Women's representation in national science academies: An unsettling narrative

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Science academies are well placed to contribute towards strengthening of national systems of innovation through advocating for an increased participation of girls and women in science. To successfully do so, academies would need to overcome challenges faced with regard to women's representation in their own ranks and women's resultant full participation in the activities of national science academies. We collected baseline data on the representation of women scientists in the membership and governance structures of national science academies that are affiliated with IAP: the Global Network of Science Academies. Women academy members remained far below parity with men, given that women's membership was typically about 12%. Women members were better represented in the social sciences, humanities and arts but the corresponding shares rarely exceeded 20%. In the natural sciences and engineering, women's membership remained well below 10%. On average, the largest share of women members (17%) was associated with academies in Latin America and the Caribbean. The average share of women serving on governing bodies was 20%. To change this unsettling narrative, the importance of academies of science annually collecting, analysing and reporting gender-disaggregated data on membership and activities is highlighted as a key recommendation. Several aspects of women's representation and participation in national science academies are highlighted for further investigation.

Significance:
- Demonstrates under-representation of women in national science academies.
- Reports on results of the first gender-disaggregated survey on membership and governance of national science academies, globally.
- Underscores the importance of regular collection, analysis and reporting of gender-disaggregated data in the science sector.

Introduction

The participation of women in science has attracted significant attention in recent decades, as evidenced by the growing number of policy-oriented studies on the topic[1-6] and the many scholarly studies in the academic literature[7-9]. Typical themes include the participation of the girl-child in science, technology, engineering and mathematics (STEM)[10-12], women scientists' representation and performance in STEM occupations[13-16], gender differences with regard to remuneration and promotion practices[17,18], and women's access to technologies[19,20], to mention a few.

Up to now the available studies, with the exception of one[21], have remained silent on the representation of women in the activities of national science academies. This silence is ironic as science academies – in addition to honouring scientific excellence by means of electing eminent scientists into membership – also operate as change catalysts by virtue of their participation in scientific agenda setting, science advice in support of policy development and, in some cases, the management of research activities. It could therefore be argued that national science academies are well placed to contribute towards strengthening of national systems of innovation through advocating for increased participation of girls and women in STEM, and by gendering science policies and applying the gender lens in research and innovation. However, to do so successfully, academies would need to overcome challenges faced with regard to women's representation in their own ranks, for instance, in academy membership and governance. It also means that reliable gender-disaggregated baseline information and appropriate international benchmarks would need to be collected, analysed and reported in order to enable academies to regularly monitor and compare progress.

It is against this background that we undertook the current study to collect baseline data on the representation of women scientists in the membership and governance structures of national science academies affiliated with an international umbrella body of academies, namely IAP: the Global Network of Science Academies (now known as the InterAcademy Partnership). IAP is a global network of science academies that was launched in 1993, and whose primary goal is 'to help member academies work together to advise citizens and public officials on the scientific aspects of critical global issues'[22]. It represents over 110 national academies of science in both the global North and South. IAP considers progress towards women's full participation in science a critical issue of global importance. The results represented here follow recommendations, in 2006, by another academy umbrella body, the InterAcademy Council (IAC) that academies should regularly report on women's representation and participation within their ranks.[23]

Method

The Academy of Science of South Africa (ASSAf) and the InterAmerican Network of Academies of Sciences (IANAS) executed the study as two separate but related online surveys during the period 2014–2015.

IANAS surveyed the 19 national science academies of IAP in North America and Latin America and the Caribbean. ASSAf surveyed the 84 academies of IAP in the other world regions. The other regions comprised Africa; the Middle East and Central Asia; South Asia; South East Asia and the Pacific; Western and Northern Europe; South Eastern Europe; and Central and Eastern Europe. A number of regional networks of science academies are affiliated to the IAP as observers and carry out the IAP mandate within the regions. They represent the Association of Academies and Societies of Sciences in Asia (AASSA), the Euro-Mediterranean Academic Network (EMAN), the European Academies' Science Advisory Council (EASAC), IANAS, the Network of Academies of Science of the Organisation of Islamic Conference (NASIC), and the Network of African Science Academies (NASAC). It is in this context that IANAS' involvement in the survey should be viewed.

For both surveys, data were collected on women's share of national academy membership, their representation in academy governance structures and whether the academy had a committee in place to advise on gender and/or diversity issues. A 'member' was taken to mean any person elected into the academy. Academies use different names to refer to those elected into their ranks, for example, member or fellow. In some instances, disparate categories distinguish membership (e.g. affiliate, honorary or even patron), with specific limitations of participation in academy activities placed in alignment to these categories. For example, affiliate members may not be eligible to vote in academy leadership elections. The reference year for membership figures was 2013/2014, as academies could use one of two sets of figures: the 2013 intake of members in cases in which elections for the 2014 intake had not yet occurred, or the 2014 member intake in those cases in which the relevant elections had already occurred.

Respondents in the ASSAf survey were asked to specify the number of academy members in nine broad discipline groups and to indicate the number of women members in those groups. An 'all other' option was included to cater for a situation in which the academy's discipline did not match any of the nine groups provided. The IANAS survey used 10 broad disciplinary groups, together with an 'other' option. For consistency, the broad disciplines in the IANAS survey were mapped onto those in the ASSAf survey. It should be noted here that science academies vary regarding their definition of disciplines and which of the latter are eligible for elections. For example, some academies do not elect into membership scientists in the humanities, arts and social sciences.

The survey was completed by a variety of individuals within academies, who included the presidents of academies and other office bearers, executive officers and the academy secretariat. IANAS focal points on gender at each of the North and Latin American, and Caribbean academies, also assisted some academies in that region in completing the questionnaire. A total of 69 national science academies provided information. The number of 'unique' academies was 65, given that the Swiss Academies of Arts and Sciences and its four constituency academies participated individually. The eventual response rate was 63% (i.e. 65 out of 103 national academies). It should be noted that many of the IAP member academies, at the time of the survey, might not have gathered the requested gender-disaggregated statistics, or had limited staffing capacity to answer extensive requests.

Results

Academy membership

The science academies reported on the total number of academy members together with the number of women academy members. Table 1 reports the share of women members for the 63 national science academies that provided data. The two academies ranked highest are both IANAS members: the Cuban Academy of Sciences (27%) and the Caribbean Academy of Sciences (26%). The national science academies of Mexico, Nicaragua, Peru, Uruguay, Honduras and Canada – all IANAS members – also feature on the list of the top 10 academies with the largest shares of women members (between 16% and 23%). In terms of organisations ranked lowest, for 30 of the 63 science academies in Table 1 the share of women members is 10% or less. ASSAf is the only African academy that ranks among the top five organisations as far as women membership is concerned (24%). The Uganda National Academy of Sciences occupies the second position on the African continent (13%), followed by the academies of Ghana and Cameroon (both 11%). The average share of women members, across all 63 national science academies, is 12% (median = 11%).

Table 2 compares the mean share of women academy members in each world region. The largest mean share (17%) is associated with Latin America and the Caribbean. Because the mean is sensitive to outliers, it is advisable to also focus on the median shares. In terms of the median shares of women academy members, North America occupies the first place (15%), with Latin America and the Caribbean in close second place (14%). However, the North American region includes only two national science academies with exceptionally large membership figures (Table 1): the Royal Society of Canada (with 2108 members, of which 16% are women) and the United States National Academy of Sciences (with 2252 members, of which 13% are women). In Africa, women comprise on average 10% of academy members.

Figure 1 shows, for each of the nine broad disciplines, the mean share of women members across all the science academies that completed the relevant items in the survey. The figure ranges from as high as 22% (biological sciences) to as low as 5% (engineering sciences). However, given that there are size differences between the individual science academies as far as the share of women members is concerned (Table 1), it would be more appropriate to report the median share. Following this suggestion, we witness three broad disciplines for which the median share of women members per science academy equals zero: computer sciences/ICT, mathematical sciences and engineering sciences. This trend is also indicative of academic reflections on the representation of women in these fields.[24-26]

Academy governance

The average share of women serving on the governing bodies of national science academies (20%, Table 1) is markedly higher than the share of women in the academy membership (12%). The corresponding median shares are 18% and 11%. Further investigation is required to uncover the reasons for this apparent difference. At this stage one can only speculate on possible reasons. For instance, it could point to the fact that there is a general recognition among academies that women need greater representation and a logical first step would be to include those already elected into the academy in the governing body. An equally plausible hypothesis is that women volunteer their time more readily than men do and hence are better represented in the governance of academies. According to Table 1, the US National Academy of Sciences (47%), together with two European academies (in Switzerland and Sweden, both 47%), have the best representation of women as members of the governing body. Outside Europe, three IANAS members are also noteworthy: Cuba (40%), Canada (38%) and Panama (38%). Relatively high shares are also recorded for three other European academies: the Netherlands (43%), the United Kingdom (40%) and Ireland (36%). In Africa, ASSAf recorded the largest share of women in academy governance (31%).

Lastly, the ASSAf survey enquired about the existence of an academy committee to address gender and/or diversity issues, or at the least someone to advise the academy on such issues. Of the 51 responding academies, 31 (61%) had no such committee or advisor. A third of academies (33%; 17 academies) had an established infrastructure (i.e. a dedicated committee) while the remainder (6%; 3 academies) relied on the input and guidance of individuals. Typically, academies with a larger share of women in their membership, specifically in Latin America, also reported having some infrastructure to address gender or diversity issues. On a regional level, IANAS has established a women in science working group comprising members of academies who are national focal points, and who act as strategic advisers to academies.

Table 1: Percentage of women members of national science academies and their governing bodies, by individual academy

Academy	Country	Academy membership			Academy governance		
		Total members	Women members	% Women	Total members	Women members	% Women
Cuban Academy of Sciences	Cuba	313	85	27%	10	4	40%
Caribbean Academy of Sciences	Caribbean	223	57	26%	7	2	29%
Academy of Sciences of the Czech Republic	Czech Republic	250	60	24%	17	4	24%
Academy of Science of South Africa	South Africa	423	101	24%	13	4	31%
Mexican Academy of Sciences	Mexico	2499	587	23%	10	3	30%
Nicaraguan Academy of Sciences	Nicaragua	30	7	23%	30	7	23%
National Academy of Sciences of Peru	Peru	114	23	20%	See table notes[a]		
National Academy of Sciences of Uruguay	Uruguay	26	5	19%	5	1	20%
National Academy of Sciences of Sri Lanka	Sri Lanka	136	25	18%	17	4	24%
Latvian Academy of Sciences	Latvia	393	70	18%	30	7	23%
National Academy of Sciences of Honduras	Honduras	29	5	17%	3	1	33%
Finnish Academy of Science and Letters	Finland	715	123	17%	10	3	30%
Science Council of Japan	Japan	2101	361	17%	16	4	25%
Swiss Academy of Medical Sciences	Switzerland	222	38	17%	14	4	29%
Royal Society of Canada	Canada	2108	346	16%	16	6	38%
Academy of Sciences Malaysia	Malaysia	265	41	15%	16	4	25%
Academy of Sciences and Arts of Bosnia and Herzegovina	Bosnia and Herzegovina	55	8	15%	16	3	19%
Royal Irish Academy	Ireland	480	69	14%	22	8	36%
Venezuelan Academy of Physical, Mathematical and Natural Sciences	Venezuela	50	7	14%	6	1	17%
National Academy of Sciences of Costa Rica	Costa Rica	43	6	14%	8	1	13%
Royal Netherlands Academy of Arts and Sciences	Netherlands	547	74	14%	7	3	43%
Colombian Academy of Exact, Physical and Natural Sciences	Colombia	190	26	14%	7	2	29%
Austrian Academy of Sciences	Austria	790	105	13%	4	1	25%
Academy of Sciences of the Dominican Republic	Dominican Republic	168	22	13%	17	5	29%
Brazilian Academy of Sciences	Brazil	506	64	13%	13	1	8%
Uganda National Academy of Sciences	Uganda	56	7	13%	11	1	9%
Royal Swedish Academy of Sciences	Sweden	624	78	13%	15	7	47%
US National Academy of Sciences	United States of America	2252	294	13%	17	8	47%
Academy of Medical, Physical and Natural Sciences	Guatemala	68	8	12%	6	1	17%
Chilean Academy of Sciences	Chile	75	9	12%	6	1	17%
National Academy of Exact, Physical and Natural Sciences	Argentina	34	4	12%	7	2	29%
Ghana Academy of Arts and Sciences	Ghana	105	12	11%	11	2	18%
Cameroon Academy of Sciences	Cameroon	83	9	11%	9	0	0%
Academy of Sciences of Albania	Albania	39	4	10%	7	1	14%
Croatian Academy of Sciences and Arts	Croatia	150	15	10%	5	1	20%
German National Academy of Sciences Leopoldina	Germany	1534	152	10%	12	2	17%

Table 1 continued

Academy	Country	Academy membership			Academy governance		
		Total members	Women members	% Women	Total members	Women members	% Women
Hassan II Academy of Science and Technology	Morocco	71	7	10%	6	1	17%
Australian Academy of Science	Australia	479	46	10%	17	5	29%
Swiss Academy of Engineering Sciences	Switzerland	263	25	10%	11	4	36%
Serbian Academy of Sciences and Arts	Serbia	141	13	9%	13	1	8%
Montenegrin Academy of Sciences and Arts	Montenegro	44	4	9%	7	0	0%
Nigerian Academy of Science	Nigeria	160	14	9%	See table notes[b]		
Royal Society of New Zealand	New Zealand	446	39	9%	7	1	14%
Turkish Academy of Sciences	Turkey	197	17	9%	11	0	0%
National Academy of Sciences of Bolivia	Bolivia	47	4	9%	9	1	11%
Royal Academy of Exact, Physical and Natural Sciences	Spain	49	4	8%	6	1	17%
French Academy of Sciences – Institute of France	France	485	38	8%	7	1	14%
Pakistan Academy of Sciences	Pakistan	90	7	8%	17	2	12%
Georgian National Academy of Sciences	Georgia	103	8	8%	20	1	5%
Bangladesh Academy of Sciences	Bangladesh	85	6	7%	13	2	15%
Kenya National Academy of Sciences	Kenya	146	10	7%	14	2	14%
Palestine Academy for Science and Technology	Palestine	75	5	7%	6	1	17%
The Royal Society	United Kingdom	1419	92	6%	20	8	40%
Sudanese National Academy of Sciences	Sudan	78	5	6%	5	1	20%
Indian National Science Academy	India	864	52	6%	31	0	0%
Chinese Academy of Sciences	China	741	42	6%	16	1	6%
National Academy of Lincei	Italy	530	28	5%	8	0	0%
Slovenian Academy of Sciences and Arts	Slovenia	95	5	5%	13	0	0%
Hungarian Academy of Sciences	Hungary	776	39	5%	33	1	3%
Ethiopian Academy of Sciences	Ethiopia	102	5	5%	11	1	9%
Mongolian Academy of Sciences	Mongolia	63	3	5%	17	1	6%
Polish Academy of Sciences	Poland	533	22	4%	24	1	4%
Tanzania Academy of Sciences	Tanzania	130	5	4%	6	1	17%
Academy of Scientific Research and Technology	Egypt	See table notes[c]			27	2	7%
Union of the German Academies of Sciences and Humanities	Germany	See table notes[c]			8	0	0%
Swiss Academies of Arts and Sciences	Switzerland	See table notes[c]			19	9	47%
Swiss Academy of Humanities and Social Sciences	Switzerland	See table notes[c]			18	5	28%
Swiss Academy of Sciences	Switzerland	See table notes[c]			7	2	29%
National Academy of Sciences of Panama	Panama	See table notes[d]			8	3	38%

[a]*The National Academy of Sciences of Peru did not provide information on the composition of its governing council.*

[b]*The Nigerian Academy of Science reported that only one person (a woman) sits on the governing body.*

[c]*Five national academies did not provide any statistics to calculate the share of women academy members: the Academy of Scientific Research and Technology in Egypt, the Union of the German Academies of Sciences and Humanities, and the Swiss Academies of Arts and Sciences and two of its four constituent members (the Swiss Academy of Humanities and Social Sciences [SAHS] and the Swiss Academy of Sciences [SCNAT]). In the case of the Swiss Academies of Arts and Sciences, the SAHS and SCNAT do not have a system of individual members – their members are scientific unions with individuals from the relevant disciplines.*

[d]*Although the National Academy of Sciences of Panama participated in the IANAS survey, its statistic for members is not included in the table. The membership entry process for this science academy in Latin America is by application rather than election. Its relatively high share of women members (40%) is thus not comparable to figures for other academies.*

Table 2: Percentage of women members of national science academies, by IAP world region

IAP world region	Number of academies	% Women				
		Mean	Median	Standard deviation	Minimum	Maximum
Africa	10	10%	10%	6%	4%	24%
Central and Eastern Europe	4	13%	12%	10%	4%	24%
Latin America and the Caribbean	16	17%	14%	5%	9%	27%
Middle East and Central Asia	3	8%	8%	1%	7%	9%
North America	2	15%	15%	2%	13%	16%
South Asia	4	10%	8%	6%	6%	18%
South East Asia and the Pacific	6	10%	10%	5%	5%	17%
South Eastern Europe	6	10%	10%	3%	5%	15%
Western and Northern Europe	12	11%	12%	4%	5%	17%
Total	**63**	**12%**	**11%**	**6%**	**4%**	**27%**

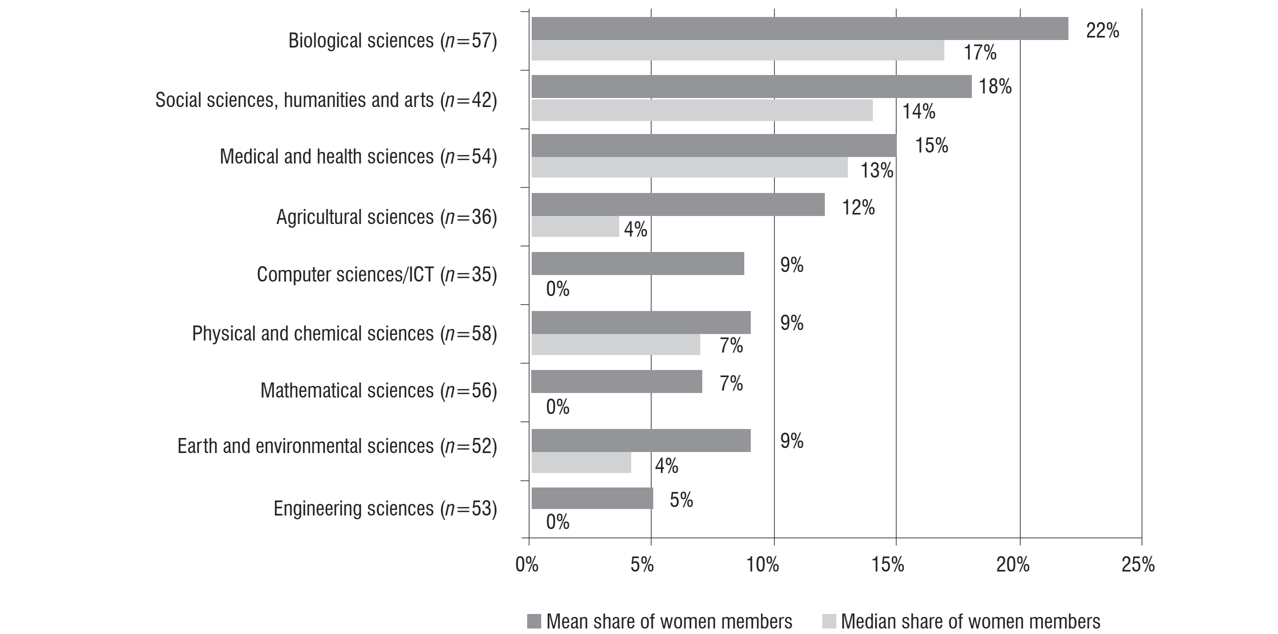

Figure 1: Percentage of women members of national science academies, expressed as both mean and median shares, by broad discipline group.

Conclusion and recommendations

Although not optimal, the number and spread of participating academies provide a good base for future surveys. Large response variations were observed among the IAP member academies with regard to women's representation in membership and governance. Still, a common message emerged that needs to be acted upon. Elements of this rather familiar message include the following: women academy members remain far below parity with men given that women's membership is typically about 12%; in the natural sciences and engineering, women's membership remains well below 10%; and women members are better represented in the social sciences, humanities and arts, but rarely at over 20%.

In light of the above and other findings derived from this study, a number of recommendations are proposed: (1) IAP member academies should annually collect, analyse and report gender-disaggregated data on their respective membership and activities; (2) the IAP should publish gender-disaggregated data of its member academies in its annual report; (3) the IAP annual report should report on the gender dimensions of IAP's internal activities; and (4) IAP member academies should establish permanent organisational structures that provide strategic direction and implement the academy's gender mainstreaming activities. Moreover, as it could take time to achieve a significant shift in academy membership, it is recommended that academies report on the 'gender make-up' of each year's election, in order to determine whether there is an overall trajectory of improvement.

There are also several aspects of women's representation in science that we did not explore in the current study. It is not clear what the main criteria for academy member selection or election are: honouring a lifetime body of work, or honouring scientific excellence and achievement even if that has been reached at an earlier career stage. It is often believed that women follow a different age structure within the scientific community; they tend to be younger, having more recently gained access to select science fields and in some cases have gaps in their scientific career as a result of the work–life balance cycle. To the extent that there is reliance on a body of work as opposed to significant achievement at an earlier career stage, women may be forced to 'wait their turn'. Another pattern we may see for women is one of career interruptions, for example, as a result of family responsibilities, so their record of work is less comprehensive when it comes to consideration for academy membership.[27-29] It is also not clear to what extent the fields are given equal weight or priority when selecting women for academy membership. If there is positive bias towards engineering, computer science or the physical sciences, then fewer women will appear among those nominated as fewer are present among the share of researchers in those fields. If there is negative bias towards the biological, medical, social and behavioural sciences then women's higher representation in those fields will not be reflected in the overall academy representation.

Cultural effects that may affect women's election into science academies were also not addressed through the quantitative findings presented here. An argument could be made that the (mostly) male academy members nominate and elect colleagues from their established professional networks that were formed during past decades[30-31], based on the academy's membership rules. Also, to what extent is unconscious bias[32] against women shared by both men and women scientists? Many cultures have male and female work spheres, confine girls to less valued 'women's work' and underestimate women's intellectual and technological capacities. This bias can be replicated in the processes of nomination, evaluation and selection of women and men, for example, for science grants, fellowships and prizes[33], which contribute to the body of evaluation for membership into academies of science. Moreover, a number of questions warrant further investigation to better contextualise the findings of the IAP survey. Five examples will suffice:

- What is the age (mean and median) of women and men at time of election into the academy?
- Are the national governments of the science academies actively addressing gender equality in science?
- Do women researchers in some fields (e.g. social sciences and humanities) have a lower expectation of being nominated into the academy, given historical reasons for how academies are structured?
- Are all members of the science academies amenable to the development and implementation of gender policies to promote fairness in the assessment of women's contributions to the mandates of academies of science? This question should be linked to a greater understanding on male perception regarding the inclusion of women in academies of science.
- In cases in which the proportion of women on the academy governing board is much higher than in the membership, does this 'advantage' translate into actions to change the membership rules in order to improve the gender balance of the membership?

In summary, although the statistics present a picture of the status of women's representation in national science academies, they reveal the importance of further qualitative research to engage the unsettling quantitative narrative concluded by the study. This further research should allow for the design and implementation of appropriate policies to bring about needed changes.

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Authors' contributions

D.N. was responsible for the conceptualisation, methodology, data collection, data analysis, validation, writing the initial draft, making revisions, project leadership, project management, funding acquisition. N.B. was responsible for the conceptualisation, methodology, data collection, data curation, data analysis, validation, writing the initial draft, making revisions, project management. F.H. was responsible for the conceptualisation, methodology, data collection, data curation, data analysis, validation, revising the draft, project management. R.D. was responsible for making revisions, project leadership, funding acquisition. S.M. and J.T. were responsible for revising the draft.

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