

Sport and exercise medicine/physiotherapy publishing has a gender/sex equity problem: we need action now!

Sallie M Cowan ^{1,2,3} Joanne L Kemp ^{1,2} Clare L Ardern ^{1,2,4}
Jane S Thornton ⁵ Ebonie Kendra Rio,^{1,2,6} Andrea M Bruder ^{1,2}
Andrea Britt Mosler ^{1,2} Brooke Patterson ^{1,2} Melissa Haberfield ^{1,2}
Eliza A Roughead,^{1,2} Harvi Hart ^{1,2,7} Laura To,^{1,2} Sydney Neufeld,⁸ Nada Mazahir,⁸
Kay M Crossley ^{1,2}

¹La Trobe Sport and Exercise Medicine Research Centre, School of Allied Health, Human Services and Sport, La Trobe University, Bundoora, Victoria, Australia

²Australian IOC Research Centre, La Trobe University, Bundoora, Victoria, Australia

³Clifton Hill Physiotherapy, Clifton Hill, Victoria, Australia

⁴Department of Family Practice, The University of British Columbia, Vancouver, British Columbia, Canada

⁵Public Health and Family Medicine, University of Western Ontario Schulich School of Medicine and Dentistry, London, Ontario, Canada

⁶Physiotherapy Department, Victorian Institute of Sport, Melbourne, Victoria, Australia

⁷Department of Physical Therapy, Western University, London, Ontario, Canada

⁸Return to Health and Performance Lab, Schulich School of Medicine and Dentistry, Western University, London, Ontario, Canada

Correspondence to

Dr Sallie M Cowan, La Trobe Sport and Exercise Medicine Research Centre, School of Allied Health, Human Services and Sport., La Trobe University, Bundoora, Victoria, Australia; sallie.cowan@latrobe.edu.au

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ABSTRACT

Objectives We aimed to determine (1) the proportion of women authors overall, in first (lead) and last (senior) author positions, (2) the proportion of women research participants and (3) the association between women in first and/or last author positions and the proportion of women research participants in original research articles and editorials/opinion pieces in four sport and exercise medicine/physiotherapy journals.

Methods The journals evaluated were the *British Journal of Sports Medicine*, *Journal of Orthopaedic and Sports Physical Therapy*, *Physical Therapy in Sport* and *International Journal of Sports Physical Therapy*.

We reviewed all original research articles and editorials/opinion pieces published in 2008, 2009, 2018 and 2019. For each, we aimed to determine the gender/sex of all authors (through gender pronouns, Google Scholar, ResearchGate, institutional profiles, personal websites, photographs and/or social media), and the gender/sex of study participants reported as 'female' or 'male' or 'women' or 'men' or 'girls' or 'boys'.

Results We included 952 original studies and 219 editorials/opinion pieces. There were 5146 authors of original studies and 706 authors of editorials/opinion pieces. Compared with 2008/2009, the proportion of women as first and last authors was 3.6% (33.0% compared with 29.4%) and 4.8% (33.2% compared with 27.4%) higher respectively in 2018/2019. On average, the proportion of women participants in original studies remained largely unchanged over the 10-year period, only 10% of all participants were women in studies.

Conclusion Women are strikingly under-represented in first and last author positions, as are women participants in sports and exercise medicine/physiotherapy journals.

INTRODUCTION

Gender inequality in science is undeniable.^{1–2} Although women increasingly study Science, Technology, Engineering, Mathematics and Medicine (STEMM) subjects, they comprise a minority of senior academic staff, are promoted more slowly, are less often trained in elite research groups and more likely to leave STEMM careers.^{3–5} In Medical and Allied Health fields, the gender parity in graduates has not transferred to academic leadership:

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Gender inequality is well documented in sport science research in terms of authorship and participant representation.

WHAT THIS STUDY ADDS

⇒ This study highlights that gender inequality exists in sport and exercise medicine/physiotherapy research. Women were poorly represented as first and last authors of research and women participants poorly represented in research.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ These striking results demand bold actions to close the gender gap in sport and exercise medicine/physiotherapy publishing. We propose pragmatic steps for granting bodies, journal editors and research leads to address the gender/sex gap.

women are under-represented in publications, grant funding, leadership roles, conference keynotes and as panel members⁶ compared with men. Under-representation of women in leadership denies women important role models—you cannot be what you cannot see.

Academic publications are the primary means to disseminate scientific knowledge and remain the principal measure of research productivity and career influence.⁵ In STEMM publication leadership,⁷ women represent the minority of first author (<30%) and last (senior) author (<20%) positions.^{5–8} In sports science, there is similar under-representation of women: only 25% of first author and 17% of last author positions.¹ While the proportion of women first authors increased between 2000 and 2020, it was at a paltry rate of 0.5% per year—requiring a staggering 50 more years to reach parity for first author positions in sports science research.¹ In sports and exercise medicine/physiotherapy, the gender gap in publication leadership is unknown. Implicit gender bias in sports and exercise medicine/physiotherapy is evident from the prevalence of all men panels or

'manels' at sports and exercise medicine/physiotherapy conferences,⁹ and we suspect it pervades sport and exercise medicine/physiotherapy publication metrics.

Sex and/or gender inequality in sport and exercise medicine/physiotherapy research participation is also likely, despite increasing sports participation by women athletes. In Sports Science research, only one in every three research participants were women.¹⁰ Do journals with a greater focus on sport and exercise medicine/physiotherapy (including clinical populations, injury and illness prevention and management) have better representation of women participants? Are women who lead publications more likely to include women participants?

Addressing gender and/or sex equity in sport and exercise medicine/physiotherapy research requires a reasonable understanding of current representation.^{11 12} Despite sex and gender being distinct and non-binary constructs,¹¹ there are challenges to understand their representation in peer-review publications. Sex (female/male/other) is determined by biological characteristics, and gender (women/girl/men/boy/trans/non-binary other) relates to socially constructed roles and behaviours. However, sex and/or gender are rarely defined, and often erroneously used interchangeably (eg, women/man used to describe sex, or female/male used to describe gender). Commonly, the methods to assess gender and/or sex are not well described and are only reported as binary. Consequently, a proportion of people are not represented accurately, it is difficult to interpret and apply study findings¹² and challenging to synthesise gender and/or sex data. Due to inadequate reporting, in this paper, we will use the term gender/sex and the more inclusive phrases of women and men, acknowledging and apologising that some people will be misclassified.

We examined publications from four sport and exercise medicine/physiotherapy journals to (1) determine the proportion of women authors overall, and in author leadership positions (first and last); (2) explore the proportion of women authors in 2018/2019 compared with 2008/2009 and (3) investigate the relationship between women in author leadership positions with the inclusion of women participants in the research.

METHODS

Search strategy

Publications from four sport and exercise medicine/physiotherapy journals were examined: The *British Journal of Sports Medicine*, The *Journal of Orthopaedic and Sports Physical Therapy*, *Physical Therapy in Sport* and The *International Journal of Sports Physical Therapy*.

The inclusion criteria were: (1) frequently publish sport and exercise medicine/physiotherapy research,

(2) currently or previously listed in the 2020 Journal of Citation Report first two quartiles in Sport Sciences or Rehabilitation categories and/or (3) published on behalf of a sport and exercise medicine scientific organisation.

Data extraction

All articles published in 2008/2009 and 2018/2019 were extracted from the individual journal home pages accessible through the La Trobe University Library in September 2020. Articles were extracted by manually screening for original research and editorials from the four sport and exercise medicine/physiotherapy journals, with each assessor extracting articles from two journals (SMC, EKR, JLK and ABM).

Articles were classified as either (1) original research (including systematic reviews) or (2) editorials/opinion pieces. Letters to

the editor, case reports and infographics were excluded. Data extraction took place between October 2020 and October 2021, each article was assessed by teams of two independent reviewers (SMC, JLK, JST, EKR, AMB, BP, MH, EAR, HH, LT, SN and NM). Any discrepancies were resolved during a consensus meeting; a third reviewer was available if disagreements could not be resolved.

For each article, we attempted to identify the gender/sex of all authors, specifically noting the gender of first(lead) and last(senior) authors as these positions are mostly related to the article/project conception and design.¹³ The gender/sex of authors was individually identified using gender pronouns or estimated from: Google Scholar, ResearchGate, institutional profiles, personal websites, photographs or social media. If the gender/sex of either the first or last author was not clearly distinguishable through these different resources, we excluded the article.

The number and gender/sex of participants were determined for each original article (excluding systematic reviews) and whether the authors had analysed data in their published article with reference to gender/sex. Terms used to classify participant gender/sex were 'female' or 'male' or 'women' or 'men' or 'girls' or 'boys'. For the analyses of participants' gender/sex, studies including animal models, in vitro research, cadavers, systematic reviews and meta-analyses were excluded.

Gendered language

We aimed not to conflate sex and gender, despite sex and gender being distinct and non-binary concepts, it was often unclear whether the researchers and/or participants of the included studies specifically referred to biological sex or gender. Therefore, we use the term gender/sex and the more inclusive terms of women and men throughout this paper. We acknowledge and apologise that this may result in some people being misclassified. We acknowledge that for a proportion of people gender is fluid and that neither gender nor sex are binary constructs.

Equity, diversity and inclusion statement

Our study investigates the representation of women as authors, editors and participants in sports medicine/physiotherapy research. The author group consists of women who are junior, mid-career and senior researchers from different disciplines; however, the majority of authors are from one country. Our manuscript focuses on women, however, we acknowledge that many other groups experience discrimination in publishing and are under-represented as research participants.

Statistical analysis

Descriptive statistics were reported as the average percentage of women as authors, first and last authors, the average percentage of manuscripts including women participants, the total number of women participants and the average percentage of women participants per article. The percentage of women as authors was compared over time, weighted by the total number of publications per year and compared separately for the total, first and last authors.

The association between the presence of last (senior) women authors and the inclusion of women participants and analysis of results by gender/sex was assessed using Spearman's correlations. To assess the association between number of first and/or last women authors and percentage of women participants in original research articles, linear regression was conducted with the independent variable of number of women authors as an ordinal factor (0, 1 or 2). Statistical analysis was performed using

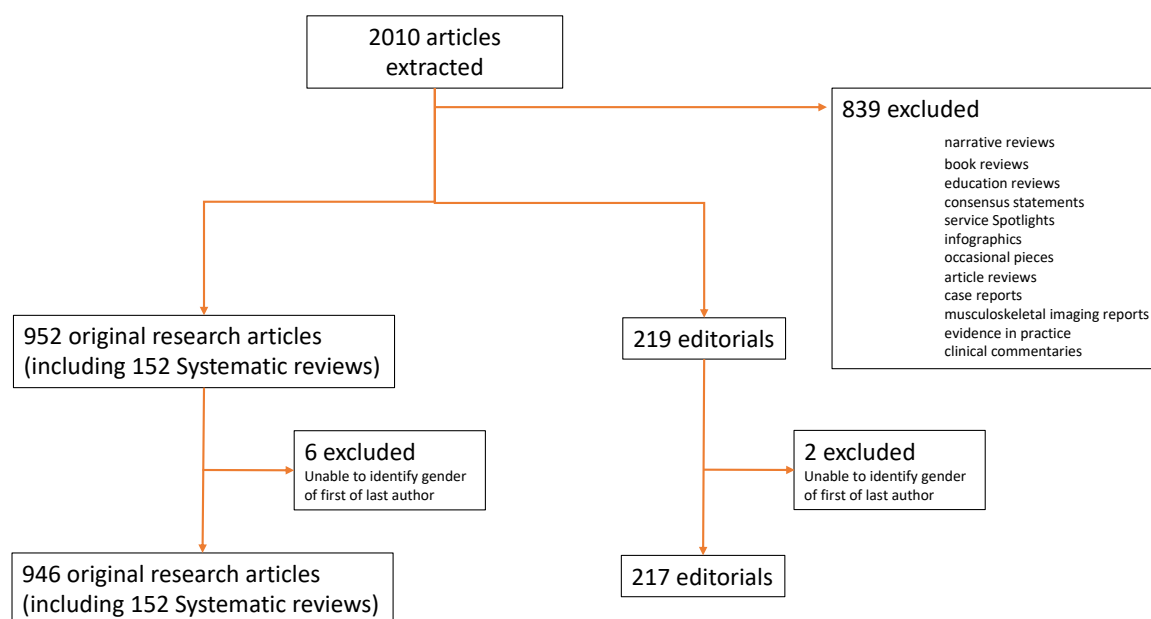


Figure 1 Included/excluded articles.

IBM SPSS Statistics V.19.0.0.0, statistical significance was set at $p < 0.05$.

RESULTS

We included 952 original research articles (figure 1): 302 from 2008/2009 and 650 from 2018/2019. We included 219 editorials/opinion pieces: 49 from 2008/2009 and 170 from 2018/2019. Overall, 5146 (1676 women) authors were identified for original research articles and 706 (176 women) authors for editorials/opinion pieces. Six original articles and two reviews were excluded as we could not identify the gender of either the first or last author.

First and last author gender

The number of women as first and last authors of original research articles was relatively similar in 2008/2009 and 2018/2019 (figure 2). The proportion of women as first authors

was 3.6% higher in 2018/2019 compared with 2008/2009 (33.0% compared with 29.4%), and the percentage of women as last authors was 4.8% higher (33.2% compared with 27.4%). Figure 3 models the projected time to reach parity for women as first authors if this trend continues (4% per 10 years). The percentage of women leading (first or last author position) editorial/opinion pieces was 2% lower in 2018/2019 compared with 2008/2009 (25.0% compared with 27.1%).

Gender/sex disparity in sport and exercise medicine/physiotherapy participants

There were 7 537 569 participants involved in original research articles (excluding systematic reviews) in the 4 years examined, and 776 146 (10%) were women. A total of 175 studies included only men participants (18% of studies); 75 studies included only women participants (8%). There were nearly 2 million



Figure 2 Percentage of first and last authors for different study types and overall author percentages across years.

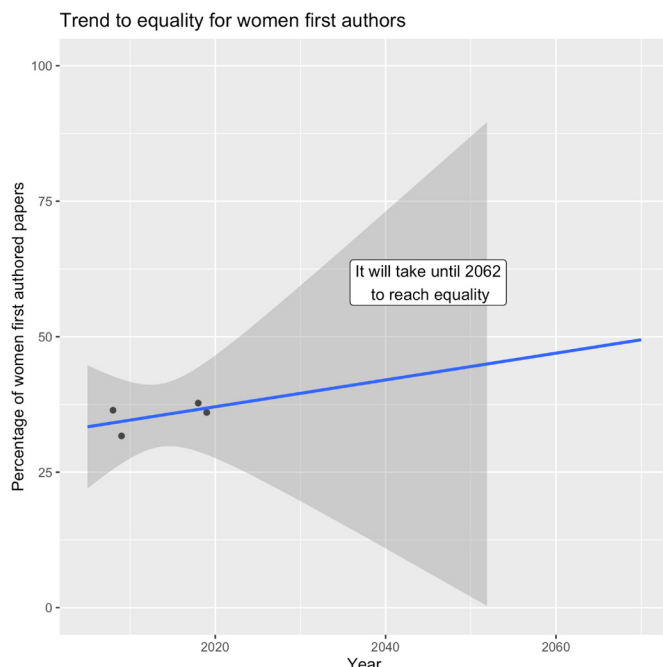


Figure 3 Predicted time to reach parity for women as first authors in sports and exercise medicine/physiotherapy publications.

participants in the men only studies compared with 350 000 participants in the women only studies.

The overall number of women participants in original research articles (excluding systematic reviews) was higher in 2018/2019 than 2008/2009 (727 864 compared with 48 282), however, the relative proportion of women participants was 15% lower in 2018/2019 (10% women) compared with 2008/2009 (25% women). The average proportion of women participants per

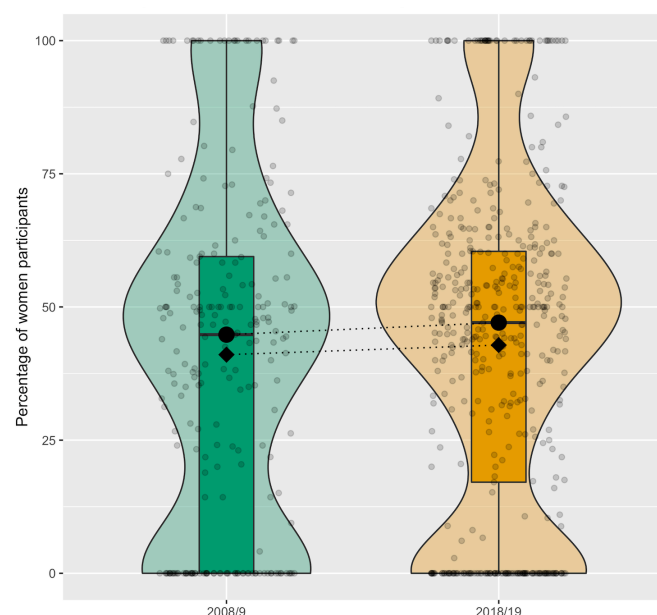


Figure 4 Box and violin plot of average proportion of women participants per original research study (excluding systematic reviews) in 2008/2009 and 2018/2019. Box shows the IQR, violin shows distribution of data for each time point, opaque dots represent raw data points.

study changed negligibly over the 10-year period (from 41.0% to 42.8%) (figure 4).

Association between women first authors and proportion of women participants studied

There was no correlation between the presence of women lead authors (ie, women in first or last author position) and the inclusion of women participants or analysis including gender/sex ($r(957) = 0.017$ $p = 0.593$ and $r(683) = -0.001$ $p = 0.986$). There was a linear relationship between number of women lead authors (ie, 2=woman first and last, 1=woman first or last, 0=man first and last) and proportion of women participants. An additional woman lead author was associated with 8.5% more women participants included in original research studies (95% CI 3.63 to 13.41), $t = 3.419$, $p < 0.001$ (figure 5).

DISCUSSION

Women are under-represented in research author leadership positions in the sport and exercise medicine/physiotherapy journals reviewed in this paper and as participants in these journals. Disappointingly little had changed in the 10 period between our assessments. In 2018/2019, women authors accounted for only 33% of first and last author positions on original research articles, and 25% of editorial/opinion pieces first authors. Women participants are also under-represented; in the 4 years studied, only 10% of >7.5 million participants involved in original research were women. There was no association between women as last authors and the investigation of women participants in research, however, having more women in lead positions (first and last) was associated with more women participants included.

Women leading original research articles

The percentage of women as first and last authors was marginally higher in 2018/2019 than in 2008/2009, yet change is depressingly slow. Continuing at the current rate, it will take until 2062 for women authors to reach parity with their men colleagues. The gender authorship gap, while perhaps not surprising, is especially disappointing given the well-established gender parity for graduates of medicine and physiotherapy. Advancement in academia is largely contingent on productivity and, even with identical curricula vitae, men are nearly three quarters more likely to be judged as having leadership potential than women.¹⁴ Sport and exercise medicine/physiotherapy publishing should abolish the current gender authorship gap.

Women leading editorial/opinion pieces

The percentage of women who were invited or accepted to lead editorial pieces in sport and exercise medicine/physiotherapy journals (25%) was similar to medical journals and rehabilitation and sports science journals, where only one-quarter of editorial/opinion pieces were led by women.^{15 16} We found that the proportion of women leading editorial/opinion pieces was 2% lower in 2018/2019 compared with the decade earlier. Editors' invitations to provide scientific opinions on published research signals thought leadership. Failing to recognise the voices and ideas of women as thought leaders in sport and exercise medicine/physiotherapy research might negatively impact women's career prospects and visibility. With so few women leading editorial and opinion pieces, we feel compelled to spotlight that the dominant 'voice' in these journals is men. Readers are not sufficiently exposed to women's opinions and thoughts on key issues in sports and exercise medicine/physiotherapy. We are

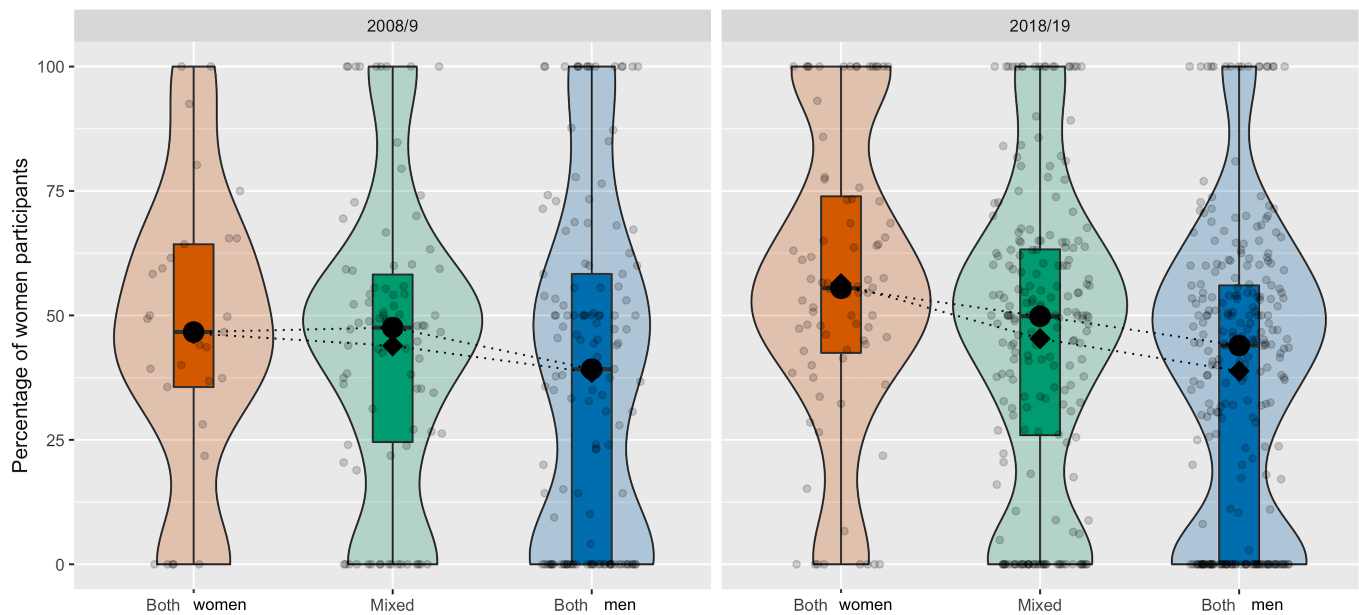


Figure 5 Box and violin plot of relationship between the number of women first authors and proportion of women participants. Box shows the IQR, violin shows distribution of data for each time point, opaque dots represent raw data points.

concerned that published work reflects biased perspectives of key issues in the field.

Women participants in sport and exercise medicine/physiotherapy research

Women participants are also under-represented in sport and exercise medicine/physiotherapy research, similar to other disciplines.^{10 17} Men and women athletes differ in many areas, including injury risk, energy metabolism, exercise capacity and sleep patterns.^{18–21} Without research on women participants, we cannot know if research findings can or should be applied to women athletes and/or patients.^{22 23} Our study indicates that having more women in leading author positions (ie, first and last) was associated with greater inclusion of women participants. Increasing women's leadership of research may deliver a simple means to increase the representation of women participants in sport and exercise medicine/physiotherapy research. This, and other strategies with potential to increase women research participants are required.

Multiple factors may contribute to the gender/sex disparity for women in sports and exercise medicine/physiotherapy publishing. These factors have been widely discussed elsewhere include family caring duties (work–life balance), hiring bias, academic promotion, scholarly recognition, gendered socio-cultural stereotypes, the associating of leadership with masculine qualities and lack of mentoring and role models.^{6 16 24–26} Previous studies have presented underlying mechanisms for the lack of women in leadership roles.^{1 27} Mechanisms detailed include (1) barriers in the career progression pipeline (with women lost at each career stage, leaving very few left in the pipeline at the top^{1 6 27 28}; (2) the Matilda effect (the same skill set for women is given unequal opportunities and recognition or merit)¹⁰ and (3) the glass ceiling effect (women and minorities face an invisible barrier preventing them from achieving leadership positions).¹⁶

Sport and exercise medicine/physiotherapy has a gender/sex equity problem: what can the field do to fix the problem?

It is time to stop assuming that the sport and exercise medicine/physiotherapy culture provides equal opportunities and acknowledge the data. Bold actions are required if women's careers are no longer to be systematically impeded by gender/sex assumptions and stereotypes.²⁹ Affirmative action and plans to reduce the gender/sex gap in publication leadership and in research participants are urgently needed. We propose four pragmatic actions to close the gender/sex gap in author representation and leadership, and five to address women participant representation in sport and exercise medicine/physiotherapy research.

Author representation and leadership

1. Granting bodies can prioritise funding women researchers, especially beyond early career (where funding rates are often equitable). Women are less likely to be funded,^{6 30} needing 2.5 times the productivity than men to be considered equal in grant competitions.³¹ The gender/sex authorship gap may partly reflect poor funding outcomes, and publications arising from funding, for women.³² Less success with grants and fellowships also results in fewer opportunities to assume research leadership positions. We encourage funders to lead by example, instigating women-only fellowships or funding quotas (eg, gender/sex equality) and insisting on a transparent and appropriately resourced gender equality plan.³³
2. Publishers and Journal Editorial Boards can act by:
 - Reporting the gender (including pronouns) of editors-in-chief, editorial boards, editors, associate editors and reviewers.
 - Considering quotas to achieve gender/sex balance on editorial boards.
 - Creating, and nurturing appropriate (and culturally safe) pathways for junior women researchers to join editorial boards and be promoted to more senior editorial positions.

- Embracing options for job-sharing of senior editorial roles (eg, co-editors-in-chief).
- 3. Scientific journal editors can act by:
 - Collecting and reporting on the gender of their publication's authorship (including pronouns)—this will encourage accountability and transparency. Note: some journals include author pronouns in the author list (see example: <https://onlinelibrary.wiley.com/doi/epdf/10.1002/ece3.8106>).
 - Commissioning special editions focusing on women, and calls for submissions by women and about women (eg, British Journal of Sports Medicine e-edition: Female athlete health).
 - Considering quotas for author positions (eg, women should occupy first and/or last author position on 50% of accepted papers). While sometimes unpopular, quotas have effectively achieved gender balance in other fields.³⁴
- 4. Research leads can act by:
 - Mentoring women to take leadership roles on publications.
 - Sponsoring women to raise their profile in environments that are outside their direct sphere of influence.
 - Providing allyship to drive organisational culture change for women researchers.

Participant representation

1. Journal editors can ensure that the gender/sex distribution of participants is documented and rationalised, and encourage gender-specific/sex-specific (or interaction where relevant) analyses.
2. Journal editors can commission special editions with calls for publications on women participants.
3. Journal editors can prioritise papers that include women participants.
4. Authors of systematic reviews and clinical guidelines can perform gender-specific/sex-specific analyses and/or provide recommendations, where appropriate;
5. Researchers (and supervisors of graduate students/post-doctoral fellows) can aim to recruit equal numbers of women and men participants. If recruitment of women participants is lower than expected, researchers might look at support strategies (such as childcare, adequate compensation, less time burden) that might increase the likelihood of women volunteering to participate.

Limitations

Many authors conflate sex and gender and did not report if they asked participants to identify based on their biology or sociocultural identity (we implore researchers to understand the terms and accurately and appropriately collect and report data relating to sex and/or gender, and provide non-binary options). As such, some of our gender/sex assessments may have been incorrect. To answer our authorship question, we needed to include sources and methods that may have been imprecise, and could not estimate the proportion of authors with non-binary (and/or fluid) gender identity. We acknowledge and apologise that our methods may have inadvertently led to classification error. We attempted to report the inequities faced by women as authors and participants but acknowledge there is still much work to be done to highlight other equally deserving and marginalised groups. We also acknowledge that for some people gender is fluid and this may have also contributed to misclassification in our study.

We selected four sport and exercise medicine/physiotherapy journals for their relevance to the field. The 4 years we chose as the publication time window for review might not reflect publishing trends during the intervening years (ie, 2010–2017), nor that of other sport and exercise medicine/physiotherapy journals.

This study focused on the inclusion of women as authors and research participants. We acknowledge that many other groups experience discrimination in publishing and are under-represented as research participants. Other equity deserving groups might be based on race, sexual orientation, career stage, age, culture, ability, socioeconomic background. We were also unable to examine the geographic distribution of authors which may also have highlighted further inequity for women as authors/editors in low-income and middle-income countries¹⁶ We are sad to report that it is difficult to obtain sufficient data to examine the experiences of other under-represented groups in sport and exercise medicine/physiotherapy research. Future research should aim to report and/or include members of equity-deserving communities including women, trans and non-binary gender, black, indigenous, and people of colour and low-middle-income communities in sports exercise medicine/physiotherapy research. Our suggested actions could extend to recording inequities more broadly, an approach that would facilitate a more nuanced analysis of inequities in future publishing in sport and exercise medicine/physiotherapy.

CONCLUSION

Women are under-represented in leadership positions in sport and exercise medicine/physiotherapy journals, and women participants are understudied. Further, there has been little change in women author representation and in the number of women participants included in research between 2008/2009 and 2018/2019. It is time for funders, academic journals, universities and research leads to take bold actions to address these inequities, which have wide-ranging and enduring consequences. For too long, we have tolerated gender/sex discrimination in sport and exercise medicine/physiotherapy research—now is the time for actions to redress the gender/sex gap.

Twitter Sallie M Cowan @PhysioHill, Joanne L Kemp @JoanneLKemp, Clare L Ardern @clare_ardern, Jane S Thornton @janesthornton, Ebonie Kendra Rio @tendonpain, Andrea M Bruder @AndreaBruder, Andrea Britt Mosler @AndreaBMosler, Brooke Patterson @Knee_Howells, Melissa Haberfeld @melhabphysio and Kay M Crossley @kaymccrossley

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Contributors SMC, JLK, KMC and CLA designed the study. SMC, EKR, JLK and ABM manually screening and extracted original research and editorials from the four sport and exercise medicine/physiotherapy journals. SMC, JST, EKR, AMB, BP, MH, EAR, HH, LT, SN and NM extracted data from included articles. SMC and KMC analysed data. SMC drafted the manuscript and all coauthors provided feedback and revised the manuscript critically for important intellectual content. All authors gave final approval of the version to be published. All authors agreed to be accountable for all aspects of the work. All authors agreed to ensure that questions related to the accuracy or integrity of any part of the work have been appropriately investigated and resolved. SMC is the author responsible for the overall content of the manuscript as guarantor.

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Competing interests CLA has served as editor-in-chief for JOSPT (Journal of Orthopaedic and Sports Physical Therapy) since 2018. JST has served as editor for BJSM (British Journal of Sports Medicine) since 2021. EKR has served as a senior

associate editor (BJSM) since 2017. ABM has served as an associate/deputy editor at (BJSM) since 2017, associate editor at JSAMS since 2020, associate editor at IJSPT since 2020. BP has served as an associate editor at BJSM since 2021.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

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ORCID iDs

Sallie M Cowan <http://orcid.org/0000-0002-8900-5873>

Joanne L Kemp <http://orcid.org/0000-0002-9234-1923>

Clare L Ardern <http://orcid.org/0000-0001-8102-3631>

Jane S Thornton <http://orcid.org/0000-0002-3519-7101>

Andrea M Bruder <http://orcid.org/0000-0001-5422-5756>

Andrea Britt Mosler <http://orcid.org/0000-0001-7353-2583>

Brooke Patterson <http://orcid.org/0000-0002-6570-5429>

Melissa Haberfield <http://orcid.org/0000-0002-6366-0896>

Harvi Hart <http://orcid.org/0000-0002-5802-510X>

Kay M Crossley <http://orcid.org/0000-0001-5892-129X>

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