Biologists correct misinformation about biological sex

Submission on the "Legislation (Definitions of Woman and Man) Amendment Bill", 2026.

By: Ad Hoc Working Group on Sex Denialism, 1 July, 2026. Signatories listed at the end.

Executive Summary. We are a group of academics, primarily biologists, from New Zealand and abroad, concerned that public debate about the proposed legislation is being shaped by inaccurate biological claims about sex.

We do not take a position for or against the Bill as a matter of law or policy. Our contribution is scientific: to clarify what biology does, and does not, show about sex.

The central problem is not that sex development can never go awry. It can. The problem is that rare disorders of sex development are being misrepresented as evidence that sex itself is a spectrum. This is a misrepresentation of science: extremely rare edge cases are elevated, while the broader biological reality is obscured.

In humans, as in other mammals, there are two sexes: female and male. These correspond to the two reproductive pathways organized around large gametes, ova, and small gametes, sperm. Sex is not a social assignment, a spectrum, or a matter of identity. It is a developmental and reproductive feature of the body.

Some individuals have Disorders/Differences of Sex Development, or DSDs. These conditions deserve medical accuracy and humane treatment. But they do not show that sex is a spectrum, nor do they justify replacing clear sex-based language for the whole population.

A major source of confusion is prevalence inflation. Activist materials often claim that 1.7%, 2%, or more of people are “intersex.” These figures are not reliable estimates of people whose sex is genuinely ambiguous. They come from expansive definitions that group together very different conditions, many of which do not make a person’s sex unclear. Some involve hormone exposure, late-onset endocrine disorders, or sex-specific developmental anomalies in otherwise clearly male or clearly female individuals. Treating these as evidence that male and female are unstable categories is misleading.

This distinction matters for policymakers. A law can recognize and make provision for rare, medically complex cases without pretending that those cases undermine the sex categories relevant to the overwhelming majority of people. Good policy should not be built by taking exceedingly rare edge cases and using them to rewrite language, data collection, medicine, sport, safeguarding, prisons, or women’s rights for everyone.

We therefore correct the intersex claim, and several more common, but false, claims:

1. **False claim: 1.7% of humans are intersex.**
   This statistic relies on an overbroad and heavily criticized definition. The rate of births involving significant genital ambiguity is orders of magnitude lower.
2. **False claim: sex is a spectrum.**
   Many traits vary continuously, but mammalian reproductive organization is binary. Variation within males and females does not create additional sexes.
3. **False claim: there is no reliable definition of sex.**
   Biology defines sex by reproductive function: the distinction between large and small gametes.
4. **False claim: male and female are "assigned at birth."**
   Sex is observed and recorded, usually with high reliability; it is not assigned by social convention.
5. **False claim: brain scans prove "female brains in male bodies" or the reverse.**
   The neuroimaging literature does not support such simple claims.
6. **False claim: drugs and surgeries can change sex.**
   Medical interventions can alter appearance, hormones, and some secondary sex characteristics, but they do not change reproductive sex.
7. **Very dubious claim: "gender identity" is genetic.**
   Current evidence does not justify strong claims of genetic causation.

Scientific accuracy requires acknowledging rare DSDs. It also requires refusing to let rare cases be used to erase the ordinary, objective, and policy-relevant distinction between female and male.

We provide detailed documentation and references in the attached supplement. We ask MPs, journalists, and the public to evaluate claims about sex by scientific merit, not by repetition, institutional prestige, or political usefulness.

Full document: Biologists debunk sex-denialist pseudoscience

Purpose: We do not write for or against the proposed *Legislation (Definitions of Woman and Man) Amendment Bill*. The text of the bill will likely change, and the interaction of any bill text with the body of preexisting law is a complex question. As biologists speaking on our professional expertise, these questions are beyond our ken.

We also do not aim to comment on "gender." Gender has several strongly conflicting definitions in society, ranging from being a polite synonym of sex, to being a social construction completely disconnected from sex. For present purposes, we are happy to state that gender refers to social roles and stereotypes, and that the study of gender is in the domain of social scientists rather than biologists.

We do, however, have something to contribute on sex, by which we mean biology and not social roles. As biologists, we have observed that *sex-denialist pseudoscience* has become ubiquitous. By sex denialism, we mean *assertions that support the idea that biological sexes, female and male, are not real and fixed, but instead are socially constructed impositions on a continuum or spectrum*. Originally stemming from activist academics and groups, sex-denialist pseudoscience has become widely embedded in the media, NGOs, academia, the education system, and many parts of government. This has occurred internationally and in New Zealand.

The main form that sex-denialist pseudoscience takes is "talking points" – claimed facts that sound scientific and authoritative. They are quickly stated, and thus can be easily raised in a conversation, debate, curriculum, or presentation. They seem authoritative because of constant repetition, and because few people have the time or scientific background to research and evaluate the claims based on scientific evidence.

As sex-denialist pseudoscience is already a major part of the conversation around the Bill, we submit that it will be useful to MPs, the media, and the broader public to have these misconceptions debunked.

False claim #1: 1.7% of humans are intersex (or 1%, 2%, 4%, etc.)

The claim that some high percentage of humans are intersex, most often 1.7%, is ubiquitous. Amongst hundreds of possible examples, notable institutions repeating this mistaken claim include the United Nations Human Rights Office of the High

Commissioner (UN OHCHR)[1], Amnesty International New Zealand[2], RNZ[3], Stuff[4], a funded Marsden grant[5], and NZ InsideOut[6]. The InsideOut resource was produced with the support of the NZ Ministry of Education (MoE), and is still advertised on the MoE website.[7] Of all of these, only the last cites an actual study as a source. The rest either just assert the statistic, or call it "an international estimate" or similar.

However, to biologists who follow this issue, the source is well-known. The "1.7% intersex" statistic comes from a much-criticized paper published in 2000 (Blackless et al. 2000[8]) by a group led by Anne Fausto-Sterling[9]. This statistic has gained credibility through sheer repetition by activists and institutions, along with catchy phrases (e.g. "*intersex is more common than red hair*"). In New Zealand, the 1.7% claim is often rounded to around 2%, leading to claimed statistics like "117,000 intersex people in Aotearoa – roughly equal to the population of Lower Hutt."[10]

However, Fausto-Sterling's statistic was debunked soon after it was published. A 2003 rebuttal (Hull 2003), published in the same journal, wrote:

> Blackless et al. (2000, chief researcher, Anne Fausto-Sterling) suggest that as many as 1.728% of live births are sexually nondimorphic. In this letter, I will outline several errors and oversights in that article and propose that their estimate is **incorrect by an order of magnitude**", and concludes "the numerous errors and omissions made by Blackless et al. suggest that they were too keen to find a relatively high incidence of sexual nondimorphism.[11]

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[1] https://www.ohchr.org/en/sexual-orientation-and-gender-identity/intersex-people
[2] https://amnesty.org.nz/five-intersex-myths/
[3] https://www.rnz.co.nz/news/community/501068
/intersex-awareness-day-aotearoa-s-journey-towards-change
[4] https://www.stuff.co.nz/pou-tiaki/131382320/
census-2023-intersex-new-zealanders-encouraged-to-tick-the-box
[5] 2024 Marsden Grant 24-UOW-007, $868,000 awarded.
https://www.royalsociety.org.nz/assets/2024-Marsden-Fund-announcement-supplement_v9.xlsx
[6] https://insideout.org.nz/wp-content/uploads/2021/11/Making-Schools-Safer.pdf
[7] https://gazette.education.govt.nz/articles/schools-pride-week-aotearoa/
[8] Melanie Blackless, Anthony Charuvastra, Amanda Derryck, Anne Fausto-Sterling, Karl Lauzanne, Ellen Lee (2000). How sexually dimorphic are we? Review and synthesis. *Am J Hum Biol*, 12(2):151-166. http://dx.doi.org/10.1002/(SICI)1520-6300(200003/04)12:2<151::AID-AJHB1>3.0.CO;2-F
[9] An American sexologist at Brown University. Now emeritus. Her coauthors on Blackless et al. 2000 were her students in a seminar she led.
[10] https://www.stuff.co.nz/pou-tiaki/131382320/census-2023-intersex-new-zealanders-encouraged-to-tick-the-box
[11] Emphasis added. Carrie L. Hull (2003). Letter to the Editor: How sexually dimorphic are we? Review and synthesis. *American Journal of Human Biology*, 15(1):112-115. http://dx.doi.org/10.1002/ajhb.10122

The rebuttal author, Carrie Hull, went on to write an entire book on the definition of sexes and the surrounding philosophical and scientific issues.[12] Of Fausto-Sterling's estimate, Hull notes that Fausto-Sterling had previously promoted even higher estimates, like 4%. Hull writes,

> As someone who formerly relied on Fausto-Sterling's 4 percent estimate of intersex without much thought, I decided to study her recent survey article reducing the figure to 1.728 percent with greater care. I found numerous errors and oversights, ranging from minor to substantial. Decimal points are in the wrong place. The incidence of two anomalies, Turner Syndrome (XO) and vaginal atresia, both specific to females, are represented as the incidence across both sexes, effectively doubling their frequency. Findings of zero cases of certain conditions in several studies are treated as blanks in the data, whereas a "0" would have the effect of lowering the average incidence across of the conditions. Studies with above-average incidences of anomalies are sometimes used to create the impression that were we more open to the possibility of intersex we would see that it is more common than we would think. In reality, some of these studies should have been excluded, as they involved non-random samples of high-risk populations. The condition that contributes the lion's share to Fausto-Sterling's figure -- 1.5 of the 1.728 intersexed per 100 live births, or a full 87 percent -- is a form of congenital adrenal hyperplasia (non-classic CAH). This is an inherited metabolic disease leading in some cases to excess production of androgen. Frustratingly, Fausto-Sterling's team fails to disclose that the statistic they use is from a patient population, and that experts in the field typically cite an overall incidence of 0.1%, or one in 1000, for the condition.
>
> My analysis therefore indicates that Fausto-Sterling's reduced estimate of the incidence of intersex is still a dramatic overstatement[.] [...] I am also disturbed that Fausto-Sterling and her co-authors permit their numbers to stand uncorrected. Furthermore, many feminists and activists unquestioningly cite these results -- some even as "meticulous" -- while ignoring the lower estimates in other studies. [...] She explicitly leaves it to readers to "judge for themselves" between the competing numbers. Post-structuralism and constructivism prove convenient here, as Fausto-Sterling seems unwilling to make a distinction between statistical errors and differences in judgment. Andrew Sayer cautions against such a stance, as it is tantamount to saying, "all science is ideological, only we admit it, and we will not let the facts get in the way of our favored stories."[13]

Another critique of Fausto-Sterling's estimate was published in the *Journal of Sex Research* in 2002.[14] It states,

> Reviewing the list of conditions which Fausto-Sterling considers to be intersex, we find that this one condition – late-onset congenital adrenal hyperplasia (LOCAH) – accounts for 88% of all those patients whom Fausto-Sterling classifies as intersex (1.5/1.7 = 88%). From a clinician's perspective, however, LOCAH is not an intersex condition. The genitalia of these babies are

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[12] Hull, Carrie (2006). *The Ontology of Sex: A critical inquiry into the deconstruction and reconstruction of categories*. Routledge Studies in Critical Realism. New York, Routledge: Taylor & Francis Group. pp. 1-185. https://www.routledge.com/Ontology-of-Sex/Hull/p/book/9780415464369

[13] Hull (2006), pp. 67-68.

[14] Leonard Sax (2002). How common is intersex? a response to Anne Fausto-Sterling. *Journal of Sex Research*, 39(3):174-8. http://dx.doi.org/10.1080/00224490209552139

> normal at birth, and consonant with their chromosomes: XY males have normal male genitalia, and XX females have normal female genitalia. The average woman with this condition does not present until about 24 years of age (Speiser et al., 2000). Men with LOCAH present later, if ever: Many go through life undetected or are discovered only incidentally (Holler et al., 1985).

Many of Fausto-Sterling's other included conditions are also clearly either male or female. The number of cases that actually correspond to what most readers think of when they hear the term "intersex", where the genitals at birth are sufficiently ambiguous that expert diagnosis is required, is about 100 times lower than Fausto-Sterling's statistic, i.e. about 0.018%.[15]

In her replies to these critiques, Fausto-Sterling neither defends the 1.7% statistic nor refines it to a justifiable figure[16]. Instead, Fausto-Sterling defends the statistic as a useful political tool, rather than on its scientific merit. And she changes the subject. In the 2020 revised edition of Fausto-Sterling's 2000 book *Sexing the Body*, she introduces another condition, hypospadias, which was not mentioned in Blackless et al. (2000). The 2020 edition cites a ~1% rate of hypospadias in some populations, apparently to revive a number around 1%. This ignores the fact that hypospadias is a *male* condition (in which the meatus is not at the tip of the penis[17]). and most hypospadias are mild.

Yet another problem with the promotion of Fausto-Sterling's debunked pseudostatistic is the very term "intersex." While still favored by activists, scientifically and medically the term is now outdated and unclear, and should be avoided in favour of updated terminology. It survives within activist terminology, mostly due to forced-teaming with a variety of conditions via Fausto-Sterling's overly broad definition. "Intersex" and several other misleading terms ("hermaphrodite", etc.) were replaced by the term "Disorder of Sex Development" (DSD) in 2006 with a Consensus Statement that was published

[15] Sax (2002); see also "Consensus Statement" by Hughes et al. (2006), cited below.
[16] Anne Fausto-Sterling (2003). Response. *Am J Hum Biol*, 15(1):11-1165. http://dx.doi.org/10.1002/ajhb.10122 ; Anne Fausto-Sterling (2020 [2000]). *Sexing the Body: Gender Politics and the Construction of Sexuality*. Updated edition. New York: Basic Books.
[17] https://starship.org.nz/guidelines/hypospadias/

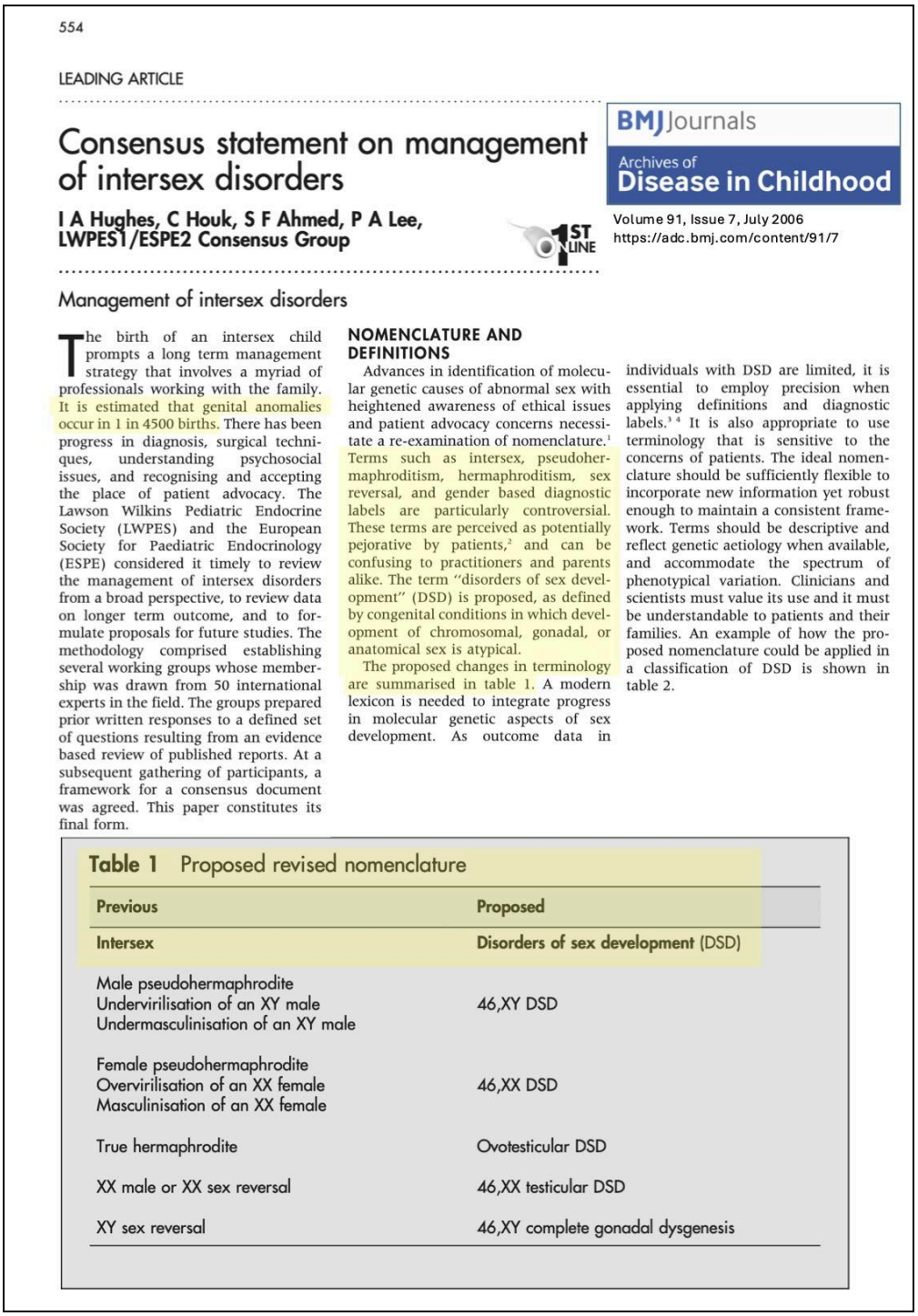
concurrently in three major journals,[18] the *Journal of Pediatric Urology*, the American Medical Association's journal *Pediatrics*, and the BMJ's (originally British Medical Journal) *Archives of Disease in Childhood.*

We attach the Consensus Statement's argument for updated terminology, and its Table 1 of recommendations. Readers will note the substantial contrast between the medical consensus terminology, and that used by modern activist groups. (We highlight key parts.)

[18] Hughes, I.A., Houk, C., Ahmed, S.F., Lee, P.A., Lawson Wilkins Pediatric Endocrine Society (LWPES)/European Society for Paediatric Endocrinology (ESPE) Consensus Group (2006). Consensus statement on management of intersex disorders. *Journal of Pediatric Urology*, 2(3), 148-162. https://doi.org/10.1016/j.jpurol.2006.03.004

Lee, P.A., Houk C.P., Ahmed S.F., Hughes IA., International Consensus Conference on Intersex organized by the Lawson Wilkins Pediatric Endocrine Society and the European Society for Paediatric Endocrinology. (2006). Consensus statement on management of intersex disorders. International Consensus Conference on Intersex. *Pediatrics*. 118(2):e488-500. http://dx.doi.org/10.1542/peds.2006-0738

Hughes, I.A., Houk, C., Ahmed, S.F., Lee, P.A., LWPES Consensus Group; ESPE Consensus Group. (2006). Consensus statement on management of intersex disorders. *Archives of Disease in Childhood*. 91(7):554-63. https://adc.bmj.com/content/91/7/554



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LEADING ARTICLE

Consensus statement on management of intersex disorders

I A Hughes, C Houk, S F Ahmed, P A Lee, LWPES1/ESPE2 Consensus Group

BMJ Journals
Archives of Disease in Childhood
Volume 91, Issue 7, July 2006
https://adc.bmj.com/content/91/7

1ST LINE

Management of intersex disorders

The birth of an intersex child prompts a long term management strategy that involves a myriad of professionals working with the family. It is estimated that genital anomalies occur in 1 in 4500 births. There has been progress in diagnosis, surgical techniques, understanding psychosocial issues, and recognising and accepting the place of patient advocacy. The Lawson Wilkins Pediatric Endocrine Society (LWPES) and the European Society for Paediatric Endocrinology (ESPE) considered it timely to review the management of intersex disorders from a broad perspective, to review data on longer term outcome, and to formulate proposals for future studies. The methodology comprised establishing several working groups whose membership was drawn from 50 international experts in the field. The groups prepared prior written responses to a defined set of questions resulting from an evidence based review of published reports. At a subsequent gathering of participants, a framework for a consensus document was agreed. This paper constitutes its final form.

NOMENCLATURE AND DEFINITIONS

Advances in identification of molecular genetic causes of abnormal sex with heightened awareness of ethical issues and patient advocacy concerns necessitate a re-examination of nomenclature.[1] Terms such as intersex, pseudohermaphroditism, hermaphroditism, sex reversal, and gender based diagnostic labels are particularly controversial. These terms are perceived as potentially pejorative by patients,[2] and can be confusing to practitioners and parents alike. The term "disorders of sex development" (DSD) is proposed, as defined by congenital conditions in which development of chromosomal, gonadal, or anatomical sex is atypical.

The proposed changes in terminology are summarised in table 1. A modern lexicon is needed to integrate progress in molecular genetic aspects of sex development. As outcome data in individuals with DSD are limited, it is essential to employ precision when applying definitions and diagnostic labels.[3 4] It is also appropriate to use terminology that is sensitive to the concerns of patients. The ideal nomenclature should be sufficiently flexible to incorporate new information yet robust enough to maintain a consistent framework. Terms should be descriptive and reflect genetic aetiology when available, and accommodate the spectrum of phenotypical variation. Clinicians and scientists must value its use and it must be understandable to patients and their families. An example of how the proposed nomenclature could be applied in a classification of DSD is shown in table 2.

Table 1 Proposed revised nomenclature

Previous	Proposed
Intersex	**Disorders of sex development** (DSD)
Male pseudohermaphrodite Undervirilisation of an XY male Undermasculinisation of an XY male	46,XY DSD
Female pseudohermaphrodite Overvirilisation of an XX female Masculinisation of an XX female	46,XX DSD
True hermaphrodite	Ovotesticular DSD
XX male or XX sex reversal	46,XX testicular DSD
XY sex reversal	46,XY complete gonadal dysgenesis

The second sentence of the Consensus Statement states, "It is estimated that genital anomalies occur in 1 in 4500 births." This is 0.022%. Multiplication indicates that roughly 1,000 people in New Zealand might have this condition, rather than over 100,000.[19]

[19] We briefly note that these numbers may not be static from decade to decade. For example, infants born prematurely can have partially incomplete development that later resolves, and early prenatal cfDNA

A more recent paper on the genetic causes of DSDs, in the journal *Chromosome Research*, shows how they are discussed in a scientific framework:

> DSD are congenital conditions in which development of chromosomal, gonadal, or anatomical sex is atypical (Hughes et al. 2006). DSD covers a wide spectrum of different phenotypes with hypospadias being the most common defect with an average of 1 in 250-350 male births. In addition, 1 in 4,500 babies worldwide is born with significant ambiguous genitalia (Hughes et al. 2006) and significantly, DSDs account for 7.5% of all birth defects. Furthermore, DSD phenotypes are often associated with other syndromes, such as Mayer-Rokitansky-Kuster-Hauser syndrome, Smith-Lemli-Opitz syndrome or genitopalato-cardiac syndrome (Porter 2008; Sultan et al. 2009).[20]

Figure 1 from that paper gives an indication of what is known about the Gene Regulatory Networks (GRNs) that produce human male or female development (the network is very similar in mice and other placental mammals).

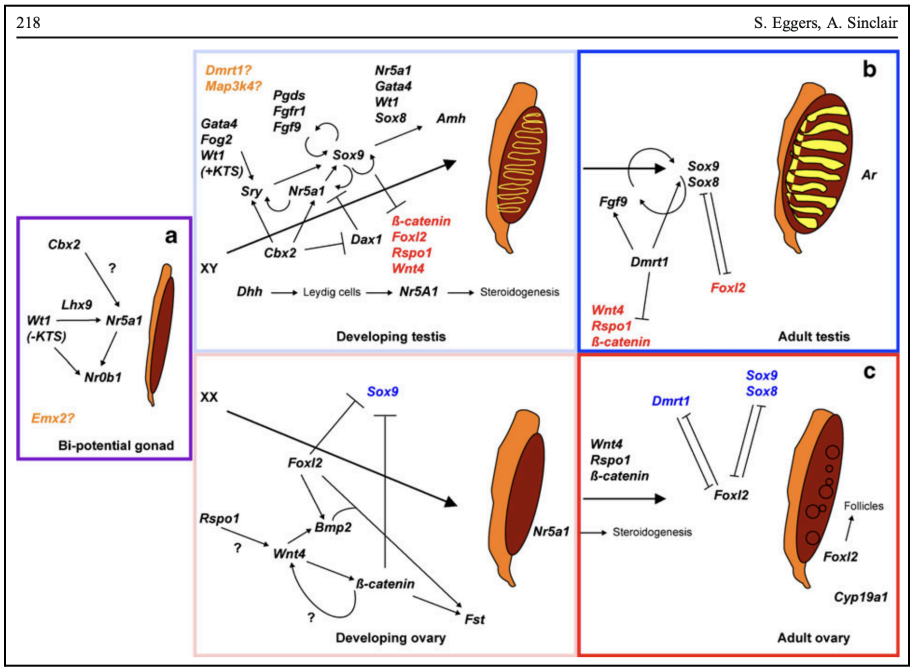

Figure 1 from Eggers & Sinclair (2012). Arrows show which genes activate (-->) or suppress (--|) other genes in mammalian male development leading to testis (top), or female development leading to ovaries (bottom). Red: female pathway genes suppressed in the male pathway. Blue: male pathway genes suppressed in the female pathway. The presence or absence of a functional *Sry* gene determines whether the male or female pathway, respectively, is started around 6 weeks embryonic development. Rare mutations to these genes are major causes of DSDs.

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blood testing (available starting around week 10 of pregnancy) for chromosomal anomalies and genetic screening is now routinely available. The rates of both have changed historically and continue to do so.

[20] Stefanie Eggers & Andrew Sinclair (2012). Mammalian sex determination -- insights from humans and mice. *Chromosome Research*, 20:215-238. http://dx.doi.org/10.1007/s10577-012-9274-3

There is no need to delve into the details, except to note the following:

1. There are 2 different Gene Regulatory Networks, producing male and female development, respectively.
2. This developmental process starts early in embryonic development (around week 6) and completes in mid-embryonic development (female embryos produce all the ova – egg cells – they will ever have by around week 20).
3. Once one, or the other, pathway begins, the genes in the male and female networks promote their own expression (see arrows → that form positive feedback loops) and, crucially, suppress the expression of key genes in the opposite sex network (the lines ending without arrows, —|, indicate suppression). Expression of female-pathway genes (red) is suppressed by the male pathway, and expression of male-pathway genes (blue) is suppressed by the female pathway. This antagonistic regulation means that male vs. female development is highly canalized; it cannot be reversed except in the rarest of cases, i.e. severe mutations to key genes in the GRN, and then only if the mutations have occurred before conception or extremely early in the developmental process.
4. Biology thus now has a mechanistic explanation of the physical causation of male or female development (although more details are always being added). The developmental decision for male or female development is made based on the presence or absence of a functional *Sry* gene (Sex-determining Region of the Y-chromosome).
5. The most severe DSDs are caused by mutations that "knock out" or impair the functions of key genes in one of the Gene Regulatory Networks. If these knockouts occur in genes very early in the male pathway, they can block the male pathway and result in female development (the situation is not symmetrical; knockouts of female genes do not lead to male development). Knockouts occurring in genes that act later typically lead to incomplete development of portions of the reproductive system. As most of these mutations lead to infertility, natural selection ensures they remain very rare.

The existence of distinct, and developmentally antagonistic (mutually exclusive) Gene Regulatory Networks for male and female development has important implications for any discussion of sexes in humans. We discuss these as they arise below, while we address several other common instances of sex-denialist pseudoscience.

False claim #2: Sex is a spectrum

The claim that "sex is a spectrum" is another activist phrase that has obtained currency through repetition rather than through correctness. The assertion is often based on the claimed high rate of intersex in humans – which is imaginary, as shown above.

Another variation on the sex-is-a-spectrum claim notes that some traits (such as height) overlap between the sexes, and slides from this obvious fact to the insinuation that everything is a spectrum between the sexes. A notable example was produced by an advocate against the Sex Definitions bill:

> Biology is often a normal curve, and in this case, it's well to think of that. The population of humans is distributed into two normal curves, one based around what Seymour calls 'female', and one around 'male'. But the complexity of how we build our bodies and how they differentiate into different states is huge. Those two normal curves have outliers, and they overlap. Biology isn't about two fixed, set boxes for gender; there is complexity and shades in between. While you might believe it is sensible LEGALLY to define male and female as one thing, biologically, that is nonsense. As an aside, we have no evidence that this complexity isn't adaptive, and part of our species current evolutionary success.[21]

Unfortunately for this argument, statements about "normal distributions" are meaningless unless it is stated what measurements are being represented by a normal distribution. When it comes to human sexes, it is true that a variety of quantitative traits, like height, have overlapping normal distributions. However, other traits do not overlap, and notably these are the key traits involved in sexual reproduction. There is no meaningful sense in which men and women have overlapping normal distributions in uterus size, sperm production, anatomy adapted for the function of becoming pregnant or impregnating, or other primary sexual characteristics. These characteristics are binary, and it is not a coincidence that they correspond to the male/female distinction recognized by all cultures. Cultures also recognize the distinct sexes in many other animal species, and indeed, animals themselves routinely recognize this distinction.

We address two of the most commonly-discussed distinctions between the sexes, gametes and sex hormones. The sex binary is most stark in the difference between gametes. This is not surprising, as gametes (sperm and egg) are the reproductive cells, and the specialization of the reproductive cells on either motility (sperm) or nutrient retention (egg) is the oldest specialisation that marked the very beginning of the evolution of sexes, approaching 1 billion years ago in early multicellular life.

[21] https://peterkdearden.substack.com/p/on-gender

The mean volume of sperm cells is approximately ~34 femtoliters, and the mean volume of human egg cells is approximately 800 picoliters.[22] The standard deviation is unknown, but to be generous we will assign a standard deviation of 10%. On normal distribution assumptions, this suggests that the 95% confidence interval would cover roughly 20% below to 20% above the mean value. A plot of gamete sizes under these assumptions looks like this:

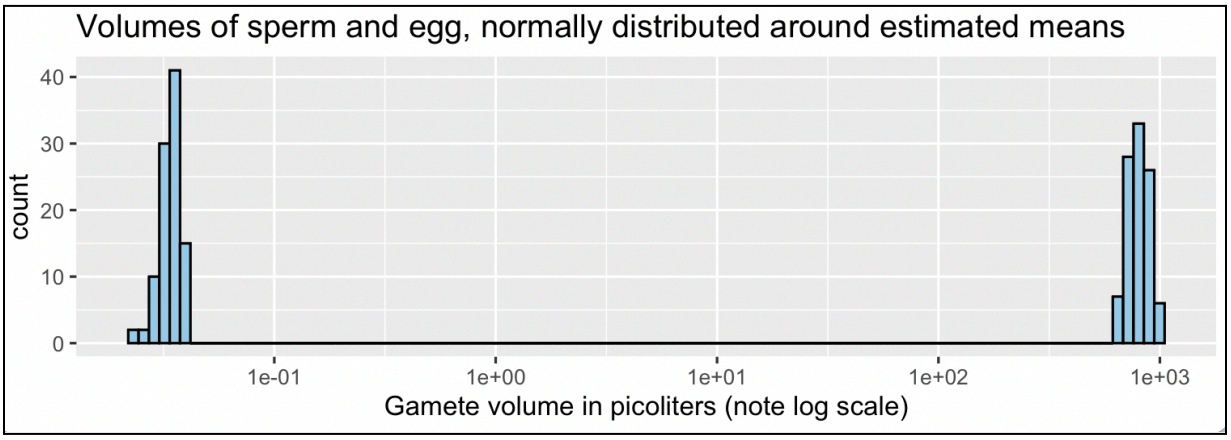

Figure: Distributions of the volume of sperm cells (left) and egg cells (right), using empirical mean volumes and generous assumptions about the standard deviation. Even when normal distributions are assumed, there is no overlap. Note that the x-axis is log-scaled. Human egg cells have approximately 20,000 times the volume of sperm cells.

This is an example of normal distributions nevertheless producing a clear binary.

On the subject of sex hormones, it is commonly claimed that testosterone levels overlap between males and females. However, this subject was reviewed in depth in the 2021 book *T: The Story of Testosterone* by Carole Hooven.[23] She points out that the least accurate tests of testosterone levels are based on saliva samples measured with radioimmunoassay (RIA), a cheap and relatively easy technique. The inaccuracy is particularly problematic for accurately measuring female testosterone levels, which are very low. The most accurate measures of testosterone levels are done on blood samples, measured with mass spectrometry.

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[22] See detailed discussion among biologists at the "Why Evolution is True" blog, run by evolutionary biologist Jerry Coyne: https://whyevolutionistrue.com/2024/03/28/what-is-the-difference-in-volume-between-a-human-sperm-and-egg/#comment-2089951 . Note that a common result returned by Google or AI is a difference of 10 million times, repeated in some popular science articles. This appears to be an error; the true difference is roughly 20,000 times (in humans). In other species, it can easily be bigger, e.g. due to the large eggs of birds.

[23] Carole Hooven (2021). *T: The Story of Testosterone, the Hormone that Dominates and Divides Us*. Cassell, pp. 1-352. https://www.amazon.com.au/Story-Testosterone-Hormone-Dominates-Divides/dp/1250811457

Notably, the claims of overlap are based on measurements with the less accurate technique. Hooven writes,

> So what does the evidence from more reliable measurement methods show? Mass spectrometry ("mass spec") is the gold standard of T measurement and is increasingly used by clinical and behavioral researchers in endocrinology. It is the only method used by anti-doping agencies, which require a high level of accuracy for both males and females.
>
> The most recent, comprehensive, and rigorous study on adult T levels was led by an Australian endocrinologist, David Handelsman. Handelsman is one of the top experts in the world on androgens, their function, and their measurement in athletes.
>
> Handelsman and his collaborators surveyed the scientific literature and compiled a list of studies on testosterone levels in adults, all of which relied on mass spectrometry. This kind of study, a "meta-analysis," is vital for understanding a body of scientific literature, and what science as a whole has to say about a particular question. Rather than providing one set of data from one study, which could be unreliable for a host of reasons, a meta-analysis consolidates, compares, and evaluates data from many different studies. Results that are consistent across studies provide strong evidence for support of a particular hypothesis.
>
> The researchers evaluated thirteen studies, published from 2005 to 2017, that met their high standards for eligibility. Only studies that reported on T levels sampled from blood (rather than saliva) were included, since this method is the most accurate, particularly for women. None of the subjects in these studies were known to have any health problems that would affect their testosterone levels, so were assumed to be a representative sample of healthy men and women, aged about twenty to forty years old. The number in each study ranged from a low of twenty-five to over fifteen hundred people, and most tested the T level of over one hundred subjects, which is large for any study of this kind.
>
> There was widespread agreement in results across the studies, which confirms the accuracy of the T measurements. In particular, there was very little difference in the high and low end of the average T ranges for each sex. This consistency provides a strong starting place to evaluate the extent of the overlap in T levels between the sexes. Based on the evidence from T measurements from the various independent research labs, Handelsman concluded: "Circulating testosterone in adults has a strikingly non-overlapping bimodal distribution with wide and complete separation between men and women."
>
> We already saw a "bimodal" distribution in the first chapter -- the distribution of adult height. A bimodal distribution has two peaks. And in the case of height, the male and female distributions look like two mountains with wide, overlapping bases. In other words, male and female heights significantly overlap, since some men are shorter than many women and some women are taller than many men. But with testosterone levels, that bimodal distribution has a "*wide and complete separation*," like two mountains separated by a vast plain, as you can see in the figure here. In other words: a binary.[24]

[24] pp. 111-113 of Hooven (2021). Emphasis original.

Hooven summarizes this binary graphically:

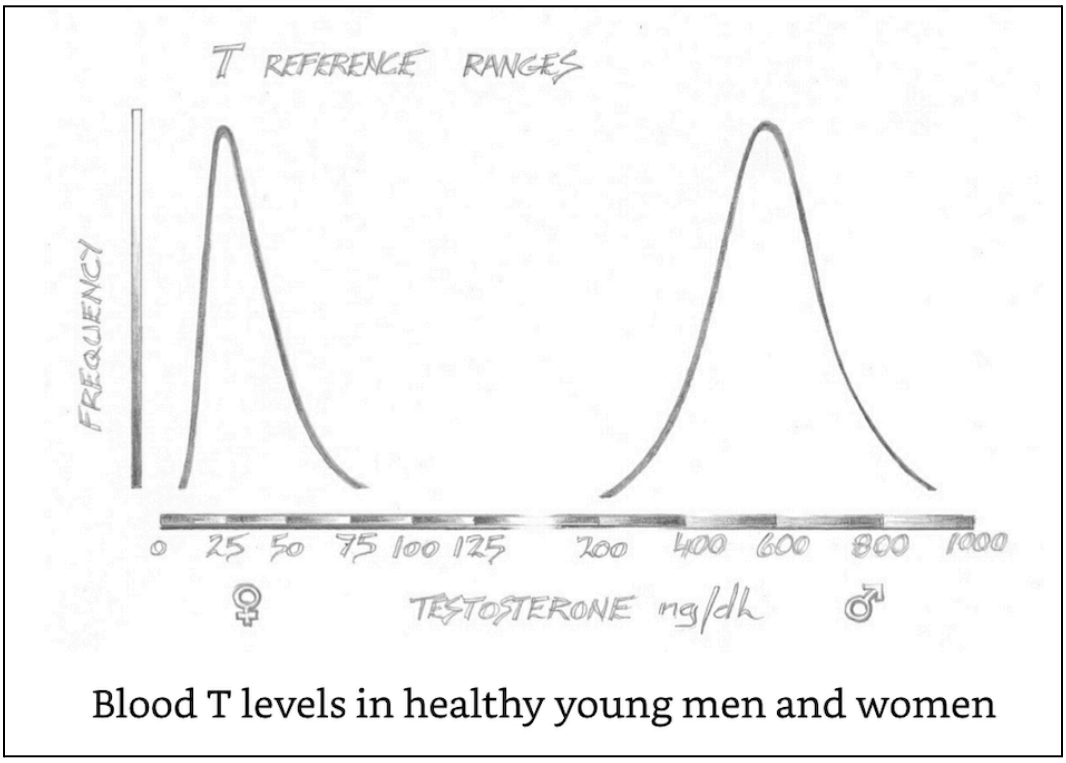

Figure from Hooven (2021), *T: The Story of Testosterone* showing the nonoverlapping distribution of testosterone in healthy adult males and females.

The review article Hooven cites, Handelsman et al. (2018)[25] in *Endocrine Reviews*, documents the "strikingly non-overlapping bimodal distribution with wide and complete separation between men and women" via its Table 1. This information is summarized in graphical form in Handelsman (2024)[26], Figure 2. Hooven's diagram is a simplified representation of that data.

In passing, we note that Handelsman (2024) adds some additional points reinforcing the argument we made above about the incredible rarity, and seriousness, of developmental disorders so severe that diagnosis of sex requires medical specialists:

> Neonatal diagnosis of ambiguous genitalia arises from disruption of androgen-driven morphological development of external male genitalia due to rare genetic 46 XY DSD or acquired interference in androgen action. These rare (1:14000-20000 births) cases constitute a neonatal emergency requiring urgent resolution to resolve potentially life-threatening medical (adrenal)

[25] David J. Handelsman, Angelica L. Hirschberg, Stephane Bermon (2018). "Circulating Testosterone as the Hormonal Basis of Sex Differences in Athletic Performance." *Endocrine Reviews*, 39(5): 803-829. October 2018. DOI: http://dx.doi.org/10.1210/er.2018-00020

[26] David J. Handelsman (2024). Toward a Robust Definition of Sport Sex. *Endocrine Reviews*, 45, 709-736. https://doi.org/10.1210/endrev/bnae013

> crises in some cases, as well as meeting in all cases the social expectations of parents, families, and the community to define a neonate's birth sex as a guide to the optimal gender of their upbringing. The inherently multidimensional nature of biological sex is incorporated into the urgent neonatal and pediatric management of children born with ambiguous genitalia. Adroit management of this neonatal emergency requires prompt and expert specialist psychosocial and medical care within a multidisciplinary team. Mistaken claims of a much higher prevalence, such as claims of 1:200 to 300 births, arise from including relatively frequent reproductive disorders such as cryptorchidism, hypospadias, and Klinefelter's syndrome where the underlying natal male sex is not ambiguous.[27]

On the binary in adult hormone levels, Handselman (2018) summarizes:

> [F]rom puberty onward a clear sex difference in athletic performance emerges as circulating testosterone concentrations rise in men because testes produce 30 times more testosterone than before puberty with circulating testosterone exceeding 15-fold that of women at any age. There is a wide sex difference in circulating testosterone concentrations and a reproducible dose-response relationship between circulating testosterone and muscle mass and strength as well as circulating hemoglobin in both men and women. These dichotomies largely account for the sex differences in muscle mass and strength and circulating hemoglobin levels that result in at least an 8% to 12% ergogenic advantage in men.[28]

In conclusion, all that is required to falsify the "spectrum" claim is some traits that, alone or in combination, are nonoverlapping between two groups. These are readily available in human sexes.

There are numerous biological phenomena that are accurately described as a "continuum" or "spectrum." Obvious examples include race (in terms of population genetics, humans are a gene pool of gradually changing gene frequencies, without any breaks), age, height, weight, etc. However, sexes are fundamentally different from these other phenomena, from DNA, through development, up to adult reproductive biology.

Other recent articles by evolutionary biologists making this case include Richard Dawkins, who writes, "Race is a Spectrum. Sex is Pretty Damn Binary."[29] We also recommend evolutionary biologist Colin Wright's article "Why there are exactly two sexes" in the *Archives of Sexual Behavior*.[30]

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[27] Handselman (2024). Internal citations omitted.
[28] Handselman (2018), p. 802.
[29] Richard Dawkins (2023). Race is a Spectrum. Sex is Pretty Damn Binary. *RichardDawkins.com* https://richarddawkins.com/articles/article/race-is-a-spectrum-sex-is-pretty-damn-binary
[30] Colin Wright (2025). Why there are exactly two sexes. *Archives of Sexual Behavior*, 54: 3941-3945. https://link.springer.com/article/10.1007/s10508-025-03348-3
https://www.realityslaststand.com/p/why-there-are-exactly-two-sexes

False claim #3: No reliable definition of sexes

Since at least the 1800s, the biological sciences have defined the sexes by reference to gametes, namely the sex cells, sperm and egg, a definition that is universal to all animals and vascular plants. With the discovery of the function of DNA in the 1900s, it became clear that the sex cells have half the amount of DNA found in other cells, and that the two sex cells combine to produce a fertilized egg with a full genome, which is then duplicated trillions of times to produce a developing organism. The fundamental nature of these discoveries cannot be overstated, as familiar as they are today. These processes produced everyone reading this text.

There are only two types of gametes in humans and millions of other animals. As Arnold et al. (2024) stated in *Nature*,

> Sex has been with us since our species originated as a result of sexual reproduction. The division of humans and other mammals into two sexes, female and male, derives from the fact that each individual is created by the union of a sperm and an egg. On the basis of the type of germ cell (gamete) that reproducing individuals are able to produce, there are only two sex categories in mammals (Intersex is not a third category with respect to the type of gamete individuals can produce.) Indeed, understanding of how the mammalian genome evolved and how it functions is based on the foundation of sexual reproduction.[31]

In a similar vein, Goymann et al. (2023) write in *BioEssays*,

> Biological sex is binary, even though there is a rainbow of sex roles: Denying biological sex is anthropocentric and promotes species chauvinism," stating "the rejection of biological sex seems to be based on a lack of knowledge about evolution and it champions species chauvinism, inasmuch as it imposes human identity notions on millions of other species.[32]

They continue,

> As explained above, every sexually reproducing species produces two distinct types of gamete, which are either large (eggs in animals, ovules in plants) or small (sperm in animals, pollen in plants). There are no “speggs” or “pollules” (gametes of intermediate size), nor five different biological sexes as postulated by Fausto-Sterling, nor are the male and female sex “context-dependent categories with flexible associations to multiple variables”.[6] All there is are two reproductive strategies based on two distinct categories of gametes that fuse to make offspring.[9,17,35] As Joan Roughgarden, a biologist who identifies as a transgender person, put

[31] Arnold, Arthur P.; Klein, Sabra L.; McCarthy, Margaret M.; Mogil, Jeffrey S. (2024). Male-female comparisons are powerful in biomedical research - don't abandon them. *Nature*. 629(8010), 37-40. doi: http://dx.doi.org/10.1038/d41586-024-01205-2

[32] Goymann, W., Brumm, H., & Kappeler, P. M. (2023). Biological sex is binary, even though there is a rainbow of sex roles: Denying biological sex is anthropocentric and promotes species chauvinism. *BioEssays*, 45, e2200173. https://doi.org/10.1002/bies.202200173 For internal citations, see original.

> it: “[...] 'male' means making small gametes, and 'female' means making large gametes. Period!”.[36] Moreover, it is important to note that the fundamental definition of the biological sexes (based on gamete size) must be distinguished from any operational usage of the term, for example that based on chromosomes or genes, etc., because fundamental and operational definitions are not equivalent.[33]

Sex denialism has recently become rampant inside and outside the academy, with strained attempts to deny the sex binary (the most prominent ones are rebutted in the above citations). While these statements may be well intentioned, they are misguided attempts to co-opt biology to support particular societal and political positions regarding culturally constructed genders. Organismal biology does not care what positions humans take. It is true that gender (in the modern academic usage of the term) is socially constructed, along with money, political systems, claimed racial categories, numerous cultural conventions, etc. But sexes are different. Sexes were constructed by evolution. They pre-date not just modern social categories but the existence of mammals (roughly 150 million years ago).

For evolutionary biologists, sex is a core concept, and one of the most studied. The relevant terminology is well worked-out. Studying evolutionary biology without sex would be like studying physics while ignoring gravity.

In biology, adaptations are identified by their *function*, where "function" refers to the survival and/or reproductive benefit that natural selection acts on to maintain the trait. As there are two pathways to reproduction, two sets of reproductive anatomy adapted for reproduction, and two Gene Regulatory Networks that produce that anatomy via development, there are two sexes. Developmental biologist Emma Hilton accurately summarizes the vast biological literature on this question:

> Across the natural world, the words “male” and “female” reference the two specific reproductive functions within a system of sexual reproduction that involves two differently-specialised gamete types. These terms describe cells, tissues, organs and/or entire individuals that have a physical role in the contribution of small gametes (like sperm) or large gametes (like ova), respectively, to the next generation.
>
> In humans (and indeed, in almost all animals and many plants), the two reproductive functions are divided between two classes of individual[s] (‘gonochorism’), a state described as: “an almost inevitable consequence of sexual reproduction in complex multicellular organisms.” [ref omitted] Each class of individual possesses a distinct and specialised molecular and anatomical pattern corresponding to one of the two

[33] Goymann, W., Brumm, H., & Kappeler, P. M. (2023). Biological sex is binary, even though there is a rainbow of sex roles: Denying biological sex is anthropocentric and promotes species chauvinism. *BioEssays*, 45, e2200173. https://doi.org/10.1002/bies.202200173 For internal citations, see original.

> reproductive functions. In humans, there are two sexes. In most gonochoristic species, including humans, sex is fixed during early embryonic development and remains stable throughout the organism lifespan. Thus, human sex is immutable.[34]

It is important to rebut one countermove that is almost always made by activists at this juncture. They will often note that various humans do not have gametes: prepubertal boys, postmenopausal women, and numerous people who have lost this ability through operations to treat cancer or other causes.[35] This rather obvious point is then deployed as a "gotcha" against the gamete-based definition.

However, activists are too quick to claim victory here. The "gotcha" makes use of rules no one would apply in any other situation in biology. Eyes are defined as organs with the function of seeing, but no one says that eyes that have gone blind are no longer eyes. A heart is defined as the organ that pumps blood, but hearts that are defective, or even dead, are still hearts. The function employed in a biological definition is the evolutionarily selected function that produced and maintains the structure over geological timespans. Loss of function in individual organisms due to age or injury is easily accommodated, and is no more surprising than organismal death.

There is, of course, such a thing as removing an organ – in rare cases, an entire eye might be removed because of cancer, for instance. But, unfortunately for sex-denialism, sexes in mammals[36] are whole-body adaptations which, in mammals, are identifiable from conception through reproductive age to death. Removing part of the reproductive anatomy in a mammal no more changes its sex than surgical alterations could change its species.

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[34] Emma Hilton (2026). Male and female: A short account. *Fond of Beetles Substack*. March 07, 2026. https://fondofbeetles.substack.com/p/male-and-female Internal references omitted.

[35] For some reason, it is never mentioned during these arguments that girls are born with all the eggs they will ever have; these develop by about week 20 of embryonic development and are gradually depleted throughout the lifetime until menopause. We speculate that some are perturbed by the observation that human biological hardware seems determined to attempt to reproduce, rather than conform to whatever ideas are currently favoured by the software in the brain.

[36] Mammals, and any other animals with genetic sex determination and obligate *gonochorism*. Gonochorism is a term specifying that the male and female sexes are in separate individual organisms, unlike hermaphroditic organisms. Approximately 94% of known invertebrates are gonochorist, along with about 99% of vertebrates, and exactly 100% of mammals.

False claim #4: Male and female are "assigned at birth"

All of the foregoing demonstrates why the now-common phrases “assigned male at birth” (AMAB) and "assigned female at birth" (AFAB), or more generally "assigned sex at birth," are dramatic distortions of biological science and reality. Sex in mammals is genetically determined, and exists before anyone knows what it is. Sex is observed and recorded at birth, and is as objective and observer-independent as numerous other checks and diagnoses that are done on infants (screenings for blood type, PKU and other genetic disorders, breathing and hearing checks, etc.). None of these is “assigned at birth.” In fact, except in the rarest of cases, sex is even simpler than these other screenings, as no special equipment is required and sex is as obvious in human infants as it is in numerous other mammals.

Readers who have not become parents recently may not be aware that medical science and technology has long since left behind activist phraseology. The observation of sex is now utterly routine *well before birth*. Of course, sex observation via ultrasound technology has been available and quite reliable for decades. However, it required waiting until the fetus was sufficiently developed. More recently, companies and medical labs have made available sex detection of the embryo via a blood test of the mother.

By around week 10 of development, cfDNA (cell-free DNA) from the embryo circulates in the mother's bloodstream in sufficient quantities to enable detection of the Y-chromosome by DNA sequencing[37]. The same test also identifies chromosomal variation other than sex, for example trisomy of chromosome 21 (formerly known as Down Syndrome) and a variety of rare conditions. Such tests are available in New Zealand for NZD $690.[38] A paper analysing 2022 data finds that at least 2.80 million such prenatal cfDNA tests were done around the world.[39] Multiplication implies a current market approaching $2 billion. The same paper finds that 2.18 million cfDNA tests were done in the USA, which is 60% of the total number of USA births in 2022.

Apart from testing for rare conditions, and satisfying the curiosity of parents about the sex of their baby, the availability of prenatal sex testing can have some serious material

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[37] Maryam Zargari; Mohammad Reza Sadeghi; Mohammad Hassan Shahhosseiny; Koroush Kamali; Kyomars Saliminejad; Ali Esmaeilzadeh; Hamid Reza Khorram Khorshid (2012). Fetal Sex Determination using Non-Invasive Method of Cell-free Fetal DNA in Maternal Plasma of Pregnant Women During 6th–10th Weeks of Gestation. *Avicenna J Med Biotechnol.* 3(4):201-206. https://pmc.ncbi.nlm.nih.gov/articles/PMC3558193/

[38] Illumiscreen (2024). About Illumiscreen: Learning the sex of your baby. https://www.illumiscreen.co.nz/parents-to-be/learning-the-sex-of-your-baby/

[39] Glenn E. Palomaki, Philip Wyatt, Ross Rowsey, Phillip Michael Cacheris, Nathalie Lepage, Marvin R. Natowicz, Thomas Long, Ann M. Moyer (2024). Numbers of prenatal cell-free DNA screens performed: Results of a 2022 CAP exercise. *Prenatal Diagnosis*, 44:8, 946-952. April 15, 2024. https://obgyn.onlinelibrary.wiley.com/doi/10.1002/pd.6574

consequences. Some cultures have a historical preference for boys. When combined with prenatal sex testing (starting with widespread ultrasound in the 1980s) and the availability of pregnancy termination, this has led to major skews in the sex ratios of babies, detectable in national birth statistics. Thankfully, these ratios can also return to the natural rate. Some examples are given in Tafuro & Guilmoto (2020):[40]

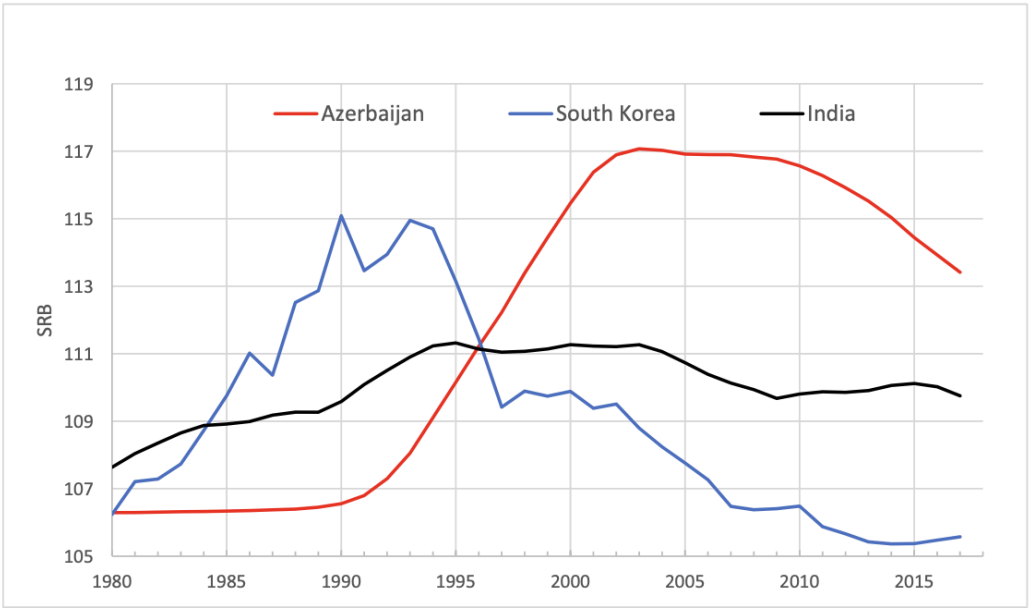

Fig. 1. Trends in the sex ratio at birth in Azerbaijan, India, South Korea and Vietnam, 1980–2017.

(Note: Human births have a slight natural sex bias; without intervention, about 105-106 boys are born for every 100 girls. Deviations above this are readily detectable.)

Tafuro & Guilmoto (2020) term this "prenatal discrimination," writing, "[a]ccording to the latest estimate for 2015, there were no less than 136 million 'missing females' in the world," adding that this

> will have considerable social implications in the forthcoming decades. The main effect will arguably be the rising 'marriage squeeze': many men will indeed not be able to marry due to a lack of potential brides, which in itself constitutes quite a challenge for societies largely based on a norm of universal marriage. Some scholars even speculated that involuntary male singlehood may result in increased crime, human trafficking and unhealthy behaviors.

[40] Tafuro, S.; Guilmoto, C.Z. (2020). Skewed sex ratios at birth: A review of global trends. Early Human Development, 141, 104868, https://doi.org/10.1016/j.earlhumdev.2019.104868.

Whatever one thinks about this phenomenon, what is undeniable is that it can occur only because sex is reliably observable before birth. There is no way a country can get out of it by changing how they "assign sex at birth."

To conclude this section, we recommend two prominent recent critiques of "sex assigned at birth" terminology. The first[41] is by Richard Dawkins (world-famous evolutionary biologist) and Alan Sokal (a left-wing physicist who famously criticized the postmodernist relativism and social constructionism of the academic left, via the "Sokal Hoax"[42]). The second[43] is by testosterone expert Carole Hooven and her husband Alex Byrne, a philosopher at Massachusetts Institute of Technology (MIT) who authored the book *Trouble with Gender: Sex Facts, Gender Fictions*. Both have attracted flak from activists. Hooven was, (in)famously, driven to resign from her job at Harvard,[44] an event which soon contributed to the massive conservative backlash against universities that is still going on today.

We include these short articles for the convenience of Parliament:

Sex and gender: The medical establishment's reluctance to speak honestly about biological reality

It is never justified to distort the facts in the service of a social or political cause, no matter how just.

By Alan Sokal and Richard Dawkins

The American Medical Association says that the word "sex" — as in male or female — is problematic and outdated; we should all now use the "more precise" phrase "sex assigned at birth." The American Psychological Association concurs: Terms like "birth sex" and "natal sex" are "disparaging" and misleadingly "imply that sex is an immutable characteristic." The American Academy of Pediatrics is on board too: "sex," it declares, is "an assignment that is made at birth." And now the Centers for Disease Control and Prevention urge us to say "assigned male/female at birth" or "designated male/female at birth" instead of "biologically male/female" or "genetically male/female."

Advocates defend this lexical revision, both on purported scientific grounds and because the traditional terminology of male and female is said to undermine "inclusivity" and "equity." But

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[41] Sokal, Alan; Dawkins, Richard (2024). Sex and gender: The medical establishment's reluctance to speak honestly about biological reality. It is never justified to distort the facts in the service of a social or political cause, no matter how just. *Boston Globe*, April 8, 2024. https://www.bostonglobe.com/2024/04/08/opinion/sex-gender-medical-terms/ or https://archive.ph/5vNbq

[42] https://physics.nyu.edu/sokal/weinberg.html

[43] Alex Byrne and Carole K. Hooven (2024). The Problem With Saying 'Sex Assigned at Birth.' *New York Times*, April 3, 2024. https://www.nytimes.com/2024/04/03/opinion/sex-assigned-at-birth.html or https://archive.is/wGF4S

[44] Hooven, Carole (2024). Why I Left Harvard. *American Enterprise Institute*, January 17, 2024. https://www.aei.org/op-eds/why-i-left-harvard/

these justifications do not hold water. And the medical associations' newspeak twists simple scientific facts beyond recognition.

Nearly all animals, as well as many plants, reproduce sexually. In all sexually reproducing species this occurs by combining a large gamete, called an ovum — or egg — with a small gamete, called a sperm. Though some hermaphrodite plants and animals produce both ova and sperm, there are no mammalian species that do. In mammals, each individual produces only one kind of gamete. Those individuals that produce (relatively few) ova are called female; those that produce (large numbers of) sperm are called male. Whether a mammal embryo develops into a male or a female is determined by a pair of sex chromosomes: XX for females, XY for males.

In short, sex in all animals is defined by gamete size; sex in all mammals is determined by sex chromosomes; and there are two and only two sexes: male and female. All this is, of course, hardly news: It has been known for over a century, and it is basic stuff from any half-decent high school course in biology. For sure, quirks of mutation or prenatal development may leave some individuals unable to produce viable gametes at all. But an infertile individual with a Y chromosome is still male, just as a one-legged person remains a full member of our bipedal species.

Much is speciously made of the fact that a very few humans are born with chromosomal patterns other than XX and XY. The most common, Klinefelter syndrome with XXY chromosomes, occurs in about 0.1 percent of live births; these individuals are anatomically male, though often infertile. Some extremely rare conditions, such as de la Chapelle syndrome (0.003 percent) and Swyer syndrome (0.0005 percent), arguably fall outside the standard male/female classification. Even so, the sexual divide is an exceedingly clear binary, as binary as any distinction you can find in biology.

So where does this leave the medical associations' claims about "sex assigned at birth"?

A baby's name is assigned at birth; no one doubts that. But a baby's sex is not "assigned"; it is determined at conception and is then observed at birth, first by examination of the external genital organs and then, in cases of doubt, by chromosomal analysis. Of course, any observation can be erroneous, and in rare cases the sex reported on the birth certificate is inaccurate and needs to be subsequently corrected. But the fallibility of observation does not change the fact that what is being observed — a person's sex — is an objective biological reality, just like their blood group or fingerprint pattern, not something that is "assigned." The medical associations' pronouncements are social constructionism gone amok.

Sex is a fundamental feature of the human species; it is a key variable in psychology, sociology, and public policy. Worldwide, men commit the vast majority of homicides; women are far more likely than men to be single parents. While these distinctions are statistical, not absolute, they matter. Our public discourse becomes impoverished and distorted if we are unable to speak and write straightforwardly about sex. And nowhere is this loss clearer than in medicine.

For decades, feminists have protested against the neglect of sex as a variable in medical diagnosis and treatment, and the tacit assumption that women's bodies react similarly to men's bodies. Two years ago, the prestigious medical journal The Lancet finally acknowledged this criticism, but the editors apparently could not bring themselves to use the word "women." Instead the journal's cover proclaimed: "Historically, the anatomy and physiology of bodies with vaginas

have been neglected." But now even this double-edged concession may be lost, as the denial of biological sex threatens to undermine the training of future doctors.

The medical establishment's newfound reluctance to speak honestly about biological reality most likely stems from a laudable desire to defend the human rights of transgender people. But while the goal is praiseworthy, the chosen method is misguided. Protecting transgender people from discrimination and harassment does not require pretending that sex is merely "assigned."

It is never justified to distort the facts in the service of a social or political cause, no matter how just. If the cause is truly just, then it can be defended in full acceptance of the facts about the real world.

And when an organization that proclaims itself scientific distorts the scientific facts in the service of a social cause, it undermines not only its own credibility but that of science generally. How can the public be expected to trust the medical establishment's declarations on other controversial issues, such as vaccines — issues on which the medical consensus is indeed correct — when it has so visibly and blatantly misstated the facts about something so simple as sex?

*Alan Sokal is professor of mathematics at University College London and professor emeritus of physics at New York University. He is coauthor (with Jean Bricmont) of "*Fashionable Nonsense: Postmodern Intellectuals' Abuse of Science*" and author of "*Beyond the Hoax: Science, Philosophy and Culture*." Richard Dawkins is professor emeritus for the public understanding of science at the University of Oxford. He is the author of 17 books, including "*The Selfish Gene*" and "*The Ancestor's Tale*."*

The Problem With Saying 'Sex Assigned at Birth'

By Alex Byrne and Carole K. Hooven

*Mr. Byrne is a philosopher and the author of "*Trouble With Gender: Sex Facts, Gender Fictions*." Ms. Hooven is an evolutionary biologist and the author of "*T: The Story of Testosterone, the Hormone That Dominates and Divides Us"

As you may have noticed, "sex" is out, and "sex assigned at birth" is in. Instead of asking for a person's sex, some medical and camp forms these days ask for "sex assigned at birth" or "assigned sex" (often in addition to gender identity). The American Medical Association and the American Psychological Association endorse this terminology; its use has also exploded in academic articles. The Cleveland Clinic's online glossary of diseases and conditions tells us that the "inability to achieve or maintain an erection" is a symptom of sexual dysfunction, not in "males," but in "people assigned male at birth."

This trend began around a decade ago, part of an increasing emphasis in society on emotional comfort and insulation from offense — what some have called "safetyism." "Sex" is now often seen as a biased or insensitive word because it may fail to reflect how people identify themselves. One reason for the adoption of "assigned sex," therefore, is that it supplies respectful euphemisms, softening what to some nonbinary and transgender people, among others, can feel like a harsh biological reality. Saying that someone was "assigned female at birth" is taken to be an indirect and more polite way of communicating that the person is biologically female. The

terminology can also function to signal solidarity with trans and nonbinary people, as well as convey the radical idea that our traditional understanding of sex is outdated.

The shift to “sex assigned at birth” may be well intentioned, but it is not progress. We are not against politeness or expressions of solidarity, but “sex assigned at birth” can confuse people and creates doubt about a biological fact when there shouldn’t be any. Nor is the phrase called for because our traditional understanding of sex needs correcting — it doesn’t.

This matters because sex matters. Sex is a fundamental biological feature with significant consequences for our species, so there are costs to encouraging misconceptions about it.

Sex matters for health, safety and social policy and interacts in complicated ways with culture. Women are nearly twice as likely as men to experience harmful side effects from drugs, a problem that may be ameliorated by reducing drug doses for females. Males, meanwhile, are more likely to die from Covid-19 and cancer, and commit the vast majority of homicides and sexual assaults. We aren’t suggesting that “assigned sex” will increase the death toll. However, terminology about important matters should be as clear as possible.

More generally, the interaction between sex and human culture is crucial to understanding psychological and physical differences between boys and girls, men and women. We cannot have such understanding unless we know what sex is, which means having the linguistic tools necessary to discuss it. The Associated Press cautions journalists that describing women as “female” may be objectionable because “it can be seen as emphasizing biology,” but sometimes biology is highly relevant. The heated debate about transgender women participating in female sports is an example; whatever view one takes on the matter, biologically driven athletic differences between the sexes are real.

When influential organizations and individuals promote “sex assigned at birth,” they are encouraging a culture in which citizens can be shamed for using words like “sex,” “male” and “female” that are familiar to everyone in society, as well as necessary to discuss the implications of sex. This is not the usual kind of censoriousness, which discourages the public endorsement of certain opinions. It is more subtle, repressing the very vocabulary needed to discuss the opinions in the first place.

A proponent of the new language may object, arguing that sex is not being avoided, but merely addressed and described with greater empathy. The introduction of euphemisms to ease uncomfortable associations with old words happens all the time — for instance “plus sized” as a replacement for “overweight.” Admittedly, the effects may be short-lived, because euphemisms themselves often become offensive, and indeed “larger-bodied” is now often preferred to “plus sized.” But what’s the harm? No one gets confused, and the euphemisms allow us to express extra sensitivity. Some see “sex assigned at birth” in the same positive light: It’s a way of talking about sex that is gender-affirming and inclusive.

The problem is that “sex assigned at birth”— unlike “larger-bodied”— is very misleading. Saying that someone was “assigned female at birth” suggests that the person’s sex is at best a matter of educated guesswork. “Assigned” can connote arbitrariness — as in “assigned classroom seating” — and so “sex assigned at birth” can also suggest that there is no objective reality behind “male” and “female,” no biological categories to which the words refer.

Contrary to what we might assume, avoiding “sex” doesn’t serve the cause of inclusivity: not speaking plainly about males and females is patronizing. We sometimes sugarcoat the biological facts for children, but competent adults deserve straight talk. Nor are circumlocutions needed to secure personal protections and rights, including transgender rights. In the Supreme Court’s Bostock v. Clayton County decision in 2020, which outlawed workplace discrimination against gay and transgender people, Justice Neil Gorsuch used “sex,” not “sex assigned at birth.”

A more radical proponent of “assigned sex” will object that the very idea of sex as a biological fact is suspect. According to this view — associated with the French philosopher Michel Foucault and, more recently, the American philosopher Judith Butler — sex is somehow a cultural production, the result of labeling babies male or female. “Sex assigned at birth” should therefore be preferred over “sex,” not because it is more polite, but because it is more accurate.

This position tacitly assumes that humans are exempt from the natural order. If only! Alas, we are animals. Sexed organisms were present on Earth at least a billion years ago, and males and females would have been around even if humans had never evolved. Sex is not in any sense the result of linguistic ceremonies in the delivery room or other cultural practices. Lonesome George, the long-lived Galápagos giant tortoise, was male. He was not assigned male at birth — or rather, in George’s case, at hatching. A baby abandoned at birth may not have been assigned male or female by anyone, yet the baby still has a sex. Despite the confusion sown by some scholars, we can be confident that the sex binary is not a human invention.

Another downside of “assigned sex” is that it biases the conversation away from established biological facts and infuses it with a sociopolitical agenda, which only serves to intensify social and political divisions. We need shared language that can help us clearly state opinions and develop the best policies on medical, social and legal issues. That shared language is the starting point for mutual understanding and democratic deliberation, even if strong disagreement remains.

What can be done? The ascendance of “sex assigned at birth” is not an example of unhurried and organic linguistic change. As recently as 2012 *The New York Times* reported on the new fashion for gender-reveal parties, “during which expectant parents share the moment they discover their baby’s sex.” In the intervening decade, sex has gone from being “discovered” to “assigned” because so many authorities insisted on the new usage. In the face of organic change, resistance is usually futile. Fortunately, a trend that is imposed top-down is often easier to reverse.

Admittedly, no one individual, or even a small group, can turn the lumbering ship of English around. But if professional organizations change their style guides and glossaries, we can expect that their members will largely follow suit. And organizations in turn respond to lobbying from their members. Journalists, medical professionals, academics and others have the collective power to restore language that more faithfully reflects reality. We will have to wait for them to do that.

Meanwhile, we can each apply Strunk and White’s famous advice in “The Elements of Style” to “sex assigned at birth”: omit needless words.

False claim #5: Brain scans have demonstrated "female brains in male bodies" or "male brains in female bodies"

A common claim of online activists is that brain scans have "proven" that there is such a thing as "female brains in male bodies" and the reverse. Unfortunately, neuroimaging is like some other topics popular with the public (health, pop psychology, "gene for [some trait]", etc.) where small exploratory studies, with tiny dataset sizes and only suggestive results, can get picked up by the media and given outsized influence.

We do not propose to do a review of the literature, but we recommend caution, as skeptics[45] have often noted that claims about brain scans often have classic warning signs: they are based on studying only a handful of individuals (the necessary scans are expensive and time-consuming), obvious potential confounders are not accounted for (e.g. sexuality, exogenous hormone usage), and typically yield small effect sizes or inconsistent results between studies. Most fundamentally, brain scans measure hundreds or thousands of features, and in a hunt for differences and similarities amongst all these features, there is a strong risk that "data mining" approaches will appear to find something that is in fact an artefact of multiple testing bias.

In terms of the big picture, a crucial point that is never raised in activist discussions is the following: *the brains of male and female humans are not actually very different*. A massive, 31-page review of the literature on male/female differences in brain structure was recently published in *Neuroscience & Biobehavioral Reviews*,[46] and its conclusion is in the title and abstract:

> **Dump the "dimorphism": Comprehensive synthesis of human brain studies reveals few male-female differences beyond size**
>
> **Abstract:** With the explosion of neuroimaging, differences between male and female brains have been exhaustively analyzed. Here we synthesize three decades of human MRI and postmortem data, emphasizing meta-analyses and other large studies, which collectively reveal

[45] Michael Shermer (2008). Why You Should Be Skeptical of Brain Scans. *Scientific American Mind*, 19(5), 66-71. https://www.jstor.org/stable/24939978

Scott O. Lilienfeld, Elizabeth Aslinger, Julia Marshall, Sally Satel (2017). Neurohype: A Field Guide to Exaggerated Brain-Based Claims. *The Routledge Handbook of Neuroethics*, 1st Edition. https://www.taylorfrancis.com/reader/read-online/1e14c716-2517-40ce-b8b2-79959fec830b/chapter/pdf?context=ubx

[46] Lise Eliot, Adnan Ahmed, Hiba Khan, Julie Patel (2021). Dump the "dimorphism": Comprehensive synthesis of human brain studies reveals few male-female differences beyond size. Neuroscience & Biobehavioral Reviews, 125, 667-697. https://doi.org/10.1016/j.neubiorev.2021.02.026

few reliable sex/gender differences and a history of unreplicated claims. Males' brains are larger than females' from birth, stabilizing around 11% in adults. This size difference accounts for other reproducible findings: higher white/gray matter ratio, intra- versus interhemispheric connectivity, and regional cortical and subcortical volumes in males. But when structural and lateralization differences are present independent of size, sex/gender explains only about 1% of total variance. Connectome differences and multivariate sex/gender prediction are largely based on brain size, and perform poorly across diverse populations. Task-based fMRI has especially failed to find reproducible activation differences between men and women in verbal, spatial or emotion processing due to high rates of false discovery. Overall, male/female brain differences appear trivial and population-specific. The human brain is not "sexually dimorphic."

We note that the difference in male/female brain size is partially explained by the fact that brain size scales with overall body size, and average body size is different between males and females. (There is no evidence for a systematic difference in things like average IQ between the sexes.)

Given that, apart from size, reproducible brain differences are hard to find, and this is a finding summarizing decades of brain studies representing a large amount of data, it is dubious to uncritically accept studies that make claims about brains being more male- or female-like based on very small samples. Eliot et al. (2021) summarize the very strongest case, that of the "sexually dimorphic nucleus" (SDN):

> [T]he search for human brain sexual dimorphisms has been based on the supposition that specific structures or circuits differ disproportionately between men and women in ways that will explain well-known behavioral s/g differences, such as empathy, spatial navigation, and gender identity itself. This paradigm has its roots in animal neurobiology, where certain brain areas are indeed dramatically larger in one sex, with clear links to behaviors such as courtship and mating. [...] [A]nother structure is literally called the "sexually-dimorphic nucleus" (SDN) and is located in the anterior hypothalamus where it can measure up to 5-fold larger in male rats, compared to females.
>
> In the case of the SDN, the search for its human homologue took nearly 20 years to reach consensus, but was finally settled upon as the third interstitial nucleus of the anterior hypothalamus (INAH-3), a tiny (0.1 mm^3) subnucleus situated lateral to the much larger medial preoptic nucleus. Again, the magnitude of this difference is a fraction of the 5-fold rodent difference. Four different labs reported that the structure is larger in men, but the difference averages only 1.6-fold (Allen et al., 1989; Byne et al., 2000; Garcia-Falgueras and Swaab, 2008; LeVay, 1991). Nor is there a clear relationship of INAH-3 volume to sexual behavior: LeVay (1991) reported that the structure is smaller in homosexual, compared to heterosexual men, whereas Byne et al. (2001) found no significant difference between such groups. With regard to gender identity, Garcia-Falgueras and Swaab (2008) reported reduced INAH-3 volume in a small sample of transgender women, but this has yet to be independently confirmed. Small though it is, the reason INAH-3 has been so extensively studied is because this 60% volume difference is by far the largest "sexual dimorphism" in the human brain.

A 60% volume difference between males and female, in a nucleus of size 0.1 cubic millimeters, with a small 2008 study reporting a gender difference but which had not been replicated as of 2021, is not a promising basis for grand claims about brain scans validating "brain in the wrong body" narratives. (The volume of the human brain is roughly 1300-1500 cubic centimeters, which is 1,300,000 to 1,500,000 cubic millimeters.)

It is true that, despite the weak evidence for sexual dimorphism in gross brain structure, there are some replicably measurable differences between the sexes in various psychological measurements (these are differences in averages; the distributions in psychological measurements have broad overlap between the sexes, but the means can differ). Of course such differences presumably have some form of physical causation in the brain, but whether these will be findable in a replicable way via gross brain scans is an open question. Even if found, it would be yet another open question to what degree any differences would be attributable to genetics, family and social experiences, learning, hormones, sexual orientation, etc. Anyway, if it is difficult to find consistent brain scan differences between males and females, we need to be skeptical of even more subtle claims.

Eliot et al. (2021) conclude:

> [A] picture is emerging not of two brain types nor even a continuous gradient from masculine to feminine, but of a multidimensional “mosaic” of countless brain attributes that differ in unique patterns across all individuals (Joel et al., 2015). Although such differences may, in a particular sample, sum up to discriminate male from female brains, the precise discriminators do not translate across populations (Table 7; see also Joel et al., 2018; Sanchis-Segura et al., 2020) so are not diagnostic of two species-wide types. In this sense, the brains of male and females are not dimorphic (like the gonads) but monomorphic, like the kidneys, heart and lungs, which can be transplanted between women and men with great success. [...]
>
> [T]he present synthesis indicates that such “real” or universal sex-related difference[s] do not exist. Or at best, they are so small as to be buried under other sources of individual variance arising from countless genetic, epigenetic, and experiential factors. Thus, s/g [sex and/or gender] differences in brain architecture may be similar to sex effects in gene-phenotype architecture; while statistically discernable in a very large (>100,000) sample, such effects contributed only 1.4% to the accuracy of genotype-phenotype prediction (Rawlik et al., 2016).
>
> In layperson’s terms, these findings can be interpreted as rebutting popular discourse about the “male brain” and “female brain” as distinct organs.

False claim #6: Medical drugs and surgeries can change sex

We have made the general argument for the immutability of sexes in mammals above.

However, in following this debate, we have noticed that among the public, the media, and politicians, there is often a substantial degree of ignorance and what can only be called dangerous naivete and magical thinking about "sex change" procedures. We are afraid that many find the topic uncomfortable and tend to "black box" it into a "doctors do complex stuff behind the curtain" category. Therefore, we make some general remarks (without doing a literature review, which would be off-topic for this submission) to encourage caution in readers who may have heard rosy activist rhetoric about these procedures but not have done the reading to determine what they entail.

In casual conversations and in online discussion forums, we have found that it is not rare for even reasonably well-educated people to think that medical interventions will allow a male to "grow a vagina," or that breasts can be "put back on" if desired after they have been removed after a double mastectomy, or that medical interventions will soon make it possible for a male to get pregnant, or that maintaining sexual function is a likely outcome of genital surgery.

Therefore, it is important to state that anyone who thinks these medical interventions actually bring about a literal change from male to female or the reverse is badly misinformed. Briefly, cross-sex interventions only provide some cosmetic changes in secondary sexual characteristics (body hair, voice, fat distribution, and the like). The primary sexual characteristics (the reproductive organs) are all developed in the embryo, and it is impossible to reverse or re-run that developmental process post-birth. All that cross-sex hormonal interventions can do to primary reproductive organs is atrophy and/or injure them. Genital surgeries (vaginoplasty and phalloplasty) are highly traumatic interventions into originally healthy delicate and sensitive systems. Complications are common and the fatality rate is non-trivial. While in general we do not recommend that readers look up these procedures, anyone who is doing policy or media commentary on these issues has a responsibility to have a clear and realistic understanding of what they entail and what the risks are.

Compared to the extreme case of genital surgery, removing breasts in a mastectomy is comparatively less severe, but the casual idea that breasts can be "put back on" with surgery is disturbingly common. This is technically impossible. Onerous procedures can be done to gradually stretch skin and then insert implants to restore the general body shape, but breastfeeding ability and functional nipples never return. Furthermore, the procedure is substantially more difficult and painful than cosmetic breast implants.

Above all else, the claim that these often-brutal procedures reduce rates of suicide or suicidality is highly disputed. It is entirely possible that the procedures actually *raise* the long-term risk of suicide, for example as found by Straub et al. (2024): "Individuals who underwent gender-affirming surgery had a 12.12-fold higher suicide attempt risk than those who did not."[47]

Very Dubious claim #1: "Gender identity" is genetic

This claim is actually not commonly made explicitly in the public sex/gender discussion. However, we suspect it lingers in the background, as a trait being genetic is the most obvious way for a trait to be "innate", which is a common claim. A similar dubious logic has long motivated the "search for a gay gene," still unsuccessful after decades of false positives.

While it is true that almost all traits (intelligence measures, smoking, shyness, etc.) have some degree of what biologists call "heritability", and so the same might be expected in this case, it is important to note that "heritability" is really a statistical term applied to a measure of correlation between genetic similarity and trait similarity. Famously, correlation is not proof of causation. Only in carefully controlled experiments, where the environmental background can be carefully controlled and factored out, e.g. when measured in a relatively uniform environment, can a positive heritability estimate be taken as good evidence of genetic causation. Such experiments are not possible in humans. Sophisticated methods in Genome-Wide Association Studies (GWAS) are another way to attempt get from heritability to genetic causation, but while they have found good evidence for genetic causation of various physical traits in humans, highly socially-mediated traits have substantially reduced heritability when Mendelian randomization between siblings is used to factor out spurious nongenetic correlations due to socially inherited factors like income and education.[48]

As a mental check on what it would look like if there were some major source of genetic causation, we need only refer back to Disorders of Sex Development (DSD). For DSDs,

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[47] Straub JJ, Paul KK, Bothwell LG, Deshazo SJ, Golovko G, Miller MS, Jehle DV. (2024). Risk of Suicide and Self-Harm Following Gender-Affirmation Surgery. *Cureus*. 16(4):e57472. http://dx.doi.org/10.7759/cureus.57472

[48] Mostafavi, Hakhamanesh, Arbel Harpak, Ipsita Agarwal, Dalton Conley, Jonathan K. Pritchard, Molly Przeworski (2020). Variable prediction accuracy of polygenic scores within an ancestry group. *eLife* 9:e48376. https://doi.org/10.7554/eLife.48376

there are dozens of cases where scientists have identified specific mutations of high impact on the function of specific developmental genes (namely, the genes in the Gene Regulatory Networks for male or female development, depicted above). While there remains a minority of DSD cases where the genetic causation has not yet been determined, this is likely because the mutation involved is unique or nearly so, and in some part of the Gene Regulatory Network that is not yet fully understood.

We make no causative assertion. We just caution against assuming genetic causation in the absence of strong evidence, as this assumption has led people astray in many previous controversies.

Conclusion

We hope these comments are useful in your deliberations, and that they help inform the broader debate about the Bill and claims involving the biology of sex.

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Notes

Some of the text of this Submission was repurposed from the Biologists' Letter protesting a UoA administration attempt to impose a sex-denialist talking point on the teaching of Professor Elizabeth Rata. (Available at: https://www.uoaseen.nz/)

AI has not been used in the writing of this document.

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