





# Gender equity in health research publishing in Africa

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## ABSTRACT

**Introduction** Women researchers find it more difficult to publish in academic journals than men, an inequity that affects women's careers and was exacerbated during the pandemic, particularly for women in low-income and middle-income countries. We measured publishing by sub-Saharan African (SSA) women in prestigious authorship positions (first or last author, or single author) during the time frame 2014–2016. We also examined policies and practices at journals publishing high rates of women scientists from sub-Saharan Africa, to identify potential structural enablers affecting these women in publishing.

**Methods** The study used Namsor V.2, an application programming interface, to conduct a secondary analysis of a bibliometric database. We also analysed policies and practices of ten journals with the highest number of SSA women publishing in first authorship positions.

**Results** Based on regional analyses, the greatest magnitude of authorship inequity is in papers from sub-Saharan Africa, where men comprised 61% of first authors, 65% of last authors and 66% of single authors. Women from South Africa and Nigeria had greater success in publishing than those from other SSA countries, though women represented at least 20% of last authors in 25 SSA countries. The journals that published the most SSA women as prominent authors are journals based in SSA. Journals with overwhelmingly male leadership are also among those publishing the highest number of SSA women.

**Conclusion** Women scholars in SSA face substantial gender inequities in publishing in prestigious authorship positions in academic journals, though there is a cadre of women research leaders across the region. Journals in SSA are important for local women scholars and the inequities SSA women researchers face are not necessarily attributable to gender discrepancy in journals' editorial leadership.

## INTRODUCTION

Inequities facing women in academia persist despite efforts to redress them. COVID-19 has impacted women's academic productivity, with the pandemic expected to result in women being left even further behind.<sup>1–5</sup> Authorship can serve as a marker for gender

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Men continue to dominate in prestigious authorship positions in academic journals (particularly for last authorship positions), and recent research suggests that the COVID-19 pandemic has further exacerbated these gender inequities.

## WHAT THIS STUDY ADDS

⇒ Based on regional analyses, the dominance of men in first and last authorship positions is greatest among sub-Saharan African affiliated researchers.  
⇒ Sub-Saharan African women authors are more likely to get published in prestigious authorship positions in journals in Sub-Saharan Africa, though these journals had mastheads and editorial boards that were overwhelmingly male.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Investigating various region-specific factors that impact women's ability to publish could deepen understanding of gender inequities in academic publishing.  
⇒ When measuring the effects of initiatives aimed at increasing gender or geographic diversity of authorship in academic journals, it will be important to ask if a given initiative has moved the needle for sub-Saharan African women researchers.

equity since grants and peer-reviewed papers are key currency in academia. Though women now publish more articles than in previous decades, men continue to dominate<sup>6–7</sup> and this is especially the case for the prestige authorship positions most valued for promotion at universities, a paper's first and last authors.<sup>8–10</sup> Recently, women have become more likely to be first authors, a junior stature authorship often given to a student or early career researcher, yet they are less likely to be last authors, a position given to principal investigators, or those who secured research funds.<sup>11</sup> Women are also far less likely than men to publish single-authored papers,<sup>8</sup> including editorials in medical, global health

and public health journals.<sup>12–15</sup> Men also continue to hold an overwhelming majority of editor-in-chief (EIC) positions.<sup>16–18</sup>

Based on previous research showing that researchers in low-income and middle-income countries (LMICs) find it more difficult to publish than their colleagues in higher-income countries (HICs),<sup>19–20</sup> we posit that women in sub-Saharan Africa (SSA) might experience even greater inequities since they are more likely to face additional systemic barriers beyond those faced by women in HICs. While women researchers worldwide may publish less due to caregiver duties, time off for maternity leaves or leaving scientific careers sooner than their male counterparts,<sup>6</sup> women in sub-Saharan countries are further confronted with normative expectations of more patriarchal societies and more limited resources.<sup>21–23</sup> However, the sub-Saharan region is not monolithic and certain countries in the region may offer women greater opportunities due to a country's wealth or the organisational and scientific capacities of its academic institutions, among other factors.

Academic journals are central to a researcher's career development, and a key measure of productivity in academia relies heavily on the number of journal publications, H-index and impact factor of journals. Various efforts to address the publication gap have reduced barriers for academics from LMICs to some extent but have not sufficiently focused on LMIC women researchers. To address these knowledge gaps, this study's aim is two-fold. First, we examine publishing by SSA women researchers as first or last authors or as authors of single-authored papers in health science journals from 2014 to 2016. Second, we explore the policies and practices of selected journals which have published high numbers of SSA women researchers, to identify structural enablers and barriers affecting SSA women researchers when publishing.

## METHODS

### Secondary analysis of database

We conducted a secondary analysis using the database developed for a previous bibliometric analysis.<sup>19</sup> It is composed of PubMed articles published between 2014 and 2016 with the term 'health' in either the title or abstract and 'Africa South of the Sahara' indicated as the Medical Subject Heading term. The 2014–2016 time frame used in the previous bibliometric analysis was chosen because 2014 was the year that PubMed began recording author affiliation data, and the previous analysis was conducted in 2017.<sup>19</sup> Other data extracted included: title, abstract, key words, type of publication, author names, author order, region of author affiliations and journal names. Detailed inclusion and exclusion criteria for selected articles are published elsewhere.<sup>19</sup> Based on these criteria, 7100 studies were included in the bibliometric analysis, corresponding to 43 429 unique authors and 47 253 unique country affiliations for authors.

### Determining gender of authors

Namsor V.2, an application programming interface (API) was used to determine the gender of authors. The gender of authors was defined as a binary variable (comprising either man or woman categories). This API was chosen because its algorithm considers the country of origin, ethnicity, both first and last names, and draws on linguistic and cultural information. Namsor also has a larger database of names (1.3 million names) compared with another API, genderize.io (200 000 names), and genderize.io only infers gender from the first name.<sup>24</sup> Namsor has been used previously in a bibliometric analysis of author gender.<sup>15</sup>

### Gender and author region of affiliation statistical analysis

We provide descriptive statistics summarising the number and proportion of first and last authors identified as men or women. We computed the gender composition among authors overall and among first authors, last authors and single authors separately. Overall, and for each authorship position, we conducted two-sided one-sample tests of proportions to determine whether the proportion of women authors was significantly different from 0.5.

The region of author affiliation was determined in the main research area using the author's primary institution. We then classified the region of author affiliation into four categories: (1) if the author was classified with only an SSA affiliation (whether of the same country as the paper's focus or another country), they were categorised as an SSA affiliated author, (2) if the author was classified with only a European or North American (EU/NA) affiliation, they were categorised as a EU/NA affiliated author, (3) if the author was classified with both African and EU/NA affiliations, they were categorised as Both SSA and EU/NA affiliated author and (4) if the author was classified as none of those, they were categorised as Other. Using these four categories, we examined the gender composition of first, last, and single authors by region of affiliation. We particularly looked at the relationship between gender and author region of affiliation among first and last authors using  $\chi^2$  tests of association. Due to the relatively small number of single authors, we used a Fisher's exact test to examine the association between gender and region of affiliation in this group. Within each region of affiliation category, and by authorship position, we again conducted two-sided one-sample tests of proportions to test whether the proportion of women authors was significantly different from 0.5.

### Quality check and sensitivity analysis

A quality check and sensitivity analysis were conducted to validate the gender assignment by Namsor V.2. The author names were first stratified based on whether the full name was available or whether only last name or initials were available (the case for 3747 or 8% of all authors). Namsor V.2 can assign gender using last names and/or initials only and provides the associated probability of correct classification. The author names were

further stratified based on this probability. We sampled names from each of the strata (see online supplemental table 1) for the numbers and percentages sampled for the quality check).

In total, 893 (2.1% of total sample) authors were identified for the quality check, where the genders of sampled authors were manually checked through searching their institutional web pages and online social network sites (eg, LinkedIn, ResearchGate). Of the authors with initials or missing first names and a classification probability of less than 0.7, 28% of the author names were misclassified; of the n=21 female classifications, 13 (61.9%) were incorrect, while for the n=166 male classifications, 39 (23.5%) were incorrect. The error rates in the other categories were lower, ranging from 0% to 8%.

Due to the high error rate among authors with initials/low classification probability, we conducted a sensitivity analysis to explore the robustness of our results to changes in the gender classification of author names. We repeated our original analysis, in which the genders were assigned by Namsor, with an adjusted gender classification variable, based on the error rates computed in the data quality check. Among authors with initials/low classification probability, we randomly selected and changed the classifications of 61.9% of those originally classified as woman to man and randomly changed the classifications of 23.5% of those originally classified as man to woman.

Based on this validation sample of 893 authors, we computed error rates by author region of affiliation. Twelve percent of authors affiliated with an institution in SSA (n=488) had an incorrect gender classification, while the error rates for authors affiliated with EU/NA (n=288), both SSA and EU/NA (n=104), or neither (n=13), were 8%, 11%, and 15%, respectively (see of the online supplemental table 3). We conducted a second sensitivity analysis using an adjusted gender classification variable based on the region-specific error rates.

### Academic journal selection

We selected a sample of journals with the highest number of published SSA women researchers because it aligned with our aim to study the intersection of gender and geography that impacts SSA women researchers; and, to identify policies and practices that may act as structural enablers and/or barriers affecting SSA women scientists. We identified 10 journals in our database with the highest number of SSA women published as first authors and used this sample to conduct a further analysis of journal policies and practices. This approach biases our sample towards the journals that are performing the best in our database to highlight the practices and policies that may encourage SSA women first and last authorship.

We also identified the 10 journals with the highest number of SSA women published as first or last authors. These journals were then ranked from those with the highest proportion of SSA women as first or last authors to those with the lowest proportion of SSA women as first or last authors. The 2016 impact factor extracted

during the creation of the database was included for each journal.

### Analysis of journal policies and practices

Our analysis of journals examined the composition of their editorial boards (EB), EIC and/or managing/executive directors, and any statements about promoting gender equality in authorship, reviewing and publishing. We relied on publicly available information on each journal's website. We conducted manual searches of each journal's website, extracting information about journal characteristics, including the gender of the EIC, managing/executive editors, EB members, and any statements on gender and authorship. We used Namsor V.2 to classify the gender of EIC, managing/executive editors and EB members in combination with web searches. We excluded editorial staff. We analysed publicly available information regarding journal policies or practices that discussed gender, diversity, equity and/or inclusion during 2014–2016, to ensure this information corresponded to the time frame of our bibliometric analysis. The web tool Wayback Machine (<https://web.archive.org/>), an internet archive library which allows you to visit websites on selected dates, was used to identify and extract information for 2014–2016. We conducted a thematic analysis of journal practices and policies for the ten journals in our study.

## RESULTS

### Gender composition of authors and author region of affiliation

Overall, 59.8% (n=25 958) of the 43 429 authors were men and 40.2% (17 471) were women. **Table 1** presents the gender composition of first authors, last authors and single authors overall and by region of affiliation. There was a higher proportion of men authors compared with women authors in all authorship positions. Among first authors, 54.3% are men, while 45.7% are women (p<0.001 based on a one-sample test of proportions). The difference is greater among last authors, where 61.5% are men and 38.5% are women (p<0.001). Women comprise 44.1% of authors of single-author papers (p=0.049).

Gender of first authors was significantly associated with region of author affiliation (p<0.001) based on a  $\chi^2$  test of association, as was gender of last authors (p<0.001), while gender among single-author papers was also significantly associated with author affiliation region (p<0.001) based on a Fisher's exact test. Women dominated in one tier: the first authorship position among authors affiliated only with EU/NA (60.0% women vs 40.0% men, p<0.001). Among SSA affiliated authors, men comprised a larger proportion of first authors (61.2%, p<0.001), last authors (64.6%, p value<0.001) and authors of single-authored papers (66.4%, p<0.001). For authors affiliated with both SSA and EU/NA: 61.3% (p<0.001) of first authors and 60.2% (p<0.001) of last authors were men.

When examining sub-Saharan countries individually, among SSA women who published as last authors, over

**Table 1** Association between region of author affiliation and gender

	Authorship position		
	First author (n=6819)	Last author (n=6819)	Single author (n=281)
Overall	P<0.001*	P<0.001*	P=0.049*
Men	3701 (54.3%)	4212 (61.8%)	157 (55.9%)
Women	3118 (45.7%)	2607 (38.2%)	124 (44.1%)
Region of author affiliation†	P<0.001‡	P<0.001‡	P<0.001§
Sub-Saharan Africa	n=3768	n=3350	n=146
Men	2305 (61.2%)	2164 (64.6%)	97 (66.4%)
Women	1463 (38.8%)	1186 (35.4%)	49 (33.6%)
Europe/North America	n=2206	n=2764	n=122
Men	883 (40.0%)	1623 (58.7%)	51 (41.8%)
Women	1323 (60.0%)	1141 (41.3%)	71 (58.2%)
Both sub-Saharan Africa and Europe/North America	n=729	n=543	n=8
Men	447 (61.3%)	327 (60.2%)	5 (62.5%)
Women	282 (38.7%)	216 (39.8%)	3 (37.5%)
Other	n=116	n=162	n=5
Men	66 (56.9%)	98 (60.5%)	4 (66.4%)
Women	50 (43.1%)	64 (39.5%)	1 (33.6%)

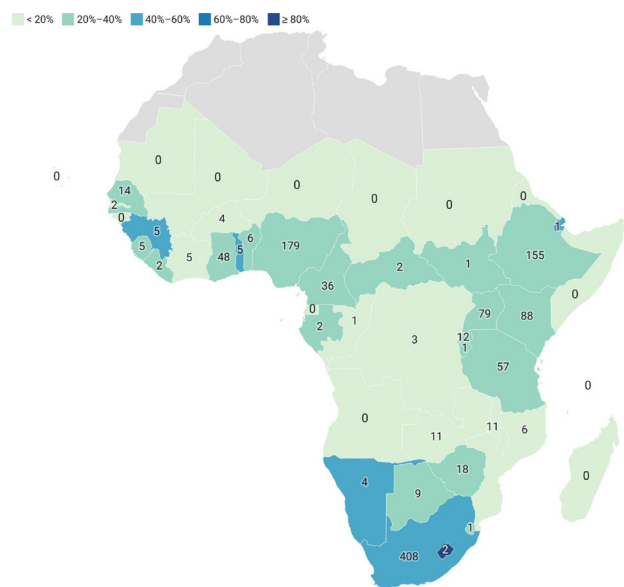
\*P value associated with two-sided one-sample test of proportions, with the null proportion set to 0.5.

†P values associated with one-sample tests of proportions within each region of affiliation and author position category, though discussed in the results section, are not included in this table for brevity.

‡P value associated with  $\chi^2$  test of association between region of affiliation and gender.

§P value associated with Fisher's exact test of association between region of affiliation and gender

one-third were from South Africa (408/1186), where 45% of last authors were women (408/909). In 25 other SSA countries women comprised at least 20% of last authors (see [figure 1](#)).



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**Figure 1** Numbers show the number of women last authors in each country.

### Results of sensitivity analysis

The results of the sensitivity analyses are similar to those based on the Namsor V.2 classification of author gender. For the first sensitivity analysis, in which error rates for the names with initials/low probability of classification were used to construct an adjusted gender variable (see in online supplemental table 2 and 3), 46.7% of first authors are women, while 40.3% of last authors are women. The association between region of affiliation and gender remains statistically significant for both first and last authors ( $p<0.001$  in both cases), and the gender breakdown within each region of affiliation is like that found in the primary analysis. Among first authors affiliated with SSA, the sensitivity analysis found 40.1% are women, while 37.5% of last authors are women. Similarly, the results of the second sensitivity analysis, in which an adjusted gender variable was constructed based on the region of affiliation-specific error rates (see in online supplemental table 3 and 4), did not differ substantially from the primary analysis presented in this paper.

### Analysis of journals selected

Tables 2 and 3 present the results on these selected journals, with journals listed in descending order according to the proportion of each journal's papers in our database that had SSA women as first (table 2) or last (table 3) authors. Of note, [tables 2 and 3](#) do not entirely overlap.

**Table 2** Journal characteristics by number and proportion of sub-Saharan African women first authors

Rank	Journal name	Impact factor (2016)	N (total # of first authors in database/ by Journal)	No of sub-Saharan African women, first authors	Proportion of sub-Saharan African women, first authors
1	African Journal of Primary Health Care & Family Medicine	NA	66	34	0.515
2	African Journal of Reproductive Health	0.7	55	23	0.418
3	South African Medical Journal	1.73	85	30	0.353
4	Global Health Action	1.79	155	47	0.303
5	Pan African Medical Journal	NA	233	69	0.296
6	BMC Public Health	2.27	298	88	0.295
7	BMC Health Services Research	1.83	188	53	0.282
8	BMC Research Notes	2.28	148	39	0.264
9	PLOS ONE	2.81	550	103	0.187
10	Malaria Journal	2.72	229	39	0.170

(Note: If an impact factor was not reported on a journal's website or in Journal Citation Reports, it is listed as NA).  
NA, not available.

Also, nearly 400 journals in our data set had zero SSA women among their first or last authors.

### Analysis of 10 journal policies and practices

#### Gender

The analysis of ten journals is presented in [table 4](#), with journals listed in descending order according to the proportion of each journal's first authors that were SSA women.

The total editorial leadership across all roles consisted of 36.3% women (N=1010 for total journal leadership across all journals), and 21.1% women for EIC or managing editor/executive editor (N=19 when combining all three types of roles across all journals) who served at the 10

journals during the 2-year time period, although information was not available for all role categories (see [table 4](#)). Some journals with substantial gender discrepancies in leadership are also among those publishing the highest number of SSA women first authors, including the Africa-based journals *African Journal of Primary Health Care & Family Medicine*, *African Journal of Reproductive Health*, and *Pan African Medical Journal*. Only one journal, *African Journal of Primary Health Care & Family Medicine*, has SSA women as over 50% of its first authors and that same journal is the only journal that has SSA women comprising over 50% of its last authors. Yet that journal's leadership team was 72% male.

**Table 3** Journal characteristics by number and proportion of sub-Saharan African women last authors

Rank	Journal name	Impact factor (2016)	N (total # of last authors in database/ by Journal)	No of sub-Saharan African women, last authors	Proportion of sub-Saharan African women, last authors
1	African Journal of Primary Health Care & Family Medicine	NA	66	34	0.515
2	BMC Research Notes	2.28	148	48	0.324
3	South African Medical Journal	1.73	85	26	0.306
4	Pan African Medical Journal	NA	223	59	0.265
5	BMC Public Health	2.27	298	74	0.248
6	Reproductive Health	2.21	83	18	0.217
7	Global Health Action	1.79	155	33	0.213
8	BMC Health Services Research	1.83	188	32	0.170
9	PLOS ONE	2.81	550	74	0.135
10	Malaria Journal	2.72	229	25	0.109

NA, not available.

**Table 4** Editorial board, editor-in-chief/managing/executive editors' gender composition of the ten journals publishing the most sub-Saharan Africa women in first authorship position\*

Rank	Journal name	Total leadership N(1010) (EB+EIC +managing/executive editors)	N (editorial board) and breakdown by gender	Editors-in-chief (2014–2016)	Managing editors/executive Editors (2014–2016)	Gender breakdown by total leadership
1	African Journal of Primary Health Care & Family Medicine	25	24 Men: 17 Women: 7	Men: 1 Women: 0	N/A	Men: 72% Women: 28%
2	African Journal of Reproductive Health	12	11 Men: 7 Women: 4	Men: 1 Women: 0	N/A	Men: 66.7% Women: 33.3%
3	South African Medical Journal	2	N/A	Men: 0 Women: 2	N/A	N/A (could not calculate due to lack of info.)
4	Global Health Action	13	12 Men: 6 Women: 6	Men: 1 Women: 0	N/A	Men: 53.8% Women: 46.2%
5	Pan African Medical Journal	49	46 Men: 37 Women: 9	N/A	Men: 2 Women: 1	Men: 79.5% Women: 20.4%
6	BMC Public Health	230	225 Men: 124 Women: 101	Men: 5 Women: 0	N/A	Men: 56.1% Women: 43.9%
7	BMC Health Services Research	342	340 Men: 189 Women: 151	N/A	Men:1 Women:1	Men: 55.6% Women: 44.4%
8	BMC Research Notes	285	284 Men: 215 Women: 69	N/A	Man:1 Woman:0	Men: 75.8% Women: 24.2%
9	PLOS ONE	2	N/A	Man: 1 Woman: 0	Man:1 Woman:0	N/A ((could not calculate due to lack of info.)
10	Malaria Journal	50	49 Men: 33 Women: 16	Men: 1 Women: 0	N/A	Men: 68% Women: 32%

\*The total N includes editor-in-chief, managing/executive editor and editorial board members for each journal. Several journals had more than one editor-in-chief between 2014 and 2016. Several journals (PLOS ONE; Pan African Medical Journal, BMC Health Services Research, BMC Research Notes) utilised different leadership titles such as 'Executive Editor' or 'Managing Editor' and these are captured separately. For journals where information on the editorial boards was not accessible, we have labelled them as 'N/A'. NA, not available.

None of the 10 journals publicly posted statements about gender and authorship on their websites within the 2014–2016 time frame, nor did these journal websites discuss the gender breakdown of authors submitting manuscripts. The analysis did not identify policies at any of the 10 journals encouraging manuscripts from women authors or promoting gender equity in publishing. Notably, 4 of the 10 journals analysed are BMC journals, which likely adhere to a uniform overarching policy for authorship and publishing.

#### Diversity, equity and/or inclusion

Explicit statements on diversity were rare. Only one of the 10 journals, *Global Health Action*, explicitly discussed

diversity of authorship, with a statement encouraging papers from LMICs and articles from South-South and South-North collaborations. There were implicit statements encouraging diversity of authorship for two of the journals, *African Journal of Primary Health Care & Family Medicine* and *PLOS ONE*. The *African Journal of Primary Health Care & Family Medicine* stated that it 'welcomes submissions that encourage scholarly exchange between family medicine and primary healthcare researchers and practitioners across Africa.' Five of the ten journals included a statement that article processing fees could be waived for authors from LMICs. The way in which fee waivers were processed varied, with some journals

automatically cancelling fees for authors from LMICs as classified by the World Bank (*Global Health Action, Malaria Journal, BMC Health Services Research*), and others waiving fees on a case-by-case basis (*BMC Research Notes*).

## DISCUSSION

### Under-representation of SSA women in prestigious authorship

We found that the greatest magnitude of authorship inequity is among researchers from SSA, where men comprised 61% of first authors, 65% of last authors and 66% of authors of single-authored papers. The two countries where the most SSA women achieved last authorship were South Africa and Nigeria, both middle-income or low-middle income countries respectively, while most other countries are low income. This is consistent with a study of global surgery papers that found women comprised a higher proportion of last authors among HIC authors than among LMIC authors.<sup>25</sup>

In 25 SSA countries, we found that women represented at least 20% of last authors, suggesting the emergence of a cadre of women research leaders across the region (see figure 1).

Africa's Francophone researchers face particular difficulties; among the ten journals in our data that published the most papers by SSA women, only one, *Pan African Medical Journal*, publishes in French and English. Linguistic isolation of researchers from Francophone countries has been compared with the inequity women researchers experience.<sup>26</sup> Multilanguage journals in other regions enable researchers to also publish in French and we suggest that more journals, including those based in SSA, might adopt a multilanguage model, although we acknowledge the financial implications of doing so.

Academic journals are attempting to drive greater gender equity; they are enacting multiple strategies to improve the presence of women authors including developing gender-equal EB; increasing women's representation among editors or members of EB; and peer review panels and requesting information on gender and race or ethnicity from authors.<sup>27-37</sup> Our findings suggest the importance of assessing the effectiveness of such strategies to investigate whether such strategies can move the needle for women in regions such as SSA, where women are profoundly underrepresented in academic literature. Some journals are also working to expand geographic equity for their authors. They do so by declining to review papers with data from an LMIC if no author is from that LMIC,<sup>38</sup> making it known that they disapprove of such papers,<sup>39</sup> asking authors why a paper involving data from an LMIC lacks local authors,<sup>40</sup> requiring authors submitting research resulting from collaborations between high-income-country authors and partners in LMICs to include an author statement describing how that partnership has promoted equity,<sup>41 42</sup> and offering specialised editorial services for authors from LMICs who may need help bringing their manuscripts up to international publication standards.<sup>43</sup> When measuring outcomes from

such efforts, our results suggest that journals should look separately at outcomes for LMIC women. Yet journals are only one part of the picture.

The diminished presence of SSA women as prominent authors in health research literature is also a consequence of other systemic barriers, which are likely to play an even greater role in academic productivity than journals.<sup>21</sup> Liani *et al* identified some of these more deeply rooted problems facing women academics in SSA. They include lack of time for their careers when bearing the brunt of reproductive labour and domestic responsibilities, regardless of marital status; rigid power structures in institutions with gender-blind or discriminatory policies; and limited access to institutional research 'resources', including research funding allocation, social capital and networks.<sup>21 22</sup> A survey of over 200 men and women alumni of SSA STEM PhD programmes found that women also receive less university and outside funding for their graduate studies than their male counterparts.<sup>44</sup> And they face enormous personal pressures due to the unequal division of labour in the family, without commensurate efforts by academic leaders to create specific supports for women in research institutions. Among these women alumni, only one in four were aware of 'any policies and practices at their PhD institution to support women graduate students, such as maternity leave, on-site or subsidised child care or extension of academic deadlines,' (Fisher M<sup>44</sup>, p.14). Respondents also reported sexual harassment by faculty at their institutions. Women in the region also contend with bullying, discrimination and gender-based violence, yet these issues largely go unaddressed by institutions in the region.

Given such findings, it appears that African institutions could be far more active in encouraging women researchers. They could promulgate specific policies and focused programmes to address major barriers such as harassment, and facilitate career development via mentorship or leadership programmes for women.<sup>45 46</sup> Worldwide, women tend to fall in the lower echelons of health research institutions and are underrepresented as leaders of such institutions.<sup>47</sup> Stronger demonstrations of allyship from institutions involved in global health research could involve policies or programmes in regions where they conduct research, including SSA, to address barriers for women researchers or promote women's career growth.<sup>48</sup> Efforts to revise academic promotion criteria in North America aimed at supporting researchers in LMICs<sup>49</sup> could also be valuable for women researchers in SSA.

### Journal location, policies and practices

As our results suggest, journal location does seem to increase its likelihood of publishing SSA women. Four of the five journals that published the most SSA women as first authors are in SSA, showing that these women scientists are more likely to be published in prestigious positions in local journals. While papers published in African journals may be more likely to only have coauthors who

are local or from another African institution,<sup>19</sup> this would not necessarily lead to greater representation of women as first authors. Local journals may also use different acceptance criteria; however, it is premature to conclude that this may favour female authorship. Other reasons to explain this difference are that women may be less likely to submit to international journals or may be 'stuck in the middle' authorship position or left off as authors, thereby receiving less credit than they deserve on international journal papers.<sup>50 51</sup> If women submit less to international journals, that could be related to these women receiving less of the sort of institutional, financial and mentorship support that could help them submit to and publish in international journals, as well as fewer opportunities for collaboration with high-income country researchers.<sup>25</sup> Processing fees can also present major barriers for authors in SSA due to insufficient financial support from their academic institutions or grant funding.<sup>52 53</sup> Partial or full fee waivers such as those offered by 5 of the 10 journals have been increasingly important to African researchers.

Yet our study underscores the role of local journals in building the careers of local researchers in SSA.<sup>54</sup> Given this finding, it may be valuable to reflect on steps taken to boost the visibility and quality of Africa's journals since 2008, when codirectors of the African Journal Partnership Programme asked whether most journals in Africa were 'too weak to be useful to local practitioners, researchers and policy-makers' (Goehl TJ<sup>55</sup>, p.A514). The ecosystem of Africa's journals has progressed since then, with the launch of multiple local journals; the growth of regional supportive organisations such as the Forum for African Medical Editors and the African Journal Partnership Programme, and country-specific support such as the Academy of Science of South Africa's Scholarly Publishing Programme<sup>56</sup>; and journal-based initiatives training young African researchers to become published authors and peer reviewers.<sup>57–59</sup> Continuing support for Africa's local journals may be an important step towards ensuring publication of women in the region, however, several journals in SSA published no SSA women in prestigious authorship positions so we encourage local and international journals to be attentive to that inequity.

Overall, our data show no clear association between the percentage of women serving in journal leadership and rates of SSA women first authorship. On the contrary, only 3 of the 10 journals publishing the most SSA women first authors had any women editors, though nearly all appeared to have women EB members. However, other studies suggest that women editors may invite more women peer reviewers who in turn, may give more favourable assessments to papers by women authors.<sup>60</sup> Authorship is a marker for complex, multifaceted issues so our findings are not a reason to disregard underrepresentation of women in journal leadership positions. Rather, we would encourage local African journals to consider how they could bring more women onto their EB or promote women to be editors-in-chief.

We urge further research on specific journal policies and how they link to publication of women and other underrepresented groups. We suggest that journals that fail to publish any SSA women as first or last authors could be an area for future investigation. It would be valuable to understand potential structural barriers at such journals.

We applaud efforts currently underway to develop guidelines encouraging all academic publishers and journals to achieve gender equity in their workforce,<sup>61 62</sup> and we concur with researchers calling on journals to actively work for equity and against discrimination in their editorial decisions.<sup>63</sup> Journals and consensus groups have also issued guidance aimed at promoting gender equity, geographical equity and diversity in academic publishing.<sup>41 64–66</sup>

The lack of information found on journal websites illustrates transparency and governance issues in science journals, and we echo others in calling for journal analyses of author and reviewer demographics and data on journal editorial processes to be shared openly.<sup>60 67</sup> We encourage journals to routinely publish the gender make-up of their EB and to be more transparent with data on any policies and practices used to address gender and geographic inequity. Otherwise, it is difficult to infer what practices related to journal leadership enable or hinder the publishing of such marginalised groups as SSA women scientists. The lack of transparent journal policies may also serve to shield journals from valid criticism.

### Limitations

Limitations exist when assigning genders to authors using gender assignment algorithms in bibliometric analyses. First, reducing gender to a binary 'women' and 'men' category may exclude or misclassify individuals who do not identify with these categories. Additionally, the association of names with gender depends on cultural and regional contexts, yet data sources for the algorithm we used are composed mostly of European and Asian names, where African names amount to at most 6% of names within each data source for Namsor V.2.<sup>24</sup> This embeds Eurocentric biases in the programming, resulting in potential misidentification of gender in African contexts. However, our sensitivity analyses were conducted to address some of these known limitations.

In ranking journals based on the number of SSA women published as first or last authors, the small number of articles by these women in each journal, and the variation in number of articles per journal, limits the robustness of our ranking approach.

When using the Wayback Machine database, archival information was not always available or was incomplete for different journal leadership roles for our time frame (2014–2016), which may have impacted our analysis. This occurred when the journal's website had not been created and when there were technical barriers preventing access of information during that time frame. Where journal websites were



not existent within the 2014–2016 time frame, we selected the earliest available time frame for that website.

Another potential limitation of our journal analysis is that we relied solely on what journals posted on their websites. While we did not search other sites for journal policies, editorial leaders or conduct interviews with journal representatives, we nonetheless consistently relied on a site that potential authors are likely to check, namely, a journal's own website. Future qualitative studies, including interviews with journal representatives, would enable further examination of journal policies and practices, though recent reports suggest journals may not be open to sharing such information.<sup>37</sup>

Our analysis focused solely on journals that performed the best in our database, and while this highlights factors that may enable SSA women to obtain prestigious authorships, it did not underscore journal-specific factors that are obstacles to SSA women researchers. Yet it was not feasible to analyse the group performing the worst in our database, since nearly 400 journals had zero SSA women among their first or last authors.

Although we did not find a link between the gender composition of a journal's editors and EB and the publication of SSA women, this may reflect the small number of journals assessed.

Finally, we are limited by the 2014–2016 time frame of our database. Since then, the importance of gender equity in academia has gained further ground, with increasing interest in promoting women across professional arenas, including in health research. However, the 2014–2016 time frame gives us the opportunity to look retrospectively at where matters stood prior to the implementation of strategies to improve gender equity.

## CONCLUSION

Women researchers in SSA lag far behind women in EU/NA in their contributions to the health research literature as prestigious (first or last) authors and as authors of single-author papers. Women in South Africa and Nigeria appear to be more successful in publishing than women in other sub-Saharan countries, and SSA women who publish as prestigious authors are more likely to appear in Africa-based journals than in other academic journals. In a set of journals chosen for their high rates of publishing first-authored articles by SSA women, journals with overwhelmingly male leadership were among those publishing the highest number of such women. While further research is needed to fully understand the obstacles preventing women in this region from publishing health research, our findings show the need to focus on SSA women when measuring the effects of initiatives aimed at increasing diversity of authorship in academic journals.

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## Supplementary File for

**Title:** Gender equity in health research publishing in Africa

**Authors:** Baobeid A, Faghani-Hamadani T, Sauer S, et al.

### *Sensitivity analysis #1:*

In the first sensitivity analysis, we considered the error rates among strata defined by the level of information in the author name (initials or missing first name vs full name) and the probability of correct classification generated by the Namsor algorithm. Due to the high error rate (28%) among authors with initials/low classification probability, we conducted a sensitivity analysis to explore the robustness of our results to changes in the gender classification of author names. In particular, we repeated our original analysis described in the main paper, in which the genders were assigned by Namsor, with an adjusted gender classification variable, based on the error rates computed in the data quality check: among authors with initials or missing first name/low classification probability, we randomly selected and changed the classifications of 61.9% of those originally classified as woman to man, and randomly selected and changed the classifications of 23.5% of those originally classified as man to woman.

Table 1: Author names stratified based on probability of correctness.

	Probability of correct classification	Number of authors sampled	Percentage of names sampled from each strata	Error rate <sup>†</sup>
Initials/missing names of authors	< 0.7	187	5%	Overall: 28% Classified as women: 61.9% Classified as men: 23.5%
	0.7-0.9	11	100%	Overall: 0%
Full names of authors	< 0.7	520	2%	Overall: 8% Classified as women: 9.2% Classified as men: 6.6%
	0.7-0.9	38	1%	Overall: 3% Classified as women: 0% Classified as men: 2.7%
	> 0.9	137	1%	Overall: 0%
Overall		893	2.1%	

<sup>†</sup>The genders of the sampled authors were determined manually by searching their institutional web pages and online social network sites such as LinkedIn and ResearchGate. The number of sampled authors with misclassified gender in each stratum was calculated, and error rates were computed by dividing these by the number of sampled authors in the respective stratum. Names that were misclassified were subsequently corrected in our database.

Table 2: Author gender composition by region of affiliation after adjusting for probability classification error rates.

	Authorship position		
	First author (n=6819)	Last author (n=6819)	Single author (n=281)
<b>Overall</b>	p < 0.001 <sup>1</sup>	p < 0.001 <sup>1</sup>	p=0.06 <sup>1</sup>
<i>Men</i>	3632 (53.3%)	4117 (60.4%)	156 (55.5%)
<i>Women</i>	3187 (46.7%)	2747 (40.3%)	125 (45.5%)
<b>Region of author affiliation<sup>4</sup></b>	p < 0.001 <sup>2</sup>	p = 0.003 <sup>2</sup>	p < 0.001 <sup>3</sup>
Sub-Saharan Africa	n = 3768	n = 3350	n = 146
<i>Men</i>	2257 (59.9%)	2095 (62.5%)	95 (65.1%)
<i>Women</i>	1511 (40.1%)	1255 (37.5%)	51 (34.9%)
Europe/North America	n = 2206	n = 2764	n = 122
<i>Men</i>	868 (39.3%)	1598 (57.8%)	52 (42.6%)
<i>Women</i>	1338 (60.7%)	1166 (42.2%)	70 (57.4%)
Both Sub-Saharan Africa and Europe/North America	n = 729	n = 543	n = 8
<i>Men</i>	442 (60.6%)	327 (60.2%)	5 (62.5%)
<i>Women</i>	287 (39.4%)	216 (39.8%)	3 (37.5%)

Other	n = 116	n = 162	n = 5
<i>Men</i>	65 (56.0%)	97 (59.9%)	4 (80.0%)
<i>Women</i>	51 (44.0%)	65 (40.1%)	1 (20.0%)

<sup>1</sup>p-value associated with two-sided one-sample test of proportions, with the null proportion set to 0.5

<sup>2</sup>p-value associated with Chi-squared test of association between region of affiliation and gender

<sup>3</sup>p-value associated with Fisher's exact test of association between region of affiliation and gender

<sup>4</sup>p-values associated with one-sample tests of proportions within each region of affiliation and author position category are not included in this table for brevity

*Sensitivity analysis #2:*

For the second sensitivity analysis, we considered error rates stratified by author region of affiliation, using the same sample of 893 authors. Table 3 shows these error rates, and Table 4 shows the results, based on the corresponding error adjusted gender classification variable.

Table 3: Author names stratified based on region of affiliation.

	Number of authors sampled	Percentage of names sampled from each strata	Error rate
Sub-Saharan Africa	488	2%	<i>Overall: 12.5%</i> <i>Classified as women: 17.9%</i> <i>Classified as men: 9.1%</i>
Europe/North America	288	2%	<i>Overall: 8%</i> <i>Classified as women: 5.4%</i> <i>Classified as men: 10.8%</i>
Both Sub-Saharan Africa and Europe/North America	104	3.7%	<i>Overall: 8%</i> <i>Classified as women: 8.5%</i> <i>Classified as men: 12.3%</i>
Other	13	1.5%	<i>Overall: 3%</i> <i>Classified as women: 20%</i> <i>Classified as men: 12.5%</i>
Overall	893	2.1%	

Table 4: Author gender composition by region of affiliation after adjusting for region-specific error rates.

	Authorship position		
	First author (n=6819)	Last author (n=6819)	Single author (n=281)
<b>Overall</b>	p < 0.001 <sup>1</sup>	p < 0.001 <sup>1</sup>	p =0.51 <sup>1</sup>
<i>Men</i>	3736 (54.8%)	4072 (59.7%)	146 (52.0%)
<i>Women</i>	3083 (45.3%)	2747 (40.3%)	135 (48.0%)
<b>Region of author affiliation<sup>4</sup></b>	p < 0.001 <sup>2</sup>	p < 0.001 <sup>2</sup>	p < 0.001 <sup>3</sup>
Sub-Saharan Africa	n = 3768	n = 3350	n = 146
<i>Men</i>	2374 (63.0%)	2171 (64.8%)	92 (63.0%)
<i>Women</i>	1394 (37.0%)	1179 (35.2%)	54 (37.0%)
Europe/North America	n = 2206	n = 2764	n = 122
<i>Men</i>	866 (39.3%)	1505 (54.5%)	47 (38.5%)
<i>Women</i>	1340 (60.7%)	1259 (45.5%)	75 (61.5%)
Both Sub-Saharan Africa and Europe/North America	n = 729	n= 543	n = 8
<i>Men</i>	428 (58.7%)	294 (54.1%)	4 (50.0%)
<i>Women</i>	301 (41.3%)	249 (45.9%)	4 (50.0%)
Other	n = 116	n = 162	n = 5



<i>Men</i>	68 (58.6%)	102 (63.0%)	3 (60.0%)
<i>Women</i>	48 (41.3%)	60 (37.0%)	2 (40.0%)

<sup>1</sup>p-value associated with two-sided one-sample test of proportions, with the null proportion set to 0.5

<sup>2</sup>p-value associated with Chi-squared test of association between region of affiliation and gender

<sup>3</sup>p-value associated with Fisher's exact test of association between region of affiliation and gender

<sup>4</sup>p-values associated with one-sample tests of proportions within each region of affiliation and author position category are not included in this table for brevity