Sex and gender: what is the difference?

It is clear that sex is a key biological variable that should be considered in all basic physiological and biological research. However, despite a long history of interest in sex-based investigations, this topic has historically not been well studied. The current importance of sex research is obvious by the recent rise in articles reporting on sex-based biology across scientific journals, including the *Journal of Applied Physiology*. There are two terms being used in this contemporary dialogue to describe the sex-based research: “sex” and “gender.” The term gender is becoming more common in scientific publications to describe biological variation traditionally assigned to sex, and this nonspecific language merits a standardized approach. Increasingly, researchers are becoming aware of the appropriate use of the terms sex vs. gender. Still, some scientists are vaguely aware that a distinction exists between these terms or that this difference is an important one. The purpose of this article is to publicize the necessity for implementing a standardized use of the terms sex and gender in physiology. Thus this article will present a general history examining the transition in the frequency of use of the term gender instead of sex in physiology, present standard definitions by promoting the recommendation from the Institute of Medicine (IOM), and provide examples of appropriate use of these terms in reference to specific contexts.

Coming to a consensus in the use of terminology is a worthwhile endeavor for disciplines such as physiology that rely heavily on specific language to explain phenomena. Other disciplines, including psychology and anthropology, have put into practice distinguishing between the terms sex and gender in their discourse (4, 11, 12). As physiologists, we will likely find that adopting this distinction can only improve communication within as well as outside our discipline.

Physiologists are at the forefront of the nationally and internationally recognized work on sex-based research and women’s health. Although certainly sex-based research is growing in all areas of science, it is critical to understand the history. Physiologists are aware of and socially sensitive to a history of science where the long-standing norm was a 70-kg man. The prominence of research investigations using the established “norm” of a 70-kg man shaped an understanding of human biology that lacked information in regard to female-specific biology, anatomy, pathology, and treatments for disease. In 1985, the US Public Health Task Force on Women’s Health declared that “the historical lack of research focus on women’s health concerns has compromised the quality of health information available to women as well as the health care they receive” (7). This report prompted federal legal action and started a momentum of sex-based research that has led to fundamental changes in science. By the mid-1990s, the National Institutes of Health, the Food and Drug Administration, the Government Accounting Office, the Congressional Caucus on Women’s Issues, and most prominently the Society for Women’s Health Research had collectively established the Women’s Health Equity Act, and new National Institutes of Health policies demanding the inclusion of women in federally funded clinical trials and ensuring that women and minorities are included in all human subjects research (7).

The American Physiological Society (APS) has been a leader in integrating sex-based research into its journals and has devoted issues of the *Journal of Applied Physiology* to sex-based differences, including the Highlighted Topics series on “Genome and Hormones: Gender Differences in Physiology.” In the series editorial by Dr. Gary Sieck, physiologists are recognized for their ever-growing efforts in sex-based physiology research and interdisciplinary approaches to these investigations (9). Importantly, the editorial highlights the confusion within APS over the use of these terms. In this editorial, sometimes “gender,” sometimes “sex,” and sometimes “gender/sex” is used to describe the recent advances that physiologists are making in recognizing the important implications of sex difference on all physiological systems. The growing interest in sex-based research and growing publications related to this work have led to the increased use of the term gender instead of the term sex.

Before the 2001 *Journal of Applied Physiology* Highlighted Topic series, from July 1948 through December 2000 there were 59 Journal article titles that contained the words sex and/or gender. From January 2001 through December 2004 there have been 60 titles containing the terms sex and/or gender. Notably, in the last 5 years the Journal has included more sex-based research articles in the journal than in the last 50+ years. However, this increase in sex-based research is connected to the appropriation of the term gender as a synonym for sex and has led to misuse of that term in physiology. The increase in frequency of the use of the term gender in the American Physiological Society journals is highlighted in Table 1. In the journals of the American Physiological Society, gender was first introduced into a title in 1982, whereas sex had been used since the early 1920s. It was not until the mid-1990s that use of the term gender began to exceed use of the term sex in APS titles, and today gender more the doubles that of sex (Table 1). The term gender appears to have undergone appropriation by some scientists as a politically correct way to talk about sex. This may be because some scientists are sensitive to the verity that discussing sex often means discussing difference and gender may be construed as a less loaded term.

Accordingly, it is imperative that scientists and editors come to a consensus on these terms to alleviate any confusion in their usage. These words have specifically different etymologies and meanings. In the most basic sense, sex is biologically determined and gender is culturally determined. The noun sex includes the structural, functional, and behavioral characteristics of living things determined by sex chromosomes. Sex (noun) is derived from the Latin word “sexus,” meaning either of two divisions of organic nature distinguished as male or female, respectively (8). According to the Oxford English Dictionary, sex (noun) has a definition as “the sum of those differences in the structure and function of the reproductive organs on the ground of which beings are distinguished as male and female, and of the other physiological differences consequent on these; the class of phenomena with which these differences are concerned” (8). Gender can be thought of as the
behavioral, cultural, or psychological traits typically associated with one sex. Gender (noun) is derived from the Latin word “genus” referring to kind or race (8). Gender (noun) is defined as “a kind, sort, or class referring to the common sort of people” (8). It is through an understanding of these principal definitions that scientists can apply these terms in a specific manner to sex-based research.

After the late 20th century legislation on sex-based research initiatives, the IOM established the Committee on Understanding the Biology of Sex and Gender Difference to outline the most important issues and establish future direction for sex-based research (1). Included in this essential IOM report was a recommendation for using the terms sex and gender in research. The recommendation identified by the 2001 IOM report calls for researchers to clarify and be specific in their use of the terms sex and gender in publications and, by doing so, create consistency across the literature. The Committee provided three guidelines for using sex and gender correctly in human and animal research. First, in the study of human subjects, the term sex should be used as a classification according to the reproductive organs and functions that derive from the chromosomal complement. Second, in the study of human subjects, the term gender should be used to refer to a person’s self-representation as male or female, or how that person is responded to by social institutions on the basis of the individual’s gender presentation. Third, in most studies of nonhuman animals the term sex should be used. Although clearly any discipline or author could choose to define sex and gender according to their intentional meaning, these are a standard set of definitions for use in sex-based research and this is the theoretical basis for the use of these terms in other disciplines (1, 4, 11, 12).

Using the IOM term specificity as a guide, the vast majority of articles published in APS journals are reporting on sex in humans and animals, not gender. Of the article titles examined by the authors of this article from 1960 to 2004 in the Journal of Applied Physiology, all titles using gender were sex-based investigations (Fig. 1). APS article titles that indicate sex-based research was conducted on “age, gender, and ethnicity” or “genetic background and gender on hypertension” are examples of publications where specificity and consistency between using sex and gender are imperative because sex and gender can be differentially related to health outcomes in humans. Across science, there is growing interest in understanding how levels of stress relate to depression, alcoholism, hypertension, and cardiovascular risk in individuals whose stress may be directly related to particular gender roles and/or socioeconomic variables.

There are also an increased number of investigations on how hormones affect human physiology and human behavior. An article by Sheri Berenbaum (2), “Effects of early androgens on sex-typed activities and interests in adolescents with congenital adrenal hyperplasia,” succeeds in examining both sex and gender in humans. The report examines mechanisms of steroid-mediated development of the human brain and includes a model that considers behaviors like toy play, playmate preferences, and gender identity in children tracked through childhood to evaluate the effects of exposure to prenatal androgens while considering cultural exposure to gender ideology in the development of behaviors. In another topic related to hormones, recognition of the sex and gender difference will serve

![Fig. 1. Number of articles titles from 1960 to 2004 examined by the authors in which the term gender was used as an equivalent term for sex in sex-based research publications in the Journal of Applied Physiology.](http://jap.physiology.org/)
physiologists to better describe the growing data on hormones and transgender and transsexual individuals. Transgender individuals have a genetic sex but occupy a gender role other than that typically assigned to their sex. Some transgender individuals are using exogenous sex hormones in their day-to-day life, and these hormones are impacting their physiology. Alternatively, transsexual individuals are genetically one sex and have gone through a range of surgical modifications and hormonal interventions that allow sex reassignment. Progressively there are more interest and more data coming from research involving trans individuals that are helping to elucidate organizational and activation effects of endogenous and exogenous sex hormones in female-to-male and male-to-female transitions in areas such as vascular function (10), metabolic disorders (3), and breast tumors (5, 6).

Along these lines, physiologists will surely be contributors in upcoming debates on the biological categorization of transgender and transsexual individuals. For instance, in May 2004 the International Olympic Committee (IOC) announced that transsexual individuals will now be able to compete in Olympic events in their new sex after a sex-change surgery. This poses some interesting new physiological questions yet to be answered, but certainly of great importance in this area. For instance, how many structural and or hormonally mediated changes in gene regulation and over what time period are required for an individual to be physiologically transitioned to a new sex? The IOC Medical Commission has issued the recommendation that eligibility can occur 2 yr postgonadectomy and after hormonal therapy has been administered for a sufficient length of time to minimize differences between genetic females and males and those with sex reassignment. The IOC Medical Commission recommendation makes clear that there is a necessity for sex-based research in exploring whether there is ever sufficient time to overcome the genetic influence of the XX or XY chromosome on performance and whether there are physiological functions that cannot be modulated by sex steroid hormones if there is the presence of a Y chromosome. As physiologists, we will certainly engage in this debate by providing the data necessary, and using the proper terminology will be of utmost importance in this potentially confusing topic.

The continuing dedication by physiologists to sex-based and women’s health research comes from the understanding that although females and males share many physiological similarities, they are fundamentally different. This is a basic biological principle in all species in which sexes exist, and there is an obvious need to explore the differentiation that the evolution of sex has afforded humans and their biology, but female and male sex-based research is not the same as gender-based research. The point is that avoiding synonymous use of the terms sex and gender serves to avoid misusing the concepts of sex and gender across disciplines of science. In summary, it is appropriate to use the term sex when referring to the biology of human and animal subjects, and the term gender is reserved for reference to the self-identity and/or social representation of an individual. Although certainly there will be those who do not feel that this specificity of terms is necessary in physiology, on the whole this approach will reduce wordiness in publications and allow for simpler integration of discussion on human biology. Outside of physiology, many social scientists draw on biological and psychological data to better understand the human condition and explain human behavior in a more comprehensive way. Because of this, it seems valid to argue that a consensus for using sex and gender in a standard context, as outlined by the IOM, needs to be implemented in physiology to provide consistency and alleviate confusion within as well as outside this discipline.

REFERENCES


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