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Trends in the publication output of women at South African universities

Significance:

- This Commentary provides an updated picture of the contribution of female academics to university research output in South Africa over the past 16 years.
- From 2005 to 2020, participation and productivity of women, and especially black women, have increased, particularly in the areas of agriculture and engineering.
- Despite the substantial increases in the share of female-authored publications and participation of female academic staff, there remains a large gender gap.

One of the key imperatives of the post-1994 science and higher education system in South Africa has been and remains the transformation of the human resource base of knowledge production. One of the specific ways in which this has been envisaged is through interventions that would lead to the research system becoming more inclusive of female and black scientists and academics. Such interventions include the Thuthuka and Women-in-Science funding instruments of the National Research Foundation, the University Capacity Development Plan of the Department of Higher Education and Training (DHET), and initiatives by the Academy of Science of South Africa and the National Science and Technology Forum to create and stimulate the interest and participation of female students and scholars in knowledge production.

The 2019 White Paper on Science, Technology and Innovation of the Department of Science and Innovation (DSI) reiterates the importance of ensuring greater participation by women in the scientific workforce and calls for the establishment of a Women in Science Desk at the DSI. Additionally, most South African universities have pursued institutional policies and strategies to enable the increased scholarly contribution of female students and staff. In this contribution, we address the specific question of whether the contribution of female academics to the research publication output of the higher education sector has in fact increased.

This Commentary is based on data captured in the Centre for Research on Evaluation, Science and Technology (CREST)'s database (*SA Knowledgebase*) which contains – under a data sharing agreement with DHET – all publications produced by academic staff and students at South African universities that qualify for subsidy. The 'gender' and 'race' fields used in our analyses are based on the information provided by the universities themselves to the DHET, which applies a binary notion of gender and categorises race as African, Indian, coloured (which we combine into the category 'black') and white.

In our analysis we include authors who have published at least one paper between 2005 and 2020. A total of 245 251 articles were submitted by the universities for subsidy between 2005 and 2020. These articles were disaggregated into authorship records. For each contributing author of a paper, the available demographics (race, gender, year of birth, etc.) were linked to that author. The resultant authorship file consists of 586 428 individual records. Of these, we have the gender for 99.9% or 586 187 of the records, while coverage of race (of South African nationals) is equally high, at 99.6%.

When studying research output, 'participation'¹ (i.e. employment in the higher education sector and the capacity to conduct research in such employment) needs to be controlled for to ensure that, in the case of a gender analysis such as ours, female productivity cannot be 'accidentally underestimated by failing to take into account the amount of female academic staff time that is available for research'². We control for 'participation' by using data on permanent instructional and research staff (i.e. 'academics') employed at South African universities, as submitted annually by public universities to the DHET, through the Higher Education Management Information Systems (HEMIS). In addition to some demographics, the data include 'headcounts' as well as the full-time equivalent (FTE) value of academic staff's capacity allocated to research and instruction. Where data were available, we calculated the ratio of number of authorships to the value of research/instruction FTE. We believe that a comparison of this ratio for women and men, although far from perfect, provides a more nuanced measure of the gender productivity gap.

Gender of authors: An increase in overall contribution of female academics to research publications

The trend over the past 16 years (Figure 1) is that of a steady, linear increase in the contribution of female authors at South African universities to the publication of scientific articles: from 31.1% ($n=3312$) in 2005 to 36.8% ($n=21\ 960$) in 2020.

Previous research spanning six decades, using a myriad of measures, and covering diverse disciplines in a multitude of countries worldwide, has clearly established the lower productivity of female scientists, per capita and as a group, in most areas of science. In Figure 1, we find evidence for this phenomenon in the South African higher education sector, when we compare the share of female authors with that of female academics for the period 2005 to 2020. We find that, although there has been a similar increase in the share of female authors and academics of approximately 5 percentage points for the period studied, women's proportional share among academics has been consistently higher (by 12–14 percentage points) than their share among authors.

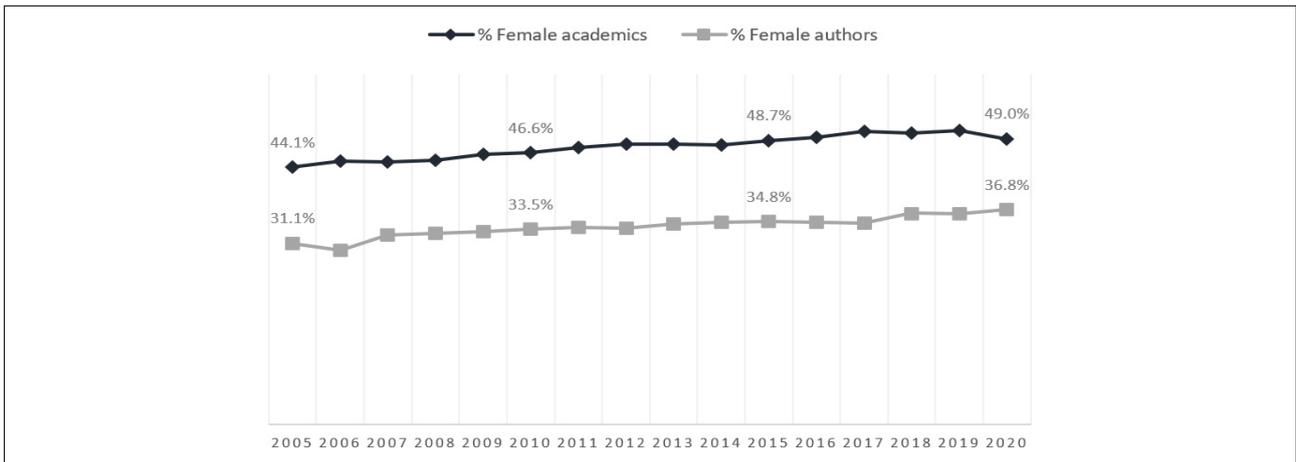


Figure 1: Women's proportional share among academics is consistently higher than their share among authors, although both have increased by 5% from 2005 to 2020.

Table 1: Authorship-staff (FTE) ratio by gender and race, and changes over time from 2005 to 2020

Year	Indicator	Black				Gender gap	White				Gender gap
		Women		Men			Women		Men		
		Staff	Authors	Staff	Authors		Staff	Authors	Staff	Authors	
2005	Proportional share	17%	4%	25%	11%		27%	27%	31%	58%	
	Ratio of authors to staff	0.24		0.44		0.2	1		1.87		0.87
2020	Proportional share	29%	18%	34%	24%		20%	27%	17%	31%	
	Ratio of authors to staff	0.62		0.71		0.09	1.4		1.82		0.42
Change in the ratio of authors to staff		+0.38		+0.27		-0.11	+0.4		-0.05		-0.35

Simply focusing on the 'gender' of publishing academics by itself does not provide us with a sufficiently informative or even accurate picture of how publication output is linked with other factors. For this reason, we have disaggregated our data for a preliminary analysis of how the relationship between gender, race and scientific field of authors contributes to their research output. We would ideally have liked to include other relevant demographic variables such as the highest qualification and rank of the publishing authors. Unfortunately, the data on these two variables are only available for the past 2 years and hence could not be included in our analyses.

Gender and race of authors

Our focus in this section is on the relationship between the gender and race of publishing authors. This analysis is confined to those authors for whom it is clear from the data that they are South African nationals. The results presented in Table 1 are revealing, as they show that the contribution of black female authors has increased more than fourfold over the reporting period: from constituting 4% of all South African-authored papers in 2005 it increased to 18% in 2020. In terms of the productivity ratio, we find that in 2020 black women produced 0.62 authorships per staff FTE compared to 1.4 for white women. However, both black and white women reported the largest increase in productivity ratio (0.38 and 0.4) between 2005 and 2020.

Our results show a substantial shift towards the greater participation and productivity of black (both male and female) South African academics. The trend for white academics is equally interesting as white women have 'maintained' their overall share of publication output in the sector (at around 27%). The biggest single shift has been the relative decrease in the contribution of 'white' authors from producing the majority of papers in 2005 (58%) to a much-reduced share (although the highest single contribution) of 31% in 2020.

Gender, race and scientific field of authors

It has been extensively shown that women are not equally well represented across different scientific fields and disciplines. In South Africa, women tend to be underrepresented in fields such as engineering, mathematics and physics and 'overrepresented' in fields such as the life and health sciences (notably nursing), social work, psychology, education and the like.^{2,3} In Table 2, we see that there has been an increase in the share of female authors across all six broad science domains from 2005 to 2020; but the table also shows that female authors produced 48% of publications in the health sciences in 2020, compared to only 20% in engineering. Although the share of women authors in engineering is the lowest among the science domains, Prozesky and Van Lill⁴ found that women in that field constitute only 20% of its research capacity. This means that, although female authors make up only a fifth of authors in the engineering sciences, they are equally productive to men, when taking into account their share of capacity in the sector.

Table 2: Comparison of share of female (co)authored publications by science domain for selected years

Science domain	2005	2010	2015	2020
Health sciences	38.5%	40.8%	44.9%	47.9%
Social sciences	38.4%	40.3%	41.3%	40.2%
Humanities and arts	33.4%	33.4%	33.2%	38.2%
Agricultural sciences	25.0%	30.3%	27.8%	33.6%
Natural sciences	22.4%	25.5%	25.2%	28.8%
Engineering	14.8%	18.6%	17.8%	20.4%
Average	30.9%	33.0%	34.0%	36.4%

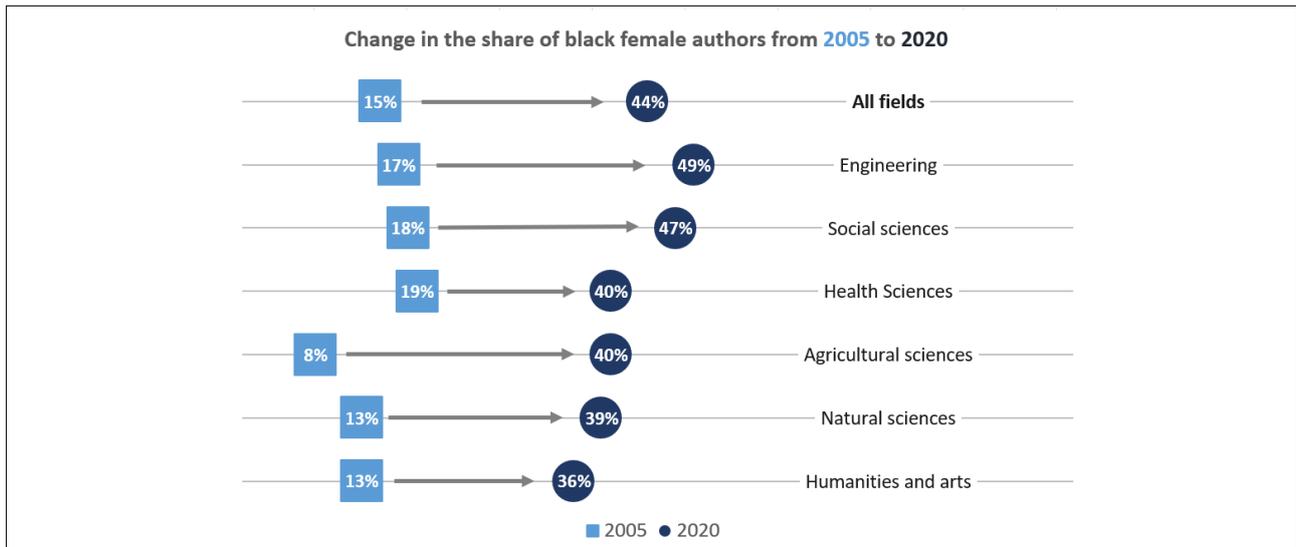


Figure 2: Change in the share of female South African authors by science domain between 2005 and 2020.

Our final set of results pertain to the contribution of black, female, South African-born authors when comparing 2005 and the latest available data (2020) by science domain (Figure 2). The results show that across all fields, the share of black female-authored papers increased substantially between 2005 and 2020. We see large shifts (more than the average for all fields at 29%) in the share of black female authors in the agricultural sciences (32%) and engineering (32%), while the smallest increase (21%) is observed for black female authors in the health sciences.

In conclusion

The aim of this Commentary has been to present a more refined and updated picture of the contribution of female academics to university research output in South Africa over the past 16 years. The aim was primarily descriptive. Our analyses show very clearly the interplay of gender with race and field. When we disaggregate by race (for South African nationals), we see a clear movement over time towards greater participation and productivity of women, and especially black women. When drilling down to the level of scientific fields, we again see a general trend, across science domains, towards the more inclusive production by female authors and especially black female authors, particularly in the areas of agriculture and engineering.

Despite the substantial increases in the share of female-authored publications and participation of female academic staff, our results also show that there remains a large gap – especially as far as race of author is concerned – between the capacity in the university sector and research publication production, as reported in the lower authorship-to-staff ratios of black South African women.

After decades of research globally, there is still no consensus on the reasons for gender differences in research output.⁵ Nevertheless, some useful conceptual frameworks have been suggested^{6–8} and in South Africa, research published in the past decade has found female academics' publication output to be negatively affected by, among other factors, their preference for teaching over research, heavy administrative workloads, lack of confidence and capacity as well as family commitments^{9–17}. However, much of this research tends to be limited to single institutions and/or disciplines, and while the results we report in this Commentary provide a quantitative overview of the trends in the publication output, they are preliminary and require further analysis.

From a policy and research strategy point of view, it is imperative that the system needs more targeted interventions and initiatives that are aimed at those scientific disciplines in which progress towards a more inclusive sector has been slowest. It is also evident, from these analyses,

that further disaggregation of publication output by highest qualification, rank and age of author is likely to point to further disparities and areas where we need such interventions in order to be able to mobilise the full knowledge-production potential of all academics in the sector.

This Commentary is an extended version of an earlier working paper (SciByte 4) to which Milandr  van Lill and Herman Redelinghuys made important contributions.

Competing interests

We have no competing interests to declare.

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