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Relative Dearth of ‘Sex Differences’ Research in Sports Medicine

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Abstract

A dearth of sex differences research exists in sports medicine. Although females now participate in sports medicine research, a disparity of representation still exists in the literature for female athletes. Additionally, a lack of sex difference reporting exists that ultimately leads to issues of relevancy to sex and scientific reproducibility. It is important for future research to address sex differences in research design, analysis, and report.

Keywords

sex differences; sports medicine; sports injury

Sex-Specific Research

As a natural genesis to the National Institutes of Health (NIH) policy on the Inclusion of Women in Clinical Research,¹ since early 2016, the NIH requires ‘sex as a biological variable’ to be addressed in submitted grant applications that pertain to vertebrate animals and humans.² This policy is evidence of the NIH’s commitment to improvement of health outcomes of both women and men through support of rigorous science that advances fundamental knowledge about the nature and behavior of living systems.² With implementation of the policy, females now have a defined representation in NIH-supported clinical research. However, basic and preclinical biomedical research still primarily emphasizes male animals and cells. In consequence of the over-reliance of data on male animals and cells, the disseminated results may obscure interpretation of key sex influences

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on health processes and outcomes;³ subsequently, the reported results may induce issues of research reproducibility.

Sex has profound effects on physiology and the susceptibility to disease. The function of cells and organs depends on their sex, determined by the interplay among the genome and biological and social environments.⁴ The study of sex differences is a discipline in itself, with its own concepts and methods that apply across tissues. Sex plays a role in how health and disease processes differ across individuals;^{5,6} consideration of these important factors in research studies will work to inform the development and testing of preventive and therapeutic interventions in both sexes.

Much of sports medicine research is in large part inclusive of women participants in research, yet the research nevertheless fails to adequately parse out sex differences in the analysis and results (Figure 1). In the absence of equal and rigorous investigation of the female athlete from the outset of experimental design through to data analysis and presentation, we will fail to understand the basic biology, pathophysiology and injury mechanisms that differ between sexes.³ Accordingly, we will fail to inform efficacious clinical interventions for both prevention and rehabilitation of both sexes, but especially that of girls and women, with a continuation of the approaches established in much of the literature that are primarily relevant to male athletes.

Sex-Specific Results

It is imperative to recognize an important distinction that should be made clear in all future sports medicine studies to increase research reproducibility and advancement towards individualized medicine. Sex and gender are not interchangeable terms and should be properly outlined in sports medicine research. Sex is defined by characteristics encoded in DNA, such as reproductive organs and other physiological and functional characteristics. Gender is defined by social, cultural, and psychological traits linked to human women and men through social context.⁵ In general, the majority of sports medicine research would fall under the sex distinction category. Males and females have distinct chromosomal differences that lead to key cellular and molecular differences which will affect hormones, physiology, growth and development, body composition, healing, and aging.

Many diseases and injury patterns differ in males and females. For example, anterior cruciate ligament injuries have a higher incidence rate in young, active females than in males.⁷ Many other injuries or diseases that pertain to sports medicine are likely sex dependent. Often, one sex is more prone to a disease or injury due to biological or environmental factors. Thus, it is important to understand these sex differences to discover and enhance sex-biasing factors that protect from disease, and to develop optimal preventive and rehabilitative therapies for both women and men. Therefore, knowledge of sex differences must be employed in the research design, power analysis, methodology, analysis, and result report. Appropriate analysis and transparent reporting of data by sex will likely enhance the rigor and applicability of preclinical biomedical research.² Sex differences research must be integral to advance personalized medicine in our era of individualized and precision medicine.⁸ With appropriate emphases on sex differences in sports medicine

research, improved innovation of medical, surgical, pharmacological, regenerative, and genetic technologies is possible.

Summary

In conclusion, future sports medicine research should not just include pooled reports of the results for both sexes in one output, but should incorporate adequate planning at the project development stage to ensure adequate power to determine individual sex differences. Future research should include separation of sex (and potentially gender) in the design, analysis, interpretation, data presentation, and generalizability of the results to advance individualized medicine for both prevention and rehabilitation. This methodology will ensure that preventive and rehabilitative outcomes are custom-tailored to the athlete, regardless of sex, and achieve improved health, function, and performance of the athletes.

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Figure 1.

Six leading sports medicine journals were surveyed for original human research articles published over a 3-month period (August through October 2017). Of the 194 articles identified, 130 (67%) collected data from both male and female subjects, but only 39 articles (20.1%) statistically analyzed between-sex differences or presented sex-specific outcomes.