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Homepage: www.gathacognition.com/journal/gcj2

<http://dx.doi.org/10.21523/gcj2>



Original Research Paper

Women Authorship of Scholarly Publications on COVID-19: Leadership Analysis



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Abstract

Women are continuously underrepresented in authorship of scholarly publications. 1) The authorship positions as first -, last and corresponding author, and 2) performance as citations and Altmetric records of published papers are indicators of leadership qualities of the authors. Comparative leadership qualities of women authors were calculated using odds ratios. The proportion analysis was performed to get comparative contributions and per article citations and Altmetric records to understand the quality of publications. Information about scholarly publications was downloaded from Dimensions and data about names and gender was collected from different online sources. Author's gender was detected based on first name.

The proportions of women authorship as first, last and corresponding author were calculated to understand the share of women in scholarly publications. Women show underrepresentation in authorship of scholarly publications on COVID-19. Female-to-male odds ratio was calculated for these authorships and the performance was calculated of research papers authored by women as first and last authors. Female-to-male odds ratios calculated for 1) women authorships as first author, 2) citations, and 3) Altmetric tracking records for articles authored by women as first author were more than 1. Further, 1) women authorship as last- and corresponding authors and 2) citations and Altmetric tracking records for articles authored women as last author show calculated value were less than 1. All these ratios were considered as indicators of women leadership in scholarly publications on COVID-19. Leadership index was calculated to understand the level of women leadership in this field. Calculated leadership index for women (7.11) shows leadership qualities of women authors. Financial support provided was almost equal for research reported in women and men first authored papers. The field is very new; it is as active and challenging area of research for social justice and welfare society. The method and results reported in the paper is useful for preparation of research policies and monitoring the research projects, grants with feminist approach.

Article history

Received: 26 May 2020
Revised: 09 June 2020
Accepted: 10 June 2020

Keywords

Authorship;
COVID-19;
Publications;
Research Papers;
Women.

Processing Editor(s)

Fatima Sadiqi
Hejer Ben Jomaa

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1 INTRODUCTION

Women are continuously underrepresented in authorship of scholarly publications on Science, Technology, Engineering, Mathematics and Medicine (STEMM). Studies have reported only 30% of women representation with less appearance as prestigious authorship as first-, last and corresponding authors. Several mechanisms including special grants for women researchers, permissions for higher positions like full

professor, etc. were implemented to element the gender difference in scholarly publications. However, only few women are acquiring higher positions like principal investigators, full professors, chair, invited speakers, member of editorial boards, etc. (Larivière *et al.*, 2013). Only six countries show gender balance in authorships (Larivière *et al.*, 2013). Developed countries show more gender gap than poor countries (Holman *et al.*, 2018). Similarly, authorship of patents also shows large disparities. Women are commenting lesser than men on

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<https://dx.doi.org/10.21523/gcj2.20010102>

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scholarly publications (Wu et al., 2020). Therefore, elimination of large gender gap is the challenge for international scholarly community, planners and government organizations (Larivière et al., 2013; Long et al., 2015; Fox et al. 2016). The authorship analysis of scholarly publications is indeed an important topic for feminism which generally targets two major objectives: 1) equality between the sexes in terms of rights in society, 2) equality of opportunities to enhance women's contribution to the production of knowledge (academic leadership).

Pandemic COVID-19 transmits human-to-human by contacts and now reached across the world. The citizens, health workers, administrators, etc. are under fear, pressure and all are at risk. The number of infected personas is crossed 7.2 million and 0.4 million are died (up to 09th June 2020) in few months only (<https://ncov2019.live/data>). Developed countries like USA, Italy, Spain, United Kingdom, France, Russia, Turkey, etc. are facing very severe infections and long term effects on society and economy. Others are in queue for severe infections and their impacts. Therefore, pandemic COVID-19 is high priority topic for search across the scholarly community including all faculties of STEM, economics, sociology, law, management and governance, etc. to minimize the casualties, save lives, maintain social and economic welfare, law and order, etc. Scholars from several fields are working to find appropriate solutions including medicines, hospitality, administration at national and local level, etc. Several institutes have made their major focus on research on pandemic COVID-19 and their impacts. Some of the online platforms made available research documents for scholars at one place through dedicated pages and storages. Here, we have analyzed women authorship of scholarly publications on COVID-19 to understand women's contribution and leadership in this situation.

The sincerity, hard work and quality of women authorship can be indicated through quality of publications instead of number (Cikara et al., 2012). Several scholars have analyzed women authorship of scholarly publication from most of the fields including STEM and social sciences. All these analyses were processed to understand women representations, productions, citations, collaboration patterns (Frances et al., 2020) and network, commenting (Wu et al., 2020), etc. However, women leadership for scholarly publication is unopened and un-discussed a recent topic. Further, no analysis is reported on women authorship of scholarly publications on COVID-19 as it is very recent topic for research. First author conducts research and

prepares the manuscript for submission to the journal and last author gives elite contributions including preparation of project proposal, principal investigations, preparing methodology and checking manuscript before submission therefore first and last authors play a leading role in any scholarly publications (Tscharnke et al., 2007; Bendels et al., 2018). Further, corresponding authors communicate the manuscript to the journal, editorial system, keep communications with the editorial office, the editor and publisher for fulfilling all the requirements before publication. Therefore, the role of corresponding author is crucial and the leading in process of publication any manuscript. Thus, the share of women as first-, last and corresponding authors indicates not only prestige but leadership qualities for scholarly publications. The performance of research paper can be analyzed using citations and Altmetric tracking records to understand the quality of the publications. Therefore, the study focuses on analysis of women participation and leadership in the publication on COVID-19 based on authorships and performance of the publications. The results can be helpful for preparation of policies and monitoring the research projects, grants with feminist approach.

2 DATA AND METHODOLOGY

Several studies on authorship analysis are focused on the analysis of representation of women in authorship of scholarly publications in different fields including STEM, social sciences, cultural studies, etc. 1) The first authorship indicates the research abilities and manuscript writing skills, 2) last authorship indicates guiding and supervising abilities and skills, and 3) corresponding authorship leading in the publication process. Therefore, first-, last- and corresponding authors are leaders in research and processing of scholarly publications. Further, the qualities of the publication can be analyzed based on citations in scholarly publications and Altmatrix tracking records. Therefore, first-, last- and corresponding authorships and citations and Altmatrix tracking records can be considered as indicators of women leadership in scholarly publications. The analysis of women leadership can be outlined (Figure 1) as: 1) collection of metadata of scholarly publications, 2) preparation on master list of names with gender, 3) separation of authorship wise (first-, co-, last- and corresponding authors) names and first names, 4) the detection of gender using authors' first name recorded with scholarly publications; 5) identification of leadership indicators, 6) data analysis: authorship proportion, odds ratio, and 7) estimation leadership.

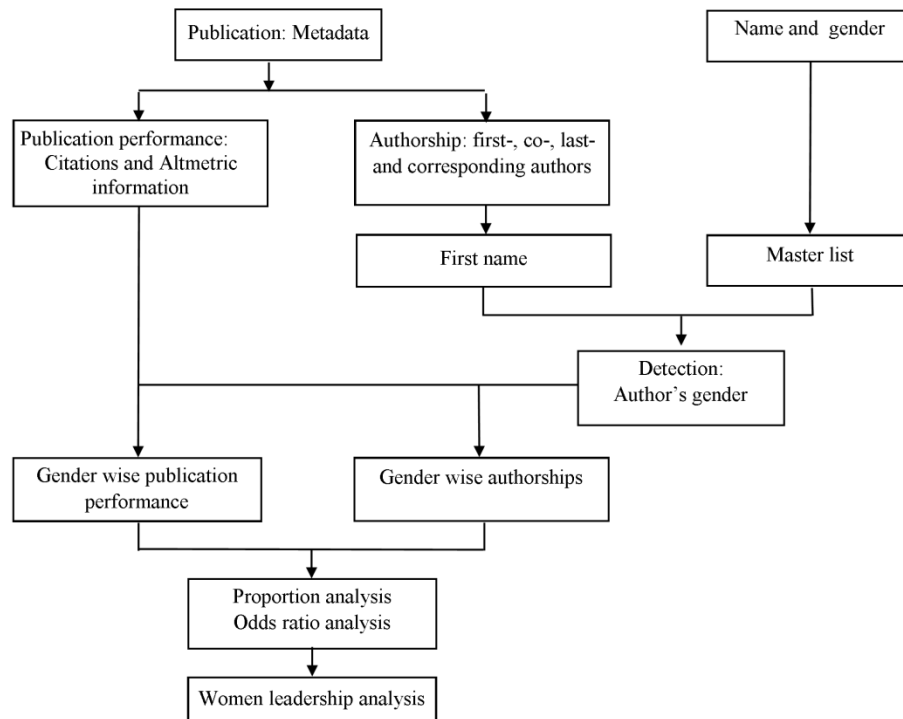


Figure 1. Methodology

2.1 Data

The analysis of women representation in authorship of scholarly publications requires information of authors, citations, Altmetric tracking records of publications on COVID-19. Several studies have used author records available at big-data systems like WOS, SCOPUS and records available at journals' homepages. All these data sources are limited to their own listing records which excludes large data of many contributions. 'Dimensions' (<https://www.dimensions.ai/>) is the database system established by Digital Science, Clarivate™ (<https://clarivate.com/about-us/>) in 2018 for database management of scholarly publications. It is free database of scholarly publication similar to WOS and SCOPUS (Thelwall, 2018). The system uses metadata records of all publications at Crossref (<https://www.crossref.org/>) which is prime source of the metadata. Crossref records DOI [Digital Object Identifier] with datasets of article title, list of authors, journal name, author affiliation(s), funding agency, copyright details, etc. They are also building a database of associated references. Therefore, Dimensions is more inclusive database for scholarly publications and source of inclusive data for analysis of women representation and leadership in scholarly publications (Hook *et al.*, 2018).

Metadata of published research papers on COVID-19 is available at dedicated link provided by Dimensions (<https://www.dimensions.ai/>) and can be downloaded in MS excel Spreadsheet. The information includes DOI,

title, list of authors, name of the journal, publishers, publication date and year, access details, affiliation of authors, city and country of the research conducted, funding agency, etc. We have downloaded and analyzed metadata of 15995 research papers published during August 2017 to April 2020. The author names are available in name list as first and last names separated with semicolon and comma.

2.2 Authorship Identification

2.2.1 Gender

Several scholars have used first name from the author list available with publication for detection of the gender (Budden *et al.*, 2008; Long *et al.*, 2015; Filardo *et al.*, 2016). Here, gender of the author was identified using first name (Table 1). Global dataset was used for the analysis and the gender meaning of the author name varies according to culture, religion, region, country, etc. Therefore, it is a very challenging task to detect the gender meaning from first name of the author for analysis of women authorship of the research publications. The detection of the author can be outlined as: 1) preparation of authorship list from the author list separated by semicolon which is available with the publication, 2) preparation of separate list of first-, co- and last- authors from the comma separated list, 3) checking and cleaning of the list, 4) preparation of authorship matrix of first names, 4) preparation of master lists of names with gender, and 5) detection of authors' gender using first names.

Table 1. Data sources

Type	Source	Links	Remarks
Publication: Metadata	Dimensions	https://covid-19.dimensions.ai/	Dedicated link for research documents on COVID-19 Used data: August 2017 to April 2020
Gender	US Social Security Administration	https://www.ssa.gov/oact/babynames/limits.html	Names by gender
	Genderize.io	https://genderize.io/	Names by gender
	Data World	https://data.world/arunbabu/gender-by-names	Gender by name
	Current Online Social Networks	https://sites.google.com/site/facebooknamelist/namelist	Facebook generated name and gender list
	Back4App	https://www.back4app.com/database/back4app/list-of-names-dataset	Gender by name
	Wikipedia: French names	http://en.wikipedia.org/wiki/French_name http://en.wikipedia.org/wiki/Category:French_feminine_given_names http://en.wikipedia.org/wiki/Category:French_masculine_given_names	
	Wikipedia: Korean Names	http://en.wikipedia.org/wiki/List_of_Korean_given_names http://en.wikipedia.org/wiki/Category:Korean_given_names	
	Wikipedia: Brazil/Portugal	http://en.wikipedia.org/wiki/Brazilian_name#Brazilian_names	

Author list is available in text format and converted in column form using ‘Text to Column’ function available in MS excel. The full name of the author was separated using semicolon and first and last name using comma. Additions like Dr., Miss, etc. appeared with first names were separated using space and removed from the list. For example ‘Dr. Seema’ was considered as ‘Seema’, ‘Santoshi Rani’ as ‘Rani’, Young-II is Young, ‘T. Alp’ is ‘Alp’, etc. The names showing both gender (male and female), unisex and ambiguous naming are excluded from the list. Some publications or authors show gender blind names like initials, they are also excluded in the analysis. Some publications show last names instead of first name and first names in the place of last names. They were made difficult to identify the gender of the author and reduced accuracy for the detection (Holman *et al.*, 2018).

The author name (first name) matrix ($p_n \times a_n$; $p = \text{publication}, a = \text{author}$) was prepared using authorship list of all publication considered for the analysis and the master list showing name and gender was prepared from the information available at different sources (Table). The names in author matrix were searched and compared with master list and detected gender of the author using the function ‘VLOOKUP’ in MS Excel.

2.2.2 Authorship Order

Authorship order: First-, co-, last-, corresponding-author shows relative contribution of the author in conducting the research and preparation of the manuscript (Rahman *et al.*, 2017). First author conducts

the research and last author makes study possible through his/her guidance and elite intellectual contributions including research proposal writing, principal investigation, manuscript checking, etc. (Haws *et al.*, 2018). Further, corresponding author keeps communication with editors and publishers during the editorial and publication processing. Therefore, First-, last- and corresponding authors are considered as prestigious positions in authorship of the co-authored publication. We have classified the author list into: first authors, co-authors, last authors and corresponding authors. The names listed at first and last position in the list was considered as first- and last authors, respectively and all listed authors were considered as co-authors. Most of the publishers mention the name of corresponding author, separately.

2.3 Authorship Analysis

2.3.1 Proportion Analysis

Proportion analysis indicates the share of women or men in total gender [women and men] detected authorship of scholarly publications. Authorship by gender blind e.g. unisex first name, entails, etc. authorships are excluded for the analysis. Here, proportion of women authorship (PF_A) was analyzed (equation (1)) as:

$$PF_A = \frac{F_A}{F_A + M_A} \times 100 \quad (1)$$

(after Bendels *et al.*, 2018)

F_A = female authors and M_A = male authors

PF_A is quantitative representation of women as first-, last-, corresponding and total authorship of scholarly articles (Bendels et al., 2018). Same proportions were calculated for men authors for comparisons.

2.3.2 Authorship Odds Ratio (FOR_A)

Authorship based on women leadership in scholarly publication on COVID-19 was calculated using female-to-male authorship odds ratio (FOR_A) (Bendels et al., 2018). It is ratio between share of female authorship position (first-, last-, corresponding- and co-authors) in female authorship excluding particular authorship and share of male authorships in male authors excluding particular position (Bendels et al., 2018). It can be calculated as:

$$FOR_{A_First} = \text{FemaleOdds}_{A_First} / \text{MaleOdds}_{A_First} \text{ after Bendels et al. (2018)} \quad (2)$$

$$\text{FemaleOdds}_{A_First} = \frac{\text{Female}N_{A_First}}{\text{Female}N_{A_Co} + \text{Female}N_{A_Last}}$$

$$\text{MaleOdds}_{A_First} = \frac{\text{Male}N_{A_First}}{\text{Male}N_{A_Co} + \text{Male}N_{A_Last}}$$

Where, $\text{Female}N$ and $\text{Male}N$ are number of female and male authorship according to types. Bendels et al. (2018). A_First are first-, A_Co are co- and A_Last are last authors. Bendels et al. (2018) have used this ratio for identification of prestige of women authorship. As first authors are conducting research, last authors are contributing major intellectuals to make possibilities of publications and corresponding author communicating the manuscript with editorial system of the journal, FOR_A was calculated for first-, last and corresponding authors to find out the women leadership in publications on pandemic COVID-19. FOR_A for corresponding author was calculated as:

$$FOR_{A_Cr} = \text{FemaleOdds}_{A_Cr} / \text{MaleOdds}_{A_Cr} \text{ after Bendels et al. (2018)} \quad (3)$$

$$\text{FemaleOdds}_{A_Cr} = \text{Female}N_{A_Cr} / \text{Female}N_A$$

$$\text{MaleOdds}_{A_Cr} = \text{Male}N_{A_Cr} / \text{Male}N_A$$

where, A_Cr are corresponding authors and A is authorship.

Here, it is considered that corresponding author is one of the listed authors of scholarly publication. Therefore, odds for women (FemaleOdds_{A_Cr}) and men (MaleOdds_{A_Cr}) authors were calculated as women corresponding authors ($\text{Female}N_{A_Cr}$) to all women authors ($\text{Female}N_A$) and men corresponding authors ($\text{Male}N_{A_Cr}$) to all men authors ($\text{Male}N_A$).

2.4 Citation Analysis

Citations of the scholarly publication represent the performance as academic, institutional and social recognitions of author (Ghias et al., 2015; Holman et al., 2018). Therefore, the proportion and odds ratio of

citations of scholarly publication by women authors were calculated.

2.4.1 Proportion Analysis

The proportion of citations (PF_C) (equation (4)) recorded for scholarly publication by women was calculated using citation records for publications by women (F_C) and men (M_C).

$$PF_C = \frac{F_C}{F_C + M_C} \times 100 \quad (4)$$

PF_C is helpful to understand the comparative academic performance of scholarly publication by women. Results are multiplied by 100 for better readability.

2.4.2 Female-to-Male Citation Odds Ratio (FOR_C)

Odds for citations of publications by women (FemaleOdds_C) (equation (5)) and men (MaleOdds_C) was calculated to estimate the female-to-male odds ratio (FOR_C) for first (C_First) and last (C_Last) authors. $\text{FemaleOdds}_{C_First}$ was calculated with reference to citations for publication authored by first male ($\text{Male}N_{C_First}$) and unisex ($\text{Unisex}N_{C_First}$) authors and $\text{MaleOdds}_{C_First}$ with reference to citations for publications by women ($\text{Female}N_{C_First}$) and unisex authors. Here, unisex includes all gender blind authorships. These odds give comparative performance of publication by women and men.

$$FOR_{C_First} = \text{FemaleOdds}_{C_First} / \text{MaleOdds}_{C_First} \quad (5)$$

$$\text{FemaleOdds}_{C_First} = \frac{\text{Female}N_{C_First}}{\text{Male}N_{C_First} + \text{Unisex}N_{C_First}}$$

$$\text{MaleOdds}_{C_First} = \frac{\text{Male}N_{C_First}}{\text{Female}N_{C_First} + \text{Unisex}N_{C_First}}$$

Similar equations were composed for calculation of FOR_C for citations of publications by women and men last authors.

Per article citations (PAC_W) were calculated (equation (6)) to understand comparative quality of the publications by female authors to publications by male authors.

$$PAC_W = \frac{C_W}{A_W} \quad (6)$$

where, C_W = citation appeared for scholarly publications by female authors; A_W = number scholarly publications female authors. This calculation will be helpful to understand comparative performance in the leadership qualities of women.

2.5 Altmetric Analysis

Altmetric tracks the attention of scholarly community and society at large to scholarly publications in the forms of research outputs, policy documents, mainstream media, blogs, online referencing system, post publication peer-review forums and systems,

popular social medias, patents and other online sources like Wikipedia, etc. (<https://help.altmetric.com/support/solutions/articles/6000060968>). Altmetric tracking records help to understand the level of social attention for published materials. Therefore, the proportion and female-to-male odds ratio were calculated for the estimation of women leadership in scholarly publications.

2.5.1 Proportion Analysis

The proportion of Altmetric analysis of scholarly publications by women and men as first and last authorships was performed as:

$$PF_{Al} = \frac{F_{Al}}{F_{Al} + M_{Al}} \times 100 \quad (7)$$

F_{Al} = Altmetric recorded for articles by female authors and M_{Al} = Altmetric recorded for articles by male authors. PF_{Al} shows quantitative representation of Altmetric of research papers published by women authors.

2.5.2 Female-to-Male Altmetric Odds Ratio (FOR_{Al})

FOR_{Al} was calculated based on odds estimated for women ($FemaleOdds_{Al}$) and men ($MaleOdds_{Al}$) first ($Al\ First$) authors as:

$$FOR_{Al_First} = FemaleOdds_{Al_First} / MaleOdds_{Al_First} \quad (8)$$

$$FemaleOdds_{Al_First} = \frac{FemaleN_{Al_First}}{(MaleN_{Al_First} + UnisexN_{Al_First})}$$

$$MaleOdds_{Al_First} = \frac{MaleN_{Al_First}}{(FemaleN_{Al_First} + UnisexN_{Al_First})}$$

Similar formulae were composed for analysis FOR_{Al} for first ($Al\ First$) authors. Unisex includes all gender blind first names: initial and names.

2.6 Funding Analysis

Only few authors have recorded their names of funding agency with published articles. The proportion of research articles by female authors with recorded funding agencies by women and men scholars was calculated to understand the share of financial support to women author.

$$PF_F = \frac{F_F}{F_F + M_F} \times 100 \quad (9)$$

F_F = number of funding agency for articles by female authors and M_F = number of funding agency for articles by male authors. PF_F shows quantitative representation of funding support for research papers published by women authors

2.7 Leadership Analysis

Several studies have analyzed the representation of women in scholarly publications and reported underrepresentation. Women represent only 30% of authorship. Scholars have analyzed women

representation as first-, last-, co- and corresponding authors as well as patterns collaborations and network in research and publications, citations in scholarly publications, pattern of comments on scholarly publications, etc. First, last and corresponding authorship are prestigious and leading in scholarly publications. Further, citations of publications are indicator of quality and Altmetric tracking shows attention from the scholarly society. Therefore, authorship as first, last and corresponding and quality indicators viz. citations and Altmetric records were considered as indicator of the women leadership in scholarly publications. Odds ratio is an indicator of comparative representation and performance of women authors for these indicators. Thus leadership of women in scholarly publications on COVID-19 can be calculated as:

$$\begin{aligned} \text{Leadership index} = & FOR_{A_First} + FOR_{A_Last} + \\ & FOR_{A_Corresponding} + FOR_{C_First} + \\ & FOR_{C_Last} + +FOR_{AL_First} + \\ & FOR_{AL_Last} \end{aligned} \quad (10)$$

If, FOR ratio is equal to '1', then representation of women and men is distributed equally and if it is less than 1, then representation of men is more than the women and if this value is more than 1, then representation of women is more than the men. Thus, equality value for leadership is 7 ($n \times 1 = 7, n = 7$). The value more than 7 will be interpreted as women leadership in scholarly publications COVID-19.

3 RESULTS AND DISCUSSIONS

Very recently, Wu *et al.* (2020) have reported under representation of women as: 1) fewer prestigious authorships including first-, last- and corresponding authors, 2) less attempt of reading, sharing, citations, 3) less willingness to submit papers for publication in the journals and act as reviewer, 4) longer duration of editorial processing due to women submission of papers to high standard journals, 5) less response from men reviewers to calls from women editors, 6) less coverage in media for women authored papers, etc. Further, Frances *et al.* (2020) have noted less number of co-author due to tendency of women authors to collaborate with men co-authors. Similarly, Wu *et al.* (2020) also reported that women collaborate less with men and credited less if women collaborated with men (Wu *et al.*, 2020). Several scholars have reported fewer publications by women authors. However, number of citations for publications by women authors is less due to fewer publications than the men but not due to quality of publication (Cole and Zuckerman, 1984; Long, 1992). Therefore, proportions of publication by women authors as first-, last- and corresponding authors were analyzed and the focus was laid on understanding the qualitative results of publications. Odds ratio was calculated for this qualitative understanding of women's contributions. Authorships as first-, last- and corresponding author are leading positions in publication process and representation. Further, citations' records and Altmetric

tracking records of publication are giving qualitative picture of the publication. Therefore, comparative analysis of leading authorship and quality analysis using citations and Altmetric tracking were used as indicators of leadership analysis of women authorship in scholarly publications.

3.1 Authors' Gender

Several scholars have detected gender of authors' based on first name for analysis of women representation in scholarly publications. However, detection of person's gender is very complicated process as many parameters are involved in gender meaning of recorded first name (Santamaria and Mihaljevic, 2018) as the gender meaning of first name varies according to culture, region, religion, nation, etc. About 14846 articles of selected 15965 articles have declared their 80389 authorships including first-, co-, last- and corresponding authors. In this study, first name was used for detection of authors' gender and 94% (75781) authors' names were observed gender sensitive. Gender blind first names including unisex, initial were excluded from the analysis. Metadata was downloaded from dedicated page for COVID-19 at Dimensions. As this metadata is coming from Crossref and some database systems made not mandatory to declare their authorship with first name or gender sensitive first names. Some authors have recorded their initials or kept blank.

3.2 Authorship

First-, co- and last authors were delineated from the semicolon separated array of the author names in database. List of corresponding authors is given in a separate column and separated from the list for analysis. About 15% articles show single author, 22.8% show double authors, 11.8% show three authors and 9.2% show four authors (Figure 2). About 59% articles show authorship of less than 4 articles and average per article authors are 5. The proportion of women authors is 40.74% and for men is 59.26% in gender detected authorships (Table 1).

First authors are 18% of the total declared authorship, equal authors are detected as the last authors and 58.2% are co-authors. Any one from author list can be worked as corresponding author for the article and some articles show multiple corresponding authors. Only 5.3% authors were showed declared corresponding authorship.

Several scholars have showed under representation of women as first, last and corresponding authorships

(Larivière *et al.*, 2013). Here, about 46.6% of first authors are women and 53.40 % are men (Table 2). Last women authors are 37.74% and men are 62.26%. Similarly, corresponding authorship also biased, only 36.78% of total corresponding authors are women and 63.22 men.

We have calculated average proportion of first women and men authors counted based on the number of authors as per research paper. Average proportion of women is about 38.8% and of men about 61.2% (Figure 2). The proportional difference between women and men authors was 6.8% for single authored articles, 11.9% for double authored article and observed between 20 and 25 for majority of articles with authors more than two. Similarly, average proportion of women last authors was 35.1% and men 64.9%. Average difference between proportion of women and men last authors was 29.9% and this difference was about 11.1% for last authors of article written by two authors (Figure 4). One observation needs to be recorded here that difference between first and last women and men authors is notably considerable for articles written by single or double authors. Gap between women and men authors is widening with increasing number of team members conducting research and writing research articles. It is supportive to findings of Wu *et al.* (2020) about less collaboration of women with men and women credited less if collaborated with men. The studies conducted on research collaborations show need of collaborations in multiple scholars, institutions, etc. for better performance of research (Wuchty *et al.*, 2007). Multiple authored papers are attracting more attentions from scholarly community like citations than the single-authored papers (Kyvik and Teigen, 1996). The study shows a decrease in number of women authors with increasing number of authors of published articles. Last and corresponding women authors are also fewer than the men. This analysis supportive to the findings of scholars like West (2013), Bendels *et al.* (2018) and Mueller *et al.* (2016): Men dominance in prestigious authorship as first, last and corresponding author. Social status and career progress of the scholar are fully relying on author positions (Bhagat, 2018). The study shows less share of women authorship as last and corresponding author as several scholars reported in their studies (Haws *et al.*, 2018). As research related to COVID-19 is more biological, better achievement of women is observed as first author. Similar observation was reported about women contributions in research health and life sciences by GGRL (2017).

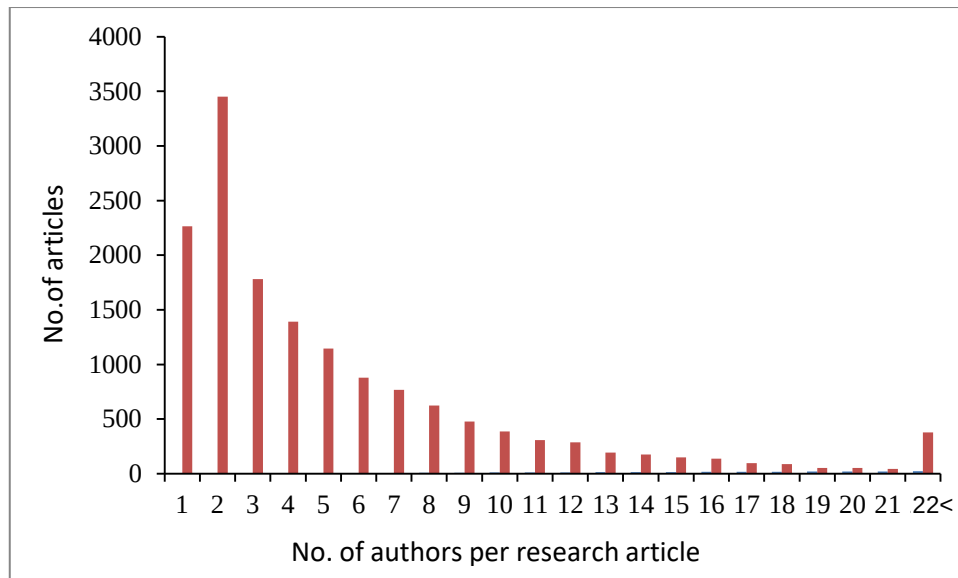


Figure 2. Research papers and authorship

Table 2. Authorship proportion

First authors		Last authors		Corresponding authors		Total authors	
Female	Male	Female	Male	Female	Male	Female	Male
46.60	53.40	37.74	62.26	36.78	63.22	40.74	59.26

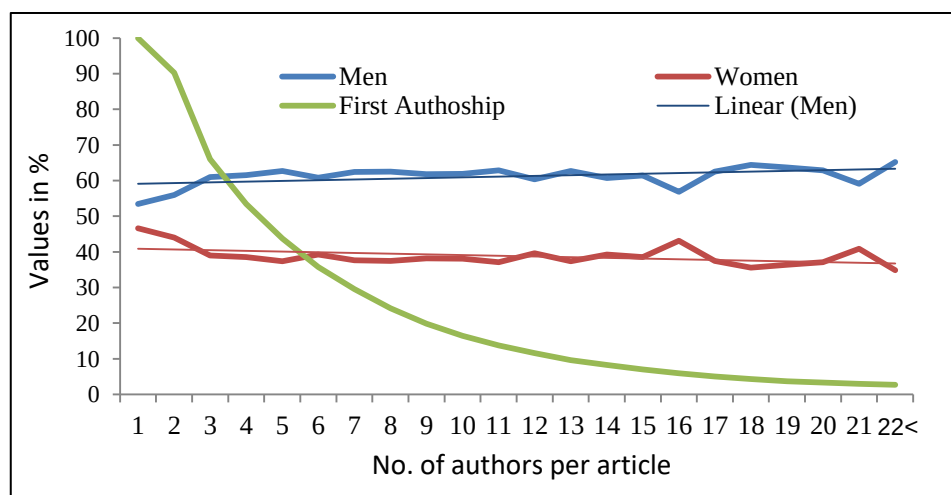


Figure 3. First authorship and proportion of women and men

Female-to-male odds ratio was calculated to understand the share of women contributions in the authorship of scholarly publications. It is the ratio of calculated female odds and male odds. First-, last- and corresponding authorships are leading and prestigious positions, therefore considered as indicators of women leadership in authorship of scholarly publications. Female odds for first authorship were estimated about

0.26 and male odds was 0.20. Therefore, female-to-male odds ratio was 1.34 indicating the prestigious first authorship by women and men leadership in writing research papers. However, female odds for last and corresponding author were less than the men and calculated female-to-male odds ratio were 0.86 and 0.86, respectively. Here, prestigious positions were acquired by men authors.

3.3 Citations

Many scholars have reported fewer publications by women with fewer citations in scholarly publications (Larivière *et al.* 2013a). It is proved that number of citations was less due less publication than the men not due to quality of publication (Cole and Zuckerman, 1984; Long, 1992). The number of citations of scholarly publication is indicator of quality and applicability of the research.

Average citations of published papers on COVID-19 were calculated as 2.6 citations/article. Average citations of papers authored by women as first author (3.12%) are more than the citation of papers by men first authors (1.84). The proportion of citation of papers by women first authors (59.7%) are also more than men first authors (40.3%) though women have published less than the men (Table 4). However, citations of paper by women (40.6%) as last author is fewer than the men (59.4%) last authors. Average citations of papers by women last authors are almost similar to men last authors. Similar observation was noted by Bendels *et al.* (2018). As discussed above, first authors are junior and conducting the research and last authors are senior and guiding the research. Therefore, junior women scholars are acquiring a leading position in research

projects and authorship of scholarly articles on COVID-19.

Similar observations are noted from female-to-male odds ratio calculated for citations by women first and last authors. Odds calculated for first women authors was 1.08 and men first authors was 0.54 therefore, ratio was 2.00 (Table 5). The calculated value of female-to-male odds ratio was double than the value showing equal (1) contributions by women and men. However, this ratio calculated for last authorship shows far less (0.54) than 1. Men show leading citation than women as last authors.

3.4 Altmetric Tracking

Altmetric tracking records show attentions from scholarly community and society towards published scholarly documents. It gives clear picture of social attaining, influence and applications of the research outputs. Share of women and men scholars in Altmetric tracking records shows influence, leadership and contributions in research and scholarly publications. Therefore, proportion of Altmetric records of women first and last author, per article Altmetric records and female-to-male odds ratio were calculated to understand women contributions and leadership in scholarly publications on COVID-19.

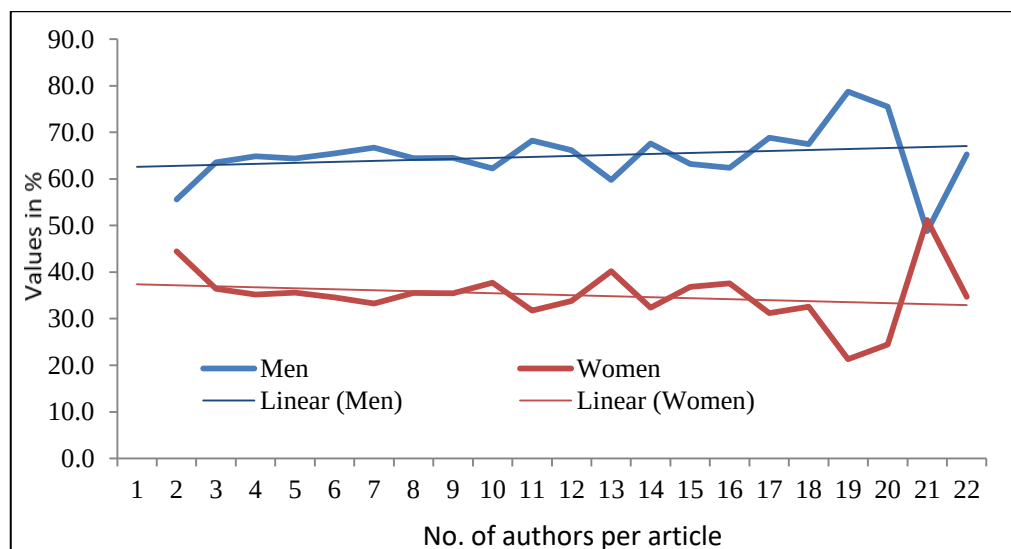


Figure 4. Women and men proportion of last authorship

Table 3. Female-to-male authorship odds ratio

First authors			Last authors			Corresponding authors		
Female Odds	Male Odds	FOR	Female Odds	Male Odds	FOR	Female Odds	Male Odds	FOR
0.26	0.20	1.34	0.18	0.21	0.86	0.05	0.06	0.85

About 51.5% share of Altmetric records was estimated for women first author and 48.5% for men first authors. These records for papers having women last authors (38.1%) show less than the men (61.9%). However, per paper Altmetric records were observed more for papers authored by women first and last author than the men (Table 5). Therefore, as far as Altmetric records are concerns research papers authored by women first- and last authors performed more than the men. This finding nullifying the observation noted by Wu *et al.* (2020) as less media coverage for women authored papers.

Female-to-male odds ratio calculated for Altmetric records of women first authored papers is more than the men and nearly half for last authored papers (Table 5). Altmetric records of articles by women first authors are 10% more than the value (1) showing equal contribution. Therefore, this record and analysis show quality publication by women first authors with leadership qualities.

3.5 Funding for Research Papers

About 1304 articles show funding source with their metadata (Table 6). It is notable that funding support for research and articles published by women and men first

author is almost equal. But, funding support for research published article authored by last women authors is far less than the men.

3.6 Women Leadership

Several studies have focused on analysis of representation of women in authorship of published scholarly papers with different dimensions like authorship position, productivity, collaboration patterns and networking, attention from scholarly community and society, responses from men scholars for women calls as editors, authors, reviewers, etc. However, calculation of women leadership is an unopened topic. Here, it is considered that author positions viz. first, last and corresponding author is very crucial and leading at all the stages of research conducting, reporting and publication for large attention. Citations in scholarly publication and attention from scholarly community and society for published research give importance and applicability of the publications. Therefore, 1) authorship as first, last and corresponding author and 2) research performance appeared as citations and Altmetric records are considered as indicators for calculation of leadership of women in scholarly publications on COVID-19.

Table 4. Citation analysis

Credits	First authors		Last authors	
	Female	Male	Female	Male
Citations				
%	59.7	40.3	40.6	59.4
Per article	3.1	1.8	2.5	2.3
Altmetric				
%	51.5	48.5	38.1	61.9
Per article	118.7	97.6	107.2	59.6

Table 5. Female-to-male credits odds ratio

	First authors			Last authors		
	Female Odds	Male Odds	FOR	Female Odds	Male Odds	FOR
Citations	1.08	0.54	2.00	0.44	0.81	0.54
Altmetric	0.79	0.72	1.11	0.40	0.88	0.46

Table 6. Funding support for research papers

Funding details	First authorship	Last authorship
Recorded funding agencies with research paper	1304	
Funding agencies of gender detected authors	1123	986
Funding agencies of women authors	555 (49.42%)	350 (35.50%)
Funding agencies of men authors	568 (50.68%)	636 (74.5%)

Female-to-male odds ratio was used for analysis of representation of women as prestigious author of scholarly publication (Bendels *et al.*, 2018; 2018a). Here, this female-to-male odds ratio is used for analysis of women leadership in the scholarly publications in COVID-19. The calculated female-to-male odds ratio for each indicator was summed to get total effect of calculated ratio. Calculated leadership index was 7.16 and more than value of equality ($7; n \times 1 = 7, n = 7$). The value 1 shows equality for each indicator and total used indicators are 7, therefore equality value for this analysis is 7.

Here, it is notable that female-to-male odds ratio for first authorship, citations and Altmetric records of research papers by first women authors was estimated higher than the values for last, corresponding authors and citations and Altmetric records of research papers by last women authors were fewer than the men. It means that women are establishing their leadership as first authorship. Leadership through last and corresponding authorship is the next object for women scholars. Scholars have reported disparities for women scholars as: fewer institution support and access to laboratory facilities (NRC, 2010; Duch *et al.*, 2012), less earning for equal or more work (NRC, 2010; Shen, 2013), need higher performance for successful professional careers (Ghias *et al.*, 2015; Besselaar and Sandström, 2016), etc. The results of this analysis show higher potential of women leadership in scholarly publications even in condition of fear and pressure of COVID-19. Successful implementation of policies for elimination of the said disparities in scholarly community, institutions and society will be helpful for successful women leadership in research and scholarly publications.

Feminist analysis and reform in educational policies, institutional setup, socio-economic organizations, political and cultural canvas will be helpful to reduce the gap between women and men in research and scholarly publication (Holman *et al.*, 2018). The present analysis will be helpful for the preparation of gender sensitive policies for research on STEMM, social sciences, law, governance and management by governmental and non-governmental organizations to achieve social justice at local, regional and global level.

4 CONCLUSIONS

Women are continuously underrepresented in the authorship of scholarly publications. 1) The authorship positions as first -, last and corresponding author and 2) performance as citations and Altmetric records of published papers are indicators of leadership qualities of the author. Comparative leadership qualities of women authors were calculated using odds ratios. Proportion analysis was performed to get comparative contributions and per article citations and Altmetric records to understand the quality of publications. Information about scholarly publications was downloaded from Dimensions and data about names and gender was

collected from different online sources. Author's gender was detected based on the first name.

The proportions of women authorship as first-, last- and corresponding author were calculated to understand the share of women in scholarly publications. Women show underrepresentation in the authorship of scholarly publications on COVID-19. Female-to-male odds ratio was calculated for these authorships and performance was calculated of research papers authored by women as first and last authors. Female-to-male odds ratios calculated for 1) women authorship as first author and 2) citations and Altmetric tracking records for articles authored by women as first author were more than 1. Further, 1) women authorship as last- and corresponding author, and 2) citations and Altmetric tracking records for articles authored by women as last author are show calculated value less than 1. All these ratios were considered as indicators of women leadership in scholarly publications on COVID-19. Leadership index was calculated to understand the level of women leadership in this field. Calculated leadership index for women (7.11) shows leadership qualities of women authors. Financial support provided was almost equal for research reported in women and men first authored papers. The field is very new; it is an active and challenging area of research for social justice and welfare society. The method and results reported in the paper is useful for the preparation of research policies and monitoring the research projects, grants with feminist approach.

ACKNOWLEDGEMENTS

Author is thankful to Dimensions (<https://www.dimensions.ai/>) for metadata of scholarly publications and US Social Security Administration, Genderize.io, Data World, Current Online Social Networks, Back4App and Wikipedia for information of names with their gender. Author is thankful to anonymous reviewers and the processing editor for constructive comments and suggestions on the manuscript.

CONFLICT OF INTEREST

The author declares no conflict of interest.

ABBREVIATIONS

DOI: Digital Object Identifier; **STEMM:** Science, Technology, Engineering, Mathematics and Medicine; **WOS:** Web of Science.

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