Inequalities in research funding for women scientists: systematic analysis of UK investments in global infectious disease research 1997–2010

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-003362
Article Type:	Research
Date Submitted by the Author:	07-Jun-2013
Complete List of Authors:	Head, Michael; University College London, Infection & Population Health Fitchett, Joseph; London School of Hygiene & Tropical Medicine, Cooke, Mary; University College London, Wurie, Fatima; University College London, Atun, Rifat; Imperial College London,
Primary Subject Heading:	Infectious diseases
Secondary Subject Heading:	Global health
Keywords:	INFECTIOUS DISEASES, PUBLIC HEALTH, STATISTICS & RESEARCH METHODS, VIROLOGY, PARASITOLOGY, MYCOLOGY

Inequalities in research funding for women scientists: systematic analysis of UK investments in global infectious disease research 1997–2010

Michael G Head[a], Joseph R Fitchett[b], Mary K Cooke[a], Fatima B Wurie[a], Rifat Atun[c*]

a University College London, Research Department of Infection and Population Health, UCL Royal Free Campus, Rowland Hill Street, London, NW3 2PF

b London School of Hygiene & Tropical Medicine, Keppel Street, London, WC1E 7HT

c Imperial College Business School and the Faculty of Medicine, Imperial College London, South Kensington Campus, London SW7 2AZ

*Corresponding Author

Number of Words: **3 758**

Keywords – gender, funding, research, women, inequality

Abstract

Objectives: Women are under-represented in biomedical science. Funding awarded to UK institutions for all infectious disease research from 1997 to 2010 was investigated, across disease categories and along the research and development continuum.

Design: Systematic analysis

Methods: Data was obtained from several sources for infectious disease research for the period 1997-2010 and each study assigned to - disease categories; type of science (pre-clinical, phases I, II or III, product development, implementation research): categories of funding organisation. Fold differences and statistical analysis were used to compare total investment, study numbers, mean grant, and median grant between men and women according to disease system, specific infection and funding organisation.

Results**:** 325,922 studies were screened and 6052 studies included in the final analysis, comprising 4357 grants (72.0%) awarded to men and 1695 grants (28.0%) awarded to women, totalling £2.274 billion. Of this, men received £1.786 billion (78.5%) and women £488 million (21.5%). The median value of award was greater for men (£179 389; IQR £59146–£371 977) than women (£125 556; IQR £30 982–£261 834).

Awards were greater for male PIs across all infectious disease systems, excepting neurological infections and sexually transmitted infections. The proportion of total funding awarded to women ranged from 14.3% in 1998 to 26.8% in 2009 (mean 21.4%); and was lowest for pre-clinical research at 18.2% (£285.5 million of £1.573 billion) and highest for operational research at 30·9% (£151.4 million of £489.7 million).

Conclusions: There are clear and consistent disparities in funding received by men and women principal investigators. Women have fewer funded studies and receive less funding in absolute and in relative terms. The median funding awarded are lower for women across

most infectious disease areas, by funder, and type of science funded along the R&D pipeline. The disparities remain broadly unchanged over the 14-year study period.

Article summary

Article focus

- Our aim was to investigate the distribution of funding across infectious disease research by gender of principal investigator, and to identify any disparities between genders.

Key messages

- There are clear and consistent disparities in funding received by men and women principal investigators.
- Total funding and the median award is typically greater in male PIs than female PIs
- Worryingly, these disparities remain consistent over the time period of our analysis (1997-2010)

Strengths and limitations of this study

- This is the first study to present data to such a great level of detail and quantifying the results with statistical analysis adds rigour.
- Our results add further evidence to previous work highlighting inequalities around gender, and can be used to enhance the debate on furthering the numbers and career paths of women in science
- Weaknesses include being unable to assess the success and failure rates by gender and we also lacked data on the academic ranking of principal investigators and were hence unable to adjust for levels of seniority across both genders.

Introduction

Women are under-represented in biomedical science, with a limited number of studies suggesting inequalities and discriminatory practices in the United Kingdom (UK), United States of America (US) and the European Union (EU) as a whole.

Yet, few studies have systematically explored the extent of these inequalities in relation to women in science. Women make up 50% of EU student population and 45% of doctoral students, but only one third of career researchers are women – a figure that is lower for senior positions.[1] In 1997 an analysis of the Swedish Medical Research Council suggested that peer-reviewers could not judge scientific merit independent of gender and noted the clear discrimination against women researchers.[2]

A number of UK studies have raised concerns on the position of women in biomedical science. In 2001, a Wellcome Trust survey, concluded that although women were as successful as men in securing funding for biomedical research, they were less likely to apply for grant funds because of their status in scientific institutions and the level of support they received.[3] An analysis of Wellcome Trust awards in 2000-08 revealed a significant gender difference in the amount of funding awarded, even after adjusting for the seniority of the principal investigator, with conclusion “the most likely explanation for the difference in amounts awarded to women and men is that women are systematically less ambitious in the amounts of funding requested in their grant applications.”[4] Although, in 2011, around 44% of academics in UK universities were women, only 39% of senior lecturers and 19% of professors were women.[5]

A number of studies from US have shown that women in science are disadvantaged compared to men.[6–8] In 2012, a study which asked faculty from research-intensive US universities to rate equally qualified man and woman applicant for a laboratory manager, found that the male applicant was rated significantly more competent and employable by both male and female faculty.[9]

The low numbers of women in science and the reasons for this anomaly is a concern for scientists and policy makers. Although the UK Medical Research Council (MRC) has a gender equality scheme that briefly states gender equality is reflected in agreements with research organisations receiving MRC funding, it is not clear how this scheme is implemented.[10]

While a number of initiatives have aimed to increase the numbers of women involved in science, there are no affirmative actions or binding policies in the UK or Europe to definitively ensure women are better represented in science. Indeed, some initiatives aimed at increasing women in science have been criticised. For example, in 2012, the European Commission campaign targeting 13-18 year-old secondary school students[11] was widely criticised and described as an insult to women in science.[12,13] The offending video clip was removed from the EU campaign website. The effects of campaigns attempting to raise the profile of women in science[14,15] have not been assessed.

We have systematically analysed research funding awarded to UK institutions for all infectious disease research, for the 14-year period from 1997 to 2010[16] In this study we examine with trends over time the distribution of funding awarded to men and women principal investigators (PIs) across specific infections, in investigation categories, and along the research and development (R&D) continuum, extending from pre-clinical to clinical and operational research.

Methods

We obtained data from several sources for infectious disease research studies where funding was awarded between 1997 and 2010. We identified 325,922 studies for screening. We assigned each study to primary disease categories. We briefly outline the methodology for the categorisation of disease areas and classification of the funding sources, elaborated in detail elsewhere.[16]. Figure 1 shows the sources of data and the numbers of studies at each stage of screening to reach the final set of studies for detailed analysis.

Figure 1. Methodology flow chart

Within each category, we documented topic-specific subsections, including specific pathogen or disease. We allocated studies to one of four categories along the R&D continuum: pre-clinical; phases I, II or III; product development; and operational research, and to one of the 26 categories for funding organisations.

Where the PI was named, we assigned them to men or women categories. The studies where only an initial was available for the forename were assigned as "unclear" if we were unable to establish the PIs gender from a review of the literature and publicly available publications.

Reference to sexually transmitted infections excludes HIV. Neglected tropical diseases were categorised according to classification used by the World Health Organization (WHO) (http://www.who.int/neglected_diseases/diseases/en). Antimicrobial resistance includes antibacterial, antiviral, antifungal and antiparasitic studies. No private sector funding was included in this analysis due to limited publicly available data.

We converted grants awarded in a currency other than pounds sterling to UK pounds using the mean exchange rate in the year of the award. We adjusted grant funding amounts for inflation and reported in 2010 UK pounds.

We excluded studies not immediately relevant to infection, veterinary infectious disease research studies (unless there was a zoonotic component) those exploring the use of viral vectors to investigate non-communicable diseases, grants for symposia or meetings, or studies with UK contributions (e.g. as a collaborator), but the funding was awarded to a non-UK institution. Unfunded studies were excluded.

We used Microsoft Excel versions 2000 and 2007 to categorise studies. Where needed, data were exported into Microsoft Access (versions 2000 and 2007) and specific keyword queries used to select precise sections of the data for analysis. We used Stata (version 11·0) for statistical analysis and to generate figures.

We used fold differences to compare total investment, number of studies, mean grant, and median grant between men and women according to disease system, specific infection and funding organisation.

We used nonparametric Mann-Whitney rank-sum test to assess the distribution of funding by gender. Nonparametric K-sample test on equality of medians was applied to compare the median funding by gender, and reported as a chi-squared statistic without Yates' correction for continuity. Nonparametric Wilcoxon signed-rank test was applied when comparing matched data, such as time trends by gender. The significance for all tests was defined at the 5% level (two-sided *P*=0·05).

Results

We identified 6165 studies from the 325,922 studies screened that were suitable for inclusion in our analysis. Of these, we were unable to ascertain the gender of principal investigator for 30 studies (0·5%). We excluded 83 studies (1·3%) funded by the Bill and Melinda Gates Foundation (Gates Foundation) (38 studies; 0·6%) and the UK Department for International Development (DFID) (22 studies; 0·4%), accounting for £321·2 million (12·3% of total) that did not specify the PIs name or gender. We included 6052 studies in the final analysis, comprising 4357 grants (72·0%) awarded to men and 1695 grants (28·0%) awarded to women, totalling £2·274 billion. Of this, £1·786 billion (78·5%) were awarded to men and £488 million (21·5%) awarded to women.

The median value of grant funding was greater for men (£179 389; IQR £59146–£371 977) than for women (£125 556; IQR £30 982–£261 834). Similarly, mean value of the grant funding was greater for men (£409 910; SD £840 087) than for women (£288 011; SD £704 474). Figure 2 shows the distribution of the total investments and median funding awarded to PIs by gender over time.

Figure 2a. Total investment over time awarded to male and female principal investigators

Figure 2b Median investment over time awarded to male and female principal investigators

Infectious disease system

Table 1A (web appendix 1) shows the total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to 9 disease systems and by gender of PI. We identified no infectious disease system where women led the majority of research efforts or were awarded the majority of funding. Median funding awards were greater for male PIs across all infectious disease systems, with the exception of neurological infections and sexually transmitted infections.

Greatest levels of funding awarded to men and to women were for research into respiratory infections and HIV. Men received a total of £312·1 million for research into respiratory infections compared with £84·4 million for women, a 3·70 fold difference, and a total of £290·8 million for HIV research compared with £79·7 million for women, a 3·65 fold difference.

The largest difference between total funding for men and for women were with gastrointestinal infections (5·65 fold difference) where women received only 15·0% of the total investment (£37·0 million) and spearheaded 18.9% (149) of the studies and neurological infections (4·22 fold difference). Smallest difference between total funding for men and for women were with research into sexually transmitted infections (1·90 fold difference) where women received 35.0% (£45·4 million) of the total funding and spearheaded 49·0% (182) of the studies.

Mean funding for grants were significantly greater for men (£409 910; SD £840 087) than for women (£288 011; SD £704 474). The differences were statistically significant (P > 0.01) for gastrointestinal infections (men £328 021; SD £458 720) (women £248 615; SD £433 176), for haematological infections (men £417 889; SD £914 626) (women £306 126; SD £819 910), and for HIV (men £649 216; SD £1 550 920) (women £278 505; SD £545 657).

Median funding for grants showed a similar pattern with significantly greater grant funding for men (£179 389; IQR £59 146–£371 977) than women (£125 556; IQR £30 983–£261 835). Differences were statistically significant (P > 0.05) for gastrointestinal infections (men £208 369; IQR £78 852–357 771) (women £155 066; IQR £43 637–£305 928), for hepatic infections (men £118 638; IQR £41 342–£269 629) (women £68 620; IQR £26 720–£221 952), and for HIV (men £163 462; IQR £39 153–£511 800) (women £114 272; IQR £29 880–£305 339).

Specific Infections

Table 1B (web appendix 1) shows total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to specific infection by gender.

Men received significantly higher levels of total research funding, spearheaded greater numbers of studies, and were awarded greater median and mean funding for grants for malaria (*P = 0·01*), HIV (*P = 0·01*) and influenza (*P = 0·04*).

Major differences between total funding for men and for women were with research into candida (47·75 fold difference), rotavirus (33·65 fold difference), campylobacter (24·33 fold difference) and norovirus (23·33 fold difference). Smallest differences between total funding for men and women were for research into dengue (1·07 fold difference) and leishmaniasis (1·55 fold difference). Women received greater total funding than men for research into leprosy (0·09 fold difference), diphtheria (0·18 fold difference), chlamydia (0·36 fold difference), syphilis (0·37 fold difference), and varicella zoster (0·54 fold difference).

Differences in mean grant funding was statistically significant ($P > 0.05$) for malaria research (men £590 422; SD £1 324 909) (women £318 054; SD £726 872), for influenza (men £616 643; SD £881 493) (women £387 186; SD £489 997), for respiratory syncytial virus (men £485 283; SD £539 396) (women £187 931; SD £268 412), and for HIV (men £649 216; SD £1 550 920) (women £278 505; SD £545 657).

Differences in median grant funding were statistically significant ($P > 0.05$) for malaria research (men £209 646; IQR £63 826–£529 610) (women £143 358; IQR £42 754–£314 524), for hepatitis C (men £124 797; IQR £42 475–£289 293) (women £67 265; IQR £29 880–£233 467), for influenza (men £348 730; IQR £213 601–£668 561) (women £200 787; IQR £124 210–£398 191), for herpes simplex virus (men £119 295; IQR £40 009–£446 395) (women £309 610; IQR £147 885–£439 305), and for HIV (men £163 462; IQR £39 153–£511 800) (women £114 272; IQR £29 880–£305 339).

Figure 3 shows the proportion of total funding awarded to principal investigators by gender over time and a breakdown of investment by research pipeline. The proportion of the total funding awarded to women ranged from a low of 14·3% in 1998 to a high of 26·8% in 2009, with a mean of 21·4% for the period studied. The proportion of funding was lowest for pre-clinical research at 18·2% (£285·5 million of £1·573 billion total) and highest for operational research at 30·9% (£151·4 million of £489·7 million). The funding for clinical (Phase I, II and III) research was 29·9% (£25·5 of £85·2) and for product development amounted to 20·4% (£25·8 million of £126·6 million).

Figure 3a. Proportion of investment over time awarded to male and female principal investigators

Figure 3b. Total investment by research pipeline awarded to male and female principal investigators

Funding organisation

Table 2 (web appendix 2) shows in detail the total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to funding organisation and by gender.

Public funding organisations invested a total of £1·025 billion in research led by men (78·6%) and £279·8 in research led by women (21·4%). Greatest levels of funding awarded to men and to women were by the Wellcome Trust and the UK MRC. Major differences between funding awarded to men and to women PIs were by the BBSRC, with a 6·12 fold difference. Smallest differences between funding awarded to men and to women were by the UK Government funding streams such as the National Institute for Health Research, with a 1·66 fold difference. Mean grant funding from public funding organisations were significantly greater for men at £595 361 (SD £1 080 718) than for women at £448 414 (SD £814 979). Differences were also statistically significant (P > 0.01) for UK MRC grants with men at £751 413 (SD £1 020 748) and women at £544 427 (SD £884 442), and for UK Government grants with men at £208 828 (SD £492 519) and women at £182 907 (SD £619 889).

Median grant funding from public funding organisations had a similar pattern with significantly greater grant funding for men at £272 452 (IQR £138 322–£572 529) and women at £213 718 (IQR £92 880–£402 917). Differences were also statistically significant (P > 0.05) for UK MRC grants with men at £404 615 (IQR £ 210 068–£811 860) and women at £286 679 (£178 182–£468 998), and for UK Government grants with men at £129 660 (IQR £23 761–£207 320) and women at £59 976 (IQR £12 564–£157 053).

Philanthropic funding organisations invested a total of £691·7 million in research led by men (78·8%) and £185·9 million in research led by women (21·2%).

Mean grant funding from philanthropic funding organisations were significantly greater for men at £338 396 (SD £695 025) than for women at £242 014 (SD £711 420). Differences were also statistically significant (*P* > 0.01) for Wellcome Trust grants with men receiving £393 652 (SD £723 549) and women £230 168 (SD £362 836), and for other charitable funding organisations with men receiving £211 190 (SD £454 108) and women £271 842 (SD £1 208 852).

Median grants from philanthropic funding organisations showed a similar pattern with significantly greater grant funding for men at £153 653 (IQR £58 589 – £302 774) and women at £114 173 (IQR £42 658 – £222 842). Differences were also statistically significant (*P* > 0.05) for Wellcome Trust grants with men receiving £191 461 (IQR £74 759 – £362 424) and women £137 241 (IQR £54 019 – £250 723), and for other charitable funding organisations with men receiving £91 991 (IQR £36 429 – £172 497) and women £76 058 (IQR £17 279 – £150 727).

Figure 4 shows the association between funding organisation and total investment and median funding by gender. The MRC awarded the highest median amount in grants to women (£286 679; IQR £178 182–£468 998), but the median funding amount in grants for men were 1·41 fold higher than that awarded to women (£404 615; IQR £210 068–£811 860). European Commission awarded the highest mean grants to women at £923 364 (SD £1 316 016) however mean funding amount in grants for men were 1·44 fold higher at £1325 149 (SD £2 409 860) than that for women.

Figure 4a. Association between funding organisation and total investment by gender

Figure 4b. Association between funding organisation and median award by gender

Time trend

Table 3 (web appendix 3) shows in detail the trends in funding over time from 1997 to 2010 by gender of principal investigators, with amounts and relative proportions each year of funding. Mean annual funding received was greater by men at £127·6 million (SD £48·7 million) than women at £34·9 million (SD £13·4 million). Proportions of annual funding received by men ranged from 73.2% to 85.7%, with a mean of 78.6%.

Proportions of annual funding received by women ranged from 14.3% to 26.8% with a mean of 21.4%. The largest annual funding received by men was £245·7 million in 2000, and the smallest at £64·2 million in 1997. The largest annual funding received by women was £59·6 million in 2002, with the smallest at £13·1 million in 1998.

Over the 14-year study period, the proportion of investment awarded to women each year remains relatively unchanged with a mean of 21·4% of total (range 14·3%–26·8%; £13·1 million to £59·6 million)). Figure 5 shows the funding trends over time and fold differences in total investments by gender. Absolute difference in the funding amounts in the grants awarded to men and women ranges between £47·9 million and £190·1 million, with a mean difference of £92·7 million (SD £38·3 million). Fold difference in grant funding for men and women ranged from 2·74 to 5·97, with a mean fold difference of 3·66.

Figure 5a. Total investment and trend over time, by gender

Figure 5b. Fold difference of investment over time, by gender

Discussion

We present the first, detailed and systematic analysis of the investments in infectious disease research by gender for the 14-year period 1997-2010. We identified 6165 studies funded by public and philanthropic funding organisations, with total research investment of £2·6 billion.

We quantify the differences in research funding awarded by gender, to show these to be substantial. The analysis shows clear and consistent disparities between men and women principal investigators, with lower funding in terms of the total investment, the number of funded studies, the median funding awarded and the mean funding awarded across most of the infectious disease areas funded. The analysis reveals consistent disparities, with women receiving less funding in absolute amounts and in relative terms, by funder and the type of science funded along the R&D pipeline. Analysis of the funding trends by year reveals that the disparities persist over time.

We show large disparities in median funding amounts for men and women researchers in investments by the European Commission and the MRC. Such differences were much less apparent when comparing funding from the Department of Health and BBSRC, although the BBSRC awarded 86% of funding to men. The BBSRC almost entirely funds pre-clinical research,[16] and this matches the increased proportions of pre-clinical studies being led by male principal investigators.

Our findings, the most detailed to date, provide new evidence to show that women in science working in the area of infectious disease research are clearly disadvantaged. Our findings confirm the concerns raised in the published literature on the subject.[4,9,15,17] Disparities that are more marked at senior levels of academia need to be investigated to explain and account for the observed differences.

The precise reasons why the median awards across most infectious disease conditions should be significantly less for women principal investigators cannot be deduced from the available data. The next step may be to investigate success rates by gender to assess how many women are applying. Some studies have suggested that women were systematically less ambitious in the amounts of funding requested in their grant applications when compared with men who are equivalently ranked academically, and that relatively simple mentoring programmes could at least partially overcomes this anomaly.[4] However, there is no evidence supporting the assertions. Others have suggested that systems which ensure PI anonymity during review of grant funding submissions may help reduce subtle gender biases[9], though in practice this approach would be challenging as the experience of the PI is a key factor when considering suitability of request for research support. However, evidence on effective interventions to address barriers for women scientists are lacking.[17] Women of child-bearing age are being disadvantaged in some areas of employment, even though in relation to scientific endeavour productivity as measured by published outputs is not significantly different between women with and without children.[18]

Study limitations

Our analysis has several limitations. We rely on the accuracy of the original data from the funding organisations and as described elsewhere we have excluded data from industry as the publicly available data are incomplete.[16]

In the period analysed, we were not able to find data on the number of men and women PIs requesting financial support for research agencies from the funding sources studies. Hence, we were unable to assess the success and failure rates by gender. We also did not have complete data on gender of co-applicants for each study or on the proportion of awards made to clinical and non-clinical researchers. The proportion of doctors registered in the UK favours men (56.8%as of January 2013) over women,[19] but the proportion of those carrying out research appears to be unknown. Understanding the distribution of researchers is critical to understanding the research landscape.

We lacked data on the academic ranking of principal investigators and were hence unable to adjust for levels of seniority across both genders. We were unable to get data on gender from the Gates Foundation and DFID and hence were unable to clarify the gender of a small proportion of investigators, though we believe these limitations are not likely to change the conclusions of the study.

Notwithstanding these limitations, our study provides a systematic analysis of the unequal distribution of investments in infectious disease research by gender. We demonstrate that in the UK there are clear and unacceptable disparities in the number of women at the level of principal investigator in infectious disease research.

Although earlier studies have discussed possible solutions, including mentoring programmes and advertising campaigns, none have systematically explored the reasons why such inequalities persist. Hence, without an understanding of the reasons for the observed inequalities, the proposed solutions are not very meaningful. Research is needed to elucidate an understanding of the factors that can explain the observed disparities.

There is no evidence that women and men researchers are not equally able, hence, other factors are likely to be at play to explain the unacceptable disparities in research funding between men and women, which have persisted over the 14-year study period. We strongly urge policy makers, funders and scientists to urgently investigate the factors leading to the observed disparities and develop policies developed to address them, in order to ensure that, as in all walks of life, women are appropriately supported and equally valued in scientific endeavour.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Author contribution

MGH designed the study with input from RA and JF and collated the dataset. JRF, FW and MKC checked and refined the dataset. JRF undertook data analysis and created the graphs and figures with input from MGH and RA. MGH, JRF, and RA interpreted the data and wrote the first draft. MGH, JRF, and RA refined the analysis and paper with input from MKC and FBW. All authors reviewed and approved the final version. RA is guarantor of the paper.

Competing interests

RA has received research funding from the UK Medical Research Council, the UK National Institute for Health Research, UK CRC, UK EPSCRC, the UK Department for International Development and the UK Department of Health. RA is a member of the UL Medical Research Council Global Health Group. MGH works for the Infectious Disease Research Network, which has supported this work and is funded by the UK Department of Health. JRF has received funds from the Wellcome Trust and is a steering group member for the Infectious Disease Research Network. MKC has received funding from the Medical

Research Council and the Bill & Melinda Gates Foundation. FBW has received funds from UCLH Charitable Foundation.

Acknowledgements

We thank Jennifer Harris and Raidah Haider for their input and assistance, and acknowledge the assistance of the research and development funding agencies for provision of data.

Data-sharing statement

All gender data is available with this submission. Further data relating to the Research Investments project can be found at www.researchinvestments.org or by contacting the corresponding author.

References

1 More women in senior positions. Key to economic stability and growth. European Commission, Luxembourg, 2010.

2 Wenneras C, Wold A. Nepotism and sexism in peer-review. *Nature* 1997; **387**: 341–3.

3 Blake M, La Valle I. Who applies for research funding? Key factors shaping funding application behaviour among women and men in British higher education institutions. London, 2000.

4 Bedi G, Van Dam NT, Munafo M. Gender inequality in awarded research grants. *Lancet* 2012; **380**: 474.

5 Fitzpatrick S. A Survey of Staffing Levels of Medical Clinical Academics in UK Medical Schools as at 31 July 2011. London, 2012 http://www.medschools.ac.uk/Publications/Documents/MSC_Clinical_Academic_Staff_Survey_310711.pdf.

6 Burrelli J. Thirty-Three Years of Women in S&E Faculty Positions - US National Science Foundation. Arlington, 2008 http://www.nsf.gov/statistics/infbrief/nsf08308/.

7 Lincoln AE, Pincus SH, Leboy PS. Scholars' awards go mainly to men. *Nature* 2011; **469**: 472.

8 Pohlhaus JR, Jiang H, Sutton J. Sex differences in career development awardees' subsequent grant attainment. *Annals of internal medicine* 2010; **152**: 616–7; author reply 617.

9 Moss-Racusin CA, Dovidio JF, Brescoll VL, Graham MJ, Handelsman J. Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences of the United States of America* 2012; **109**: 16474–9.

10 Medical Research Council. MRC Gender Equality Scheme. 2007.http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC003655 (accessed 21 Dec 2012).

11 European Commission. About this site- Science: It's a girl thing! 2012.http://science-girl-thing.eu/en/about-this-site (accessed 29 Nov 2012).

12 Gill M. "Science, it's a girl thing!" says EU Commission, holding lipstick and bunsen burner. New Statesman. 2012.http://www.newstatesman.com/blogs/martha-gill/2012/06/science-its-girl-thing-says-eu-commission-holding-lipstick-and-bunsen-burn (accessed 29 Nov 2012).

13 Swain F. Science: It's a girl thing. Excuse me while I die inside. – SciencePunk. ScienceBlogs. 2012.http://scienceblogs.com/sciencepunk/2012/06/22/science-its-a-girl-thing-excuse-me-while-i-die-inside/ (accessed 29 Nov 2012).

14 Yong E. Edit-a-thon gets women scientists into Wikipedia. Nature. 2012.http://www.nature.com/news/edit-a-thon-gets-women-scientists-into-wikipedia-1.11636 (accessed 29 Nov 2012).

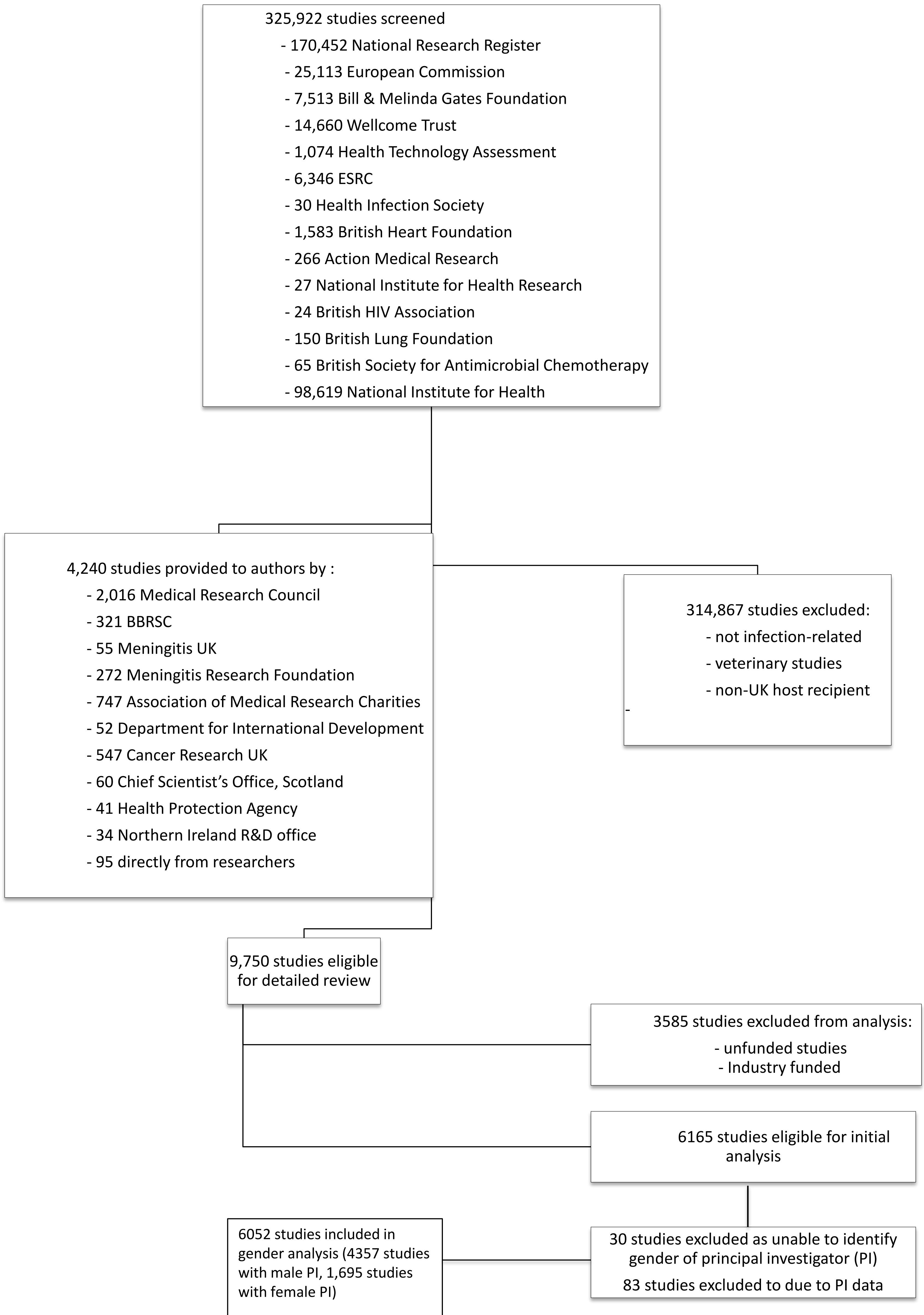
15 Donald A. Throw off the cloak of invisibility. *Nature* 2012; **490**: 447.

16 Head MG, Fitchett JR, Cooke MK, Wurie FB, Hayward AC, Atun R. UK investments in global infectious disease research 1997-2010: a case study. *The Lancet infectious diseases* 2012.http://www.thelancet.com/journals/a/article/PIIS1473-3099(12)70261-X/fulltext (accessed 17 Nov 2012).

17 Ceci SJ, Williams WM. Understanding current causes of women's underrepresentation in science. *Proceedings of the National Academy of Sciences of the United States of America* 2011; **108**: 3157–62.

18 Fox MF. Gender, Family Characteristics, and Publication Productivity among Scientists. *Social Studies of Science* 2005; **35**: 131–50.

19 List of Registered Medical Practitioners - statistics. General Medical Council. http://www.gmc-uk.org/doctors/register/search_stats.asp (accessed 26 Jan 2013).


325,922 studies screened
- 170,452 National Research Register
- 25,113 European Commission
- 7,513 Bill & Melinda Gates Foundation
- 14,660 Wellcome Trust
- 1,074 Health Technology Assessment
- 6,346 ESRC
- 30 Health Infection Society
- 1,583 British Heart Foundation
- 266 Action Medical Research
- 27 National Institute for Health Research
- 24 British HIV Association
- 150 British Lung Foundation
- 65 British Society for Antimicrobial Chemotherapy
- 98,619 National Institute for Health
4,240 studies provided to authors by :
- 2,016 Medical Research Council
- 321 BBRSC
- 55 Meningitis UK
- 272 Meningitis Research Foundation
- 747 Association of Medical Research Charities
- 52 Department for International Development
- 547 Cancer Research UK
- 60 Chief Scientist's Office, Scotland
- 41 Health Protection Agency
- 34 Northern Ireland R&D office
- 95 directly from researchers
314,867 studies excluded:
- not infection-related
- veterinary studies
- non-UK host recipient
-
9,750 studies eligible for detailed review
3585 studies excluded from analysis:
- unfunded studies
- Industry funded
6165 studies eligible for initial analysis
30 studies excluded as unable to identify gender of principal investigator (PI)
83 studies excluded to due to PI data
6052 studies included in gender analysis (4357 studies with male PI, 1,695 studies with female PI)

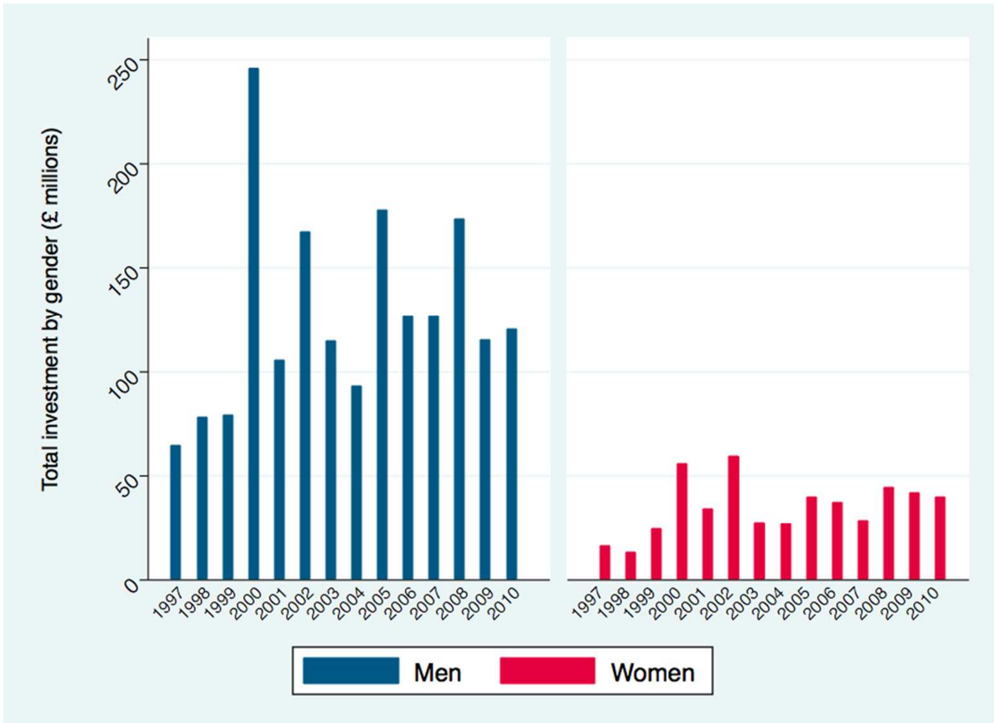


Figure 2a. Total investment over time awarded to male and female principal investigators
329x239mm (72 x 72 DPI)

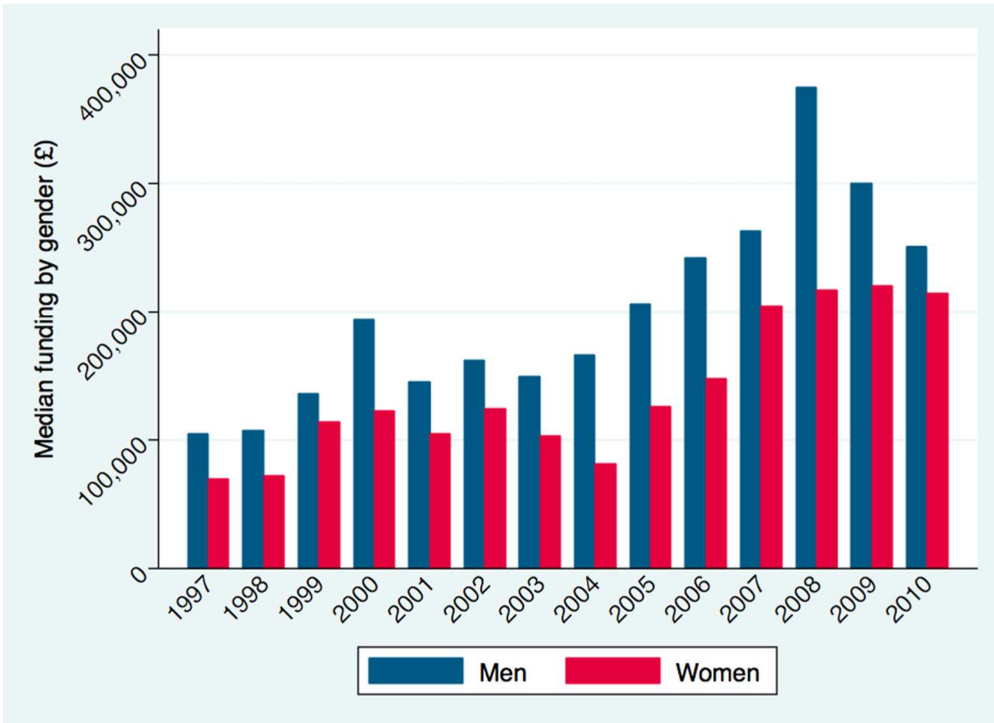


Figure 2b Median investment over time awarded to male and female principal investigators
329x239mm (72 x 72 DPI)

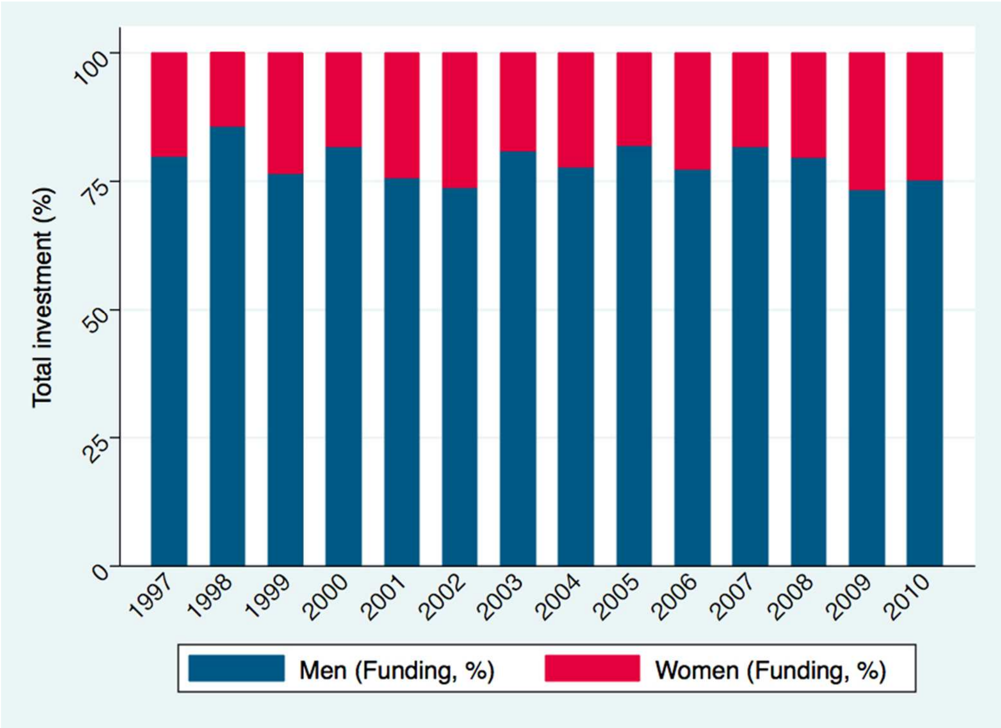
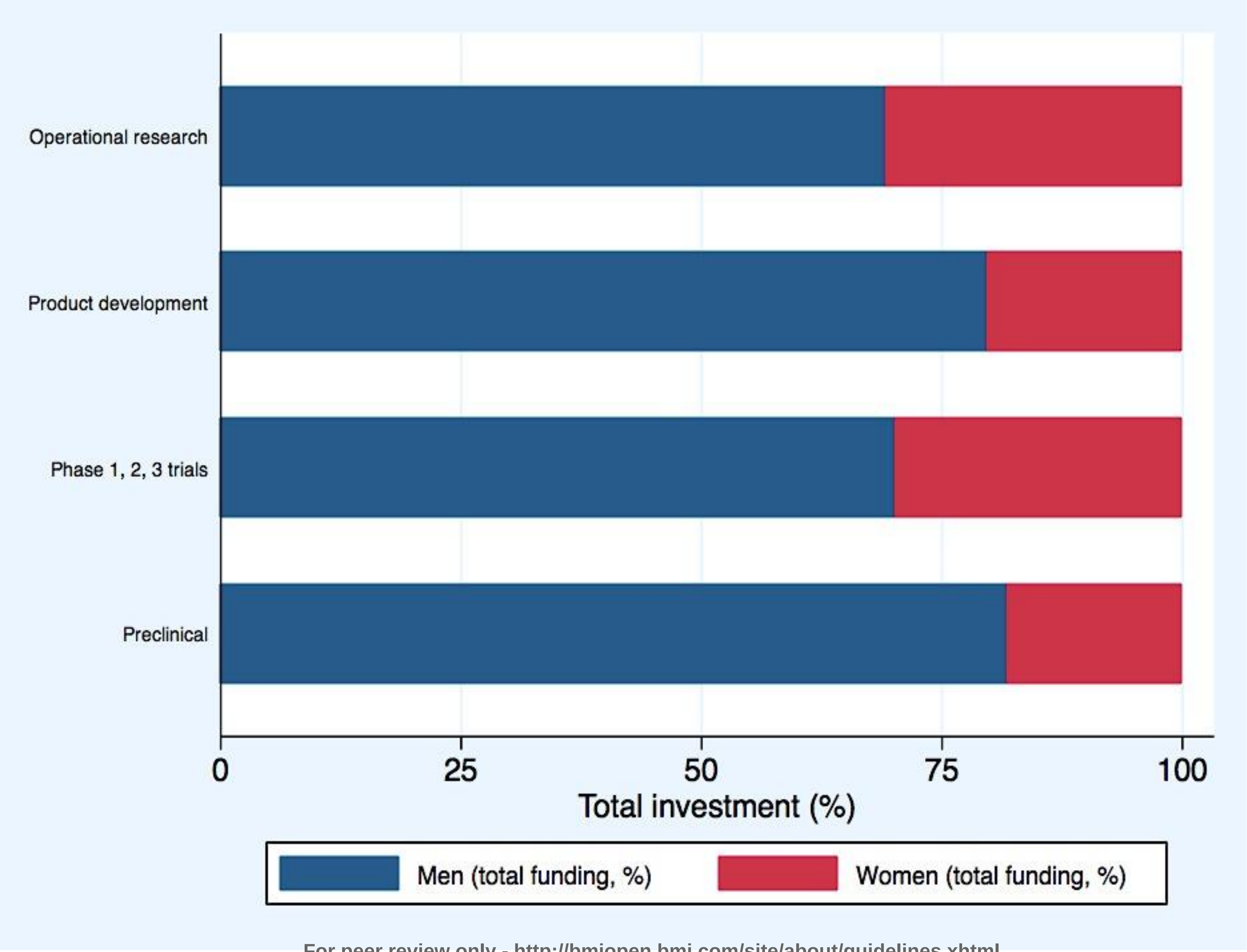
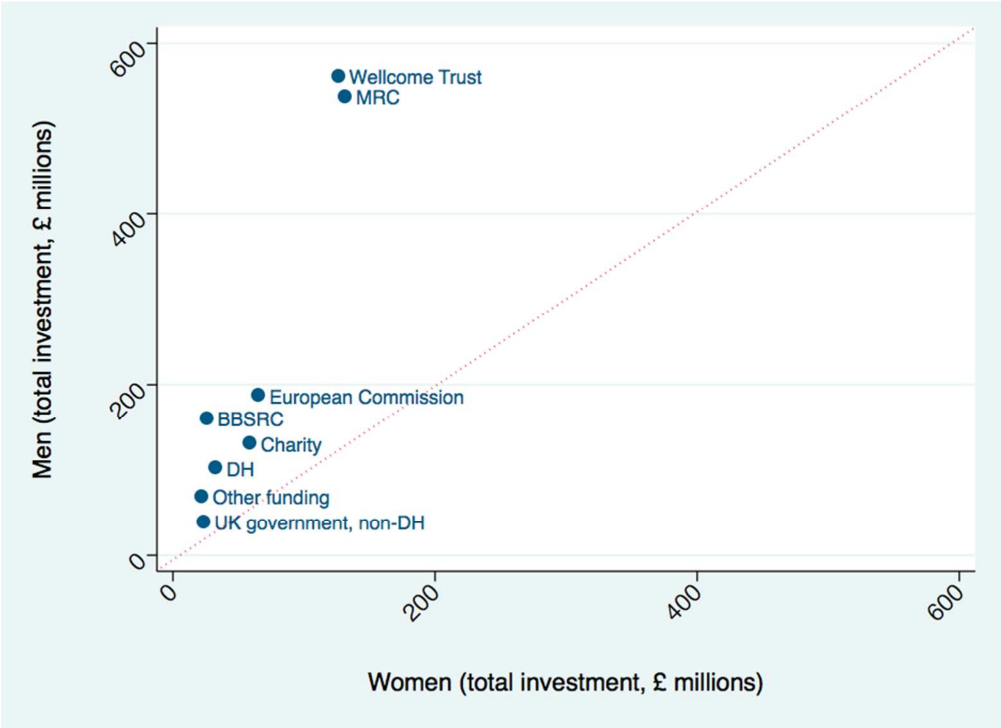
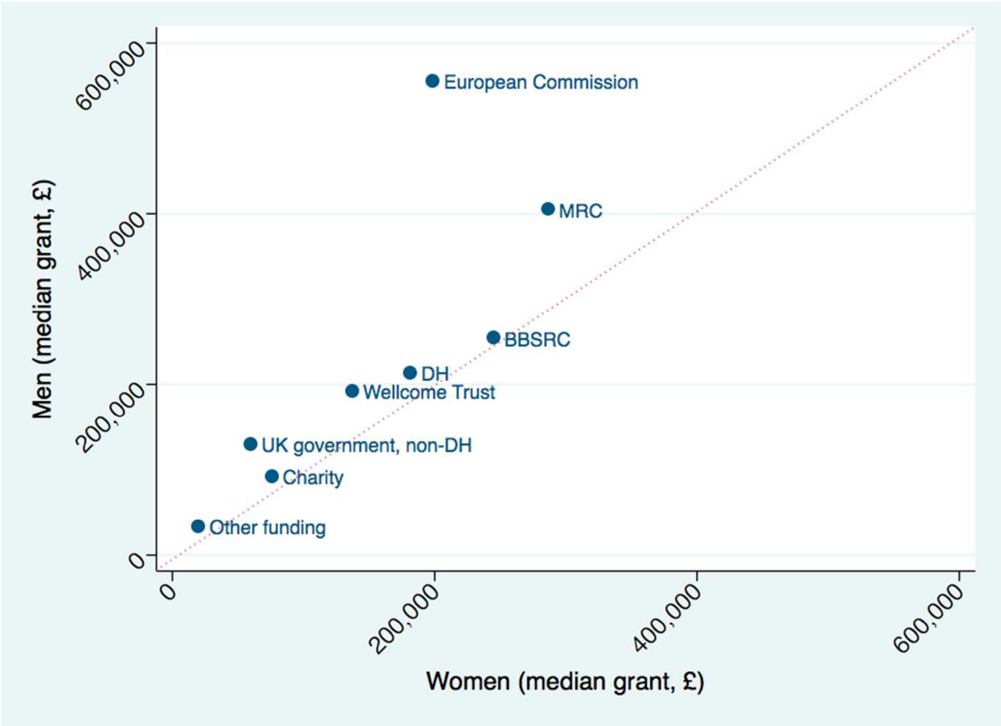


Figure 3a. Proportion of investment over time awarded to male and female principal investigators
329x239mm (72 x 72 DPI)

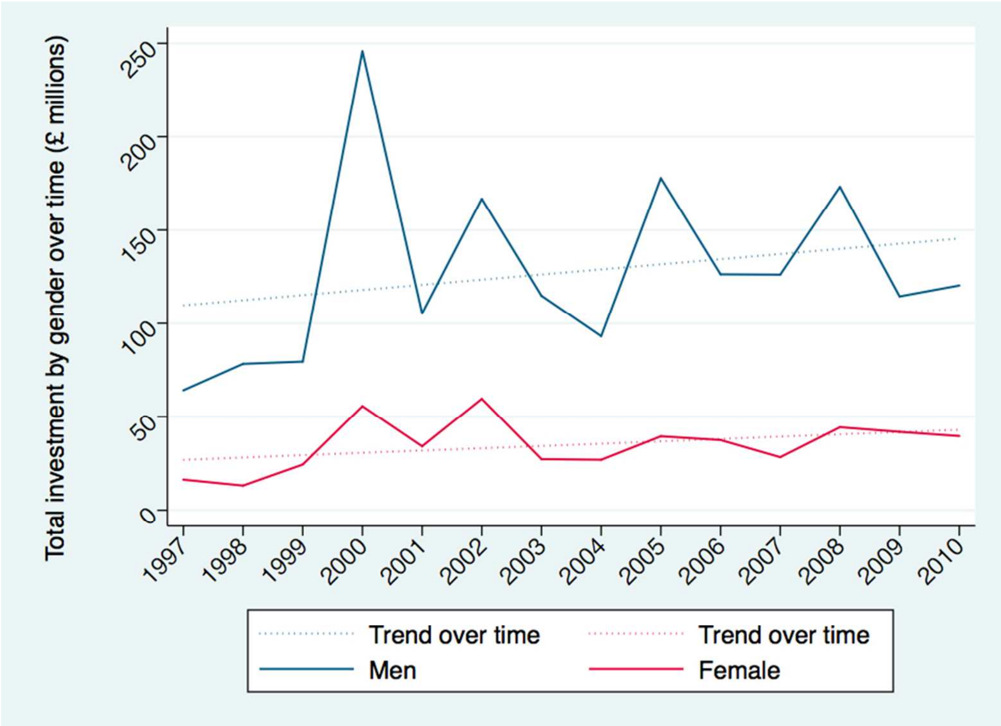

Operational research
Product development
Phase 1, 2, 3 trials
Preclinical
0
25
50
75
100
Total investment (%)
Men (total funding, %)
Women (total funding, %)



329x239mm (72 x 72 DPI)



329x239mm (72 x 72 DPI)



329x239mm (72 x 72 DPI)

Figure 5b. Fold difference of investment over time, by gender
329x239mm (72 x 72 DPI)

Disease system	Investment (total); £ (%)	Investment (male); £ (%)	Investment (female); £	Fold differenc	Studies (total); n	Studies (male); £	Studies (female); n	Fold differenc	Mean grant (total); £	Mean grant (male); £	Mean grant (female); £	Fold differenc	*P*	Median grant (total); £ (IQR)	Median grant (male); £	Median grant (female); £	Fold differenc	Chi-square	*P*
Gastrointestinal infections	248,971,849	209,315,616	37,043,642	5.65	799	638	149	4.28	315,154	328,081	248,615	1.32	0.01	199,043	208,369	155,066	1.34	6.87	0.01
	9.6%	85.0%	15.0%		12.9%	81.1%	18.9%		457,988	458,720	433,176			721,37-351,372	78,852-357,771	43,637-305,928			
Haematological infections	413,489,870	225,660,012	56,021,079	4.03	742	540	183	2.95	557,264	417,889	306,126	1.37	0.01	157,280	160,655	121,353	1.32	3.15	0.08
	15.9%	80.1%	19.9%		12.0%	74.7%	25.3%		2,179,537	914,626	819,910			157,280-362,727	54,244-366,799	32,207- 271,883			
Hepatic infections	73,965,716	57,998,793	15,618,661	3.71	322	229	90	2.54	229,707	253,270	173,541	1.46	0.07	114,621	118,638	68,620	1.73	3.82	0.05
	2.8%	78.8%	21.2%		5.2%	71.8%	28.2%		375,988	418,392	237,165			40,076-244,293	41,342-269,629	26,270-221,952			
Neglected tropical diseases	229,606,965	118,477,812	37,747,437	3.14	392	280	105	2.67	564,145	418,439	406,270	1.03	0.28	249,458	257,736	199,648	1.29	0.82	0.36
	8.8%	75.8%	24.2%		6.4%	72.7%	27.3%		2,104,383	509,169	667,547			91,196-451,453	82,786-429,781	107,474-413,242			
Neurological infections	101,885,586	79,281,163	18,779,321	4.22	339	268	67	4.00	300,548	295,825	280,288	1.06	0.67	155,404	153,724	166,514	0.92	0.19	0.66
	3.9%	80.8%	19.2%		5.5%	80.0%	20.0%		463,870	474,995	329,198			64,434-334,128	64,702-298,666	33,886-399,971			
Ocular infections	7,407,218	5,788,089	1,619,129	3.57	36	24	12	2.00	205,756	241,170	134,927	1.79	0.92	120,849	146,169	102,901	1.42	0.00	1.00
	0.3%	78.1%	21.9%		0.6%	66.7%	33.3%		280,206	327,354	132,475			7,860-293,837	6,344-348,501	23,666-232,501			
Respiratory infections	418,838,875	312,055,217	84,436,423	3.70	1,190	897	272	3.30	351,375	347,888	310,428	1.12	0.13	158,966	165,813	142,281	1.17	1.87	0.17
	16.1%	78.7%	21.3%		19.3%	76.7%	23.3%		661,990	624,555	558,282			50,203-342,049	56,715-344,512	36,236-311,548			
Sexually-transmitted infectic	138,616,211	86,016,584	45,352,512	1.90	380	190	182	1.04	366,710	452,719	249,190	1.82	0.34	94,790	93,495	101,785	0.92	0.17	0.68
	5.3%	65.5%	34.5%		6.2%	51.1%	48.9%		958,450	1,142,638	647,494			15,332-241,505	18,389-257,444	14,480-204,559			
HIV	477,555,690	290,848,557	79,652,343	3.65	760	448	286	1.57	625,073	649,216	278,505	2.33	0.01	147,404	163,462	114,272	1.43	3.87	0.05
	18.4%	78.5%	21.5%		12.3%	61.0%	39.0%		2,276,762	1,550,920	545,657			37,195-395,644	39,153-511,800	29,880-305,339			
Overall	2,599,985,851	1,785,979,172	488,178,602	3.66	6,170	4,357	1,695	2.57	421,733	409,910	288,011	1.42	0.01	158,055	179,389	125,556	1.43	74.40	0.01
		78.53%	21.47%			71.99%	28.01%		1,315,935	840,087	704,474			49,490-352,699	59,146-371,977	30,983-261,835			

Specific infection	Investment (total); £ (%)	Investment (male); £ (%)	Investment (female); £ (%)	Fold differenc	Studies (total); n	Studies (male); £	Studies (female); n	Fold differenc	Mean grant (total); £	Mean grant (male); £	Mean grant (female); £	Fold differenc	*P*	Median grant (total); £ (IQR)	Median grant (male); £ (IQR)	Median grant (female); £	Fold differenc	Chi-square	*P*
Gastrointestinal infections																			
Campylobacter	24,116,021	23,164,038	951,983	24.33	87	80	7	11.43	277,196	289,551	135,998	2.13	0.13	221,532	228,164	49,000	4.66	1.32	0.25
	#VALUE!	96.1%	3.9%		2.2%	92.0%	8.0%		408,655	421,925	156,276			90,341-311,497	92,885-311,530	3,435-305,928			
Clostridium	29,751,310	31,657,635	2,361,459	13.41	72	58	15	3.87	453,647	524,175	157,431	3.33	0.07	204,389	218,177	80,431	2.71	2.06	0.15
	#VALUE!	93.1%	6.9%		1.8%	79.5%	20.5%		796,207	868,222	178,916			42,630-415,635	49,750-451,158	8,256-316,326			
E. coli	25,589,407	23,913,566	2,392,586	9.99	106	95	12	7.92	245,852	251,722	199,382	1.26	0.16	206,784	217,705	132,232	1.65	3.25	0.07
	#VALUE!	90.9%	9.1%		2.7%	88.8%	11.2%		209,792	212,046	192,964			117,440-329,159	132,815-331,037	84,455-262,238			
Helicobacter	15,109,554	12,488,366	2,617,778	4.77	101	78	22	3.55	149,600	160,107	118,990	1.35	0.64	83,986	87,694	83,533	1.05	0.00	1.00
	#VALUE!	82.7%	17.3%		2.6%	78.0%	22.0%		214,832	232,566	138,013			11,555-187,678	11,555-191,570	11,647-187,678			
Norovirus	5,102,250	4,892,527	209,723	23.33	12	10	2	5.00	425,188	489,253	104,861	4.67	0.28	200,621	265,972	104,861	2.54	2.40	0.12
	#VALUE!	95.9%	4.1%		0.3%	83.3%	16.7%		568,372	604,564	133,320			91,363-435,732	93,571-496,514	10,590-199,133			
Rotavirus	5,883,445	6,004,983	178,450	33.65	18	17	2	8.50	325,444	353,234	89,225	3.96	0.23	164,690	179,066	89,225	2.01	2.01	0.16
	#VALUE!	97.1%	2.9%		0.5%	89.5%	10.5%		414,279	429,739	98,723			114,718-299,988	134,988-299,988	19,417-159,033			
Salmonella	55,716,287	48,902,187	6,814,100	7.18	145	123	22	5.59	384,250	397,579	309,732	1.28	0.95	256,185	258,483	255,602	1.01	0.18	0.67
	#VALUE!	87.8%	12.2%		3.7%	84.8%	15.2%		474,060	500,122	284,742			132,107-431,762	109,210-440,900	155,066-361,873			
Shigella	3,292,442	2,270,191	1,022,251	2.22	9	6	3	2.00	365,827	378,365	340,750	1.11	1.00	211,456	214,819	211,456	1.02	0.23	0.64
	#VALUE!	69.0%	31.0%		0.2%	66.7%	33.3%		335,500	374,690	312,800			134,251-658,278	134,251-658,278	113,326-697,470			
Haematological infections																			
EBV	45,310,414	36,908,000	7,692,800	4.80	147	115	31	3.71	305,485	320,939	248,155	1.29	0.36	156,697	158,107	154,947	1.02	0.04	0.84
	#VALUE!	82.8%	17.2%		3.7%	78.8%	21.2%		430,746	459,332	301,211			49,657-364,013	65,350-364,013	12,342-364,199			
Listeria	4,751,097	3,146,834	1,731,229	1.82	10	8	3	2.67	443,460	393,354	577,076	0.68	0.41	239,595	236,570	605,470	0.39	0.75	0.39
	#VALUE!	64.5%	35.5%		0.3%	72.7%	27.3%		353,486	359,163	369,384			126,966-705,717	113,867-634,775	194,315-931,444			
Malaria	346,180,494	211,961,339	40,710,857	5.21	501	359	128	2.80	700,143	590,422	318,054	1.86	0.01	203,348	209,646	143,358	1.46	4.13	0.04
	#VALUE!	83.9%	16.1%		12.7%	73.7%	26.3%		2,283,790	1,324,909	726,872			59,122-500,817	63,826-529,610	42,754-314,524			
Hepatic infections																			
CMV	28,369,415	26,102,458	1,911,586	13.65	68	55	12	4.58	417,197	474,590	159,299	2.98	0.06	188,607	201,658	107,488	1.88	1.48	0.22
	#VALUE!	93.2%	6.8%		1.7%	82.1%	17.9%		656,508	714,181	178,655			100,221-392,186	116,516-608,024	23,605-223,834			
Hepatitis B	11,768,095	7,512,333	4,215,080	1.78	68	45	22	2.05	173,060	166,941	191,595	0.87	0.89	65,624	68,646	52,873	1.30	0.19	0.66
	#VALUE!	64.1%	35.9%		1.7%	67.2%	32.8%		287,576	294,644	284,042			19,659-209,501	19,615-202,317	19,703-221,952			
Hepatitis C	59,727,829	47,621,165	11,799,084	4.04	235	167	66	2.53	254,161	285,157	178,774	1.60	0.07	116,883	124,797	67,265	1.86	5.22	0.02
	#VALUE!	80.1%	19.9%		5.9%	71.7%	28.3%		418,722	469,807	242,710			41,342-269,629	42,475-289,293	29,880-233,467			
Neglected tropical diseases																			
African trypanosomiasis	48,082,259	34,546,175	4,478,699	7.71	116	61	13	4.69	563,175	566,331	344,515	1.64	0.54	262,145	256,771	265,009	0.97	0.09	0.76
	#VALUE!	88.5%	11.5%		2.9%	82.4%	17.6%		1,139,333	1,227,091	408,381			151,883-466,918	155,868-455,554	119,521-406,701			
Chagas disease	3,448,856	4,675,712	250,535	18.66	15	17	1	17.00	273,680	275,042	250,535	1.10	0.77	215,639	215,530	250,535	0.86	1.06	0.30
	#VALUE!	94.9%	5.1%		0.4%	94.4%	5.6%		207,903	214,219				163,472-350,741	163,472-350,741				
Dengue	43,742,101	5,251,615	4,924,187	1.07	28	13	13	1.00	1,511,059	403,970	378,784	1.07	0.32	269,824	378,745	199,648	1.90	0.15	0.70
	#VALUE!	51.6%	48.4%		0.7%	50.0%	50.0%		5,899,700	336,526	504,639			107,474-530,125	148,612-515,075	69,518-361,828			
Helminths	47,026,454	39,675,624	14,701,767	2.70	114	104	43	2.42	452,438	381,496	341,902	1.12	0.87	233,772	235,696	215,206	1.10	0.24	0.62
	#VALUE!	73.0%	27.0%		2.9%	70.7%	29.3%		1,112,173	464,792	414,897			82,786-386,182	67,614-383,928	126,942-358,645			

Leishmaniasis	36,027,609	25,384,994	16,332,809	1.55	75	50	26	1.92	536,433	507,700	628,185	0.81	0.53	289,354	320,800	229,548	1.40	2.10	0.15
	#VALUE!	60.8%	39.2%		1.9%	65.8%	34.2%		797,514	579,922	1,127,441			91,196-518,477	80,166-518,477	131,221-573,851			
Leprosy	623,080	49,229	573,851	0.09	2	1	1	1.00	311,540	49,229	573,851	0.09	0.32	311,540	49,229	573,851	0.09	2.00	0.16
	#VALUE!	7.9%	92.1%		0.1%	50.0%	50.0%		370,963					49,229-573,851					
Lymphatic filariasis	51,112,541	1,802,818	317,909	5.67	16	3	2	1.50	6,723,245	600,939	158,954	3.78	0.25	551,459	551,459	158,954	3.47	2.22	0.14
	#VALUE!	85.0%	15.0%		0.4%	60.0%	40.0%		12,112,993	426,007	127,226			201,834-12,844,013	201,834-1,049,526	68,992-248,917			
Onchocerciasis	1,338,978	1,317,029	380,594	3.46	4	2	3	0.67	339,525	658,515	126,865	5.19	0.25	35,769	658,515	21,359	30.83	0.14	0.71
	#VALUE!	77.6%	22.4%		0.1%	40.0%	60.0%		546,719	880,696	200,996			21,359-358,645	35,769-1,281,261	590-358,645			
Schistosomiasis	38,677,801	11,068,267	2,686,364	4.12	46	32	12	2.67	867,572	345,883	223,864	1.55	0.60	197,557	216,603	165,622	1.31	0.46	0.50
	#VALUE!	80.5%	19.5%		1.2%	72.7%	27.3%		3,825,582	467,692	252,854			59,912-361,947	61,878-356,186	46,460-318,519			
Trachoma	3,718,572	3,718,572	0		3	2	0		1,859,286	1,859,286				1,859,286	1,859,286				
	#VALUE!	100.0%	0.0%		0.1%	100.0%	0.0%		1,768,466	1,768,466				608,792-3,109,780	60,879-3,109,780				
Neurological infections																			
Meningitis	54,078,664	42,305,152	9,347,473	4.53	223	183	38	4.82	243,434	231,176	245,986	0.94	0.59	146,153	137,694	155,670	0.88	1.21	0.27
	#VALUE!	81.9%	18.1%		5.6%	82.8%	17.2%		355,892	332,118	297,867			66,895-228,405	66,895-222,767	33,886- 369,244			
Polio	1,189,984	729,017	11,069	65.86	4	3	1	3.00	185,021	243,006	11,069	21.95	0.18	164,849	236,812	11,069	21.40	1.33	0.25
	#VALUE!	98.5%	1.5%		0.1%	75.0%	25.0%		170,640	153,310				51,977-318,065	92,886-399,318				
Tetanus	5,108,068	5,108,068	0		5	5	0		1,021,614	1,021,614				231,879	231,879				
	#VALUE!	100.0%	0.0%		0.1%	100.0%	0.0%		1,819,723	1,819,723				200,112-395,050	200,112-395,050				
Respiratory infections																			
Diphtheria	139,863	21,624	118,239	0.18	2	1	1	1.00	69,931	21,624	118,239	0.18	0.32	69,931	21,624	118,239	0.18	2.00	0.16
	#VALUE!	15.5%	84.5%		0.1%	50.0%	50.0%		68,317					21,624-118,239					
Influenza	79,763,001	68,447,401	11,615,587	5.89	140	111	30	3.70	567,823	616,643	387,186	1.59	0.04	299,988	348,730	200,787	1.74	4.06	0.04
	#VALUE!	85.5%	14.5%		3.5%	78.7%	21.3%		818,009	881,493	489,997			159,841-656,509	213,601-668,561	124,210-398,191			
Measles	2,597,677	3,827,746	646,169	5.92	9	7	3	2.33	416,179	546,821	215,390	2.54	0.57	284,882	662,131	261,846	2.53	0.48	0.49
	#VALUE!	85.6%	14.4%		0.2%	70.0%	30.0%		403,740	481,360	122,549			67,471-683,714	58,538-893,212	76,405-307,919			
Pertussis	2,432,158	2,432,158	0		9	9	0		270,240	270,240				299,840	299,840				
	#VALUE!	100.0%	0.0%		0.2%	100.0%	0.0%		246,165	246,165				37,151-452,939	37,151-452,939				
RSV	16,899,738	14,073,205	2,818,964	4.99	45	29	15	1.93	375,550	485,283	187,931	3.96	0.05	184,292	223,517	149,828	1.49	2.53	0.11
	#VALUE!	83.3%	16.7%		1.1%	65.9%	34.1%		480,715	539,396	268,412			56,431-498,006	64,191-638,823	22,277-199,329			
Tuberculosis	148,801,691	99,451,331	37,578,889	2.65	327	225	94	2.39	472,083	442,006	399,775	1.11	0.39	190,467	190,657	170,542	1.12	0.21	0.65
	#VALUE!	72.6%	27.4%		8.3%	70.5%	29.5%		930,157	825,956	742,928			69,899-421,992	74,747- 416,236	37,034-401,346			
Sexually-transmitted infections																			
Chlamydia	21,702,378	5,753,740	15,936,845	0.36	112	43	68	0.63	193,771	133,808	234,365	0.57	0.71	50,469	52,258	52,318	1.00	0.01	0.91
	#VALUE!	26.5%	73.5%		2.8%	38.7%	61.3%		561,173	197,759	701,950			10,298-174,939	14,885-174,644	6,003-175,234			
Gonorrhoea	948,399	669,866	278,532	2.40	18	9	9	1.00	52,689	74,430	30,948	2.40	0.51	7,548	8,149	6,525	1.25	0.22	0.64
	#VALUE!	70.6%	29.4%		0.5%	50.0%	50.0%		81,648	104,267	47,232			1,820-54,145	6,471-150,196	1,820-40,986			
HIV	460,547,457	290,848,557	79,652,343	3.65	760	448	286	1.57	625,073	649,216	278,505	2.33	0.01	147,404	163,462	114,272	1.43	3.87	0.05
	#VALUE!	78.5%	21.5%		19.2%	61.0%	39.0%		2,276,762	1,550,920	545,657			37,195-395,644	39,153-511,800	29,880-305,339			
HPV	57,795,110	42,592,795	9,393,693	4.53	150	88	56	1.57	355,514	484,009	167,745	2.89	0.30	92,143	103,966	82,325	1.26	0.47	0.49
	#VALUE!	81.9%	18.1%		3.8%	61.1%	38.9%		849,406	1,042,481	360,400			30,079-220,559	29,742-264,540	32,566- 171,377			
HSV	22,063,300	15,472,470	6,536,189	2.37	48	28	19	1.47	459,652	552,588	344,010	1.61	0.19	202,564	119,295	309,610	0.39	4.85	0.03

	#VALUE!	70.3%	29.7%		1.2%	59.6%	40.4%		720,790	908,183	287,596			52,597-421,960	40,009-446,395	147,885-439,305			
Syphilis	1,061,560	286,117	775,444	0.37	5	2	3	0.67	212,312	143,058	258,481	0.55	0.56	207,346	143,058	207,346	0.69	0.14	0.71
	#VALUE!	27.0%	73.0%		0.1%	40.0%	60.0%		152,848	122,822	176,603			113,088-229,907	56,210-229,907	113,088-455,010			
Other infections																			
Aspergillus	4,853,858	4,482,101	371,757	12.06	26	24	2	12.00	186,687	186,754	185,879	1.00	1.00	47,948	47,948	185,879	0.26	0.00	1.00
	#VALUE!	92.3%	7.7%		0.7%	92.3%	7.7%		420,903	435,756	248,298			19,703-157,829	20,890-135,113	10,306-361,451			
Candida	1,219,072	1,194,064	25,008	47.75	8	6	2	3.00	152,384	199,011	12,504	15.92	0.18	28,518	72,375	12,504	5.79	2.67	0.10
	#VALUE!	97.9%	2.1%		0.2%	75.0%	25.0%		262,390	293,075	17,226			10,508-188,568	17,076-264,740	324-24,684			
Pseudomonas	6,473,237	6,096,633	376,604	16.19	43	39	4	9.75	150,540	156,324	94,151	1.66	0.90	81,793	81,793	79,244	1.03	0.00	0.96
	#VALUE!	94.2%	5.8%		1.1%	90.7%	9.3%		175,911	182,442	83,286			11,204-253,337	11,108-253,459	27,396-160,906			
VZV	4,186,583	1,472,968	2,713,615	0.54	20	9	11	0.82	209,329	163,663	246,692	0.66	0.21	145,505	47,343	161,033	0.29	0.20	0.65
	#VALUE!	35.2%	64.8%		0.5%	45.0%	55.0%		261,063	250,869	275,194			46,117-227,502	26,213-147,593	105,632-233,537			
Total specific infections	#VALUE!	#VALUE!	#VALUE!	#VALUE!	3,953	#VALUE!	#VALUE!	#VALUE!						158,055					
Overall	2,599,985,851	1,785,979,172	488,178,602	3.66	6,170	4,357	1,695	2.57	421,733	409,910	288,011	1.42	0.01	49,490-352,699	179,389	125,556	1.43	74.40	0.01
		78.53%	21.47%			71.99%	28.01%		1,315,935	840,087	704,474								

Funder	Investment (total); £ (%)	Investment (male); £ (%)	Investment (female); £ (%)	Fold difference	Studies (total); n (%)	Studies (male); £ (%)	Studies (female); n (%)	Fold difference	Mean grant (total); £ (SD)	Mean grant (male); £ (SD)	Mean grant (female); £ (SD)	Fold difference	*P*	Median grant (total); £ (IQR)	Median grant (male); £ (IQR)	Median grant (female); £ (IQR)	Fold difference	Chi-squared	*P*
Public funding	1,393,972,967	1,025,211,218	279,810,244	3.66	1,082	1,722	624	2.76	588,503	595,361	448,414	1.17	0.01	255,992	272,452	213,718	1.27	29.38	0.01
	53.6%	78.6%	21.4%		17.6%	73.4%	26.6%		1,447,668	1,080,718	814,979			127,167-529,610	138,322- 572,529	92,880-402,917			
BBSRC	186,268,429	160,120,540	26,147,889	6.12	578	485	93	5.22	322,264	330,145	281,160	1.17	0.78	253,398	253,498	244,972	1.03	0.12	0.73
	7.2%	86.0%	14.0%		9.4%	83.9%	16.1%		361,565	383,963	205,593			169,787-365,159	176,763-363,830	149,828-371,577			
DFID																			
DH	134,961,745	101,933,746	32,757,325	3.11	285	194	89	2.18	473,550	525,432	368,060	1.43	0.37	203,544	213,107	181,697	1.17	0.36	0.55
	5.2%	75.7%	24.3%		4.6%	68.6%	31.4%		846,024	968,640	482,041			72,628-514,066	72,627-542,097	65,015-383,886			
European Commission	255,015,533	186,846,015	65,558,847	2.85	219	141	71	1.99	1,164,454	1,325,149	923,364	1.44	0.58	439,762	555,497	199,133	2.79	3.58	0.06
	9.8%	74.0%	26.0%		3.6%	66.5%	33.5%		2,084,358	2,409,860	1,316,016			127,419-1,454,94	123,042-1,504,88	134,621-1,449,403			
MRC	672,895,698	537,260,180	131,751,245	4.08	962	715	242	2.95	699,476	751,413	544,427	1.38	0.01	366,479	404,615	286,679	1.41	18.44	0.01
	25.9%	80.3%	19.7%		15.6%	74.7%	25.3%		993,012	1,020,748	884,442			199,287-713,178	210,068-811,860	178,182-468,998			
UK government, non-DH	144,831,562	39,050,737	23,594,939	1.66	237	187	129	1.45	452,898	208,828	182,907	1.14	0.01	110,178	129,660	59,976	2.16	3.79	0.05
	5.6%	62.3%	37.7%		3.8%	59.2%	40.8%		2,811,384	492,519	619,889			19,073-206,784	23,761- 207,320	12,564-157,053			
Philanthropy	1,108,966,983	691,680,388	185,866,898	3.72	2,879	2,044	768	2.66	383,601	338,396	242,014	1.40	0.01	146,060	153,653	114,173	1.35	23.28	0.01
	42.7%	78.8%	21.2%		46.7%	72.7%	27.3%		1,377,079	659,025	711,420			52,433-286,518	58,589-302,774	42,658-222,842			
Bill & Melinda Gates Foundation	220,923,242				39				5,664,699					1,488,432					
	8.5%				0.6%				8,966,093					628,545-5,576,863					
Charity	199,703,382	130,726,509	58,989,705	2.22	855	619	217	2.85	227,332	211,190	271,842	0.78	0.01	87,318	91,991	76,058	1.21	5.23	0.02
	7.7%	68.9%	31.1%		13.9%	74.0%	26.0%		730,057	454,108	1,208,852			27,616-167,829	36,429-172,497	17,279-150,727			
Wellcome Trust	688,340,359	560,953,880	126,592,102	4.43	1,985	1,425	550	2.59	346,818	393,652	230,168	1.71	0.01	168,434	191,461	137,241	1.40	39.83	0.01
	26.5%	81.6%	18.4%		32.2%	72.2%	27.8%		646,625	723,549	362,836			66,419-335,557	74,759-362,424	54,019-250,723			
Other funding	103,542,992	69,087,566	22,501,460	3.07	1,010	591	303	1.95	103,683	116,899	74,262	1.57	0.01	28,626	32,557	20,373	1.60	4.80	0.03
	4.0%	75.4%	24.6%		16.4%	66.1%	33.9%		273,102	309,358	154,373			6,282-105,082	7,225-113,479	4,408-79,809			
Overall	2,599,985,851	1,785,979,172	488,178,602	3.66	6,165	4,357	1,695	2.57	421,733	409,910	288,011	1.42	0.01	158,055	179,389	125,556	1.43	74.40	0.01
		78.5%	21.5%			72.0%	28.0%		1,315,935	840,087	704,474			49,490-352,699	59,146-371,977	30,983-261,835			

Year	Investment (male); £	Change from previous year (male); £	Fold difference (male)	*P*	Change over 1997 (male); £	Fold difference (male)	*P*	Investment (female); £	Change from previous year (female); £	Fold difference (female)	*P*	Change over 1997 (female); £	Fold difference (female)	*P*	Investment (male); %	Investment (female); %	Absolute difference (gender)	Fold difference (gender)
1997	64,158,003							16,305,109							79.7%	20.3%	47,852,894	3.93
1998	78,287,824	14,129,821	1.22	0.57	14,129,821	1.22	0.57	13,110,597	-3,194,512	0.80	0.90	-3,194,512	0.80	0.90	85.7%	14.3%	65,177,227	5.97
1999	79,477,324	1,189,500	1.02	0.37	15,319,321	1.24	0.14	24,366,507	11,255,911	1.86	0.79	8,061,398	1.49	0.88	76.5%	23.5%	55,110,816	3.26
2000	245,740,477	166,263,153	3.09	0.00	181,582,474	3.83	0.01	55,636,657	31,270,150	2.28	0.01	39,331,548	3.41	0.01	81.5%	18.5%	190,103,820	4.42
2001	105,423,252	-140,317,225	0.43	0.09	41,265,248	1.64	0.01	34,133,067	-21,503,591	0.61	0.23	17,827,958	2.09	0.01	75.5%	24.5%	71,290,185	3.09
2002	166,695,481	61,272,230	1.58	0.89	102,537,478	2.60	0.01	59,568,874	25,435,807	1.75	0.41	43,263,765	3.65	0.01	73.7%	26.3%	107,126,607	2.80
2003	114,827,602	-51,867,880	0.69	0.03	50,669,599	1.79	0.50	27,241,313	-32,327,560	0.46	0.14	10,936,204	1.67	0.05	80.8%	19.2%	87,586,288	4.22
2004	93,129,587	-21,698,015	0.81	0.09	28,971,584	1.45	0.30	26,908,997	-332,316	0.99	0.91	10,603,888	1.65	0.04	77.6%	22.4%	66,220,590	3.46
2005	177,791,995	84,662,408	1.91	0.03	113,633,992	2.77	0.26	39,460,786	12,551,789	1.47	0.60	23,155,677	2.42	0.01	81.8%	18.2%	138,331,209	4.51
2006	126,329,085	-51,462,910	0.71	0.60	62,171,082	1.97	0.54	37,473,263	-1,987,522	0.95	0.35	21,168,154	2.30	0.03	77.1%	22.9%	88,855,822	3.37
2007	126,144,324	-184,761	1.00	0.03	61,986,320	1.97	0.12	28,293,204	-9,180,059	0.76	0.01	11,988,095	1.74	0.48	81.7%	18.3%	97,851,119	4.46
2008	173,132,770	46,988,446	1.37	0.07	108,974,767	2.70	0.01	44,307,821	16,014,617	1.57	0.70	28,002,712	2.72	0.73	79.6%	20.4%	128,824,949	3.91
2009	114,490,290	-58,642,480	0.66	0.12	50,332,287	1.78	0.01	41,820,953	-2,486,868	0.94	0.03	25,515,844	2.56	0.01	73.2%	26.8%	72,669,337	2.74
2010	120,351,159	5,860,868	1.05	0.33	56,193,155	1.88	0.01	39,551,453	-2,269,500	0.95	0.56	23,246,344	2.43	0.06	75.3%	24.7%	80,799,705	3.04
Mean	*127,569,941*	*4,322,550*			*68,289,779*			*34,869,900*	*1,788,180*			########			*78.6%*	*21.4%*	*92,700,041*	
SD	*48,770,855*	*76,214,220*			*47,073,847*			*13,365,475*	*17,657,139*			########					*38,264,674*	
Total Gende	*1,785,979,172*							*488,178,602*									*1,297,800,569*	3.66
Total Overal	2,599,985,851																	

Disparities in research funding for women scientists: systematic analysis of UK investments in global infectious disease research 1997–2010

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-003362.R1
Article Type:	Research
Date Submitted by the Author:	22-Aug-2013

Complete List of Authors:	Head, Michael; University College London, Infection & Population Health Fitchett, Joseph; London School of Hygiene & Tropical Medicine, Cooke, Mary; University College London, Wurie, Fatima; University College London, Atun, Rifat; Imperial College London,

Primary Subject Heading:	Infectious diseases
Secondary Subject Heading:	Global health
Keywords:	INFECTIOUS DISEASES, PUBLIC HEALTH, STATISTICS & RESEARCH METHODS, VIROLOGY, PARASITOLOGY, MYCOLOGY

Disparities in research funding for women scientists: systematic analysis of UK investments in global infectious disease research 1997–2010

Michael G Head[a*], Joseph R Fitchett[b], Mary K Cooke[a], Fatima B Wurie[a], Rifat Atun[c]

a University College London, Research Department of Infection and Population Health, UCL Royal Free Campus, Rowland Hill Street, London, NW3 2PF

b London School of Hygiene & Tropical Medicine, Keppel Street, London, WC1E 7HT

c Imperial College London, South Kensington Campus, London SW7 2AZ and Harvard School of Public Health, Harvard University, Boston, USA

*Corresponding Author

Number of Words: **3 758**

Keywords – gender, funding, research, women,

Abstract

Objectives: There has not previously been a systematic analysis exploring gender disparities in awards for research funding. We investigated funding awards to UK institutions for all infectious disease research from 1997 to 2010, across disease categories and along the research and development continuum.

Design: Systematic analysis

Methods: Data were obtained from several sources for awards from the period 1997-2010 and each study assigned to - disease categories; type of science (pre-clinical, phases I-III trials, product development, implementation research); categories of funding organisation. Fold differences and statistical analysis were used to compare total investment, study numbers, mean grant, and median grant between men and women.

Results**:** 6052 studies were included in the final analysis, comprising 4357 grants (72.0%) awarded to men and 1695 grants (28.0%) awarded to women, totalling £2.274 billion. Of this, men received £1.786 billion (78.5%) and women £488 million (21.5%). The median value of award was greater for men (£179 389; IQR £59146–£371 977) than women (£125 556; IQR £30 982–£261 834).

Awards were greater for male PIs across all infectious disease systems, excepting neurological infections and sexually transmitted infections. The proportion of total funding awarded to women ranged from 14.3% in 1998 to 26.8% in 2009 (mean 21.4%), and was lowest for pre-clinical research at 18.2% (£285.5 million of £1.573 billion) and highest for operational research at 30·9% (£151.4 million of £489.7 million).

Conclusions: There are consistent disparities in funding received by men and women principal investigators: women have fewer funded studies and receive less funding in absolute and in relative terms; the median funding awarded to women is lower across most

infectious disease areas, by funder, and type of science. These disparities remain broadly unchanged over the 14-year study period.

Article summary

Article focus

- We explore the distribution of funding across infectious disease research by the gender of principal investigator to identify any disparities in funding received by men and women researchers in the UK.

Key messages

- There are consistent disparities in funding received by men and women principal investigators (PIs) in infectious disease research funded in the UK.
- Total funding and the median award across most disease areas and type of science is typically greater in male PIs than female PIs
- These disparities remain consistent over the time period of analysis (1997-2010)

Strengths and limitations of this study

- This is the first study to present detailed data and rigorously quantify funding disparities between men and women researchers in infectious disease research in the UK.
- Our results provides new and additional evidence on disparities on funding for men and women researchers highlighted in earlier studies and provides a case for new research explain the source of these disparities, especially given government commitments to increase the number of women in science

- We were unable to assess the success and failure rates by gender and thus cannot comment on the extent of inequalities or bias. As we could not access data on the academic ranking of principal investigators, we were hence unable to adjust for levels of seniority across both genders.

Introduction

Women are under-represented in biomedical science, yet few studies have systematically explored the extent and reasons for the observed disparities between men and women scientists. Women comprise 50% of the EU student population and 45% of doctoral students, but only one third of career researchers are women – a figure that is lower for senior positions.[1]

In 2001, a Wellcome Trust survey concluded that although women were as successful as men in securing funding for biomedical research, they were less likely to apply for grant funds because of their status in scientific institutions and the level of support they received.[2] An analysis of Wellcome Trust awards in 2000-08 revealed a significant gender difference in the amount of funding awarded, even after adjusting for the seniority of the principal investigator, concluding "the most likely explanation for the difference in amounts awarded to women and men is that women are systematically less ambitious in the amounts of funding requested in their grant applications."[3] In 2011, around 44% of academics in UK universities were women, yet only 39% of senior lecturers and 19% of professors were women.[4] Furthermore, a number of studies from the US have shown that women in science are disadvantaged compared to men.[5–7]

The low numbers of women in science and the reasons for this anomaly is a concern for scientists and policy makers. Although the UK Medical Research Council (MRC) has a gender equality scheme, which briefly states gender equality is reflected in agreements with research organisations receiving MRC funding, it is not clear how the scheme is implemented.[8]

While several initiatives have aimed to increase the numbers of women involved in science, there are no affirmative actions or binding policies in the UK or Europe to definitively ensure women are better represented in science. Indeed, some initiatives aimed at increasing women in science have been criticised. For example, in 2012, the European Commission campaign targeting 13-18 year-old secondary school students[9] was rebuked and described as an insult to women in science[10],[11], with the offending video clip removed from the EU campaign website. The effects of campaigns aimed at raising the profile of women in science[12,13] have not been assessed.

We have previously undertaken a systematic analysis of research funding awarded to UK institutions for all infectious disease research, for the 14-year period from 1997 to 2010.[14] Here, we use the dataset gathered for this earlier study to examine trends over time, the distribution of funding awarded to men and women principal investigators (PIs) across specific infections, funder categories, and along the research and development (R&D) continuum, extending from pre-clinical to clinical and operational research.

Methods

We obtained data from several sources for infectious disease research studies where funding was awarded between 1997 and 2010. The methods for the original study are elaborated in detail elsewhere,[14] and summarised here. We identified 325,922 studies for screening that covered all areas of disease from several funders, and filtered these to identify funding for infectious diseases where the lead institution was in the UK in the period and the year of award 1997-2010. We obtained data from publicly available sources and directly from the funders. We did not include private sector funding in the analysis, as pharmaceutical sector data were not publicly available. Figure 1 shows the sources of data

and the numbers of studies included and excluded at each stage of screening to reach the final set of studies for detailed analysis.

Figure 1. Methodology flow chart for filtering studies firstly by infectious disease and then by gender

Data collection and cleaning took place alongside routine duties between 2006 and 2011, primarily by MGH and assisted by JRF, MKC and FBW. Funding records could feasibly be obtained going back to 1997, hence the decision to cover awards during 1997-2010. We assigned each study to primary disease categories, and within each category, we documented topic-specific subsections, including specific pathogen or disease. We allocated studies to one of four categories along the R&D continuum: pre-clinical; phases I, II or III; product development; and operational research, and to one of the 26 categories for funding organisations.

Where the PI was named, we assigned them to men or women categories. The studies where only an initial was available for the forename were assigned as “unclear” if we were unable to establish the PIs gender from a review of the literature, institutional websites or publicly available publications and documents.

Reference to sexually transmitted infections excludes HIV. Neglected tropical diseases were categorised according to classification used by the World Health Organization (WHO) (http://www.who.int/neglected_diseases/diseases/en). Antimicrobial resistance includes antibacterial, antiviral, antifungal and antiparasitic studies.

We converted grants awarded in a currency other than pounds sterling to UK pounds using the mean exchange rate in the year of the award. We adjusted grant funding amounts for inflation and reported in 2010 UK pounds.

As well as excluding studies not immediately relevant to infection, we excluded unfunded studies, veterinary infectious disease research studies (unless there was a zoonotic component), those exploring the use of viral vectors to investigate non-communicable diseases, grants for symposia or meetings, or studies with UK contributions (e.g. as a collaborator), but the funding was awarded to a non-UK institution.

We used Microsoft Excel versions 2000 and 2007 to categorise studies. Where needed, data were exported into Microsoft Access (versions 2000 and 2007) and specific keyword queries used to select precise sections of the data for analysis. We used Stata (version 11·0) for statistical analysis and to generate figures.

We used fold differences to compare total investment, number of studies, mean grant, and median grant between men and women according to disease system, specific infection and funding organisation.

We used nonparametric Mann-Whitney rank-sum test to assess the distribution of funding by gender. Nonparametric K-sample test on equality of medians was applied to compare the median funding by gender, and reported as a chi-squared statistic without Yates' correction for continuity. Nonparametric Wilcoxon signed-rank test was applied when comparing matched data, such as time trends by gender. The significance for all tests was defined at the 5% level (two-sided P=0.05).

We present disparities between gender and do not attempt to investigate or imply bias or inequalities as we could not access data on unsuccessful grant applications.

Results

We identified 6165 studies from the 325,922 studies screened that were suitable for inclusion in our analysis. Of these, we were unable to ascertain the gender of principal investigator for 30 studies (0.5%). We excluded 83 studies (1.3%) that did not specify the PIs name or gender – these were funded by the Bill and Melinda Gates Foundation (Gates Foundation) (38 studies; 0.6%) and the UK Department for International Development (DFID) (22 studies; 0.4%), accounting for £321.2 million (12.3% of the total). We included 6052 studies in the final analysis, comprising 4357 grants (72.0%) awarded to men and 1695 grants (28.0%) awarded to women, totalling £2.274 billion, of which £1.786 billion (78.5%) were awarded to men and £488 million (21.5%) awarded to women.

The median value of grant funding was greater for men (£179 389; IQR £59146–£371 977) than for women (£125 556; IQR £30 982–£261 834). Similarly, mean value of the grant funding was greater for men (£409 910; SD £840 087) than for women (£288 011; SD £704 474). Figure 2 shows the distribution of the total investments and median funding awarded to PIs by gender over time.

Figure 2a. Total investment over time awarded to male and female principal investigators

Figure 2b Median investment over time awarded to male and female principal investigators

Infectious disease system

Table 1A (web appendix 1) shows the total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to nine disease systems and by gender of PI. We identified no infectious disease system where women led the majority of research efforts or were awarded the majority of funding. Median funding awards were greater for male PIs across all infectious disease systems, with the exception of neurological infections and sexually transmitted infections.

Greatest levels of funding awarded to men and to women were for research into respiratory infections and HIV. Men received a total of £312.1 million for research into respiratory infections compared with £84.4 million for women – a 3.70 fold difference – and a total of £290.8 million for HIV research compared with £79.7 million for women – a 3.65 fold difference.

The largest difference between total funding for men and for women was with gastrointestinal infections (5.65 fold difference) where women received only 15.0% of the total investment (£37.0 million) and spearheaded 18.9% (149) of the studies and neurological infections (4.22 fold difference). Smallest difference between total funding for men and for women was in research into sexually transmitted infections (1.90 fold difference), where women received 35.0% (£45.4 million) of the total funding and led 49.0% (182) of the studies.

Mean funding for grants was significantly greater for men (£409 910; SD £840 087) than for women (£288 011; SD £704 474). The differences in median funding were statistically significant (*P* > 0.01) for gastrointestinal infections (men £328 021; SD £458 720) (women £248 615; SD £433 176), for haematological infections (men £417 889; SD £914 626)

(women £306 126; SD £819 910), and for HIV (men £649 216; SD £1 550 920) (women £278 505; SD £545 657).

Median funding for grants showed a similar pattern, with significantly greater grant funding for men (£179 389; IQR £59 146–£371 977) than women (£125 556; IQR £30 983–£261 835). Differences in median funding were statistically significant (*P* > 0.05) for gastrointestinal infections (men £208 369; IQR £78 852–357 771) (women £155 066; IQR £43 637–£305 928), for hepatic infections (men £118 638; IQR £41 342–£269 629) (women £68 620; IQR £26 720–£221 952), and for HIV (men £163 462; IQR £39 153–£511 800) (women £114 272; IQR £29 880–£305 339).

Specific Infections

Table 1B (web appendix 1) shows total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to specific infection by gender.

Men received significantly higher levels of total research funding, spearheaded greater numbers of studies, and were awarded greater median and mean funding for grants for malaria (*P = 0.01*), HIV (*P = 0.01*) and influenza (*P = 0.04*).

Major differences between total funding for men and for women were observed for research into candida (47.75 fold difference), rotavirus (33.65 fold difference), campylobacter (24.33 fold difference) and norovirus (23.33 fold difference). Smallest differences between total funding for men and women were for research into dengue (1.07 fold difference) and leishmaniasis (1.55 fold difference). Women received greater total funding than men for research into leprosy (0.09 fold difference), diphtheria (0.18 fold difference), chlamydia (0.36 fold difference), syphilis (0.37 fold difference), and varicella zoster (0.54 fold difference).

Differences in mean grant funding were statistically significant (*P* > 0.05) for malaria research (men £590 422; SD £1 324 909) (women £318 054; SD £726 872), for influenza (men £616 643; SD £881 493) (women £387 186; SD £489 997), for respiratory syncytial virus (men £485 283; SD £539 396) (women £187 931; SD £268 412), and for HIV (men £649 216; SD £1 550 920) (women £278 505; SD £545 657).

Differences in median grant funding were statistically significant (*P* > 0.05) for malaria research (men £209 646; IQR £63 826–£529 610) (women £143 358; IQR £42 754–£314 524), for hepatitis C (men £124 797; IQR £42 475–£289 293) (women £67 265; IQR £29 880–£233 467), for influenza (men £348 730; IQR £213 601–£668 561) (women £200 787; IQR £124 210–£398 191), for herpes simplex virus (men £119 295; IQR £40 009–£446 395) (women £309 610; IQR £147 885–£439 305), and for HIV (men £163 462; IQR £39 153–£511 800) (women £114 272; IQR £29 880–£305 339).

Figure 3 shows the proportion of total funding awarded to principal investigators by gender over time and a breakdown of investment by research pipeline. The proportion of the total funding awarded to women ranged from 14.3% (in 1998) to 26.8% (in 2009), with a mean proportion of 21.4% for the period studied. The proportion of funding was lowest for pre-clinical research at 18.2% (£285·5 million of £1.573 billion total) and highest for operational research at 30.9% (£151.4 million of £489.7 million). The funding for clinical (Phase I, II and III) research was 29.9% (£25.5 of £85.2) and for product development amounted to 20.4% (£25.8 million of £126.6 million).

Figure 3a. Proportion of investment over time awarded to male and female principal investigators

Figure 3b. Total investment by research pipeline awarded to male and female principal investigators

Funding organisation

Table 2 (web appendix 2) shows in detail the total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to funding organisation and by gender.

Public funding organisations invested a total of £1.025 billion in research led by men (78.6%) and £279.8 in research led by women (21.4%). Greatest levels of funding awarded to men and to women were by the Wellcome Trust and the UK MRC. Major differences between funding awarded to men and to women PIs were by the BBSRC, with a 6.12 fold difference. Smallest differences between funding awarded to men and to women were by the UK Government funding streams such as the National Institute for Health Research, with a 1.66 fold difference. Mean grant funding from public funding organisations were significantly greater for men at £595 361 (SD £1 080 718) than for women at £448 414 (SD £814 979). Differences were also statistically significant ($P > 0.01$) for UK MRC grants with men at £751 413 (SD £1 020 748) and women at £544 427 (SD £884 442), and for UK Government grants with men at £208 828 (SD £492 519) and women at £182 907 (SD £619 889).

Median grant funding from public funding organisations had a similar pattern with significantly greater grant funding for men at £272 452 (IQR £138 322–£572 529) and women at £213 718 (IQR £92 880–£402 917). Differences were also statistically significant ($P > 0.05$) for UK MRC grants with men at £404 615 (IQR £ 210 068–£811 860) and women at £286 679 (£178 182–£468 998), and for UK Government grants with men at £129 660 (IQR £23 761–£207 320) and women at £59 976 (IQR £12 564–£157 053).

Philanthropic funding organisations invested a total of £691.7 million in research led by men (78.8%) and £185.9 million in research led by women (21.2%).

Mean grant funding from philanthropic funding organisations were significantly greater for men at £338 396 (SD £695 025) than for women at £242 014 (SD £711 420). Differences were also statistically significant ($P > 0.01$) for Wellcome Trust grants with men receiving £393 652 (SD £723 549) and women £230 168 (SD £362 836), and for other charitable funding organisations with men receiving £211 190 (SD £454 108) and women £271 842 (SD £1 208 852).

Median grants from philanthropic funding organisations showed a similar pattern with significantly greater grant funding for men at £153 653 (IQR £58 589 – £302 774) and women at £114 173 (IQR £42 658 – £222 842). Differences were also statistically significant ($P > 0.05$) for Wellcome Trust grants with men receiving £191 461 (IQR £74 759 – £362 424) and women £137 241 (IQR £54 019 – £250 723), and for other charitable funding organisations with men receiving £91 991 (IQR £36 429 – £172 497) and women £76 058 (IQR £17 279 – £150 727).

Figure 4 shows the association between funding organisation and total investment and median funding by gender. The MRC awarded the highest median amount in grants to women (£286 679; IQR £178 182–£468 998), but the median funding amount in grants for men were 1.41 fold higher than that awarded to women (£404 615; IQR £210 068–£811 860). European Commission awarded the highest mean grants to women at £923 364 (SD £1 316 016) however mean funding amount in grants for men were 1.44 fold higher at £1325 149 (SD £2 409 860) than that for women.

Figure 4a. Association between funding organisation and total investment by gender

Figure 4b. Association between funding organisation and median award by gender

Time trend

Table 3 (web appendix 3) shows in detail the trends in funding over time from 1997 to 2010 by gender of principal investigators, with amounts and relative proportions each year of funding. Mean annual funding received was greater by men at £127.6 million (SD £48.7 million) than women at £34.9 million (SD £13.4 million). Proportions of annual funding received by men ranged from 73.2% to 85.7%, with a mean of 78.6%.

Proportions of annual funding received by women ranged from 14.3% to 26.8% with a mean of 21.4%. The largest annual funding received by men was £245.7 million in 2000, and the smallest at £64.2 million in 1997. The largest annual funding received by women was £59.6 million in 2002, with the smallest at £13.1 million in 1998.

Over the 14-year study period, the proportion of investment awarded to women each year remains relatively unchanged with a mean of 21.4% of total (range 14.3%–26.8%; £13.1 million to £59.6 million). Figure 5 shows the funding trends over time and fold differences in total investments by gender. Absolute difference in the funding amounts in the grants awarded to men and women ranges between £47.9 million and £190.1 million, with a mean difference of £92.7 million (SD £38.3 million). Fold difference in grant funding for men and women ranged from 2.74 to 5.97, with a mean fold difference of 3.66.

Figure 5a. Total investment and trend over time, by gender

Figure 5b. Fold difference of investment over time, by gender

Discussion

We present the first detailed and systematic analysis by gender of investments in infectious disease research in the UK for the 14-year period 1997-2010. We identified 6165 studies funded by public and philanthropic funding organisations, with total research investment of £2.6 billion.

We quantified the differences in research funding awarded by gender to show these to be substantial. The analysis shows clear and consistent disparities between men and women principal investigators, with lower funding in terms of the total investment, the number of funded studies, the median funding awarded and the mean funding awarded across most of the infectious disease areas funded. Women received less funding in absolute amounts and in relative terms, by funder and the type of science funded along the R&D pipeline. These disparities in funding between men and women persist over time.

We show large disparities in median funding amounts for men and women researchers in investments by the European Commission and the MRC. Such differences were much less apparent when comparing funding from the Department of Health and BBSRC, although the BBSRC awarded 86% of funding to men. The BBSRC almost entirely funds pre-clinical research,[14] and this matches the increased proportions of pre-clinical studies being led by male principal investigators.

Our findings in infectious disease research, the most detailed to date, provide new evidence on disparities between men and women researchers, to reinforce the concerns raised in earlier studies.[4,15,16] Disparities that are more marked at senior levels of academia need to be investigated to explain and account for the observed differences.

The reasons why the median awards across most infectious disease conditions should be significantly less for women principal investigators cannot be deduced from the available data. The next step may be to investigate success rates by gender to assess how many women are applying, and what proportion of the initial request for funding is actually allocated.

There have been suggestions that women are systematically less ambitious in the amounts of funding requested in their grant applications when compared with men who are equivalently ranked academically, and that relatively simple mentoring programmes could at least partially overcomes this anomaly.[3] However, there is no evidence supporting these assertions. Others have suggested that systems which ensure PI anonymity during review of grant funding submissions may help reduce the presence of any subtle gender biases[17], though in practice this approach would be challenging as the experience of the PI is a key factor when considering suitability of request for research support. However, evidence on effective interventions to address barriers for women scientists are lacking.[16] Women of child-bearing age are being disadvantaged in some areas of employment, even though in relation to scientific endeavour, productivity as measured by published outputs is not significantly different between women with and without children.[15]

Study limitations

Our analysis has several limitations. We rely on the accuracy of the original data from the funding organisations and as described elsewhere we have excluded data from the private sector as the publicly available data are incomplete.[14]

In the period analysed, we were not able to find data on the number of men and women PIs requesting financial support for research agencies from the funding sources studies. Hence, we were unable to assess the success and failure rates by gender. We also did not have complete data on the amount of funding initially requested, the gender of co-applicants for each study, the total pool of researchers in each disease area and within each type of science, or the proportion of awards made to clinical and non-clinical researchers, all of which would be useful pieces of information in developing a clearer picture of the reasons for the presented differences. The proportion of doctors registered in the UK favours men (56.8% as of January 2013) over women,[18] but the proportion of those carrying out research appears to be unknown. Understanding the distribution of researchers is critical to understanding the research landscape.

We lacked data on the academic ranking of principal investigators and were hence unable to adjust for levels of seniority across both genders. We were unable to get data on gender from the Gates Foundation and DFID and hence were unable to clarify the gender of a small proportion of investigators, though we believe this limitation is not likely to change the conclusions of the study. Our analysis focuses on infectious disease research, and analysis of other areas of scientific research would be needed if these disparities persisted for all research areas.

Conclusions

Notwithstanding limitations, our systematic analysis shows unequal distribution of investments in infectious disease research for men and women. There are fewer women receiving funding as principal investigators in infectious disease research, with fewer studies funded with lower funding amounts when successful.

Although earlier studies have discussed possible solutions, including mentoring programmes and advertising campaigns, none have systematically explored the reasons why such differences persist. Hence, without an understanding of the reasons for the observed disparities, the proposed solutions are not very meaningful. There is no evidence that women and men researchers are not equally able, hence, other factors are likely to be at play to explain the observed disparities which have persisted over the 14-year study period. Research is needed to elucidate an understanding of the factors that can explain the observed disparities. We strongly urge policy makers, funders and scientists to urgently investigate the factors leading to the observed disparities and develop policies developed to address them, in order to ensure that women are appropriately supported in scientific endeavour.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Author contribution

MGH designed the study with input from RA and JF and collated the dataset. JRF, FW and MKC checked and refined the dataset. JRF undertook data analysis and created the graphs and figures with input from MGH and RA. MGH, JRF, and RA interpreted the data and wrote the first draft. MGH, JRF, and RA refined the analysis and paper with input from MKC and FBW. All authors reviewed and approved the final version. MH is guarantor of the paper.

Competing interests

RA has received research funding from the UK Medical Research Council, the UK National Institute for Health Research, UK CRC, UK EPSCRC, the UK Department for International Development and the UK Department of Health. RA is a member of the UL Medical

Research Council Global Health Group. MGH works for the Infectious Disease Research Network, which has supported this work and is funded by the UK Department of Health. JRF has received funds from the Wellcome Trust and is a steering group member for the Infectious Disease Research Network. MKC has received funding from the Medical Research Council and the Bill & Melinda Gates Foundation. FBW has received funds from UCLH Charitable Foundation.

Acknowledgements

We thank Jennifer Harris and Raidah Haider for their input and assistance, and acknowledge the assistance of the research and development funding agencies for provision of data.

Data-sharing statement

All gender data is available with this submission. Further data relating to the Research Investments project can be found at www.researchinvestments.org or by contacting the corresponding author.

References

1 More women in senior positions. Key to economic stability and growth. European Commission, Luxembourg: 2010.

2 Blake M, La Valle I. Who applies for research funding? Key factors shaping funding application behaviour among women and men in British higher education institutions. London: 2000.

3 Bedi G, Van Dam NT, Munafo M. Gender inequality in awarded research grants. *Lancet* 2012;**380**:474.

4 Fitzpatrick S. A Survey of Staffing Levels of Medical Clinical Academics in UK Medical Schools as at 31 July 2011. London: 2012. http://www.medschools.ac.uk/Publications/Documents/MSC_Clinical_Academic_Staff_Survey_310711.pdf (date accessed 22 August 2013)

5 Burrelli J. Thirty-Three Years of Women in S&E Faculty Positions - US National Science Foundation. Arlington: 2008. http://www.nsf.gov/statistics/infbrief/nsf08308/ (date accessed 22 August 2013)

6 Lincoln AE, Pincus SH, Leboy PS. Scholars' awards go mainly to men. *Nature* 2011;**469**:472.

7 Pohlhaus JR, Jiang H, Sutton J. Sex differences in career development awardees' subsequent grant attainment. *Annals of internal medicine* 2010;**152**:616–7; author reply 617.

8 Medical Research Council. MRC Gender Equality Scheme. 2007.http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC003655 (date accessed 22 August 2013).

9 European Commission. About this site- Science: It's a girl thing! 2012. http://science-girl-thing.eu/en/about-this-site (date accessed 22 August 2013)

10 Gill M. "Science, it's a girl thing!" says EU Commission, holding lipstick and bunsen burner. New Statesman. 2012. http://www.newstatesman.com/blogs/martha-gill/2012/06/science-its-girl-thing-says-eu-commission-holding-lipstick-and-bunsen-burn (date accessed 22 August 2013).

11 Swain F. Science: It's a girl thing. Excuse me while I die inside. – SciencePunk. ScienceBlogs. 2012. http://scienceblogs.com/sciencepunk/2012/06/22/science-its-a-girl-thing-excuse-me-while-i-die-inside/ (date accessed 22 August 2013)

12 Yong E. Edit-a-thon gets women scientists into Wikipedia. Nature. 2012. http://www.nature.com/news/edit-a-thon-gets-women-scientists-into-wikipedia-1.11636 (date accessed 22 August 2013)

13 Donald A. Throw off the cloak of invisibility. *Nature* 2012;**490**:447.http://www.nature.com/news/throw-off-the-cloak-of-invisibility-1.11638 (date accessed 22 August 2013).

14 Head MG, Fitchett JR, Cooke MK, *et al.* UK investments in global infectious disease research 1997-2010: a case study. *The Lancet infectious diseases* Published Online First: 7 November 2012.

15 Fox MF. Gender, Family Characteristics, and Publication Productivity among Scientists. *Social Studies of Science* 2005;**35**:131–50.

16 Ceci SJ, Williams WM. Understanding current causes of women's underrepresentation in science. *Proceedings of the National Academy of Sciences of the United States of America* 2011;**108**:3157–62.

17 Moss-Racusin CA, Dovidio JF, Brescoll VL, *et al.* Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences of the United States of America* 2012;**109**:16474–9.

18 List of Registered Medical Practitioners - statistics. General Medical Council. http://www.gmc-uk.org/doctors/register/search_stats.asp (date accessed 22 August 2013).

~~Inequalities~~ Disparities in research funding for women scientists: systematic analysis of UK investments in global infectious disease research 1997–2010

Michael G Head[a*], Joseph R Fitchett[b], Mary K Cooke[a], Fatima B Wurie[a], Rifat Atun[c*]

a University College London, Research Department of Infection and Population Health, UCL Royal Free Campus, Rowland Hill Street, London, NW3 2PF

b London School of Hygiene & Tropical Medicine, Keppel Street, London, WC1E 7HT

c Imperial College London, South Kensington Campus, London SW7 2AZ and Harvard School of Public Health, Harvard University, Boston, USA~~Imperial College Business School and the Faculty of Medicine, Imperial College London, South Kensington Campus, London SW7 2AZ~~

*Corresponding Author

Number of Words: **3 758**

Keywords – gender, funding, research, women, ~~inequality~~

Abstract

Objectives: ~~Women are under-represented in biomedical science. Funding awarded to UK institutions for all infectious disease research from 1997 to 2010 was investigated, across disease categories and along the research and development continuum.~~There has not previously been a systematic analysis exploring gender disparities in awards for ~~gender against~~ research funding ~~awards~~. ~~Using an existing dataset,~~We investigated funding awards to UK institutions for all infectious disease research from 1997 to 2010 ~~were investigated~~, across disease categories and along the research and development continuum. ~~There was no attempt to investigate bias.~~

Comment [MGH1]: I think this sentence, although a tad irregular, is worth including in the abstract. Reinforces in the mind of the reader what the paper cannot do.

Design: Systematic analysis

Methods: Data ~~was~~ were obtained from several sources for ~~infectious disease research for~~awards from the period 1997-2010 and each study assigned to - disease categories; type of science (pre-clinical, phases I~~, II or~~ - III trials, product development, implementation research);~~:~~ categories of funding organisation. Fold differences and statistical analysis were used to compare total investment, study numbers, mean grant, and median grant between men and women ~~according to disease system, specific infection and funding organisation~~.

Results**:** ~~325,922 studies were screened and~~ 6052 studies were included in the final analysis, comprising 4357 grants (72.0%) awarded to men and 1695 grants (28.0%) awarded to women, totalling £2.274 billion. Of this, men received £1.786 billion (78.5%) and women £488 million (21.5%). The median value of award was greater for men (£179 389; IQR £59146–£371 977) than women (£125 556; IQR £30 982–£261 834).

Awards were greater for male PIs across all infectious disease systems, excepting neurological infections and sexually transmitted infections. The proportion of total funding awarded to women ranged from 14.3% in 1998 to 26.8% in 2009 (mean 21.4%),~~;~~ and was

lowest for pre-clinical research at 18.2% (£285.5 million of £1.573 billion) and highest for operational research at 30·9% (£151.4 million of £489.7 million).

Conclusions: There are ~~clear and~~ consistent disparities in funding received by men and women principal investigators; ~~. W~~women have fewer funded studies and receive less funding in absolute and in relative terms; ~~. T~~the median funding awarded ~~are lower for~~to women is lower across most infectious disease areas, by funder, and type of science ~~funded along the R&D pipeline~~. These disparities remain broadly unchanged over the 14-year study period.

Article summary

Article focus

- ~~Our aim was to~~We ~~investigate~~ explore the distribution of funding across infectious disease research by the gender of principal investigator ~~, and~~ to identify any disparities in funding received by men and women~~between genders~~ researchers in the UK.

Key messages

- In There are ~~clear and~~ consistent disparities in funding received by men and women principal investigators in infectious disease research (PIs) funded in the UK.~~-~~
- Total funding and the median award across most disease areas and type of science is typically greater in male PIs than female PIs
- ~~Worryingly, these~~These disparities remain consistent over the time period of ~~our~~ analysis (1997-2010)

Strengths and limitations of this study

- This is the first study to present detailed data and rigorously quantify ~~on these~~ funding disparities between men and women researchers in infectious disease research ~~to such a great level of~~ in the UK~~detail and quantifying the results with statistical analysis adds rigour~~.
- Our results provides new and additional evidence on disparities on funding for men and women researchers highlighted in earlier studies and~~add further evidence to previous work highlighting inequalities differences around gender, and can be used to enhance~~ provides a case for ~~the~~ new research explain the source of these disparities, especially given government commitments ~~debate on furthering the numbers and~~to increase the number of ~~career paths of~~ women in science
- ~~Weaknesses include being~~We were unable to assess the success and failure rates by gender and thus ~~we~~ cannot comment on ~~true~~the extent of inequalities or bias. ~~;~~As~~and~~ we ~~also lacked~~could not access data on the academic ranking of principal investigators, we ~~and~~ were hence unable to adjust for levels of seniority across both genders.

Introduction

Women are under-represented in biomedical science, , with a limited number of studies suggesting inequalities and discriminatory practices in the United Kingdom (UK), United States of America (US) and the European Union (EU) as a whole.

Yyet, few studies have systematically explored the extent and reasons for of the observed these inequalities disparities between men and women scientistsin relation to women in science. Women make upcomprise 50% of the EU student population and 45% of doctoral students, but only one third of career researchers are women – a figure that is lower for senior positions.[1]

In 1997 an analysis of the Swedish Medical Research Council suggested that peer-reviewers could not judge scientific merit independent of gender and noted the clear discrimination against women researchers.[2]

A number of UK studies have raised concerns on the position of women in biomedical science. In 2001, a Wellcome Trust survey, concluded that although women were as successful as men in securing funding for biomedical research, they were less likely to apply for grant funds because of their status in scientific institutions and the level of support they received.[2] An analysis of Wellcome Trust awards in 2000-08 revealed a significant gender difference in the amount of funding awarded, even after adjusting for the seniority of the principal investigator, with conclusionconcluding "the most likely explanation for the difference in amounts awarded to women and men is that women are systematically less ambitious in the amounts of funding requested in their grant applications."[3] Although, iIn 2011, around 44% of academics in UK universities were women, yet only 39% of senior lecturers and 19% of professors were women.[4] Furthermore, Formatted: Tab stops: 2.72", Left

~~A~~a number of studies from the US have shown that women in science are disadvantaged compared to men.[5–7] ~~In 2012, a study which asked faculty from research-intensive US universities to rate equally qualified man and woman applicant for a laboratory manager, found that the male applicant was rated significantly more competent and employable by both male and female faculty.~~[9]

The low numbers of women in science and the reasons for this anomaly is a concern for scientists and policy makers. Although the UK Medical Research Council (MRC) has a gender equality scheme, which briefly states gender equality is reflected in agreements with research organisations receiving MRC funding, it is not clear how ~~this~~ the scheme is implemented.[8]

While ~~a number of~~several initiatives have aimed to increase the numbers of women involved in science, there are no affirmative actions or binding policies in the UK or Europe to definitively ensure women are better represented in science. Indeed, some initiatives aimed at increasing women in science have been criticised. For example, in 2012, the European Commission campaign targeting 13-18 year-old secondary school students[9] was ~~widely criticised~~ rebuked and described as an insult to women in science~~.~~[10],[11], with ~~The~~ the offending video clip ~~was~~ removed from the EU campaign website. The effects of campaigns ~~attempting~~ aimed at ~~to~~ rais~~e~~ing the profile of women in science[12,13] have not been assessed.

We have~~previously~~ previously undertaken a ~~carried out an analysis tracking investments in infectious disease research whereby we have~~ systematic~~ally analysed~~ analysis of research funding awarded to UK institutions for all infectious disease research, for the 14-year period from 1997 to 2010.[14] In this studyHere, we use information from this the dataset gathered for this earlier study andto examine with trends over time the distribution of funding awarded to men and women principal investigators (PIs) across specific infections, in investigation funder categories, and along the research and development (R&D) continuum, extending from pre-clinical to clinical and operational research.

Methods

We obtained data from several sources for infectious disease research studies where funding was awarded between 1997 and 2010. The methods for the original study are elaborated in detail elsewhere,[14] and in summaryised here. We - Wwe identified 325,922 studies for screening that covered all areas of disease from several funders, and filtered these according to our primary interest ofto identify funding for being related to infectious diseases where the lead institution was in the UK in the period, and plus the year of award (1997-2010. We obtained data from publicly available sources and directly from the funders.) and the lead institution being in the UK. We assigned each study to primary disease categories. We briefly outline the methodology for the categorisation of disease areas and classification of the funding sources, elaborated in detail elsewhere.[16]. No open accessWe did not include private sector funding was included in the original analysis, as this data was clearly under-representative of the pharmaceutical sector data were not publicly availableas a whole. Figure 1 shows the sources of data (the databases searched and where funders provided us with information directly) and the numbers of studies included and excluded at each stage of screening to reach the final set of studies for detailed analysis.

Figure 1. Methodology flow chart for filtering studies firstly by infectious disease and then by gender

Data collection and cleaning took place alongside routine duties between 2006 and 2011, primarily by MGH and assisted by JRF, MKC and FBW. Funding records could feasibly be obtained going back to 1997, hence the decision to cover awards during 1997-2010. We assigned each study to primary disease categories, and W within each category, we documented topic-specific subsections, including specific pathogen or disease. We allocated studies to one of four categories along the R&D continuum: pre-clinical; phases I, II or III; product development; and operational research, and to one of the 26 categories for funding organisations.

Where the PI was named, we assigned them to men or women categories. The studies where only an initial was available for the forename were assigned as "unclear" if we were unable to establish the PIs gender from a review of the literature, institutional websites or and publicly available publications and documents.

Reference to sexually transmitted infections excludes HIV. Neglected tropical diseases were categorised according to classification used by the World Health Organization (WHO) (http://www.who.int/neglected_diseases/diseases/en). Antimicrobial resistance includes antibacterial, antiviral, antifungal and antiparasitic studies. No private sector funding was included in this analysis due to limited publicly available data.

We converted grants awarded in a currency other than pounds sterling to UK pounds using the mean exchange rate in the year of the award. We adjusted grant funding amounts for inflation and reported in 2010 UK pounds.

We As well as excludinged studies not immediately relevant to infection, we further exclusions in the original study includedexcluded unfunded studies, veterinary infectious disease research studies (unless there was a zoonotic component), those exploring the use of viral vectors to investigate non-communicable diseases, grants for symposia or meetings, or studies with UK contributions (e.g. as a collaborator), but the funding was awarded to a non-UK institution. Unfunded studies were excluded.

We used Microsoft Excel versions 2000 and 2007 to categorise studies. Where needed, data were exported into Microsoft Access (versions 2000 and 2007) and specific keyword queries used to select precise sections of the data for analysis. We used Stata (version 11·0) for statistical analysis and to generate figures.

We used fold differences to compare total investment, number of studies, mean grant, and median grant between men and women according to disease system, specific infection and funding organisation.

We used nonparametric Mann-Whitney rank-sum test to assess the distribution of funding by gender. Nonparametric K-sample test on equality of medians was applied to compare the median funding by gender, and reported as a chi-squared statistic without Yates' correction for continuity. Nonparametric Wilcoxon signed-rank test was applied when comparing matched data, such as time trends by gender. The significance for all tests was defined at the 5% level (two-sided P=0·05).

We present disparities between gender and do not attempt to investigate or imply bias or inequalities as we could not access data on unsuccessful grant applications.

Results

We identified 6165 studies from the 325,922 studies screened that were suitable for inclusion in our analysis. Of these, we were unable to ascertain the gender of principal investigator for 30 studies (0.5%). We excluded 83 studies (1.3%) that did not specify the PIs name or gender – these were funded by the Bill and Melinda Gates Foundation (Gates Foundation) (38 studies; 0.6%) and the UK Department for International Development (DFID) (22 studies; 0.4%), accounting for £321.2 million (12.3% of the total) ~~that did not specify the PIs name or gender~~. We included 6052 studies in the final analysis, comprising 4357 grants (72.0%) awarded to men and 1695 grants (28.0%) awarded to women, totalling £2.274 billion, of which ~~. Of this,~~ £1.786 billion (78.5%) were awarded to men and £488 million (21.5%) awarded to women.

The median value of grant funding was greater for men (£179 389; IQR £59146–£371 977) than for women (£125 556; IQR £30 982–£261 834). Similarly, mean value of the grant funding was greater for men (£409 910; SD £840 087) than for women (£288 011; SD £704 474). Figure 2 shows the distribution of the total investments and median funding awarded to PIs by gender over time.

Figure 2a. Total investment over time awarded to male and female principal investigators

Figure 2b Median investment over time awarded to male and female principal investigators

Infectious disease system

Table 1A (web appendix 1) shows the total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to 9 disease systems and by gender of PI. We identified no infectious disease system where women led the majority of research efforts or were awarded the majority of funding. Median funding awards were greater for male PIs across all infectious disease systems, with the exception of neurological infections and sexually transmitted infections.

Greatest levels of funding awarded to men and to women were for research into respiratory infections and HIV. Men received a total of £312.1 million for research into respiratory infections compared with £84.4 million for women, a 3.70 fold difference, and a total of £290.8 million for HIV research compared with £79.7 million for women, a 3.65 fold difference.

The largest difference between total funding for men and for women ~~were~~ was with gastrointestinal infections (5.65 fold difference) where women received only 15.0% of the total investment (£37.0 million) and spearheaded 18.9% (149) of the studies and neurological infections (4.22 fold difference). Smallest difference between total funding for men and for women ~~were~~ was ~~with~~ in research into sexually transmitted infections (1.90 fold difference), where women received 35.0% (£45.4 million) of the total funding and ~~spearheaded~~ led 49.0% (182) of the studies.

Mean funding for grants ~~were~~ was significantly greater for men (£409 910; SD £840 087) than for women (£288 011; SD £704 474). The differences in median funding were statistically significant ($P > 0.01$) for gastrointestinal infections (men £328 021; SD £458 720) (women £248 615; SD £433 176), for haematological infections (men £417 889; SD £914 626) (women £306 126; SD £819 910), and for HIV (men £649 216; SD £1 550 920) (women £278 505; SD £545 657).

Median funding for grants showed a similar pattern, with significantly greater grant funding for men (£179 389; IQR £59 146–£371 977) than women (£125 556; IQR £30 983–£261 835). Differences in median funding were statistically significant (*P* > 0.05) for gastrointestinal infections (men £208 369; IQR £78 852–357 771) (women £155 066; IQR £43 637–£305 928), for hepatic infections (men £118 638; IQR £41 342–£269 629) (women £68 620; IQR £26 720–£221 952), and for HIV (men £163 462; IQR £39 153–£511 800) (women £114 272; IQR £29 880–£305 339).

Specific Infections

Table 1B (web appendix 1) shows total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to specific infection by gender.

Men received significantly higher levels of total research funding, spearheaded greater numbers of studies, and were awarded greater median and mean funding for grants for malaria (*P = 0.01*), HIV (*P = 0.01*) and influenza (*P = 0.04*).

Major differences between total funding for men and for women were ~~with~~ observed for research into candida (47.75 fold difference), rotavirus (33.65 fold difference), campylobacter (24.33 fold difference) and norovirus (23.33 fold difference). Smallest differences between total funding for men and women were for research into dengue (1.07 fold difference) and leishmaniasis (1.55 fold difference). Women received greater total funding than men for research into leprosy (0.09 fold difference), diphtheria (0.18 fold difference), chlamydia (0.36 fold difference), syphilis (0.37 fold difference), and varicella zoster (0.54 fold difference).

Differences in mean grant funding was were statistically significant ($P > 0.05$) for malaria research (men £590 422; SD £1 324 909) (women £318 054; SD £726 872), for influenza (men £616 643; SD £881 493) (women £387 186; SD £489 997), for respiratory syncytial virus (men £485 283; SD £539 396) (women £187 931; SD £268 412), and for HIV (men £649 216; SD £1 550 920) (women £278 505; SD £545 657).

Differences in median grant funding were statistically significant ($P > 0.05$) for malaria research (men £209 646; IQR £63 826–£529 610) (women £143 358; IQR £42 754–£314 524), for hepatitis C (men £124 797; IQR £42 475–£289 293) (women £67 265; IQR £29 880–£233 467), for influenza (men £348 730; IQR £213 601–£668 561) (women £200 787; IQR £124 210–£398 191), for herpes simplex virus (men £119 295; IQR £40 009–£446 395) (women £309 610; IQR £147 885–£439 305), and for HIV (men £163 462; IQR £39 153–£511 800) (women £114 272; IQR £29 880–£305 339).

Figure 3 shows the proportion of total funding awarded to principal investigators by gender over time and a breakdown of investment by research pipeline. The proportion of the total funding awarded to women ranged from a low of 14.·3% (in 1998) to a high of 26.·8% (in 2009,), with a mean proportion of 21.·4% for the period studied. The proportion of funding was lowest for pre-clinical research at 18.·2% (£285·5 million of £1.·573 billion total) and highest for operational research at 30.·9% (£151.·4 million of £489.·7 million). The funding for clinical (Phase I, II and III) research was 29.·9% (£25.·5 of £85.·2) and for product development amounted to 20.·4% (£25.·8 million of £126·.6 million).

Figure 3a. Proportion of investment over time awarded to male and female principal investigators

Figure 3b. Total investment by research pipeline awarded to male and female principal investigators

Funding organisation

Table 2 (web appendix 2) shows in detail the total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to funding organisation and by gender.

Public funding organisations invested a total of £1.025 billion in research led by men (78.6%) and £279.8 in research led by women (21.4%). Greatest levels of funding awarded to men and to women were by the Wellcome Trust and the UK MRC. Major differences between funding awarded to men and to women PIs were by the BBSRC, with a 6.12 fold difference. Smallest differences between funding awarded to men and to women were by the UK Government funding streams such as the National Institute for Health Research, with a 1.66 fold difference. Mean grant funding from public funding organisations were significantly greater for men at £595 361 (SD £1 080 718) than for women at £448 414 (SD £814 979). Differences were also statistically significant ($P > 0.01$) for UK MRC grants with men at £751 413 (SD £1 020 748) and women at £544 427 (SD £884 442), and for UK Government grants with men at £208 828 (SD £492 519) and women at £182 907 (SD £619 889).

Median grant funding from public funding organisations had a similar pattern with significantly greater grant funding for men at £272 452 (IQR £138 322–£572 529) and women at £213 718 (IQR £92 880–£402 917). Differences were also statistically significant ($P > 0.05$) for UK MRC grants with men at £404 615 (IQR £ 210 068–£811 860) and women at £286 679 (£178 182–£468 998), and for UK Government grants with men at £129 660 (IQR £23 761–£207 320) and women at £59 976 (IQR £12 564–£157 053).

Philanthropic funding organisations invested a total of £691.7 million in research led by men (78.8%) and £185.9 million in research led by women (21.2%).

Mean grant funding from philanthropic funding organisations were significantly greater for men at £338 396 (SD £695 025) than for women at £242 014 (SD £711 420). Differences were also statistically significant (*P* > 0.01) for Wellcome Trust grants with men receiving £393 652 (SD £723 549) and women £230 168 (SD £362 836), and for other charitable funding organisations with men receiving £211 190 (SD £454 108) and women £271 842 (SD £1 208 852).

Median grants from philanthropic funding organisations showed a similar pattern with significantly greater grant funding for men at £153 653 (IQR £58 589 – £302 774) and women at £114 173 (IQR £42 658 – £222 842). Differences were also statistically significant (*P* > 0.05) for Wellcome Trust grants with men receiving £191 461 (IQR £74 759 – £362 424) and women £137 241 (IQR £54 019 – £250 723), and for other charitable funding organisations with men receiving £91 991 (IQR £36 429 – £172 497) and women £76 058 (IQR £17 279 – £150 727).

Figure 4 shows the association between funding organisation and total investment and median funding by gender. The MRC awarded the highest median amount in grants to women (£286 679; IQR £178 182–£468 998), but the median funding amount in grants for men were 1.41 fold higher than that awarded to women (£404 615; IQR £210 068–£811 860). European Commission awarded the highest mean grants to women at £923 364 (SD

£1 316 016) however mean funding amount in grants for men were 1.44 fold higher at £1325 149 (SD £2 409 860) than that for women.

Figure 4a. Association between funding organisation and total investment by gender

Figure 4b. Association between funding organisation and median award by gender

Time trend

Table 3 (web appendix 3) shows in detail the trends in funding over time from 1997 to 2010 by gender of principal investigators, with amounts and relative proportions each year of funding. Mean annual funding received was greater by men at £127.6 million (SD £48.7 million) than women at £34.9 million (SD £13.4 million). Proportions of annual funding received by men ranged from 73.2% to 85.7%, with a mean of 78.6%.

Proportions of annual funding received by women ranged from 14.3% to 26.8% with a mean of 21.4%. The largest annual funding received by men was £245.7 million in 2000, and the smallest at £64.2 million in 1997. The largest annual funding received by women was £59.6 million in 2002, with the smallest at £13.1 million in 1998.

Over the 14-year study period, the proportion of investment awarded to women each year remains relatively unchanged with a mean of 21.4% of total (range 14.3%–26.8%; £13.1 million to £59.6 million). Figure 5 shows the funding trends over time and fold differences in total investments by gender. Absolute difference in the funding amounts in the grants awarded to men and women ranges between £47.9 million and £190.1 million, with a mean difference of £92.7 million (SD £38.3 million). Fold difference in grant funding for men and women ranged from 2.74 to 5.97, with a mean fold difference of 3.66.

Figure 5a. Total investment and trend over time, by gender

Figure 5b. Fold difference of investment over time, by gender

Discussion

We present the first, detailed and systematic analysis by gender of the investments in infectious disease research in the UK by gender for the 14-year period 1997-2010. We identified 6165 studies funded by public and philanthropic funding organisations, with total research investment of £2.·6 billion.

We quantify quantified the differences in research funding awarded by gender, to show these to be substantial. The analysis shows clear and consistent disparities between men and women principal investigators, with lower funding in terms of the total investment, the number of funded studies, the median funding awarded and the mean funding awarded across most of the infectious disease areas funded. The analysis reveals consistent disparities, withW women receiving received less funding in absolute amounts and in relative terms, by funder and the type of science funded along the R&D pipeline. Analysis of the funding trends by year reveals that theThese disparities in funding between men and women persist over time.

We show large disparities in median funding amounts for men and women researchers in investments by the European Commission and the MRC. Such differences were much less apparent when comparing funding from the Department of Health and BBSRC, although the BBSRC awarded 86% of funding to men. The BBSRC almost entirely funds pre-clinical research,[14] and this matches the increased proportions of pre-clinical studies being led by male principal investigators.

Our findings in infectious disease research, the most detailed to date, provide new evidence to show that there areon disparities between men and women reserachers in leading studies in infectious disease research, to reinforce.science working in the area of infectious disease research are clearly disadvantaged. Our findings confirm the concerns raised in the publishedin earlier studies literature on the subject.[4,15,16][4,9,15,17] Disparities that are more marked at senior levels of academia need to be investigated to explain and account for the observed differences.

Field Code Changed

The precise reasons why the median awards across most infectious disease conditions should be significantly less for women principal investigators cannot be deduced from the available data. The next step may be to investigate success rates by gender to assess how many women are applying, and what proportion of the initial request for funding is actually allocated.

Some studies have suggestedThere have been suggestions that women were are systematically less ambitious in the amounts of funding requested in their grant applications when compared with men who are equivalently ranked academically, and that relatively simple mentoring programmes could at least partially overcomes this anomaly.[3] However, there is no evidence supporting these assertions. Others have suggested that systems which ensure PI anonymity during review of grant funding submissions may help reduce the presence of any subtle gender biases[17], though in practice this approach would be challenging as the experience of the PI is a key factor when considering suitability of request for research support. However, evidence on effective interventions to address barriers for women scientists are lacking.[16] Women of child-bearing age are being disadvantaged in some areas of employment, even though in relation to scientific endeavour, productivity as measured by published outputs is not significantly different between women with and without children.[15]

Study limitations

Our analysis has several limitations. We rely on the accuracy of the original data from the funding organisations and as described elsewhere we have excluded data from ~~industry~~ the private sector as the publicly available data are incomplete.[14]

In the period analysed, we were not able to find data on the number of men and women PIs requesting financial support for research agencies from the funding sources studies. Hence, we were unable to assess the success and failure rates by gender. We also did not have complete data on the amount of funding initially requested, the gender of co-applicants for each study, the total pool of researchers in each disease area and within each type of science, or ~~on~~ the proportion of awards made to clinical and non-clinical researchers, all of which would be useful pieces of information in ~~building up~~developing a clearer picture of the reasons for the presented differences. The proportion of doctors registered in the UK favours men (56.8% as of January 2013) over women,[18] but the proportion of those carrying out research appears to be unknown. Understanding the distribution of researchers is critical to understanding the research landscape.

We lacked data on the academic ranking of principal investigators and were hence unable to adjust for levels of seniority across both genders. We were unable to get data on gender from the Gates Foundation and DFID and hence were unable to clarify the gender of a small proportion of investigators, though we believe ~~these~~ this limitation~~s~~ ~~are~~is not likely to change the conclusions of the study. Our analysis focuses ~~solely~~ on infectious disease research, and ~~similarly~~analysis of ~~exploring~~ other areas of scientific research would ~~be interesting to see~~be needed if these disparities persisted for all research areas.~~.~~

Conclusions

Notwithstanding ~~these~~ limitations, our ~~study provides a~~ systematic analysis shows ~~of the~~ unequal distribution of investments in infectious disease research ~~by gender. We demonstrate that in the UK there are clear and unacceptable disparities in the number of~~for men and women. There are fewer women receiving funding ~~at the~~as ~~level of~~ principal investigators in infectious disease research, with fewer studies funded with lower funding amounts when successful.

Although earlier studies have discussed possible solutions, including mentoring programmes and advertising campaigns, none have systematically explored the reasons why such ~~inequalities~~ differences persist. Hence, without an understanding of the reasons for the observed ~~inequalities~~disparities, the proposed solutions are not very meaningful. ~~. Research is needed to elucidate an understanding of the factors that can explain the observed disparities.~~

There is no evidence that women and men researchers are not equally able, hence, other factors are likely to be at play to explain the observed ~~unacceptable~~ disparities ~~in research funding between men and women,~~ which have persisted over the 14-year study period. Research is needed to elucidate an understanding of the factors that can explain the observed disparities. We strongly urge policy makers, funders and scientists to urgently investigate the factors leading to the observed disparities and develop policies developed to address them, in order to ensure that~~, as in all walks of life,~~ women are appropriately supported ~~and equally valued~~ in scientific endeavour.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Author contribution

MGH designed the study with input from RA and JF and collated the dataset. JRF, FW and MKC checked and refined the dataset. JRF undertook data analysis and created the graphs and figures with input from MGH and RA. MGH, JRF, and RA interpreted the data and wrote the first draft. MGH, JRF, and RA refined the analysis and paper with input from MKC and FBW. All authors reviewed and approved the final version. ~~RA~~ MH is guarantor of the paper.

Competing interests

RA has received research funding from the UK Medical Research Council, the UK National Institute for Health Research, UK CRC, UK EPSCRC, the UK Department for International Development and the UK Department of Health. RA is a member of the UL Medical Research Council Global Health Group. MGH works for the Infectious Disease Research Network, which has supported this work and is funded by the UK Department of Health. JRF has received funds from the Wellcome Trust and is a steering group member for the Infectious Disease Research Network. MKC has received funding from the Medical Research Council and the Bill & Melinda Gates Foundation. FBW has received funds from UCLH Charitable Foundation.

Acknowledgements

We thank Jennifer Harris and Raidah Haider for their input and assistance, and acknowledge the assistance of the research and development funding agencies for provision of data.

Data-sharing statement

All gender data is available with this submission. Further data relating to the Research Investments project can be found at www.researchinvestments.org or by contacting the corresponding author.

References

1 More women in senior positions. Key to economic stability and growth. European Commission, Luxembourg: 2010.

2 Blake M, La Valle I. Who applies for research funding? Key factors shaping funding application behaviour among women and men in British higher education institutions. London: 2000.

3 Bedi G, Van Dam NT, Munafo M. Gender inequality in awarded research grants. *Lancet* 2012;**380**:474.http://www.thelancet.com/journals/a/article/PIIS0140-6736(12)61292-6/fulltext (accessed 29 Nov2012).

4 Fitzpatrick S. A Survey of Staffing Levels of Medical Clinical Academics in UK Medical Schools as at 31 July 2011. London: 2012. http://www.medschools.ac.uk/Publications/Documents/MSC_Clinical_Academic_Staff_Survey_310711.pdf

5 Burrelli J. Thirty-Three Years of Women in S&E Faculty Positions - US National Science Foundation. Arlington: 2008. http://www.nsf.gov/statistics/infbrief/nsf08308/

6 Lincoln AE, Pincus SH, Leboy PS. Scholars' awards go mainly to men. *Nature* 2011;**469**:472.http://www.ncbi.nlm.nih.gov/pubmed/21270876 (accessed 25 Jan2013).

7 Pohlhaus JR, Jiang H, Sutton J. Sex differences in career development awardees' subsequent grant attainment. *Annals of internal medicine* 2010;**152**:616–7; author reply 617.http://www.ncbi.nlm.nih.gov/pubmed/20439584 (accessed 25 Jan2013).

8 Medical Research Council. MRC Gender Equality Scheme. 2007.http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC003655 (accessed 21 Dec2012).

9 European Commission. About this site- Science: It's a girl thing! 2012.http://science-girl-thing.eu/en/about-this-site (accessed 29 Nov2012).

10 Gill M. "Science, it's a girl thing!" says EU Commission, holding lipstick and bunsen burner. New Statesman. 2012.http://www.newstatesman.com/blogs/martha-gill/2012/06/science-its-girl-thing-says-eu-commission-holding-lipstick-and-bunsen-burn (accessed 29 Nov2012).

11 Swain F. Science: It's a girl thing. Excuse me while I die inside. – SciencePunk. ScienceBlogs. 2012.http://scienceblogs.com/sciencepunk/2012/06/22/science-its-a-girl-thing-excuse-me-while-i-die-inside/ (accessed 29 Nov2012).

12 Yong E. Edit-a-thon gets women scientists into Wikipedia. Nature. 2012.http://www.nature.com/news/edit-a-thon-gets-women-scientists-into-wikipedia-1.11636 (accessed 29 Nov2012).

13 Donald A. Throw off the cloak of invisibility. *Nature* 2012;**490**:447.http://www.nature.com/news/throw-off-the-cloak-of-invisibility-1.11638 (accessed 29 Nov2012).

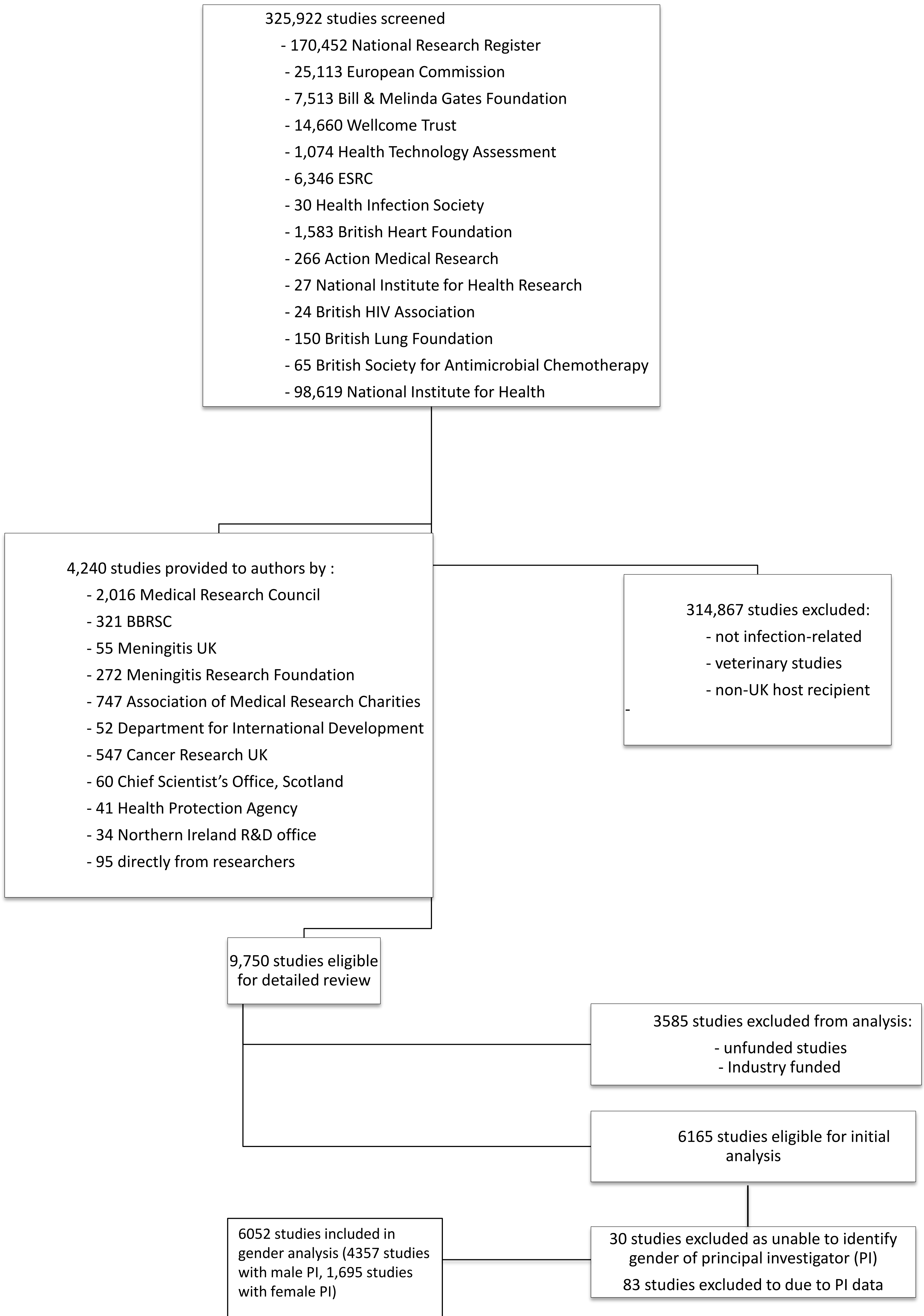
14 Head MG, Fitchett JR, Cooke MK, *et al.* UK investments in global infectious disease research 1997-2010: a case study. *The Lancet infectious diseases* Published Online First: 7 November 2012.http://www.thelancet.com/journals/a/article/PIIS1473-3099(12)70261-X/fulltext (accessed 17 Nov2012).

15 Fox MF. Gender, Family Characteristics, and Publication Productivity among Scientists. *Social Studies of Science* 2005;**35**:131–50.http://sss.sagepub.com/content/35/1/131.short (accessed 29 Nov2012).

16 Ceci SJ, Williams WM. Understanding current causes of women's underrepresentation in science. *Proceedings of the National Academy of Sciences of the United States of America* 2011;**108**:3157–62.http://www.pnas.org/content/early/2011/02/02/1014871108 (accessed 1 Nov2012).

17 Moss-Racusin CA, Dovidio JF, Brescoll VL, *et al.* Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences of the United States of America* 2012;**109**:16474–9.http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3478626&tool=pmcentrez&rendertype=abstract (accessed 25 Oct2012).

18 List of Registered Medical Practitioners - statistics. General Medical Council. http://www.gmc-uk.org/doctors/register/search_stats.asp (accessed 26 Jan2013).


325,922 studies screened
- 170,452 National Research Register
- 25,113 European Commission
- 7,513 Bill & Melinda Gates Foundation
- 14,660 Wellcome Trust
- 1,074 Health Technology Assessment
- 6,346 ESRC
- 30 Health Infection Society
- 1,583 British Heart Foundation
- 266 Action Medical Research
- 27 National Institute for Health Research
- 24 British HIV Association
- 150 British Lung Foundation
- 65 British Society for Antimicrobial Chemotherapy
- 98,619 National Institute for Health
4,240 studies provided to authors by :
- 2,016 Medical Research Council
- 321 BBRSC
- 55 Meningitis UK
- 272 Meningitis Research Foundation
- 747 Association of Medical Research Charities
- 52 Department for International Development
- 547 Cancer Research UK
- 60 Chief Scientist's Office, Scotland
- 41 Health Protection Agency
- 34 Northern Ireland R&D office
- 95 directly from researchers
314,867 studies excluded:
- not infection-related
- veterinary studies
- non-UK host recipient
9,750 studies eligible for detailed review
3585 studies excluded from analysis:
- unfunded studies
- Industry funded
6165 studies eligible for initial analysis
30 studies excluded as unable to identify gender of principal investigator (PI)
83 studies excluded to due to PI data
6052 studies included in gender analysis (4357 studies with male PI, 1,695 studies with female PI)

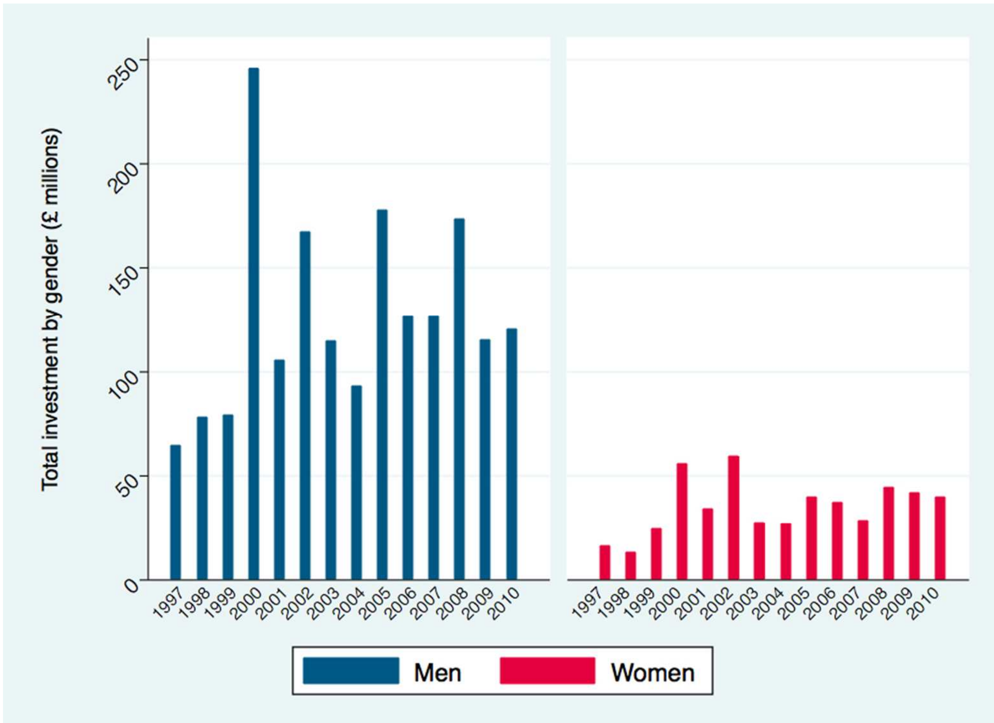


Figure 2a. Total investment over time awarded to male and female principal investigators
329x239mm (72 x 72 DPI)

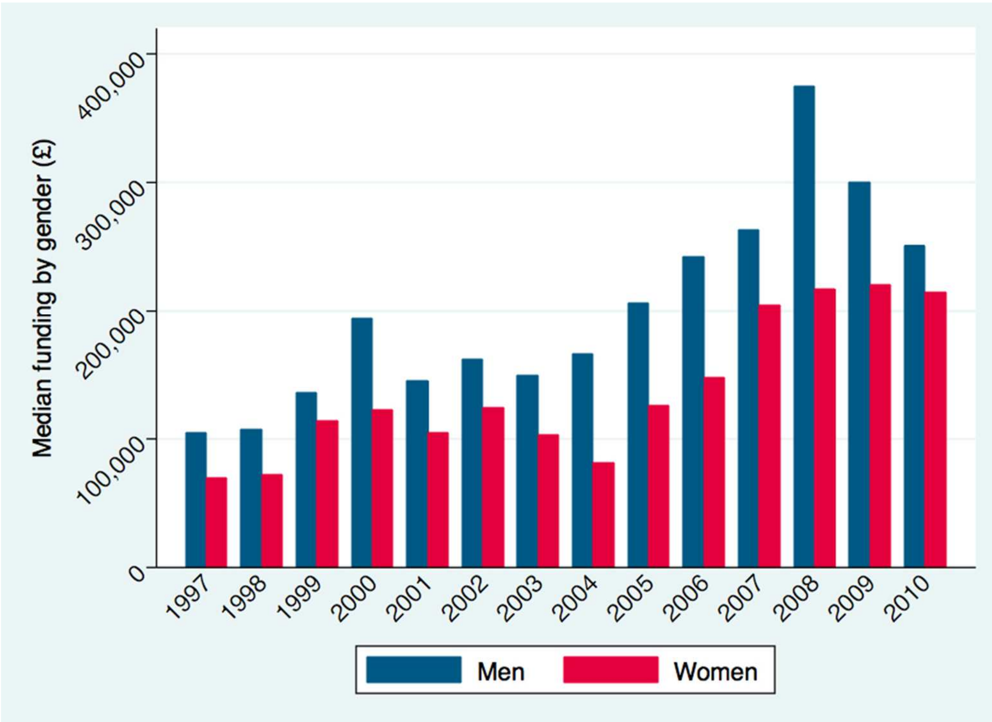


Figure 2b Median investment over time awarded to male and female principal investigators
329x239mm (72 x 72 DPI)

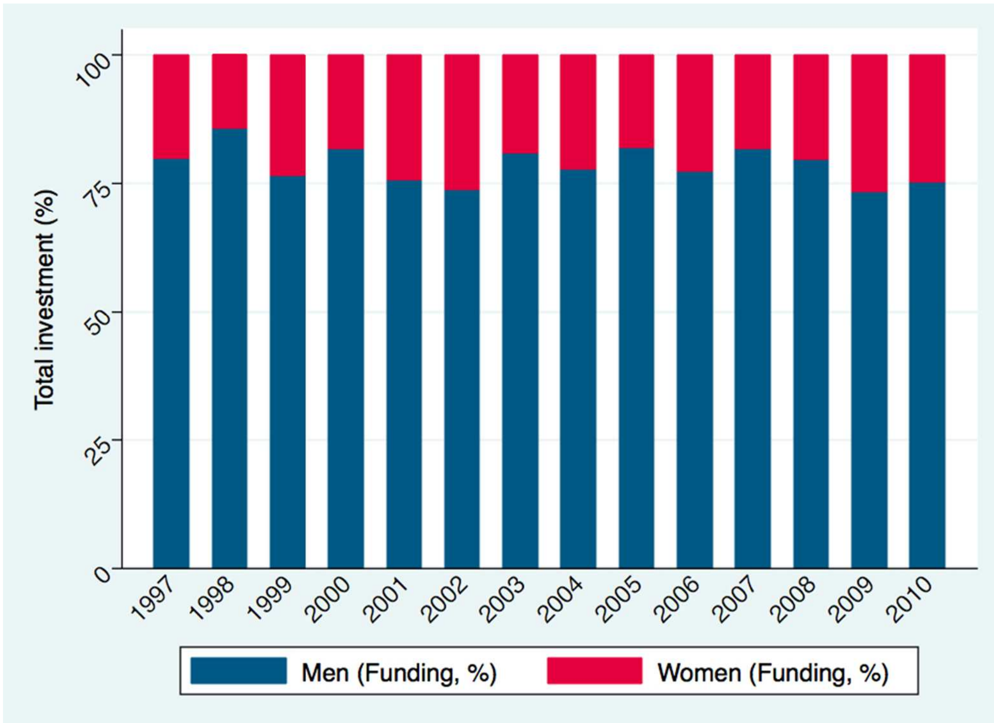
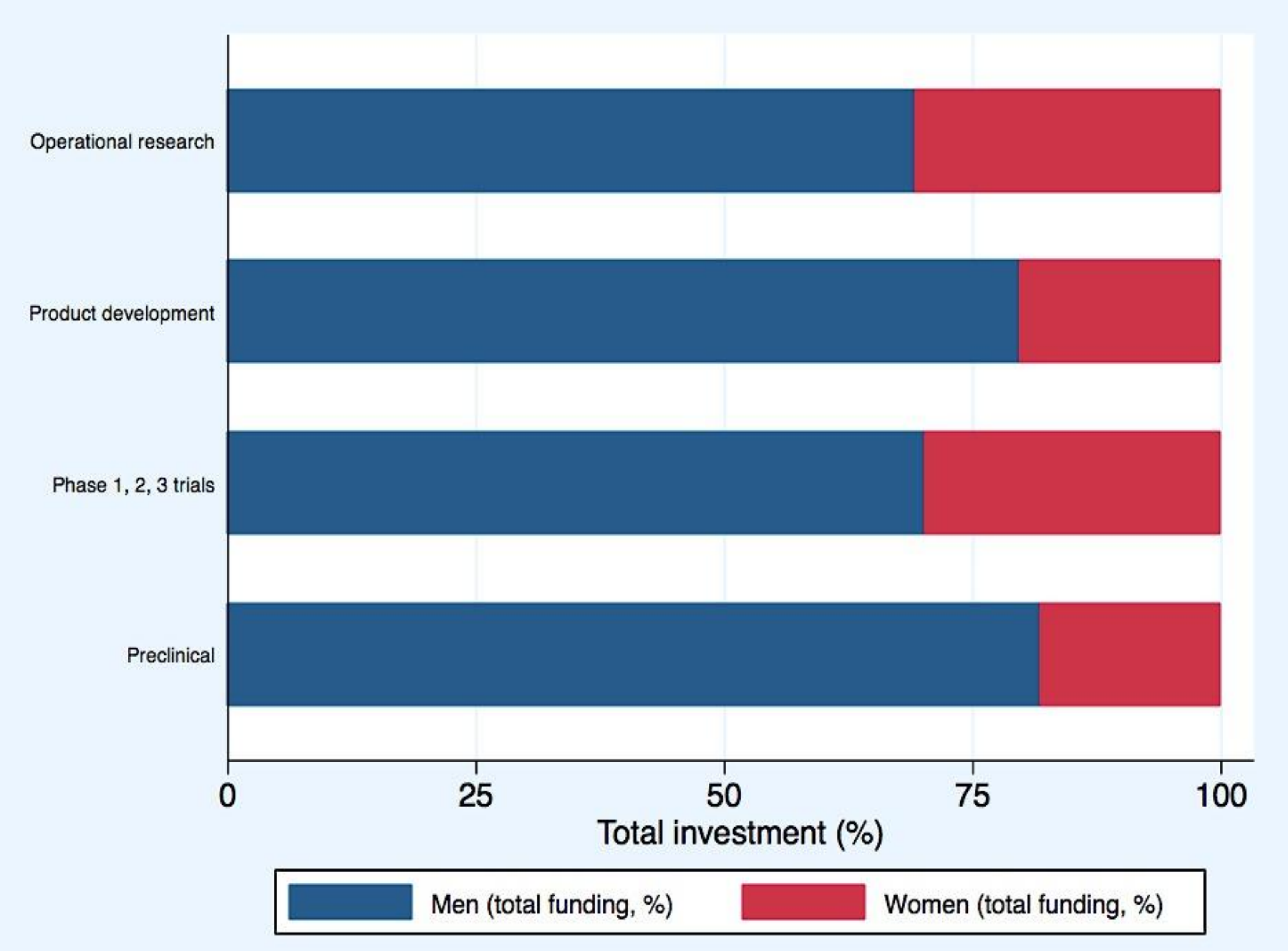
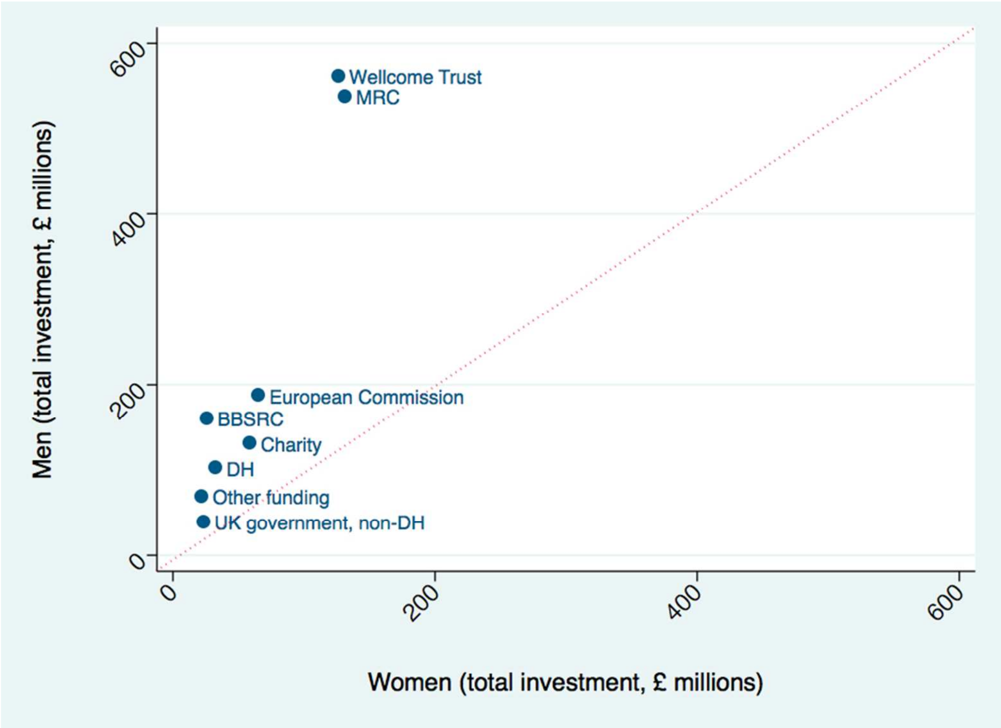
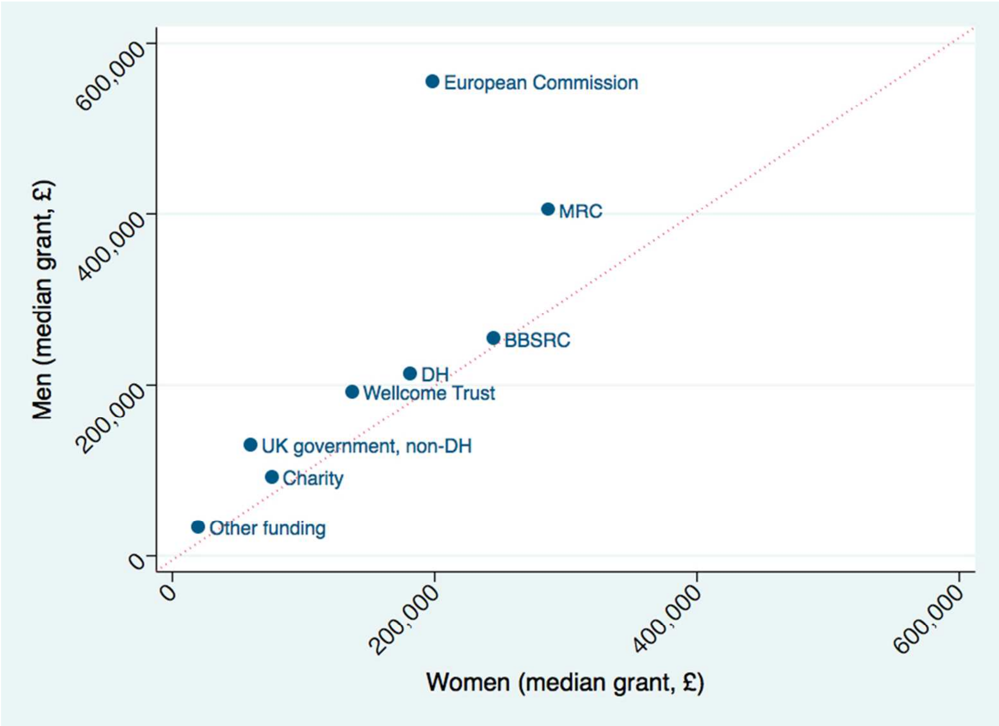


Figure 3a. Proportion of investment over time awarded to male and female principal investigators
329x239mm (72 x 72 DPI)

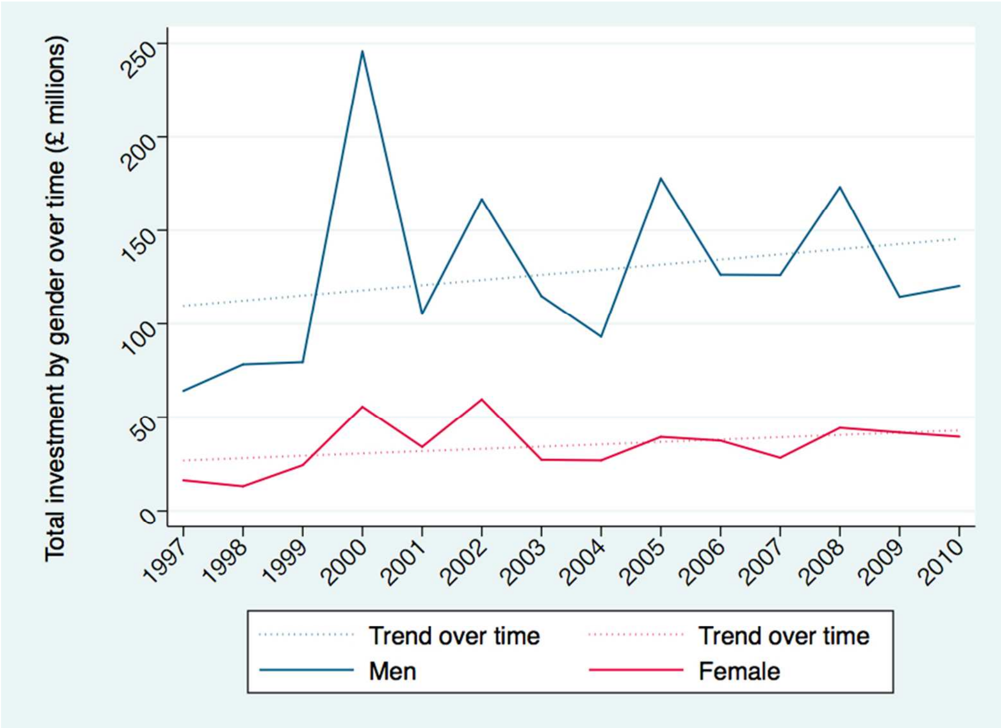

Operational research
Product development
Phase 1, 2, 3 trials
Preclinical
0
25
50
75
100
Total investment (%)
Men (total funding, %)
Women (total funding, %)



329x239mm (72 x 72 DPI)



329x239mm (72 x 72 DPI)



329x239mm (72 x 72 DPI)

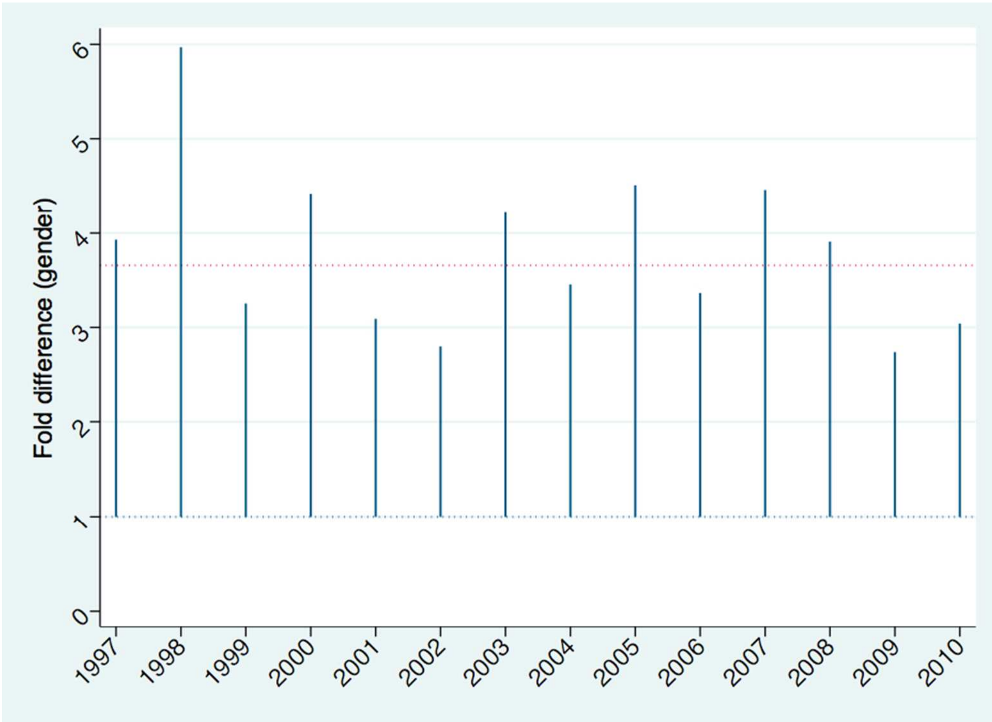


Figure 5b. Fold difference of investment over time, by gender
329x239mm (72 x 72 DPI)

Disease system	Investment (total); £ (%)	Investment (male); £ (%)	Investment (female); £	Fold differenc	Studies (total); n	Studies (male); £	Studies (female); n	Fold differenc	Mean grant (total); £	Mean grant (male); £	Mean grant (female); £	Fold differenc	*P*	Median grant (total); £ (IQR)	Median grant (male); £	Median grant (female); £	Fold differenc	Chi-square	*P*
Gastrointestinal infections	248,971,849	209,315,616	37,043,642	5.65	799	638	149	4.28	315,154	328,081	248,615	1.32	0.01	199,043	208,369	155,066	1.34	6.87	0.01
	9.6%	85.0%	15.0%		12.9%	81.1%	18.9%		457,988	458,720	433,176			721,37-351,372	78,852-357,771	43,637-305,928			
Haematological infections	413,489,870	225,660,012	56,021,079	4.03	742	540	183	2.95	557,264	417,889	306,126	1.37	0.01	157,280	160,655	121,353	1.32	3.15	0.08
	15.9%	80.1%	19.9%		12.0%	74.7%	25.3%		2,179,537	914,626	819,910			157,280-362,727	54,244-366,799	32,207- 271,883			
Hepatic infections	73,965,716	57,998,793	15,618,661	3.71	322	229	90	2.54	229,707	253,270	173,541	1.46	0.07	114,621	118,638	68,620	1.73	3.82	0.05
	2.8%	78.8%	21.2%		5.2%	71.8%	28.2%		375,988	418,392	237,165			40,076-244,293	41,342-269,629	26,270-221,952			
Neglected tropical diseases	229,606,965	118,477,812	37,747,437	3.14	392	280	105	2.67	564,145	418,439	406,270	1.03	0.28	249,458	257,736	199,648	1.29	0.82	0.36
	8.8%	75.8%	24.2%		6.4%	72.7%	27.3%		2,104,383	509,169	667,547			91,196-451,453	82,786-429,781	107,474-413,242			
Neurological infections	101,885,586	79,281,163	18,779,321	4.22	339	268	67	4.00	300,548	295,825	280,288	1.06	0.67	155,404	153,724	166,514	0.92	0.19	0.66
	3.9%	80.8%	19.2%		5.5%	80.0%	20.0%		463,870	474,995	329,198			64,434-334,128	64,702-298,666	33,886-399,971			
Ocular infections	7,407,218	5,788,089	1,619,129	3.57	36	24	12	2.00	205,756	241,170	134,927	1.79	0.92	120,849	146,169	102,901	1.42	0.00	1.00
	0.3%	78.1%	21.9%		0.6%	66.7%	33.3%		280,206	327,354	132,475			7,860-293,837	6,344-348,501	23,666-232,501			
Respiratory infections	418,838,875	312,055,217	84,436,423	3.70	1,190	897	272	3.30	351,375	347,888	310,428	1.12	0.13	158,966	165,813	142,281	1.17	1.87	0.17
	16.1%	78.7%	21.3%		19.3%	76.7%	23.3%		661,990	624,555	558,282			50,203-342,049	56,715-344,512	36,236-311,548			
Sexually-transmitted infectic	138,616,211	86,016,584	45,352,512	1.90	380	190	182	1.04	366,710	452,719	249,190	1.82	0.34	94,790	93,495	101,785	0.92	0.17	0.68
	5.3%	65.5%	34.5%		6.2%	51.1%	48.9%		958,450	1,142,638	647,494			15,332-241,505	18,389-257,444	14,480-204,559			
HIV	477,555,690	290,848,557	79,652,343	3.65	760	448	286	1.57	625,073	649,216	278,505	2.33	0.01	147,404	163,462	114,272	1.43	3.87	0.05
	18.4%	78.5%	21.5%		12.3%	61.0%	39.0%		2,276,762	1,550,920	545,657			37,195-395,644	39,153-511,800	29,880-305,339			
Overall	2,599,985,851	1,785,979,172	488,178,602	3.66	6,170	4,357	1,695	2.57	421,733	409,910	288,011	1.42	0.01	158,055	179,389	125,556	1.43	74.40	0.01
		78.53%	21.47%			71.99%	28.01%		1,315,935	840,087	704,474			49,490-352,699	59,146-371,977	30,983-261,835			

Specific infection	Investment (total); £ (%)	Investment (male); £ (%)	Investment (female); £ (%)	Fold differenc	Studies (total); n	Studies (male); £	Studies (female); n	Fold differenc	Mean grant (total); £	Mean grant (male); £	Mean grant (female); £	Fold differenc	*P*	Median grant (total); £ (IQR)	Median grant (male); £ (IQR)	Median grant (female); £	Fold differenc	Chi-square	*P*
Gastrointestinal infections																			
Campylobacter	24,116,021	23,164,038	951,983	24.33	87	80	7	11.43	277,196	289,551	135,998	2.13	0.13	221,532	228,164	49,000	4.66	1.32	0.25
	#VALUE!	96.1%	3.9%		2.2%	92.0%	8.0%		408,655	421,925	156,276			90,341-311,497	92,885-311,530	3,435-305,928			
Clostridium	29,751,310	31,657,635	2,361,459	13.41	72	58	15	3.87	453,647	524,175	157,431	3.33	0.07	204,389	218,177	80,431	2.71	2.06	0.15
	#VALUE!	93.1%	6.9%		1.8%	79.5%	20.5%		796,207	868,222	178,916			42,630-415,635	49,750-451,158	8,256-316,326			
E. coli	25,589,407	23,913,566	2,392,586	9.99	106	95	12	7.92	245,852	251,722	199,382	1.26	0.16	206,784	217,705	132,232	1.65	3.25	0.07
	#VALUE!	90.9%	9.1%		2.7%	88.8%	11.2%		209,792	212,046	192,964			117,440-329,159	132,815-331,037	84,455-262,238			
Helicobacter	15,109,554	12,488,366	2,617,778	4.77	101	78	22	3.55	149,600	160,107	118,990	1.35	0.64	83,986	87,694	83,533	1.05	0.00	1.00
	#VALUE!	82.7%	17.3%		2.6%	78.0%	22.0%		214,832	232,566	138,013			11,555-187,678	11,555-191,570	11,647-187,678			
Norovirus	5,102,250	4,892,527	209,723	23.33	12	10	2	5.00	425,188	489,253	104,861	4.67	0.28	200,621	265,972	104,861	2.54	2.40	0.12
	#VALUE!	95.9%	4.1%		0.3%	83.3%	16.7%		568,372	604,564	133,320			91,363-435,732	93,571-496,514	10,590-199,133			
Rotavirus	5,883,445	6,004,983	178,450	33.65	18	17	2	8.50	325,444	353,234	89,225	3.96	0.23	164,690	179,066	89,225	2.01	2.01	0.16
	#VALUE!	97.1%	2.9%		0.5%	89.5%	10.5%		414,279	429,739	98,723			114,718-299,988	134,988-299,988	19,417-159,033			
Salmonella	55,716,287	48,902,187	6,814,100	7.18	145	123	22	5.59	384,250	397,579	309,732	1.28	0.95	256,185	258,483	255,602	1.01	0.18	0.67
	#VALUE!	87.8%	12.2%		3.7%	84.8%	15.2%		474,060	500,122	284,742			132,107-431,762	109,210-440,900	155,066-361,873			
Shigella	3,292,442	2,270,191	1,022,251	2.22	9	6	3	2.00	365,827	378,365	340,750	1.11	1.00	211,456	214,819	211,456	1.02	0.23	0.64
	#VALUE!	69.0%	31.0%		0.2%	66.7%	33.3%		335,500	374,690	312,800			134,251-658,278	134,251-658,278	113,326-697,470			
Haematological infections																			
EBV	45,310,414	36,908,000	7,692,800	4.80	147	115	31	3.71	305,485	320,939	248,155	1.29	0.36	156,697	158,107	154,947	1.02	0.04	0.84
	#VALUE!	82.8%	17.2%		3.7%	78.8%	21.2%		430,746	459,332	301,211			49,657-364,013	65,350-364,013	12,342-364,199			
Listeria	4,751,097	3,146,834	1,731,229	1.82	10	8	3	2.67	443,460	393,354	577,076	0.68	0.41	239,595	236,570	605,470	0.39	0.75	0.39
	#VALUE!	64.5%	35.5%		0.3%	72.7%	27.3%		353,486	359,163	369,384			126,966-705,717	113,867-634,775	194,315-931,444			
Malaria	346,180,494	211,961,339	40,710,857	5.21	501	359	128	2.80	700,143	590,422	318,054	1.86	0.01	203,348	209,646	143,358	1.46	4.13	0.04
	#VALUE!	83.9%	16.1%		12.7%	73.7%	26.3%		2,283,790	1,324,909	726,872			59,122-500,817	63,826-529,610	42,754-314,524			
Hepatic infections																			
CMV	28,369,415	26,102,458	1,911,586	13.65	68	55	12	4.58	417,197	474,590	159,299	2.98	0.06	188,607	201,658	107,488	1.88	1.48	0.22
	#VALUE!	93.2%	6.8%		1.7%	82.1%	17.9%		656,508	714,181	178,655			100,221-392,186	116,516-608,024	23,605-223,834			
Hepatitis B	11,768,095	7,512,333	4,215,080	1.78	68	45	22	2.05	173,060	166,941	191,595	0.87	0.89	65,624	68,646	52,873	1.30	0.19	0.66
	#VALUE!	64.1%	35.9%		1.7%	67.2%	32.8%		287,576	294,644	284,042			19,659-209,501	19,615-202,317	19,703-221,952			
Hepatitis C	59,727,829	47,621,165	11,799,084	4.04	235	167	66	2.53	254,161	285,157	178,774	1.60	0.07	116,883	124,797	67,265	1.86	5.22	0.02
	#VALUE!	80.1%	19.9%		5.9%	71.7%	28.3%		418,722	469,807	242,710			41,342-269,629	42,475-289,293	29,880-233,467			
Neglected tropical diseases																			
African trypanosomiasis	48,082,259	34,546,175	4,478,699	7.71	116	61	13	4.69	563,175	566,331	344,515	1.64	0.54	262,145	256,771	265,009	0.97	0.09	0.76
	#VALUE!	88.5%	11.5%		2.9%	82.4%	17.6%		1,139,333	1,227,091	408,381			151,883-466,918	155,868-455,554	119,521-406,701			
Chagas disease	3,448,856	4,675,712	250,535	18.66	15	17	1	17.00	273,680	275,042	250,535	1.10	0.77	215,639	215,530	250,535	0.86	1.06	0.30
	#VALUE!	94.9%	5.1%		0.4%	94.4%	5.6%		207,903	214,219				163,472-350,741	163,472-350,741				
Dengue	43,742,101	5,251,615	4,924,187	1.07	28	13	13	1.00	1,511,059	403,970	378,784	1.07	0.32	269,824	378,745	199,648	1.90	0.15	0.70
	#VALUE!	51.6%	48.4%		0.7%	50.0%	50.0%		5,899,700	336,526	504,639			107,474-530,125	148,612-515,075	69,518-361,828			
Helminths	47,026,454	39,675,624	14,701,767	2.70	114	104	43	2.42	452,438	381,496	341,902	1.12	0.87	233,772	235,696	215,206	1.10	0.24	0.62
	#VALUE!	73.0%	27.0%		2.9%	70.7%	29.3%		1,112,173	464,792	414,897			82,786-386,182	67,614-383,928	126,942-358,645			

Leishmaniasis	36,027,609	25,384,994	16,332,809	1.55	75	50	26	1.92	536,433	507,700	628,185	0.81	0.53	289,354	320,800	229,548	1.40	2.10	0.15
	#VALUE!	60.8%	39.2%		1.9%	65.8%	34.2%		797,514	579,922	1,127,441			91,196-518,477	80,166-518,477	131,221-573,851			
Leprosy	623,080	49,229	573,851	0.09	2	1	1	1.00	311,540	49,229	573,851	0.09	0.32	311,540	49,229	573,851	0.09	2.00	0.16
	#VALUE!	7.9%	92.1%		0.1%	50.0%	50.0%		370,963					49,229-573,851					
Lymphatic filariasis	51,112,541	1,802,818	317,909	5.67	16	3	2	1.50	6,723,245	600,939	158,954	3.78	0.25	551,459	551,459	158,954	3.47	2.22	0.14
	#VALUE!	85.0%	15.0%		0.4%	60.0%	40.0%		12,112,993	426,007	127,226			201,834-12,844,013	201,834-1,049,526	68,992-248,917			
Onchocerciasis	1,338,978	1,317,029	380,594	3.46	4	2	3	0.67	339,525	658,515	126,865	5.19	0.25	35,769	658,515	21,359	30.83	0.14	0.71
	#VALUE!	77.6%	22.4%		0.1%	40.0%	60.0%		546,719	880,696	200,996			21,359-358,645	35,769-1,281,261	590-358,645			
Schistosomiasis	38,677,801	11,068,267	2,686,364	4.12	46	32	12	2.67	867,572	345,883	223,864	1.55	0.60	197,557	216,603	165,622	1.31	0.46	0.50
	#VALUE!	80.5%	19.5%		1.2%	72.7%	27.3%		3,825,582	467,692	252,854			59,912-361,947	61,878-356,186	46,460-318,519			
Trachoma	3,718,572	3,718,572	0		3	2	0		1,859,286	1,859,286				1,859,286	1,859,286				
	#VALUE!	100.0%	0.0%		0.1%	100.0%	0.0%		1,768,466	1,768,466				608,792-3,109,780	60,879-3,109,780				
Neurological infections																			
Meningitis	54,078,664	42,305,152	9,347,473	4.53	223	183	38	4.82	243,434	231,176	245,986	0.94	0.59	146,153	137,694	155,670	0.88	1.21	0.27
	#VALUE!	81.9%	18.1%		5.6%	82.8%	17.2%		355,892	332,118	297,867			66,895-228,405	66,895-222,767	33,886- 369,244			
Polio	1,189,984	729,017	11,069	65.86	4	3	1	3.00	185,021	243,006	11,069	21.95	0.18	164,849	236,812	11,069	21.40	1.33	0.25
	#VALUE!	98.5%	1.5%		0.1%	75.0%	25.0%		170,640	153,310				51,977-318,065	92,886-399,318				
Tetanus	5,108,068	5,108,068	0		5	5	0		1,021,614	1,021,614				231,879	231,879				
	#VALUE!	100.0%	0.0%		0.1%	100.0%	0.0%		1,819,723	1,819,723				200,112-395,050	200,112-395,050				
Respiratory infections																			
Diphtheria	139,863	21,624	118,239	0.18	2	1	1	1.00	69,931	21,624	118,239	0.18	0.32	69,931	21,624	118,239	0.18	2.00	0.16
	#VALUE!	15.5%	84.5%		0.1%	50.0%	50.0%		68,317					21,624-118,239					
Influenza	79,763,001	68,447,401	11,615,587	5.89	140	111	30	3.70	567,823	616,643	387,186	1.59	0.04	299,988	348,730	200,787	1.74	4.06	0.04
	#VALUE!	85.5%	14.5%		3.5%	78.7%	21.3%		818,009	881,493	489,997			159,841-656,509	213,601-668,561	124,210-398,191			
Measles	2,597,677	3,827,746	646,169	5.92	9	7	3	2.33	416,179	546,821	215,390	2.54	0.57	284,882	662,131	261,846	2.53	0.48	0.49
	#VALUE!	85.6%	14.4%		0.2%	70.0%	30.0%		403,740	481,360	122,549			67,471-683,714	58,538-893,212	76,405-307,919			
Pertussis	2,432,158	2,432,158	0		9	9	0		270,240	270,240				299,840	299,840				
	#VALUE!	100.0%	0.0%		0.2%	100.0%	0.0%		246,165	246,165				37,151-452,939	37,151-452,939				
RSV	16,899,738	14,073,205	2,818,964	4.99	45	29	15	1.93	375,550	485,283	187,931	3.96	0.05	184,292	223,517	149,828	1.49	2.53	0.11
	#VALUE!	83.3%	16.7%		1.1%	65.9%	34.1%		480,715	539,396	268,412			56,431-498,006	64,191-638,823	22,277-199,329			
Tuberculosis	148,801,691	99,451,331	37,578,889	2.65	327	225	94	2.39	472,083	442,006	399,775	1.11	0.39	190,467	190,657	170,542	1.12	0.21	0.65
	#VALUE!	72.6%	27.4%		8.3%	70.5%	29.5%		930,157	825,956	742,928			69,899-421,992	74,747- 416,236	37,034-401,346			
Sexually-transmitted infections																			
Chlamydia	21,702,378	5,753,740	15,936,845	0.36	112	43	68	0.63	193,771	133,808	234,365	0.57	0.71	50,469	52,258	52,318	1.00	0.01	0.91
	#VALUE!	26.5%	73.5%		2.8%	38.7%	61.3%		561,173	197,759	701,950			10,298-174,939	14,885-174,644	6,003-175,234			
Gonorrhoea	948,399	669,866	278,532	2.40	18	9	9	1.00	52,689	74,430	30,948	2.40	0.51	7,548	8,149	6,525	1.25	0.22	0.64
	#VALUE!	70.6%	29.4%		0.5%	50.0%	50.0%		81,648	104,267	47,232			1,820-54,145	6,471-150,196	1,820-40,986			
HIV	460,547,457	290,848,557	79,652,343	3.65	760	448	286	1.57	625,073	649,216	278,505	2.33	0.01	147,404	163,462	114,272	1.43	3.87	0.05
	#VALUE!	78.5%	21.5%		19.2%	61.0%	39.0%		2,276,762	1,550,920	545,657			37,195-395,644	39,153-511,800	29,880-305,339			
HPV	57,795,110	42,592,795	9,393,693	4.53	150	88	56	1.57	355,514	484,009	167,745	2.89	0.30	92,143	103,966	82,325	1.26	0.47	0.49
	#VALUE!	81.9%	18.1%		3.8%	61.1%	38.9%		849,406	1,042,481	360,400			30,079-220,559	29,742-264,540	32,566- 171,377			
HSV	22,063,300	15,472,470	6,536,189	2.37	48	28	19	1.47	459,652	552,588	344,010	1.61	0.19	202,564	119,295	309,610	0.39	4.85	0.03

	#VALUE!	70.3%	29.7%		1.2%	59.6%	40.4%		720,790	908,183	287,596			52,597-421,960	40,009-446,395	147,885-439,305			
Syphilis	1,061,560	286,117	775,444	0.37	5	2	3	0.67	212,312	143,058	258,481	0.55	0.56	207,346	143,058	207,346	0.69	0.14	0.71
	#VALUE!	27.0%	73.0%		0.1%	40.0%	60.0%		152,848	122,822	176,603			113,088-229,907	56,210-229,907	113,088-455,010			
Other infections																			
Aspergillus	4,853,858	4,482,101	371,757	12.06	26	24	2	12.00	186,687	186,754	185,879	1.00	1.00	47,948	47,948	185,879	0.26	0.00	1.00
	#VALUE!	92.3%	7.7%		0.7%	92.3%	7.7%		420,903	435,756	248,298			19,703-157,829	20,890-135,113	10,306-361,451			
Candida	1,219,072	1,194,064	25,008	47.75	8	6	2	3.00	152,384	199,011	12,504	15.92	0.18	28,518	72,375	12,504	5.79	2.67	0.10
	#VALUE!	97.9%	2.1%		0.2%	75.0%	25.0%		262,390	293,075	17,226			10,508-188,568	17,076-264,740	324-24,684			
Pseudomonas	6,473,237	6,096,633	376,604	16.19	43	39	4	9.75	150,540	156,324	94,151	1.66	0.90	81,793	81,793	79,244	1.03	0.00	0.96
	#VALUE!	94.2%	5.8%		1.1%	90.7%	9.3%		175,911	182,442	83,286			11,204-253,337	11,108-253,459	27,396-160,906			
VZV	4,186,583	1,472,968	2,713,615	0.54	20	9	11	0.82	209,329	163,663	246,692	0.66	0.21	145,505	47,343	161,033	0.29	0.20	0.65
	#VALUE!	35.2%	64.8%		0.5%	45.0%	55.0%		261,063	250,869	275,194			46,117-227,502	26,213-147,593	105,632-233,537			
Total specific infections	#VALUE!	#VALUE!	#VALUE!	#VALUE!	3,953	#VALUE!	#VALUE!	#VALUE!						158,055					
Overall	2,599,985,851	1,785,979,172	488,178,602	3.66	6,170	4,357	1,695	2.57	421,733	409,910	288,011	1.42	0.01	49,490-352,699	179,389	125,556	1.43	74.40	0.01
		78.53%	21.47%			71.99%	28.01%		1,315,935	840,087	704,474								

Funder	Investment (total); £ (%)	Investment (male); £ (%)	Investment (female); £ (%)	Fold difference	Studies (total); n (%)	Studies (male); £ (%)	Studies (female); n (%)	Fold difference	Mean grant (total); £ (SD)	Mean grant (male); £ (SD)	Mean grant (female); £ (SD)	Fold difference	P	Median grant (total); £ (IQR)	Median grant (male); £ (IQR)	Median grant (female); £ (IQR)	Fold difference	Chi-squared	P
Public funding	1,393,972,967	1,025,211,218	279,810,244	3.66	1,082	1,722	624	2.76	588,503	595,361	448,414	1.17	0.01	255,992	272,452	213,718	1.27	29.38	0.01
	53.6%	78.6%	21.4%		17.6%	73.4%	26.6%		1,447,668	1,080,718	814,979			127,167-529,610	138,322- 572,529	92,880-402,917			
BBSRC	186,268,429	160,120,540	26,147,889	6.12	578	485	93	5.22	322,264	330,145	281,160	1.17	0.78	253,398	253,498	244,972	1.03	0.12	0.73
	7.2%	86.0%	14.0%		9.4%	83.9%	16.1%		361,565	383,963	205,593			169,787-365,159	176,763-363,830	149,828-371,577			
DFID																			
DH	134,961,745	101,933,746	32,757,325	3.11	285	194	89	2.18	473,550	525,432	368,060	1.43	0.37	203,544	213,107	181,697	1.17	0.36	0.55
	5.2%	75.7%	24.3%		4.6%	68.6%	31.4%		846,024	968,640	482,041			72,628-514,066	72,627-542,097	65,015-383,886			
European Commission	255,015,533	186,846,015	65,558,847	2.85	219	141	71	1.99	1,164,454	1,325,149	923,364	1.44	0.58	439,762	555,497	199,133	2.79	3.58	0.06
	9.8%	74.0%	26.0%		3.6%	66.5%	33.5%		2,084,358	2,409,860	1,316,016			127,419-1,454,94	123,042-1,504,88	134,621-1,449,403			
MRC	672,895,698	537,260,180	131,751,245	4.08	962	715	242	2.95	699,476	751,413	544,427	1.38	0.01	366,479	404,615	286,679	1.41	18.44	0.01
	25.9%	80.3%	19.7%		15.6%	74.7%	25.3%		993,012	1,020,748	884,442			199,287-713,178	210,068-811,860	178,182-468,998			
UK government, non-DH	144,831,562	39,050,737	23,594,939	1.66	237	187	129	1.45	452,898	208,828	182,907	1.14	0.01	110,178	129,660	59,976	2.16	3.79	0.05
	5.6%	62.3%	37.7%		3.8%	59.2%	40.8%		2,811,384	492,519	619,889			19,073-206,784	23,761- 207,320	12,564-157,053			
Philanthropy	1,108,966,983	691,680,388	185,866,898	3.72	2,879	2,044	768	2.66	383,601	338,396	242,014	1.40	0.01	146,060	153,653	114,173	1.35	23.28	0.01
	42.7%	78.8%	21.2%		46.7%	72.7%	27.3%		1,377,079	659,025	711,420			52,433-286,518	58,589-302,774	42,658-222,842			
Bill & Melinda Gates Foundation	220,923,242				39				5,664,699					1,488,432					
	8.5%				0.6%				8,966,093					628,545-5,576,863					
Charity	199,703,382	130,726,509	58,989,705	2.22	855	619	217	2.85	227,332	211,190	271,842	0.78	0.01	87,318	91,991	76,058	1.21	5.23	0.02
	7.7%	68.9%	31.1%		13.9%	74.0%	26.0%		730,057	454,108	1,208,852			27,616-167,829	36,429-172,497	17,279-150,727			
Wellcome Trust	688,340,359	560,953,880	126,592,102	4.43	1,985	1,425	550	2.59	346,818	393,652	230,168	1.71	0.01	168,434	191,461	137,241	1.40	39.83	0.01
	26.5%	81.6%	18.4%		32.2%	72.2%	27.8%		646,625	723,549	362,836			66,419-335,557	74,759-362,424	54,019-250,723			
Other funding	103,542,992	69,087,566	22,501,460	3.07	1,010	591	303	1.95	103,683	116,899	74,262	1.57	0.01	28,626	32,557	20,373	1.60	4.80	0.03
	4.0%	75.4%	24.6%		16.4%	66.1%	33.9%		273,102	309,358	154,373			6,282-105,082	7,225-113,479	4,408-79,809			
Overall	2,599,985,851	1,785,979,172	488,178,602	3.66	6,165	4,357	1,695	2.57	421,733	409,910	288,011	1.42	0.01	158,055	179,389	125,556	1.43	74.40	0.01
		78.5%	21.5%			72.0%	28.0%		1,315,935	840,087	704,474			49,490-352,699	59,146-371,977	30,983-261,835			

Year	Investment (male); £	Change from previous year (male); £	Fold difference (male)	*P*	Change over 1997 (male); £	Fold difference (male)	*P*	Investment (female); £	Change from previous year (female); £	Fold difference (female)	*P*	Change over 1997 (female); £	Fold difference (female)	*P*	Investment (male); %	Investment (female); %	Absolute difference (gender)	Fold difference (gender)
1997	64,158,003							16,305,109							79.7%	20.3%	47,852,894	3.93
1998	78,287,824	14,129,821	1.22	0.57	14,129,821	1.22	0.57	13,110,597	-3,194,512	0.80	0.90	-3,194,512	0.80	0.90	85.7%	14.3%	65,177,227	5.97
1999	79,477,324	1,189,500	1.02	0.37	15,319,321	1.24	0.14	24,366,507	11,255,911	1.86	0.79	8,061,398	1.49	0.88	76.5%	23.5%	55,110,816	3.26
2000	245,740,477	166,263,153	3.09	0.00	181,582,474	3.83	0.01	55,636,657	31,270,150	2.28	0.01	39,331,548	3.41	0.01	81.5%	18.5%	190,103,820	4.42
2001	105,423,252	-140,317,225	0.43	0.09	41,265,248	1.64	0.01	34,133,067	-21,503,591	0.61	0.23	17,827,958	2.09	0.01	75.5%	24.5%	71,290,185	3.09
2002	166,695,481	61,272,230	1.58	0.89	102,537,478	2.60	0.01	59,568,874	25,435,807	1.75	0.41	43,263,765	3.65	0.01	73.7%	26.3%	107,126,607	2.80
2003	114,827,602	-51,867,880	0.69	0.03	50,669,599	1.79	0.50	27,241,313	-32,327,560	0.46	0.14	10,936,204	1.67	0.05	80.8%	19.2%	87,586,288	4.22
2004	93,129,587	-21,698,015	0.81	0.09	28,971,584	1.45	0.30	26,908,997	-332,316	0.99	0.91	10,603,888	1.65	0.04	77.6%	22.4%	66,220,590	3.46
2005	177,791,995	84,662,408	1.91	0.03	113,633,992	2.77	0.26	39,460,786	12,551,789	1.47	0.60	23,155,677	2.42	0.01	81.8%	18.2%	138,331,209	4.51
2006	126,329,085	-51,462,910	0.71	0.60	62,171,082	1.97	0.54	37,473,263	-1,987,522	0.95	0.35	21,168,154	2.30	0.03	77.1%	22.9%	88,855,822	3.37
2007	126,144,324	-184,761	1.00	0.03	61,986,320	1.97	0.12	28,293,204	-9,180,059	0.76	0.01	11,988,095	1.74	0.48	81.7%	18.3%	97,851,119	4.46
2008	173,132,770	46,988,446	1.37	0.07	108,974,767	2.70	0.01	44,307,821	16,014,617	1.57	0.70	28,002,712	2.72	0.73	79.6%	20.4%	128,824,949	3.91
2009	114,490,290	-58,642,480	0.66	0.12	50,332,287	1.78	0.01	41,820,953	-2,486,868	0.94	0.03	25,515,844	2.56	0.01	73.2%	26.8%	72,669,337	2.74
2010	120,351,159	5,860,868	1.05	0.33	56,193,155	1.88	0.01	39,551,453	-2,269,500	0.95	0.56	23,246,344	2.43	0.06	75.3%	24.7%	80,799,705	3.04
Mean	*127,569,941*	*4,322,550*			*68,289,779*			*34,869,900*	*1,788,180*			########			*78.6%*	*21.4%*	*92,700,041*	
SD	*48,770,855*	*76,214,220*			*47,073,847*			*13,365,475*	*17,657,139*			########					*38,264,674*	
Total Gende	*1,785,979,172*							*488,178,602*									*1,297,800,569*	3.66
Total Overal	2,599,985,851																	

Differences in research funding for women scientists: a systematic comparison of UK investments in global infectious disease research 1997–2010

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-003362.R2
Article Type:	Research
Date Submitted by the Author:	12-Oct-2013
Complete List of Authors:	Head, Michael; University College London, Infection & Population Health Fitchett, Joseph; London School of Hygiene & Tropical Medicine, Cooke, Mary; University College London, Wurie, Fatima; University College London, Atun, Rifat; Imperial College London,
Primary Subject Heading:	Infectious diseases
Secondary Subject Heading:	Global health
Keywords:	INFECTIOUS DISEASES, PUBLIC HEALTH, STATISTICS & RESEARCH METHODS, VIROLOGY, PARASITOLOGY, MYCOLOGY

Differences in research funding for women scientists: a systematic comparison of UK investments in global infectious disease research 1997–2010

Michael G Head[a*], Joseph R Fitchett[b], Mary K Cooke[a], Fatima B Wurie[a], Rifat Atun[c]

a University College London, Research Department of Infection and Population Health, UCL Royal Free Campus, Rowland Hill Street, London, NW3 2PF

b London School of Hygiene & Tropical Medicine, Keppel Street, London, WC1E 7HT

c Imperial College London, South Kensington Campus, London SW7 2AZ and Harvard School of Public Health, Harvard University, Boston, USA

*Corresponding Author

Number of Words: **3 758**

Keywords – gender, funding, research, women,

Abstract

Objectives: There has not previously been a systematic comparison of awards for research funding in infectious diseases by sex. We investigated funding awards to UK institutions for all infectious disease research from 1997 to 2010, across disease categories and along the research and development continuum.

Design: Systematic comparison

Methods: Data were obtained from several sources for awards from the period 1997-2010 and each study assigned to - disease categories; type of science (pre-clinical, phases I-III trials, product development, implementation research); categories of funding organisation. Fold differences and statistical analysis were used to compare total investment, study numbers, mean grant, and median grant between men and women.

Results**:** 6052 studies were included in the final analysis, comprising 4357 grants (72.0%) awarded to men and 1695 grants (28.0%) awarded to women, totalling £2.274 billion. Of this, men received £1.786 billion (78.5%) and women £488 million (21.5%). The median value of award was greater for men (£179 389; IQR £59146–£371 977) than women (£125 556; IQR £30 982–£261 834).

Awards were greater for male PIs across all infectious disease systems, excepting neurological infections and sexually transmitted infections. The proportion of total funding awarded to women ranged from 14.3% in 1998 to 26.8% in 2009 (mean 21.4%), and was lowest for pre-clinical research at 18.2% (£285.5 million of £1.573 billion) and highest for operational research at 30·9% (£151.4 million of £489.7 million).

Conclusions: There are consistent differences in funding received by men and women principal investigators: women have fewer funded studies and receive less funding in absolute and in relative terms; the median funding awarded to women is lower across most

infectious disease areas, by funder, and type of science. These differences remain broadly unchanged over the 14-year study period.

Article summary

Article focus

- We explore the distribution of funding across infectious disease research by the gender of principal investigator to identify any differences in funding received by men and women researchers in the UK.

Key messages

- There are consistent differences in funding received by men and women principal investigators (PIs) in infectious disease research funded in the UK.
- Total funding and the median award across most disease areas and type of science is typically greater in male PIs than female PIs
- These differences remain consistent over the time period of analysis (1997-2010)

Strengths and limitations of this study

- This is the first study to present detailed data and rigorously quantify funding differences between men and women researchers in infectious disease research in the UK.
- Our results provides new and additional evidence on differences on funding for men and women researchers highlighted in earlier studies and provides a case for new research to explain the source of these differences, especially given government commitments to increase the number of women in science

- We were unable to assess the success and failure rates by gender and thus cannot comment on the extent of inequalities or bias. As we could not feasibly access data on the academic ranking of principal investigators, we were hence unable to adjust for levels of seniority across both genders. A follow-up study incorporating this data would allow for more meaningful conclusions to be drawn about the nature of any possible disparities.

Introduction

Women are under-represented in biomedical science, yet few studies have systematically explored the extent and reasons for the observed differences between men and women scientists. Women comprise 50% of the EU student population and 45% of doctoral students, but only one third of career researchers are women – a figure that is lower for senior positions.[1]

In 2001, a Wellcome Trust survey concluded that although women were as successful as men in securing funding for biomedical research, they were less likely to apply for grant funds because of their status in scientific institutions and the level of support they received.[2] An analysis of Wellcome Trust awards in 2000-08 revealed a significant gender difference in the amount of funding awarded, even after adjusting for the seniority of the principal investigator, concluding "the most likely explanation for the difference in amounts awarded to women and men is that women are systematically less ambitious in the amounts of funding requested in their grant applications."[3] In 2011, around 44% of academics in UK universities were women, yet only 39% of senior lecturers and 19% of professors were women.[4] Furthermore, a number of studies from the US have shown that women in science are disadvantaged compared to men.[5–7]

The low numbers of women in science and the reasons for this anomaly is a concern for scientists and policy makers. Although the UK Medical Research Council (MRC) has a gender equality scheme, which briefly states gender equality is reflected in agreements with research organisations receiving MRC funding, it is not clear how the scheme is implemented.[8]

While several initiatives have aimed to increase the numbers of women involved in science, there are no affirmative actions or binding policies in the UK or Europe to definitively ensure women are better represented in science. Indeed, some initiatives aimed at increasing women in science have been criticised. For example, in 2012, the European Commission campaign targeting 13-18 year-old secondary school students[9] was rebuked and described as an insult to women in science[10],[11], with the offending video clip removed from the EU campaign website. The effects of campaigns aimed at raising the profile of women in science[12,13] have not been assessed.

We have previously undertaken a systematic analysis of research funding awarded to UK institutions for all infectious disease research, for the 14-year period from 1997 to 2010.[14] Here, we use the dataset gathered for this earlier study to examine trends over time, the distribution of funding awarded to men and women principal investigators (PIs) across specific infections, funder categories, and along the research and development (R&D) continuum, extending from pre-clinical to clinical and operational research.

Methods

We obtained data from several sources for infectious disease research studies where funding was awarded between 1997 and 2010. The methods for the original study are elaborated in detail elsewhere,[14] and summarised here. We identified 325,922 studies for screening that covered all areas of disease from several funders, and filtered these to identify funding for infectious diseases where the lead institution was in the UK in the period and the year of award 1997-2010. We obtained data from publicly available sources and directly from the funders. We did not include private sector funding in the analysis, as pharmaceutical sector data were not publicly available. Figure 1 shows the sources of data

and the numbers of studies included and excluded at each stage of screening to reach the final set of studies for detailed analysis.

Figure 1. Methodology flow chart for filtering studies firstly by infectious disease and then by gender

Data collection and cleaning took place alongside routine duties between 2006 and 2011, primarily by MGH and assisted by JRF, MKC and FBW. Funding records could feasibly be obtained going back to 1997, hence the decision to cover awards during 1997-2010. We assigned each study to primary disease categories, and within each category, we documented topic-specific subsections, including specific pathogen or disease. We allocated studies to one of four categories along the R&D continuum: pre-clinical; phases I, II or III; product development; and operational research, and to one of the 26 categories for funding organisations.

Where the PI was named, we assigned them to men or women categories. The studies where only an initial was available for the forename were assigned as “unclear” if we were unable to establish the PIs gender from a review of the literature, institutional websites or publicly available publications and documents.

Reference to sexually transmitted infections excludes HIV. Neglected tropical diseases were categorised according to classification used by the World Health Organization (WHO) (http://www.who.int/neglected_diseases/diseases/en). Antimicrobial resistance includes antibacterial, antiviral, antifungal and antiparasitic studies.

We converted grants awarded in a currency other than pounds sterling to UK pounds using the mean exchange rate in the year of the award. We adjusted grant funding amounts for inflation and reported in 2010 UK pounds.

As well as excluding studies not immediately relevant to infection, we excluded unfunded studies, veterinary infectious disease research studies (unless there was a zoonotic component), those exploring the use of viral vectors to investigate non-communicable diseases, grants for symposia or meetings, or studies with UK contributions (e.g. as a collaborator), but the funding was awarded to a non-UK institution.

We used Microsoft Excel versions 2000 and 2007 to categorise studies. Where needed, data were exported into Microsoft Access (versions 2000 and 2007) and specific keyword queries used to select precise sections of the data for analysis. We used Stata (version 11·0) for statistical analysis and to generate figures.

We used fold differences to compare total investment, number of studies, mean grant, and median grant between men and women according to disease system, specific infection and funding organisation.

We used nonparametric Mann-Whitney rank-sum test to assess the distribution of funding by gender. Nonparametric K-sample test on equality of medians was applied to compare the median funding by gender, and reported as a chi-squared statistic without Yates' correction for continuity. Nonparametric Wilcoxon signed-rank test was applied when comparing matched data, such as time trends by gender. The significance for all tests was defined at the 5% level (two-sided P=0.05).

We present differences between gender and do not attempt to investigate or imply bias or inequalities as we could not access data on unsuccessful grant applications.

Results

We identified 6165 studies from the 325,922 studies screened that were suitable for inclusion in our analysis. Of these, we were unable to ascertain the gender of principal investigator for 30 studies (0.5%). We excluded 83 studies (1.3%) that did not specify the PIs name or gender – these were funded by the Bill and Melinda Gates Foundation (Gates Foundation) (38 studies; 0.6%) and the UK Department for International Development (DFID) (22 studies; 0.4%), accounting for £321.2 million (12.3% of the total). We included 6052 studies in the final analysis, comprising 4357 grants (72.0%) awarded to men and 1695 grants (28.0%) awarded to women, totalling £2.274 billion, of which £1.786 billion (78.5%) were awarded to men and £488 million (21.5%) awarded to women.

The median value of grant funding was greater for men (£179 389; IQR £59146–£371 977) than for women (£125 556; IQR £30 982–£261 834). Similarly, mean value of the grant funding was greater for men (£409 910; SD £840 087) than for women (£288 011; SD £704 474). Figure 2 shows the distribution of the total investments and median funding awarded to PIs by gender over time.

Figure 2a. Total investment over time awarded to male and female principal investigators

Figure 2b Median investment over time awarded to male and female principal investigators

Infectious disease system

Table 1A (web appendix 1) shows the total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to nine disease systems and by gender of PI. We identified no infectious disease system where women led the majority of research efforts or were awarded the majority of funding. Median funding awards were greater for male PIs across all infectious disease systems, with the exception of neurological infections and sexually transmitted infections.

Greatest levels of funding awarded to men and to women were for research into respiratory infections and HIV. Men received a total of £312.1 million for research into respiratory infections compared with £84.4 million for women – a 3.70 fold difference – and a total of £290.8 million for HIV research compared with £79.7 million for women – a 3.65 fold difference.

The largest difference between total funding for men and for women was with gastrointestinal infections (5.65 fold difference) where women received only 15.0% of the total investment (£37.0 million) and spearheaded 18.9% (149) of the studies and neurological infections (4.22 fold difference). Smallest difference between total funding for men and for women was in research into sexually transmitted infections (1.90 fold difference), where women received 35.0% (£45.4 million) of the total funding and led 49.0% (182) of the studies.

Mean funding for grants was significantly greater for men (£409 910; SD £840 087) than for women (£288 011; SD £704 474). The differences in median funding were statistically significant (*P* > 0.01) for gastrointestinal infections (men £328 021; SD £458 720) (women £248 615; SD £433 176), for haematological infections (men £417 889; SD £914 626)

(women £306 126; SD £819 910), and for HIV (men £649 216; SD £1 550 920) (women £278 505; SD £545 657).

Median funding for grants showed a similar pattern, with significantly greater grant funding for men (£179 389; IQR £59 146–£371 977) than women (£125 556; IQR £30 983–£261 835). Differences in median funding were statistically significant (*P* > 0.05) for gastrointestinal infections (men £208 369; IQR £78 852–357 771) (women £155 066; IQR £43 637–£305 928), for hepatic infections (men £118 638; IQR £41 342–£269 629) (women £68 620; IQR £26 720–£221 952), and for HIV (men £163 462; IQR £39 153–£511 800) (women £114 272; IQR £29 880–£305 339).

Specific Infections

Table 1B (web appendix 1) shows total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to specific infection by gender.

Men received significantly higher levels of total research funding, spearheaded greater numbers of studies, and were awarded greater median and mean funding for grants for malaria (*P = 0.01*), HIV (*P = 0.01*) and influenza (*P = 0.04*).

Major differences between total funding for men and for women were observed for research into candida (47.75 fold difference), rotavirus (33.65 fold difference), campylobacter (24.33 fold difference) and norovirus (23.33 fold difference). Smallest differences between total funding for men and women were for research into dengue (1.07 fold difference) and leishmaniasis (1.55 fold difference). Women received greater total funding than men for research into leprosy (0.09 fold difference), diphtheria (0.18 fold difference), chlamydia (0.36 fold difference), syphilis (0.37 fold difference), and varicella zoster (0.54 fold difference).

Differences in mean grant funding were statistically significant (*P* > 0.05) for malaria research (men £590 422; SD £1 324 909) (women £318 054; SD £726 872), for influenza (men £616 643; SD £881 493) (women £387 186; SD £489 997), for respiratory syncytial virus (men £485 283; SD £539 396) (women £187 931; SD £268 412), and for HIV (men £649 216; SD £1 550 920) (women £278 505; SD £545 657).

Differences in median grant funding were statistically significant (*P* > 0.05) for malaria research (men £209 646; IQR £63 826–£529 610) (women £143 358; IQR £42 754–£314 524), for hepatitis C (men £124 797; IQR £42 475–£289 293) (women £67 265; IQR £29 880–£233 467), for influenza (men £348 730; IQR £213 601–£668 561) (women £200 787; IQR £124 210–£398 191), for herpes simplex virus (men £119 295; IQR £40 009–£446 395) (women £309 610; IQR £147 885–£439 305), and for HIV (men £163 462; IQR £39 153–£511 800) (women £114 272; IQR £29 880–£305 339).

Figure 3 shows the proportion of total funding awarded to principal investigators by gender over time and a breakdown of investment by research pipeline. The proportion of the total funding awarded to women ranged from 14.3% (in 1998) to 26.8% (in 2009), with a mean proportion of 21.4% for the period studied. The proportion of funding was lowest for pre-clinical research at 18.2% (£285·5 million of £1.573 billion total) and highest for operational research at 30.9% (£151.4 million of £489.7 million). The funding for clinical (Phase I, II and III) research was 29.9% (£25.5 of £85.2) and for product development amounted to 20.4% (£25.8 million of £126.6 million).

Figure 3a. Proportion of investment over time awarded to male and female principal investigators

Figure 3b. Total investment by research pipeline awarded to male and female principal investigators

Funding organisation

Table 2 (web appendix 2) shows in detail the total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to funding organisation and by gender.

Public funding organisations invested a total of £1.025 billion in research led by men (78.6%) and £279.8 in research led by women (21.4%). Greatest levels of funding awarded to men and to women were by the Wellcome Trust and the UK MRC. Major differences between funding awarded to men and to women PIs were by the BBSRC, with a 6.12 fold difference. Smallest differences between funding awarded to men and to women were by the UK Government funding streams such as the National Institute for Health Research, with a 1.66 fold difference. Mean grant funding from public funding organisations were significantly greater for men at £595 361 (SD £1 080 718) than for women at £448 414 (SD £814 979). Differences were also statistically significant ($P > 0.01$) for UK MRC grants with men at £751 413 (SD £1 020 748) and women at £544 427 (SD £884 442), and for UK Government grants with men at £208 828 (SD £492 519) and women at £182 907 (SD £619 889).

Median grant funding from public funding organisations had a similar pattern with significantly greater grant funding for men at £272 452 (IQR £138 322–£572 529) and women at £213 718 (IQR £92 880–£402 917). Differences were also statistically significant ($P > 0.05$) for UK MRC grants with men at £404 615 (IQR £ 210 068–£811 860) and women at £286 679 (£178 182–£468 998), and for UK Government grants with men at £129 660 (IQR £23 761–£207 320) and women at £59 976 (IQR £12 564–£157 053).

Philanthropic funding organisations invested a total of £691.7 million in research led by men (78.8%) and £185.9 million in research led by women (21.2%).

Mean grant funding from philanthropic funding organisations were significantly greater for men at £338 396 (SD £695 025) than for women at £242 014 (SD £711 420). Differences were also statistically significant ($P > 0.01$) for Wellcome Trust grants with men receiving £393 652 (SD £723 549) and women £230 168 (SD £362 836), and for other charitable funding organisations with men receiving £211 190 (SD £454 108) and women £271 842 (SD £1 208 852).

Median grants from philanthropic funding organisations showed a similar pattern with significantly greater grant funding for men at £153 653 (IQR £58 589 – £302 774) and women at £114 173 (IQR £42 658 – £222 842). Differences were also statistically significant ($P > 0.05$) for Wellcome Trust grants with men receiving £191 461 (IQR £74 759 – £362 424) and women £137 241 (IQR £54 019 – £250 723), and for other charitable funding organisations with men receiving £91 991 (IQR £36 429 – £172 497) and women £76 058 (IQR £17 279 – £150 727).

Figure 4 shows the association between funding organisation and total investment and median funding by gender. The MRC awarded the highest median amount in grants to women (£286 679; IQR £178 182–£468 998), but the median funding amount in grants for men were 1.41 fold higher than that awarded to women (£404 615; IQR £210 068–£811 860). European Commission awarded the highest mean grants to women at £923 364 (SD £1 316 016) however mean funding amount in grants for men were 1.44 fold higher at £1325 149 (SD £2 409 860) than that for women.

Figure 4a. Association between funding organisation and total investment by gender

Figure 4b. Association between funding organisation and median award by gender

Time trend

Table 3 (web appendix 3) shows in detail the trends in funding over time from 1997 to 2010 by gender of principal investigators, with amounts and relative proportions each year of funding. Mean annual funding received was greater by men at £127.6 million (SD £48.7 million) than women at £34.9 million (SD £13.4 million). Proportions of annual funding received by men ranged from 73.2% to 85.7%, with a mean of 78.6%.

Proportions of annual funding received by women ranged from 14.3% to 26.8% with a mean of 21.4%. The largest annual funding received by men was £245.7 million in 2000, and the smallest at £64.2 million in 1997. The largest annual funding received by women was £59.6 million in 2002, with the smallest at £13.1 million in 1998.

Over the 14-year study period, the proportion of investment awarded to women each year remains relatively unchanged with a mean of 21.4% of total (range 14.3%–26.8%; £13.1 million to £59.6 million). Figure 5 shows the funding trends over time and fold differences in total investments by gender. Absolute difference in the funding amounts in the grants awarded to men and women ranges between £47.9 million and £190.1 million, with a mean difference of £92.7 million (SD £38.3 million). Fold difference in grant funding for men and women ranged from 2.74 to 5.97, with a mean fold difference of 3.66.

Figure 5a. Total investment and trend over time, by gender

Figure 5b. Fold difference of investment over time, by gender

Discussion

We present the first detailed and systematic comparison by sex of investments in infectious disease research in the UK for the 14-year period 1997-2010. We identified 6165 studies funded by public and philanthropic funding organisations, with total research investment of £2.6 billion.

We quantified the differences in research funding awarded by gender to show these to be substantial. The analysis shows clear and consistent differences between men and women principal investigators, with lower funding in terms of the total investment, the number of funded studies, the median funding awarded and the mean funding awarded across most of the infectious disease areas funded. Women received less funding in absolute amounts and in relative terms, by funder and the type of science funded along the R&D pipeline. These differences in funding between men and women persist over time.

We show large differences in median funding amounts for men and women researchers in investments by the European Commission and the MRC. Such differences were much less apparent when comparing funding from the Department of Health and BBSRC, although the BBSRC awarded 86% of funding to men. The BBSRC almost entirely funds pre-clinical research,[14] and this matches the increased proportions of pre-clinical studies being led by male principal investigators.

Our findings in infectious disease research, the most detailed to date, provide new evidence on differences between men and women researchers, to reinforce the concerns raised in earlier studies.[4,15,16] Differences that are more marked at senior levels of academia need to be investigated to explain and account for the observed differences.

The reasons why the median awards across most infectious disease conditions should be significantly less for women principal investigators cannot be deduced from the available data. Thus, it is not possible to recommend interventions to address this phenomenon, given that it is unclear if there is any bias, or precisely what mechanisms are at play. The next step may be to investigate success rates by gender to assess how many women are applying, and what proportion of the initial request for funding is actually allocated.

There have been suggestions that women are systematically less ambitious in the amounts of funding requested in their grant applications when compared with men who are equivalently ranked academically, and that relatively simple mentoring programmes could at least partially overcomes this anomaly.[3] However, there is no evidence supporting these assertions. Others have suggested that systems which ensure PI anonymity during review of grant funding submissions may help reduce the presence of any subtle gender biases[17], though in practice this approach would be challenging as the experience of the PI is a key factor when considering suitability of request for research support. However, evidence on effective interventions to address barriers for women scientists are lacking.[16] Women of child-bearing age are being disadvantaged in some areas of employment, even though in relation to scientific endeavour, productivity as measured by published outputs is not significantly different between women with and without children.[15]

Study limitations

Our analysis has several limitations. We rely on the accuracy of the original data from the funding organisations and as described elsewhere we have excluded data from the private sector as the publicly available data are incomplete.[14]

In the period analysed, we were not able to find data on the number of men and women PIs requesting financial support for research agencies from the funding sources studies. Hence, we were unable to assess the success and failure rates by gender. We also did not have complete data on the amount of funding initially requested, the gender of co-applicants for each study, the total pool of researchers in each disease area and within each type of science, or the proportion of awards made to clinical and non-clinical researchers, all of which would be useful pieces of information in developing a clearer picture of the reasons for the presented differences. The proportion of doctors registered in the UK favours men (56.8% as of January 2013) over women,[18] but the proportion of those carrying out research appears to be unknown. Understanding the distribution of researchers is critical to understanding the research landscape.

We lacked data on the academic ranking of principal investigators and were hence unable to adjust for levels of seniority across both genders. We were unable to get data on gender from the Gates Foundation and DFID and hence were unable to clarify the gender of a small proportion of investigators, though we believe this limitation is not likely to change the conclusions of the study. Our analysis focuses on infectious disease research, and analysis of other areas of scientific research would be needed if these differences persisted for all research areas.

Conclusions

Notwithstanding limitations, our systematic analysis shows unequal distribution of investments in infectious disease research for men and women. There are fewer women receiving funding as principal investigators in infectious disease research, with fewer studies funded with lower funding amounts when successful.

Although earlier studies have discussed possible solutions, including mentoring programmes and advertising campaigns, none have systematically explored the reasons why such differences persist. Hence, without an understanding of the reasons for the observed differences, the proposed solutions are not very meaningful. There is no evidence that women and men researchers are not equally able, hence, other factors are likely to be at play to explain the observed differences which have persisted over the 14-year study period. From our data, the limitations mean that we cannot explain what these mechanisms might be. Research is needed to elucidate an understanding of the factors that can explain the observed differences. A sub-analysis of our dataset where information on academic rank at time of award is obtained would allow for more meaningful conclusions. We strongly urge policy makers, funders and scientists to urgently investigate the factors leading to the observed differences and develop policies developed to address them, in order to ensure that women are appropriately supported in scientific endeavour.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Author contribution

MGH designed the study with input from RA and JF and collated the dataset. JRF, FW and MKC checked and refined the dataset. JRF undertook data analysis and created the graphs and figures with input from MGH and RA. MGH, JRF, and RA interpreted the data and wrote the first draft. MGH, JRF, and RA refined the analysis and paper with input from MKC and FBW. All authors reviewed and approved the final version. MH is guarantor of the paper.

Competing interests

RA has received research funding from the UK Medical Research Council, the UK National Institute for Health Research, UK CRC, UK EPSCRC, the UK Department for International Development and the UK Department of Health. RA is a member of the UL Medical Research Council Global Health Group. MGH works for the Infectious Disease Research Network, which has supported this work and is funded by the UK Department of Health. JRF has received funds from the Wellcome Trust and is a steering group member for the Infectious Disease Research Network. MKC has received funding from the Medical Research Council and the Bill & Melinda Gates Foundation. FBW has received funds from UCLH Charitable Foundation.

Acknowledgements

We thank Jennifer Harris and Raidah Haider for their input and assistance, and acknowledge the assistance of the research and development funding agencies for provision of data.

Data-sharing statement

All gender data is available with this submission. Further data relating to the Research Investments project can be found at www.researchinvestments.org or by contacting the corresponding author.

References

1 More women in senior positions. Key to economic stability and growth. European Commission, Luxembourg: 2010.

2 Blake M, La Valle I. Who applies for research funding? Key factors shaping funding application behaviour among women and men in British higher education institutions. London: 2000.

3 Bedi G, Van Dam NT, Munafo M. Gender inequality in awarded research grants. *Lancet* 2012;**380**:474.

4 Fitzpatrick S. A Survey of Staffing Levels of Medical Clinical Academics in UK Medical Schools as at 31 July 2011. London: 2012. http://www.medschools.ac.uk/Publications/Documents/MSC_Clinical_Academic_Staff_Survey_310711.pdf (date accessed 22 August 2013)

5 Burrelli J. Thirty-Three Years of Women in S&E Faculty Positions - US National Science Foundation. Arlington: 2008. http://www.nsf.gov/statistics/infbrief/nsf08308/ (date accessed 22 August 2013)

6 Lincoln AE, Pincus SH, Leboy PS. Scholars' awards go mainly to men. *Nature* 2011;**469**:472.

7 Pohlhaus JR, Jiang H, Sutton J. Sex differences in career development awardees' subsequent grant attainment. *Annals of internal medicine* 2010;**152**:616–7; author reply 617.

8 Medical Research Council. MRC Gender Equality Scheme. 2007.http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC003655 (date accessed 22 August 2013).

9 European Commission. About this site- Science: It's a girl thing! 2012. http://science-girl-thing.eu/en/about-this-site (date accessed 22 August 2013)

10 Gill M. "Science, it's a girl thing!" says EU Commission, holding lipstick and bunsen burner. New Statesman. 2012. http://www.newstatesman.com/blogs/martha-gill/2012/06/science-its-girl-thing-says-eu-commission-holding-lipstick-and-bunsen-burn (date accessed 22 August 2013).

11 Swain F. Science: It's a girl thing. Excuse me while I die inside. – SciencePunk. ScienceBlogs. 2012. http://scienceblogs.com/sciencepunk/2012/06/22/science-its-a-girl-thing-excuse-me-while-i-die-inside/ (date accessed 22 August 2013)

12 Yong E. Edit-a-thon gets women scientists into Wikipedia. Nature. 2012. http://www.nature.com/news/edit-a-thon-gets-women-scientists-into-wikipedia-1.11636 (date accessed 22 August 2013)

13 Donald A. Throw off the cloak of invisibility. *Nature* 2012;**490**:447.http://www.nature.com/news/throw-off-the-cloak-of-invisibility-1.11638 (date accessed 22 August 2013).

14 Head MG, Fitchett JR, Cooke MK, *et al.* UK investments in global infectious disease research 1997-2010: a case study. *The Lancet infectious diseases* Published Online First: 7 November 2012.

15 Fox MF. Gender, Family Characteristics, and Publication Productivity among Scientists. *Social Studies of Science* 2005;**35**:131–50.

16 Ceci SJ, Williams WM. Understanding current causes of women's underrepresentation in science. *Proceedings of the National Academy of Sciences of the United States of America* 2011;**108**:3157–62.

17 Moss-Racusin CA, Dovidio JF, Brescoll VL, *et al.* Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences of the United States of America* 2012;**109**:16474–9.

18 List of Registered Medical Practitioners - statistics. General Medical Council. http://www.gmc-uk.org/doctors/register/search_stats.asp (date accessed 22 August 2013).

~~Disparities~~ Differences in research funding for women scientists: a systematic ~~analysis of~~ comparison of UK investments in global infectious disease research 1997–2010

Michael G Head[a*], Joseph R Fitchett[b], Mary K Cooke[a], Fatima B Wurie[a], Rifat Atun[c]

a University College London, Research Department of Infection and Population Health, UCL Royal Free Campus, Rowland Hill Street, London, NW3 2PF

b London School of Hygiene & Tropical Medicine, Keppel Street, London, WC1E 7HT

c Imperial College London, South Kensington Campus, London SW7 2AZ and Harvard School of Public Health, Harvard University, Boston, USA

*Corresponding Author

Number of Words: **3 758**

Keywords – gender, funding, research, women,

Abstract

Objectives: There has not previously been a systematic comparison of awards for research funding in infectious diseases by sexThere has not previously been a systematic analysis exploring gender disparities in awards for research funding. We investigated funding awards to UK institutions for all infectious disease research from 1997 to 2010, across disease categories and along the research and development continuum.

Formatted: Font: (Default) Arial, 11 pt

Design: Systematic analysis

Methods: Data were obtained from several sources for awards from the period 1997-2010 and each study assigned to - disease categories; type of science (pre-clinical, phases I-III trials, product development, implementation research); categories of funding organisation. Fold differences and statistical analysis were used to compare total investment, study numbers, mean grant, and median grant between men and women.

Results: 6052 studies were included in the final analysis, comprising 4357 grants (72.0%) awarded to men and 1695 grants (28.0%) awarded to women, totalling £2.274 billion. Of this, men received £1.786 billion (78.5%) and women £488 million (21.5%). The median value of award was greater for men (£179 389; IQR £59146–£371 977) than women (£125 556; IQR £30 982–£261 834).

Awards were greater for male PIs across all infectious disease systems, excepting neurological infections and sexually transmitted infections. The proportion of total funding awarded to women ranged from 14.3% in 1998 to 26.8% in 2009 (mean 21.4%), and was lowest for pre-clinical research at 18.2% (£285.5 million of £1.573 billion) and highest for operational research at 30·9% (£151.4 million of £489.7 million).

Conclusions: There are consistent disparities differences in funding received by men and women principal investigators: women have fewer funded studies and receive less funding in

absolute and in relative terms; the median funding awarded to women is lower across most infectious disease areas, by funder, and type of science. These ~~disparities~~ differences remain broadly unchanged over the 14-year study period.

Article summary

Article focus

- We explore the distribution of funding across infectious disease research by the gender of principal investigator to identify any ~~disparities~~ differences in funding received by men and women researchers in the UK.

Key messages

- There are consistent ~~disparities~~ differences in funding received by men and women principal investigators (PIs) in infectious disease research funded in the UK.
- Total funding and the median award across most disease areas and type of science is typically greater in male PIs than female PIs
- These ~~disparities~~ differences remain consistent over the time period of analysis (1997-2010)

Strengths and limitations of this study

- This is the first study to present detailed data and rigorously quantify funding ~~disparities~~ differences between men and women researchers in infectious disease research in the UK.
- Our results provides new and additional evidence on ~~disparities~~ differences on funding for men and women researchers highlighted in earlier studies and provides a case for new research to explain the source of these ~~disparities~~differences,

especially given government commitments to increase the number of women in science

- We were unable to assess the success and failure rates by gender and thus cannot comment on the extent of inequalities or bias. As we could not feasibly access data on the academic ranking of principal investigators, we were hence unable to adjust for levels of seniority across both genders. A follow-up study incorporating this data would allow for more meaningful conclusions to be drawn about the nature of any possible disparities.

Introduction

Women are under-represented in biomedical science, yet few studies have systematically explored the extent and reasons for the observed ~~disparities~~ differences between men and women scientists. Women comprise 50% of the EU student population and 45% of doctoral students, but only one third of career researchers are women – a figure that is lower for senior positions.[1]

In 2001, a Wellcome Trust survey concluded that although women were as successful as men in securing funding for biomedical research, they were less likely to apply for grant funds because of their status in scientific institutions and the level of support they received.[2] An analysis of Wellcome Trust awards in 2000-08 revealed a significant gender difference in the amount of funding awarded, even after adjusting for the seniority of the principal investigator, concluding "the most likely explanation for the difference in amounts awarded to women and men is that women are systematically less ambitious in the amounts of funding requested in their grant applications."[3] In 2011, around 44% of academics in UK universities were women, yet only 39% of senior lecturers and 19% of professors were women.[4] Furthermore, a number of studies from the US have shown that women in science are disadvantaged compared to men.[5–7]

The low numbers of women in science and the reasons for this anomaly is a concern for scientists and policy makers. Although the UK Medical Research Council (MRC) has a gender equality scheme, which briefly states gender equality is reflected in agreements with research organisations receiving MRC funding, it is not clear how the scheme is implemented.[8]

While several initiatives have aimed to increase the numbers of women involved in science, there are no affirmative actions or binding policies in the UK or Europe to definitively ensure women are better represented in science. Indeed, some initiatives aimed at increasing women in science have been criticised. For example, in 2012, the European Commission campaign targeting 13-18 year-old secondary school students[9] was rebuked and described as an insult to women in science[10],[11], with the offending video clip removed from the EU campaign website. The effects of campaigns aimed at raising the profile of women in science[12,13] have not been assessed.

We have previously undertaken a systematic analysis of research funding awarded to UK institutions for all infectious disease research, for the 14-year period from 1997 to 2010.[14] Here, we use the dataset gathered for this earlier study to examine trends over time, the distribution of funding awarded to men and women principal investigators (PIs) across specific infections, funder categories, and along the research and development (R&D) continuum, extending from pre-clinical to clinical and operational research.

Methods

We obtained data from several sources for infectious disease research studies where funding was awarded between 1997 and 2010. The methods for the original study are elaborated in detail elsewhere,[14] and summarised here. We identified 325,922 studies for screening that covered all areas of disease from several funders, and filtered these to identify funding for infectious diseases where the lead institution was in the UK in the period and the year of award 1997-2010. We obtained data from publicly available sources and directly from the funders. We did not include private sector funding in the analysis, as pharmaceutical sector data were not publicly available. Figure 1 shows the sources of data

and the numbers of studies included and excluded at each stage of screening to reach the final set of studies for detailed analysis.

Figure 1. Methodology flow chart for filtering studies firstly by infectious disease and then by gender

Data collection and cleaning took place alongside routine duties between 2006 and 2011, primarily by MGH and assisted by JRF, MKC and FBW. Funding records could feasibly be obtained going back to 1997, hence the decision to cover awards during 1997-2010. We assigned each study to primary disease categories, and within each category, we documented topic-specific subsections, including specific pathogen or disease. We allocated studies to one of four categories along the R&D continuum: pre-clinical; phases I, II or III; product development; and operational research, and to one of the 26 categories for funding organisations.

Where the PI was named, we assigned them to men or women categories. The studies where only an initial was available for the forename were assigned as "unclear" if we were unable to establish the PIs gender from a review of the literature, institutional websites or publicly available publications and documents.

Reference to sexually transmitted infections excludes HIV. Neglected tropical diseases were categorised according to classification used by the World Health Organization (WHO) (http://www.who.int/neglected_diseases/diseases/en). Antimicrobial resistance includes antibacterial, antiviral, antifungal and antiparasitic studies.

We converted grants awarded in a currency other than pounds sterling to UK pounds using the mean exchange rate in the year of the award. We adjusted grant funding amounts for inflation and reported in 2010 UK pounds.

As well as excluding studies not immediately relevant to infection, we excluded unfunded studies, veterinary infectious disease research studies (unless there was a zoonotic component), those exploring the use of viral vectors to investigate non-communicable diseases, grants for symposia or meetings, or studies with UK contributions (e.g. as a collaborator), but the funding was awarded to a non-UK institution.

We used Microsoft Excel versions 2000 and 2007 to categorise studies. Where needed, data were exported into Microsoft Access (versions 2000 and 2007) and specific keyword queries used to select precise sections of the data for analysis. We used Stata (version 11·0) for statistical analysis and to generate figures.

We used fold differences to compare total investment, number of studies, mean grant, and median grant between men and women according to disease system, specific infection and funding organisation.

We used nonparametric Mann-Whitney rank-sum test to assess the distribution of funding by gender. Nonparametric K-sample test on equality of medians was applied to compare the median funding by gender, and reported as a chi-squared statistic without Yates' correction for continuity. Nonparametric Wilcoxon signed-rank test was applied when comparing matched data, such as time trends by gender. The significance for all tests was defined at the 5% level (two-sided P=0.05).

We present ~~disparities~~ differences between gender and do not attempt to investigate or imply bias or inequalities as we could not access data on unsuccessful grant applications.

Results

We identified 6165 studies from the 325,922 studies screened that were suitable for inclusion in our analysis. Of these, we were unable to ascertain the gender of principal investigator for 30 studies (0.5%). We excluded 83 studies (1.3%) that did not specify the PIs name or gender – these were funded by the Bill and Melinda Gates Foundation (Gates Foundation) (38 studies; 0.6%) and the UK Department for International Development (DFID) (22 studies; 0.4%), accounting for £321.2 million (12.3% of the total). We included 6052 studies in the final analysis, comprising 4357 grants (72.0%) awarded to men and 1695 grants (28.0%) awarded to women, totalling £2.274 billion, of which £1.786 billion (78.5%) were awarded to men and £488 million (21.5%) awarded to women.

The median value of grant funding was greater for men (£179 389; IQR £59146–£371 977) than for women (£125 556; IQR £30 982–£261 834). Similarly, mean value of the grant funding was greater for men (£409 910; SD £840 087) than for women (£288 011; SD £704 474). Figure 2 shows the distribution of the total investments and median funding awarded to PIs by gender over time.

Figure 2a. Total investment over time awarded to male and female principal investigators

Figure 2b Median investment over time awarded to male and female principal investigators

Infectious disease system

Table 1A (web appendix 1) shows the total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to nine disease systems and by gender of PI. We identified no infectious disease system where women led the majority of research efforts or were awarded the majority of funding. Median funding awards were greater for male PIs across all infectious disease systems, with the exception of neurological infections and sexually transmitted infections.

Greatest levels of funding awarded to men and to women were for research into respiratory infections and HIV. Men received a total of £312.1 million for research into respiratory infections compared with £84.4 million for women – a 3.70 fold difference – and a total of £290.8 million for HIV research compared with £79.7 million for women – a 3.65 fold difference.

The largest difference between total funding for men and for women was with gastrointestinal infections (5.65 fold difference) where women received only 15.0% of the total investment (£37.0 million) and spearheaded 18.9% (149) of the studies and neurological infections (4.22 fold difference). Smallest difference between total funding for men and for women was in research into sexually transmitted infections (1.90 fold difference), where women received 35.0% (£45.4 million) of the total funding and led 49.0% (182) of the studies.

Mean funding for grants was significantly greater for men (£409 910; SD £840 087) than for women (£288 011; SD £704 474). The differences in median funding were statistically significant ($P > 0.01$) for gastrointestinal infections (men £328 021; SD £458 720) (women £248 615; SD £433 176), for haematological infections (men £417 889; SD £914 626)

(women £306 126; SD £819 910), and for HIV (men £649 216; SD £1 550 920) (women £278 505; SD £545 657).

Median funding for grants showed a similar pattern, with significantly greater grant funding for men (£179 389; IQR £59 146–£371 977) than women (£125 556; IQR £30 983–£261 835). Differences in median funding were statistically significant (*P* > 0.05) for gastrointestinal infections (men £208 369; IQR £78 852–357 771) (women £155 066; IQR £43 637–£305 928), for hepatic infections (men £118 638; IQR £41 342–£269 629) (women £68 620; IQR £26 720–£221 952), and for HIV (men £163 462; IQR £39 153–£511 800) (women £114 272; IQR £29 880–£305 339).

Specific Infections

Table 1B (web appendix 1) shows total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to specific infection by gender.

Men received significantly higher levels of total research funding, spearheaded greater numbers of studies, and were awarded greater median and mean funding for grants for malaria (*P = 0.01*), HIV (*P = 0.01*) and influenza (*P = 0.04*).

Major differences between total funding for men and for women were observed for research into candida (47.75 fold difference), rotavirus (33.65 fold difference), campylobacter (24.33 fold difference) and norovirus (23.33 fold difference). Smallest differences between total funding for men and women were for research into dengue (1.07 fold difference) and leishmaniasis (1.55 fold difference). Women received greater total funding than men for research into leprosy (0.09 fold difference), diphtheria (0.18 fold difference), chlamydia (0.36 fold difference), syphilis (0.37 fold difference), and varicella zoster (0.54 fold difference).

Differences in mean grant funding were statistically significant ($P > 0.05$) for malaria research (men £590 422; SD £1 324 909) (women £318 054; SD £726 872), for influenza (men £616 643; SD £881 493) (women £387 186; SD £489 997), for respiratory syncytial virus (men £485 283; SD £539 396) (women £187 931; SD £268 412), and for HIV (men £649 216; SD £1 550 920) (women £278 505; SD £545 657).

Differences in median grant funding were statistically significant ($P > 0.05$) for malaria research (men £209 646; IQR £63 826–£529 610) (women £143 358; IQR £42 754–£314 524), for hepatitis C (men £124 797; IQR £42 475–£289 293) (women £67 265; IQR £29 880–£233 467), for influenza (men £348 730; IQR £213 601–£668 561) (women £200 787; IQR £124 210–£398 191), for herpes simplex virus (men £119 295; IQR £40 009–£446 395) (women £309 610; IQR £147 885–£439 305), and for HIV (men £163 462; IQR £39 153–£511 800) (women £114 272; IQR £29 880–£305 339).

Figure 3 shows the proportion of total funding awarded to principal investigators by gender over time and a breakdown of investment by research pipeline. The proportion of the total funding awarded to women ranged from 14.3% (in 1998) to 26.8% (in 2009), with a mean proportion of 21.4% for the period studied. The proportion of funding was lowest for pre-clinical research at 18.2% (£285·5 million of £1.573 billion total) and highest for operational research at 30.9% (£151.4 million of £489.7 million). The funding for clinical (Phase I, II and III) research was 29.9% (£25.5 of £85.2) and for product development amounted to 20.4% (£25.8 million of £126.6 million).

Figure 3a. Proportion of investment over time awarded to male and female principal investigators

Figure 3b. Total investment by research pipeline awarded to male and female principal investigators

Funding organisation

Table 2 (web appendix 2) shows in detail the total investment, total numbers of studies, mean grant funding, median grant funding and fold differences in funding according to funding organisation and by gender.

Public funding organisations invested a total of £1.025 billion in research led by men (78.6%) and £279.8 in research led by women (21.4%). Greatest levels of funding awarded to men and to women were by the Wellcome Trust and the UK MRC. Major differences between funding awarded to men and to women PIs were by the BBSRC, with a 6.12 fold difference. Smallest differences between funding awarded to men and to women were by the UK Government funding streams such as the National Institute for Health Research, with a 1.66 fold difference. Mean grant funding from public funding organisations were significantly greater for men at £595 361 (SD £1 080 718) than for women at £448 414 (SD £814 979). Differences were also statistically significant ($P > 0.01$) for UK MRC grants with men at £751 413 (SD £1 020 748) and women at £544 427 (SD £884 442), and for UK Government grants with men at £208 828 (SD £492 519) and women at £182 907 (SD £619 889).

Median grant funding from public funding organisations had a similar pattern with significantly greater grant funding for men at £272 452 (IQR £138 322–£572 529) and women at £213 718 (IQR £92 880–£402 917). Differences were also statistically significant ($P > 0.05$) for UK MRC grants with men at £404 615 (IQR £ 210 068–£811 860) and women at £286 679 (£178 182–£468 998), and for UK Government grants with men at £129 660 (IQR £23 761–£207 320) and women at £59 976 (IQR £12 564–£157 053).

Philanthropic funding organisations invested a total of £691.7 million in research led by men (78.8%) and £185.9 million in research led by women (21.2%).

Mean grant funding from philanthropic funding organisations were significantly greater for men at £338 396 (SD £695 025) than for women at £242 014 (SD £711 420). Differences were also statistically significant (P > 0.01) for Wellcome Trust grants with men receiving £393 652 (SD £723 549) and women £230 168 (SD £362 836), and for other charitable funding organisations with men receiving £211 190 (SD £454 108) and women £271 842 (SD £1 208 852).

Median grants from philanthropic funding organisations showed a similar pattern with significantly greater grant funding for men at £153 653 (IQR £58 589 – £302 774) and women at £114 173 (IQR £42 658 – £222 842). Differences were also statistically significant (P > 0.05) for Wellcome Trust grants with men receiving £191 461 (IQR £74 759 – £362 424) and women £137 241 (IQR £54 019 – £250 723), and for other charitable funding organisations with men receiving £91 991 (IQR £36 429 – £172 497) and women £76 058 (IQR £17 279 – £150 727).

Figure 4 shows the association between funding organisation and total investment and median funding by gender. The MRC awarded the highest median amount in grants to women (£286 679; IQR £178 182–£468 998), but the median funding amount in grants for men were 1.41 fold higher than that awarded to women (£404 615; IQR £210 068–£811 860). European Commission awarded the highest mean grants to women at £923 364 (SD £1 316 016) however mean funding amount in grants for men were 1.44 fold higher at £1325 149 (SD £2 409 860) than that for women.

Figure 4a. Association between funding organisation and total investment by gender

Figure 4b. Association between funding organisation and median award by gender

Time trend

Table 3 (web appendix 3) shows in detail the trends in funding over time from 1997 to 2010 by gender of principal investigators, with amounts and relative proportions each year of funding. Mean annual funding received was greater by men at £127.6 million (SD £48.7 million) than women at £34.9 million (SD £13.4 million). Proportions of annual funding received by men ranged from 73.2% to 85.7%, with a mean of 78.6%.

Proportions of annual funding received by women ranged from 14.3% to 26.8% with a mean of 21.4%. The largest annual funding received by men was £245.7 million in 2000, and the smallest at £64.2 million in 1997. The largest annual funding received by women was £59.6 million in 2002, with the smallest at £13.1 million in 1998.

Over the 14-year study period, the proportion of investment awarded to women each year remains relatively unchanged with a mean of 21.4% of total (range 14.3%–26.8%; £13.1 million to £59.6 million). Figure 5 shows the funding trends over time and fold differences in total investments by gender. Absolute difference in the funding amounts in the grants awarded to men and women ranges between £47.9 million and £190.1 million, with a mean difference of £92.7 million (SD £38.3 million). Fold difference in grant funding for men and women ranged from 2.74 to 5.97, with a mean fold difference of 3.66.

Figure 5a. Total investment and trend over time, by gender

Figure 5b. Fold difference of investment over time, by gender

Discussion

We present the first detailed and systematic ~~analysis~~ comparison by ~~gender~~ sex of investments in infectious disease research in the UK for the 14-year period 1997-2010. We identified 6165 studies funded by public and philanthropic funding organisations, with total research investment of £2.6 billion.

We quantified the differences in research funding awarded by gender to show these to be substantial. The analysis shows clear and consistent ~~disparities~~ differences between men and women principal investigators, with lower funding in terms of the total investment, the number of funded studies, the median funding awarded and the mean funding awarded across most of the infectious disease areas funded. Women received less funding in absolute amounts and in relative terms, by funder and the type of science funded along the R&D pipeline. These ~~disparities~~ differences in funding between men and women persist over time.

We show large ~~disparities~~ differences in median funding amounts for men and women researchers in investments by the European Commission and the MRC. Such differences were much less apparent when comparing funding from the Department of Health and BBSRC, although the BBSRC awarded 86% of funding to men. The BBSRC almost entirely funds pre-clinical research,[14] and this matches the increased proportions of pre-clinical studies being led by male principal investigators.

Our findings in infectious disease research, the most detailed to date, provide new evidence on ~~disparities~~ differences between men and women researchers, to reinforce the concerns raised in earlier studies.[4,15,16] ~~Disparities~~ Differences that are more marked at senior levels of academia need to be investigated to explain and account for the observed differences.

The reasons why the median awards across most infectious disease conditions should be significantly less for women principal investigators cannot be deduced from the available data. Thus, it is not possible to recommend interventions to address this phenomenon, given that it is unclear if there is any bias, or precisely what mechanisms are at play. The next step may be to investigate success rates by gender to assess how many women are applying, and what proportion of the initial request for funding is actually allocated.

Formatted: Font: (Default) Arial, 11 pt

Formatted: Font: (Default) Arial, 11 pt

There have been suggestions that women are systematically less ambitious in the amounts of funding requested in their grant applications when compared with men who are equivalently ranked academically, and that relatively simple mentoring programmes could at least partially overcomes this anomaly.[3] However, there is no evidence supporting these assertions. Others have suggested that systems which ensure PI anonymity during review of grant funding submissions may help reduce the presence of any subtle gender biases[17], though in practice this approach would be challenging as the experience of the PI is a key factor when considering suitability of request for research support. However, evidence on effective interventions to address barriers for women scientists are lacking.[16] Women of child-bearing age are being disadvantaged in some areas of employment, even though in relation to scientific endeavour, productivity as measured by published outputs is not significantly different between women with and without children.[15]

Study limitations

Our analysis has several limitations. We rely on the accuracy of the original data from the funding organisations and as described elsewhere we have excluded data from the private sector as the publicly available data are incomplete.[14]

In the period analysed, we were not able to find data on the number of men and women PIs requesting financial support for research agencies from the funding sources studies. Hence, we were unable to assess the success and failure rates by gender. We also did not have complete data on the amount of funding initially requested, the gender of co-applicants for each study, the total pool of researchers in each disease area and within each type of science, or the proportion of awards made to clinical and non-clinical researchers, all of which would be useful pieces of information in developing a clearer picture of the reasons for the presented differences. The proportion of doctors registered in the UK favours men (56.8% as of January 2013) over women,[18] but the proportion of those carrying out research appears to be unknown. Understanding the distribution of researchers is critical to understanding the research landscape.

We lacked data on the academic ranking of principal investigators and were hence unable to adjust for levels of seniority across both genders. We were unable to get data on gender from the Gates Foundation and DFID and hence were unable to clarify the gender of a small proportion of investigators, though we believe this limitation is not likely to change the conclusions of the study. Our analysis focuses on infectious disease research, and analysis of other areas of scientific research would be needed if these ~~disparities~~ differences persisted for all research areas.

Conclusions

Notwithstanding limitations, our systematic analysis shows unequal distribution of investments in infectious disease research for men and women. There are fewer women receiving funding as principal investigators in infectious disease research, with fewer studies funded with lower funding amounts when successful.

Although earlier studies have discussed possible solutions, including mentoring programmes and advertising campaigns, none have systematically explored the reasons why such differences persist. Hence, without an understanding of the reasons for the observed disparitiesdifferences, the proposed solutions are not very meaningful. There is no evidence that women and men researchers are not equally able, hence, other factors are likely to be at play to explain the observed disparities differences which have persisted over the 14-year study period. From our data, the limitations mean that we cannot explain what these mechanisms might be. Research is needed to elucidate an understanding of the factors that can explain the observed disparitiesdifferences. A sub-analysis of our dataset where information on academic rank at time of award is obtained would allow for more meaningful conclusions. We strongly urge policy makers, funders and scientists to urgently investigate the factors leading to the observed disparities differences and develop policies developed to address them, in order to ensure that women are appropriately supported in scientific endeavour.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors

Author contribution

MGH designed the study with input from RA and JF and collated the dataset. JRF, FW and MKC checked and refined the dataset. JRF undertook data analysis and created the graphs and figures with input from MGH and RA. MGH, JRF, and RA interpreted the data and wrote the first draft. MGH, JRF, and RA refined the analysis and paper with input from MKC and FBW. All authors reviewed and approved the final version. MH is guarantor of the paper.

Competing interests

RA has received research funding from the UK Medical Research Council, the UK National Institute for Health Research, UK CRC, UK EPSCRC, the UK Department for International Development and the UK Department of Health. RA is a member of the UL Medical Research Council Global Health Group. MGH works for the Infectious Disease Research Network, which has supported this work and is funded by the UK Department of Health. JRF has received funds from the Wellcome Trust and is a steering group member for the Infectious Disease Research Network. MKC has received funding from the Medical Research Council and the Bill & Melinda Gates Foundation. FBW has received funds from UCLH Charitable Foundation.

Acknowledgements

We thank Jennifer Harris and Raidah Haider for their input and assistance, and acknowledge the assistance of the research and development funding agencies for provision of data.

Data-sharing statement

All gender data is available with this submission. Further data relating to the Research Investments project can be found at www.researchinvestments.org or by contacting the corresponding author.

References

1 More women in senior positions. Key to economic stability and growth. European Commission, Luxembourg: 2010.

2 Blake M, La Valle I. Who applies for research funding? Key factors shaping funding application behaviour among women and men in British higher education institutions. London: 2000.

3 Bedi G, Van Dam NT, Munafo M. Gender inequality in awarded research grants. *Lancet* 2012;**380**:474.

4 Fitzpatrick S. A Survey of Staffing Levels of Medical Clinical Academics in UK Medical Schools as at 31 July 2011. London: 2012. http://www.medschools.ac.uk/Publications/Documents/MSC_Clinical_Academic_Staff_Survey_310711.pdf (date accessed 22 August 2013)

5 Burrelli J. Thirty-Three Years of Women in S&E Faculty Positions - US National Science Foundation. Arlington: 2008. http://www.nsf.gov/statistics/infbrief/nsf08308/ (date accessed 22 August 2013)

6 Lincoln AE, Pincus SH, Leboy PS. Scholars' awards go mainly to men. *Nature* 2011;**469**:472.

7 Pohlhaus JR, Jiang H, Sutton J. Sex differences in career development awardees' subsequent grant attainment. *Annals of internal medicine* 2010;**152**:616–7; author reply 617.

8 Medical Research Council. MRC Gender Equality Scheme. 2007.http://www.mrc.ac.uk/Utilities/Documentrecord/index.htm?d=MRC003655 (date accessed 22 August 2013).

9 European Commission. About this site- Science: It's a girl thing! 2012. http://science-girl-thing.eu/en/about-this-site (date accessed 22 August 2013)

10 Gill M. "Science, it's a girl thing!" says EU Commission, holding lipstick and bunsen burner. New Statesman. 2012. http://www.newstatesman.com/blogs/martha-gill/2012/06/science-its-girl-thing-says-eu-commission-holding-lipstick-and-bunsen-burn (date accessed 22 August 2013).

11 Swain F. Science: It's a girl thing. Excuse me while I die inside. – SciencePunk. ScienceBlogs. 2012. http://scienceblogs.com/sciencepunk/2012/06/22/science-its-a-girl-thing-excuse-me-while-i-die-inside/ (date accessed 22 August 2013)

12 Yong E. Edit-a-thon gets women scientists into Wikipedia. Nature. 2012. http://www.nature.com/news/edit-a-thon-gets-women-scientists-into-wikipedia-1.11636 (date accessed 22 August 2013)

13 Donald A. Throw off the cloak of invisibility. *Nature* 2012;**490**:447.http://www.nature.com/news/throw-off-the-cloak-of-invisibility-1.11638 (date accessed 22 August 2013).

14 Head MG, Fitchett JR, Cooke MK, *et al.* UK investments in global infectious disease research 1997-2010: a case study. *The Lancet infectious diseases* Published Online First: 7 November 2012.

15 Fox MF. Gender, Family Characteristics, and Publication Productivity among Scientists. *Social Studies of Science* 2005;**35**:131–50.

16 Ceci SJ, Williams WM. Understanding current causes of women's underrepresentation in science. *Proceedings of the National Academy of Sciences of the United States of America* 2011;**108**:3157–62.

17 Moss-Racusin CA, Dovidio JF, Brescoll VL, *et al.* Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences of the United States of America* 2012;**109**:16474–9.

18 List of Registered Medical Practitioners - statistics. General Medical Council. http://www.gmc-uk.org/doctors/register/search_stats.asp (date accessed 22 August 2013).

Figure 1. Methodology flow chart
90x119mm (300 x 300 DPI)

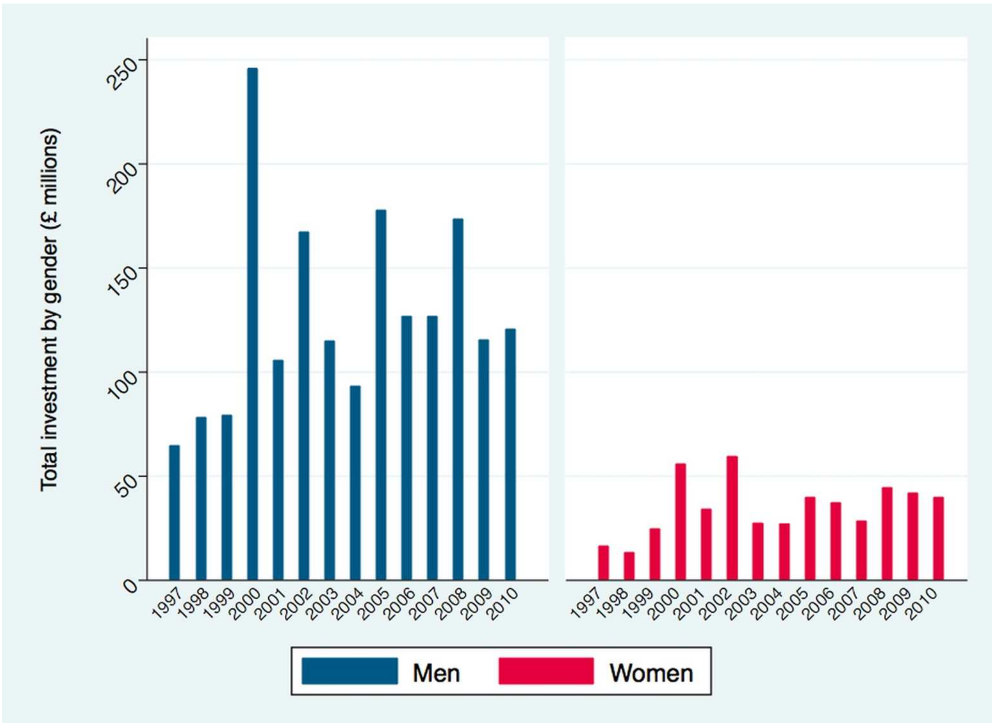


Figure 2a. Total investment over time awarded to male and female principal investigators
123x90mm (300 x 300 DPI)

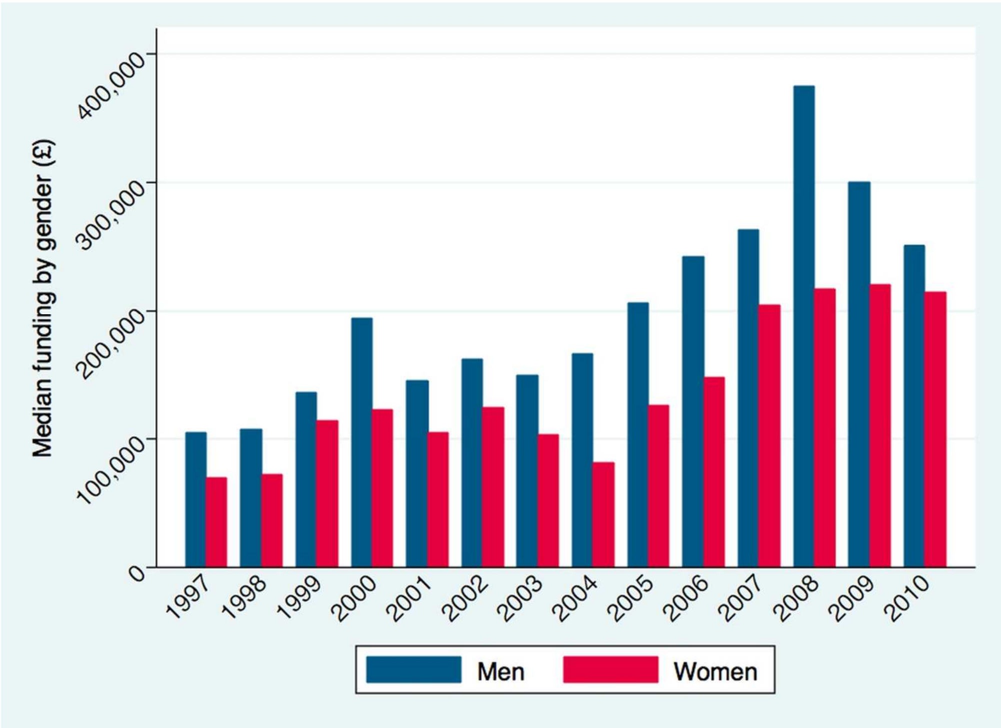


Figure 2b Median investment over time awarded to male and female principal investigators
123x90mm (300 x 300 DPI)

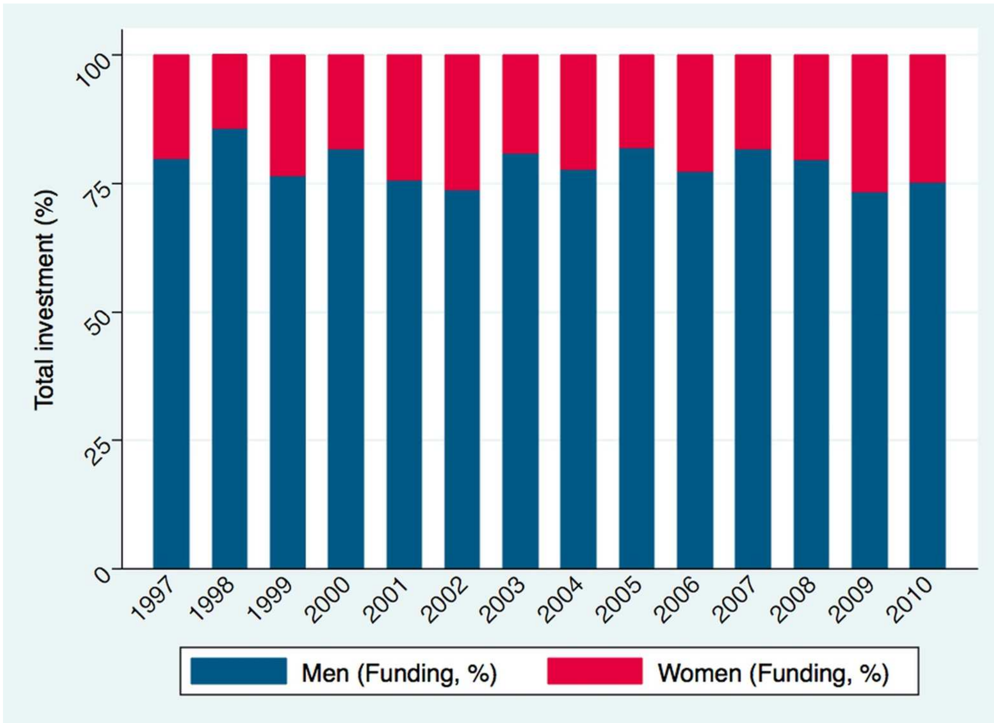
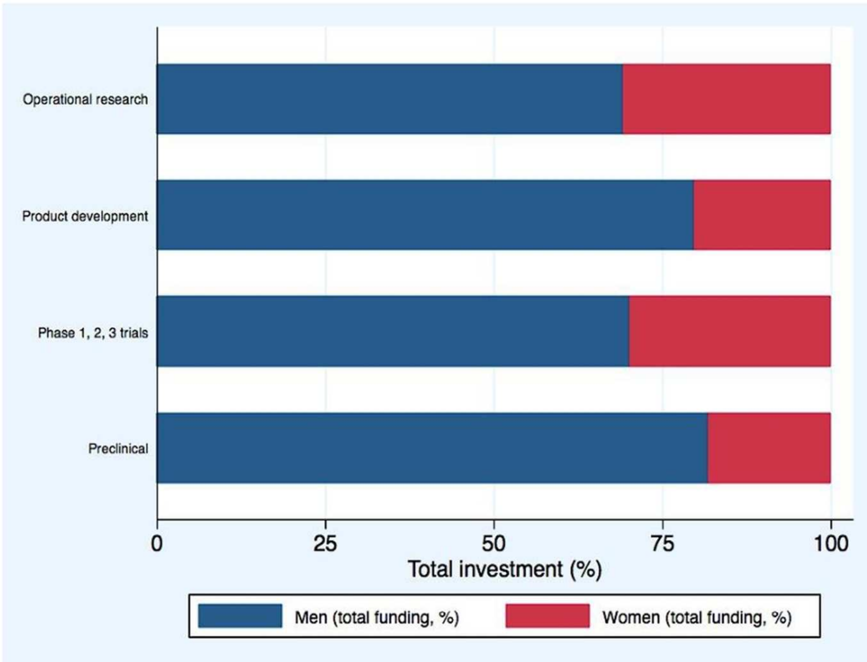
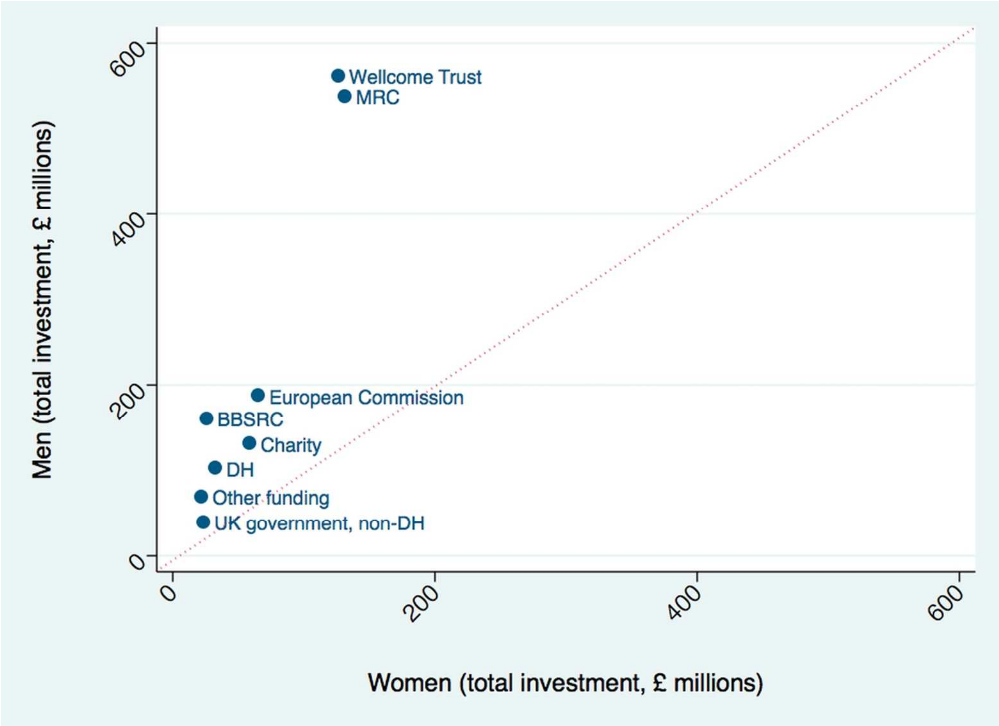


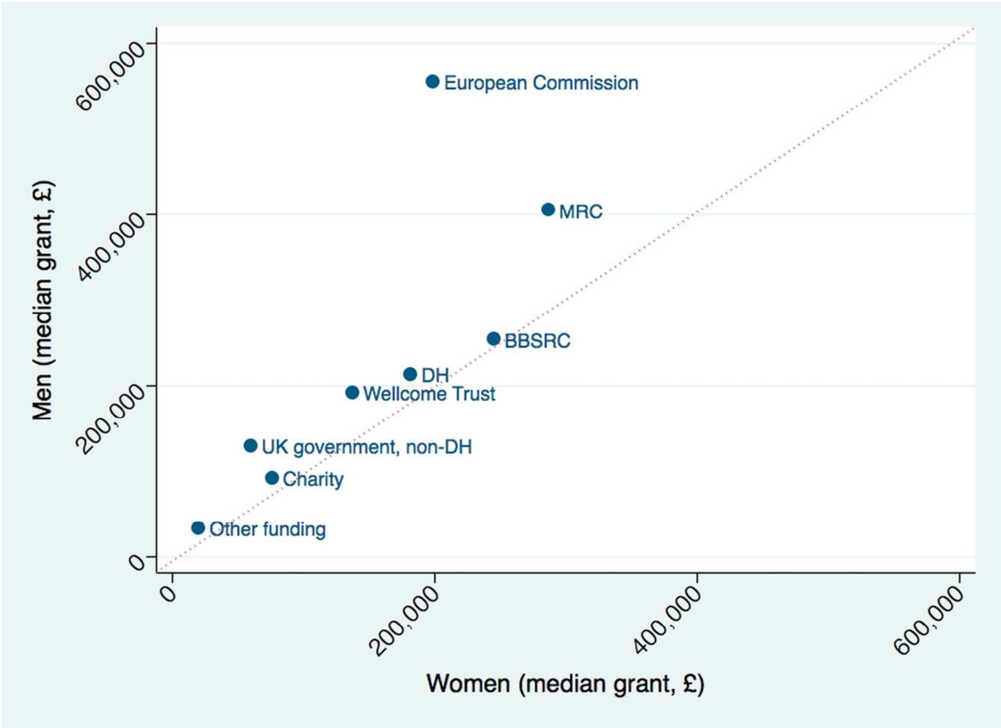
Figure 3a. Proportion of investment over time awarded to male and female principal investigators
123x90mm (300 x 300 DPI)



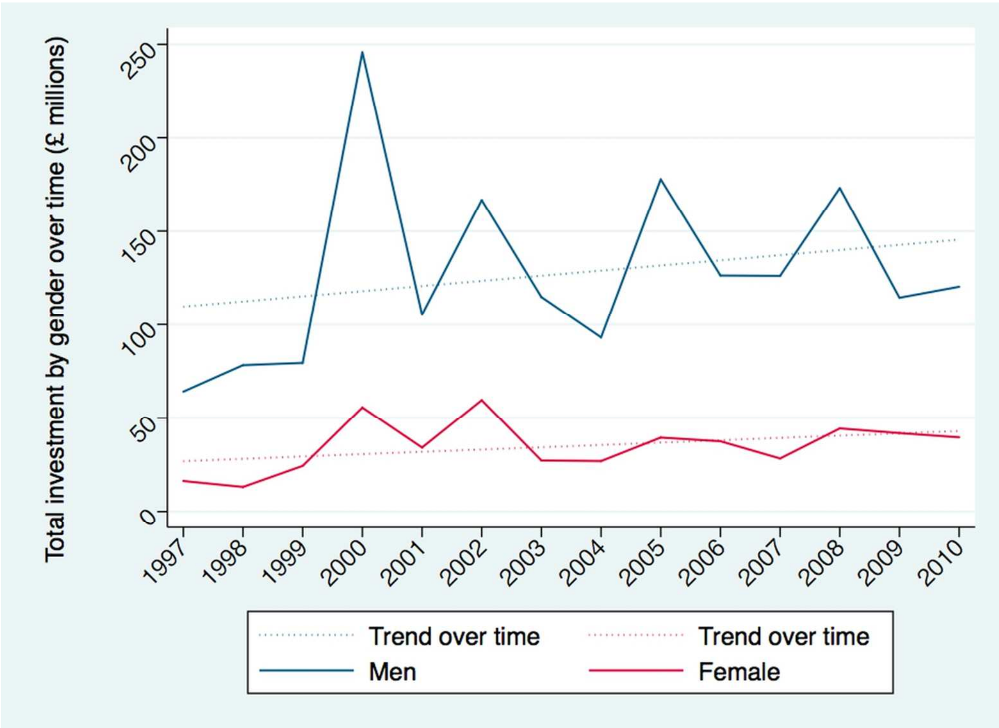
119x90mm (300 x 300 DPI)



123x90mm (300 x 300 DPI)



123x90mm (300 x 300 DPI)



123x90mm (300 x 300 DPI)

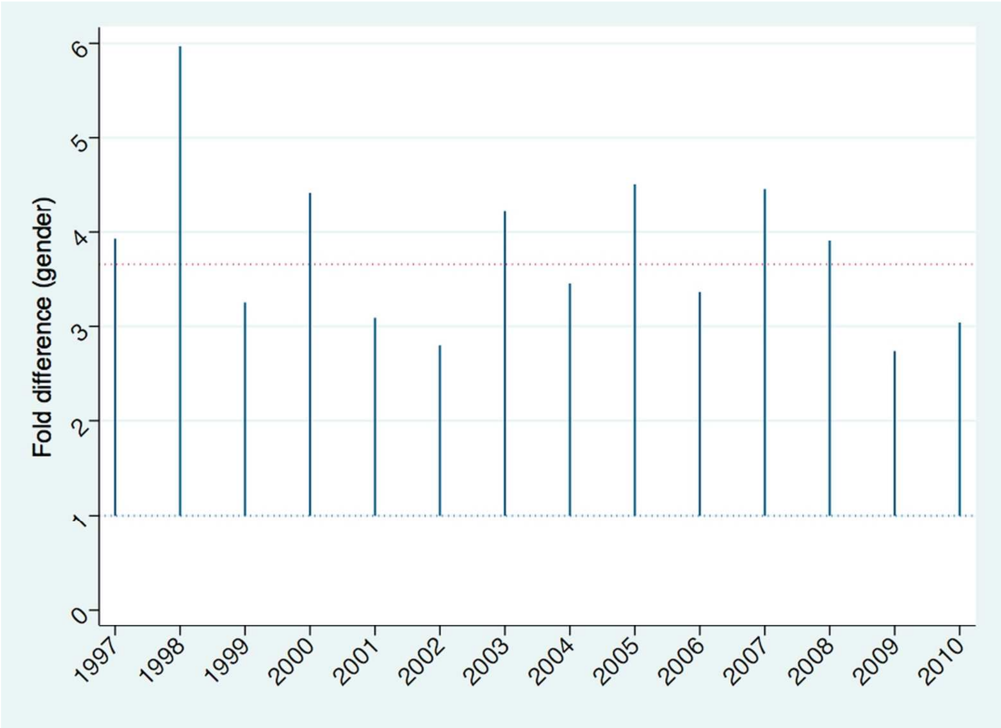


Figure 5b. Fold difference of investment over time, by gender
123x90mm (300 x 300 DPI)

Disease system	Investment (total); £ (%)	Investment (male); £ (%)	Investment (female); £	Fold differenc	Studies (total); n	Studies (male); £	Studies (female); n	Fold differenc	Mean grant (total); £	Mean grant (male); £	Mean grant (female); £	Fold differenc	*P*	Median grant (total); £ (IQR)	Median grant (male); £	Median grant (female); £	Fold differenc	Chi-squar	*P*
Gastrointestinal infections	248,971,849	209,315,616	37,043,642	5.65	799	638	149	4.28	315,154	328,081	248,615	1.32	0.01	199,043	208,369	155,066	1.34	6.87	0.01
	9.6%	85.0%	15.0%		12.9%	81.1%	18.9%		457,988	458,720	433,176			721,37-351,372	78,852-357,771	43,637-305,928			
Haematological infections	413,489,870	225,660,012	56,021,079	4.03	742	540	183	2.95	557,264	417,889	306,126	1.37	0.01	157,280	160,655	121,353	1.32	3.15	0.08
	15.9%	80.1%	19.9%		12.0%	74.7%	25.3%		2,179,537	914,626	819,910			157,280-362,727	54,244-366,799	32,207- 271,883			
Hepatic infections	73,965,716	57,998,793	15,618,661	3.71	322	229	90	2.54	229,707	253,270	173,541	1.46	0.07	114,621	118,638	68,620	1.73	3.82	0.05
	2.8%	78.8%	21.2%		5.2%	71.8%	28.2%		375,988	418,392	237,165			40,076-244,293	41,342-269,629	26,270-221,952			
Neglected tropical diseases	229,606,965	118,477,812	37,747,437	3.14	392	280	105	2.67	564,145	418,439	406,270	1.03	0.28	249,458	257,736	199,648	1.29	0.82	0.36
	8.8%	75.8%	24.2%		6.4%	72.7%	27.3%		2,104,383	509,169	667,547			91,196-451,453	82,786-429,781	107,474-413,242			
Neurological infections	101,885,586	79,281,163	18,779,321	4.22	339	268	67	4.00	300,548	295,825	280,288	1.06	0.67	155,404	153,724	166,514	0.92	0.19	0.66
	3.9%	80.8%	19.2%		5.5%	80.0%	20.0%		463,870	474,995	329,198			64,434-334,128	64,702-298,666	33,886-399,971			
Ocular infections	7,407,218	5,788,089	1,619,129	3.57	36	24	12	2.00	205,756	241,170	134,927	1.79	0.92	120,849	146,169	102,901	1.42	0.00	1.00
	0.3%	78.1%	21.9%		0.6%	66.7%	33.3%		280,206	327,354	132,475			7,860-293,837	6,344-348,501	23,666-232,501			
Respiratory infections	418,838,875	312,055,217	84,436,423	3.70	1,190	897	272	3.30	351,375	347,888	310,428	1.12	0.13	158,966	165,813	142,281	1.17	1.87	0.17
	16.1%	78.7%	21.3%		19.3%	76.7%	23.3%		661,990	624,555	558,282			50,203-342,049	56,715-344,512	36,236-311,548			
Sexually-transmitted infectic	138,616,211	86,016,584	45,352,512	1.90	380	190	182	1.04	366,710	452,719	249,190	1.82	0.34	94,790	93,495	101,785	0.92	0.17	0.68
	5.3%	65.5%	34.5%		6.2%	51.1%	48.9%		958,450	1,142,638	647,494			15,332-241,505	18,389-257,444	14,480-204,559			
HIV	477,555,690	290,848,557	79,652,343	3.65	760	448	286	1.57	625,073	649,216	278,505	2.33	0.01	147,404	163,462	114,272	1.43	3.87	0.05
	18.4%	78.5%	21.5%		12.3%	61.0%	39.0%		2,276,762	1,550,920	545,657			37,195-395,644	39,153-511,800	29,880-305,339			
Overall	2,599,985,851	1,785,979,172	488,178,602	3.66	6,170	4,357	1,695	2.57	421,733	409,910	288,011	1.42	0.01	158,055	179,389	125,556	1.43	74.40	0.01
		78.53%	21.47%			71.99%	28.01%		1,315,935	840,087	704,474			49,490-352,699	59,146-371,977	30,983-261,835			

Specific infection	Investment (total); £ (%)	Investment (male); £ (%)	Investment (female); £ (%)	Fold differen	Studies (total); n	Studies (male); £	Studies (female); n	Fold differen	Mean grant (total); £	Mean grant (male); £	Mean grant (female); £	Fold differen	*P*	Median grant (total); £ (IQR)	Median grant (male); £ (IQR)	Median grant (female); £	Fold differen	Chi-square	*P*
Gastrointestinal infections																			
Campylobacter	24,116,021	23,164,038	951,983	24.33	87	80	7	11.43	277,196	289,551	135,998	2.13	0.13	221,532	228,164	49,000	4.66	1.32	0.25
	#VALUE!	96.1%	3.9%		2.2%	92.0%	8.0%		408,655	421,925	156,276			90,341-311,497	92,885-311,530	3,435-305,928			
Clostridium	29,751,310	31,657,635	2,361,459	13.41	72	58	15	3.87	453,647	524,175	157,431	3.33	0.07	204,389	218,177	80,431	2.71	2.06	0.15
	#VALUE!	93.1%	6.9%		1.8%	79.5%	20.5%		796,207	868,222	178,916			42,630-415,635	49,750-451,158	8,256-316,326			
E. coli	25,589,407	23,913,566	2,392,586	9.99	106	95	12	7.92	245,852	251,722	199,382	1.26	0.16	206,784	217,705	132,232	1.65	3.25	0.07
	#VALUE!	90.9%	9.1%		2.7%	88.8%	11.2%		209,792	212,046	192,964			117,440-329,159	132,815-331,037	84,455-262,238			
Helicobacter	15,109,554	12,488,366	2,617,778	4.77	101	78	22	3.55	149,600	160,107	118,990	1.35	0.64	83,986	87,694	83,533	1.05	0.00	1.00
	#VALUE!	82.7%	17.3%		2.6%	78.0%	22.0%		214,832	232,566	138,013			11,555-187,678	11,555-191,570	11,647-187,678			
Norovirus	5,102,250	4,892,527	209,723	23.33	12	10	2	5.00	425,188	489,253	104,861	4.67	0.28	200,621	265,972	104,861	2.54	2.40	0.12
	#VALUE!	95.9%	4.1%		0.3%	83.3%	16.7%		568,372	604,564	133,320			91,363-435,732	93,571-496,514	10,590-199,133			
Rotavirus	5,883,445	6,004,983	178,450	33.65	18	17	2	8.50	325,444	353,234	89,225	3.96	0.23	164,690	179,066	89,225	2.01	2.01	0.16
	#VALUE!	97.1%	2.9%		0.5%	89.5%	10.5%		414,279	429,739	98,723			114,718-299,988	134,988-299,988	19,417-159,033			
Salmonella	55,716,287	48,902,187	6,814,100	7.18	145	123	22	5.59	384,250	397,579	309,732	1.28	0.95	256,185	258,483	255,602	1.01	0.18	0.67
	#VALUE!	87.8%	12.2%		3.7%	84.8%	15.2%		474,060	500,122	284,742			132,107-431,762	109,210-440,900	155,066-361,873			
Shigella	3,292,442	2,270,191	1,022,251	2.22	9	6	3	2.00	365,827	378,365	340,750	1.11	1.00	211,456	214,819	211,456	1.02	0.23	0.64
	#VALUE!	69.0%	31.0%		0.2%	66.7%	33.3%		335,500	374,690	312,800			134,251-658,278	134,251-658,278	113,326-697,470			
Haematological infections																			
EBV	45,310,414	36,908,000	7,692,800	4.80	147	115	31	3.71	305,485	320,939	248,155	1.29	0.36	156,697	158,107	154,947	1.02	0.04	0.84
	#VALUE!	82.8%	17.2%		3.7%	78.8%	21.2%		430,746	459,332	301,211			49,657-364,013	65,350-364,013	12,342-364,199			
Listeria	4,751,097	3,146,834	1,731,229	1.82	10	8	3	2.67	443,460	393,354	577,076	0.68	0.41	239,595	236,570	605,470	0.39	0.75	0.39
	#VALUE!	64.5%	35.5%		0.3%	72.7%	27.3%		353,486	359,163	369,384			126,966-705,717	113,867-634,775	194,315-931,444			
Malaria	346,180,494	211,961,339	40,710,857	5.21	501	359	128	2.80	700,143	590,422	318,054	1.86	0.01	203,348	209,646	143,358	1.46	4.13	0.04
	#VALUE!	83.9%	16.1%		12.7%	73.7%	26.3%		2,283,790	1,324,909	726,872			59,122-500,817	63,826-529,610	42,754-314,524			
Hepatic infections																			
CMV	28,369,415	26,102,458	1,911,586	13.65	68	55	12	4.58	417,197	474,590	159,299	2.98	0.06	188,607	201,658	107,488	1.88	1.48	0.22
	#VALUE!	93.2%	6.8%		1.7%	82.1%	17.9%		656,508	714,181	178,655			100,221-392,186	116,516-608,024	23,605-223,834			
Hepatitis B	11,768,095	7,512,333	4,215,080	1.78	68	45	22	2.05	173,060	166,941	191,595	0.87	0.89	65,624	68,646	52,873	1.30	0.19	0.66
	#VALUE!	64.1%	35.9%		1.7%	67.2%	32.8%		287,576	294,644	284,042			19,659-209,501	19,615-202,317	19,703-221,952			
Hepatitis C	59,727,829	47,621,165	11,799,084	4.04	235	167	66	2.53	254,161	285,157	178,774	1.60	0.07	116,883	124,797	67,265	1.86	5.22	0.02
	#VALUE!	80.1%	19.9%		5.9%	71.7%	28.3%		418,722	469,807	242,710			41,342-269,629	42,475-289,293	29,880-233,467			
Neglected tropical diseases																			
African trypanosomiasis	48,082,259	34,546,175	4,478,699	7.71	116	61	13	4.69	563,175	566,331	344,515	1.64	0.54	262,145	256,771	265,009	0.97	0.09	0.76
	#VALUE!	88.5%	11.5%		2.9%	82.4%	17.6%		1,139,333	1,227,091	408,381			151,883-466,918	155,868-455,554	119,521-406,701			
Chagas disease	3,448,856	4,675,712	250,535	18.66	15	17	1	17.00	273,680	275,042	250,535	1.10	0.77	215,639	215,530	250,535	0.86	1.06	0.30
	#VALUE!	94.9%	5.1%		0.4%	94.4%	5.6%		207,903	214,219				163,472-350,741	163,472-350,741				
Dengue	43,742,101	5,251,615	4,924,187	1.07	28	13	13	1.00	1,511,059	403,970	378,784	1.07	0.32	269,824	378,745	199,648	1.90	0.15	0.70

	#VALUE!	51.6%	48.4%		0.7%	50.0%	50.0%		5,899,700	336,526	504,639			107,474-530,125	148,612-515,075	69,518-361,828			
Helminths	47,026,454	39,675,624	14,701,767	2.70	114	104	43	2.42	452,438	381,496	341,902	1.12	0.87	233,772	235,696	215,206	1.10	0.24	0.62
	#VALUE!	73.0%	27.0%		2.9%	70.7%	29.3%		1,112,173	464,792	414,897			82,786-386,182	67,614-383,928	126,942-358,645			
Leishmaniasis	36,027,609	25,384,994	16,332,809	1.55	75	50	26	1.92	536,433	507,700	628,185	0.81	0.53	289,354	320,800	229,548	1.40	2.10	0.15
	#VALUE!	60.8%	39.2%		1.9%	65.8%	34.2%		797,514	579,922	1,127,441			91,196-518,477	80,166-518,477	131,221-573,851			
Leprosy	623,080	49,229	573,851	0.09	2	1	1	1.00	311,540	49,229	573,851	0.09	0.32	311,540	49,229	573,851	0.09	2.00	0.16
	#VALUE!	7.9%	92.1%		0.1%	50.0%	50.0%		370,963					49,229-573,851					
Lymphatic filariasis	51,112,541	1,802,818	317,909	5.67	16	3	2	1.50	6,723,245	600,939	158,954	3.78	0.25	551,459	551,459	158,954	3.47	2.22	0.14
	#VALUE!	85.0%	15.0%		0.4%	60.0%	40.0%		12,112,993	426,007	127,226			201,834-12,844,013	201,834-1,049,526	68,992-248,917			
Onchocerciasis	1,338,978	1,317,029	380,594	3.46	4	2	3	0.67	339,525	658,515	126,865	5.19	0.25	35,769	658,515	21,359	30.83	0.14	0.71
	#VALUE!	77.6%	22.4%		0.1%	40.0%	60.0%		546,719	880,696	200,996			21,359-358,645	35,769-1,281,261	590-358,645			
Schistosomiasis	38,677,801	11,068,267	2,686,364	4.12	46	32	12	2.67	867,572	345,883	223,864	1.55	0.60	197,557	216,603	165,622	1.31	0.46	0.50
	#VALUE!	80.5%	19.5%		1.2%	72.7%	27.3%		3,825,582	467,692	252,854			59,912-361,947	61,878-356,186	46,460-318,519			
Trachoma	3,718,572	3,718,572	0		3	2	0		1,859,286	1,859,286				1,859,286	1,859,286				
	#VALUE!	100.0%	0.0%		0.1%	100.0%	0.0%		1,768,466	1,768,466				608,792-3,109,780	60,879-3,109,780				
Neurological infections																			
Meningitis	54,078,664	42,305,152	9,347,473	4.53	223	183	38	4.82	243,434	231,176	245,986	0.94	0.59	146,153	137,694	155,670	0.88	1.21	0.27
	#VALUE!	81.9%	18.1%		5.6%	82.8%	17.2%		355,892	332,118	297,867			66,895-228,405	66,895-222,767	33,886- 369,244			
Polio	1,189,984	729,017	11,069	65.86	4	3	1	3.00	185,021	243,006	11,069	21.95	0.18	164,849	236,812	11,069	21.40	1.33	0.25
	#VALUE!	98.5%	1.5%		0.1%	75.0%	25.0%		170,640	153,310				51,977-318,065	92,886-399,318				
Tetanus	5,108,068	5,108,068	0		5	5	0		1,021,614	1,021,614				231,879	231,879				
	#VALUE!	100.0%	0.0%		0.1%	100.0%	0.0%		1,819,723	1,819,723				200,112-395,050	200,112-395,050				
Respiratory infections																			
Diphtheria	139,863	21,624	118,239	0.18	2	1	1	1.00	69,931	21,624	118,239	0.18	0.32	69,931	21,624	118,239	0.18	2.00	0.16
	#VALUE!	15.5%	84.5%		0.1%	50.0%	50.0%		68,317					21,624-118,239					
Influenza	79,763,001	68,447,401	11,615,587	5.89	140	111	30	3.70	567,823	616,643	387,186	1.59	0.04	299,988	348,730	200,787	1.74	4.06	0.04
	#VALUE!	85.5%	14.5%		3.5%	78.7%	21.3%		818,009	881,493	489,997			159,841-656,509	213,601-668,561	124,210-398,191			
Measles	2,597,677	3,827,746	646,169	5.92	9	7	3	2.33	416,179	546,821	215,390	2.54	0.57	284,882	662,131	261,846	2.53	0.48	0.49
	#VALUE!	85.6%	14.4%		0.2%	70.0%	30.0%		403,740	481,360	122,549			67,471-683,714	58,538-893,212	76,405-307,919			
Pertussis	2,432,158	2,432,158	0		9	9	0		270,240	270,240				299,840	299,840				
	#VALUE!	100.0%	0.0%		0.2%	100.0%	0.0%		246,165	246,165				37,151-452,939	37,151-452,939				
RSV	16,899,738	14,073,205	2,818,964	4.99	45	29	15	1.93	375,550	485,283	187,931	3.96	0.05	184,292	223,517	149,828	1.49	2.53	0.11
	#VALUE!	83.3%	16.7%		1.1%	65.9%	34.1%		480,715	539,396	268,412			56,431-498,006	64,191-638,823	22,277-199,329			
Tuberculosis	148,801,691	99,451,331	37,578,889	2.65	327	225	94	2.39	472,083	442,006	399,775	1.11	0.39	190,467	190,657	170,542	1.12	0.21	0.65
	#VALUE!	72.6%	27.4%		8.3%	70.5%	29.5%		930,157	825,956	742,928			69,899-421,992	74,747- 416,236	37,034-401,346			
Sexually-transmitted infections																			
Chlamydia	21,702,378	5,753,740	15,936,845	0.36	112	43	68	0.63	193,771	133,808	234,365	0.57	0.71	50,469	52,258	52,318	1.00	0.01	0.91
	#VALUE!	26.5%	73.5%		2.8%	38.7%	61.3%		561,173	197,759	701,950			10,298-174,939	14,885-174,644	6,003-175,234			

Gonorrhoea	948,399	669,866	278,532	2.40	18	9	9	1.00	52,689	74,430	30,948	2.40	0.51	7,548	8,149	6,525	1.25	0.22	0.64
	#VALUE!	70.6%	29.4%		0.5%	50.0%	50.0%		81,648	104,267	47,232			1,820-54,145	6,471-150,196	1,820-40,986			
HIV	460,547,457	290,848,557	79,652,343	3.65	760	448	286	1.57	625,073	649,216	278,505	2.33	0.01	147,404	163,462	114,272	1.43	3.87	0.05
	#VALUE!	78.5%	21.5%		19.2%	61.0%	39.0%		2,276,762	1,550,920	545,657			37,195-395,644	39,153-511,800	29,880-305,339			
HPV	57,795,110	42,592,795	9,393,693	4.53	150	88	56	1.57	355,514	484,009	167,745	2.89	0.30	92,143	103,966	82,325	1.26	0.47	0.49
	#VALUE!	81.9%	18.1%		3.8%	61.1%	38.9%		849,406	1,042,481	360,400			30,079-220,559	29,742-264,540	32,566- 171,377			
HSV	22,063,300	15,472,470	6,536,189	2.37	48	28	19	1.47	459,652	552,588	344,010	1.61	0.19	202,564	119,295	309,610	0.39	4.85	0.03
	#VALUE!	70.3%	29.7%		1.2%	59.6%	40.4%		720,790	908,183	287,596			52,597-421,960	40,009-446,395	147,885-439,305			
Syphilis	1,061,560	286,117	775,444	0.37	5	2	3	0.67	212,312	143,058	258,481	0.55	0.56	207,346	143,058	207,346	0.69	0.14	0.71
	#VALUE!	27.0%	73.0%		0.1%	40.0%	60.0%		152,848	122,822	176,603			113,088-229,907	56,210-229,907	113,088-455,010			
Other infections																			
Aspergillus	4,853,858	4,482,101	371,757	12.06	26	24	2	12.00	186,687	186,754	185,879	1.00	1.00	47,948	47,948	185,879	0.26	0.00	1.00
	#VALUE!	92.3%	7.7%		0.7%	92.3%	7.7%		420,903	435,756	248,298			19,703-157,829	20,890-135,113	10,306-361,451			
Candida	1,219,072	1,194,064	25,008	47.75	8	6	2	3.00	152,384	199,011	12,504	15.92	0.18	28,518	72,375	12,504	5.79	2.67	0.10
	#VALUE!	97.9%	2.1%		0.2%	75.0%	25.0%		262,390	293,075	17,226			10,508-188,568	17,076-264,740	324-24,684			
Pseudomonas	6,473,237	6,096,633	376,604	16.19	43	39	4	9.75	150,540	156,324	94,151	1.66	0.90	81,793	81,793	79,244	1.03	0.00	0.96
	#VALUE!	94.2%	5.8%		1.1%	90.7%	9.3%		175,911	182,442	83,286			11,204-253,337	11,108-253,459	27,396-160,906			
VZV	4,186,583	1,472,968	2,713,615	0.54	20	9	11	0.82	209,329	163,663	246,692	0.66	0.21	145,505	47,343	161,033	0.29	0.20	0.65
	#VALUE!	35.2%	64.8%		0.5%	45.0%	55.0%		261,063	250,869	275,194			46,117-227,502	26,213-147,593	105,632-233,537			
Total specific infections	#VALUE!	#VALUE!	#VALUE!	#VALUE!	3,953	#VALUE!	#VALUE!	#VALUE!						158,055					
Overall	2,599,985,851	1,785,979,172	488,178,602	3.66	6,170	4,357	1,695	2.57	421,733	409,910	288,011	1.42	0.01	49,490-352,699	179,389	125,556	1.43	74.40	0.01
		78.53%	21.47%			71.99%	28.01%		1,315,935	840,087	704,474								

Funder	Investment (total); £ (%)	Investment (male); £ (%)	Investment (female); £	Fold differenc	Studies (total); n (%)	Studies (male); £	Studies (female); n	Fold differenc	Mean grant (total); £	Mean grant (male); £	Mean grant (female); £	Fold differenc	P	Median grant (total); £ (IQR)	Median grant (male); £ (IQR)	Median grant (female); £ (IQR)	Fold differenc	Chi-square	P
Public funding	1,393,972,967	1,025,211,218	279,810,244	3.66	1,082	1,722	624	2.76	588,503	595,361	448,414	1.17	0.01	255,992	272,452	213,718	1.27	29.38	0.01
	53.6%	78.6%	21.4%		17.6%	73.4%	26.6%		1,447,668	1,080,718	814,979			127,167-529,610	138,322- 572,529	92,880-402,917			
BBSRC	186,268,429	160,120,540	26,147,889	6.12	578	485	93	5.22	322,264	330,145	281,160	1.17	0.78	253,398	253,498	244,972	1.03	0.12	0.73
	7.2%	86.0%	14.0%		9.4%	83.9%	16.1%		361,565	383,963	205,593			169,787-365,159	176,763-363,830	149,828-371,577			
DFID																			
DH	134,961,745	101,933,746	32,757,325	3.11	285	194	89	2.18	473,550	525,432	368,060	1.43	0.37	203,544	213,107	181,697	1.17	0.36	0.55
	5.2%	75.7%	24.3%		4.6%	68.6%	31.4%		846,024	968,640	482,041			72,628-514,066	72,627-542,097	65,015-383,886			
European Commission	255,015,533	186,846,015	65,558,847	2.85	219	141	71	1.99	1,164,454	1,325,149	923,364	1.44	0.58	439,762	555,497	199,133	2.79	3.58	0.06
	9.8%	74.0%	26.0%		3.6%	66.5%	33.5%		2,084,358	2,409,860	1,316,016			127,419-1,454,94	123,042-1,504,88	134,621-1,449,403			
MRC	672,895,698	537,260,180	131,751,245	4.08	962	715	242	2.95	699,476	751,413	544,427	1.38	0.01	366,479	404,615	286,679	1.41	18.44	0.01
	25.9%	80.3%	19.7%		15.6%	74.7%	25.3%		993,012	1,020,748	884,442			199,287-713,178	210,068-811,860	178,182-468,998			
UK government, non-DH	144,831,562	39,050,737	23,594,939	1.66	237	187	129	1.45	452,898	208,828	182,907	1.14	0.01	110,178	129,660	59,976	2.16	3.79	0.05
	5.6%	62.3%	37.7%		3.8%	59.2%	40.8%		2,811,384	492,519	619,889			19,073-206,784	23,761- 207,320	12,564-157,053			
Philanthropy	1,108,966,983	691,680,388	185,866,898	3.72	2,879	2,044	768	2.66	383,601	338,396	242,014	1.40	0.01	146,060	153,653	114,173	1.35	23.28	0.01
	42.7%	78.8%	21.2%		46.7%	72.7%	27.3%		1,377,079	659,025	711,420			52,433-286,518	58,589-302,774	42,658-222,842			
Bill & Melinda Gates Foundation	220,923,242				39				5,664,699					1,488,432					
	8.5%				0.6%				8,966,093					628,545-5,576,863					
Charity	199,703,382	130,726,509	58,989,705	2.22	855	619	217	2.85	227,332	211,190	271,842	0.78	0.01	87,318	91,991	76,058	1.21	5.23	0.02
	7.7%	68.9%	31.1%		13.9%	74.0%	26.0%		730,057	454,108	1,208,852			27,616-167,829	36,429-172,497	17,279-150,727			
Wellcome Trust	688,340,359	560,953,880	126,592,102	4.43	1,985	1,425	550	2.59	346,818	393,652	230,168	1.71	0.01	168,434	191,461	137,241	1.40	39.83	0.01
	26.5%	81.6%	18.4%		32.2%	72.2%	27.8%		646,625	723,549	362,836			66,419-335,557	74,759-362,424	54,019-250,723			
Other funding	103,542,992	69,087,566	22,501,460	3.07	1,010	591	303	1.95	103,683	116,899	74,262	1.57	0.01	28,626	32,557	20,373	1.60	4.80	0.03
	4.0%	75.4%	24.6%		16.4%	66.1%	33.9%		273,102	309,358	154,373			6,282-105,082	7,225-113,479	4,408-79,809			
Overall	2,599,985,851	1,785,979,172	488,178,602	3.66	6,165	4,357	1,695	2.57	421,733	409,910	288,011	1.42	0.01	158,055	179,389	125,556	1.43	74.40	0.01
		78.5%	21.5%			72.0%	28.0%		1,315,935	840,087	704,474			49,490-352,699	59,146-371,977	30,983-261,835			

Year	Investment (male); £	Change from previous year (male); £	Fold difference (male)	*P*	Change over 1997 (male); £	Fold difference (male)	*P*	Investment (female); £	Change from previous year (female); £	Fold difference (female)	*P*	Change over 1997 (female); £	Fold difference (female)	*P*	Investment (male); %	Investment (female); %	Absolute difference (gender)	Fold difference (gender)
1997	64,158,003							16,305,109							79.7%	20.3%	47,852,894	3.93
1998	78,287,824	14,129,821	1.22	0.57	14,129,821	1.22	0.57	13,110,597	-3,194,512	0.80	0.90	-3,194,512	0.80	0.90	85.7%	14.3%	65,177,227	5.97
1999	79,477,324	1,189,500	1.02	0.37	15,319,321	1.24	0.14	24,366,507	11,255,911	1.86	0.79	8,061,398	1.49	0.88	76.5%	23.5%	55,110,816	3.26
2000	245,740,477	166,263,153	3.09	0.00	181,582,474	3.83	0.01	55,636,657	31,270,150	2.28	0.01	39,331,548	3.41	0.01	81.5%	18.5%	190,103,820	4.42
2001	105,423,252	-140,317,225	0.43	0.09	41,265,248	1.64	0.01	34,133,067	-21,503,591	0.61	0.23	17,827,958	2.09	0.01	75.5%	24.5%	71,290,185	3.09
2002	166,695,481	61,272,230	1.58	0.89	102,537,478	2.60	0.01	59,568,874	25,435,807	1.75	0.41	43,263,765	3.65	0.01	73.7%	26.3%	107,126,607	2.80
2003	114,827,602	-51,867,880	0.69	0.03	50,669,599	1.79	0.50	27,241,313	-32,327,560	0.46	0.14	10,936,204	1.67	0.05	80.8%	19.2%	87,586,288	4.22
2004	93,129,587	-21,698,015	0.81	0.09	28,971,584	1.45	0.30	26,908,997	-332,316	0.99	0.91	10,603,888	1.65	0.04	77.6%	22.4%	66,220,590	3.46
2005	177,791,995	84,662,408	1.91	0.03	113,633,992	2.77	0.26	39,460,786	12,551,789	1.47	0.60	23,155,677	2.42	0.01	81.8%	18.2%	138,331,209	4.51
2006	126,329,085	-51,462,910	0.71	0.60	62,171,082	1.97	0.54	37,473,263	-1,987,522	0.95	0.35	21,168,154	2.30	0.03	77.1%	22.9%	88,855,822	3.37
2007	126,144,324	-184,761	1.00	0.03	61,986,320	1.97	0.12	28,293,204	-9,180,059	0.76	0.01	11,988,095	1.74	0.48	81.7%	18.3%	97,851,119	4.46
2008	173,132,770	46,988,446	1.37	0.07	108,974,767	2.70	0.01	44,307,821	16,014,617	1.57	0.70	28,002,712	2.72	0.73	79.6%	20.4%	128,824,949	3.91
2009	114,490,290	-58,642,480	0.66	0.12	50,332,287	1.78	0.01	41,820,953	-2,486,868	0.94	0.03	25,515,844	2.56	0.01	73.2%	26.8%	72,669,337	2.74
2010	120,351,159	5,860,868	1.05	0.33	56,193,155	1.88	0.01	39,551,453	-2,269,500	0.95	0.56	23,246,344	2.43	0.06	75.3%	24.7%	80,799,705	3.04
Mean	*127,569,941*	*4,322,550*			*68,289,779*			*34,869,900*	*1,788,180*			*########*			*78.6%*	*21.4%*	*92,700,041*	
SD	*48,770,855*	*76,214,220*			*47,073,847*			*13,365,475*	*17,657,139*			*########*					*38,264,674*	
Total Gende	*1,785,979,172*							*488,178,602*									*1,297,800,569*	3.66
Total Overal	2,599,985,851																	