Abstract

The aim of this study is to estimate the ratio of male and female participants in Sports and Exercise Medicine research. Original research articles published in three major Sports and Exercise Medicine journals (*Medicine and Science in Sport and Exercise*, *British Journal of Sports Medicine* and *American Journal of Sports Medicine*) over a three year period were examined. Each article was screened to determine the following: total number of participants, the number of female participants and the number of male participants. The percentage of females and males per article in each of the journals was also calculated. Cross tabulations and Chi square analysis were used to compare the gender representation of participants within each of the journals. Data were extracted from 1, 382 articles involving a total of 6,076,580 participants. A total of 2,366,968 (39%) participants were female and 3,709,612 (61%) were male. The average percentage of female participants per article across the journals ranged from 35-37%. Females were significantly under-represented across all of the journals (X^2 =23566, df=2, p<0.00001). There were no significant differences between the three journals. In conclusion, Sports and Exercise Medicine practitioners should be cognisant of sexual dimorphism and gender disparity in the current literature.

Keywords: Sport Medicine; Exercise, Gender Bias; Ethics; Muscle Damage

Introduction

Sexual dimorphism is the phenotypic difference between males and females of the same species and is particularly relevant within Sports and Exercise Medicine (Lewis et al., 1986; Reider, 2012). For example, there are notable differences between the sexes when it comes to susceptibility and response to concussion (Covassin, Elbin, Harris, Parker, & Kontos, 2012; Covassin, Schatz, & Swanik, 2007; Dick, 2009; Farace & Alves, 2000; Marar, McIlvain, Fields, & Comstock, 2012), hip strength and range of motion (Brophy et al., 2009) and risk of knee injuries (Arendt & Dick, 1995; Mizuno, Andrish, van den Bogert, & McLean, 2009). The psychological response to athletic injury also seems to vary across genders with females, more likely to be concerned about long term implications (Granito, 2002). Consequently, original research should be correctly planned and powered to allow for identification of factors that may affect injury risk or prognosis; sex and gender are therefore obvious candidates for scrutiny (Reider, 2012).

The Olympic Charter states that one of the roles of the International Olympic Committee is "*to encourage and support the promotion of women in sport at all levels and in all structures, with a view to implementing the principle of equality of men and women*" (International Olympic Committee, 2013). The success of the International Olympic Committee in seeking gender equality is demonstrated by the number of females participating in the Summer Olympics increasing from 22 (2.2% of total participants) in 1900 to 4, 676 (44.2%) in London 2012. The Winter Olympics has followed a similar trend in recent decades, with female Olympians growing from 13 (5%) in 1924 to over 1000 (40.7%) in Vancouver 2010.

A range of similar strategies, organisations, charters and laws have been introduced by Governments and sporting organisations internationally, in an attempt to increase female participation in sport and reduce gender-based discrimination. Over the last number of decades in the United Kingdom a collaboration of the national sports agencies, equity organisations and national sports organisations (including national governing bodies of sport) has focused on equality standards and dealing with diversity issues; such as gender discrimination (Spracklen, Hylton, & Long, 2006). The Education Amendments of 1972 in the United States of America led to Title IX, a federal law banning sex discrimination in any federally-funded education program was enacted (Carpenter & Acosta, 2005). The

Department of Justice have recently reported that Title IX has dramatically expanded women's access to athletic programs and increased their educational attainment by providing girls and women equal access to education (United States Department of Justice, 2012). In relation to sport, Title IX was arguably the most important intervention to increase physical activity and led to a 600% increase in girls' sports participation between 1972 and 1978 in America (United States Department of Justice, 2012; Kaestner & Xu, 2010; Sandberg & Verbalis, 2013).

In Sports and Exercise Medicine, it is commonly accepted that there are physiological and morphological gender differences (Convertino, 1998; Dick, 2009; Kaciuba-Uscilko & Grucza, 2001; Lewis, Kamon, & Hodgson, 1986; Mendelsohn & Karas, 2005; Reider, 2012; Stupka et al., 2000; Tarnopolsky, MacDougall, Atkinson, Tarnopolsky, & Sutton, 1990). However, to our knowledge no authors have examined the number, ratio, or percentage of male and female subjects participating in research in this field. Therefore, in this study we examine the gender of participants involved in research published in a sample of top Sports and Exercise Medicine journals. It was hypothesised that an equal representation of both male and female participants would be observed in the literature.

Methods

Articles published in three major Sports and Exercise Medicine journals (*British Journal of Sports Medicine*, *American Journal of Sports Medicine* and *Medicine and Science in Sport and Exercise*) were studied from January 2011 to August 2013 inclusive. These journals were chosen as they have been consistently ranked in the top 6 of the 'Sport Science' category since 2011, according to the Thomson Reuters science citation index. Other journals consistently featuring in the top six of this category, including *Sports Medicine*, *Exercise Immunology Review and Exercise and Sport Sciences Reviews* were not considered as they predominantly consisted of review articles.

Only original and epidemiological articles were considered. Editorials, special communications, methodological advances, book reviews, narrative/systematic reviews, meta-analyses or letters to the editor were not considered. The number and gender of participants included in the study was extracted where possible. In articles where the gender of the participants was not explicit (from either the title, abstract, text, tables or figures) the information was not included. Similarly, only articles involving human participants were

considered. Studies involving cadavers, animal models or other in vitro research were excluded from the analysis. Each article was screened to determine the total number of participants and the total number split by gender. Chi square (X^2) analysis (Excel 2007, version 12) was used to compare the gender counts across each of the journals.

Results

Data were extracted from 1382 articles involving 6,076,580 participants. A total of 2,366,968 (39%) participants were female and 3,709,612 (61%) were male (Table I). Females were significantly under-represented across all of the journals (X^2 =23566, df=2, p<0.00001). The average percentage of female participants per article in the *British Journal of Sports Medicine*, *American Journal of Sports Medicine* and *Medicine and Science in Sport and Exercise* was 35, 35 and 37% respectively. There were no significant differences between the three journals (p>0.05).

Table I. Gender of participants included in three major international sports medicine journals

	Br J Sports Med	*Am J Sports Med*	*Med Sci Sports Exercise*	Total
Total females (%)	268,570 (33)	260,071 (52)	1,838,327 (39)	2,366,968 (39)
Total males (%)	547,354 (67)	234,203 (48)	2,928,055 (61)	3,709,612 (61)
Average % of female/male participants per article	35/65	35/65	37/63	

Br J Sports Med, British Journal of Sports Medicine; Am J Sport Med, American Journal of Sports Medicine; Med Sci Sport Exercise, Medicine and Science in Sports and Exercise.

Table 2 represents data regarding the use of male only, female only and both genders as participants in the three leading journal from 2011-2013. Only 4-13% of the articles incorporated females only, 18-34% males only and 53-78% of the articles included both males and females.

Table II. Absolute number of original research articles including male only, female only and both genders as participants

	Br J Sports Med			*Am J Sports Med*			*Med Sci Sports Exercise*		
	M (%)	F (%)	Both (%)	M (%)	F (%)	Both (%)	M (%)	F (%)	Both (%)
2011	24 (25)	8 (8)	64 (67)	40 (19)	10 (5)	157 (75)	79 (33)	32 (13)	131 (54)
2012	26 (33)	4 (5)	49 (62)	34 (19)	3 (2)	139 (79)	88 (35)	35 (14)	129 (51)
2013[a]	18 (35)	5 (10)	29 (56)	16 (15)	6 (5)	88 (80)	61 (36)	18 (11)	90 (53)
Total	68 (30)	17 (8)	141 (62)	90 (18)	19 (4)	384 (78)	228 (34)	85 (13)	350 (53)

Br J Sports Med, British Journal of Sports Medicine; Am J Sport Med, American Journal of Sports Medicine; Med Sci Sport Exercise, Medicine and Science in Sports and Exercise. M, male participants only; F, female participants only; Both, both male and female participants.
[a]January–August only.

Discussion

To our knowledge this is the first study which has sought to examine the gender of participants in articles published in the Sports and Exercise Medicine literature. Using a sample of leading journals in the field, namely the *British Journal of Sports Medicine, American Journal of Sports Medicine* and *Medicine and Science in Sport and Exercise,* we have found evidence that female participants are significantly under-represented in the current literature.

Females typically account for <40% (Table I) of the total number of participants in original and epidemiological research. Interestingly, the average percentage of female participants per original article was very consistent at 35-37% (Table I). The discrepancy between the absolute and relative percentage of female participants (3-5%) may be explained by some of the larger epidemiological studies. Several of these larger studies incorporated male and female participants from a school or community setting, and therefore the absolute number and percentage of females is inflated. Although, 53-78% of the articles published in the aforementioned journals over this time period incorporated male and female participants (Table II), less than 40% of the total sample were female. It is plausible that there are two explanations for this; firstly, articles tended to over-represent male participants and therefore reduce the number of female participants and secondly, the greater volume of articles utilising males only, compared to females only, inflated the findings.

Historically, women's competitive sport was controversial and female athletes have been subjected to a variety of discriminatory practices. Indeed, the 2012 Summer Olympics were the first games in which every country's delegation included a female competitor. Today females are increasingly represented among sport participants and sport audiences and there is growing gender equality in terms of media coverage (Capranica et al., 2005; Capranica et al., 2008, Capranica et al., 2012). Bleakley and colleagues have previously reviewed the quality of research (Bleakley & MacAuley, 2002) and the type of subjects (e.g. healthy, sedentary, recreationally active, elite and injured) (Bleakley, MacAuley, & McDonough, 2004) of original research published in Sports and Exercise Medicine journals. Our findings expand on these reviews (Bleakley & MacAuley, 2002; Bleakley et al., 2004) and indicate that a gender imbalance exists within the literature.

For demonstration purposes we examined the gender representation of one aspect of research in the Sports and Exercise Medicine literature, notably the management of delayed onset muscle soreness (DOMS). The gender of participants studied in a total of six systematic reviews (Bennett, Best, Babul, Taunton, & Lepawsky, 2005; Bieuzen, Bleakley, & Costello, 2013; Bleakley et al., 2012; Herbert, de Noronha, & Kamper, 2011; Hill, Howatson, van Someren, Leeder, & Pedlar, 2013; Leeder, Gissane, van Someren, Gregson, & Howatson, 2012) investigating interventions commonly used to alleviate DOMS was extracted (Table III). These interventions included hyperbaric oxygen therapy (Bennett et al., 2005), contrast water therapy (Bieuzen et al., 2013), cold water immersion (Bleakley et al., 2012; Leeder et al., 2012), stretching (Herbert et al., 2011) and compression garments (Hill et al., 2013). This body of research comprises more than 60 original studies, with the average percentage of female participants ranging from 16 (Bieuzen et al., 2013) to 36% (Herbert et al., 2011).

Table III. Gender of participants included in systematic reviews examining the effectiveness of various therapeutic interventions used in the management of DOMS

	Bleakley (2012; CWI)	Leeder (2012; CWI)	Bieuzen (2013; CWT)	Hill (2013; CG)	Herbert (2011; Stretch)	Bennett (2005; HT)[a]	Total
Females (%)	100 (27)	71 (27)	55 (15)	69 (34)	1566 (61)	26 (15)	1887 (48)
Males (%)	266 (73)	196 (73)	317 (85)	135 (66)	995 (39)	142 (85)	2051 (52)
Average % of female/male participants[b]	25/75	27/73	16/84	28/72	36/64	23/77	

CWI, cold water immersion; CWT, contrast water therapy; CG, compression garments; Stretch, stretching; HT, hyperbaric oxygen therapy.
[a]Only studies examining muscle soreness recovery after exercise are included, studies on soft tissue injury excluded.
[b]These data pertain to the individual studies included within the various review.

It is difficult to provide a specific rationale for the gender bias in the broader Sport and Exercise Medicine literature, and it is likely that a range of physiological and methodological issues contribute. These data relating to the current evidence on DOMS highlight the difficulty in extrapolating findings, predominately provided by male participants, to female athletes. Sexual dimorphisms such as increased levels of adiposity (Jutte, Hawkins, Miller, Long, & Knight, 2012) and the menstrual cycle (Coyne, Kesick, Doherty, Kolka, & Stephenson, 2000) are likely to alter tissue and core body temperature and thus implicating the clinical effectiveness of the various treatments, particularly cold water immersion, contrast water therapy and compression garments. In addition, oestrogen levels, the inflammatory process (Stupka et al., 2000) and signalling responses (West et al., 2012) have been consistently reported to attenuate damage and/or inflammation and to accentuate tissue repair in females (Tiidus & Enns, 2009). Consequently, the role of oral contraceptive use (Savage & Clarkson, 2002) and the menstrual cycle (Willoughby & Wilborn, 2006) in the

severity and recovery of muscle damage has recently been debated within the literature (Enns & Tiidus, 2010) and may have potentially led to the scarcity of females participating in these studies.

Limitations and future research

The strength of the current study is the extremely large number of participants (>6 million) sourced from original and epidemiological articles published in a sample of three leading Sports and Exercise Medicine journals. A similar examination of other journals in this area and a historical analysis of the use of male and female participants in Sport and Exercise Medicine research are warranted. The current review did not consider the following in the analysis; studies involving a) multiple publications based on data from the same population/sample, b) sex specific studies or sports involving males/females only (e.g. pregnancy, testicular cancer) or c) the higher overall participation of men in physical competition (Deaner et al., 2012). Finally, due to the large number of participants, we did not provide additional information on the demographics (e.g. age, anthropometrics or training status) of the included participants. It is plausible this information would demonstrate other biases and warrants further investigation.

Conclusion

The current study demonstrated that female participants are typically under-represented in the *British Journal of Sports Medicine, American Journal of Sports Medicine* and *Medicine and Science in Sport and Exercise*. The absolute number and percentage of female participants (39%) is significantly lower than males and the average ratio of male to female per articles is almost 2-fold greater (~65:35) across the three leading journals. Evidence of a gender bias toward male participants is also evident in research examining various intervention strategies used in the management of DOMS following exercise. Consequently, Sports and Exercise Medicine practitioners should be cognisant of sexual dimorphism and gender disparity in the current literature. As the current findings are limited to research published in these journals from 2011 to 2013, further research is required to address the issue of gender disparity in Sports and Exercise Medicine research.

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