



## Original research

## Representation of women in sport sciences research, publications, and editorial leadership positions: are we moving forward? ☆



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## ABSTRACT

**Objectives:** We determined the representation of women in sport sciences research leadership by assessing the proportion of women in (i) leading authorship positions of randomized controlled trials (RCTs) published from January 2000 to September 2020 in sport sciences journals and (ii) editorial boards of these journals as of September 2020.

**Design:** Review.

**Methods:** We searched PubMed for RCTs published from January 1, 2000, to September 1, 2020, in a representative sample of the top sport sciences journals and identified the sex of first and senior authors through photographs, sex pronouns, Google Scholar, ResearchGate, institutional, or other profiles. This strategy was also used to identify the sex of the editorial board members from the selected journals.

**Results:** A total of 4841 articles published in 14 journals, and 1418 editors, were analyzed. The average proportions of female first and senior authorship were 24.8% and 16.8%, respectively. The percentage of female first authorship increased by -0.5% annually ( $\beta = 0.702$ ;  $B = 0.46$ , 95% CI = 0.24 to 0.68,  $p < 0.001$ ) from 2000 to 2020, while the percentage of female senior authorship did not change over time ( $\beta = 0.274$ ;  $B = 0.15$ , 95% CI = -0.102 to 0.398,  $p = 0.230$ ). Among the editorial boards' positions, 19.7% were occupied by women. None of the editors-in-chief of the selected journals were women.

**Conclusions:** Women are markedly underrepresented in leading authorship and editorial board positions in sport sciences, despite a -0.5% annual increase in female first authorship in the past two decades. The mechanisms underlying these findings and the actions needed to reduce potential gender inequalities warrant further research.

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## Practical implications

- Women accounted for 1/4 of first and < 1/5 of senior authorship positions of >4800 randomized controlled trials published from January 2000 to September 2020 in a representative sample of top sport sciences journals.

- By September 2020, women occupied <1/5 of all editorial board positions, and none of the editors-in-chief of the 14 selected journals were women, suggesting that women might still have much to say in deciding which research topics are relevant in sport sciences research.
- Although these results provide clear evidence of a lack of gender diversity in the field of sport sciences, the extent to which they are caused by gender inequalities or simply reflect the proportion of individuals currently working (or who formerly worked) in this scientific field remains unknown.

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## 1. Introduction

Gender inequality in leading scientific positions and academia deserves critical attention.<sup>1</sup> Increasing evidence indicates an underrepresentation of women in numerous scientific fields<sup>2</sup> including medical research.<sup>3–5</sup> Consistent evidence indicates that women represent a minority at first (range 9.3–29.4%)<sup>2,4</sup> and senior (range 10–19%)<sup>3,5</sup>

authorship positions of scientific articles. In addition, women have had a rather low contribution to the development of clinical guidelines (20% in the United States and 14% in European heart failure guidelines),<sup>4</sup> as well as a limited presence at steering/executive committees of clinical trials published in top medical journals (10%),<sup>3</sup> or at editorial board positions of medical journals (17.5%).<sup>6</sup> The absence of women in leadership positions is problematic for a variety of reasons, including narrower points of view in decision making, limited sensitivity toward female-related topics and, potentially, lower respect for different perspectives.<sup>1</sup> All of the above represent important features for the progress of science.

In the field of sport sciences, the gender gap in leading scientific positions remains unknown. Dynako et al.<sup>7</sup> observed that over a 30-year period, the average percentage of women as first authors of original articles ranged from 5 to 19%, with a significant increase in female first authorship over time. Although this reveals an extraordinarily low proportion of women leading scientific articles, this study is not representative of the field of sport sciences because it only assessed two US journals (*American Journal of Sports Medicine* and *Arthroscopy*) partially specialized in orthopedics. In addition, to the best of our knowledge, there is no prior evidence on the sex composition of editorial boards of major sport sciences journals. Editors are responsible for making decisions on manuscript acceptance/rejection and, consequently, for selecting the relevant research topics that drive the field forward. Thus, understanding the extent to which the female perspective is present on editorial boards could partly explain, for instance, the reasons why some female-related issues in sport sciences have been hardly prioritized,<sup>7,8</sup> and the diversity of perspectives in decision-making.

To provide an overall picture of the representation of women in leading scientific positions in the field of sport sciences, a suitable approach would be (i) to include a representative sample of the top sport sciences journals; (ii) to assess the sex of the leading authorship positions of a significant number of articles published in the field; and (iii) to examine the sex composition of editorial boards of relevant journals in the field. Assessing the current situation regarding the sex composition of leading scientific positions in the field of sport sciences is of scientific, practical, and political relevance because the results would, on the one hand, help to understand potential gender inequalities and, on the other hand, provide objective data to guide future action.

Consequently, the aim of this study was to determine the representation of women in sport sciences research by assessing the proportion of women in (i) leading authorship positions of randomized controlled trials (RCTs; the highest-quality designs that are generally behind funded research projects)<sup>9</sup> published from 2000 to September 2020 in a representative sample of sport sciences journals and (ii) current editorial boards of these journals. Based on the evidence derived from different fields<sup>2–5</sup> and considering that the sport sciences have a tradition of male predominance, we hypothesized that women would be underrepresented in this scientific field.

## 2. Methods

We searched PubMed for all articles filtered as RCTs that were published in a selection of sport sciences journals from January 1, 2000, to September 1, 2020. The specific search strategy is presented in the Supplementary Table S1. We identified the sex of first and senior (last) authors since these authorship positions are considered the leading positions, which are mostly related to the article/project conception and design.<sup>9</sup> We also identified the sex of all authorship positions in a representative subsample of randomly selected articles. Finally, we identified the sex of the editorial board members from the selected journals as of September 2020.

To be selected, the journals had to meet at least one of these 3 inclusion criteria: (i) to be within the first 2019 Journal of Citation Reports

(JCR) decile (top 10%) in sport sciences; (ii) to have continuously been within the first JCR quartile (Q1; top 25%) for the past 10 years and to belong to the sport sciences field, only; (iii) to have ever been within JCR Q1, to belong to the sport sciences field, only, and to be published on behalf of a sport sciences scientific organization. The sex of authors and editors were individually identified by photographs, sex pronouns, Google Scholar, ResearchGate, institutional profiles, personal websites, or social media. Whenever the sex of either the first or senior author was not clearly distinguishable through the different resources, it was categorized as unknown, and the article was excluded.

Descriptive statistics are reported as the average percentage of women as first and senior authors and as members of editorial boards. Scatterplots of individual publications and fitted linear regressions were used to evaluate the percentage of female authorship over time, weighted by the total number of publications per year, and performed separately for first and senior authorship. In addition, we used random sampling to select a representative subsample of articles to estimate the overall proportion of women considering all authorship positions. To guarantee representativeness, we used the *sampler* R Package (v0.2.4; Baldassarro, 2019)<sup>10</sup> to calculate the number of articles needed using a confidence level of 99% and a margin of error of 5%. Statistical analysis was performed using Stata v.16.1 (StataCorp LP., College Station, Texas, USA). Statistical significance was set at  $p < 0.05$ .

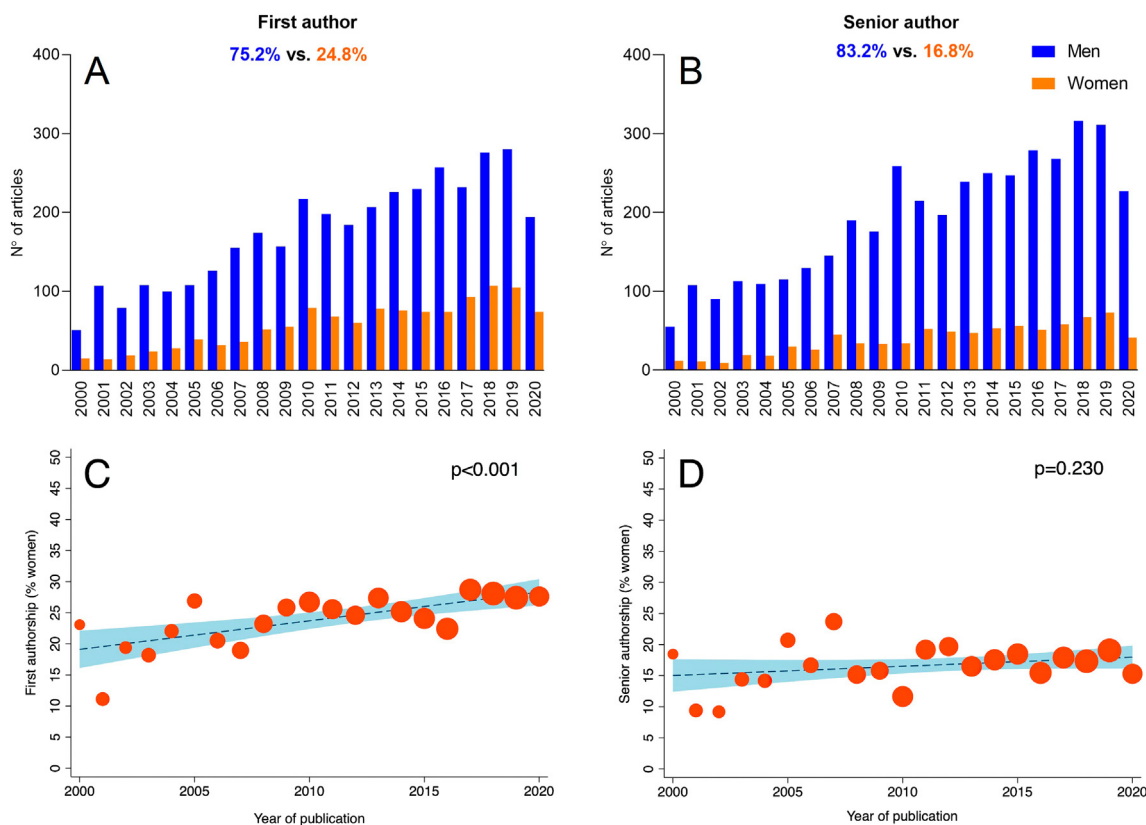
## 3. Results

Fourteen sport sciences journals were included. The number of articles published in each journal and filtered by PubMed as RCT is listed in Table S2. There were 4 journals (*Exercise and Sport Sciences Reviews*, *Sports Medicine*, *Exercise Immunology Review*, and *Journal of Sport and Health Sciences*) that each contributed a small number of articles ( $n \leq 12$ ). In total, 4890 articles were found. Of these, 49 articles were excluded because we were unable to identify the sex of either the first or the senior author. Of the 4841 articles analyzed, the average percentage of female first authorship since 2020 was 24.8% (Fig. 1A; range from 9.7% to 38.5% across journals), and the average percentage of female senior authorship was 16.8% (Fig. 1B; range from 7.6% to 22.3% across journals). The complete sex distribution profile by year of publication for the journals that contributed >12 articles is presented in Supplementary Figs. S1, S2, and S3. The percentage of female first authorship increased significantly from 2000 to 2020 ( $\beta = 0.702$ ;  $B = 0.46$ , 95% CI = 0.24 to 0.68,  $p < 0.001$ ; Fig. 1C). The percentage of female senior authorship did not change over time ( $\beta = 0.274$ ;  $B = 0.15$ , 95% CI =  $-0.102$  to 0.398,  $p = 0.230$ ; Fig. 1D). When all authorship positions were considered in a subsample of 586 articles, there were 807 women out of 3157 authors (25.6% women), and the percentage of overall female authorship did not increase over time ( $\beta = 0.206$ ;  $B = 0.220$ , 95% CI =  $-0.282$  to 0.723,  $p = 0.370$ ).

There were a total of 1418 editorial board positions among the 14 selected journals, and 279 (19.7%) of these positions (range 1.7% to 56.7% across journals) were occupied by women (Table 1; Fig. 2). None of the editors-in-chief of the 14 selected journals were women (Fig. 2).

## 4. Discussion

To the best of our knowledge, this is the first study to assess the proportion of women in leadership positions in sport sciences research. Our results provide clear evidence of an underrepresentation of women in the first and senior authorship positions of RCTs and as members of editorial boards. This picture was even more pronounced when considering higher responsibility positions such as senior authorship and, particularly, the editor-in-chief. Interestingly, the percentage of female first authorship increased significantly from 2000 to 2020, although the percentage of female senior authorship and overall female authorship did not increase over time.



**Fig. 1.** Number of articles published by men and women as first (A) and senior (B) authorship from January 1, 2000 to September 1, 2020. Linear regression assessing the evolution of the percent female first (C) and senior (D) authorship over the study period, weighted by the total number of publications per year (dots-size represent the number of articles published per year).

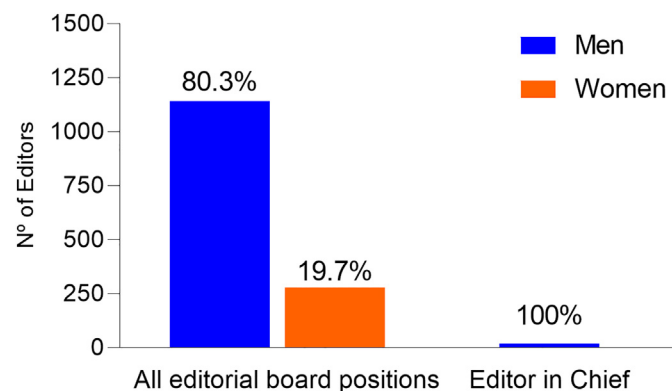
On average, women accounted for 25% of the first authorship positions with wide variability (10–39%) across journals. Noteworthy, the proportion of female first authorship increased by an average of ~0.5% annually since 2000, despite the overall female authorship not increasing over the studied period. These results are in line with previous studies conducted in medical research,<sup>3,5</sup> and reveal a larger proportion of female first authorship than that observed by Dynako et al.,<sup>11</sup> with a

much larger variability across journals. In addition, we observed that women accounted for an even lower proportion of senior authorship positions (17% on average), which remained stable throughout the past 20 years. In light of these figures, it could be argued that women are leading a rather low proportion of research projects in sport sciences, where the so-called “demographic inertia” phenomenon, by which the proportion of men and women working in the field some decades ago explains the sex distribution in leadership positions today,<sup>12</sup> could play a role. However, our results suggest that women seem to progressively be getting into the field by leading an increasing proportion of articles as first authors. This increase could be partly due to an increasing number of female PhD students, although this requires further investigation.

**Table 1**  
Analysis of the representation of women in editorial board positions in the selected sport sciences journals.

Journal	Total number of editors <sup>a</sup>	Number (%) of women in editorial board
British Journal of Sports Medicine	155	70 (45.2)
Sports Medicine	27	3 (11.1)
American Journal of Sports Medicine	181	12 (6.6)
Exercise Immunology Review	11	3 (27.3)
Journal of Sport and Health Science	42	6 (21.4)
Journal of the International Society of Sports Nutrition	67	10 (14.9)
Exercise and Sport Sciences Reviews	30	17 (56.7)
Arthroscopy - The journal of arthroscopic and related surgery	118	2 (1.7)
Medicine and Science in Sports and Exercise	130	37 (28.5)
Journal of Science and Medicine in Sport	90	26 (28.9)
Scandinavian Journal of Medicine & Science in Sport	106	11 (10.4)
Journal of Strength & Conditioning Research	188	34 (18.1)
European Journal of Sport Science	104	15 (14.4)
Journal of Sport Sciences	169	30 (17.8)
<b>Total</b>	<b>1418</b>	<b>279 (19.7)</b>

<sup>a</sup> All the editorial board positions are included except Editor Emeritus/Honorary Editors/Former Editors and publication staff.



**Fig. 2.** Sex distribution of editorial boards of the 14 sports sciences journals selected as of September 2020.

Another relevant finding of this study is that women accounted for only 19.7% of all editorial board positions. These results are in line with a previous study showing that only 17.5% of editorial board positions of the 60 top-ranked medical journals were occupied by women.<sup>6</sup> Interestingly, the proportion of women in editorial boards and senior authorship positions (<1/5) was similar. Our results, particularly considering that none of the editors-in-chief of the 14 selected journals were women, provide clear evidence of a rather low gender diversity in decision making in sport sciences, where men are predominantly selecting the relevant topics to drive this scientific field forward. An additional exploratory analysis of the sex of the 103 editors-in-chief of the 85 JCR sport sciences journals revealed that only 12 (12%) were women, with 2 of 26 (7.7% women) in the journals included in 2019 JCR Q1 (data not shown). This could partly explain why female-related topics have been largely ignored<sup>8</sup> and could reveal a potential for the field of sport sciences to improve quality, innovation, and discovery. Wing et al.<sup>13</sup> analyzed the review process of all original articles submitted to a medical journal from 2002 to 2008 and demonstrated, on the one hand, that female editors were less likely to recommend acceptance without revisions or with minor revisions than their male counterparts and, on the other hand, that women received a significantly higher score (related to the review process) from the editors-in-chief than men. We suggest that replicating this study in sport sciences journals would add valuable information as to the need to include more women in editorial teams to enhance quality in the review process, decision making, and diversity.<sup>5,13</sup>

A variety of mechanisms might explain the underrepresentation of women observed in sport sciences research. One of them is “demographic inertia,” as stated above, as well as the tradition of the sport sciences being a predominantly masculine field. It would not be surprising that a significantly lower proportion of women are pursuing a degree in sport sciences worldwide compared with men. For instance, according to the Spanish National Institute of Statistics, of 3866 students who graduated in sport sciences in 2014, only 819 (21.2%) were women.<sup>14</sup> Another theory that could partially explain the sex-related differences in sport sciences research leadership is the “pipeline theory,” which suggests that a proportion of women is lost at each educational stage, from high school to graduate school, leaving very few women at the end of the pipeline<sup>15</sup> (masters, PhD students, and post-doc, etc.). Women face several barriers to advance in their academic career, including slower promotions compared with men, lack of career flexibility, lack of mentorship, higher likelihood of being affected by work-life imbalance, or stereotyping (women being more likely to be perceived as professors and men as researchers).<sup>16–18</sup> The lack of female role models, as well as generalized societal discouragement about the potential of women to become scientists or experts in the field, might also preclude attracting female talent in sport sciences,<sup>1</sup> resulting in women not pursuing a scientific career in this field. This could require actions at different educational levels to encourage women to become sport sciences professionals and scientists. Finally, the “Matilda effect,” which reflects gender-related unequal opportunities and unequal value granted to the same merits (i.e., the scientific efforts and achievements of women do not receive the same recognition as those of men<sup>19</sup>), could also partly explain our results. Wenneras et al.<sup>20</sup> observed in 1997 that women applying for a research grant needed to be 2.5 times more productive than men in order to be considered equally competent. The Matilda effect has also been present when recognizing scientific careers or merits at scientific awards ceremonies. In this regard, Carnes et al.<sup>21</sup> provided a comprehensive rationale by which the selection process for the Director's Pioneer Award of the National Institute of Health in 2005 was biased against women.

All of the aspects mentioned above might be explanatory factors for the results presented in this study, and we can only speculate as to whether they could apply to the field of sport sciences. Therefore, future studies are needed to test these hypotheses. The absence of female leaders might not only limit recruitment of female participants in

sport sciences research,<sup>7</sup> but also provide limited views and approaches, thus potentially limiting innovation and discovery.<sup>1</sup> The extent to which greater sex heterogeneity in publication and editorial leadership will lead to a wider range of research topics being investigated, as well as higher quality research and publication in sport sciences,<sup>22</sup> should also be explored. Finally, the extent to which our findings are the result of true gender inequalities is also a matter of research.

This study has several limitations. We included only a selection of the top journals of the field of sport sciences, some of which were specialized in reviews and did not contribute RCTs. We did not account for exercise trials published in leading medical journals or other disciplines. We did not account for co-first/senior authorship; we did not take into consideration whether there were non-binary identities or other gender-related considerations, and we cannot exclude human error in sex determination, although it is very unlikely that accounting for all these factors could modify the results. Moreover, observational studies, reviews, meta-analyses, and qualitative research were not considered, and it remains unclear whether the results would vary. This study has strengths that must also be highlighted. First, to the best of our knowledge, this is the first study assessing the so-called “gender gap” in sport sciences research. Second, we assessed all the articles filtered by PubMed as RCT, which are considered the highest quality designs that are most likely conducted under funded research projects. However, possible filter-related errors in a small number of PubMed results cannot be discarded. Finally, a major strength of this study is that we identified the sex of each author and editor individually, which clearly improves the methodology of previous studies<sup>4,11</sup> based on automatic tools<sup>23</sup> that might be subject to classification bias.

## 5. Conclusion

In conclusion, our results provide clear evidence of an underrepresentation of women in sport sciences research, with a significantly lower proportion of women in the first and senior authorship positions of RCTs and as members of editorial boards, compared with men. This picture was even more pronounced when considering higher responsibility positions such as senior authorship and, particularly, the editor-in-chief. The percentage of female first authorship increased by ~0.5% yearly from 2000 to 2020, although the percentage of female senior authorship positions and overall female authorship did not increase over time. Further research is needed to understand the rationale behind these findings and the mechanisms by which this scientific field may enhance gender diversity.

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## Declaration of interest

None.

## Confirmation of ethical compliance

Because this study did not involve patients, it was not subject to approval from the local ethics committee.



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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jsams.2021.04.010>.

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