

The under-representation of women in biomechanical sports-related concussion studies

Phoebe Haste, Leonardo De Almeida E. Bueno, Antoine Jerusalem, Jeroen Bergmann

I. INTRODUCTION

Sports-Related Traumatic Brain Injury (SR-TBI) has become a topic of focus within TBI research, with head-trauma-related deficits being first noted in boxing as ‘punch-drunk syndrome’ in 1928 [1]. This focus has intensified as legal challenges have been brought against sport’s governing bodies for misrepresentation of the long-term consequences of repeated head impacts or injuries [2]. Concerns around these consequences have led to the development of many concussion screening tools, some of which are biomechanical in nature.

The rate of presentations of TBI in emergency departments in the US has been observed to be 546.7 per 100,000 persons for males and 385.9 per 100,000 persons for females (a ratio of 1.42) [3]. However, in sports where it is possible to compare between sexes, female athletes have been reported to have sustained 1.4 times the number of concussions of male athletes [4]. Females are predisposed to have longer symptom duration after concussive injuries [5]. This short communication aims to explore the characteristics of studies used to validate concussion screening tools with a focus on the disparity of data available between the sexes.

II. METHODS

The methodology of this study was constructed according to PRISMA guidelines [6] for an upcoming systematic review [7]. A search strategy was devised to capture studies that consider the assessment of athletes who have been concussed in sports within a day of injury. As the definition of concussion is subject to debate [8], papers investigating sub-concussive injuries are included. Studies are also required to provide performance metrics (e.g., accuracy, specificity, sensitivity, and other related metrics). The search strategy was created based on these factors and implemented in five separate databases: Embase via Ovid; IEEEXplore; Medline via Ovid; Scopus; and Web of Science.

The resulting dataset of papers was compiled and deduplicated. Published journal articles are included if they assess injured athletes within a day of the initial insult, and either consider measures of evaluation or diagnosis of SR-TBI or predict outcomes from the data collected. Papers were rejected if they solely focus on return to play, recovery monitoring, or are reviews. Data was extracted and analysed from the final set of papers. Where sex breakdowns of case groups were not available, the total study sex breakdown was used. No databases were present in duplicate.

III. INITIAL FINDINGS

From an initial dataset of 1,945 papers, 51 papers were extracted. Of these papers, 16 fail to mention sex at all. All these papers may reasonably be assumed to discuss men (where half of them refer to majority male sports, and the other half refer to male leagues). Considering the remaining 35 studies, more than 90% of the participants are males in 25 of them. There is a total of 27,207 participants between all the studies, with 23,635 male

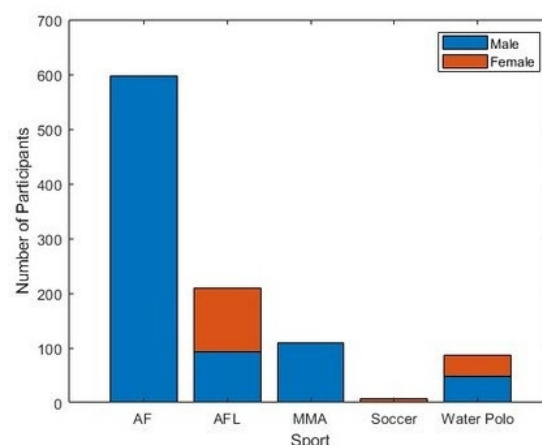


Fig. 1. Breakdown of participants in biomechanical sports-related concussion studies found in literature search by sport and sex; AF: American football, AFL: Australian rules football, MMA: Mixed Martial Arts.

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participants, and 3,572 female participants. Therefore, 13.1% of the participants across all the accepted studies are female.

Out of the 51 papers included, only 12 papers (23.53%) discuss the biomechanics of concussive injuries. Within this subset, 75% of the papers exclusively include male participants. The total number of participants in this subset of studies is 1,011, 846 (83.68%) of which are male and 165 (16.32%) of which are female. A visualisation of the division of sex in these experiments, categorised by sex division in each sport, can be seen in Fig. 1. These biomechanical studies tend to focus on a single sport, with 8 (66%) being related to American football. A single study contains both American football and soccer, with male American football players and female soccer players. The primary sport in a single study is AFL, another MMA, with two more considering water polo. The sports which the studies containing female participants consider are soccer, AFL and water polo. The first paper published in this subgroup was published in 2010 whilst the first paper including women in the sample population in a study was in published in 2020.

IV. DISCUSSION

Within this short report, the authors show that most biomechanical impact studies captured by the search strategy do not include women in their sample populations. The statistics outlined in the introduction indicate that the different rates of participation between sports cannot solely explain the disparity visible in Fig. 1. In fact, the demographics of the investigators themselves could also perpetuate this imbalance [9]. Nielson *et al.* [10] recently linked the participation of women authors to the presence of gender and sex analyses, but only 24.8% of sports science first authors are women [11].

Including female athletes is crucial due to sex differences, which range from the impacts sustained by the athletes [12] to the biomechanical, physiological, and musculoskeletal properties of the body itself [13]. When studies are focused on methods which measure, diagnose, and predict sports-related concussion, imbalances in their datasets could lead to flaws in the methods that they are validating. As existing impact monitoring methods that are implemented in professional sports, such as PROTECHT [14], are extended to both female and male athletes, the potential consequences of these flaws may become more concerning.

Therefore, to properly validate these monitoring methods for use in female athletes, robust datasets containing female athletes should be produced and examined. It is evident in this preliminary analysis that some studies have begun to consider this, but the majority of the work that exists in this area does not. Future work should aim to produce datasets which primarily focus on female athletes, as well as investigate what the precise differences are between the sexes in biomechanical impact studies, and how these differences can be utilised to make biomechanical impact measures more universally applicable. This work supports the findings of other studies that have highlighted the problem of appropriate representation in the population of interest [15]. This review shows that, currently, there is a lack of external validity, which limits the potential to draw appropriate conclusions across all those who are involved in contact sports.

V. REFERENCES

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ERRATUM

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This erratum is to provide an update to our results after the acquisition of additional data, and subsequent analysis. Though the conclusions of this short communication remain unaffected, additional discussion based on the review results is provided.

50 papers remained in the review rather than 51. 10 papers failed to mention sex rather than 16. 23 studies had more than 90 percent of males. There was a total of 52,404 participants between all the studies, with 36,073 male participants, and 12,646 female participants. Therefore, 24.1% of the participants across all the accepted studies are female.

The total number of participants in this subset of studies is 1249 rather than 1011. 1062 (85.03%) are likely to be male, 463 (37.07%) of which are stated as male, 599 (47.95%) of which can be presumed to be male, and 187 (14.97%) of which are female. The first paper published in the biomechanical subgroup was published in 2007.

A corrected version of Figure 1 can be seen here.

This short communication highlights the issue of reporting participant sex within biomechanical sports-related concussion studies.

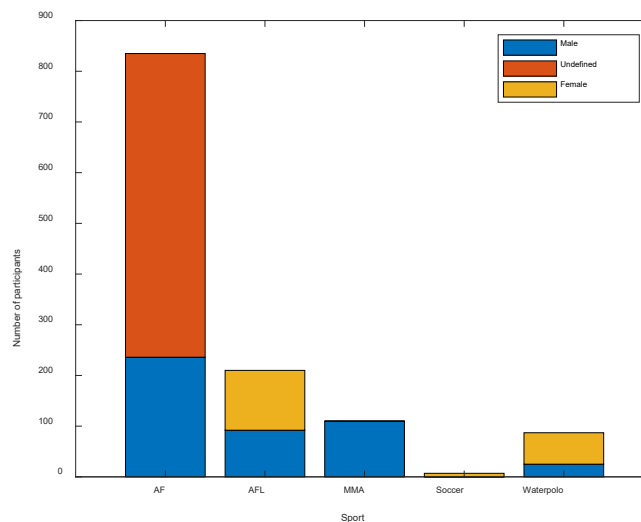


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