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A gender perspective on career challenges experienced by African scientists

Empirical knowledge of the career challenges that confront African scientists, and women scientists in particular, holds an important key to achieving future success in the science systems of the continent. In this article, we address a lack of evidence generally on the careers of scientists in Africa, by providing the first continent-wide description of the challenges they face, and how these challenges differ between women and men. Our analysis of questionnaire-survey data on approximately 5000 African scientists from 30 countries shows that women are not more challenged than men by a variety of career-related issues, with the exception of balancing work and family, which the majority of women, regardless of age and region, experience. Contrary to expectations, women are not only less likely than men to report a lack of funding as having impacted negatively on their careers, but have been more successful at raising research funding in the health sciences, social sciences and humanities. These results, as well as those from a comparison of women according to age and region, are linked to existing scholarship, which leads us to recommend priorities for future interventions aimed at effectively ensuring the equal and productive participation of women in the science systems of Africa. These priorities are addressing women's work–family role conflict; job security among younger women scientists; and women in North African and Western African countries.

Significance:

- This study is the first to describe, on a multinational scale, the career challenges that confront African scientists, and women scientists in particular.
- Contrary to expectations, we found that African women scientists do not report experiencing career challenges to a larger extent than men do, and have been more successful at raising research funding in three of the six major scientific fields.
- However, the findings highlight the significance of the challenge that balancing work and family poses to the majority of African women scientists.

Introduction

Our focus on gender in science in general and on publication output in particular is motivated by a general lack of empirical knowledge about the careers of scientists in Africa.[1] Very few studies have surveyed scientists across different African countries to gain insight into their career-related perceptions, and, to our knowledge, no study has attempted to understand the challenges that confront specifically African women scientists, such as the resources at their disposal (including non-material ones, such as mentorship and support), work–family balance, and mobility. Indications[2-8] are that patriarchy still pervades the majority of African societies, with its resulting gender based divisions of labour in both the family and scientific institutions, disparities between men's and women's access to power and resources, gender biases in rights and entitlements, etc.

These challenges and others have the potential to negatively affect women scientists' research performance and their retention, especially as emerging researchers, to the detriment of the research system that trained them. The contribution of this paper is to address this gap in the literature, and thereby to better understand what might be done to nurture the full potential of women scientists from 30 African countries. In addition to gender, our analysis also takes into account three other variables. Firstly, our focus on chronological age is informed by the continent wide challenge of retaining especially emerging researchers in science careers. Secondly, taking into account nationality recognises socio-cultural differences among countries that impact on the role and status of women. Some countries, such as Uganda, are considered more 'gender progressive'[8] than others, such as Tunisia[9], and these differences seem to be more significant than differences between institutional settings within any given country.[10] Thirdly, scientific fields differ in terms of the extent to which they are characterised by various forms of gender inequality[11], as well as many other aspects relevant to career challenges in general.

Methods

Data collection

A web-based survey was conducted between 2016 and 2017. The survey generated data from slightly more than 5000 scientists born and currently working in an African country. For the purpose of this survey, scientists are defined as individuals who dedicate at least a portion of their professional activity to research. As members of a scientific community, they communicate – primarily through peer-reviewed journal publications – their results and findings to their peers. Thus, to identify and contact African scientists, we extracted corresponding authors' emails from the Web of Science and Scopus databases for each article published from 2005 to 2015 with an institutional address in Africa. For Zambia, we also used articles in journals not indexed in the Web of Science and Scopus databases. Other sources of email addresses were the South African Knowledgebase database, the Internet, as well as snowball sampling.

Data were collected via a self-administered, structured questionnaire, which was piloted in Zambia, and translated into French for respondents in French-speaking countries. It comprised sections on educational background; employment; working conditions; research output; funding; career challenges; international mobility; collaboration; mentoring; and demographic background.

Prior to commencement of data collection, the study was approved by the Research Ethics Committee of Polytechnique Montréal (N/Réf: Dossier CÉR-1516-43) and by the Research Ethics Committee: Human Research (Humanities) of Stellenbosch University (Proposal #: SU HSD-002130). Informed consent was obtained from all respondents, whose participation in this study was voluntary. Respondents could decline to answer any question and could withdraw from the study at any time without negative consequences. All data collected were treated as confidential and the respondents' anonymity is protected in this publication.

Data processing and analysis

The focus of this study was on career challenges, i.e. the extent to which 10 identified factors may impact negatively on the scientists' careers. These factors range from personal (e.g. balancing work and family demands) to contextual (e.g. political instability or war) in nature. Originally measured with three response options ('Not at all'; 'To some extent'; and 'To a large extent') the variables were recoded into binary variables ('No' and 'Yes', with the latter including at least to some extent) for ease of comparison. In addition, a score of the original responses across the 10 challenges was calculated as a composite measure of the extent to which respondents experience challenges in their careers in general. This involved assigning numerical values to each response option ('0' to 'not at all', 1 to 'to some extent' and 2 to 'to a large extent') and adding these for the 10 challenges for each respondent. Scores therefore ranged from 0 to 20.

Where relevant, results on perceived challenges are accompanied by an analysis of related variables. These variables include reported average amount of research funding (in USD) received in the 3 years preceding the survey; average and maximum number of children and dependants; percentage of care-work and general housework undertaken; having studied or worked abroad during the 3 years preceding the survey; and holding a contract-based position.

Nationalities were recoded into four regions: Southern Africa (Botswana, Lesotho and South Africa); Western Africa (Benin, Burkina Faso, Cote d'Ivoire, Ghana, Mali, Nigeria, Senegal and Togo); North Africa (Algeria, Egypt, Morocco and Tunisia) and Eastern and Central Africa combined, because of the small numbers in these two (Cameroon, Central African Republic, DRC, Gabon, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Seychelles, Tanzania, Uganda, Zambia and Zimbabwe). Age was recoded into a binary variable to distinguish between young scientists (defined as 45 years or younger) and scientists older than 45. Scientific field was recoded into five broad categories: natural and agricultural sciences; engineering and applied technologies; health sciences; humanities; and social sciences.

Data were analysed with IBM SPSS Statistics 24. Subgroup comparisons were drawn between women and men in terms of challenges experienced, and their negative impact on career development, as well in terms of a number of other, related, variables, where relevant. The focus then shifted to an analysis of only women scientists, to determine whether the challenges they had experienced varied according to chronological age and nationality. Again, where relevant, other comparisons between these various categories of women were also drawn in terms of related variables. In the case of categorical variables, cross-tabulations were generated, and in the case of continuous variables, means (or medians when standard deviations were high) were compared.

Results

A comparison of women and men scientists

The greatest differences between female and male scientists were found with regard to the impact that they perceived a lack of funding for research equipment had had on their careers, with a much larger percentage of male respondents reporting a negative effect of this challenge (Table 1). This finding may be explained by the dominance of men in equipment-intensive scientific fields such as the natural sciences and engineering. Controlling for scientific field supports this explanation to some extent, as it reduces by half the difference between men and women in those scientific fields, but increases it quite substantially (from 14% to 25%) in the female-dominated social sciences which are less equipment intensive. Also, the second- and fourth-largest gender differences are observed for a lack of access to a library and/or information sources and a lack of research funding in general; and, in both cases, again a greater percentage of men reported the negative impact of these resource deficiencies.

Table 1: Percentage of men and women respondents reporting the negative effect, to some or a large extent, of career challenges

Challenge	Women	Men
Balancing work and family demands	80%	71%
Lack of research funding	80%	87%
Lack of mentoring and support	72%	71%
Lack of funding for research equipment	69%	83%
Lack of training opportunities	64%	70%
Lack of mobility opportunities	64%	69%
Lack of access to library and/or information sources	40%	55%
Limitation of academic freedom	40%	43%
Job insecurity	38%	37%
Political instability or war	29%	31%

It should be noted that men reported having received on average slightly less research funding (USD72 304) than women (USD75 691) did in the 3 years preceding the survey. However, when we controlled for field, a more differentiated picture emerged. In only three scientific fields – the humanities, social sciences and health sciences – women reported having received more funding than their male counterparts in those fields. In the other three scientific fields – engineering and applied technologies, the natural sciences and the agricultural sciences – the opposite applies (Figure 1).

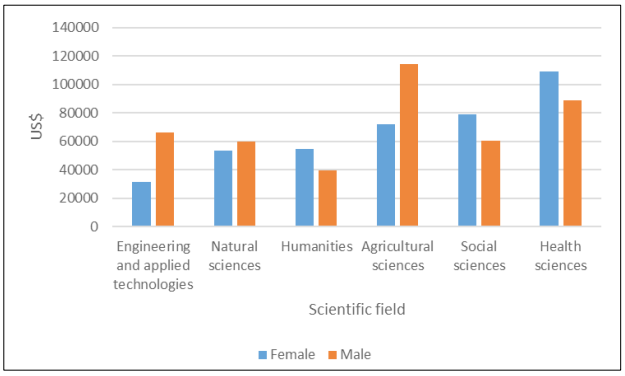

Figure 1: Reported amount of funding received, by gender and field.

The only challenge which women were more likely than men to have experienced concerns balancing work and family demands, for which the third-greatest gender difference is observed. Interestingly, men reported a larger average and maximum number of children and dependants than the women, but their care (and general housework) was not the men's main responsibility. On average, male scientists undertake a much lower percentage (37%) of such work themselves than is the case among women

(58%), while their partners contribute a much higher percentage (47%) than women scientists' partners do (23%) to care-work and general housework.

Among those for whom a lack of mobility and training opportunities have had a negative impact on their careers, we found a slightly greater percentage of men (although they are actually 10% more likely than women to have studied or worked abroad during the 3 years preceding the survey). Very small gender differences (3% or less) were found with regard to the remaining four challenges, i.e. a lack of mentoring and support, job insecurity, political instability or war, and a limitation in terms of academic freedom. In general, however, an analysis of a composite score of the responses across the 10 challenges shows that men reported having experienced, on average, challenges to a larger extent (mean = 8.56) than women did (mean = 7.71).

A comparison of women scientists in terms of age and nationality

When only women are analysed, balancing of work and family demands emerges as the challenge that has negatively affected the careers of the largest percentage (80%). A very similar majority (close to 80%) have experienced a lack of funding as a career challenge, and more than two thirds (69%) have experienced a lack of funding for research equipment specifically. However, this challenge does not seem to be a gender-related concern, as women are less likely than men to have experienced a lack of funding as a career challenge, and an exploratory survey[12] found this to be the most common challenge noted by 57 faculty members from 10 African countries (Botswana, Ethiopia, Ghana, Kenya, Nigeria, Rwanda, Senegal, South Africa, Tanzania and Uganda).

A lack of mentoring (72%) and a lack of mobility and training opportunities (64% in each case) had also been experienced by the majority of women. Poor mentoring and inadequate exposure to training have also been highlighted by qualitative research[4,6,13] among African women scientists. On the other hand, only approximately 40% of women indicated that a lack of access to library and/or information sources, a limitation in terms of academic freedom and job insecurity were major challenges to their careers. Only 29% experienced political instability or war as such.

In general, the composite score shows that women older than 45 seem to have experienced challenges to a lesser extent (mean = 7.06) than their younger counterparts (mean = 8.20). The age difference is most notable with regard to job insecurity: those who have experienced it as a career challenge are, on average, 6 years younger than those who have not. (Because of a high standard deviation in the case of age, the median rather than the mean is used as the measure of central tendency). This may be explained by the younger scientists being in the early stages of their careers. However, changes in the environment external to African research institutions – for instance volatile or uncertain economic conditions, or changes in government policy – may also lead institutions to cut costs by increasing their use of contract positions.[14] Without longitudinal data, a definitive answer in this regard is not possible. However, it is noteworthy that women 45 or younger are indeed more likely to hold contract-based positions (16%) than their older counterparts (10%).

It therefore also makes sense that younger women scientists are slightly more likely than their older counterparts to have experienced a lack of training and mobility opportunities as career challenges. At the same time, younger women have actually been more mobile: 26% have worked or studied abroad in the 3 years preceding the survey, compared to only 18% of those older than 45. No age difference was found with regard to having experienced a lack of funding in general as a challenge. However, this is not reflected in the actual amount of funding received in the 3 years preceding the survey, which was much higher for women older than 45 (USD94 443) than for those 45 or younger (USD60 551). When we controlled for scientific field, we found that this applies to all fields except the social sciences (Figure 2).

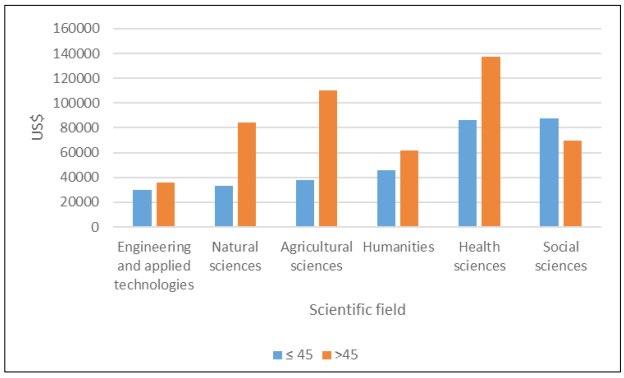

Figure 2: Reported amount of funding received by women older than 45 years and those 45 years or younger, by field.

On average, older women (but not by much) reported finding balancing work and family demands as significant career challenges. This was despite the fact that these older women had, on average, fewer dependants younger than 18 and were very similar to younger women in terms of the distribution of care-work and general housework between themselves and their partner. However, older women did have, on average, more elderly dependants in their care than their younger counterparts. It also needs to be taken into account that respondents were asked to reflect on challenges they had experienced in the past. Thus, although older women were past their intensive child-bearing and child-rearing years, certain opportunities (such as scholarships for PhD training) that they had to forego during that period have age limits, and they were no longer legible.[6]

When region of nationality is considered, the most salient pattern is that North African women scientists are more likely to have reported the negative effects of 6 of the 10 challenges on their careers: a lack of (1) mentoring and support, (2) mobility opportunities, (3) training opportunities, (4) research funding and (5) funding for research equipment; and (6) a limitation in terms of academic freedom. The composite score supports the observation that North African women scientists have experienced more and/or greater challenges than women in the other regions, and especially when compared to those in Southern Africa (Figure 3).

With regard to funding in particular, the data on the amounts received in the 3 years preceding the survey match the experience of North African women: they received by far the lowest amount at USD13 331, compared to USD57 613 for Western Africa, USD99 900 for Southern Africa, and USD203 093 (15 times more) for Eastern and Central Africa. With regard to mobility, Western African women were relatively unlikely (18%) to have worked or studied abroad recently (only Southern African women were found to be less mobile, at 16%).

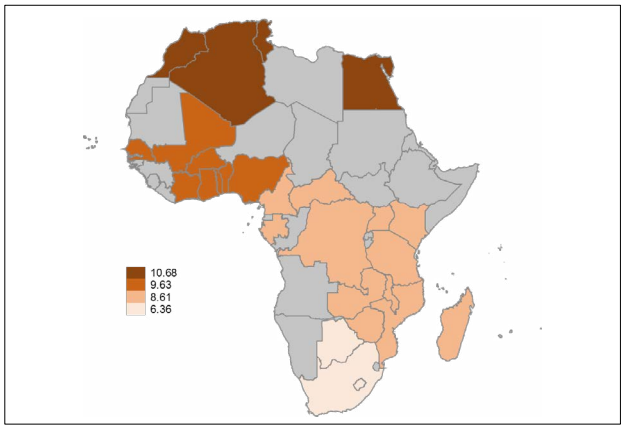

Figure 3: Women respondents' average career-challenge score, by region, from lowest to highest: Southern Africa, Eastern and Central Africa, Western Africa, and North Africa.

Furthermore, Western African women were most likely to highlight the balancing work and family demands as a career challenge. We also found them to have the highest average number of dependants older than 5, and the second-highest average number of dependants younger than 6. This finding resonates with Tsikata's[6] observation that, '[i]n keeping with the pro-natalist national cultures of Ghana, women academics are expected to marry and have children'. Interestingly, however, when compared with women from the other regions, Western African women did the smallest percentage of housework themselves. As Tsikata[6] notes with regard to Ghana, women scientists:

> *differed in how they experienced the impacts of marriage and family on their work. The ages of their children, their marital status and who they were married to, were all important factors.*

The women scientists most burdened by housework and caregiving were found in North Africa, which is explained, at least with reference to Tunisia, by Hassine's[9] observations that:

> *academic women, with few exceptions, have internalised the traditional values that define gender roles and continue to prevail in Tunisian society and are even on the increase with the rise of Islamism.*

Women from Western Africa were most likely to have experienced a lack of access to library and/or information sources, and political instability or war. The remaining challenge – job security – was most challenging for the careers of Central and Eastern African nationals.

The largest regional difference was observed with regard to a lack of access to library and/or information sources, which was a career challenge for only less than 20% Southern African women respondents compared to three-quarters of Western African women respondents. A lack of funding for research equipment and of training opportunities to develop professional skills also differed quite substantially between the regions, with Southern African women again less likely than their counterparts from other regions, especially Western Africa, to have experienced these challenges. In fact, the only challenges Southern African women were more likely to have experienced were those relating to job security and balancing work and family demands. Women across all the regions, however, were by far the most similar in terms of their experience of balancing work and family demands, with very high percentages (76–85%) citing this as a career challenge.

Conclusions

The large body of literature on women scientists leads one to expect that these women experience challenges to a larger extent than their male counterparts do. Our survey of African scientists does not, however, support this general hypothesis. The notable exception is the challenge of balancing work and family demands, which is the only challenge women are more likely than men to have experienced. It is also the challenge most frequently experienced by women, particularly those women who are older than 45 (who have a greater number of elderly dependants), and those from Western African countries.

A number of scholars[4,6,8,9,15-20] have highlighted the potential negative effects of particularly African women scientists' reproductive responsibilities and a traditional gendered division of labour within households. It has often been noted that many women scientists globally are limited in their geographic mobility by family demands and the occupational contingencies of their husbands (for a review see Prozesky[21]). Female scientists in Africa are reported to experience difficulties travelling to conferences, for example, because of the assumption that they are the primary domestic caregiver at home.[4,22] In addition, in some countries (e.g. Sudan) restrictions on women's interactions with non-familial men and norms inhibit their movement outside of the local area.[8,23]

These challenges may very well explain why the women we surveyed had been less mobile recently than the men, and that almost two-thirds of the women had experienced a lack of mobility as a career-related challenge. Campion and Shrum[22] refer to this scenario as 'educational and research localism', which leads to restricted professional networks. What is surprising, however, is that women were less likely than men to report a lack of mobility as a challenge they had experienced. A possible explanation that should be considered for further research may be found in Stouffer et al.'s[24] concept of relative deprivation: because of the normative restrictions of women's geographic mobility noted above, their expectations of mobility are arguably lower than men's. Differences between women and men in terms of their expectations have been found to apply to other work-related aspects, such as the paradox that women report higher levels of job satisfaction than do men, although, by most objective standards, women's jobs are worse than men's.[25]

Our survey shows that women's greater likelihood to experience work–family role conflict is not a function of the number of dependants they have (which is greater for men), but it corresponds well with the findings of previous research outside of Africa (and reviewed elsewhere – see Prozesky[21]) that women scientists reported having fewer children than their male counterparts did. In Africa, women who do enter scientific careers are more likely to postpone or avoid family responsibilities than men[22], but when they do have children, they take the main responsibility for 'traditional obligations' of childcare and housework, while men tend to delegate these responsibilities to their (female) partners[8,26].

However, contrary to the literature – in particular the 'deficit model' which hypothesises that in patriarchal societies men and women do not share equally in the means of scientific production[27] – we find that African women scientists are not only much less likely than men to have experienced financial resources as a career challenge, they have also received more research funding than men in the humanities, social sciences and health sciences.

However, funding is still highlighted as a career challenge by the second-largest majority of women scientists. The need for funding for research equipment is most salient among North African women (particularly when compared to Southern African women) and among those in the natural and agricultural sciences (particularly when compared to their counterparts in the less resource-intensive humanities and social sciences).

Younger women are not more likely than their older counterparts to have experienced such financial-resource deficits as a career challenge, but they do, on average, obtain less funding than their older peers, except in the social sciences. They are also much more likely to have experienced job insecurity as a career challenge and in general have experienced challenges to a larger extent than their older counterparts.

In terms of region, the 'most career-challenged' women are found amongst North African nationals. A more detailed analysis shows that Western African women are particularly likely to report a lack of material and other resources (library and/or information sources, funding for research equipment and training opportunities to develop professional skills), especially when compared to their Southern African counterparts.

To policymakers and granting councils who are tasked with designing research-support programmes to optimise the performance of women scientists, our results are in agreement with Campion and Shrum's[22] argument that gender differences in research systems 'are rooted in systemic inequities in social rather than material resources'. This seems to suggest that increasing funding for women scientists (the proverbial 'throwing money at the problem') should be less of a priority than work–family role conflict. The latter is a much more persistent challenge that is specific to women scientists in societies characterised by traditional gendered division of labour within households. It should be recognised, as Tamale and Oloka-Onyango[8] observe, that 'the roots of patriarchal oppression lie in the smallest unit of societal organisation which is the family', and therefore 'the root causes of inequities' within science are 'based on the underlying gendered division of labour'.

In addition to the need for a fundamental, although complex, change in gender relations which would 'allow men to share in both the pleasures and the burdens of time-consuming domestic and parenting responsibilities'[20], research institutions should also provide allowances in their policies or employment contracts for women in the role of caregiver (e.g. maternity, child-care and domestic-support provisions, as well as family-

responsibility leave). In short, institutions cannot remain ostensibly gender neutral while critical differences exist between men and women in African societies, especially those that have experienced decreased access to social services.[8]

Job security among younger women scientists is also highlighted as an area of concern. Finally, from a regional perspective, efforts to address women scientists' career-related challenges should be directed first and foremost towards North African and Western African countries.

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Authors' contributions

The study which produced the data analysed for this article was primarily conceptualised and methodologically designed by J.M., with H.P. providing some input during proposal writing. H.P. designed the data collection instrument, while J.M. managed the online questionnaire administration. Data analysis and interpretation was conducted by H.P., as was preparation and creation of the article, specifically writing the initial draft. J.M. provided critical review, commentary and revision of writing of that draft, which required additional analysis. Project leadership and management, as well as funding acquisition, were the responsibilities of J.M.

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