

COVID-19 lockdown effects on gender inequality

To the Editor — Among European countries, Italy was the first to be heavily hit by the outbreak of COVID-19 and quickly decreed on 9 March 2020 that the entire national territory be locked down to prevent its further spread, establishing an unprecedented situation for its citizens, including researchers.

Italy hosts a large and lively community of researchers, with about 2,000 of them engaged in different subjects of astronomy and astrophysics, distributed across national institutions, research centres and universities. According to data from the International Astronomical Union (IAU), the Italian astronomy and astrophysics community contains the largest fraction of female researchers (~30%) among the world's leading countries in astronomy (defined as the ones with IAU members >150)¹.

The social restrictions imposed from 9 March to 3 May 2020, and the subsequent period known as Phase 2, from 4 May to 15 June 2020, included the complete shutdown of schools with no caregivers (both professional and non-professional, and often grandparents) able to work, thus inducing a considerable increase in the workload at home. As female scientists are generally found to do nearly twice as much housework as their male counterparts², it seems likely that the lockdown resulted in an amount of work that was unequally distributed between men and women, which will unevenly affect their scientific productivity and, in turn, their careers. Here, we attempt to quantify this effect by using the number of preprints submitted as tracers of researchers' productivity^{3,4}.

First, using the **INAF** and **MIUR** websites, we compiled a complete database of Italian astronomy and astrophysics researchers, considered by gender, and matched it with the first authors of preprints posted on the largest preprint archive of natural science publications, arXiv. We tracked papers submitted during the first semester of each year, defined as January through June, from 2017 to 2020.

The submission rate over the previous three years is about 38.6 ± 8.2 (one standard deviation, σ) papers per month, or 232 papers for the first semester of the year, as shown in Fig. 1. The fraction of papers published by women during those periods is consistently close to 30%, which reflects the percentage of women in the community. As expected, the overall

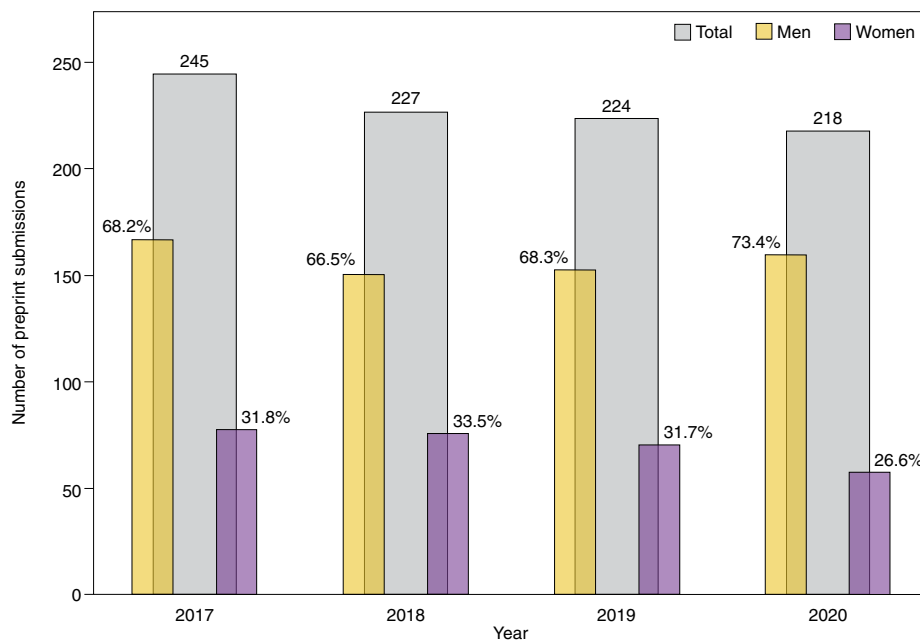


Fig. 1 | Tracking submissions. Number of papers (grey) submitted to arXiv between January and June in 2017, 2018, 2019 and 2020, and the fraction submitted by women (purple) and men (yellow). The contribution from women is significantly under average for 2020 with respect to the previous years, while that from men is even larger than the average value from previous years. The combination of these two effects produces a mild drop in the total production of around 8% or 1.7σ .

production in the first semester of 2020 was lower than the average value estimated above. But if we break down this difference by the assigned first-author gender, we find that the decrease only concerns the submissions by female researchers, while submissions by male researchers actually increased during the lockdown by up to 10% (or a difference of 3.5σ). Such a significant difference in productivity between male and female researchers during the lockdown can only be explained as a reflection of the unbalanced distribution of the unpaid workload at home between partners.

As papers are usually submitted to arXiv after up to six months of work on the manuscripts, the real impact of the COVID-19 pandemic on women's scientific production might actually be even stronger and more persistent than the one we detected, and could pose a grave threat to the diversity of the Italian community in astronomy and astrophysics, as well as in other research communities. Therefore, we urge communities to take action on this issue in order to continue

ensuring equal opportunities for male and female researchers in future job applications and funding proposals, the success of which is currently mostly based on publication records. □

Laura Inno^{1,2}✉, Alessandra Rotundi^{1,3} and Arianna Piccialli^{1,4}

¹Department of Science and Technology, Parthenope University of Naples, Napoli, Italy. ²INAF-Osservatorio Astronomico di Capodimonte, Naples, Italy. ³IAPS-INAF, Rome, Italy. ⁴Royal Belgian Institute for Space Aeronomy, Brussels, Belgium. ✉e-mail: laura.inno@uniparthenope.it

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Competing interests

The authors declare no competing interests.