Invited paper

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The Global Survey of Scientists: encountering sexual harassment

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Abstract: We describe our work on The Global Survey of Scientists and examine men's and women's experiences with sexual harassment. We use multivariate models in our analyses to account for possible confounding variables. Our model accounts for gender, discipline, age, employment sector, geographic region, and level of human development. Taking all these factors into consideration, we find that women are 14.4 times more likely than men to indicate having personally encountered sexual harassment at school or work. We take a closer look at potential differences in discipline, employment sector, geographic region, and level of development.

Keywords: Gender differences; gender gap; global; harassment; science; STEM.

The Global Survey of Mathematical, Natural, and Computing Sciences

Background

The International Science Council (ISC) funded the Gender Gap in Science project to examine persistent barriers to achievement by women in science. The project, "A Global Approach to the Gender Gap in Mathematical, Computing, and Natural Sciences: How to Measure It, How to Reduce It?" sought to produce sound data to support choosing among possible interventions to increase the participation of women in science [1]. Project partners included the International Mathematical Union, the International Union of Pure and Applied Chemistry, the International Union of Pure and Applied Physics, the International Union of History and Philosophy of Science and Technology, the International Astronomical Union, the International Union of Biological Sciences, the International Council for Industrial and Applied Mathematics, the Association of Computing Machinery, UNESCO's STEM and Gender Advancement (SAGA), Gender in Science, Innovation, Technology and Engineering (GenderInSITE), and the Organization of Women in Science for the Developing World (OWSD).

Developing the questionnaire

The 2018 Global Survey of Mathematical, Natural, and Computing Scientists seeks to develop a broader picture of the status of mathematicians and scientists across the world. The survey instrument was developed by the project leaders in collaboration with the American Institute of Physics (AIP). Various questions address specific developmental periods in the education and careers of scientists. The UNESCO Institute for Statistics

Article note: A collection of invited papers on the gender gap in science.

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reports that women constitute less than 30 % of scientific researchers worldwide, despite women accounting for 50 % of the global population. To understand representation of women in STEM fields, it is important to look at three life phases: 1) childhood, 2) early adulthood, and 3) professional life. The Global Survey takes these phases into account by assessing how scientists perceive their early years, university studies, doctoral studies, and careers. The scientific fields included represent the project partners: mathematics, mathematics—applied, chemistry, physics, astronomy, computing, biological sciences, and the history and philosophy of science and technology.

At AIP, we created a draft survey to present at regional meetings held in Colombia, Taiwan, and South Africa. Representatives in these meetings reviewed and provided feedback on the initial draft, including 1) Reviewing specific questions to collect feedback on regional implications of wording and topics, 2) Input on the full survey instrument with special consideration to ensure that the questions work for the region and for all disciplines, and 3) Outline of the distribution plan. Feedback and comments from each of the meetings was recorded, compiled, and reviewed to edit and update the questionnaire.

Translating the questionnaire

After finalizing the questionnaire, we sent it to a company that specializes in translating questionnaires. The questionnaire was translated into Spanish, Russian, French, Chinese, Japanese, and Arabic. We selected the languages based on input from the participants at the workshops, recommendations from the UN, and on the languages used for the Global Survey of Physicists, which was conducted by the International Union of Pure and Applied Physics in 2009. The professional translations were reviewed by project participants to ensure that the translations met the needs of scientists.

Distributing the questionnaire

Because there is not a single network or resource available to contact all students and professional scientists globally, we used snowball sampling to take advantage of as many personal networks as possible. We started by sending the survey invitation to partnering organizations' contact databases. The invitation encouraged recipients to forward it to colleagues, and there were also forwarding instructions on the questionnaire itself.

Snowball sampling is a non-probability method for data collection and does not result in a statistically representative sample. Because of this, there are important limitations of analysis and interpretation for the data collected by the survey. The findings presented in this report should not be assumed to be representative of the intended population as a whole. Therefore, the findings below only indicate trends for the individuals who responded to the survey, not the overall population.

The questionnaire is available online at https://statisticalresearchcenter.aip.org/global18.

The respondents

There were 32 346 respondents to the first question, which asked respondents if they had studied or worked in mathematical, computing or natural sciences, or in the history and philosophy of science and technology. The number of responses to subsequent questions will vary based on skip patterns in the questionnaire and respondent participation. We collected data from 159 unique countries, although the number of respondents from each varies (Fig. 1). Many countries did not have enough respondents to analyze respondents on a country-by-country level, while still maintaining respondent confidentiality. Therefore, we grouped respondents into 12 geographical regions: Africa, Northern America, Caribbean/Central America, South America, Western Asia, Central and Southern Asia, East and South East Asia, Northern Europe, Western Europe, Eastern Europe, Southern Europe, and Oceania. Respondents to this survey came from many different employment sectors: academia (college/university), industry, primary/secondary schools, government,

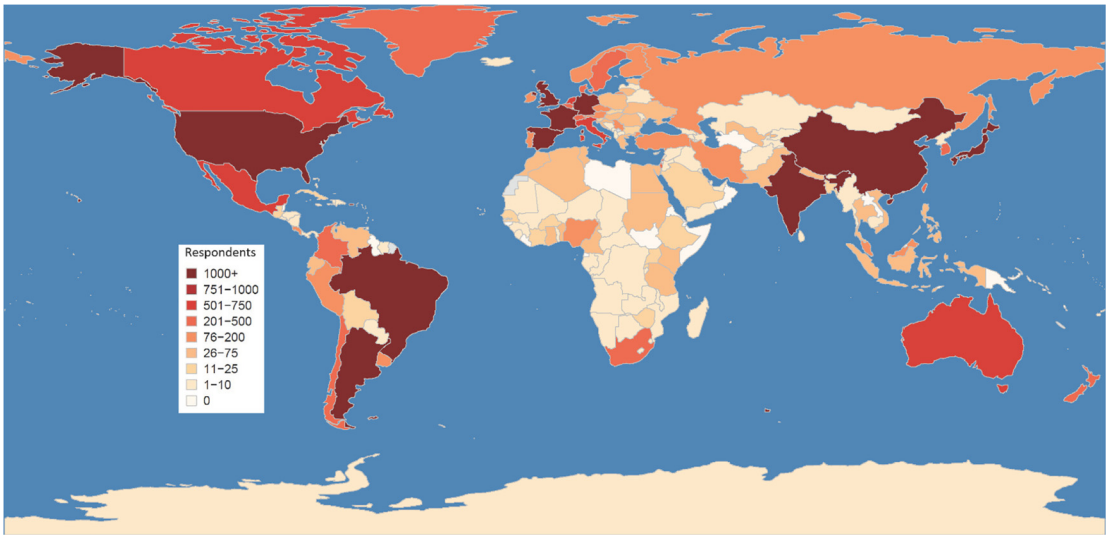

Fig. 1: Number of respondents by country.

non-governmental organizations (NGOs), and self-employed. Although students responded to the survey, the analyses in this paper focus on employed scientists.

Women and men are almost equally represented in the overall data set. The proportion of women among respondents by discipline is provided in Table 1. Three hundred and eighty respondents preferred not to respond to the question querying their gender, and, therefore, are not included in these analyses, which focus on differences in experiences between women and men. The project and the authors recognize that gender is not limited to binary man/woman. However, the project made the decision to ask binary gender to protect respondents in countries that may go so far as to severely sanction gender expressions and identities other than binary.

Table 1: Respondents by discipline and gender.

Discipline	% Women	N
Astronomy	48	2597
Biology	69	2960
Chemistry	51	2698
Computer Science	55	3150
History and Philosophy of Science	46	324
Mathematics	43	3458
Mathematics – Applied	54	2146
Physics	37	7570
OVERALL	50	[a]

[a]The grand total does not match the number of respondents to q1 because (1) there are other disciplines, and (2) not every respondent provided their gender.

Encountering sexual harassment

In a 2018 report, the National Academies (US) state that "sexual harassment is a serious issue for women at all levels in academic science, engineering, and medicine, and that these fields share characteristics that create

conditions that make harassment more likely to occur [2].” Rosser finds that even women who participate in programs targeted to improve the situation for women in STEM experienced no reduction in incidents of sexual harassment over a 12–15 year period [3]. A recent publication examines the longitudinal effects of sexual harassment on academic advancement and productivity among women. The authors find “contrary to our hypothesis, women reporting severe workplace harassment in 1995 were more rather than less likely to advance to full professor [4].” These findings were inconsistent with previous research; however, the authors believe that their longitudinal findings may more accurately reflect that the women persisted *despite* harassment. They state that this is “an unacceptable but too often required situation for women in the workplace.” Undergraduate women in STEM also face sexual harassment. Leaper and Starr report that 78 % of undergraduate women enrolled in a gateway biology course for majors experienced sexual harassment [5].

To examine respondents’ experiences with sexual harassment, we asked a question: *Have you ever encountered sexual harassment at school or work?* We compare the respondents who replied “yes, it happened to me” with those who did not reply that “it happened to me.” We first ran a logistic regression model with all respondents:

It did/not happen to me = f (gender, age, discipline, employment sector, geographic region, Human Development Index)

Results from this model allow us to compare the experiences of men and women while accounting for age, discipline, employment sector, geographic region, and level of human development as measured by the Human Development Index (HDI) [6]. The results indicate that women in this study are 14.4 (or 1440 %) times more likely to indicate having personally experienced sexual harassment at school or work than men are. Men can and do experience sexual and gender-based harassment, but the research literature shows that women are more likely than men to encounter these problems [2]. In this respect, our results are consistent with the literature.

Encountering sexual harassment by employment sector

Since most of the research reports on academic experiences, we first examined the experience of women in different employment sectors separately using six different logistic regression models, one for each employment sector. We used the same model from our prior regression but excluded employment sector since the data were now divided into six different data sets, one for each employment sector.

The results are shown graphically in Fig. 2. In short, women in every employment sector were more likely to indicate having personally experienced sexual harassment at school or work than men. Given the standard error in the estimates, we can say there is no employment sector in which the likelihood of encountering sexual harassment is lower for women than any other employment sector. For the respondents in this study, the experiences of women in academia facing sexual harassment do not differ from women in other employment sectors.

Encountering sexual harassment by discipline

We then examined the experience of women in each discipline separately using eight different logistic regression models, one for each discipline. The results are shown graphically in Fig. 3. In short, women in every discipline were more likely to indicate having personally experienced sexual harassment at school or work than men. Given the standard error in the estimates, we can say that for the respondents in this study, there is no one discipline in which the likelihood of facing sexual harassment is lower for women than any other discipline.

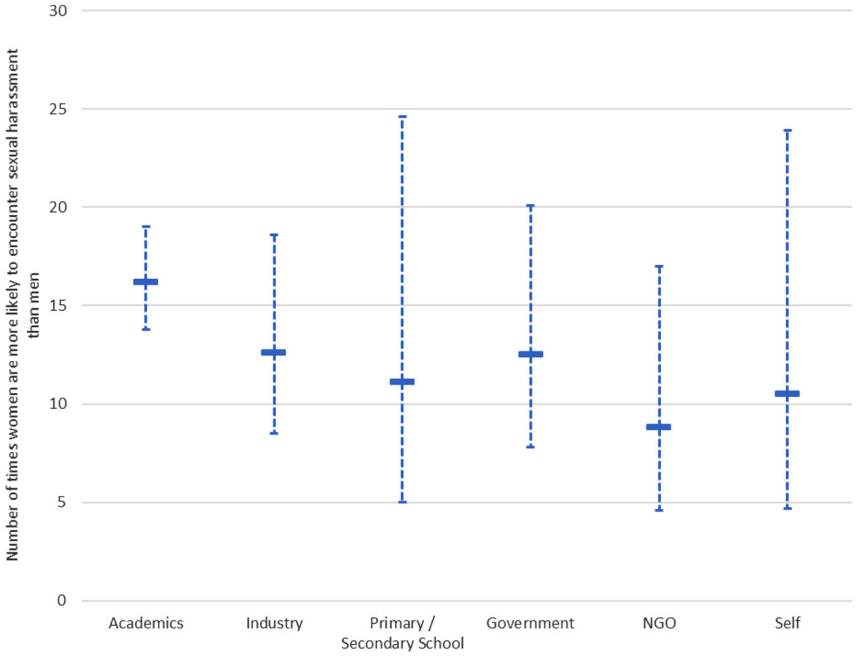

Fig. 2: Encountering sexual harassment at school or work by employment sector. The horizontal bar indicates the point estimate, and the dashed lines indicate the standard error. The size of the standard error depends on the number of respondents.

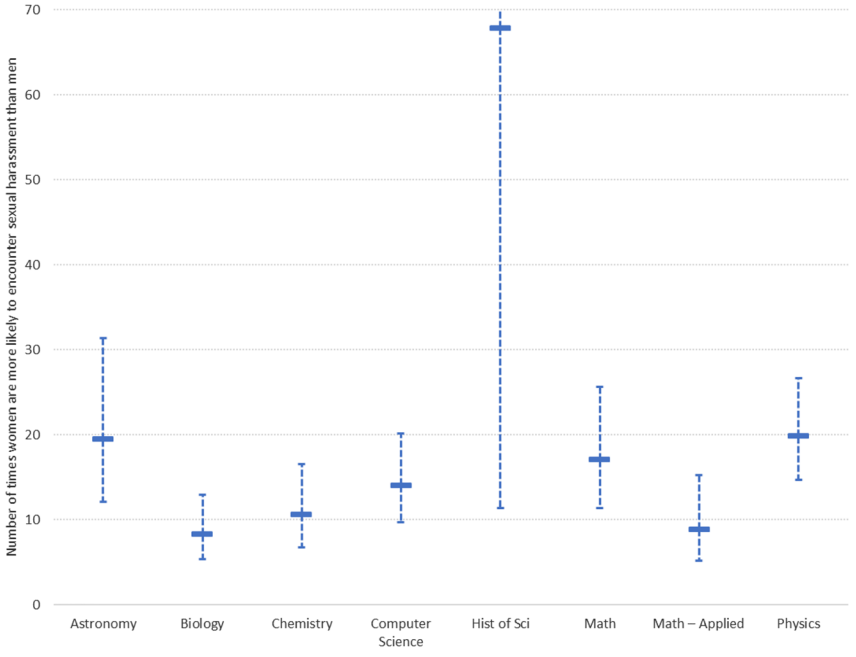

Fig. 3: Encountering sexual harassment at school or work by discipline. The horizontal bar indicates the point estimate, and the dashed lines indicate the standard error. The standard error is much larger for History of Science due to a smaller number of respondents. The upper limit for the estimate for History of Science is 405.9.

Encountering sexual harassment by geographic region

Finally, we also examined the experience of women in each geographic region separately using 12 logistic regression models, one for each geographic region. The results are shown graphically in Fig. 4. In short, women in every geographic region were more likely to indicate having personally experienced sexual harassment at school or work than men, except for Western Asia. Given the standard error in the estimates, we can say that for the respondents in this study, there is no one geographic region in which the likelihood of encountering sexual harassment is lower for women than any other geographic region, with the exception of Western Asia.

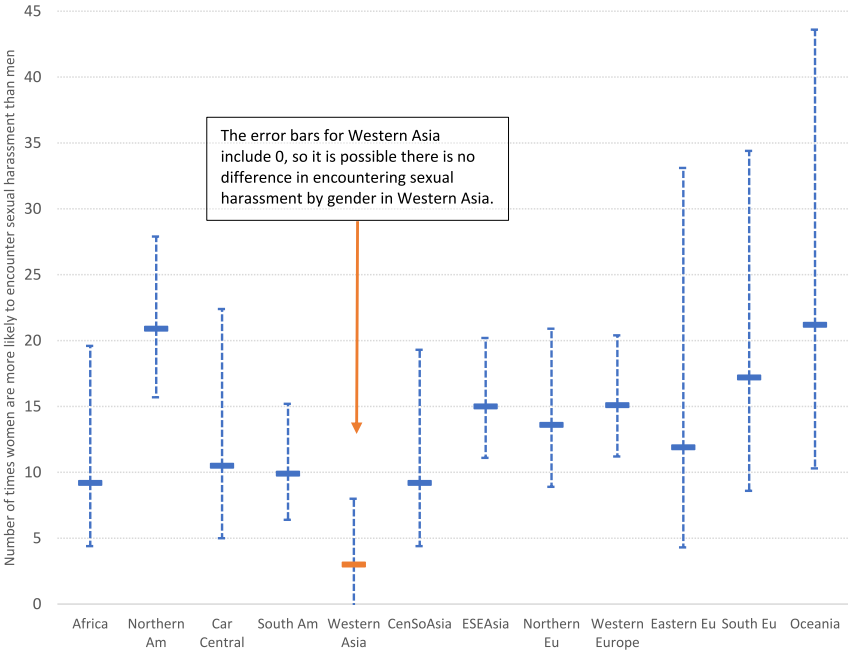

Fig. 4: Encountering sexual harassment at school or work by geographic region. The horizontal bar indicates the point estimate, and the dashed lines indicate the standard error. The size of the standard error depends on the number of respondents. The lower limit of the estimate for Western Asia is −1.

Comments from respondents

In completing open-ended answers to questions about their experiences, respondents weighed in on sexual harassment and discrimination. One noted: "*Sexism is constant and prevalent everywhere, and it's exhausting.*" Another reported: "*My institution does not have a defined sexual harassment policy. I reported a supervisor for sexual harassment and had a terrible experience during the … investigation.*"

Implications of women's experiences with sexual harassment in science

While the generalizability of our findings is limited to the respondents to this survey, these analyses provide evidence that women and men do not have the same experience with sexual harassment in science, and that women's experiences are less positive than men's. Even after accounting for discipline, geographic region, age, employment sector, and level of human development, the differences between women's and men's experiences persist. That suggests that there is systemic discrimination against women in science, in all disciplines, in all employment sectors, and across the world.

Our results are consistent with findings from other studies. The National Academies research suggests that the "consequence of [sexual harassment] is a significant and costly loss of talent in science, engineering, and medicine" [2]. Raj, et al. suggest the "women seeking advancement in male-dominated academia, with its historic tolerance of such abuses, have increased opportunity for exposure to harassment" [4]. Leaper and Starr found that sexual harassment from instructors was negatively related to STEM motivation and career aspirations for undergraduate women in STEM [5].

We have provided evidence that women are more likely than men to be sexually harassed in science disciplines. This increased likelihood cannot be explained by differences in age, employment sector, discipline, or global region. This is not a new problem. Globally, science education and institutions must do better. Awareness of the extent of the problem is one key to making changes. In the US, the National Academies of Sciences, Engineering and Medicine found that "organizational climate is, by far, the greatest predictor of the

occurrence of sexual harassment," and in its report lists specific recommendations that can be implemented to reduce the incidence of harassment [2]. The authors hope that documentation of this problem, as we present here, will encourage those with decision-making authority to enact policies designed to improve the climate of scientific workplaces and eliminate sexual harassment.

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References

[1] For more information on the project, visit gender-gap-in-science.org.
[2] National Academies of Sciences, Engineering, and Medicine. *Sexual Harassment of Women: Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine*, The National Academies Press, Washington, DC (2018).
[3] S. V. Rosser. Breaking into the lab: engineering progress for women in science and technology, *Int. J. Gend. Sci. Technol.* **10**, 213 (2018).
[4] A Raj, K. M. Freund, J. M. McDonald, P. L. Carr. Effects of sexual harassment on advancement of women in academic medicine: a multi-institutional longitudinal study, *EClinicalMedicine* 100298 (2020), https://doi.org/10.1016/j.eclinm.2020.100298, https://www.thelancet.com/journals/eclinm/article/PIIS2589-5370(20)30042-0/fulltext.
[5] C. Leaper, C. R. Starr. Helping and hindering undergraduate women's STEM motivation: experiences with STEM encouragement, STEM-related Gender Bias, and sexual harassment, *Psychol. Women Q.* **43**, 165 (2019).
[6] The United Nations Development Programme created the Human Development Index (HDI) to assess the development of a country. It is a summary measure of average achievement in key areas: long and healthy life, knowledge, and standard of living, http://hdr.undp.org/en/content/human-development-index-hdi (accessed Dec 9, 2020).