

TUTORIAL

Genders, sexes, and health: what are the connections—and why does it matter?

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Accepted 18 February 2002

Open up any biomedical or public health journal prior to the 1970s, and one term will be glaringly absent: *gender*. Open up any recent biomedical or public health journal, and two terms will be used either: (1) interchangeably, or (2) as distinct constructs: *gender* and *sex*. Why the change? Why the confusion?—and why does it matter? After briefly reviewing conceptual debates leading to distinctions between ‘sex’ and ‘gender’ as biological and social constructs, respectively, the paper draws on ecosocial theory to present 12 case examples in which gender relations and sex-linked biology are singly, neither, or both relevant as independent or synergistic determinants of the selected outcomes. Spanning from birth defects to mortality, these outcomes include: chromosomal disorders, infectious and non-infectious disease, occupational and environmental disease, trauma, pregnancy, menopause, and access to health services. As these examples highlight, not only can gender relations influence expression—and interpretation—of biological traits, but also sex-linked biological characteristics can, in some cases, contribute to or amplify gender differentials in health. Because our science will only be as clear and error-free as our thinking, greater precision about whether and when gender relations, sex-linked biology, both, or neither matter for health is warranted.

Keywords Epidemiological methods, epidemiological theory, gender, men’s health, sex, women’s health

Open up any biomedical or public health journal prior to the 1970s, and one term will be glaringly absent: *gender*. Open up any recent biomedical or public health journal, and two terms will be used either: (1) interchangeably, or (2) as distinct constructs: *gender* and *sex*. Why the change? Why the confusion?—and why does it matter?

As elegantly argued by Raymond Williams, vocabulary involves not only ‘the available and developing meaning of known words’ but also ‘particular formations of meaning—ways not only of discussing but at another level seeing many of our central experiences’ (ref. 1, p. 15). Language in this sense embodies ‘important social and historical processes’, in which new terms are introduced or old terms take on new meanings, and often ‘earlier and later senses coexist, or become actual alternatives in which problems of contemporary belief and affiliation are contested’ (ref. 1, p. 22).

So it is with ‘gender’ and ‘sex’.^{2,3} The introduction of ‘gender’ in English in the 1970s as an alternative to ‘sex’ was

expressly to counter an implicit and often explicit biological determinism pervading scientific and lay language.^{2–8} The new term was deployed to aid clarity of thought, in a period when academics and activists alike, as part of and in response to that era’s resurgent women’s movement, engaged in debates over whether observed differences in social roles, performance, and non-reproductive health status of women and men—and girls and boys—was due to allegedly innate biological differences (‘sex’) or to culture-bound conventions about norms for—and relationships between—women, men, girls, and boys (‘gender’) (Table 1). For language to express the ideas and issues at stake, one all-encompassing term—‘sex’—would no longer suffice. Thus, the meaning of ‘gender’ (derived from the Latin term ‘generare’, to beget) expanded from being a technical grammatical term (referring to whether nouns in Latin and related languages were ‘masculine’ or ‘feminine’) to a term of social analysis (ref. 1, p. 285; ref. 4, p. 2; ref. 5, pp. 136–37). By contrast, the meaning of ‘sex’ (derived from the Latin term *secus* or *sexus*, referring to ‘the male or female *section* of humanity’ [ref. 1, p. 283]) contracted. Specifically, it went from a term describing distinctions between, and the relative status of, women and men (e.g. Simone DeBeauvoir’s *The Second Sex*⁹) to a biological

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Table 1 Definitions of 'sex' and 'gender'. From *A Glossary for Social Epidemiology*²

Term	Definition
Gender, sexism, & sex	Gender refers to a social construct regarding culture-bound conventions, roles, and behaviors for, as well as relations between and among, women and men and boys and girls. Gender roles vary across a continuum and both gender relations and biologic expressions of gender vary within and across societies, typically in relation to social divisions premised on power and authority (e.g., class, race/ethnicity, nationality, religion). Sexism , in turn, involves inequitable gender relations and refers to institutional and interpersonal practices whereby members of dominant gender groups (typically men) accrue privileges by subordinating other gender groups (typically women) and justify these practices via ideologies of innate superiority, difference, or deviance. Lastly, sex is a biological construct premised upon biological characteristics enabling sexual reproduction. Among people, biological sex is variously assigned in relation to secondary sex-characteristics, gonads, or sex chromosomes; sexual categories include: male, female, intersexual (persons born with both male and female sexual characteristics), and transsexual (persons who undergo surgical and/or hormonal interventions to reassign their sex). Sex-linked biological characteristics (e.g., presence or absence of ovaries, testes, vagina, penis; various hormone levels; pregnancy, etc.) can, in some cases, contribute to gender differentials in health but can also be construed as gendered expressions of biology and erroneously invoked to explain biologic expressions of gender . For example, associations between parity and incidence of melanoma among women are typically attributed to pregnancy-related hormonal changes; new research indicating comparable associations between parity and incidence of melanoma among men, however, suggests that social conditions linked to parity, and not necessarily—or solely—the biology of pregnancy, may be aetiologically relevant.
Sexualities & heterosexism	Sexuality refers to culture-bound conventions, roles, and behaviors involving expressions of sexual desire, power, and diverse emotions, mediated by gender and other aspects of social position (e.g., class, race/ethnicity, etc.). Distinct components of sexuality include: sexual identity, sexual behavior, and sexual desire. Contemporary 'Western' categories by which people self-identify or can be labeled include: heterosexual, homosexual, lesbian, gay, bisexual, 'queer', transgendered, transsexual, and asexual. Heterosexism , the type of discrimination related to sexuality, constitutes one form of abrogation of sexual rights and refers to institutional and interpersonal practices whereby heterosexuals accrue privileges (e.g., legal right to marry and to have sexual partners of the 'other' sex) and discriminate against people who have or desire same-sex sexual partners, and justify these practices via ideologies of innate superiority, difference, or deviance. Lived experiences of sexuality accordingly can affect health by pathways involving not only sexual contact (e.g., spread of sexually-transmitted disease) but also discrimination and material conditions of family and household life.

term, referring to groups defined by the biology of sexual reproduction (or, in the meaning of 'having sex', to interactions involving sexual biology) (ref. 1, p. 285; ref. 4, p. 2; ref. 5, pp. 136–37).

As the term 'gender' began to percolate into everyday use, however, it also began to enter the scientific literature,^{3–8,10} sometimes with its newly intended meaning, other times as a seemingly trendy substitute for 'sex'—with some articles¹¹ even including both terms, interchangeably, within their titles! Other studies, by contrast, have adhered to a strict gender/sex division, typically investigating the influence of only one or the other on particular health outcomes.^{3–8,10} A new strand of health research, in turn, is expanding these terms from singular to plural by beginning to grapple with new constructs of genders and sexes now entering the scientific domain, e.g., 'transgender', 'transsexual', 'intersexual', which blur boundaries not only between but also within the gender/sex dichotomy (Table 1).⁸ The net result is that although lucid analyses have been written on why it is important to distinguish between 'gender' and 'sex',^{4–8} epidemiological and other health research has been hampered by a lack of clear conceptual models for considering both, simultaneously, to determine their relevance—or not—to the outcome(s) being researched.

Yet, we do not live as a 'gendered' person one day and a 'sexed' organism the next; we are both, simultaneously, and for any given health outcome, it is an empirical question, not a philosophical principle, as to whether diverse permutations of gender and sex matter—or are irrelevant. Illustrating the importance of asking this question, conceptually and analytically, Table 1 employs an ecosocial epidemiological perspective^{2,12} to delineate 12 examples,^{13–24} across a range of exposure—outcome associations, in which gender relations and sex-linked

biology are singly, neither, or both relevant as independent or synergistic determinants.²⁵ These examples were chosen for two reasons. First, underscoring the salience of considering these permutations for any and all outcomes, the examples range from birth defects to mortality, and include: chromosomal disorders, infectious and non-infectious disease, occupational and environmental disease, trauma, pregnancy, menopause, and access to health services. Second, they systematically present diverse scenarios across possible combinations of gender relations and sex-linked biology, as singly or jointly pertinent or irrelevant. In these examples, expressions of gender relations include: gender segregation of the workforce and gender discrimination in wages, gender norms about hygiene, gender expectations about sexual conduct and pregnancy, gendered presentation of and responses to symptoms of illness, and gender-based violence. Examples of sex-linked biology include: chromosomal sex, menstruation, genital secretions, secondary sex characteristics, sex-steroid-sensitive physiology of non-reproductive tissues, pregnancy, and menopause.

As examination of the 12 case examples makes clear, not only can gender relations influence expression—and interpretation—of biological traits, but also sex-linked biological characteristics can, in some cases, contribute to or amplify gender differentials in health. For example, as shown by case No. 9, not recognizing that parity is a social as well as biological phenomenon, with meaning for men as well as women, means important clues about why parity might be associated with a given outcome might be missed. Similarly, as shown by case No. 11, recognition of social inequalities among women (including as related to gender disparities between women and men) can enhance understanding of expressions of sex-linked biology,

Table 2 Selected examples of differential roles of gender relations and sex-linked biology on health outcomes: only gender, only sex-linked biology, neither, and both

Case	Diagrammed illustration		Exposure—outcome association	Relevance of:		Explanation
				Gender relations	Sex-linked biology	
1	gender relations	sex-linked biology	Greater prevalence of HIV/AIDS due to needle-stick injury among female health care workers providing patient care ¹³	Yes: for exposure	No	<ul style="list-style-type: none"> Gender relations: determinant of risk of exposure (needle stick injury), via gender segregation of the workforce (e.g. greater likelihood of women being nurses) Sex-linked biology: not a determinant of risk of exposure Risk of outcome, given exposure: risk of seroconversion same among women and men
2	gender relations	sex-linked biology	Greater prevalence of contact lens microbial keratitis among male compared with female contact lens wearers ¹⁴	Yes	No	<ul style="list-style-type: none"> Gender relations: determinant—among those wearing contact lenses—of risk of exposure to improperly cleaned contact lenses (men less likely to properly clean them than women) Sex-linked biology: not a determinant of exposure Risk of outcome, given exposure: risk of contact lens microbial keratitis same among women and men, once exposed to improperly cleaned contact lenses
3	gender relations	sex-linked biology	Greater prevalence of short stature and gonadal dysgenesis among women with Turner's syndrome compared with unaffected women ¹⁵	No	Yes: for exposure	<ul style="list-style-type: none"> Gender relations: not a determinant of exposure (X-monosomy, total or mosaic, or non-functional X chromosome) Sex-linked biology: determinant of exposure Risk of outcome, given exposure: not influenced by gender relations
4	gender relations	sex-linked biology	Both similar and different adverse health outcomes among women and men due to ubiquitous exposure to cooking oil contaminated by polychlorinated biphenyls (PCB) ('Yusho' disease) ¹⁶	No	Yes: once exposed	<ul style="list-style-type: none"> Gender relations: not a determinant of risk of exposure (ubiquitous exposure to the contaminated cooking oil, in staple foods) Sex-linked biology: not a determinant of risk of exposure Risk of outcome, given exposure: partly influenced by sex-linked biology, in that although both women and men experienced chloracne and other dermal and ocular lesions, only women experienced menstrual irregularities
5	gender relations	sex-linked biology	Higher risk of stroke among both women and men in the US 'stroke belt' in several Southern states, compared with women and men in other regions of the US (as distinct from differences in risk for women and men within a given region) ¹⁷	No	No	<ul style="list-style-type: none"> Gender relations: not a determinant of risk of exposure (living in the US 'stroke belt') Sex-linked biology: not a determinant of risk of exposure Risk of outcome, given exposure: neither gender relations nor sex-linked biology determine regional variation in stroke rates among men and among women (even as both may contribute to within-region higher risks among men compared with women)
6	gender relations	sex-linked biology	Higher risk of hypospadias among male infants born to women exposed to potential endocrine-disrupting agents at work ¹⁸	Yes: for exposure	Yes: once exposed	<ul style="list-style-type: none"> Gender relations: a determinant of risk of exposure, via gender segregation of the workforce (e.g. high level of phthalate exposure among hairdressers, who are mainly women) Sex-linked biology: not a determinant of risk of exposure Risk of outcome, given exposure: different for women and men, and for female and male fetus, as only women can be pregnant, and adverse exposure can lead to hypospadias only among fetuses with a penis

Table 2 continued

Case	Diagrammed illustration	Exposure—outcome association	Relevance of:		Explanation
			Gender relations	Sex-linked biology	
7		Geographical variation in women's rates of unintended pregnancy as linked to variation in state policies re family planning ¹⁹	Yes: for exposure and once exposed	Yes: once exposed	<ul style="list-style-type: none"> • Gender relations: a determinant, at societal level, of risk of exposure, i.e. state policies and spending for family planning • Sex-linked biology: not a determinant, at individual level of the girl or woman at risk of pregnancy, of state policies and spending for family planning • Risk of outcome, given exposure: gender relations, at the individual level, influence women's access to—and ability to act on information obtained from—family planning programs, and sex-linked biology is a determinant of who can get pregnant
8		Earlier age of human immunodeficiency virus infection among women compared with heterosexual men (in the US) ²⁰	Yes: for exposure	Yes: for exposure and once exposed	<ul style="list-style-type: none"> • Gender relations: a determinant of age of sexual partner and risk of unprotected sex (e.g. gender power imbalance resulting in sex between older men and younger women, the latter having a lesser ability to negotiate condom use) • Sex-linked biology: a determinant of exposure, via genital secretions • Risk of outcome, given exposure: sex-linked biology a determinant of greater biological efficiency of male-to-female, compared with female-to-male, transmission
9		Parity among both women and men associated with increased risk of melanoma ²¹	Yes: for exposures	Yes: for exposure	<ul style="list-style-type: none"> • Gender relations: a determinant of parity (via expectations of who has children, at what age) • Sex-linked biology: a determinant of who can become pregnant and pregnancy-linked hormonal levels • Risk of outcome, given exposure: decreased risk of melanoma among nulliparous women and men indicates that non-reproductive factors linked to parity may affect risk among both women and men, even as pregnancy-related hormonal factors may also affect women's risk
10		Greater referral of men compared with women for interventions for acute coronary syndromes ²²	Yes: for exposure and once exposed	Yes: for exposure	<ul style="list-style-type: none"> • Gender relations: a determinant of how people present and physicians interpret symptoms of acute coronary syndromes • Sex-linked biology a determinant of age at presentation (men are more likely to have acute infarction at younger ages) and possibly type of symptoms • Risk of outcome, given exposure: gender relations are a determinant of physician likelihood of referral for diagnostic and therapeutic interventions (women less likely to be referred, especially at younger ages)
11		Earlier age at onset of perimenopause among women experiencing greater cumulative economic deprivation over the life course ²³	Yes: for exposure	Yes: as outcome	<ul style="list-style-type: none"> • Gender relations: a determinant of poverty, across the life course, among women (via the gender gap in earnings and wealth) • Sex-linked biology: a determinant of who can experience perimenopause • Risk of outcome, given exposure: risk of earlier age at perimenopause among women subjected to greater economic deprivation across the life course, including non-smokers, may reflect impact of poverty on oocyte depletion

Table 2 continued

Case	Diagrammed illustration	Exposure—outcome association	Relevance of:		Explication
			Gender relations	Sex-linked biology	
12	<pre> graph TD GR[gender relations] --> EXP[exposure] SLB[sex-linked biology] --> EXP EXP --> HO[health outcome] </pre>	Greater rate of mortality among women compared with men due to intimate partner violence ²⁴	Yes: for exposure	Yes: for exposure and once exposed	<ul style="list-style-type: none"> • Gender relations: a determinant of likelihood of men versus women using physical violence against intimate partners, plus being encouraged to and having access to resources to increase physical strength • Sex-linked biology: a determinant of muscle strength and stamina, at a given level of training and exertion, and also body size • Risk of outcome, given exposure: risk of lethal assault related to on-average greater physical strength and size of men, and gender-related skills and training in inflicting and warding off physical attack

KEY MESSAGES

- Gender, a social construct, and sex, a biological construct, are distinct, not interchangeable, terms; the two nevertheless are often confused and used interchangeably in contemporary scientific literature.
- The relevance of gender relations and sex-linked biology to a given health outcome is an empirical question, not a philosophical principle; depending on the health outcome under study, both, neither, one, or the other may be relevant—as sole, independent, or synergistic determinants.
- Clarity of concepts, and attention to both gender relations and sex-linked biology, is critical for valid scientific research on population health.

e.g. age at perimenopause. Because our science will only be as clear and error-free as our thinking, greater precision about whether gender relations, sex-linked biology, both, or neither matter for health is warranted.

Acknowledgements

Thanks to Sofia Gruskin for helpful comments. This work was not supported by any grant.

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