From presentation to paper: Gender disparities in oncological research

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Gender disparities in scientific publications have been identified in oncological research. Oral research presentations at major conferences enhance visibility of presenters. The share of women presenting at such podia is unknown. We aim to identify gender-based differences in contributions to presentations at two major oncological conferences. Abstracts presented at plenary sessions of the American Society of Clinical Oncology (ASCO) Annual Meetings and European Society for Medical Oncology (ESMO) Congresses were collected. Trend analyses were used to analyze female contribution over time. The association between presenter’s sex, study outcome (positive/negative) and journals’ impact factors (IFs) of subsequently published papers was assessed using Chi-square and Mann–Whitney U tests. Of 166 consecutive abstracts presented at ASCO in 2011–2018 (n = 34) and ESMO in 2008–2018 (n = 132), 21% had female presenters, all originating from Northern America (n = 17) or Europe (n = 18). The distribution of presenter’s sex was similar over time (p = 0.70). Of 2,425 contributing authors to these presented abstracts, 28% were women. The proportion of female abstract authors increased over time (p < 0.05) and was higher in abstracts with female (34%) compared to male presenters (26%; p < 0.01). Presenter’s sex was not associated with study outcome (p = 0.82). Median journals’ IFs were lower in papers with a female first author (p < 0.05). In conclusion,

Additional Supporting Information may be found in the online version of this article.

Key words: research, medical oncology, sex, Congresses as topic

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there is a clear gender disparity in research presentations at two major oncological conferences, with 28% of authors and 21% of presenters of these studies being female. Lack of visibility of female presenters could impair acknowledgement for their research, opportunities in their academic career and even hamper heterogeneity in research.

What’s new?
Presenting one’s research at a conference is a great way to get your name and ideas heard within the professional community. In this study, the authors investigated how often women served as presenters at plenary sessions of ASCO Annual Meetings and ESMO Congresses. Looking through 166 abstracts over a period of 8 years, they found that 21% had female presenters, while 28% of study authors were female. Lack of visibility for female researchers at conferences can slow their career progress, and greater representation should be encouraged.

Introduction
Gender inequalities in science and medicine are increasingly brought to the fore. Despite an expanding number of women entering the field of medicine, female physicians are still at disadvantage in obtaining jobs, less rewarded than men and underrepresented in leadership positions.1–5 In medical research, gender differences are even more pronounced: women are less likely to hold first-author positions on top publications, receive requested grants, be invited as a peer reviewer, or become a full professor.1,4–7

Gender discrepancies in authorships of scientific publications have been identified in many disciplines all over the world, including oncology.2,8–12 However, results of a clinical research project are often first brought to life through a presentation at an international conference. Such a presentation gives the scientific study an actual identity through visibility of the researcher. Presentations at major international conferences are not only important for discussion of the outcomes of a study, they also provide the presenter the opportunity for recognition for as a principal investigator, and increase the chance of climbing the academic career ladder.

Female underrepresentation in presenting studies and invitation to speak at conferences has been identified in other disciplines.13–18 The exact share of women presenting at major oncological conferences is not clear. In our study, we aimed to identify potential gender-based differences in contributions to presentations at two major international oncological conferences: the American Society of Clinical Oncology (ASCO) Annual Meetings and European Society for Medical Oncology (ESMO) Congresses.

Methods
Data collection
We aimed to collect consecutive abstracts of all plenary sessions of ASCO Annual Meetings and presidential sessions of ESMO Congresses between 2000 and 2018. The abstracts presented at these sessions are assumed to have the highest impact on oncological research and practice. Specific data on ASCO abstracts were available from 2011 and on ESMO abstracts from 2008.

Data on ASCO abstracts, including sexes of the presenters, were provided by ASCO Center for Research and Analytics for all abstracts presented at the plenary sessions since 2011. All consecutive ESMO abstracts presented at the presidential sessions since 2008 were identified from the ESMO website (www.esmo.org) or the website of the conference. Data extracted from the abstracts included information on presenters, names and order of authors, country of origin, study subject and results. Sexes of presenters and authors were interpreted based on their first names or, if inconclusive, based on available online information including photos and electronic portfolio of the specific author. Study results were defined as positive and negative if they met or did not meet the primary endpoints, respectively, and neither negative nor positive if results were not clear yet, or if both positive and negative results were found.

From all abstracts, the subsequently published papers were identified and corresponding impact factors (IFs) of the journals in which they were published (obtained from InCites Journal Citation Reports) were collected. One-year IFs of the year in which the article was published were used, or of the previous year in case IFs were not yet known. Any changes in authorships compared to the presented abstract were identified.

Ethical approval to perform our study was not considered to be necessary.

Statistical analysis
Descriptive statistics were used to display the distribution of presenter’s and abstract author’s sex. Chi-square or Fisher’s exact tests where appropriate were used to compare the sex distribution in abstract presenters and authors per year. The association between presenter’s or last author’s sex and distribution of author’s sex, study outcome and IFs were analyzed using Chi-square and Mann–Whitney U tests, respectively. A trend in contribution of both sexes in presenters and abstract authors over time was tested using the Cochran-Armitage trend test; p-values lower than 0.05 were regarded as statistically significant. Statistical analyses were performed using SAS software (version 9.4, SAS institute, Cary, NC).
| Year | Abstract no. | Name | Sex | Country of origin | Author place presenter | Sex last author | No. of authors | No. of male authors | No. of female authors | No. of authors unknown sex | Study outcome | Journal published | Year | IF | Sex of the first author | Sex of the last author | Subject |
|------|-------------|------|-----|-------------------|------------------------|------------------|---------------|------------------|-------------------|------------------------|--------------|-------------------|------|----|-------------------|-------------------|---------|
| 2011 | A-2011-1 | H. Joensuu | M | Finland | First | M | 18 | 13 | 5 | 0 | P | JAMA J Am Med Assoc | 2012 | 29.978 | M | M | GIST |
| 2011 | A-2011-24 | R.L. Ladenstein | F | Austria | First | F | 19 | 9 | 10 | 0 | P | Lancet Oncol | 2017 | 36.418 | F | M | Neuroblastoma |
| 2011 | A-2011-36 | E.C. Larsen | M | United States | First | M | 16 | 8 | 8 | 0 | P | J Clin Oncol | 2016 | 26.008 | M | M | Leukemia |
| 2011 | A-2011-43 | P.B. Chapman | M | United States | First | M | 20 | 17 | 3 | 0 | P | New Engl J Med | 2011 | 53.298 | M | M | Melanoma |
| 2011 | A-2011-55 | J.D. Wolchol | M | United States | First | F | 10 | 9 | 1 | 0 | P | New Engl J Med | 2011 | 53.298 | F | M | Melanoma |
| 2012 | A-2012-1 | K.L. Blackwell | F | United States | First | M | 14 | 10 | 4 | 0 | P | New Engl J Med | 2012 | 51.658 | M | F | Breast cancer |
| 2012 | A-2012-93 | M.J. Van Den Bent | M | The Netherlands | First | M | 19 | 15 | 4 | 0 | P | J Clin Oncol | 2013 | 17.879 | M | M | Oligodendroglioma |
| 2012 | A-2012-1 | M.J. Rummel | M | Germany | First | M | 18 | 15 | 3 | 0 | P | Lancet | 2013 | 39.207 | M | M | Lymphoma |
| 2013 | A-2013-4 | M. Hussain | F | United States | First | M | 18 | 13 | 5 | 0 | N | New Engl J Med | 2013 | 34.220 | F | M | Prostate cancer |
| 2013 | A-2013-36 | M.R. Gilbert | M | United States | First | M | 20 | 15 | 5 | 0 | N | New Engl J Med | 2014 | 55.873 | M | M | Glioblastoma |
| 2013 | A-2013-34 | S.S. Shastri | M | India | First | M | 6 | 4 | 2 | 0 | P | JNCI J Natl Cancer | 2014 | 12.583 | M | M | Cervical cancer |
| 2013 | A-2013-35 | K.S. Tewari | M | United States | First | M | 10 | 6 | 4 | 0 | P | New Engl J Med | 2013 | 55.873 | M | M | Cervical cancer |
| 2013 | A-2013-41 | M.S. Brose | F | United States | First | M | 16 | 12 | 4 | 0 | P | Lancet | 2014 | 45.217 | M | F | Thyroid cancer |
| 2014 | A-2014-1 | R.G. Gray | M | United Kingdom | First | M | 22 | 15 | 7 | 0 | P | Not yet published | Breast cancer |
| 2014 | A-2014-23 | O. Pagani | F | Switzerland | First | F | 20 | 10 | 10 | 0 | P | New Engl J Med | 2014 | 55.873 | F | F | Breast cancer |
| 2014 | A-2014-24 | C. Sweeney | M | United States | First | M | 17 | 15 | 2 | 0 | P | New Engl J Med | 2015 | 55.873 | M | M | Prostate cancer |
| 2014 | A-2014-25 | A.P. Venoak | M | United States | First | M | 15 | 11 | 4 | 0 | N | JAMA J Am Med Assoc | 2017 | 47.661 | M | M | Colorectal cancer |
| 2014 | A-2014-26 | M.J. Piccart | F | Belgium | First | F | 20 | 15 | 5 | 0 | N/P | Not yet published | Breast cancer |
| 2015 | A-2015-1 | J.D. Wolchol | M | United States | First | M | 20 | 17 | 3 | 0 | P | New Engl J Med | 2015 | 55.873 | M | M | Melanoma |
| 2015 | A-2015-2 | G.T. Armstrong | M | United States | First | M | 15 | 9 | 6 | 0 | P | New Engl J Med | 2016 | 72.406 | M | M | Childhood cancers |
| 2015 | A-2015-3 | A. D'Cruz | M | India | First | M | 16 | 6 | 10 | 0 | P | New Engl J Med | 2015 | 59.583 | M | M | Oral cancer |
| 2015 | A-2015-4 | P.B. Brown | M | United States | First | M | 17 | 10 | 7 | 0 | P | JAMA J Am Med Assoc | 2016 | 44.405 | M | M | Multiple types of cancer |
| 2016 | A-2016-1 | P.E. Goss | M | United States | First | F | 20 | 11 | 9 | 0 | P | New Engl J Med | 2016 | 72.406 | M | F | Breast cancer |
| 2016 | A-2016-2 | J.R. Perry | M | Canada | First | M | 20 | 16 | 4 | 0 | P | New Engl J Med | 2017 | 79.260 | M | M | Glioblastoma |
| 2016 | A-2016-3 | J.R. Park | F | United States | First | F | 17 | 7 | 10 | 0 | P | Not yet published | Neuroblastoma |
| 2016 | A-2016-4 | A. Palumbo | M | Italy | First | M | 19 | 13 | 5 | 1 | P | New Engl J Med | 2016 | 72.406 | M | M | Multiple myeloma |
| 2017 | A-2017-1 | Q. Shi | F | United States | First | M | 20 | 16 | 4 | 0 | N/P | New Engl J Med | 2018 | 70.670 | M | M | Colorectal cancer |
| 2017 | A-2017-2 | E.M. Basch | M | United States | First | F | 13 | 6 | 7 | 0 | P | JAMA J Am Med Assoc | 2017 | 47.661 | M | F | Multiple types of cancer |
| 2017 | A-2017-3 | K. Fizazi | M | France | First | M | 15 | 11 | 3 | 1 | P | New Engl J Med | 2017 | 79.260 | M | M | Prostate cancer |
| 2017 | A-2017-4 | M.E. Robson | M | United States | First | M | 14 | 6 | 8 | 0 | P | New Engl J Med | 2017 | 79.260 | M | M | Breast cancer |
| 2018 | A-2018-1 | J.A. Sgarano | M | United States | First | M | 20 | 14 | 6 | 0 | P | New Engl J Med | 2018 | 70.670 | M | M | Breast cancer |
| 2018 | A-2018-2 | G. Bisogno | M | Italy | First | M | 12 | 6 | 6 | 0 | P | Lancet Oncol | 2018 | 35.386 | M | M | Rhabdomyosarcoma |
| 2018 | A-2018-3 | A. Mejean | F | United States | First | M | 20 | 18 | 2 | 0 | P | New Engl J Med | 2018 | 70.670 | M | M | Renal cell carcinoma |
| 2018 | A-2018-4 | G. Lopes | M | United States | First | M | 13 | 10 | 3 | 0 | P | Lancet | 2019 | 59.102 | M | M | Lung cancer |

Total N = 36
F: N = 8
F: N = 7
F: N = 3
F: N = 5
F: N = 5

Abstracts presented at plenary sessions of ASCO annual meetings between 2011 and 2018. For papers published in 2019, journal IFs of 2018 were used. Abbreviations: ASCO, American Society of Clinical Oncology; F, female; GIST, gastrointestinal stroma cell tumor; IF, impact factor; M, male; N, negative; N/P, outcome did not reach significance or endpoint, but did show improvement/benefit or reached some of the outcomes; no., number; P, positive.
| Year | Abstract no. | Name          | Country of origin | Number of authors | Number of male authors | Number of female authors | Number of authors unknown sex | Study outcome | Journal published | Year | IF | Sex of the first author | Sex of the last author | Subject          |
|------|--------------|---------------|-------------------|-------------------|-----------------------|-------------------------|----------------------------|--------------|-------------------|------|----|------------------------|------------------------|---------------------|
| 2008 | E-2008-1     | C. Manegold   | Germany           | First M           | 10                    | 6                       | 4                         | 0            | P                 | 2009 | 17.793 | M                       | M                       | Lung cancer        |
|      | E-2008-2     | T. Mok        | M Hong Kong       | First M           | 10                    | 6                       | 4                         | 0            | P                 | 2009 | 47.050 | M                       | M                       | Lung cancer        |
|      | E-2008-3     | R.S.J. Midgley| United Kingdom    | First M           | 10                    | 5                       | 5                         | 0            | N                 | 2010 | 18.970 | F                       | M                       | Colorectal cancer  |
|      | E-2008-4     | B.J. Monik    | M United States   | First M           | 10                    | 8                       | 2                         | 0            | P                 | 2010 | 18.970 | M                       | F                       | Ovarian cancer     |
|      | E-2008-5     | S. Lee        | M United Kingdom  | First F           | 5                     | 1                       | 4                         | 0            | N                 | 2010 | 18.970 | M                       | M                       | Glioma             |
|      | E-2008-6     | C. Karapetis  | M Australia       | First M           | 10                    | 7                       | 3                         | 0            | P                 | 2008 | 50.017 | M                       | M                       | Colorectal cancer  |
|      | E-2008-7     | M. Lühr       | M Germany         | First M           | 10                    | 9                       | 1                         | 0            | P                 | 2012 | 7.384  | M                       | M                       | Pancreatic cancer  |
|      | E-2008-8     | P.M. Patel    | M United Kingdom  | First M           | 10                    | 6                       | 4                         | 0            | P                 | 2011 | 5.536  | M                       | M                       | Melanoma           |
|      | E-2008-9     | M. Auerbach   | M United States   | First M           | 8                     | 6                       | 2                         | 0            | P                 | 2013 | 3.576  | M                       | M                       | Multiple types of cancer |
| 2009 | E-2009-1     | M. van Hemelrijk| United Kingdom  | First M           | 8                     | 6                       | 2                         | 0            | P                 | 2010 | 18.970 | F                       | M                       | Prostate cancer    |
|      | E-2009-2     | C. van de Velde| The Netherlands  | First M           | 10                    | 8                       | 2                         | 0            | P                 | 2011 | 38.278 | M                       | M                       | Breast cancer      |
|      | E-2009-3     | A. M. Brunet  | M United Kingdom  | First M           | 10                    | 6                       | 4                         | 0            | P                 | 2011 | 5.580  | N/A                      | N/A                     | Breast cancer      |
|      | E-2009-4     | R. Issels     | M Germany         | First M           | 10                    | 10                      | 0                         | 0            | P                 | 2010 | 17.764 | M                       | M                       | Soft-tissue sarcoma |
|      | E-2009-5     | A. Stoppeck   | F United States   | First F           | 10                    | 5                       | 5                         | 0            | P                 | 2010 | 18.970 | F                       | M                       | Breast cancer      |
|      | E-2009-6     | M.E.L. van der Burg| The Netherlands | First M           | 2                     | 1                       | 1                         | 0            | N                 | 2010 | 33.633 | M                       | F                       | Ovarian cancer     |
|      | E-2009-7     | G.G. Steger   | M Germany         | First M           | 10                    | 8                       | 2                         | 0            | P                 | 2014 | 7.040  | M                       | M                       | Breast cancer      |
|      | E-2009-8     | J. Baselga    | M Spain           | First M           | 10                    | 8                       | 2                         | 0            | N/P               | 2011 | 5.580  | M                       | M                       | Lung cancer        |
|      | E-2009-9     | M. Baumann    | M Germany         | First M           | 10                    | 8                       | 2                         | 0            | N/P               | 2011 | 5.580  | M                       | M                       | Lung cancer        |
|      | E-2009-10    | A. Silverman  | M United States   | First M           | 10                    | 9                       | 1                         | 0            | P                 | 2015 | 20.982 | M                       | M                       | Colorectal cancer  |
|      | E-2009-11    | L. Blauhman   | M United States   | First M           | 10                    | 9                       | 1                         | 0            | P                 | 2014 | 38.278 | M                       | M                       | Breast cancer      |
|      | E-2009-12    | B. Badde      | M United States   | First M           | 10                    | 7                       | 3                         | 0            | P                 | 2010 | 53.486 | M                       | M                       | Melanoma           |
|      | E-2009-13    | P. Chapman    | M United States   | First M           | 10                    | 10                      | 0                         | 0            | P                 | 2013 | 17.879 | M                       | M                       | Lung cancer        |
|      | E-2009-14    | B. Johnson    | M United States   | First M           | 7                     | 6                       | 1                         | 0            | P                 | 2013 | 6.578  | M                       | M                       | Lung cancer        |
|      | E-2009-15    | A. Kurose     | M Japan           | First M           | 10                    | 10                      | 0                         | 0            | P                 | Not (yet) published | N/A                     | Multiple types of cancer |
|      | E-2009-16    | J. Douillard  | M France          | First F           | 10                    | 9                       | 1                         | 0            | P                 | 2010 | 18.970 | M                       | F                       | Colorectal cancer  |
|      | E-2009-17    | C. Osborne    | F United States   | Second M          | 10                    | 6                       | 4                         | 0            | P                 | 2011 | 53.280 | F                       | M                       | Breast cancer      |
|      | E-2009-18    | A. Dueñas-González| M Mexico         | First M           | 11                    | 8                       | 3                         | 0            | P                 | 2011 | 18.372 | M                       | M                       | Gynecologic cancer  |
|      | E-2009-19    | E. van Cutsem | M United States   | First M           | 10                    | 7                       | 3                         | 0            | P                 | 2010 | 34.633 | M                       | M                       | Gastrointestinal cancer |
|      | E-2009-20    | C. Nutting    | M United Kingdom  | First F           | 10                    | 8                       | 2                         | 0            | P                 | 2012 | 22.589 | M                       | F                       | Head and neck cancer |
|      | E-2009-21    | A.M.M. Eggermont| The Netherlands  | First M           | 5                     | 4                       | 1                         | 0            | P                 | 2012 | 5.061  | M                       | M                       | Melanoma           |
|      | E-2009-22    | E.L. Kwak     | F United States   | First M           | 10                    | 9                       | 1                         | 0            | P                 | Not (yet) published | N/A                     | Multiple types of cancer |
| 2010 | E-2010-1     | V.A. Miller   | M United States   | First M           | 10                    | 8                       | 2                         | 0            | N/P               | 2012 | 25.117 | M                       | M                       | Lung cancer        |
|      | E-2010-2     | J. Chih-Hsin Yang| Taiwan           | First M           | 10                    | 7                       | 3                         | 0            | N                 | 2011 | 18.372 | M                       | M                       | Lung cancer        |
|      | E-2010-3     | E.A. Perez    | F United States   | First F           | 10                    | 5                       | 5                         | 0            | P                 | 2014 | 5.490  | F                       | M                       | Breast cancer      |
|      | E-2010-4     | T.J. Perren   | M United Kingdom  | First M           | 10                    | 9                       | 1                         | 0            | P                 | 2011 | 53.298 | M                       | M                       | Ovarian cancer      |
|      | E-2010-5     | J.S. De Bono  | M United States   | First M           | 10                    | 10                      | 0                         | 0            | P                 | 2011 | 53.298 | M                       | M                       | Prostate cancer     |
| 2011 | E-2011-1     | L. Dixo      | M Belgium         | First M           | 9                     | 7                       | 1                         | 1            | P                 | 2012 | 51.658 | M                       | M                       | Basal cell carcinoma |
|      | E-2011-2     | C. Parker     | M United Kingdom  | First M           | 10                    | 9                       | 1                         | 0            | P                 | 2013 | 54.420 | M                       | M                       | Prostate cancer     |

(Continues)
| Year | Abstract no. | Name | Sex | Country of origin | Author place presenter | Sex of the last author | No. of authors | No. of male authors | No. of female authors | No. of authors unknown sex | Study outcome¹ | Journal published | Year | IF | Sex of the first author | Sex of the last author | Subject |
|------|--------------|------|-----|-------------------|-----------------------|-----------------------|-----------------|-------------------|---------------------|--------------------------|----------------|---------------------|------|-----|------------------------|------------------------|---------|
| 2011 | E-2011-3⁸⁷⁹ | J. Bourhis | M | Switzerland | First | F | 17 | 15 | 2 | 0 | N | Lancet Oncol | 2012 | 25.117 | M | F | Head and neck cancer |
| 2011 | E-2011-4⁸⁸⁵ | M. Belin | F | United Kingdom | First | M | 10 | 7 | 3 | 0 | P | Not yet published | 2013 | 39.207 | M | M | Astrocitoma |
| 2011 | E-2011-5⁹⁰ | I. Fernando | M | United Kingdom | First | F | 10 | 8 | 2 | 0 | P | J Clin Oncol | 2012 | 18.038 | F | M | Ovarian cancer |
| 2011 | E-2011-6⁹¹ | J. Tabernero | M | Spain | First | F | 12 | 9 | 3 | 0 | P | Eur J Cancer | 2015 | 11.370 | M | M | Prostate cancer |
| 2011 | E-2011-7⁹² | P. Hoskin | M | United States | First | M | 13 | 9 | 4 | 0 | N | Lancet Oncol | 2011 | 22.589 | M | M | Multiple types of cancer |
| 2011 | E-2011-8⁹³ | R. Sullivan | M | United Kingdom | First | M | 10 | 10 | 0 | N/A | Lancet Oncol | 2015 | 26.509 | M | M | Mesothelioma |
| 2011 | E-2011-9⁹⁴ | L. Krug | M | United States | First | M | 10 | 9 | 1 | 0 | N | Lancet Oncol | 2015 | 26.509 | M | M | Multiple types of cancer |
| 2011 | E-2011-10⁹⁵ | J. Baselga | M | United States | First | M | 10 | 8 | 2 | 0 | P | Ann Oncol | 2014 | 7.040 | M | M | Breast cancer |
| 2011 | E-2011-11⁹⁶ | E.J.T. Rutgers | M | The Netherlands | Last | M (= presenter) | 16 | 9 | 7 | 0 | P | Eur J Cancer | 2011 | 5.536 | M | F | Breast cancer |
| 2011 | E-2011-12⁹⁷ | H.J. Bonier | M | The Netherlands | First | M | 7 | 6 | 1 | 0 | P | New Engl J Med | 2015 | 59.558 | M | F | Colorectal cancer |
| 2011 | E-2011-13⁹⁸ | M. Van Hemelrijck | F | United Kingdom | First | M | 7 | 4 | 3 | 0 | P | Hypertension | 2012 | 6.873 | F | F | Multiple types of cancer |
| 2011 | E-2011-14⁹⁹ | F. Lordick | M | Germany | First | M | 19 | 16 | 3 | 0 | N | Lancet Oncol | 2015 | 25.117 | M | M | Myelodysplastic malignancies |
| 2011 | E-2011-15⁰⁰ | J. Taieb | M | France | First | M | 19 | 14 | 5 | 0 | N | Lancet Oncol | 2011 | 5.536 | M | F | Breast cancer |
| 2011 | E-2011-16⁰¹ | E. Papaemmanuil | F | United Kingdom | First | M | 10 | 7 | 3 | 0 | P | New Engl J Med | 2011 | 5.536 | M | F | Myelodysplastic malignancies |
| 2012 | E-2012-1⁰² | M. Middleton | M | United Kingdom | First | M | 10 | 9 | 1 | 0 | N/P | Ann Oncol | 2013 | 9.269 | M | M | Melanoma |
| 2012 | E-2012-2⁰³ | A. Shaw | F | United States | First | M | 20 | 14 | 6 | 0 | P | New Engl J Med | 2013 | 54.420 | F | M | Lung cancer |
| 2012 | E-2012-3⁰⁴ | A.X. Zhu | M | United States | First | M | 14 | 13 | 1 | 0 | N | J Clin Oncol | 2013 | 20.982 | M | M | Hepatocellular carcinoma |
| 2012 | E-2012-4⁰⁵ | F. Lordick | M | Germany | First | M | 16 | 12 | 4 | 0 | N | Lancet Oncol | 2013 | 24.725 | M | M | Myelodysplastic malignancies |
| 2012 | E-2012-5⁰⁶ | J. Stuebing | F | France | First | F | 19 | 16 | 3 | 0 | N | Lancet Oncol | 2013 | 24.725 | M | M | Breast cancer |
| 2012 | E-2012-6⁰⁷ | X. Pivot | M | France | First | M | 19 | 14 | 5 | 0 | N | Lancet Oncol | 2013 | 24.725 | M | M | Breast cancer |
| 2012 | E-2012-7⁰⁸ | R. Gelber | M | United States | Second | M | 24 | 19 | 5 | 0 | N | Lancet Oncol | 2013 | 20.982 | M | M | Myelodysplastic malignancies |
| 2012 | E-2012-8⁰⁹ | W. Van der Graaf | F | The Netherlands | Last | F (= presenter) | 19 | 15 | 4 | 0 | N | Lancet Oncol | 2014 | 39.207 | M | M | Breast cancer |
| 2012 | E-2012-9ⁱ⁰ | R.J. Motzer | M | United States | First | M | 25 | 18 | 7 | 0 | P | New Engl J Med | 2013 | 54.420 | M | M | Renal cell carcinoma |
| 2013 | E-2013-1⁰¹ | P. Autier | M | France | First | M | 4 | 3 | 1 | 0 | N | Lancet Diabetes Endocrinol | 2013 | 9.185 | M | M | Multiple types of cancer |
| 2013 | E-2013-2⁰² | P. Poortmans | M | The Netherlands | First | M | 10 | 7 | 3 | 0 | P | New Engl J Med | 2013 | 59.558 | M | M | Breast cancer |
| 2013 | E-2013-3⁰³ | A.J. Breugem | F | The Netherlands | First | F | 11 | 9 | 2 | 0 | P | Lancet Oncol | 2013 | 25.117 | M | M | Colorectal cancer |
| 2013 | E-2013-4⁰⁴ | M. Reimers | M | United States | First | M | 10 | 7 | 3 | 0 | P | J Natl Cancer Inst | 2013 | 12.583 | M | M | Colorectal cancer |
| 2013 | E-2013-5⁰⁵ | G. Giaccone | M | United States | First | M | 10 | 7 | 3 | 0 | N/P | Eur J Cancer | 2014 | 6.163 | M | M | Lung cancer |
| 2013 | E-2013-6⁰⁶ | C. Van den Bogaerd | M | Belgium | First | F | 10 | 7 | 3 | 0 | P | Eur J Cancer | 2014 | 5.536 | M | F | Breast cancer |
| 2013 | E-2013-7⁰⁷ | W. Van der Graaf | F | The Netherlands | Last | F (= presenter) | 19 | 15 | 4 | 0 | N | Lancet Oncol | 2013 | 54.420 | M | M | Renal cell carcinoma |
| 2013 | E-2013-8⁰⁸ | R.J. Motzer | M | United States | First | M | 25 | 18 | 7 | 0 | P | Lancet Oncol | 2013 | 54.420 | M | M | Renal cell carcinoma |
| 2013 | E-2013-9⁰⁹ | L. Dijksterhuis | M | Netherlands | First | M | 10 | 9 | 1 | 0 | N/P | Lancet Oncol | 2015 | 25.117 | M | M | Breast cancer |

¹ Study outcome: N = Not yet published, M = Published, P = Published in press, A = Accepted for publication.
Table 2. Abstracts presented at ESMO congresses (Continued)

| Year | Abstract no. | Name | Country of origin | Author place presenter | Sex of the last author | No. of authors | No. of male authors | No. of female authors | No. of authors unknown sex | Study outcome | Journal published | Year | IF | Sex of the first author | Sex of the last author | Subject |
|------|--------------|------|-------------------|------------------------|------------------------|----------------|-------------------|---------------------|--------------------------|---------------|---------------------|------|----|------------------------|----------------------|---------|
| 2014 | E-2014-1     | J.S. Weber | M United States   | First M                | M                      | 20             | 17                | 3                   | 0                        | Lancet Oncol | 2015                  | 2509 | M  | M                      | M                    | Melanoma |
| 2016 | E-2016-1     | J. Yao    | M United States   | First M                | F                      | 22             | 18                | 4                   | 0                        | Lancet         | 2016                  | 47831 | M  | F                      | F                    | Neuroendocrine tumors |
| 2016 | E-2016-2     | A.M. Eggermont | France | First M             | M                      | 17             | 13                | 4                   | 0                        | J Clin Oncol    | 2017                  | 79260 | M  | M                      | M                    | Breast cancer |
| 2017 | E-2017-1     | D. Dearnaley | M United Kingdom | First M              | F                      | 20             | 10                | 10                  | 0                        | Lancet         | 2016                  | 33900 | M  | M                      | F                    | Prostate cancer |
| 2018 | E-2018-1     | R.A. Stahel | M Switzerland     | First M               | M                      | 20             | 15                | 5                   | 0                        | Lancet Oncol    | 2017                  | 21466 | F  | M                      | M                    | Breast cancer |
| 2018 | E-2018-2     | K. Fizazi  | M France          | First M               | M                      | 13             | 9                 | 4                   | 0                        | Lancet Oncol    | 2017                  | 36418 | M  | M                      | F                    | Muscle and bone cancer |
| 2018 | E-2018-3     | J. Sparano | M United States   | First M               | M                      | 20             | 11                | 9                   | 0                        | Lancet Oncol    | 2018                  | 70670 | M  | M                      | M                    | Breast cancer |
| 2018 | E-2018-4     | K. Habuchi | M Clinical Oncology | First M        | M                      | 20             | 17                | 3                   | 0                        | Lancet Oncol    | 2018                  | 79260 | M  | M                      | M                    | Breast cancer |
| 2018 | E-2018-5     | M. Socinski | M United States | First M          | M                      | 20             | 14                | 6                   | 0                        | Lancet Oncol    | 2018                  | 79260 | M  | M                      | M                    | Breast cancer |
| 2018 | E-2018-6     | F. Barlesi | M France          | First M               | M                      | 20             | 13                | 7                   | 0                        | Lancet Oncol    | 2018                  | 79260 | M  | M                      | M                    | Breast cancer |
| 2018 | E-2018-7     | A. Gronchi | M Italy           | First M               | M                      | 19             | 15                | 4                    | 0                        | Lancet Oncol    | 2018                  | 36418 | M  | M                      | M                    | Soft-tissue sarcoma |
| 2018 | E-2018-8     | K. Pizzuti | M France          | First M               | M                      | 13             | 9                 | 4                   | 0                        | Lancet Oncol    | 2018                  | 36418 | M  | M                      | M                    | Prostate cancer |
| 2018 | E-2018-9     | T.K. Choueiri | M United States | First M         | M                      | 12             | 10                | 2                   | 0                        | J Clin Oncol    | 2018                  | 36418 | M  | M                      | M                    | Renal cell carcinoma |
| 2018 | E-2018-10    | A. Ravaud | M France          | First M               | M                      | 20             | 16                | 3                   | 1                        | Lancet Oncol    | 2018                  | 79260 | M  | M                      | M                    | Renal cell carcinoma |

From presentation to paper: Gender disparities in oncological research

Cancer Epidemiology

(Continues)
| Year | Abstract no. | Name | Sex | Country of origin | Presenter place presenter | Sex of the last author | No. of authors | No. of male authors | No. of female authors | No. of authors unknown sex | Study outcome¹ | Journal published | Year | IF | Sex of the first author | Sex of the last author | Subject |
|------|--------------|------|-----|-------------------|---------------------------|------------------------|----------------|------------------|------------------|-----------------------------|--------------|-------------------|------|----|----------------------|-------------------------|---------|
| 2017 | E-2017-1     | L. Paz-Ares | M   | Spain             | First                      | M                       | 20             | 17               | 3                | 0                           | P            | New Engl J Med      | 2017 | 79.260 | M                     | M                        | Lung cancer |
| 2017 | E-2017-2     | V. Westeel | F   | France            | First                      | M                       | 20             | 17               | 3                | 0                           | N            | Not (yet) published |      |     |                       |                          | Lung cancer |
| 2017 | E-2017-3     | S. Ramalingam | M | United States    | First                      | M                       | 18             | 12               | 6                | 0                           | P            | New Engl J Med      | 2018 | 70.670 | M                     | M                        | Lung cancer |
| 2017 | E-2017-4     | A. Di Leo   | M   | Italy             | First                      | M                       | 17             | 10               | 7                | 0                           | P            | J Clin Oncol        | 2017 | 26.303 | M                     | M                        | Breast cancer |
| 2017 | E-2017-5     | S. Gupta    | M   | India             | First                      | M                       | 20             | 8                | 12               | 0                           | N            | J Clin Oncol        | 2018 | 26.303 | M                     | M                        | Cervical cancer |
| 2017 | E-2017-6     | D. Petylak  | M   | United States    | First                      | M                       | 20             | 14               | 6                | 0                           | P            | Lancet             | 2017 | 73.234 | M                     | F                        | Renal cell carcinoma |
| 2017 | E-2017-7     | B. Escudier | M   | France            | First                      | M                       | 20             | 15               | 5                | 0                           | P            | New Engl J Med      | 2018 | 70.670 | M                     | M                        | Renal cell carcinoma |
| 2017 | E-2017-8     | K. Lewis    | M   | United States    | First                      | M                       | 14             | 13               | 0                | 1                           | N/P          | Lancet Oncol        | 2018 | 36.418 | M                     | M                        | Melanoma |
| 2017 | E-2017-9     | A. Hauschild | M | Germany           | First                      | M                       | 19             | 12               | 7                | 0                           | P            | New Engl J Med      | 2017 | 79.260 | F                     | M                        | Melanoma |
| 2017 | E-2017-10    | J. Weber    | M   | United States    | First                      | M                       | 20             | 12               | 8                | 0                           | P            | New Engl J Med      | 2017 | 79.260 | M                     | M                        | Melanoma |
| 2018 | E-2018-1     | P. Schmid   | M   | United Kingdom   | First                      | F                       | 18             | 7                | 11               | 0                           | P            | New Engl J Med      | 2018 | 70.670 | F                     | M                        | Breast cancer |
| 2018 | E-2018-2     | M. Cristianoili | M | United States    | First                      | M                       | 19             | 9                | 10               | 0                           | P            | New Engl J Med      | 2018 | 70.670 | M                     | M                        | Breast cancer |
| 2018 | E-2018-3     | F. André    | M   | France            | First                      | M                       | 20             | 11               | 8                | 1                           | P            | New Engl J Med      | 2019 | 70.670 | M                     | M                        | Breast cancer |
| 2018 | E-2018-4     | Z. Jiang    | M   | China             | First                      | M                       | 19             | 11               | 4                | 4                           | P            | Lancet Oncol        | 2019 | 35.386 | M                     | M                        | Breast cancer |
| 2018 | E-2018-5     | A. Hoyle    | M   | United Kingdom   | First                      | M                       | 20             | 18               | 2                | 0                           | P            | Lancet Oncol        | 2018 | 59.102 | M                     | M                        | Prostate cancer |
| 2018 | E-2018-6     | C. Parker   | M   | United Kingdom   | First                      | M                       | 19             | 15               | 4                | 0                           | N            | Lancet             | 2019 | 70.670 | M                     | M                        | Renal cell carcinoma |
| 2018 | E-2018-7     | R. Motzer   | M   | United States    | First                      | M                       | 20             | 16               | 3                | 1                           | P            | New Engl J Med      | 2018 | 70.670 | M                     | M                        | Renal cell carcinoma |
| 2018 | E-2018-8     | K. Moore    | M   | United States    | First                      | M                       | 19             | 10               | 9                | 0                           | P            | New Engl J Med      | 2018 | 70.670 | F                     | M                        | Ovarian cancer |
| 2018 | E-2018-9     | B. Burtness | F   | United States    | First                      | M                       | 20             | 12               | 7                | 1                           | P            | Lancet Oncol        | 2019 | 59.102 | F                     | M                        | Head and neck cancer |
| 2018 | E-2018-10    | H. Mehdina  | M   | United Kingdom   | First                      | F                       | 20             | 14               | 6                | 0                           | N            | Lancet             | 2019 | 59.102 | F                     | M                        | Oropharyngeal cancer |
| 2018 | E-2018-11    | C. Zhou     | M   | China             | First                      | M                       | 18             | 8                | 4                | 6                           | P            | Lancet Respir Med   | 2019 | 22.992 | M                     | M                        | Lung cancer |

¹Abstracts presented at presidential symposia of ESMO Congresses (2006, 2008, 2010, 2012, 2014, 2006–2018), and ESMO/ECCO conferences (2009, 2013, 2015). Presenters were last abstract authors in E-2011-12, E-2012-7, E-2013-11, and E-2013-14, and therefore, presenter's and last abstract author's sex are similar. For papers published in 2019, journal impact factors of 2018 were used.

Abbreviations: ECCO, European Cancer Organization; ESMO, European Society for Medical Oncology; F, female; IF, impact factor; M, male; N, negative; N/A, not applicable; no., number; N/P, outcome did not reach significance or endpoint, but did show improvement/benefit or reached some of the outcomes; P, positive.
Data availability
The data that support the findings of our study are available from the corresponding author upon reasonable request.

Results

Presenters
Data of 166 consecutive abstracts presented at plenary sessions of ASCO Annual Meetings from 2011 and at ESMO Congresses from 2008 were collected. Included abstracts of the plenary sessions of ASCO Annual Meetings between 2011 and 2018 (n = 34) and of the presidential sessions of ESMO conferences between 2008 and 2018 (n = 132) are shown in Tables 1 and 2, respectively. References of all of these abstracts and subsequently published papers can be found in the Supplementary Material.

Of all 166 abstracts, 35 (21%) were presented by a woman. Although the proportion of female presenters has decreased since 2015–2016 (Fig. 1), the distribution of female and male contribution to presenters was not different over the years (p = 0.699), neither was a trend observed in contribution of both sexes over time (p = 0.350).

The majority of the presenters originated from Europe (n = 90, 54%), followed by Northern America (n = 65, 39%), Asia (n = 9, 5%) and Oceania (n = 2, 1%). All female presenters came from Northern America (n = 17) or Europe (n = 18). The share of women of all Northern American and European presenters was 26 and 20%, respectively. Per country, 17 of 62 (27%) American, 5 of 29 (17%) British, 1 of 6 (17%) Belgian, 2 of 17 (12%) French, 6 of 13 (46%) Dutch, 2 of 4 (50%) Swiss, 1 of 5 (20%) Italian presenters and the only Austrian presenter were female.

Almost a quarter of the studies presented by a female researcher (n = 35) concerned breast cancer (n = 8, 23%), lung cancer (n = 3, 9%), followed by ovarian cancer, colorectal cancer and multiple types of cancer (all: n = 4, 11%). Other subjects are shown in Tables 1 and 2. Overall, 26% of the presentations about breast cancer, 44% about ovarian cancer, 29% about colorectal cancer and 17% about lung cancer were presented by a woman.

Study outcomes were most often positive (n = 119, 71%), while 33 (20%) had negative outcomes and 14 (8%) neither positive nor negative (N/P), or nonapplicable (N/A). Outcomes were positive, negative and N/P or N/A in 71, 23 and 6% of the 35 studies presented by a female researcher, and 72, 19 and 9% of 131 abstracts with male presenters, respectively. The outcomes of presented abstracts did not differ between male and female presenters (p = 0.746). Presenter’s sex was not associated with study outcome (p = 0.815).

Abstract authors
Figure 1 shows the overall proportion of female presenters and abstract authors. Of all authors of the presented abstracts (n = 2,425), 679 (28%) were female, 1,728 (71%) were male and sex was unknown in 19 (1%) authors. The distribution of sex of abstract authors differed statistically significantly over the years (p = 0.046), and a positive trend was observed in contribution of female authors over time (p = 0.007). The number of female authors was higher in abstracts with a female presenter (34%) compared to abstracts with a male presenter (26%; p = 0.001).

Overall, contribution of women to last abstract ownership was 20% (n = 33). Last abstracts’ authors were female in 9/35 (26%) of the studies presented by a woman and in 23/131 (18%) of studies presented by a male researcher (p = 0.277).

Sex of the last abstract author was not associated with study outcomes (p = 0.433).

Subsequently published papers
The majority of the 166 presented abstracts were subsequently published in an international journal (n = 156, 94%). In 56 (36%) of these 156 papers, either the first or last author was a woman. Female researchers were involved as first author in 29 (19%) and last author in 32 (21%) articles.

A total of 30/35 (86%) abstracts presented by a woman were published as article, which was statistically significantly less than the 126/131 (96%) abstracts with a male presenter that resulted in a paper (p = 0.021). In 4/30 (13%) articles, the female presenter of the abstract was not involved as first, second or last author, and the first authors of these papers were all males (A-2017-1, E-2011-4, E-2013-8 and E-2015-10; Tables 1 and 2). In 3/126 (2%) published papers with a male abstract presenter, the presenter was not first, second or last author of the article, and all the first authors were other males (E-2010-2, E-2011-1, E-2017-1; Table 2).

Median IF of journals of papers with a female first author was 20.3 (interquartile range [IQR], 8.4, 53.4), which was lower than of papers with a male first author (median IF 35.4 [IQR, 20.5, 59.1]; p = 0.046). Sex of the presenter, last abstract author, or last author of the manuscript were not associated with IF of journals of subsequently published papers (p = 0.101, p = 0.864 and p = 0.922, respectively).

Figure 1. Proportion of female presenters and abstract authors over time at plenary sessions of American Society of Clinical Oncology (ASCO) Annual Meetings and European Society for Medical Oncology (ESMO) Congresses. Results of 2008–2010 is based on ESMO abstracts solely. Abstract authors with unknown sex (n = 19) are not displayed.
ASCOS vs. ESMO

Figure 2 shows the sex distribution of abstract presenters in both ASCO and ESMO conferences. The distribution of sex of presenters did not differ between ASCO and ESMO ($p = 0.756$), but the proportion of female authors in ASCO abstracts (32%) was significantly higher compared to those of ESMO (27%; $p = 0.048$).

When analyzing the meetings separately, we found a statistically significant positive trend in female contribution observed in ESMO abstract authors ($p = 0.014$), which was not found in ASCO abstract authors ($p = 0.544$). This trend over time in female contribution was not identified in ASCO and ESMO presenters ($p = 0.350$ and $p = 0.656$).

Discussion

Although gender differences have been acknowledged in medical research, this is the first study to describe the gender gap in contribution to research presentations at the two largest oncological conferences in the world. Of all oncological studies presented at the main sessions of the past 8 ASCO Annual Meetings and 12 ESMO Congresses, the number of female presenters did not reach a quarter. In subsequently published papers, the share of female first and last authors was even smaller. The gender gap appears to be more prominent in oncological research than in clinical practice, because nearly half of the hematology–oncology fellowship trainees in the United States, more than half of medical oncologists in several European countries and 37% of ASCO and 41% of ESMO members are female. Moreover, we found an association between sex of first author of subsequently published manuscripts and the journal’s IF. Although IFs of these journals were all relatively high, which is not surprising given that these studies were presented at the most important sessions of the conferences, this corresponds with findings about the underrepresentation of female authors in high-impact journals.

The lack of women presenting at oncological conferences is in line with the trend of gender differences in other research areas, where males numerically outweigh females, despite an increase in women entering scientific careers. The number of publications by male researchers remains significantly higher than those by females, as is also seen in authorships of oncological publications. In our study, we found an overall female contribution to abstract authorships of 27–31%, with an increase of female contribution as abstract authors over time. However, this rise was not observed among female presenters at both conferences. Although it was not a statistically significant trend, the proportion of female presenters since 2015 appears to be shrinking rather than increasing and is therefore worrisome (Fig. 1).

Over the span of their academic career, publication productivity of women increases at a later stage of their career compared to men. While the publication productivity of female researchers exceeded those of male researchers toward
the end of their careers, that is, after 27 years of service, most leadership appointments occurred before the 20th year of service. Because productivity is an important factor in the selection of leaders, this could be one of the causes for the underrepresentation of women in leading positions. As not only the content of the abstract, but also past productivity and leadership positions may influence the selection of presenters for the most important sessions of ASCO and ESMO conferences, this could partly explain the underrepresentation of female presenters in these sessions as well.

Interpretation of data on gender disparities, including our data, may be hindered by a Simpson’s paradox, as described earlier.28,29 This paradox implies that an apparent association can actually be a result of a third dependent factor. For example, a finding that female researchers received requested grants less often than men was biased because women applied more often for grants in more competitive research fields.29 More specifically, our findings could be the result of self-selection, in case that less women chose to submit an abstract to ASCO and ESMO or indicated they wanted to give a poster presentation rather than an oral presentation. In other scientific fields, gender differences in presentations at a congress have been identified as a result of self-selection.14,17,30 For example, in biology women were asked less often as an invited speaker, even when adjusted for career stage, but also declined invitations more often than men.17 Similarly, at an anthropology conference, women appeared to ask for oral presentations less frequently than men, resulting in significantly more poster and less oral presentations than male researchers.30 At an conference on evolutionary biology, women presented for relatively shorter duration compared to men despite a fifty-fifty attendance, mainly because men requested longer presentations more often.14 Unfortunately, we did not have information about the number of submitted abstracts to ASCO and ESMO or whether the persons who submitted the abstracts requested a presentation or a poster. However, the findings in other fields highlight the possibility of self-selection as a cause for the gender differences that we found and emphasize the need for women to increase their assertiveness in order to narrow the gender gap.

Gender, in contrast to sex, is a social construct of characteristics as norms and roles of and between women and men, instead of a “biological given” that is beyond our control.31,32 To open up avenues for change, possible consequences of gender and its behavior-based cause must be underlined.33 This starts with recognizing the gender gap34 and efforts to change perceptions of inequality associated with gender, for example, on competence32,35 and meritocracy.24,27,35 Possible solutions beside acknowledgement of these biases that could bridge the gap in (oncological) research and level the playing field for both sexes may include encouragement of self-promotion in female researchers, and implementation of guidelines that concern gender equality.33 For example, this could start with involving more women in the organizing committees of conferences, because this has been positively associated with female representation at conferences.13,30 Second, the abstract assessment process could be changed by appraising the abstracts without information on the presenter’s or authors’ sexes or names. Moreover, female presenters could inspire and encourage female young researchers to follow their example. Finally, because all the female presenters came from the USA or Europe in our study, there should be greater awareness of the gender gap among researchers originating from other parts of the world.

Not only do gender gaps potentially disadvantage women, they could also impair patients outcomes and science.1 In oncological research, for example, several sex-based differences in the treatment and outcomes of cancer patients have been explored and revealed important issues in, for example, drug responses and toxicity.36-38 The presence of a female author in a study has been positively associated with the likelihood of the exploration and analysis of these sex-based differences.39,40 Diversity in sex of researchers could therefore also contribute to a more diverse perception of science, possibly contributing to favorable outcomes for patients in the end, especially in the light of recent findings in sex-based differences in oncology.36

Our study has some limitations. We only included abstracts presented at the most important sessions of two main oncological conferences in the world, therefore we do not know the gender balance in abstracts presented in other sessions or at other conferences. Moreover, a considerable part of the abstracts presented in 2018 were not yet published, which could have resulted in a bias. Lastly, we did not have data on the sex distribution of attendees at the conferences, or the proportion of females that participate in oncological research worldwide to compare this to the share of female presenters and abstract authors.

In conclusion, the share of female presenters at the main sessions of ASCO Annual Meetings and ESMO Congresses is only 21%, and 28% in authorships of these presented abstracts. Greater visibility of women at these large oncological conferences should be encouraged to allow acknowledgement for their research and opportunities for their academic career, as well as positively drive heterogeneity in research through diversity in sex of researches.

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