



Contribution of Women in Scientific Publications – A Comparative Study Before and After COVID-19

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ABSTRACT

Emerging evidence shows that women authors are not well represented in publications resulting in gender gaps in publications. 548 original research papers published between 2019 to 2021 in three journals selected randomly from the list of quarterly published journals from India under the *Science Citation Index Expanded (SCIE)* core collection. According to the gender-wise contributions in scientific publications, there was a significant disparity between authors (male and female). Among national-level publications, the percentage of female authors in science journals published in 2019 and 2020, before the COVID-19 pandemic was 20.25 per cent, while their contribution to science journals published during COVID-19 reduced to 17.80 per cent. The contribution of women authors in science journals was decreased by 2.47 per cent during the COVID-19 pandemic. There was a significant divergence between the average number of authors and the average number of female authors in each issue.

INTRODUCTION

Women are increasingly opting for careers in the fields of science, technology, mathematics, and medicine (Agarwal, 2021). Today, scientific innovations are progressing at an ever-increasing rate. Gender inequality in STEM (Science Technology Engineering and Math) in developing nations encompasses a range of interconnected factors, such as familial, social, cultural, and institutional aspects, which cannot be overlooked. The consequence of this under-representation of women scientists in STEM fields is a scarcity of female role models and limited mentoring prospects for girls (Fathima et al., 2020). In the majority of science, technology, engineering, and math (STEM) institutions of higher learning, women represent less than 20 per cent of the all professor positions (Sahoo, 2021).

Another study by the UK's Intellectual Property Office [Gender profiles in worldwide patenting: An analysis of female inventorship (2019 edition)] noted that women inventors account

for just under 13 per cent of patent applications globally. Furthermore, this gender gap is progressively expanding. Notably, when comparing women to men with comparable publication records, women received a slight advantage of 0.8 per cent in terms of citation counts (Huang et al., 2020). In a study by Garg et al., (2019) on content analysis of agriculture science journal (Gujarat Journal of Extension Education) based on based on research area, respondents, source of articles & type of authorship, found that as compared to the mere ten percent of the articles on farm women, nearly 68 per cent articles published were on farmers. It has been observed that women comprise only 30 per cent of the total authors of scholarly articles. To address this gender disparity in authorship, it is crucial to implement gender-responsive planning and management strategies. Achieving gender equality in scientific research is a new, dynamic, exciting and interesting area of research (Bhagat & Vijayaraghvan, 2019). The gender imbalance in the education world has been historically evident and continues till today.

The COVID-19 pandemic resulted in lockdowns across the country, which led to the emergence of telecommuting and online classes. Individuals who were previously active were confined to their homes due to sudden lockdown measures. Consequently, both their physical and mental well-being have been negatively affected (Yadav et al., 2023). A considerable number of people possess a moderate understanding of the challenges arising from the Covid-19 pandemic (Kaur et al., 2021). Additionally, the pandemic has significantly impacted the dynamics of the academic and research community, particularly among female researchers and authors who now face the difficulty of finding a balance between remote work and domestic responsibilities, including full-time childcare duties. Women, whose empowerment is of utmost importance for the progress of the society on the whole, are the indispensable other half. According to Singh et al., (2016), women deserve increased attention of agricultural extension services in every developing nation. Participation of women in economic activities is now emerging as a universal phenomenon. The COVID-19 pandemic has enabled us to highlight the fact that women have been less involved in scientific research involving COVID-19 and have held less prestigious author positions than their male colleagues. The slowdown in their publications should be taken into account, especially when analyzing academic applications for which the number of published articles is still a determining factor. This will ensure that this does not negatively affect the development of their academic career, summarizes Gayet-Ageron (2021).

The present study is observance of the following objective- Analyzing the contribution of women researchers to scientific publications and comparing the difference in their contribution before and during COVID-19.

METHODOLOGY

The study was exploratory in nature; collected data from the current contribution status of women in scientific publications and this data proved to be helpful in finding results progressively. With the exploratory method, the contribution of women in scientific publications was analyzed. The study made a thorough analysis of science journals available online. With the objective to cover the journals with a larger number of per year publications, the analysis is based on National Journals of Science which published four issues in a year. Three journals were randomly selected for study from the list of quarterly published journals from India under *Science Citation Index Expanded (SCIE) Core Collection* coming under *Web of Science Coverage from Group – 2 of UGC Care List and National Academy of Agriculture Sciences (NAAS)*. It was done to ensure the inclusion of quality publications in the study. Since UGC care-listed and NAAS-rated journals are widely sought after for publication of research, nationally, owing to their regular maintenance of quality and acceptance in job selections and subsequent promotions, the journals for the study were selected from this category.

The data were secured by three Journals of Science from the year 2019 to 2021 namely *Proceedings of the National Academy of Sciences, India Section A: Physical Sciences* (Electronic ISSN: 2250-1762 and Publisher: The National Academy of Sciences, India), *Agricultural Research* (Online ISSN: 2249-7218, Publisher:

National Academy of Agricultural Sciences) and *Journal of Indian Society of Soil Science* (Online ISSN: 0974-0228 and Publisher: Indian Society of Soil Science). All issues of each Journal from the year 2019 to 2021 were considered for the analysis. This period provided reliable data to present trends before and during the COVID-19 pandemic, therefore, this methodology assisted in achieving the objective of examining the impact of the COVID-19 pandemic on the participation of women authors in scientific publications. The thorough analysis included original research papers published in Journals of Science, excluding books, thesis, dissertations, editorials and non-research pieces. 548 original articles were analyzed for the study. The gender of the authors was mainly identified by examining their names. For authors whose name was gender neutral or whose gender was not identifiable as might be in the case of some South Indian and International authors, gender information was searched online. The information of 12 authors could not be traced properly regarding their gender, so they were not included in the study.

RESULTS AND DISCUSSION

Female contributors in science journals before and during COVID-19

It is clear from Figure 1 that there was a difference among authors (Male & Female) according to the gender wise contribution in scientific publications. Among national level publications, the percentage of female authors in science journals published before the COVID-19 pandemic was 20.25 per cent while their contribution during COVID-19 was 17.80 per cent with a decrease by 2.45 per cent. Gender inequity in science and education, especially in senior positions, is a widespread problem. The causes are poorly understood due to lack of enough studies, but there are other factors including historical sex ratios, discrimination, and gender-based behavioral differences. True to the leaky pipeline label, number drops significantly when women's participation reaches a higher level in science field, several studies indicate that women are often excluded from study groups and classes and face sexist remarks and sexual harassment in laboratory settings. These un-supportive academic environments can significantly contribute

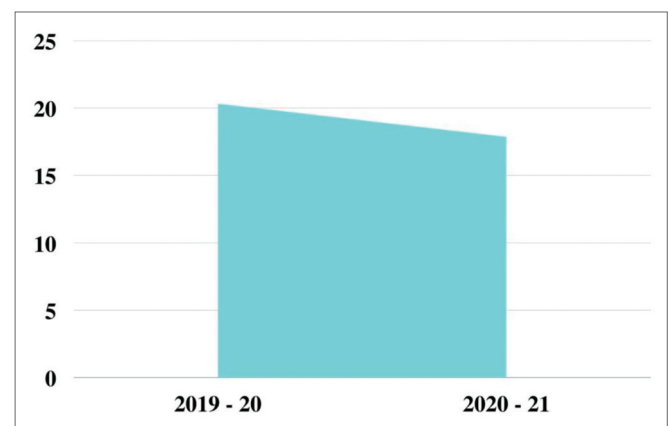


Figure 1. Distribution of female contributors in science journals before and during COVID-19

to the under-representation of women in science. The problem is related to the retention of women after education, after entering their fields. This is especially true in the context of the large number of female researchers who, after earning their doctoral degrees, either do not pursue a career in science or takes a break in employment after starting a job. This is evident in the significant disparity between the percentage of women who possess doctoral degrees and the percentage of women scientists holding postdoctoral positions, which is notably lower. In many cultures, caring for children, the elderly, or persons with disabilities is an activity entirely entrusted to women. In case of women in the field of science, they address the challenges arising from balancing family and professional responsibilities by deferring motherhood, leaving their scientific careers, sacrificing personal time, opting for less ambitious and more manageable career paths, or choosing not to have children (Dizaho, 2016). A significant proportion of scientists have a limited number of publications, possibly attributed to factors such as the high costs associated with publishing, insufficient skills in publishing among scientists, and the absence of specific guidelines mandating a minimum number of articles to be published annually within the university (Veldandi et al., 2023). In the study, the participation of women in science journals decreased by 2.45 per cent. The reasons for the slight decrease in the number of female authors in scientific publications during pandemic may be that scientific studies are done in the laboratories (accessing which could have been more difficult for female scientists in the pandemic) and scientific studies have more number of contributors i.e. research work is done in teams.

Authorship status of female authors

Decisions regarding authorship should be made in a thoughtful and strategic manner. The primary decision when collaborating is to choose between conducting research independently or as part of a team, and subsequently, to select from various types of team research. The Table 1 layouts that the number of women authors in science journals published at National level publications has decreased. The percentage contribution of female authors as researcher in the year 2019 was 23.20 per cent, which has increased to 23.95 per cent in 2020 itself then decreased by 20.34 per cent in 2021. Similar to the researcher's category, there was a shift in the percentage of female authors in supervisor category. In the year 2019, the female authors as 'Other contributors' were 19.09 per cent which came down to 16.5 per cent in 2021. Research indicates that women, particularly those in underrepresented STEM fields, have lower representation in academic literature. However, the impact of this under-representation is reduced when women

assume leadership positions in research, as evidenced by their role as corresponding authors. When women take on the role of corresponding authors, they tend to publish manuscripts with a higher number of female authors, have a greater likelihood of collaborating with female co-authors, and include more female authors overall. The figures clarified reduction in the number of female corresponding authors in selected journals. Similar to the trend observed among various categories of researchers, the percentage of female corresponding authors has also changed. The data of the study indicates the massive gender gap in authorship when it comes to prominent positions in a research paper. Across all the three years, in every authorship category, the contribution of women in the journals is nearly a quarter of that of the men. This raises big concerns for the future of women academicians and researchers.

It is recognized that male researchers generally engage in collaborations to a greater extent than their female counterparts (Fox, 2017; Kwiek & Roszka, 2020). Furthermore, studies indicate that women in academia are less engaged in global collaborative initiatives compared to their male counterparts (De Kleijn et al., 2020, Kwiek & Roszka, 2020). Another notable result showed that female academics are less likely to collaborate with international articles than male academics (De Kleijn et al., 2020). Study conducted by Bendels et al., (2018) revealed that the under-representation of women in high-impact academic journals is primarily attributed to their lower rate of submitting manuscripts for publication, rather than the rejection of their submitted work. Collaborative research and publications are known to generate more impactful and effective outcomes, yet women's participation in these collaborations is comparatively less. Women get fewer citations than men. Citations increase with the number of co-authors and the number of citations also decreases due to the lack of network and collaboration with women. Based on a study assessing merit-based decisions by prospective hiring faculty, it was found that a female applicant for science laboratory manager positions had a lower likelihood of being hired compared to a similar male applicant. The report "Beyond Bias and Barriers" (2007) extensively examined the existing literature on gender, bias, and academic careers, and its findings indicated that subtle bias persistently impacts women's career progression in the field of education. Men spend significantly less time in supervised research, are less likely to overestimate their time allocation to the demands of assigned tasks, and author more published journal articles per 100 hours of research time than their female counterparts. Collectively, these findings suggest that gender inequality manifests as differences in time-to-credit payments beginning in the first year of doctoral training. One potential reason for the under-representation of female authors could be the higher likelihood of men being more successful in negotiating for prestigious positions within the authorship hierarchy during informal team discussions. However, currently, there is a lack of specific research focused on studying these interactions among authors. Generally, men tend to engage in more interactions and self-promotion of their achievements compared to women. Another possibility is the existence of bias favoring women during the review process. Consequently, when men occupy esteemed positions, papers of

Table 1. Authorship status of female authors in national science journals

Years	Authorship category			
	Researcher (%)	Supervisor (%)	Corresponding author (%)	Other contributors (%)
2019	23.20	19.16	20.99	19.09
2020	23.95	19.23	21.87	18.45
2021	20.34	16.66	15.60	16.95

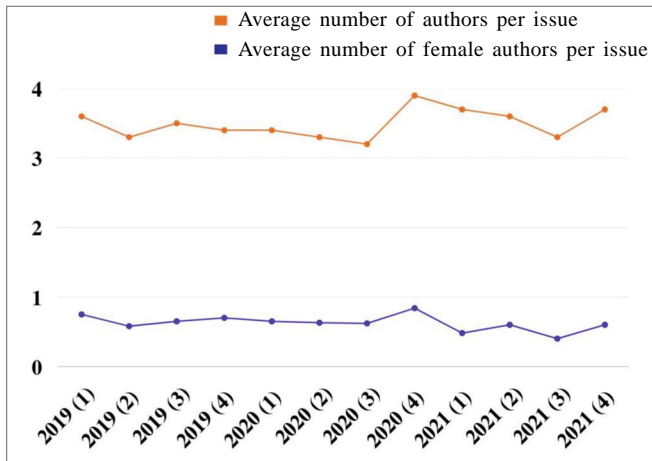


Figure 2. Distribution of average number of authors per addition

similar quality may face lower acceptance rates. This bias could result in an under-representation of women in journals that do not employ gender-blind reviews. Despite claims based on correlation data suggesting that gender bias no longer contributes to gender inequality, controlled laboratory and field experiments consistently reveal that bias negatively impacts women's decisions. In the context of the pandemic, it may take place that most of the women may not had been able to do research work properly because of the excess of household responsibilities due to staying at home after the lockdown. Research work in science is often done by teams, so even during pandemic; there was a smaller number of female authors in science journals indicating that their male counterparts done more work at that time.

Average number of authors per edition

As mentioned earlier, there was a significant disparity between the number of female authors and male authors in scientific publications. Consequently, the average number of female authors per issue was considerably lower than the overall average number of authors. This clearly illustrates that the participation of female authors in national scientific publications was significantly lower compared to their male counterparts. Moreover, the average number of female authors is notably lower than the average number of authors overall. During the pandemic there was a slight decrease seen in their percentage, the reason for this may also be that their number is very less. The Figure 2 also points that this comparatively low percentage seen in female contributors is not seasonal, i.e. the issue number of the journal has no impact over the number of female contributors.

CONCLUSION

There was a slight decrease in the proportion of female authors during the COVID-19 pandemic in comparison to the preceding two years, although in both time periods, i.e. pre and post COVID-19, women participation in scientific publications was found to be alarmingly lower than men. However, gender disparities are growing on prominent authorship positions like supervisor, researcher, corresponding author etc. Academic journals tend to have a higher average number of authors per issue, but the

average number of female authors remains relatively low. The under-representation of women as authors in academic publications has an impact on the representation of female faculty members, particularly in esteemed authorship positions. The journals may encourage women authors to submit their research papers, may be through special issues, ensuring proper review, and implementing equality in the editorial process.

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