

What is the extent of gender bias in bioinformatics?

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Introduction

As a male bioinformatician, I was curious as to the extent of gender bias in my own field. I therefore designed a short online [survey](#) to examine this issue. The survey was conducted between 5–11 May 2014, and was promoted via my [ACGT blog](#) and by twitter. The objectives of this survey were to:

1. Determine whether there is a notable gender bias within the bioinformatics community
2. Investigate whether the gender bias — if present — manifests itself at particular stages of a career

Caveats

1. The survey was connected anonymously via an online Google form. It was therefore not possible to ascertain the veracity of the answers.
2. People were asked to complete the form only if they identified their current position as being 'related to bioinformatics'. This loose definition may have been interpreted differently by different people.
3. No comparable data was collected from a control group of people working in **non**-bioinformatics science careers. Therefore it is not possible to distinguish whether any gender bias found in this survey is specific to the bioinformatics community, or is present in other scientific disciplines.

The Questions

Note that only questions 1,3, and 4 required responses in order to complete the survey. The survey was kept deliberately short to encourage participation.

1. Your gender
 - Male
 - Female
 - Other
2. If you selected 'Other' gender, please list which gender you identify with
3. Is your current role in academia or industry?
 - Academia
 - Industry
 - Governmental
 - Mixed — predominantly industry
 - Mixed — predominantly academia
 - Mixed — predominantly governmental
 - Mixed — approximately equal between all sectors

4. Which of the following best describes your current level of career advancement?
1. Currently pursuing undergraduate degree (with focus on bioinformatics/genomics)
 2. Undergraduate level position in academia or industry (e.g. Research officer / Junior specialist)
 3. Currently pursuing postgraduate qualification (with focus on bioinformatics/genomics)
 4. Postgraduate level position (e.g. Research assistant). MSc or PhD required for role.
 5. Postdoctoral scholar / Fellow / Research Associate
 6. Lecturer / Instructor/ Senior Fellow / Project Scientist (3+ years post-PhD research experience)
 7. Assistant Professor / Reader / Senior Lecturer (5+ years post-PhD research experience)
 8. Associate or Full Professor / Team Leader (7+ years post-PhD research experience)
 9. Senior Professorial role (e.g. head of a department, 10+ years post-PhD research experience)
 10. Super Senior role (e.g. Dean of a school or CEO, 15+ years post-PhD research experience)

Optional questions

5. Where are you based?
6. To what extent do you feel that your gender has limited your opportunities for career advancement in bioinformatics?

Answers to question 5 were corrected and standardized as appropriate (e.g. England -> United Kingdom, NZ -> New Zealand). The unedited answers are included in the separate data file of all survey answers.

Results

Background to survey participants

As of 12th May 2014, there were 370 responses to the survey, with similar numbers of male and female survey participants (Table 1). See Discussion for how representative these numbers might be of the bioinformatics community as a whole.

Table 1: Gender of survey participants. One individual identified themselves as [Trans man](#).

Gender	N	%
Male	198	54%
Female	171	46%
Other	1	0%

Approximately two-thirds of survey participants were located in the USA or UK, though 33 different countries were represented overall (Table 2), and the vast majority (80%) of survey participants work in the academic sector (Table 3).

Table 2: Location of survey participants. Note: this question was optional, but was answered by 351 (95%) of the survey participants. The ‘Other’ category refers to one answer that was given as ‘UK, Austria, Germany’.

Country	N	%
United States of America	154	41.6%
United Kingdom	90	24.3%
Australia	27	7.3%
Canada	12	3.2%
Germany	11	3.0%
Norway	5	1.4%
Spain	5	1.4%
Republic of Ireland	4	1.1%
Austria	3	0.8%
Belgium	3	0.8%
Brazil	3	0.8%
Denmark	3	0.8%
France	3	0.8%
Sweden	3	0.8%
Switzerland	3	0.8%
Finland	2	0.5%
India	2	0.5%
Netherlands	2	0.5%
Chile	1	0.3%
China	1	0.3%
Czech Republic	1	0.3%
Israel	1	0.3%
Kuwait	1	0.3%
Mexico	1	0.3%
New Zealand	1	0.3%
Other	1	0.3%
Pakistan	1	0.3%
Poland	1	0.3%

Portugal	1	0.3%
Russia	1	0.3%
Singapore	1	0.3%
South Africa	1	0.3%
Thailand	1	0.3%
Turkey	1	0.3%

Table 3: Career sector of survey participants. This survey did not originally include options to select governmental positions. It was modified very shortly after the survey was first published to allow these additional choices.

Sector	N	%
Academia	296	80%
Industry	23	6%
Governmental	20	5%
Mixed — predominantly industry	9	2%
Mixed — predominantly academia	19	5%
Mixed — predominantly governmental	0	0%
Mixed — approximately equal between all sectors	3	1%

Differences in career positions with respect to gender

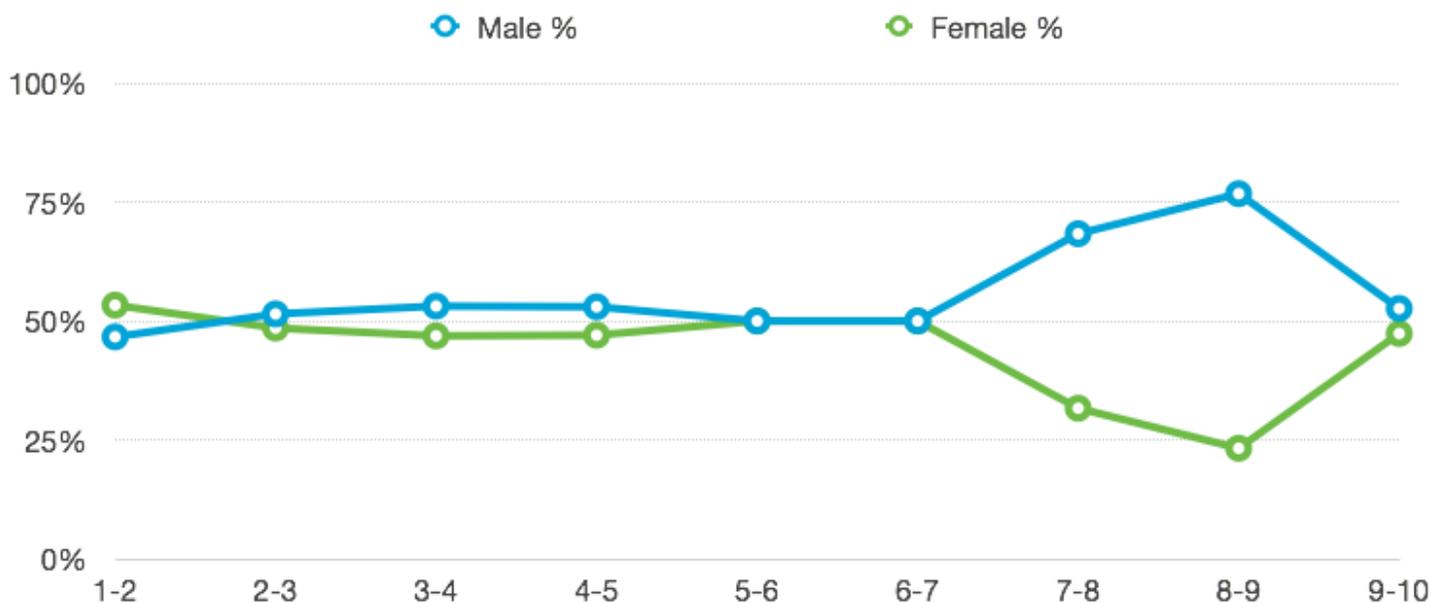
Survey participants reported their current career position; ten possible options were available, ranging from the most junior (currently pursuing undergraduate degree) to the most senior (Dean of a school or CEO). Overall, survey participants represent all stages of a bioinformatics career, with postdoctoral scholar positions (or equivalent), being the most frequent (Table 4).

Table 4: Current career position of survey participants

Career position	N	%
1. Currently pursuing undergraduate degree (with focus on bioinformatics/genomics)	12	3%
2. Undergraduate level position in academia or industry,(e.g. Research officer / Junior specialist)	18	5%
3. Currently pursuing postgraduate qualification (with focus on bioinformatics/genomics)	83	22%
4. Postgraduate level position (e.g. Research assistant). MSc or PhD required for role	45	12%
5. Postdoctoral scholar / Fellow / Research Associate	89	24%
6. Lecturer / Instructor/ Senior Fellow / Project Scientist (3+ years post-PhD research experience)	43	12%
7. Assistant Professor / Reader / Senior Lecturer (5+ years post-PhD research experience)	33	9%
8. Associate or Full Professor / Team Leader (7+ years post-PhD research experience)	28	8%
9. Senior Professorial role (e.g. head of a department, 10+ years post-PhD research experience)	14	4%
10. Super Senior role (e.g. Dean of a school or CEO, 15+ years post-PhD research experience)	5	1%

I next decided to look at the variation of these roles with respect to gender (Figure 1). As the descriptions of these ten options may be regarded subjectively, and as there are many subtle differences in position titles between academic institutions in different countries I decided to pool results together from adjacent categories. I.e. the first data point in Figure 1 represents anyone who answered '1' or '2' to this question, the second data point represents anyone who answered '2' or '3' etc.

Figure 1: Percentage of male/female survey participants at different career stages. X-axis reflects pooling of data from adjacent career stage categories, see Table 4 for details.



This suggests that there is no notable gender bias in early bioinformatics career positions but that bias appears at later career stage (e.g. Associate or Full Professor / Team Leader role). The last data point in Figure 1 suggests a narrowing in gender bias at the highest career stages. However, this also represents the category with the fewest survey participants (10 men and 9 women), so this may simply reflect sampling artifacts.

Effect of gender on limiting opportunities for career advancement

Participants were asked whether they felt their gender had limited their opportunities for career advancement in bioinformatics; five possible responses were allowed (ranging from no limitations to substantial limitations). The majority of respondents (61%) listed that they had experienced no limitations (Table 5).

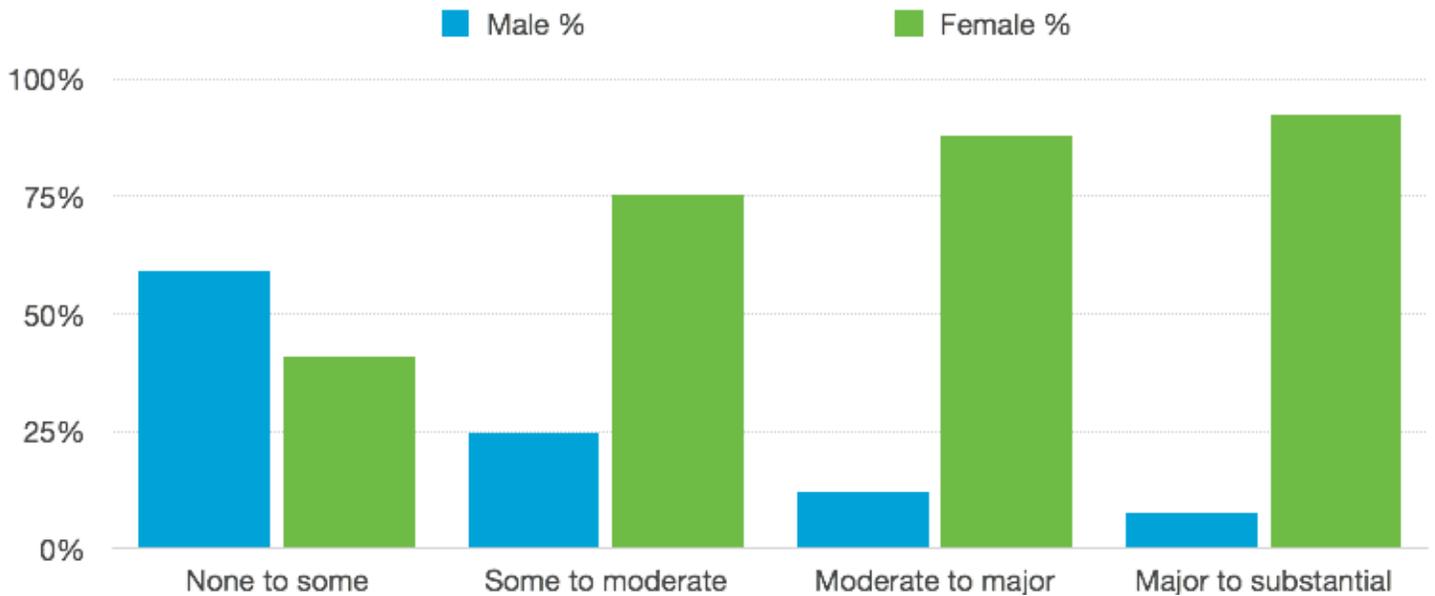
Table 5: Limitations on opportunities for career advancement due to gender.

Note: this question was optional, but was answered by 356 (96%) of the survey participants.

Limitations on career	N	%
No limitations	217	61%
Some limitations	96	27%
Moderate limitations	31	9%
Major limitations	11	3%
Substantial limitations	2	1%

However, when results are split by gender there are considerable differences in how males and females answered this question (Figure 2). Of the 195 male participants who answered this question, 80% expressed an opinion that there had been no limitation to their opportunities for career advancement due to their gender. In contrast, only 34% of female respondents (58 out of 171) expressed the same opinion.

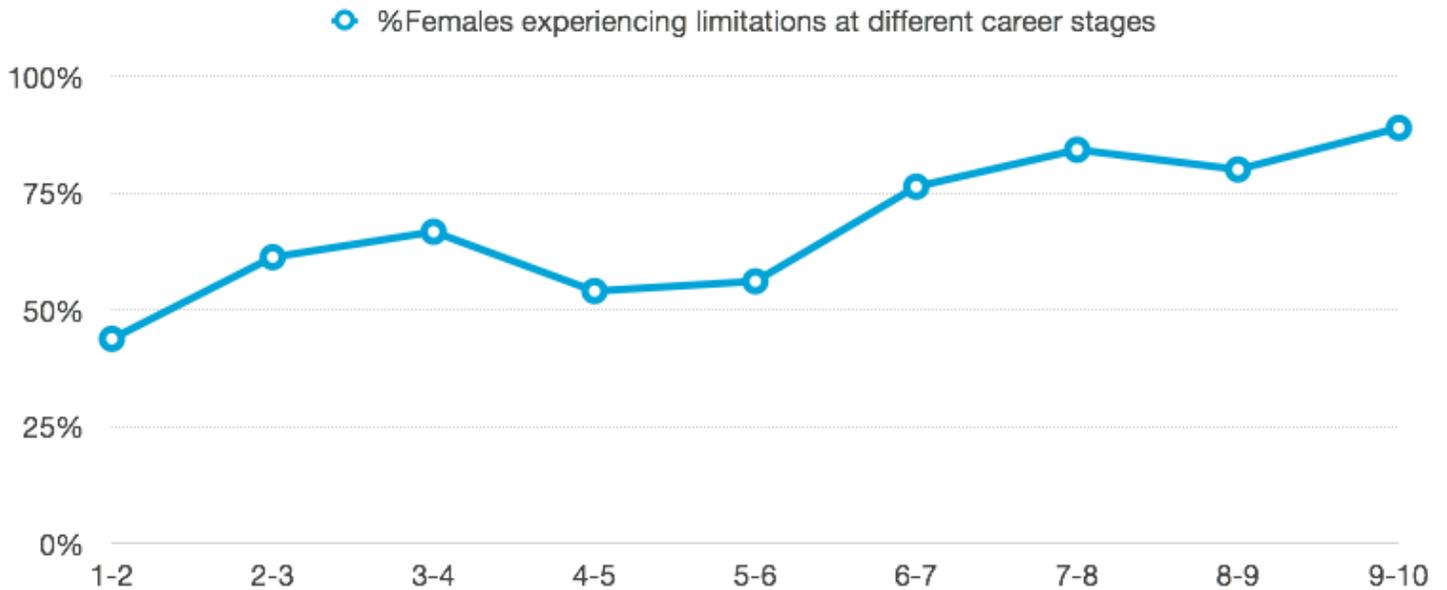
Figure 2: Percentage of male/female survey participants that have experienced limitations for career advancement due to gender. X-axis reflects pooling of data from adjacent categories listed in Table 5.



As the majority of limitations on career opportunities are experienced by women, I investigated whether this is something that happens at all career stages or not. Even in the earliest two career stages, almost half of all female respondents had experienced some form of career limitation due to their gender (Figure 3). By later career stages, the majority of female survey participants have experienced some form of limitation to their career opportunities.

Figure 3: Percentage of female participants that expressed any form of limitation of career opportunities due to gender at different career stages.

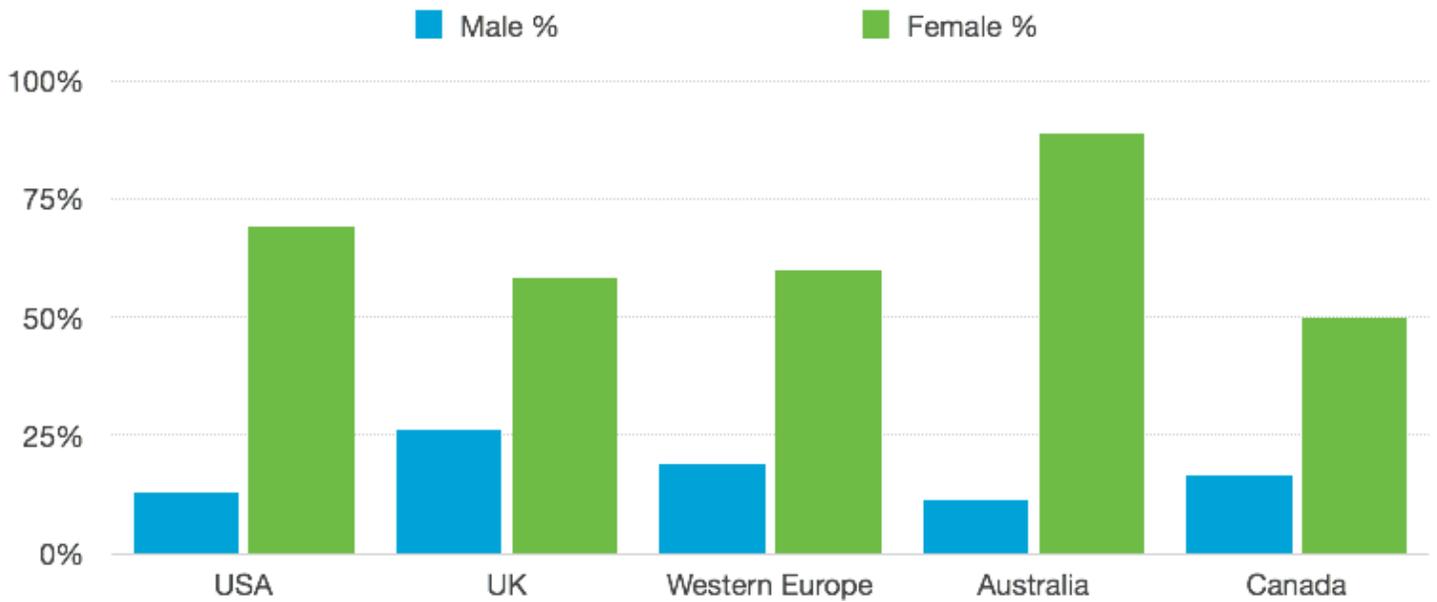
Experience of career limitations is defined as answering in the last four categories of Table 5 (some limitations to severe limitations).



Gender differences with respect to geographic location

By combining answers from different survey questions, I investigated whether the experiences of career limitations due to gender varies with location. I calculated the percentage of survey participants that had experienced any form of career limitation due to gender (Figure 4). Suitable numbers of survey responses (>10) were available for the USA, UK, Australia, and Canada; but an ‘Other Western Europe’ category was also made by pooling data from Austria, Belgium, Denmark, Finland, France, Germany, Netherlands, Norway, Portugal, Republic of Ireland, Spain, Sweden, and Switzerland. The limitations on career advancement opportunities was determined by summing responses in categories 2–5 from Table 5 (some limitations to substantial limitations).

Figure 4: Percentage of male/female survey participants that have experienced limitations for career advancement due to gender. Results separated by geographic location (x-axis). Size of datasets for each region (M+F): USA 70+81, UK 46+43, Western Europe 32+15, Australia 18+9, Canada 6+6.



For all regions, there is a notable trend towards women reporting more limitations to their opportunities for career advancement than men. Australian survey participants recorded the greatest gender difference, with 8 out of 9 females reporting some level of career limitation, but only 2 out of 18 males. When comparing the two countries with the greatest number of survey participants (UK and USA), females in the USA were more likely to report some form of career limitation due to gender than compared to females in the UK (69% vs 58%).

Discussion

A survey that is trying to find out the extent of gender bias may itself be biased to attracting responses from people for which this is an important issue. Furthermore, as this survey was heavily promoted through use of twitter, it might also reflect biases in the gender ratio of twitter users. A 2013 [report](#) by the Pew Research Center showed comparable numbers of men and women using twitter, though [other data](#) suggests that females account for a much higher fraction of twitter users.

The responses to this survey may not be representative of the bioinformatics community as a whole. Twitter provides some analytics data for some accounts which tries to identify the likely gender of users that follow those accounts (see [analytics.twitter.com](#)). The gender ratio of followers to twitter accounts that are largely identified as being 'bioinformatics-related' may therefore reveal something about the background gender ratio in the bioinformatics community.

The [@Assemblathon](#) account has 1,882 followers and twitter identifies 81% of the followers as being male. Likewise, the [@GenomeWeb](#) account has 4,398 followers with 74% being identified as male. Both of these accounts can be identified as being 'gender neutral' as they are not obviously associated with any one individual. Therefore, it is possible that this survey has attracted a higher proportion of responses from women than might be expected based on the overall make up of the bioinformatics community on twitter.

Overall, this survey finds that female bioinformaticians are notably underrepresented at later career stages, and that they experience more limitations on their opportunities for career advancement compared to their male colleagues. Unfortunately, it was outside the scope of this survey to investigate how these results compare to scientists in other fields. Therefore it remains unclear whether this gender bias in bioinformatics is better or worse than in comparable fields.

Even though this report has focused on the disparities affecting female bioinformaticians, it should still be noted that 20% of all male bioinformaticians reported that they felt their gender had limited their opportunities for career advancement.

One particular cause for concern is that even though there is equality in the *numbers* of male and female bioinformaticians in early career stages, many of those females expressed that their career opportunities have already been limited because of their gender (Figure 3). This suggests that it is not sufficient to assume that equal numbers of male/female bioinformaticians represents a situation that is free from gender bias.

Written in *Markdown format* on a 13" Apple MacBook Air, using *nvAlt* and converted to PDF using *Marked*.