

## **Bibliometric Mapping of Gender Disparity in Research Publications in India during 1999-2018: A Case Study of Shimla District, Himachal Pradesh**

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### **Abstract**

Gender disparity and gender imbalance are globally pervasive in academia. Research into gender disparity characterizing gender differences uses metrics such as publication rates, author contributions, citation rates and research impact. Previous studies are contradictory in their findings and are limited in scope. As such, the current study examines the research contribution of both men and women in Shimla, Himachal Pradesh, India. A Scopus search was used to identify all articles published over a 20-year period (1999-2018). For each article in the final sample of 2,881 publications, the gender the first author was identified. Both the number and the growth rate of publications by women were lower than those by men. Conversely, the growth in citation rate was higher for women in 2009 and 2016. Gender disparity was found to be highest at the Indian Institute of Wheat and Barley Research and less severe at the HP Govt. Dental College.

**Keywords:** Gender Disparity, Bibliometric Study, Research Publishing in Shimla, Research Productivity

## 1. Introduction

Gender disparity or gender imbalance is a pervasive problem in education. It has been seen all over the world. Over the past century, there has been a dramatic increase in research into gender disparity [1], and the main finding was that males dominate in the majority of sectors. Males are reportedly more career-driven than females [1]. However, some researchers reported the inverse; that women dominated over men. Gender inequality also found in India [2], with reports at the level of student admissions, graduates and qualifications. Traditionally, men have dominated in Higher Education; for example, the renowned Oxford University did not start awarding degrees to women until 1920 [3]. Similarly, Jagiellonian University did not accept females until 1894 [4]. Similarly, women working in science have been reported to be under greater pressure than men [5]. Despite this, women often dominate in fields such as the health sciences [6], and females out-perform males in the lower educational levels [7]. Women make up 60% of graduates in Europe, however the percentage is lower at the level of PhD, where women make up 47% of graduates [8]. Similar gender disparity can also be seen in India [2], with males being over-represented in many sectors. In India, females face problems in education, in society, and feel that they are under great pressure [9]. The literacy rate of women in India is 64.6% (Census of India 2011), compared to a rate of 73% across India as a whole [10]. The highest literacy rates are found in Kerala. The state of Himachal Pradesh was ranked 11th in India with respect to the literacy rate and was placed in 19th position in terms of their gender parity (achieving a score of 0.609658 on a scale from 0 to 1) out of 20 states in India. Himachal Pradesh was reported as one of the three states exhibiting the highest gender disparity in India [11]. Hence, the Government of India has made moves to support women's education by reducing tuition fees and reserving jobs, among other measures [2], [11]–[13].

India is the 5th largest contributor to research worldwide according to the Scopus report [14]. India is a developing country with an educational system that is stratified by gender, caste, class, region, and religion [12]. It has 28 states, of which Himachal Pradesh is one. Himachal Pradesh is a hilly state containing 12 districts [15], including Shimla, the state capital, also known as “queen of hills”. During the British rule, Shimla was referred to as the Summer Capital. There are many educational institutions established in Shimla. There have been a large number of qualitative and quantitative “Scientometric” studies showing evidence of gender disparity and male domination in journals, publishing, education, and literacy. However, there is a lack of such evidence in Shimla, with respect to the association between research publishing and gender. The current study examines gender disparity in research publishing in the district of Shimla. To achieve the research objectives, a number of aspects of academia were examined from a gender perspective, including the association between gender and the growth of literature, the growth of citations, the organizational level, individual academic disciplines, collaboration, authorship patterns, and areas of interest.

## 2. Scope and Limitation of the study

The current investigation was limited to the research out of Shimla District, Himachal Pradesh and it covered all subject. Further the study limited to the literature published between 1999 and 2018 and indexed in Scopus database. The study also only considered first author of the paper for analysis. The ratio of male and female authors calculated from the publications of the first author rather than whole authors of each the publication. In addition, the study analysed and identify gender gap using bibliometric indicator.

## 3. Review of related work

Different theories exist in the literature regarding the concepts of “gender disparity” or “the gender gap” or “gender inequality” [4], [13], [16], [17]. A previous study [4] examined science literature published in Polish between 1975 and 2014. The authors reported that out of a total of 56,634 documents published during the study period, female authors outnumbered male authors. A further study [14] analysed the authorship of 186 Indian journals published in 2017 in terms of the gender of just the first author. It was reported that across 26 fields, males outnumbered females by a factor of over 1.5. In the USA, a greater number of female first authors were found in dentistry, economics, and mathematics as compared to males. Similarly publications by females outnumbered those by males in German by 28% between 2010 to 2014 [18]. It was reported [19] that publications by female Norwegian scientists are less cited than those by males, but this was not by a large margin, and may have been related to the finding that females published fewer articles compared to males. A very recent study [20] investigated the gender inequality of citations in six English speaking countries (Australia, Canada, Ireland, New Zealand, UK, and the USA) across twenty-seven research areas between 1996 and 2014. They found that overall, females were more likely to be first authors on research papers, but only by a small margin, and that their work had a tendency to be cited more often than work published by male first authors, again by a non-significant margin. Many studies have documented that females are found to be under-represented in specific domains [21]–[25]. In particular, one study [21] reported that males published more articles than females in the field of library and information science in India between 2008 and 2017, and that one-third of the publications had single-authorship. It has been reported [26] that in neuroscience, the research production of women authors was less than that of men, with men contributing 67.1% compared to 32.9% from women. However, analysis of a sample of 26,783 research publications in the subject of management [27], demonstrated that female authors rank slightly higher than males in the top 10% most highly-cited publications. Similarly, in the field of nanoscience and technology, female authors produced more articles and had greater impact than males between 2005 and 2007 [28]. Another study in library and information science [29] showed that between 2011 and 2018, women researchers contributed fewer publications than men, where the average male authored 1.35 papers compared to an average of 0.54 papers published by females. A similar study [30] reported the vast majority of

literature to have been contributed by males (75.38%), rather than females (24.62 %). [31] Significant differences have been found in research contribution between males and females in Kashmir, India where males contributed 95.31% of published literature across a variety of subjects, compared to the 5.69% contributed by females. Contributions from male academic physicians have been found to outnumber those of females, in addition to males achieving higher h-index scores than their female counterparts [24]. Despite the large number of studies reporting a male domination with regard to research contributions, some studies have reported contradictory findings. In a study comprehensively using many metrics to compare women's contribution to medical research with that of men [32], the study sample comprised 1,910 authors of 223 publications in a single journal between 2000 and 2015. Over the study period, the proportion of female authors significantly ( $p < 0.0001$ ) increased from 32% to 41%. Further, the involvement of female authors in the conception and design of the research rose significantly ( $p = 0.0256$ ) from 55% to 61%. Involvement of female authors in critical revision significantly ( $p = 0.0009$ ) increased from 70% to 81%, in final approval increased from 81% to 86% ( $p = 0.0381$ ) and in securing research funding increased from 16% to 22% ( $p = 0.0245$ ). the workload was different between women and men, with women having greater involvement in roles such as administration and logistics (35% women compared to 26% men;  $p = 0.0188$ ) and data collection (50% women compared to 46% men;  $p = 0.0532$ ). Involvement in tasks such as data analysis and interpretation, drafting of the manuscript, provision of materials/patients and statistical expertise was similar between the genders. Across the study period, a woman researcher was also found to be significantly ( $p = 0.0102$ ) less likely to take the place of last author than a man (9% compared to 16%). Similarly, research by Sotudek and Khoshian [28] used Scientometric methodology to study the performance of women working in nanoscience and technology, in terms of scientific productivity and impact in contrast to males. They found woman researchers to be fewer in number, but to perform equally to men in terms of scientific productivity and impact. [33] conducted a study paper published in SRELS Journal of Information Management between 2011 and 2018. The authors analysed the data using bibliometric indicator and gender identification of papers published in this journal. The study found 464 publications in which 877 authors were contributed their paper. Further author noted that female author was less international collaboration with than male author.

In short, previous research investigating gender differences in publication rates, author contributions, citation rates and research impact has produced many contradictory findings that vary with the field and country of the study. The polarity and magnitude of findings vary to such a degree that no conclusions for general trends can yet be drawn, with the majority of studies being limited in scope to a specific geographical area. Moreover, there is no such research investigating the impact of gender in research in the Shimla district of Himachal Pradesh, India. As such, the current study aims to examine the research contribution of both men and women in Shimla.

## 4. Research questions

- RQ1: Do female researchers produce fewer publications than males?  
RQ2: Are the research outputs of women less cited than those of men?  
RQ3: Is there an institutional gender imbalance in research productivity?  
RQ4: How does gender disparity vary across disciplines?  
RQ5: Do women have fewer international collaborators than men?  
RQ6: Is there a gender gap in research interests?

## 5. Materials and methods

### 5.1. Collection of data

This study utilized the Scopus database as due to it having a wider coverage than Web of Science. Data were exported from Scopus using the advanced search function “Affiliation to City” = Shimla, and the search was performed on the 18th October 2019. The initial search produced 4,952 publications. Further irrelevant entries (i.e. incorrect author affiliation city, district, state or country, or the author being unidentifiable) were removed, such that an only publication where the first author was identifiable and located in Shimla district was included. This resulted in a final sample size of 2,881 publications.

### 5.2. Gender Identification

Gender identification done of first author of the publication having affiliated to Shimla district. The authors of this study first search each publication in google and extract full name of the author and then collect the first name of the paper. Then manually identify the name gender using various websites such affiliated universities, google Scholar, ResearchGate of the authors. However, the gender was doubt or unidentified the study removed such publication for further study. Finally, 2881 publications found which were affiliated to Shimla district. Out of total 774 (27%) female and 2107 (73%) male first authors found paper published between 1999 and 2018 in Shimla.

### 5.3. Data analysis

The data analysis used Microsoft Excel and Bibliometrix R Package, a mapping analysis tool, coded in R [34] and Gephi and VoSviewer used to visualize the keywords and collaboration of publications.

## 6. Results

### 6.1. Growth of literature

Figure 1 shows growth over times of publications by first author gender between 1999 and 2018. The overall growth of publications by first authors of both genders was not

stable, and fluctuated over time. The growth publications by male first authors dominated over the period. Further, the highest growth rate over a single year of publications authored by men was 179 in 2011, compared to 92 by women, which occurred in both 2015 and 2016. Growth of publications by male authors increased steadily from 2002 to 2007, but in 2008 started to decrease by progressively smaller amounts. Similarly, the growth of publications by female authors increased steadily from 2011 to 2015, and dropped slightly in 2017.

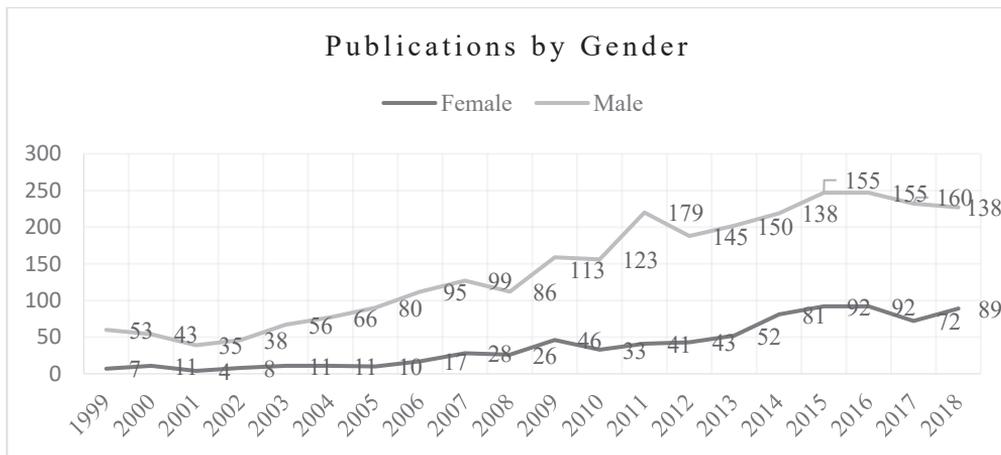


Figure 1. Growth of literature in print by gender of the first author, by year, between 1999 and 2018.

### 6.2. Citation growth

Figure 2 illustrates the growth of citations both male and female first authors over 20 years in Shimla district. There were a total of 2881 publications reviewed in which the highest citation contributed male first authors 17956 citations in 2107 while female first authors contributed 6148 in 774 publications. Both male and female first authors' citation growth rates fluctuated over a period. The closer inspection of the graph indicated that in the year 2009 and 2016 female first authors' publications received the highest citations than male first authors.

### 6.3. Publications by organization

Both male and female first authors were categorized into 11 broad categories (Table 1). Small organizations and institutes were merged into a larger group i.e. the group denoted as Government College encompasses all from RKMV, Government College Sanjauli, Govt. PG College Seema, Govt. College of Pharmacy, Govt. College Sunni, Rajiv Gandhi Govt. College, and St. Bede's College Shimla. Table 1 shows a significant gender disparity at the Indian Institute of Wheat and Barley Research (IIWBR), Regional Station, Shimla whereas a lower rate of gender disparity was

found in HP Govt. Dental College (HPGDC) and Hospital, where men were first author to 56% of research outputs and women to 44%.

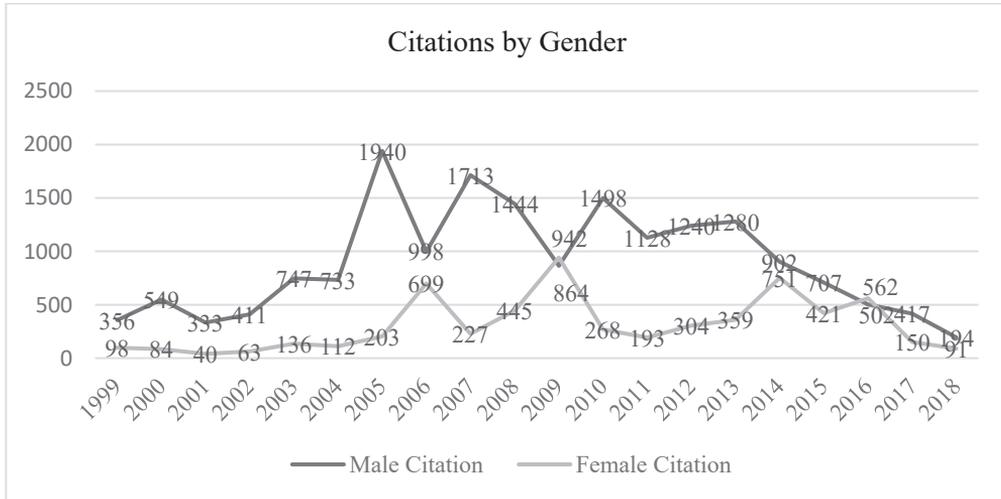


Figure 2. Growth of citations by gender of the first author of the cited paper, by year, between 1999 and 2018.

Organization	# publications with male first author	# publications with female first author	Total	Male (%)	Female (%)
CPRI	190	58	248	77	23
HFRI	14	6	20	70	30
HPGDC	34	27	61	56	44
HPU	1,025	383	1,408	73	27
IARI	16	4	20	80	20
IGMC	587	242	829	71	29
IIAS	28	14	42	67	33
IIWBR	37	0	37	100	0
NBPGR	21	3	24	88	13
Other	114	29	143	80	20
Government College	41	7	48	85	15

Table 1. Organizational gender disparity. N.B. Government College includes RKMV, Government College Sanjauli, Govt. PG College Seema, Govt. College of Pharmacy, Govt. College Sunni, Rajiv Gandhi Govt. College, and St. Bede's College Shimla.

#### 6.4. Number of co-authors by gender

Figure 3 shows the percentage of publications by both male and female first authors to have different numbers of total authors, between 1999 and 2018. There is no visible

association between the number of authors a publication has and the gender of the first author. A slight trend is seen in that the higher number of total authors a publication has, the more likely it was to have been first authored by a male. I.e. in the category of more than three authors, male first authors constituted 73.90% of the publications in this category, whereas female first authors contributed 26.10%. In contrast in outputs with single authorship, males contributed 68.83% and female contributed 31.17%.

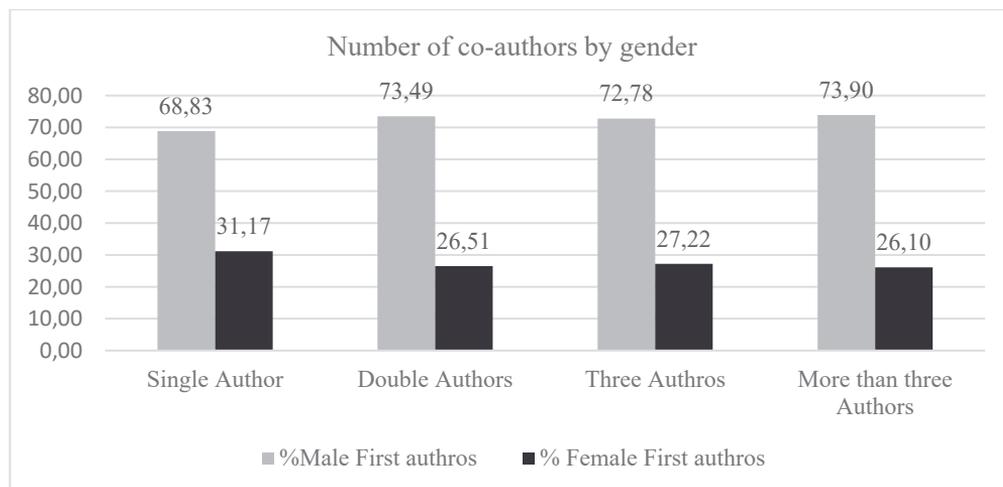


Figure 3. Authorship pattern – number of coauthors on publications first authored by men and women.

### 6.5. Publications by subject area

Gender disparity exists in all disciplines; however it is even more prominent in some disciplines compared to others. Publications were categorized into four broad disciplines according to the Scopus database. These were health sciences, life sciences, physical sciences and social sciences. The data show that the highest rate of gender disparity was found in physical sciences where male first authors contributed 74.66% of the publications and female first authors contributed only 25.34%. While the lowest gender disparity was found in social sciences (males = 66.67%; and females = 33.33%), this was still significantly different from parity.

### 6.6. Keywords of articles published by Men and Women

To assess the subject areas of interest of both male and female first authors, the keywords of all publications in the sample were extracted and visualized in the form of a network using the Bibliometrix RPackage. The 23 most-frequently occurring keywords in the sample are shown in Figure 5. The color represents the cluster, and size of the nodes/ font size represent frequency of occurrence. The weight of the line connecting two nodes denotes the strength of the relationship between the two nodes.

For articles first-authored by men, it can be seen that the strongest links found were between the following pairs of terms: potato and yield; wheat and resistance; hydrogel and drug delivery; and immobilization and lipase. For women, the strongest links were between the following pairs or groups of terms: potato and starch; density, speed and viscosity; immobilization and lipase; thermodynamic parameters and critical micelle concentration. The most commonly used keywords in work by men were potato, hydrogels, immobilization and porous medium, for women were potato, density, critical micelle concentration, lipase and immobilization. Closer inspection of the images generated in Figure 5 shows that the overlapping areas of interest, signified by highest frequency of keyword use in publications first-authored by both men and women were potato and immobilization.

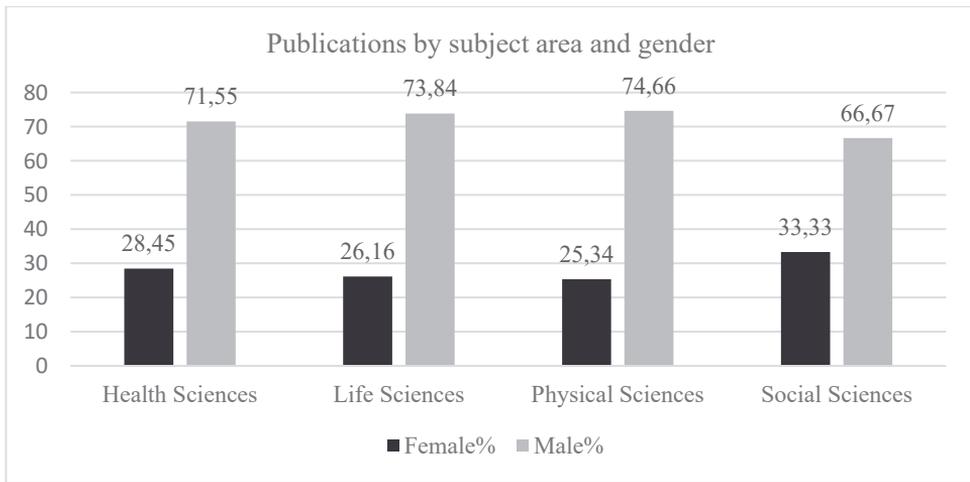


Figure 4. Gender disparity across four broad subject categories of publications. Numbers above columns denote percentages of the publication in that category.

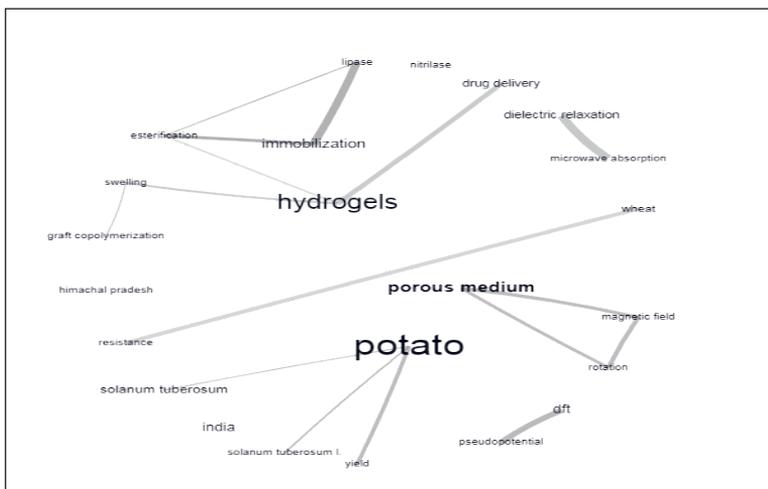


Figure 5 (A). Keywords of articles published by men

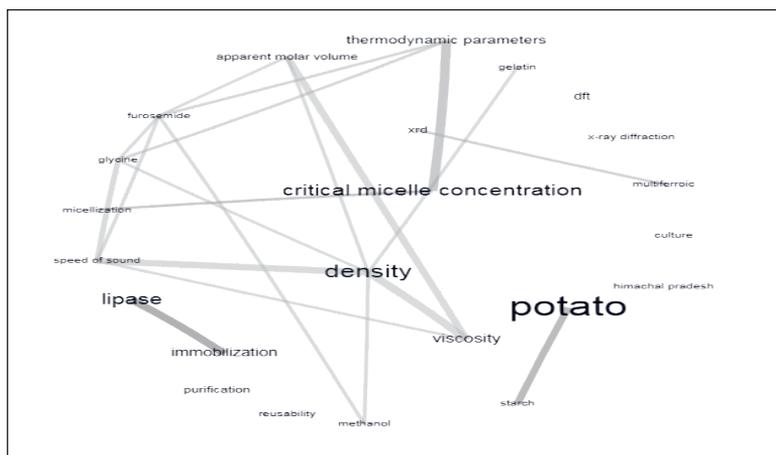


Figure 5 (B). Keywords of articles published by women.

### 6.7. International collaborations by gender

Figure 6 (A-B) shows the gender disparity of male and female first authors in the existence of international research collaborations, in terms of the strength of collaboration with the other country. The study found that men were more likely to undertake collaborative research and women had fewer collaborations. Male first authors exhibited strong collaborative relationships with researchers in the USA, Saudi Arabia, and South Korea. In contrast, female first authors were strongest with those in Saudi Arabia followed by South Korea, the USA, and Brazil. Closer inspection of the data shows that similar collaborative networks are found in both male and female first authors during the period of 1999 to 2018 in Shimla district.

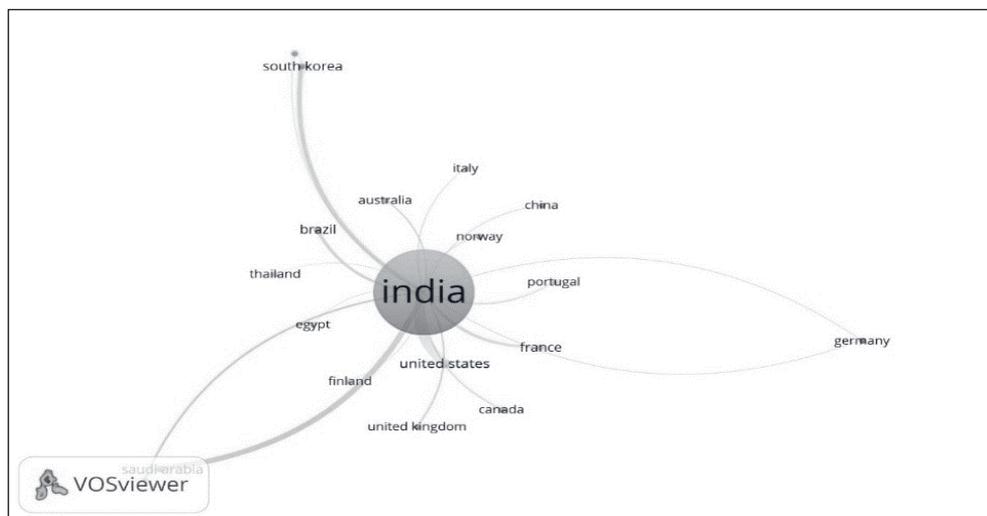


Figure 6 (A). International collaboration of first authors by gender Men.

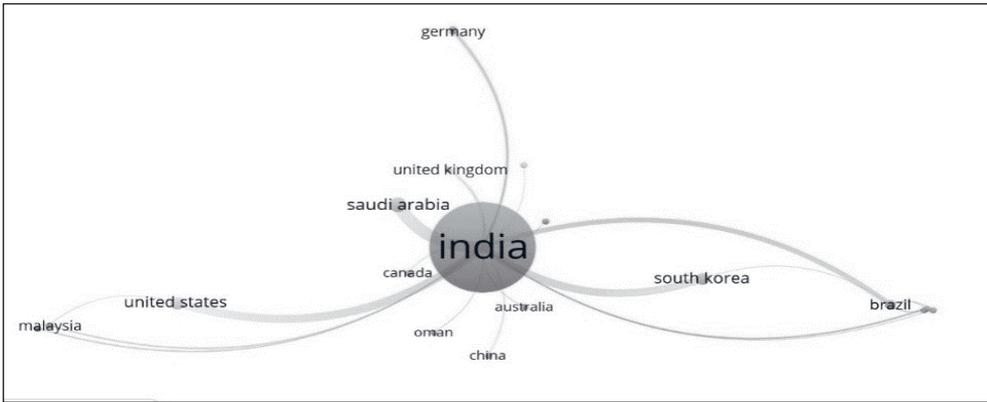


Figure 6 (B). International collaboration of first authors by gender women.

\*The thickness of the line denotes the strength of the collaborations with the other country.

## 7. Discussion and Conclusion

This study investigated gender disparity in research publishing in Shimla over a 20-year period. Our findings show that publications by male researchers outnumbered publications by female researchers overall. The growth rates of publications of both male and female first authors were not stable. However, both the number and the growth rate of publications by female first authors was lower than those by male first authors during the study period. Conversely, the growth in citation rate was higher for female first authors in 2009 and 2016. Significantly, there was a higher gender disparity in research publications found the Indian Institute of Wheat and Barley Research (IIWBR) and a less severe gender disparity found at the HP Govt. Dental College. Similar levels of gender disparity were found in the pattern of the number of separate co-authors each publication has, with a tendency for a greater gender disparity, the greater the number of co-authors listed on a publication. However, this trend was not statistically significant. The degree of gender imbalance in research productivity of both male and female first authors varied across different disciplines. The study found significant differences in research productivity in life sciences, health sciences, and physical sciences while social sciences exhibited the smallest gender disparity of merely a 2:1 male: female ratio among the first author of the sample of publications. In studying the international collaborations within the sample, no significant difference was found, however, male and female first authors both showed strong collaborations with the USA, Saudi Arabia, and South Korea with a trend for stronger collaborations involving male first authors compared to female first authors. In addition, female first authors had less international collaboration than male first authors. The areas of specific research interest, signified by the frequency of publication keywords within the sample, found both men and women to use the keywords potato and immobilization. This may be due to the relatively small sample size and great diversity of subject matter of the publications within the sample.

The study findings are in agreement with previous research reporting that women contribute less to research outputs than men. Indeed, very little of the research outputs in the Shimla district between 1999 and 2018 are attributed to female first authors, as suggested in numerous previous studies. Women in research should receive proper guidance, and institutions should be aware of the needs of the female population in order to reduce and overcome gender imbalance in research activity. This will entail the involvement of multiple research active institutions, in addition to the relevant authorities, UGC, ICMR, and ICAR and other bodies. In conclusion, the gender disparity that is ubiquitous in academia, is shown to be present in Shimla and it not decrease unless proper guidance and resolution is taken.

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