OBSERVATION

Males Are Overrepresented among Life Science Researchers Committing Scientific Misconduct

Ferric C. Fang,[a] Joan W. Bennett,[b] Arturo Casadevall[c]

Departments of Laboratory Medicine and Microbiology, University of Washington, School of Medicine, Seattle, Washington, USA[a]; Department of Plant Biology and Pathology, Rutgers University, New Brunswick, New Jersey, USA[b]; Departments of Microbiology & Immunology and Medicine, Albert Einstein College of Medicine, Bronx, New York, USA[c]

ABSTRACT **A review of the United States Office of Research Integrity annual reports identified 228 individuals who have committed misconduct, of which 94% involved fraud. Analysis of the data by career stage and gender revealed that misconduct occurred across the entire career spectrum from trainee to senior scientist and that two-thirds of the individuals found to have committed misconduct were male. This exceeds the overall proportion of males among life science trainees and faculty. These observations underscore the need for additional efforts to understand scientific misconduct and to ensure the responsible conduct of research.**

IMPORTANCE **As many of humanity's greatest problems require scientific solutions, it is critical for the scientific enterprise to function optimally. Misconduct threatens the scientific enterprise by undermining trust in the validity of scientific findings. We have examined specific demographic characteristics of individuals found to have committed research misconduct in the life sciences. Our finding that misconduct occurs across all stages of career development suggests that attention to ethical aspects of the conduct of science should not be limited to those in training. The observation that males are overrepresented among those who commit misconduct implies a gender difference that needs to be better understood in any effort to promote research integrity.**

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Address correspondence to Ferric C. Fang, fcfang@u.washington.edu.

With our colleague Grant Steen, two of us (F.F. and A.C.) recently studied all 2,047 retracted scientific articles indexed by PubMed as of 3 May 2012 (1). Unexpectedly, we found that misconduct is responsible for most retracted articles and that fraud or suspected fraud is the most common form of misconduct. Moreover, the incidence of retractions due to fraud is increasing, a trend that should be concerning to scientists and nonscientists alike. To devise effective strategies to reduce scientific misconduct, it will be essential to understand why scientists commit misconduct. However, deducing the motives for misconduct from the study of retractions alone is difficult, because retraction notices provide limited information, and many instances of misconduct do not result in retracted publications.

We therefore undertook an alternative approach by reviewing the findings of misconduct summarized in the annual reports of the U.S. Office of Research Integrity (ORI) (http://ori.hhs.gov/about-ori). The ORI is responsible for promoting the responsible conduct of research and overseeing the investigation of misconduct allegations relating to research supported by the Department of Health and Human Services. From 1994 to the present, the annual reports detail 228 individuals found by the ORI to have committed misconduct (2, 3). Fraud was involved in 215 (94%) of these cases. The total number of ORI investigations performed over this period is not known. However, data from the first ten years indicate that approximately one-half of ORI investigations conclude with a finding of misconduct (3). Although we expected most cases of misconduct to involve research trainees, we found that only 40% of instances of misconduct were attributed to a postdoctoral fellow (25%) or student (16%). Faculty members (32%) and other research personnel (28%) were responsible for the remaining instances of misconduct, and these included both junior and senior faculty members, research scientists, technicians, study coordinators, and interviewers.

We were able to determine the gender of the individual committing misconduct in all but a single case, and 149 (65%) were male. However, the gender predominance varied according to academic rank. An overwhelming 88% of faculty members committing misconduct were male, compared with 69% of postdocs, 58% of students, and 42% of other research personnel (Fig. 1). The male-female distribution of postdocs and students corresponds with the gender distribution of postdocs and students in science and engineering fields (4). However, nearly all instances of misconduct investigated by the ORI involved research in the life sciences, and the proportion of male trainees among those committing misconduct was greater than would be predicted from the gender distribution of life sciences trainees. Males also were substantially overrepresented among faculty committing misconduct in comparison to their proportion among science and engineering faculty overall, and the difference is even more pronounced for faculty in the life sciences (5). Of the 72 faculty members found to

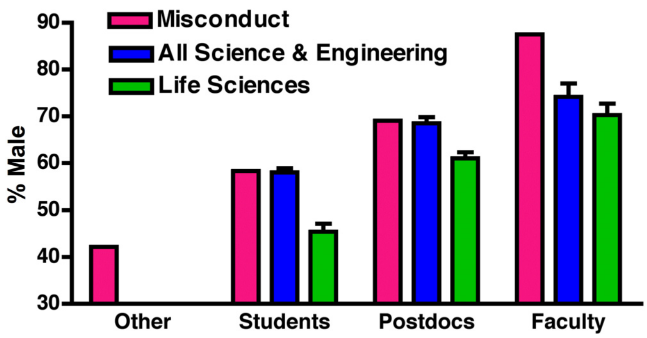

FIG 1 Gender distribution of scientists committing misconduct. The percentage of scientists sanctioned by the U.S. Office of Research Integrity who are male, stratified by rank, is compared with the percentage of males in the overall United States scientific workforce (error bars show standard deviations) (blue and green bars are from NSF data, 1999–2006 [4, 5]).

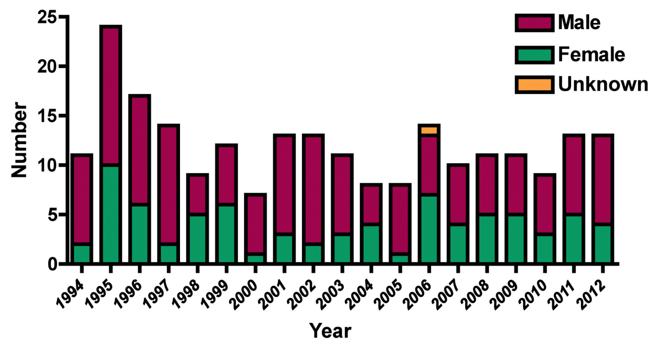

FIG 2 Gender distribution of scientists committing misconduct over time. The percentage of scientists sanctioned by the U.S. Office of Research Integrity who are male, female, or of unknown gender are shown for each reporting year. For the gender ratio in 1994–2002 ($n = 120$) compared with 2003–2012 ($n = 108$), $\chi^2 = 1.405$ and $P = 0.24$ (calculated using the online tool at http://www.quantpsy.org/chisq/chisq.htm).

have committed misconduct, only 9 were female, or one-third of the number that would have been predicted from their overall representation among life sciences faculty. We cannot exclude the possibility that females commit research misconduct as frequently as males but are less likely to be detected.

What motivates individuals to commit research misconduct? Does competition for prestige and resources disproportionately drive misconduct among male scientists? Are women more sensitive to the threat of sanctions? Is gender a correlate of integrity?

The disparity between the number of men and women in academic science fields has been considered to be evidence of biologically driven gender differences (6). Thus, it may be tempting to explain the preponderance of male fraud in terms of various evolutionary theories about Y chromosome-driven competitiveness and aggressiveness (7). For example, for more than a century the male baboon has been used to symbolize male aggression. However, stereotypes of male baboon aggression and dominance have been called into question by primatologists focusing on female social networks and competitive strategies (8). Deterministic theories based in biology have been facilely used to explain the persistent gender gap in wages and other measures in the labor market (discussed in reference 9). The pitfalls associated with such simplistic generalizations have been extensively dissected by scholars of gender in science (see, for example, references 10 and 11 and citations therein). While not excluding a role for biological factors, recent studies suggest an important contribution of social and cultural influences in the competitive tendencies of males and females (12).

Nevertheless, it is generally known that men are more likely to engage in risky behaviors than women (13) and that crime rates for men are higher than those for women. Sociologists have hypothesized that as the roles of men and women become more similar, so will their crime rates (14). There is evidence for this "convergence hypothesis" in terms of arrests for robbery, burglary, and motor vehicle theft but not for homicide (15). Similarly, while most studies show that male students cheat more frequently than female students, recent data suggest that within similar areas of study, the gender differences are small. Women majoring in engineering self-report cheating at rates comparable to those reported by men majoring in engineering (16). We did not observe a significant convergence in scientific misconduct by males and females reported by the ORI over time (Fig. 2), although the analysis was limited by the small sample size. Interestingly, we also failed to observe an overall increase in research misconduct in the ORI findings, in contrast to an increase in retractions for fraud observed in our earlier study (1), with the caveat that the present study focused on a much smaller and incompletely overlapping subset of cases.

The predominant economic system in science is "winner-take-all" (17, 18). Such a reward system has the benefit of promoting competition and the open communication of new discoveries but has many perverse effects on the scientific enterprise (19). The scientific misconduct among both male and female scientists observed in this study may well reflect a darker side of competition in science. That said, the preponderance of males committing research misconduct raises a number of interesting questions. The overrepresentation of males among scientists committing misconduct is evident, even against the backdrop of male overrepresentation among scientists, a disparity more pronounced at the highest academic ranks, a parallel with the so-called "leaky pipeline." There are multiple factors contributing to the latter, and considerable attention has been paid to factors such as the unique challenges facing young female scientists balancing personal and career interests (20), as well as bias in hiring decisions by senior scientists, who are mostly male (21). It is quite possible that, in at least some cases, misconduct at high levels may contribute to attrition of woman from the senior ranks of academic researchers.

Our observations also raise the question of whether current efforts at ethics training are targeting the right individuals. The NIH currently mandates training in the responsible conduct of research for students and postdocs receiving support from training grants. However, these groups were responsible for only 40% of the misconduct documented in the ORI reports. The psychiatrist Donald Kornfeld has analyzed a subset of the ORI data (22) and observed "an intense fear of failure" in many trainees who committed misconduct, while some faculty members seemed to possess a "conviction that they could avoid detection." This suggests that efforts to improve ethical conduct may also need to target faculty scientists, who in some cases are directly responsible for misconduct and in others may be unintentionally fostering a research environment in which trainees and other research personnel feel pressured to tailor results to meet expectations. Programs to help scientists become more effective mentors should be more widely implemented (23). The male predominance among senior scientists who commit misconduct also suggests that social expectations associated with gender may play a role in the likelihood of committing fraud and that the impact of culture and gender should be considered in ethics training. Curricula should become more sensitive to the heterogeneity of the target population because "one size does not fit all."

The role of external influences on the scientific enterprise must not be ignored. With funding success rates at historically low levels, scientists are under enormous pressure to produce high-impact publications and obtain research grants. The importance of these influences is reflected in the burgeoning literature on research misconduct, including surveys that suggest that approximately 2% of scientists admit to having fabricated, falsified, or inappropriately modified results at least once (24). A substantial proportion of instances of faculty misconduct involve misrepresentation of data in publications (61%) and grant applications (72%); only 3% of faculty misconduct involved neither publications nor grant applications.

In summary, we emphasize two observations from this study: first, misconduct is distributed along the continuum from trainee to senior scientist. Second, men are overrepresented among scientists committing misconduct, with a skewed gender ratio being most pronounced for senior scientists. While we acknowledge that our observations were made from a relatively small database that focuses exclusively on research supported by the U.S. Department of Health and Human Services, we note that each case was extensively documented, and this case series may represent the most reliable information currently available. From our findings, new challenges are directed to the scientific community to maintain the integrity of the scientific enterprise. The occurrence of misconduct at every level of the scientific hierarchy indicates that misconduct is not a problem limited to trainees and requires careful attention to pressures placed on scientists during different stages of their careers. Male predominance is but another example of the scientific enterprise reflecting social and cultural contexts.

In closing, the vital importance of the ORI is acknowledged. Without public access to their investigations, it would have been impossible to carry out this study. All countries should have independent agencies with the authority and resources to ensure proper conduct of scientific research. Although our findings may cause concern regarding the scientific enterprise, recognition is a first step toward solving a problem. With so many of the world's current challenges dependent on scientific solutions, science must look for new ways to ensure the responsible conduct of scientific research (25).

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