Is there gender bias in HIV cure research? A case study of female representation at the 2015 HIV Persistence Workshop

Rowena Johnston[1]*, Suteeraporn Pinyakorn[2,3] and Jintanat Ananworanich[2,3]

[1] amfAR, New York, USA
[2] U.S. Military HIV Research Program, Walter Reed Army Institute of Research, Silver Spring, MD, USA
[3] Henry M Jackson Foundation for the Advancement of Military Medicine, Bethesda, MD, USA

Introduction

According to the United States National Science Foundation 2015 report on women, minorities and persons with disabilities in science and engineering [1], 56.5% of college enrollees are women. Of the roughly 2.3 million freshmen who intend to major in biological and agricultural science, 63.2% are female. About 48% of people employed in life sciences are female. Of these 53.1% have doctoral degrees and 63% are technologists and technicians. Fewer than 25% of full professors are female. Of academic institution faculty, 47% of males have federal support, while 40% of women receive such support. The gender gap in science, technology, engineering and maths (STEM) participation is wider in almost every other region of the world [2]..

Several factors have been proposed to contribute to the progressively smaller female representation in positions of increasing seniority and success in STEM disciplines. Both male and female scientists cite historical bias in training of, and degrees awarded to, male scientists as explanations for the unequal participation of women in physics and biology, but men almost never cite present-day discrimination as a contributory factor [3]. Indeed, only in the last decade or so have doctoral degrees awarded to women reached parity with those awarded to men [4].

Yet, female scientists continue to encounter manifestations of sexism, defined by the online Merriam-Webster dictionary as: '1: prejudice or discrimination based on sex; especially: discrimination against women, 2: behavior, conditions, or attitudes that foster stereotypes of social roles based on sex' [5], at all stages of their careers. A recent study [6] analysed the performance, outspokenness, and perceived subject mastery of undergraduates in an introductory biology course. Teachers rated the males as more outspoken. When students were asked to nominate which of their peers seemed to have mastered the subject matter best, males received more nominations than females, independent of their actual performance on exams. The bias was stronger among males – for a male to nominate a female versus a male, her grade point average (GPA) needed to be 0.765 higher than the male nominee's. Females nominated females and males at the same rate per GPA. The three to four most-nominated students in each of the three classes that were studied were male, despite the most-nominated females having better grades than some of the most-nominated males.

Across 18 academic fields, the terms 'brilliant' and 'genius' were disproportionately used by students to describe male rather than female instructors [7]. Faculty also rate male students more favourably than female students. Identical science laboratory manager job application materials were sent to biology, chemistry and physics professors. Materials were assigned either a male or female applicant name. Male and female faculty, regardless of their field, age or tenure status, viewed the female applicant as less competent than the (identical) male applicant, and offered her a significantly lower salary and less career mentoring [8].

*Corresponding author: Rowena Johnston, amfAR 120 Wall Street, 13th Floor, New York, NY 10005-3908, USA
Email: rowena.johnston@amfar.org

Despite an increase in the proportion of biology or life sciences degrees awarded to women [1,4], proportionately fewer academic positions are held by or offered to women. An older study indicated a bias by both male and female faculty to hire a male job applicant into an academic department over an identical female, and to judge the male applicant's job experience as more satisfactory [9]. By contrast, a more recent study found evidence of bias towards women, where male and female biology faculty voted about 2:1 in favour of hiring a female over an identical male applicant [10]. A recent news feature article in *Nature* cites data that although 45% of PhDs in biology were earned by women between 1999 and 2003, only 26% of applicants for academic jobs were female. Those who did apply, however, were more likely to receive interviews and to be the first to be offered the job than men, and were more successful in tenure applications than men [11].

Although the pay gap between men and women is closing, female biologist salaries were only 77% of those of male biologists in 2008. In 2012, only 30% of NIH grants went to women, and the size of each grant was only 83% of those of men [11]. One important potential boost to early science careers, the NIH Director's Early Independence Award, for which host institutions nominate applicants, was awarded to proportionally (relative to applicants) twice as many males as females in 2015 [12]. Women publish fewer papers than men, and are under-represented in the prestige positions of first and last author. A recent analysis of scholarly articles spanning the sciences and humanities revealed that only one-in-five authors is female. Women represent almost 30% of authors in molecular and cell biology but are under-represented in the last author position, at approximately 15% [13]. Start-up support is significantly lower for female than male PhD basic scientists, where males received more than twice the funding for salary and other support, research technicians, equipment and supplies – a disparity not explained by years of experience or level of NIH support to the host institution [14]. Female physicians with faculty appointments also experience unequal career advancement: when adjusted for years since residency, scientific authorship, NIH funding and clinical trial participation, women are less likely to be full professors [15]. Perhaps not surprisingly, women are less satisfied with their careers as scientists than are men [16].

By analysing attendance at the most recent HIV cure-specific conference (the Seventh International Workshop on HIV Persistence During Therapy) and authorship of presented abstracts, we sought to determine whether there was evidence of gender bias in the selection, and type, of abstracts accepted by the conference.

Methods

HIV Persistence During Therapy conference

The Seventh International Workshop on HIV Persistence During Therapy took place in Miami December 8–11, 2015. According to the workshop's website [17], it was designed to interest physicians, clinicians, scientists and clinical researchers in the HIV persistence and latency arena. All attendees, whether submitting an abstract or not, were required to submit an application for

review and approval by abstract reviewers and/or the conference steering committee. More than 140 abstracts were submitted and reviewed by 25 reviewers, with at least four reviewers per abstract. Selected abstracts were published as a supplement to the *Journal of Virus Eradication* issue 1.4 (www.viruseradication.com). Presentations at the conference were in the form of general overview of a topic (invited oral presentation), oral presentations and poster presentations.

Information concerning the number of attendees and fraction of whom were women was obtained from the conference organisers. Details of overview, oral and poster presentations, authors, and affiliations were extracted from the published abstracts. Information concerning abstracts that were submitted but not selected, or for attendance applications that were not accepted, was not available. Sex and country of affiliation was noted for each author, and the sex of the first author of each abstract was noted.

Sex and country affiliation determinations

Perceived sex, referred to here as variable 'sex', was noted for each abstract author as either male or female. Sex determinations were made on the basis of study authors' familiarity with the abstract author or by internet search. In internet searches, photos of the abstract author were sought, where possible confirmed by mention of affiliation or co-authors, and a sex determination was made visually; or biographical documents were searched and scanned for mentions of 'he' or 'she', again where possible confirmed by mention of affiliation or co-authors. We are aware that potential errors inherent in this methodology may have led to misattribution of sex in some cases. In cases where sex appeared unclear, two or more study authors reached consensus or sex was marked as unknown and that abstract author was omitted from analyses, as noted below. Country affiliation was attributed as noted in the published abstract. In some cases the abstract noted only one affiliation for all authors, in which case that country was attributed to all authors on the abstract.

Descriptive and statistical analyses

Analyses of the sex and country affiliation of the steering committee, scientific committee, attendees and authors were conducted. Authorship analyses included: any-authorship; first-authorship of overview, oral and poster abstracts; any-authorship of oral versus poster abstracts; authorship of multiple abstracts; authorship of multiple oral versus poster abstracts; and authorship when only one abstract was selected. We assumed the number of abstracts for each author follows the Poisson distribution. Rate ratios and 95% confidence intervals (CI) were obtained by Poisson regression model to compare first authorship rates among female versus male for each type of abstract. Chi-squared test for trend was used to assess whether the proportion of female authorship decreased with more prestigious presentations (where invited overview presentations were considered more prestigious than an oral presentation, which in turn were more prestigious than a poster presentation). We tested whether the proportion of female authorship deviated from 0.5, indicating equality between male and female, by binomial probability test. All analyses were performed using Stata Statistical Software Release 13 (StataCorp, College Station, TX, USA). Significance was set at alpha equal to 0.05 and all *P* values are two-sided.

Results

Overview

The workshop steering and scientific committees ('conference directorship') consisted of 36 males and seven females. There were 259 workshop attendees, of whom 152 (59%) were male and 107 (41%) were female (P=0.006). Of 720 unique abstract authors, 701 were of known sex, of whom 294 (42%) were female. The conference directorship had significantly lower female representation than either attendees (P=0.005) or abstract authors (P=0.003). The 407 male authors had 554 abstracts, averaging 1.36 each, whereas the 294 female authors had 380 abstracts, averaging 1.29 each (P=0.42). Abstract authors noted affiliations in 21 countries, with 56.3% of all authors from the US. Female representation from each country ranged from 0 to 67% (Figure 1).

Authorship of overview *vs* oral *vs* poster presentations

The conference consisted of three types of presentations: overview presentations to orient the audience to a session theme, oral presentations and poster presentations. There were nine overview presentations, of which two (22.2%) were delivered by females. Of 53 oral presentations, 21 (39.6%) were first-authored by females. Of 75 poster presentations, 73 were first-authored by

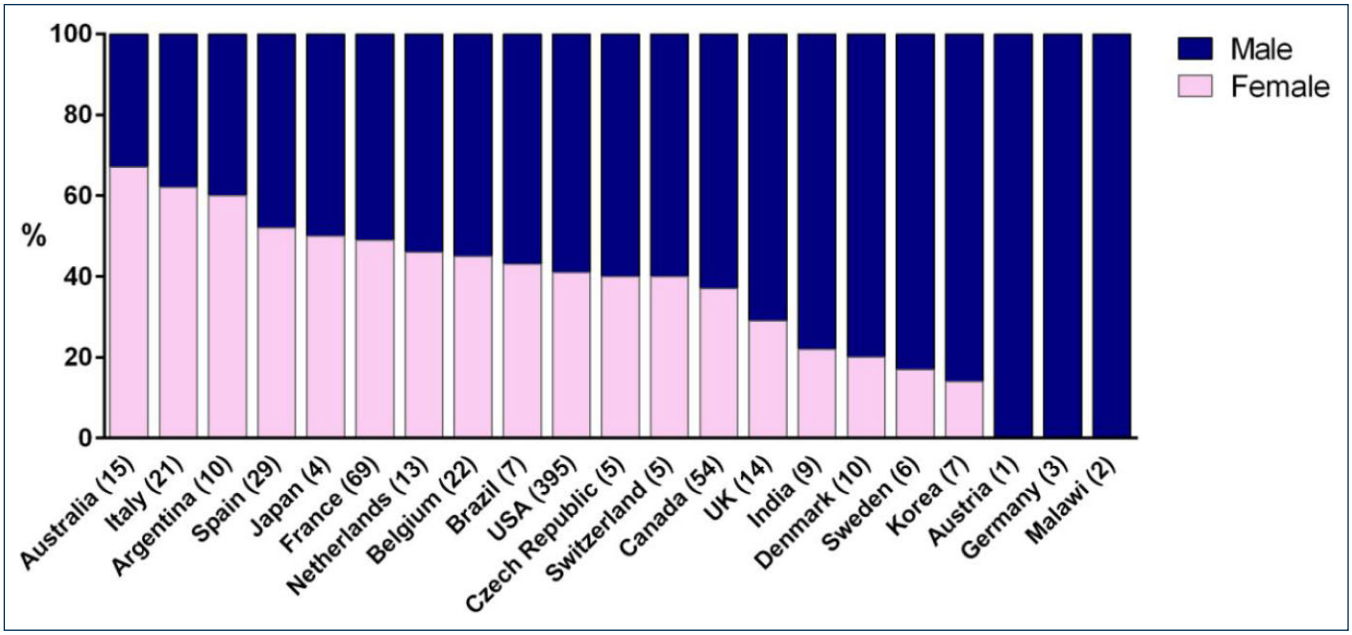

Figure 1. Percentage of male and female authors from each of 21 countries represented at the workshop. Numbers in parentheses indicate total number of authors from each country

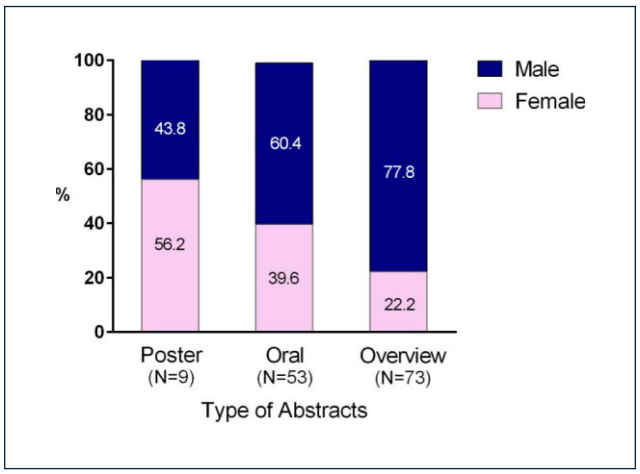

Figure 2. The percentage of male *vs* female first-author presenters of each of the three types of presentations

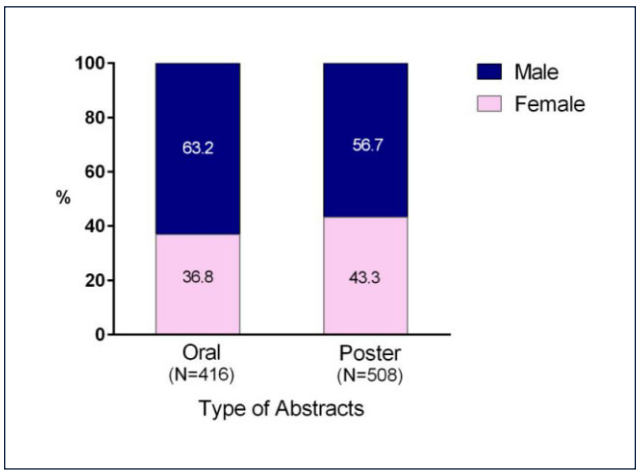

Figure 3. Percentage of total oral and poster authors who were male *vs* female

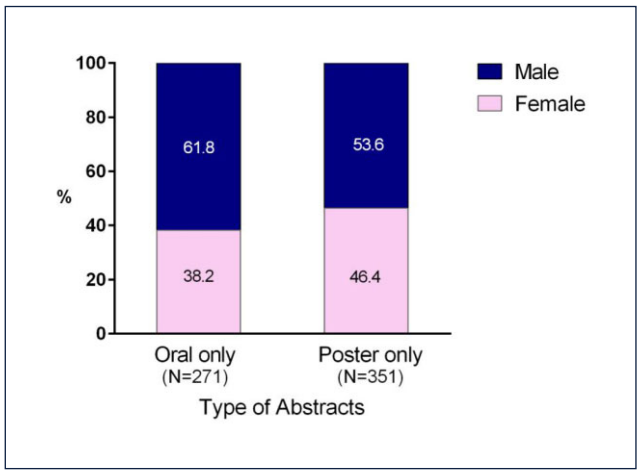

Figure 4. Of authors whose only accepted abstracts were oral or poster, percentage who were female *vs* male

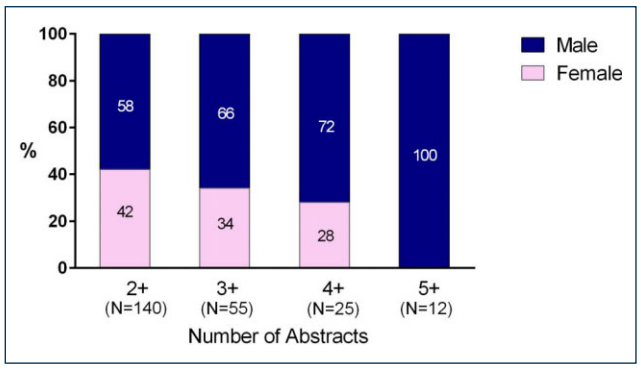

Figure 5. The percentage of authors with two or more, three or more, four or more, or five or more total abstracts who were male *vs* female. Note: Authors in higher categories (e.g. 5+) are also represented in lower categories (e.g. 4+ etc.)

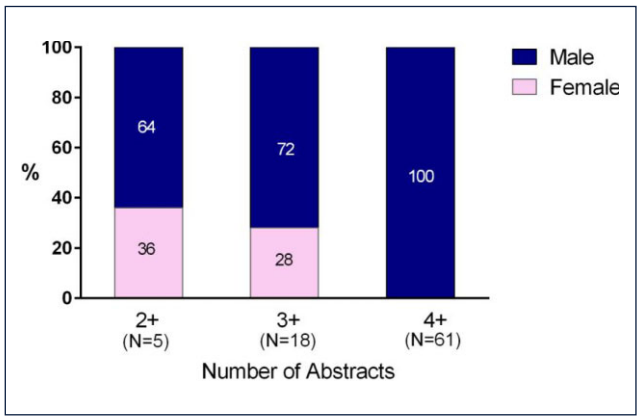

Figure 6. The percentage of authors with two or more, three or more, or four or more oral abstracts who were male *vs* female. Note: Authors in higher categories (e.g. 4+) are also represented in lower categories (e.g. 3+ etc.)

authors of known sex, of whom 41 (56.2%) were female (Figure 2). A chi-squared test for trend indicated that higher-prestige presentations were less likely to be presented by females (P=0.02).

Each overview presentation had one author. There were 416 oral abstract authors of known sex, and each oral abstract averaged 8 authors, of whom 153 (36.8%) were female. There were 508 poster abstract authors of known sex, and each poster abstract averaged 6.9 authors, of whom 220 (43.3%) were female. A significantly greater proportion of poster compared to oral presentation authors were female (P=0.003, Figure 3).

Six hundred and twenty-two authors of known sex had only *one type* (either oral or poster) of abstract accepted. Two hundred and seventy-one authors had only oral abstracts (one or more) accepted, of whom 103 (38%) were female, while 351 authors had only poster abstracts (one or more) accepted, of whom 163 (46.4%) were female (P=0.002, Figure 4).

One oral and one poster abstract were withdrawn and no data were available on these.

Authors with more than one abstract

One hundred and forty authors of known sex had more than one accepted abstract. Of the twelve authors with five or more abstracts, none were female (P≤0.001, Figure 5).

Considering authors with multiple *oral* abstracts, five authors had four or more oral abstracts, of whom none were female, although this difference did not quite reach statistical significance (P=0.06, Figure 6).

Authors with one abstract

Five hundred and sixty-one authors of known sex had one abstract, of whom 235 (41.9%) were female. Of the 239 authors whose single abstract was oral, 90 (37.7%) were female, whereas for the 322 authors whose single abstract was poster, 145 (45%) were female, a difference that did not quite reach statistical significance (P=0.08).

Discussion

We observed that female authors were proportionately less likely to hold more prestigious roles (e.g. presenting author) at the conference. The directorship of the conference had a significantly lower female representation than among attendees or authors. Females were less likely to give oral or overview presentations. Although we have no privileged insight into the thinking behind the conference planning, it seems possible that the directorship made a proactive effort to ensure higher representation of females than among their own ranks. The authors also represented a wide range of countries, again suggesting that the directorship was interested in promoting diversity. These findings suggest that sexism was none the less apparent.

According to the authors of a recent study, male scientists may be less likely than female scientists to perceive sexism or to value efforts to change it [18]. In a series of three experiments, researchers asked the general public, and faculty from non-STEM or STEM fields, to read an academic abstract describing sexism in STEM research. The research was evaluated less favourably by male than female participants from the general population. However, while there was no sex difference in evaluations by non-STEM male and female faculty, male STEM faculty evaluated the research more negatively than female STEM faculty, and the effect size was larger than among the general population. To evaluate whether male STEM faculty were antipathic towards gender bias research in general, the abstract was altered slightly to report no gender bias. Under these conditions, male STEM faculty evaluated the research more positively than did female STEM faculty. The study authors suggest that because STEM fields are male-dominated, broadening female participation will be especially challenging.

It is important to distinguish between the impact of sexism versus intent. Although we do not have access to data to support our view, we do not believe that the conference planners intended to have fewer females in prestigious presentation roles. There is ample recent research demonstrating that men and women can be exposed to beliefs throughout their lifetime that are internalised and that manifest later as poorer performance by women in traditionally male-dominated fields, or the expectation that women will perform more poorly [19,20]. Alternatively, there may be no bias against women if other factors are controlled for. Ceci and Williams [21] suggest that when resources are comparable between men and women, there is no sex discrimination in publishing, but they acknowledge that resources are not in fact comparable between the sexes.

The female participation and authorship at this conference were both around 42%. It is difficult to know how this rate compares to the HIV field in general, but at the opening session of the 2016 Conference on Retroviruses and Opportunistic Infections, it was announced that 47% of attendees were female [22], suggesting that the cure field, at least as represented at this persistence conference, may be slightly more male-dominated than HIV in general. We also had no access to data concerning rejected abstract submissions and thus cannot draw conclusions in terms of potential gender biases regarding rejections. We analysed data from only one conference that was held in the USA and female representation in other meetings, particularly those held elsewhere, may be different.

Although there may have been conscious or unconscious bias at the abstract review level, it appears more likely that some constellation of the factors discussed here – an early internalisation of stereotyped gender roles by both sexes, the preferential encouragement of males in STEM fields by male and female peers and teachers, the disproportionate hiring and early career support of males, the higher level of grant support awarded to males resulting in the potential for higher impact research, and the historical bias towards males in STEM fields resulting in males holding more senior positions – contributed to the sex differences in authorship prestige observed in this study. We encourage conference organisers of HIV cure-related conferences to be cognisant of the broader influence their decisions may have regarding the allocation of higher prestige oral presentation slots.

Acknowledgements

We thank Ms Oratai Butterworth for her help in preparing this manuscript.

Disclaimer

The views expressed are those of the authors and should not be construed to represent the positions of the US Army or the Department of Defense

References

1. National Science Foundation. *Women, minorities and person with disabilities in science and engineering*. 2015. Available at: www.nsf.gov/statistics/2015/nsf15311/start.cfm (accessed February 2016).
2. Andres JTH. *Overcoming gender barriers in science: facts and figures*. 2011. Available at: http://www.scidev.net/global/education/feature/overcoming-gender-barriers-in-science-facts-and-figures-1.html (accessed March 2016).
3. Ecklund HE, Lincoln EA, Tansey C. Gender segregation in elite academic science. *Gender & Society* 2012; **26**: 693–717.
4. Burrelli J. *Thirty-three years of women in S&E faculty positions*. 2008. Available at: www.nsf.gov/statistics/infbrief/nsf08308/ (accessed February 2016).
5. Merriam-webster. *Definition of sexism*. Available at: www.merriam-webster.com/dictionary/sexism (accessed February 2016).
6. Grunspan DZ, Eddy SL, Brownell SE *et al*. Males under-estimate academic performance of their female peers in undergraduate biology classrooms. *PLoS One* 2016; **11**: e0148405.
7. Storage D, Horne Z, Cimpian A, Leslie SJ. The frequency of "Brilliant" and "Genius" in teaching evaluations predicts the representation of women and African Americans across fields. *PLoS ONE* 2016; **11**: e0150194.
8. Moss-Racusin CA, Dovidio JF, Brescoll VL *et al*. Science faculty's subtle gender biases favor male students. *Proc Natl Acad Sci U S A* 2012; **109**: 16474–16479.
9. Steinpreis ER, Anders AK, Ritzke D. The impact of gender on the review of the curricula vitae of job applicants and tenure candidates: a national empirical study. *Sex Roles* 1999; **41**: 509–528.
10. Williams WM, Ceci SJ. National hiring experiments reveal 2:1 faculty preference for women on STEM tenure track. *Proc Natl Acad Sci U S A* 2015; **112**: 5360–5365.
11. Shen H. Inequality quantified: mind the gender gap. *Nature* 2013; **495**: 22–24.
12. Nature.com. *Funding: gender grant disparity*. 2016. Available at: www.nature.com/naturejobs/science/articles/10.1038/nj7590–373c (accessed February 2016).
13. West JD, Jacquet J, King MM *et al*. The role of gender in scholarly authorship. *PLoS One* 2013; **8**: e66212.
14. Sege R, Nykiel-Bub L, Selk S. Sex Differences in Institutional Support for Junior Biomedical Researchers. *JAMA* 2015; **314**: 1175–1177.
15. Jena AB, Khullar D, Ho O *et al*. Sex differences in academic rank in US medical schools in 2014. *JAMA* 2015; **314**: 1149–1158.
16. Holden C. General contentment masks gender gap in first AAAS salary and job survey. *Science* 2001; **294**: 396–411.
17. hiv-persistence.com. *8th Edition HIV Persistence During Therapy, Reservoirs & Eradication Strategies Workshop*. Available at: www.hiv-persistence.com/ (accessed February 2016).
18. Handley IM, Brown ER, Moss-Racusin CA, Smith JL. Quality of evidence revealing subtle gender biases in science is in the eye of the beholder. *Proc Natl Acad Sci U S A* 2015; **112**: 13201–13206.
19. Tiedemann J. *Gender-related beliefs of teachers in elementary school mathematics*. 2005. Available at: http://link.springer.com/article/10.1023/A:1003953801526 (accessed February 2016).
20. Dar-Nimrod I, Heine SJ. Exposure to scientific theories affects women's math performance. *Science* 2006; **314**: 435.
21. Ceci SJ, Williams WM. Understanding current causes of women's underrepresentation in science. *Proc Natl Acad Sci U S A* 2011; **108**: 3157–3162.
22. Conference on Retroviruses and Opportunistic Infections. *Webcasts* 2016. Available at: http://www.croiwebcasts.org/ (accessed February 2016).