

Altmetric gender bias? – An exploratory study

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ABSTRACT

The purpose of this study was to explore the existence of a gender bias in scholarly social media, specifically in the free, online reference manager Mendeley. Users of the online reference manager, Mendeley, are designated as “readers”, and Mendeley records and displays the number of users (“readers”) who saved/bookmarked the specific item to their reference libraries. In this paper we compare the number of readers of articles for which at least one author was male to the number of readers of articles for which at least one author was female. Our dataset was comprised of the publications of 60 women and 233 men. The researchers in this study were astrophysicists. Thomson Reuters’ Web of Science (WOS) was used to retrieve 12,000 publications of the above mentioned researchers. We searched for the number of Mendeley readers of each of these publications and calculated the average number of readers per male versus female authored publications. The analysis shows that the average number of readers of publications of female authored publications was slightly higher than that of male authored publications, but the proportion of male authored publications found on Mendeley was slightly higher than on Web of Science. In addition male authored publications had the highest number of Mendeley readers in the dataset. To sum up, this exploratory study did not find concrete evidence for gender bias on Mendeley.

KEYWORDS

Mendeley — Astrophysicists — Gender bias.

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1. Introduction

Gender bias in science has been studied extensively. Most studies point to a gender gap between men and women in terms of number of publications and citations. Early studies of Ferber [1]-[2] showed that authors tended to cite larger numbers of authors of their own gender, than the opposite gender, putting women at a disadvantage. West, Jacquet, King, Corell and Bergstrom [3] addressed the role of gender in academia from a perspective of productivity. While examining the JSTOR database on more than eight million papers across the natural sciences, social sciences, and humanities, they showed the existence of gender inequalities: less female authors, and less single authored papers by women, but they concluded that: “data do not allow us to uncover mechanisms that produce the gender disparities we find” (p. 6).

In a recent paper, Larivière, Ni, Gingras, Cronin and Sugimoto [4], conducted a global cross-disciplinary bibliometric analysis of more than 5 million research papers. They focused on the relationship between gender and research output, the extent of collaboration, and scientific impact of all articles pub-

lished between 2008 and 2012 and indexed in Thomson Reuters’ Web of Science database. They found that in the most productive countries, all articles with females in dominant author positions, receive fewer citations than those of males in the same position. Addressing collaboration, it seems that female collaborations are more domestically oriented, and concerning impact, analysis shows that when a woman was a sole author, first-author and last-author, the paper attracted fewer citations than in cases in which a man was in one of these roles. Asknes, Rorstad, Piro and Sivertsen [5] carried out a large-scale study of 8,500 Norwegian researchers and more than 37,000 publications and also found that female researchers are less cited. The explanation they offer is that differences in citation rates can be attributed to differences in productivity.

Ceci and Williams [6] reviewed a number of studies and concluded that there was no sex discrimination either in journal reviewing or in grant funding, thus these are not the causes of under representation of women in math-intensive fields. van Arensbergen, van der Weijden and van den Besselaar, [7] conducted a study of 852 social scientists and concluded that younger fe-

male researchers outperform younger male researchers. Marsh, Bornmann, Mutz, Daniel and O'Mara [8] carried out a meta-analysis and concluded that the gender differences in the peer review processes of grant proposals are very small. In two recent studies, van der Weijden and Calero Medina [9]-[10] showed that men produce on average more than women, but in terms of research impact based on field normalized indicators, no gender differences were found.

In spite of the contradictory conclusions of previous research presented above, there is a general perception that there is gender bias in science. There is also continued interest and debate on the existence of gender bias and ways to overcome it in the EU, as can be seen from the tri-annual publication of the "She Figures" [11]. In this study we set out to examine whether there are gender specific differences, when instead of citations we consider an altmetric, more specifically Mendeley readership counts.

2. Online Dissemination of Knowledge

The web has provided new opportunities for academics to disseminate their research results. Online CV's, homepages or publication lists for scholarly related activities of academics are examples. They can include wider publication types (e.g. journal of conference papers, books, and reports) and pre-prints, which are not indexed by major scientific databases. In this way, Academic Web CVs or online lists of publications (institutional or personal) can be a significant method to facilitate knowledge transfer [12]. Furthermore, online CVs or resumes can be updated frequently and scientists can share bibliographic information, abstract or even the full-text of published or in press research through personal or institutional self-archiving practices. In an earlier study [9] it was shown that gender has impact on the Web presence (having an online CV or an individual webpage for publication lists) of academics across fields: males are more active compared to females.

Reference managers are tools that can help researchers, students and others interested in reading scientific publications to organize their documents. If the reference manager is online and documents or details of the documents saved to it can be viewed by others, authors can also utilize this tool to disseminate their publications. Mendeley (mendeley.com) is a free and widely used online reference manager that provides aggregated counts of the number of users who bookmarked an item, i.e. saved a document or its metadata (bibliographic information) to their Mendeley libraries. Mendeley calls this the number of "readers", although we cannot be certain that users who save items to their libraries actually read them.

Zahedi, Costas and Wouters [13]-[14] provided a characterization of Mendeley users. For each document, in the Mendeley database, the top three most frequently occurring academic statuses (students, postdocs, researchers, professors, professionals, librarians etc.) is displayed. They analyzed two large samples and found that about 50% of the readers are what they call "scientific readers", who are also potential citers. On the other hand,

the rest are either "professional" or "educational readers" or their status is unknown (because Mendeley does not provide a complete breakdown of the status).

Previous studies showed that Mendeley readership counts is one of the most promising altmetric [15], both because of Mendeley's large coverage and because several studies showed significant, medium strength correlations between readership and citation counts. One of the first studies on Mendeley readership counts versus citations was conducted by Li, Thelwall and Giustini [16]. They found that the correlations between readership counts and citations for articles published in Nature and Science were of medium strength, around 0.5 and significant. More than 90% of the Nature and Science articles included in the study were found in Mendeley. Bar-Ilan et al. and Haustein et al. [17]-[18] compared Mendeley readership counts and citations of the publications of 57 bibliometricians. In this case, the set of publications was less prestigious than Nature or Science articles, still Mendeley's coverage was 82%, and in this case two the correlations between citations and readership count were around 0.5. Bar-Ilan [19]-[20] also studied the set of all the articles published in the Journal of the American Society for Information Science and Technology published between 2001 and 2010 (2011 in [19]). For this set the coverage was almost perfect, 97.5%, and again the correlations between readership counts and citation were similar to the results in the previously mentioned studies. For a review of the early Mendeley studies the reader is referred to [21].

Additional large scale studies showed similar trends both in terms of correlations between readership counts and citations. Correlations were 0.516 for the social sciences and 0.428 for the humanities. Zahedi, Costas and Wouters [15] studied a random set of 20,000 WoS publications, and found that Mendeley covered about 37% of the sample and the correlation between readership counts and citations was 0.49. Mohammadi and Thelwall [22] studied all social science and humanities publications published in 2008 and indexed by WoS, and looked for readership counts for these items. In this case the coverage was 58% for the social sciences but only 28% for the humanities. Rather interestingly, in a study of more than 5000 publications of 100 astrophysicists indexed in Scopus, the coverage of Mendeley was only 41%, and the correlation between citations and readership counts was also lower than in most other studies, only 0.23. This might be explained at least partially by the popularity of arXiv, an open access repository of e-prints in several fields, including astrophysics. Astrophysicists and astrophysics students possibly feel less inclined to use a reference manager, when almost everything is readily and freely available in this open access repository.

In this study we investigate gender-specific differences in Mendeley readership counts, concentrating on astrophysicists. To the best of our knowledge this is the first study to investigate possible gender bias using altmetric sources and measures.

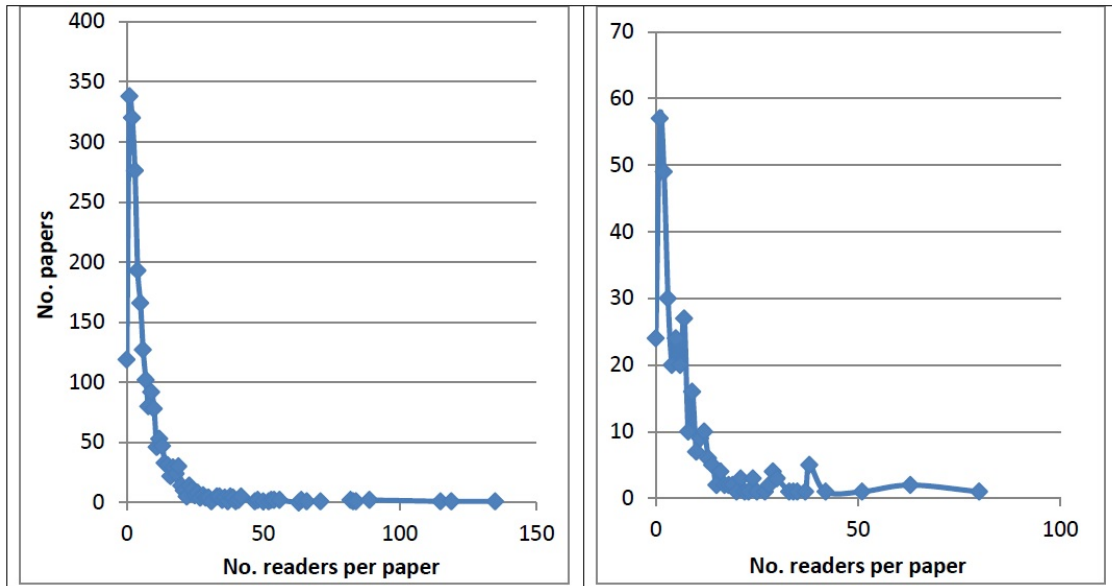


Figure 1. Reader distribution by gender of the author: Men on the left, women on the right.

3. Research Setup

Our dataset is based on the common dataset of the EU funded FP7 ACUMEN project (<http://research-acumen.eu/>). The data are comprised of a set of 494 astronomers and astrophysicists from 14 EU countries and Israel. The gender of all researchers was verified. Publications of these researchers were retrieved from Thomson Reuters' Web of Science (WOS) using the "Large scale author name disambiguation using rule-based scoring and clustering" algorithm developed at CWTS to detect publications per researcher [23]. This step resulted in a list of 27,645 publications. Some of the publications are repeated in the set, because the data retrieval step from the Web of Science provided for every researcher his full list of publications, and a number of publications were co-authored by several authors in the dataset. It should be noted that hyperauthorship [24] is quite frequent in astrophysics publications.

For 60% of the publications in the list WOS provided DOIs. When submitting the DOI of a publication, the Mendeley API retrieves the number of readers of this publication. Thus this method allows to search for only 60% (16,791) publications indexed by the Web of Science, and retrieves only those publications in the Mendeley database for which the users added the DOI of the publication. It should be noted that Mendeley is not a systematic index, items are being added by users of the service, and even though there are tools to easily add items to the personal libraries, without the need to manually add bibliographic information, users can choose to add this information manually, and thus the bibliographic information may be incomplete or may contain errors.

To partially overcome these problems and to cover publications for which WOS did not provide a DOI, and also to retrieve readership counts of items covered by Mendeley, but for which

no DOI is provided in Mendeley, we conducted title searches using Webometric Analyst 2.0 developed by Mike Thelwall (<http://lexiurl.wlv.ac.uk/>) on a subset of 12,000 publications (43.4% of the publications listed in the dataset). It should be noted that title searches are not straightforward, because special characters are not always recognized by Mendeley, and titles are not always written identically on WOS and Mendeley. As mentioned above, Mendeley is built by its users, and users do not always provide accurately the metadata describing the item. Thus partial titles were searched and these were matched with the original list of titles, checking source, year, author and DOI when available. In these searches continuous substrings from the title not containing special characters were submitted to Webometric Analyst 2.0. Readership data were collected at the beginning of March 2014.

4. Results and Discussion

Mendeley readership counts were searched for 293 researchers (59.3% of the researchers in the original dataset) and their 12,000 publications (43.4% of the total in the original dataset). Out of the 293 researchers in this subset, 60 were women (.5%) and 233 men. Women authored 1778 publications (14.8%). The percentage of women and their publication share in the subset were almost identical to the respective percentages in the whole set of 20.5% female researchers and 14.7% women authored publications.

We located 2,711 publications in Mendeley (23%). Out of the female authored publications, 360 were found in Mendeley (20%), compared with 2351 male authored publications (out of 10,222, 23%). Thus there seems to be a slight "advantage" of male authored publications to be found on Mendeley, at least in this subset. Male author's publications indexed by Mendeley,

Table 1. Sample of AIED Most read papers co-authored by female author.

Title	Source	Year	Mendeley readers	WOS citations
Kepler Detected Gravity-Mode Period Spacings in a Red Giant Star	SCIENCE	2011	80	57
Climate and carbon-cycle variability over the last millennium	CLIMATE OF THE PAST	2010	63	76
Climate forcing reconstructions for use in PMIP simulations of the Last Millennium (v1.1)	GEOSCIENTIFIC MODEL DEV.	2012	63	28
Kepler-22b: A 2.4 EARTH-RADIUS PLANET IN THE HABITABLE ZONE OF A SUN-LIKE STAR	ASTROPHYSICAL J.	2012	51	71
THE NINTH DATA RELEASE OF THE SLOAN DIGITAL SKY SURVEY	ASTROPHYSICAL J. SUPP	2012	42	110
THE EIGHTH DATA RELEASE OF THE SLOAN DIGITAL SKY SURVEY: FIRST DATA FROM SDSS-III	ASTROPHYSICAL J. SUPP	2011	38	328
CpG-free plasmids confer reduced inflammation and sustained pulmonary gene expression	NATURE BIOTECHNOLOGY	2008	35	101
THE zCOSMOS 10k-BRIGHT SPECTROSCOPIC SAMPLE	ASTROPHYSICAL J. SUPP	2009	34	138
The Detection of a Population of Submillimeter-Bright, Strongly Lensed Galaxies	SCIENCE	2010	33	94
Local supermassive black holes, relics of active galactic nuclei and the X-ray background	MONTHLY NOT. ROYAL ASTRO. SOC.	2004	30	629
ON THE COSMIC EVOLUTION OF THE SCALING RELATIONS BETWEEN BLACK HOLES AND THEIR HOST GALAXIES	ASTROPHYSICAL J.	2010	30	107
Recovering galaxy stellar population properties from broad-band spectral energy distribution fitting	MONTHLY NOT. ROYAL ASTRO. SOC.	2012	30	27

were “read” by 7.1 readers on average, while for female authored papers indexed by Mendeley the average number of readers was 7.7.

Thus the findings show that in terms of the percentage of publications found on Mendeley men have a slight advantage, but in terms of the average number of readers, the women are doing better, the median number of readers is 4 for men and 4.5 for women. On the other hand the most-highly read publications in the dataset were authored by men, as can be seen from Figure

1. The distributions are similar in shape, but the most-read item by a male author was read 135, while the most “read” item by a female author was only “read” 80 times.

Table 1 displays the twelve most read papers coauthored by women and the number of citations these papers received. Table 2 provides similar information for the twelve most read male coauthored papers. Readership counts are from March 2014 and citation counts are from the end of 2013 and were collected from the Web of Science. There is little relation between readership

Table 2. Most read papers co-authored by male author

Title	Source	Year	Mendeley readers	WOS citations
Marine ecosystems' responses to climatic and anthropogenic forcings in the Mediterranean	PROGRESS IN OCEANOGRAPHY	2011	135	16
On the variation of the initial mass function	MONTHLY NOT. ROYAL ASTRO. SOC.	2001	119	1644
REVIEW OF PARTICLE PHYSICS	J. PHYSICS G-NUCLEAR AND PARTICLE PHYSICS	2010	115	3632
The initial mass function of stars: Evidence for uniformity in variable systems	SCIENCE	2002	89	689
Ice structures, patterns, and processes: A view across the icefields	REVIEWS OF MODERN PHYSICS	2012	84	25
THE SEVENTH DATA RELEASE OF THE SLOAN DIGITAL SKY SURVEY	ASTROPHYSICAL J. SUPP	2009	83	1540
An upper limit on the stochastic gravitational-wave background of cosmological origin	NATURE	2009	82	140
Hawking Radiation from Ultrashort Laser Pulse Filaments	PHYSICAL REV. LET.	2010	71	67
A limit on the variation of the speed of light arising from quantum gravity effects	NATURE	2009	64	181
Non-Gaussianity from inflation: theory and observations	PHYSICS REPORTS-REV. SECT. PHYSICS LET.	2004	64	576
Systematic variation of the stellar initial mass function in early-type galaxies	NATURE	2012	56	69
THE LARGE AREA TELESCOPE ON THE FERMI GAMMA-RAY SPACE TELESCOPE MISSION	ASTROPHYSICAL J.	2009	54	827

and citation counts, at least for the most read items. All of the most read items were published after 2000 (only 3 of the 24 papers were published before 2008), even though in the dataset 19.8% of the papers were published before 2000 and 57.2% before 2008.

The coverage of Mendeley on the searched papers is quite low compared to previous studies [16],[18],[22]. There can be several reasons for this finding. One is that Mendeley is less popular among people interested in astrophysics. A possible explanation for this is the existence of arXiv, which is known to be highly popular among astrophysicists. Another possible explanation is that the earliest publications in the dataset are from 1979, whereas Mendeley was founded only in 2007 [25] and readers in Mendeley have a tendency to bookmark more recent items. In order to test the second possible explanation

we also looked at the set of papers published between 2008 and 2013

There were 5,141 papers listed with publication year between 2008 and 2013. In this subset the publications were coauthored there were 60 female (20.8%) and 228 (79.2%) male authors. There were 876 female coauthored papers, that are 17.0% out of the 5,141 papers in this subset, thus slightly higher than in the whole set (14.7%) and in the previous dataset (14.8%) that contained all publication years. The percentage of female authors was almost the same in all the sets.

For this subset, 1,477 documents were bookmarked in Mendeley (28.7%), which is higher than for the set where all publication years were considered (22.6%). This finding supports our statement that in Mendeley there is preference for more recent publications. Out of the 876 female coauthored publications,

204 were located in Mendeley (23.3%), and for male coauthored publications 1,273 were found in Mendeley (29.8%), which is considerably higher than when all years are considered (23.0%), and in terms of this measure there is a clear advantage of papers coauthored by a male author.

However in terms of average and median number of readers the female advantage even increases. The average number of readers of female coauthored papers is 10.7 and the median is 7, while for men the average is 9.0 and the median is 6.5. This is quite interesting since in terms of the highest number of readers, papers coauthored by men are clear winners, as can be seen from Tables 1 and 2.

5. Conclusion

In this study we searched for publications of specific authors, thus the dataset is not necessarily representative. In addition most papers in astrophysics are multi-authored, thus a paper assigned to a male author might have had a female co-author and vice versa.

The coverage in Mendeley of papers authored by men and women in the specific dataset was quite similar in the whole dataset, but men had an advantage when only papers published after 2007 were considered. On the other hand in both sets women had an advantage in terms of average and median number of readers, although the highest readership counts were achieved by men coauthored papers. Thus there does not seem to be an altmetric gender-specific bias, at least not in the specific dataset examined by us. Further studies are needed to corroborate this conclusion.

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