanics is not as strongly related to career choices, lack of resources, and publication productivity post-doctorate, as it seems to be with women, but is occurring earlier on in their career development.

Another common explanation for gender disparities in productivity are family obligations and maternity leave (Reskin 1978; Long 1990; Kyvik and Teigen 1996). The majority of the literature, especially research focused on assessing the amount of time academics spend working, has found that women who persist in academia work approximately the same number of hours as men. Women devoted to a research intensive career are able to find time to care for their families by sacrificing extra-curricular activities, not work (Cole and Zuckerman 1984; Fox and Faver 1985; Cole and Zuckerman 1987; Sax et al. 2002; Stack 2004; Fox 2005).

Sex discrimination by search committees, granting agencies, and journal reviewers are also frequent explanations for gender bias in publication productivity. Ceci and Williams' (2011) analysis of the evidence show that women are hired, receive grants and publish as often as men when they have access to comparable resources, suggesting that overt sex discrimination is no longer occurring. However, trade-offs between raising a family and having a career along with societal factors and gender expectations often influences women's decisions to seek positions that provide fewer resources for research than the positions sought by men. In addition, women in academia often choose to spend more of their professional time participating in a wide range of activities, such as mentoring, participating in committees, teaching, and community outreach that are not as valued as publication, whereas men focus more exclusively on research and publishing (Blackburn et al. 1978, 1991; CMPWASE 2007).

A more comprehensive and plausible explanation for the attrition and productivity disparities illuminated in this study is the Matthew Effect, meaning that disadvantages as a result of structural barriers, discrimination, and stereotypes occur among women and minorities early in life and continue to accumulate throughout their education and careers

(Merton 1968; Zuckerman 1996). The impacts of structural barriers that inhibit access to a good quality education, such as socioeconomic disadvantage, segregated societal practices, and restrictive cultural orientation, both historically and currently, diminishes an individual's ability to achieve academic success (Steele 1997).

Structural barriers are the most obvious deterrents to an academic career for women and minorities and have received the most policy attention through programs like ADVANCE and those focused on minority participation in academics. These programs have been successful in reducing gender disparities for those graduating with a PhD, however gender disparities by discipline and disparities between some minority groups and whites still persist along the pipeline, suggesting that there are more aspects to this problem that need to be addressed.

Another powerful disincentive for pursing or incentive for terminating an academic career is discrimination. Self-confidence, which diminishes through experiencing discrimination, is another factor that leads to women and minorities leaving academic pursuits (Fels 2004). Lower expectations by society, institutions, teachers, and leaders are other subtle modes of discrimination that can heavily influence performance among women and minorities (Steele 1999; Bransford et al. 2000; Freeman 2004).

Steele (1997) argues that sustained success in school, and by extension an academic career, requires that an individual identify with an academic discipline. Gender roles, stereotypes, and other structural barriers can disrupt the development of this identification. In addition, those women who have the skills and self-confidence to persevere and become part of the domain face the further barrier of 'stereotype threat', meaning they are constantly concerned that those in the discipline will pass judgment on their behavior and will stereotype them. This threat dramatically reduces the standardized test scores among women, especially in areas related to math and the life sciences. Many factors that have been shown to influence productivity such as alma mater, institutional affiliation, teaching load, emphasis on research, funding level, research assistance, prevalence of collaboration, and self-valuation of motivation and competence (Blackburn et al. 1978, 1991; Xie and Shauman 1998), like standardized test scores, are likely negatively influenced by structural barriers, discrimination, and stereotypes perceived by women and minorities (Steele 1997).

The debate on explanations for disparities in academic performance and academic career advancement continues to develop. Some scientists suggest that their research provides evidence for a biological explanation (Benbow and Stanley 1980, 1983; Benbow 1988) while others are building a body of evidence to support a socio-cultural explanation (Hyde and Linn 2006; Guiso et al. 2008; Hyde et al. 2008; Penner 2008; Penner and Paret 2008). Still other scholars support the hypothesis that aspects of both are at play (Halpern 2000; Ceci et al. 2009; Ceci and Williams 2010; Wai et al. 2010). There is a need for research in all areas where performance disparities have been identified to better understand the complex dynamics involved. In particular, programs of research need to be formed that focus on the subtle ways stereotypes and discrimination can undermine academic productivity and career advancement among women and minorities. Innovative means for combating the negative effects also need to be developed. The differences in performance that researchers continue to uncover may very well be explained by the cumulative effects of overt and covert stereotyping, stereotype threats, and discrimination throughout an individual's lifetime.

There were several limitations to this study including the incomplete correspondence between NSF's disciplinary categories and our choice of disciplines, the use of WoS as our data source, and the lack of data on some minority groups. Although we are aware that the disciplines we chose from the broad disciplinary categories of natural and social sciences are not comprehensively representative, we found strong relationships between our WoS data for each discipline and the corresponding NSF category, and we found that biochemistry and anthropology were good analogs for the natural and social sciences, respectively (see Figs. 1, 2). In addition, by including water resources and economics we were able to capture a broad range of publishing practices within each disciplinary category. By measuring productivity using only articles available in WoS we are likely capturing a less complete picture of productivity in the social sciences than the natural sciences because of the differences in culture of publishing that continue to exist between these broad disciplinary categories. Lastly, as was the case with the NSF data, the sample for several ethnic and racial subgroups was extremely small making it difficult to get an accurate measure of the population.

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References

AAMC (2005) *Analysis in brief: the changing representation of men and women in academic medicine*. Available at: https://www.aamc.org/download/75776/data/aibvol5no2.pdf.

Astin, H. S., & Sax, L. J. (1996). Developing scientific talent in undergraduate women. In C. S. Davis, A. B. Ginorio, B. B. Hollenshead, & P. M. Rayman (Eds.), *The equity equation: fostering the advancement of women in the sciences, mathematics and engineering*. San Francisco: Jossey-Bass Publishers.

Barnes, L. L. B., Agago, M. O., & Coombs, W. T. (1998). Effects of job-related stress on faculty intention to leave academia. *Research in Higher Education, 39*(4), 457.

Batista, P. D., Campiteli, M. G., Kinouchi, O., & Martinez, A. S. (2006). Is it possible to compare researchers with different scientific interests? *Scientometrics, 68*(1), 179–189.

Becher, T., & Trowler, P. (2001). *Academic tribes and territories: intellectual enquiry and the culture of disciplines*. Buckingham: Society for Research into Higher Education and Open University Press.

Benbow, C. P. (1988). Sex differences in mathematical reasoning ability among the intellectually talented: their characteristics, consequences, and possible explanations. *Behavioral and Brain Sciences, 11*, 169–183.

Benbow, C. P., & Stanley, J. C. (1980). Sex differences in mathematical ability: fact or artifact? *Science, 210*, 1262–1264.

Benbow, C. P., & Stanley, J. C. (1983). Sex differences in mathematical reasoning ability: more facts. *Science, 222*, 1029–1031.

Biglan, A. (1973). Relationships between subject matter characteristics and the structure and output of university departments. *Journal of Applied Psychology, 57*(3), 204–213.

Blackburn, R. T., Behymer, C. E., & Hall, D. E. (1978). Research Note: correlates of Faculty Publications. *Sociology of Education, 51*(2), 132.

Blackburn, R. T., Bieber, J. P., Lawrence, J. H., & Trautvetter, L. (1991). Faculty at work: focus on research, scholarship, and service. *Research in Higher Education, 32*(4), 385–413.

Bransford, J., Brown, A. L., & Cocking, R. R. (Eds.). (2000). *How People Learn: Brain, Mind, Experience, and School* (Expanded ed.). Washington, DC: National Academies Press.

Braxton, J. R., & Hargens, L. L. (1996). Variation among academic disciplines: analytical frameworks and research. *Higher Education: Handbook of Theory and Research, 11*, 1–46.

Callister, R. (2006). The impact of gender and department climate on job satisfaction and intentions to quit for faculty in science and engineering fields. *Journal of Technology Transfer, 31*, 367–375.

Ceci, S. J., & Williams, W. M. (2010). *The mathematics of sex: How biology and society conspire to limit talented women and girls*. New York: Oxford University Press.

Ceci, S. J., & Williams, W. M. (2011). Understanding current causes of women's underrepresentation in science. *PNAS, 108*(8), 3157–3162.

Ceci, S. J., Williams, W. M., & Barnett, S. M. (2009). Women's underrepresentation in science: sociocultural and biological considerations. *Psychological Bulletin, 135*, 218–261.

Chiliwniak L (1997) *Higher education leadership: Analyzing the gender gap*. Available at: http://www.eric.ed.gov/PDFS/ED410847.pdf.

CMPWASE (2007) *Beyond bias and barriers: Fulfilling the potential of women in academic science and engineering*. Washington, DC: National Academies Press.

Cole, J. R., & Zuckerman, H. (1984). The productivity puzzle: persistence and change in patterns of publication of men and women scientists. In P. Maehr & M. W. Steinkamp (Eds.), *Advances in Motivation and Achievement* (pp. 217–258). Greewich: JAI Press.

Cole, J. R., & Zuckerman, H. (1987). Marriage, motherhood and research performance in science. *Scientific American, 256*, 119–125.

CU-Boulder (2001) *Faculty recruitment and retention task force report*. Available at: http://www.colorado.edu/AcademicAffairs/fac_recruit/index.html.

Dundar, H., & Lewis, D. R. (1998). Determinants of research productivity in higher education. *Research in Higher Education, 39*(6), 607–631.

Feist, G. (2006). The development of scientific talent in Westinghouse Finalists and members of the National Academy of Sciences. *Journal of Adult Development, 13*(1), 23–35.

Fels, A. (2004). *A Necessary Dreams*. New York: Pantheon Press.

Fox, M. F. (2005). Gender, family characteristics, and publication productivity among scientists. *Social Studies of Science, 35*(1), 131–150.

Fox, M. F., & Faver, C. A. (1985). Men, women, and publication productivity: patterns among social work academics. *The Sociological Quarterly, 26*(4), 537–549.

Freeman CE (2004) *Trends in Educational Equity of Girls and Women: 2004 (NCES 2005– 016). U.S. Department of Education, National Center for Education Statistics.* Washington, DC: U.S. Government Printing Office.

Guiso, L., Monte, F., Sapienza, P., & Zingales, L. (2008). Culture, gender, and math. *Science, 320*, 1164–1165.

Halpern, D. F. (2000). *Sex differences in cognitive abilities*. Mahwah: Lawrence Erlbaum Associates.

Handelsman, J., Cantor, N., Carnes, M., Denton, D., Fine, E., Grosz, B., et al. (2005). More women in science. *Science, 309*(5738), 1190–1191.

Helmreich, R. L., Spence, J. T., Beane, W. E., Lucker, G. W., & Matthews, K. A. (1980). Making it in academic psychology: demographic and personality correlates of attainment. *Journal of Personality and Social Psychology, 39*(5), 896.

Hemmasi, M., Graf, L. A., & Lust, J. A. (1992). Correlates of pay and benefit satisfaction: the unique case of public university faculty. *Public Personnel Management, 21*(4), 442–443.

Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences of the United States of America, 102*(46), 16569–16572.

Holder, J. C., & Vaux, A. (1998). African American professionals: coping with occupational stress in predominantly white environments. *Journal of Vocational Behavior, 53*(3), 315–333.

Hosek, S., Cox, A., Ghosh-Dastidar, B., Kofner, A., Ramphal, N., Scott, J. S., & Berry, S. (2005) *Gender Differences in Major Federal External Grant Programs*. Available at: http://www.rand.org/pubs/technical_reports/2005/RAND_TR307.pdf.

Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B., & Williams, C. C. (2008). Gender similarities characterize math performance. *Science, 321*, 494–495.

Hyde, J. S., & Linn, M. C. (2006). Gender similarities in mathematics and science. *Science, 314*, 599–600.

Iglesias, J. E., & Pecharromán, C. (2007). Scaling the h-index for different scientific ISI fields. *Scientometrics, 73*(3), 303–320.

Jackson, J. (2004). The Story Is Not in the Numbers: academic Socialization and Diversifying the Faculty. *NWSA Journal, 1*, 172–185.

Jackson, J. F. L. (2008). Race segregation across the academic workforce—Exploring factors that may contribute to the disparate representation of African American men. *American Behavioral Scientist, 51*(7), 1004–1029.

Jena, S. P. K. (1999). Job satisfaction, and occupational stress of women. *Social Science International, 15*(1), 75–80.

Kaplowitz, M. D., Lupi, F., Couper, M. P., & Thorp, L. (2012). The effect of invitation design on web survey response rates. *Social Science Computer Review, 30*, 339–349.

Kyvik, S. (2003). Change trends in publishing behaviour among university faculty, 1980–2000. *Scientometrics, 58*(1), 35–48.

Kyvik, S., & Teigen, M. (1996). Child care, research collaboration, and gender differences in scientific productivity. *Science, Technology and Human Values, 21*(1), 54–71.

Larivière, V., Archambault, É., Gingras, Y., & Vignola-Gagné, É. (2006). The place of serials in referencing practices, comparing natural sciences and engineering with social sciences and humanities. *Journal of the American Society for Information Science and Technology, 57*, 997–1004.

Lee, S., & Bozeman, B. (2005). The impact of research collaboration on scientific productivity. *Social Studies of Science, 35*(5), 673–702.

Long, J. S. (1990). The Origins of Sex Differences in Science. *Social Forces, 68*(4), 1297–1316.

Long, J. S. (1992). Measures of Sex-Differences in Scientific Productivity. *Social Forces, 71*(1), 159–178.

Merton, R. K. (1968). The Matthew Effect in Science. *Science, 159*(3810), 56–63.

MIT (1999) *A study of the status of women faculty in Science at MIT*. Available at: http://web.mit.edu/fnl/women/women.pdf.

Nelson, D. (2005). *A national analysis of diversity in science and engineering faculties at research universities*. Available at: http://cheminfo.chem.ou.edu/faculty/djn/diversity/briefings/Diversity%20Report%20Final.pdf.

Nettles, M. T., & Millett, C. M. (2006). *Three magic letters: getting to PhD*. Baltimore, MD: Johns Hopkins University Press.

Nettles, M. T., & Perna, L. W. (1995) Sex and race differences in faculty salaries, tenure, rank, and productivity: why on average do women, African Americans, and Hispanics have lower salaries, tenure, and rank? In *Association for the Study of Higher Education*. Orlando, FL.

Niemann, Y. F., & Dovidio, J. F. (1998). Relationship of solo status, academic rank, and perceived distinctiveness to job satisfaction of racial/ethnic minorities. *Journal of Applied Psychology, 83*(1), 55–71.

NORC (2006) *Survey of Earned Doctorates Questionnaire*. Available at: http://www.nsf.gov/statistics/srvydoctorates/surveys/srvydoctorates_2006.pdf.

NSF (2004) *Women, minorities, and persons with disabilities in science and engineering*.

NSF (2009a) *ADVANCE: Increasing the participation and advancement of women in academic science and engineering careers*. Available at: http://www.advance-portal.net, http://www.nsf.gov/advance.

NSF (2009b) *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2009*. Available at: http://www.nsf.gov/statistics/wmpd/.

NSF (2010a) *Description of Survey of Doctorate Recipients*. Available at: http://www.nsf.gov/statistics/srvydoctoratework/.

NSF (2010b) *Description of Survey of Earned Doctorates*. Available at: http://www.nsf.gov/statistics/srvydoctorates/.

OER (2005) *Sex/gender in the biomedical science workforce*. Available at: http://grants2.nih.gov/grants/policy/sex_gender/q_a.htm#q5.

Pearson, W. (1985). *Black scientists, white society, and colorless science: a study of universalism in American science*. Millwood: Associated Faculty Press.

Penner, A. M. (2008). Gender differences in extreme mathematical achievement: an international perspective on biological and social factors. *American Journal of Sociology, 114*, S138–S170.

Penner, A. M., & Paret, M. (2008). Gender differences in mathematics achievement: exploring the early grades and the extremes. *Social Science Research, 37*, 239–253.

Preston, A. E. (2004). *Leaving science: occupational exit from scientific careers*. New York: Russell Sage Foundation.

Ramsden, P. (1994). Describing and Explaining Research Productivity. *Higher Education, 28*(2), 207–226.

Reskin, B. F. (1978). Scientific productivity, sex, and location in the institution of science. *American Journal of Sociology, 83*, 1235–1243.

Rosser, S. V. (2004a). *The science glass ceiling*. New York: Routledge.

Rosser, V. (2004b). Faculty Members' Intentions to Leave: a National Study on Their Worklife and Satisfaction. *Research in Higher Education, 45*(3), 285.

Rutgers (2001) *A study of gender equity in the faculty of arts and sciences*. Available at: http://fas.rutgers.edu/onlineforms/gender_report.pdf.

Sax, L. J., Hagedorn, L. S., Arredondo, M., & Dicrisi, F. A. (2002). Faculty research productivity: exploring the role of gender and family-related factors. *Research in Higher Education, 43*(4), 423–446.

Simonton, D. K. (1992). Leaders of American Psychology, 1879–1967: career development, creative output, and professional achievement. *Journal of Personality and Social Psychology, 62*(1), 5–17.

Skolnik, M. (2000). Does counting publications provide any useful information about academic performance? *Teacher Education Quarterly, 27*(2), 15–25.

Smeby, J. C., & Try, S. (2005). Departmental contexts and faculty research activity in Norway. *Research in Higher Education, 46*(6), 593–619.

Stack, S. (2004). Gender, children and research productivity. *Research in Higher Education, 45*(8), 891–920.

Steele, C. (1997). A threat in the air. How stereotypes shape intellectual identity and performance. *American Psychology, 52*(6), 613–629.

Steele, C. M. (1999) Thin ice: "stereotype threat" and black college students. *The Atlantic Monthly* 284(2), 44–54.

Trower, C. A., & Bleak, J. L. (2004) *The study of new scholars: tenure-track faculty job satisfaction survey: gender: statistical report [universities]*. Available at: http://www.kuleuven.be/diversiteit/publicaties/Gender-statistical-report.pdf.

Trower, C. A., & Chait, R. P. (2002) *Faculty diversity: too little for too long*. Cambridge, MA.

Umbach, P. (2007). Gender equity in the academic labor market: an analysis of academic disciplines. *Research in Higher Education, 48*(2), 169.

Wai, J., Cacchio, M., Putallaz, M., & Makel, M. C. (2010). Sex differences in the right tail of cognitive abilities: a 30 year examination. *Intelligence, 38*(4), 412.

Wallace, M. L., Larivière, V., & Gringas, Y. (2009). Modeling a century of citation distributions. *Journal of Informetrics, 3*, 296–303.

Wenzel, S. A., & Hollenshead, C. (1998) *Former women faculty: reasons for leaving one research university*. Available at: http://www.cew.umich.edu/sites/default/files/wenzel98.pdf.

Xie, Y., & Shauman, K. A. (1998). Sex differences in research productivity: new evidence about an old puzzle. *American Sociological Review, 63*(6), 847–870.

Zhou, Y., & Volkwein, J. F. (2004). Examining the Influences on Faculty Departure Intentions: a Comparison of Tenured Versus Nontenured Faculty at Research Universities Using NSOPF-99. *Research in Higher Education, 45*(2), 139.

Zuckerman, H. (1996). *Scientific elite: Nobel laureates in the United States*. New Brunswick: Transaction Publishers.

Zuckerman, H., & Merton, R. K. (1973). Institutional patterns of evaluation in science. In N. W. Storer (Ed.), *The Sociology of Science: Theoretical and Empirical Investigations*. Chicago: University of Chicago Press.