Sheffield Hallam University

The International Olympic Committee framework on fairness, inclusion and non-discrimination on the basis of gender identity and sex variations does not protect fairness for female athletes.

LUNDBERG, Tommy, TUCKER, Ross, MCGAWLEY, Kerry, WILLIAMS, Alun, MILLET, Gregoire, SANDBAKK, Øyvind, HOWATSON, Glyn, BROWN, Gregory, CARLSON, Lara, CHANTLER, Sarah, CHEN, Mark, HEFFERNAN, Shane, HERON, Neil, KIRK, Christopher, MURPHY, Marie, POLLOCK, Noel, PRINGLE, Jamie, RICHARDSON, Andrew, SANTOS-CONCEJERO, Jordan, STEBBINGS, Georgina, CHRISTIANSEN, Ask, PHILLIPS, Stuart, DEVINE, Cathy, JONES, Carwyn, PIKE, Jon and HILTON, Emma

Available from Sheffield Hallam University Research Archive (SHURA) at:

http://shura.shu.ac.uk/33208/

This document is the author deposited version. You are advised to consult the publisher's version if you wish to cite from it.

Published version

LUNDBERG, Tommy, TUCKER, Ross, MCGAWLEY, Kerry, WILLIAMS, Alun, MILLET, Gregoire, SANDBAKK, Øyvind, HOWATSON, Glyn, BROWN, Gregory, CARLSON, Lara, CHANTLER, Sarah, CHEN, Mark, HEFFERNAN, Shane, HERON, Neil, KIRK, Christopher, MURPHY, Marie, POLLOCK, Noel, PRINGLE, Jamie, RICHARDSON, Andrew, SANTOS-CONCEJERO, Jordan, STEBBINGS, Georgina, CHRISTIANSEN, Ask, PHILLIPS, Stuart, DEVINE, Cathy, JONES, Carwyn, PIKE, Jon and HILTON, Emma (2024). The International Olympic Committee framework on fairness, inclusion and non-discrimination on the basis of gender identity and sex variations does not protect fairness for female athletes. Scandinavian Journal of Medicine and Science in Sports.

Copyright and re-use policy

Sheffield Hallam University Research Archive
http://shura.shu.ac.uk

See http://shura.shu.ac.uk/information.html

Sheffield Hallam University Research Archive
http://shura.shu.ac.uk

Check for updates

Received: 14 October 2023 | Revised: 10 January 2024 | Accepted: 1 February 2024

DOI: 10.1111/sms.14581

NOTE

WILEY

The International Olympic Committee framework on fairness, inclusion and nondiscrimination on the basis of gender identity and sex variations does not protect fairness for female athletes

Tommy R. Lundberg[1] | **Ross Tucker**[2] | **Kerry McGawley**[3] | **Alun G. Williams**[4,5,6] | **Grégoire P. Millet**[7] | **Øyvind Sandbakk**[8] | **Glyn Howatson**[9,10] | **Gregory A. Brown**[11] | **Lara A. Carlson**[12] | **Sarah Chantler**[13] | **Mark A. Chen**[14] | **Shane M. Heffernan**[6] | **Neil Heron**[15,16] | **Christopher Kirk**[17] | **Marie H. Murphy**[18,19] | **Noel Pollock**[20] | **Jamie Pringle**[21] | **Andrew Richardson**[22] | **Jordan Santos-Concejero**[23] | **Georgina K. Stebbings**[4] | **Ask Vest Christiansen**[24] | **Stuart M. Phillips**[25] | **Cathy Devine**[26] | **Carwyn Jones**[27] | **Jon Pike**[28] | **Emma N. Hilton**[29]

Correspondence
Tommy R. Lundberg, Division of Clinical Physiology, Department of Laboratory Medicine, Karolinska Institutet, Alfred Nobels allé 8, 14152 Huddinge, Sweden.
Email: tommy.lundberg@ki.se

Abstract

The International Olympic Committee (IOC) recently published a framework on fairness, inclusion, and nondiscrimination on the basis of gender identity and sex variations. Although we appreciate the IOC's recognition of the role of sports science and medicine in policy development, we disagree with the assertion that the IOC framework is consistent with existing scientific and medical evidence and question its recommendations for implementation. Testosterone exposure during male development results in physical differences between male and female bodies; this process underpins male athletic advantage in muscle mass, strength and power, and endurance and aerobic capacity. The IOC's "no presumption of advantage" principle disregards this reality. Studies show that transgender women (male-born individuals who identify as women) with suppressed testosterone retain muscle mass, strength, and other physical advantages compared to females; male performance advantage cannot be eliminated with testosterone

Tommy R. Lundberg, Ross Tucker, and Emma N. Hilton contributed equally to this study.

Opinions expressed in this commentary are those of the authors and do not necessarily reflect the viewpoints or policies of the Scandinavian Journal of Medicine & Science in Sports, its editorial staff, or the publisher. The publication of this commentary does not constitute an endorsement of the views expressed herein.

For Affiliation refer page on 8

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.
© 2024 The Authors. *Scandinavian Journal of Medicine & Science In Sports* published by John Wiley & Sons Ltd.

suppression. The IOC's concept of "meaningful competition" is flawed because fairness of category does not hinge on closely matched performances. The female category ensures fair competition for female athletes by excluding male advantages. Case-by-case testing for transgender women may lead to stigmatization and cannot be robustly managed in practice. We argue that eligibility criteria for female competition must consider male development rather than relying on current testosterone levels. Female athletes should be recognized as the key stakeholders in the consultation and decision-making processes. We urge the IOC to reevaluate the recommendations of their Framework to include a comprehensive understanding of the biological advantages of male development to ensure fairness and safety in female sports.

KEYWORDS

exercise, sport, sports medicine, sports policy, transgender

1 | INTRODUCTION

The International Olympic Committee (IOC) recently published a framework on fairness, inclusion and non-discrimination on the basis of gender identity and sex variations.[1] This was followed by the publication of a position statement providing an explanation of the framework.[2] The stated aims of the position statement were to demonstrate how the IOC Framework aligns with existing scientific and medical knowledge and to assist with implementation. We welcome the updated explanation, the continued work in this important area, and the acknowledgment that the sports science and medicine community are important partners in policy development.

We agree with many of the Framework's ten principles, including the primacy of scientific evidence, ethical considerations such as the importance of health and bodily autonomy, a stakeholder-centered approach, and the right to privacy. We acknowledge that some of these principles may require different considerations in policy development, specifically for athletes with sex variations. Transgender athletes and those with sex variations may experience challenges and barriers to sports participation, and we agree with the IOC Olympic Charter that sports should be accessible to all and that barriers should be addressed where possible by sporting authorities.

However, we argue that the IOC Framework does not align with existing scientific and medical knowledge and we question several of the recommendations regarding implementation. The IOC framework does not provide suitable guidance to sports authorities to protect the female category in sports. In this article, we outline areas that need further consideration and describe existing evidence and principles that sports should consider to ensure fairness and safety in female sports.

2 | MALES AND FEMALES ARE PHYSICALLY DIFFERENT, AND MALES HAVE A CATEGORY-LEVEL ATHLETIC ADVANTAGE

Females and males are sexually dimorphic, and differ in terms of skeletal size and shape,[3–5] body composition including muscle mass and function,[6–9] pulmonary function[10,11] and cardiovascular function.[12–14] Sexual dimorphism is largely driven by the high levels of testosterone produced by the testes during male puberty,[15–18] although sex-specific genes and postnatal hormone differences can also contribute to sexually dimorphic differences in phenotype even before puberty.[19–21]

The IOC framework states that there should be "no presumption of advantage" based on "biological or physiological characteristics," and that eligibility criteria should recognize individual-level differences in factors that impact performance and safety. We and others[22] disagree with the IOC principle of no presumed advantage, despite the further explanation provided by the position statement. It is incoherent for the IOC to take a stance of "no presumption of advantage" when a transitioning transgender woman athlete comes directly from a population with an inherent and well-established male biological advantage. It would be more logical to assume a biological advantage until proven otherwise, especially as several physical attributes (e.g., stature, heart, lung, bone, and muscle size) have not been shown to be reversed with any treatment, as we describe subsequently (Section 4).

16000838, 2024, 3, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.14581 by Sheffield Hallam University, Wiley Online Library on [26/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

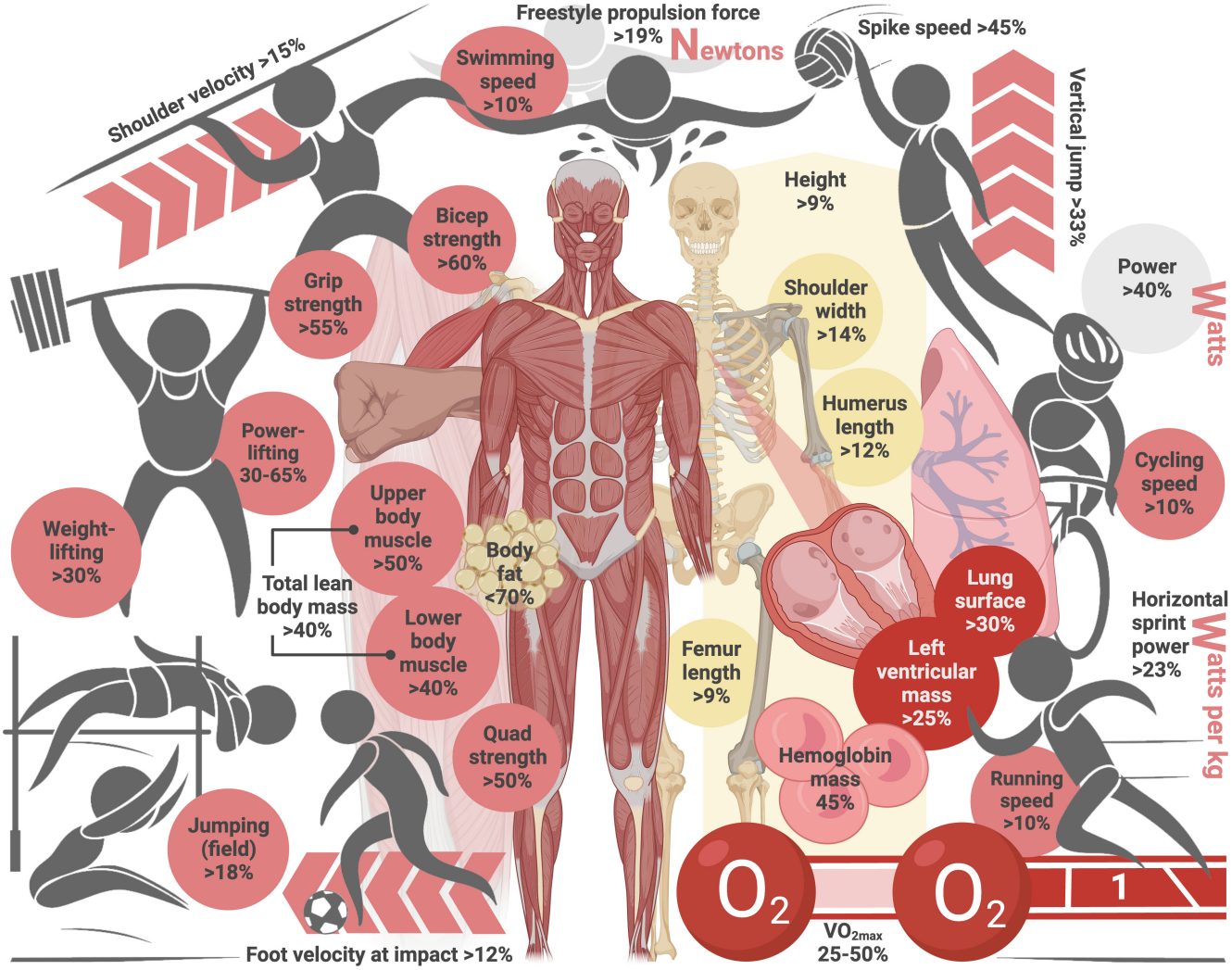

FIGURE 1 Physiological differences and resultant performance implications in males and females. Males are bigger and stronger, have higher lean mass and lower fat mass, have a differently shaped skeleton, and have higher aerobic capacity than females, generating a 10%–65% performance advantage for different attributes across athletic sports.[23–25,27–40] VO_{2max}, maximal oxygen consumption. Created with BioRender.com.

The rationale for our disagreement is supported by work in evolutionary and developmental biology, zoology, physiology, endocrinology, medicine, sport and exercise science, and observing athletic performance results within male and female sport.[23–26] Specifically, male development generates physical and physiological performance advantages so large that sport requires a separate category to exclude attributes resulting from normal male development for sports requiring power, strength, speed, and endurance[23–25,27–40] (Figure 1). Failing to acknowledge male category-level advantage or arguing it is simply a "presumption" undermines the purpose of segregated sex categories in sports and obscures the competitive differences that should be celebrated and rewarded within each sex category.[41,42]

3 | TESTOSTERONE EXPOSURE DURING MALE PUBERTY IS THE PRIMARY DRIVER OF THE PHYSICAL DIFFERENCES BETWEEN MALES AND FEMALES

In adulthood, circulating testosterone concentrations do not come close to overlapping between females (0.1–1.7 nmol/L) and males (7.7–29.4 nmol/L).[18,43] It is well established that exposure to higher levels of testosterone during male versus female development promotes the development of male sex characteristics (e.g., larger muscle mass, heart size, lung capacity, bones, strength, and circulating hemoglobin) that are integral for sports performance.[18,22,25] Thus, it is not the adult level of testosterone

16000838, 2024, 3, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.14581 by Sheffield Hallam University, Wiley Online Library on [26/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

that predicts the performance of an individual athlete, but rather developmental exposure to testosterone and the development of male secondary sex characteristics that underpin the existence of the male category and category-level differences between the sexes.

It is noteworthy that public and policy discussion focuses much less on transgender men (female-born individuals who identify as men) athletes. When these athletes compete in men's sport, issues of fairness and safety for other participants are absent, as transgender men have no biological advantage conferred by testosterone exposure during male development. A more thorough discussion of transgender men in sport would emphasize the importance of testosterone, which the IOC failed to recognize in their regulations. While testosterone administration might improve physical capacity in transgender men,[44,45] it does not completely "overcome" the physiological and morphological differences caused by endogenous testosterone during early development and puberty. Recognition of this asymmetry in how transgender women and transgender men perform in sport can therefore lead to a better understanding of the significant and lasting influences of sex-specific developmental factors.

Based on these arguments, when developing eligibility criteria for female categorization it is necessary to consider whether testosterone-driven male development has occurred. Taking only current testosterone concentrations into account ignores permanent and long-lasting physical and physiological advantages. Further, there are ethical and legal concerns with requiring athletes to medically lower testosterone "to mitigate performance" and enable eligibility for the female category, as well as important practical challenges in monitoring athletes to ensure compliance with any testosterone targets. Based on these considerations, we propose that a single or even multiple moment-in-time measurements of testosterone concentration are inappropriate and misleading as a means of assessing male performance mitigation.

4 | TESTOSTERONE SUPPRESSION POST-PUBERTY DOES NOT NEGATE THE MALE PERFORMANCE ADVANTAGE

The IOC framework suggests that testosterone concentrations could be investigated as a means to mitigate performance in transgender women. However, no study has demonstrated that transgender women with suppressed testosterone levels after puberty reach biological or physical parity with females. Conversely, numerous studies have shown that biological differences persist after testosterone is suppressed,[25,44,46] with physical performance implications. There is no plausible biological mechanism by which testosterone suppression could reduce height and associated skeletal measurements (e.g., bone length and hip or shoulder width) that may confer a discipline-dependent performance advantage. Consequently, no study has reported reductions in skeletal advantages in transgender women who suppress testosterone after puberty.[25]

Twelve controlled longitudinal studies[44,47–57] collectively following more than 800 untrained or moderately trained transgender women have shown that testosterone suppression for 1 year induces only a 5% loss of pre-transition muscle mass/strength. This loss accounts for only a fraction (one-fifth or less) of typically observed male versus female muscle mass and strength differences.[25,26,58] For example, in the study by Wiik et al.,[44] thigh muscle volume differences of 39% between transgender men and women were reduced only marginally with 1 year of testosterone suppression, and 83% percent of the initial male advantage was retained. The result is higher levels of muscle mass and strength in transgender women compared to females for at least 3 years after testosterone suppression (i.e., the longest sampling duration of current longitudinal studies), with male advantage still evident in cross-sectional studies of transgender women who suppressed testosterone for up to 14 years.[59–61]

The effects of testosterone suppression on biological factors underlying endurance performance are less well explored than those of strength and power. Nonetheless, untrained or moderately trained transgender women who have successfully suppressed testosterone after puberty achieved female-typical hemoglobin concentrations within 3–6 months.[44,46] In contrast, the effect on hemoglobin mass, which, unlike hemoglobin concentration, is strongly related to VO_{2max},[39,62] is unknown, and other factors related to endurance performance, such as work economy and fractional utilization, have not been studied.

We argue that the existing literature on physical changes induced by testosterone suppression constitutes the most robust dataset currently available, and is relevant for elite athletes, because it confirms the principle of persistence of biological characteristics even in the absence of training. These longitudinal studies are then complemented by studies in which testosterone suppression in males has been accompanied by exercise training, which demonstrate that training can partly, or even completely, attenuate reductions in muscle mass and strength.[63,64] Therefore, a rational hypothesis based on current evidence would be that retained male advantage would be larger, not smaller, in highly trained transgender women if they continued to train during testosterone suppression, compared with untrained or moderately trained individuals.

16000838, 2024, 3, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.14581 by Sheffield Hallam University, Wiley Online Library on [26/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

This hypothesis is also supported by the observation that sex-specific differences in athletic performance are at least equally pronounced in elite athletes compared to untrained or moderately trained individuals.[26]

The findings documented in the scientific literature, and the hypothesis that retained male advantage would be larger in athletes, predict that the relative ranking of transgender women in competitive sports would improve significantly after they switch from the male to the female category. This is illustrated by a case study of an American transgender swimmer, who achieved significant National Collegiate Athletic Association (NCAA) ranking improvements (from middle to top) across a range of events after switching from the male to the female category.[65] This occurred as a result of performance decreases that were significantly smaller than male versus female performance differences, supporting the retention of male biological advantage and illustrating the resultant unfairness.

5 | MEANINGFUL COMPETITION IS NOT THE SAME AS FAIR COMPETITION

The IOC framework suggests that sports organizations may need to issue eligibility criteria for sex-segregated competition to maintain a fair and proportionate distribution of competitive advantages. However, this statement blurs the lines between categorical and competitive advantage and confuses the concepts of fairness and meaningful competition.[41,66] The specific purpose of establishing eligibility criteria for the female category is not to ensure a proportionate or acceptable distribution of competitive advantages around a given level of performance but to ensure fairness by excluding all male advantages, thereby ensuring the integrity of the female category in the first place.

The IOC framework discusses meaningful competition without ever defining what it is. Based on the IOC's discussion of unfair and disproportionate advantages, we infer it to mean competition in which outcomes are unpredictable, performances are closely matched, and no single athlete, including a transgender woman, consistently wins by a large margin. This is a flawed interpretation. Countless instances of closely contested competitions between athletes (i.e., "meaningful" according to the IOC definition) can be fundamentally unfair. These include situations where athletes are later found to have used performance-enhancing drugs or deceived sporting authorities about their true age. The fairness of a competition is not determined by the predictability or closeness of the outcome, but rather by the absence of any unfair advantages that a specific category or rule is designed to exclude. Thus, meaningful (or close, by the IOC's framing of the issue) competition does not equate to fair competition and cannot be achieved by having male advantage in female sport.

Sporting competition does not penalize dominance or large winning margins if achieved fairly within predefined categories. Instead, it encourages close competition by offering rewards at different levels within those categories (e.g., international, national, regional, Division 1, and Division 2 levels). These levels of competition are usually narrow and encourage inclusive and meaningful participation in the sport, regardless of an individual's performance or ambitions.

Of course, factors independent of male development can confer performance advantages that enable exceptional female athletes to surpass the performances of relatively inferior male athletes. However, these factors are irrelevant to the fairness and justification of sex-based categorization, and it must be recognized that the size of the male biological advantage, and the number of males who compete in most sports, makes it extremely unlikely than any female would ever win medals at the highest level without the protection of a closed category that excludes male advantage, as illustrated in Figure 2.

An often-heard claim that male advantage is only one of many advantages is, in fact, an argument for the abolition of sex categories and, by logical extension, their replacement with a single open category or categorization based on performance. This is akin to suggesting that in combat sports, heavyweight advantages could be allowed in the lightweight category if other factors ensure close competition. Such reasoning undermines the purpose of categories, which is to establish a fair and safe basis for competition. We note with significant concern that USA Boxing, on referring to the IOC framework, currently allows transgender women to compete in the female category as long as their testosterone levels have been below 5 nmol/L for 48 months.[67] This is despite the statement from the Association of Ringside Physicians, who do not support transgender women competing against female athletes in combat sports,[68] and contradicts USA Boxing's claim that their overriding objective is the safety of all boxers and fair competition between all boxers.

6 | THE FRAMEWORK'S RECOMMENDATIONS FOR IMPLEMENTATION ARE UNREALISTIC AND UNWORKABLE IN PRACTICE

The IOC framework states that eligibility criteria for sex-based categorization should be based on evidence of a

16000838, 2024, 3, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.14581 by Sheffield Hallam University, Wiley Online Library on [26/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

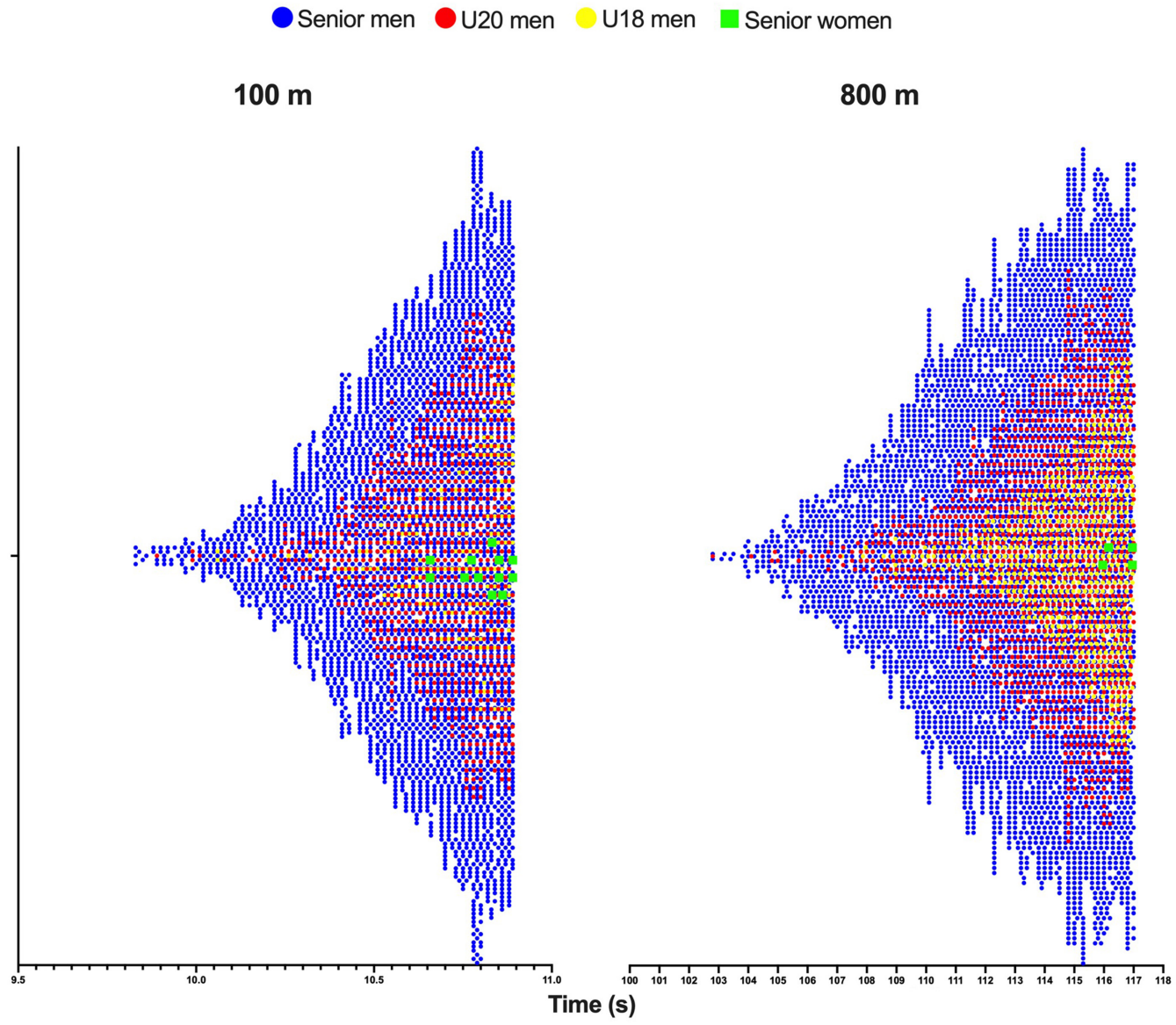

FIGURE 2 Performance differences in athletics. Performances under 10.90 s in the 100-m and under 1:57.00 (117.0 s) in the 800-m running events in 2023. The 100-m times include the top 12 women in the world rankings and 5150 men, including men competing at U18 and U20 level. The 800-m times include the top 4 women in the world rankings and 6780 men, including U18 and U20 male athletes. The list was compiled on the basis of open source information from World Athletics, which is available online.[85]

consistent, disproportionate competitive advantage. As previously mentioned, this evidence is already well documented in the scientific literature and shows a major athletic advantage of being male, which is acquired during male development and forms the basis for sex categorization. Furthermore, these male advantages are not lost with short- or long-term testosterone suppression,[25,46,69] rendering point-in-time testosterone measurements largely meaningless.

The IOC framework also recommends that relevant evidence of competitive advantage should be available for the specific sport, discipline, and event that the eligibility criteria aim to regulate. While we agree that further research on transgender athletes is important for many reasons, including our ability to provide health care and other sports performance support, it is extremely unlikely that such well-controlled, methodologically robust, peer-reviewed evidence on transgender athletes in specific sports will be available in sufficient quantity for many years or possibly, if the elite categorization and specific sport discipline is a strict requirement, ever. While decisions should be informed by the best available research, the calls for direct performance related research in controlled trials using trained transgender athletes are a misapplication of the criteria of evidence-based medicine to a context for which they were never intended and should not be prescribed. The absence of such specific evidence should not be misconstrued as a lack of knowledge or an

16000838, 2024, 3, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.14581 by Sheffield Hallam University, Wiley Online Library on [26/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

inability to draw informed conclusions about sex-based advantages in sport.

While the recommendation for international federations to provide sport-specific data on transgender athletes may be encouraged in the longer term, this recommendation is not helpful to the more immediate task of creating evidence-based eligibility criteria for the female category. Small observational cohort studies of sub-elite runners[70] and military personnel using basic fitness testing[71,72] have been performed; however, these studies include small numbers of participants, have significant dropouts, lack controls for performance times, and have issues regarding the validity of targeted performance tests for maximal performance. Such studies cannot be used in isolation to inform sports policy, particularly when the overwhelming body of evidence suggests that the effects of testosterone suppression on critical metrics like body size, limb length, muscle mass, and strength are small and that male development, and thus male advantage, cannot be reversed. Therefore, we contend that the current body of evidence demonstrating male biological advantage and the lack of evidence for its removal with testosterone suppression provides a compelling basis for sports to adopt a policy that upholds sex-segregated competition to ensure fairness and safety for female athletes.

7 | CASE-BY-CASE CONSIDERATION IS FLAWED IN PRINCIPLE AND UNLIKELY TO BE PRACTICAL OR ROBUST

The IOC framework highlights the need to protect against "disproportionate advantage" (i.e., where the physical or performance metrics of a transgender woman are beyond the typical range found in the female field), and case-by-case assessment has been suggested as a possible solution to this. However, a case-by-case assessment would exclude some transgender women, leading to the potential stigmatization of those who do not meet eligibility criteria. This approach could create negative connotations around what should be considered an "acceptably feminine" body, and body dissatisfaction already plays a prominent role in gender dysphoria.[73–75] It likely encourages unhealthy behaviors, such as attempts to fall below weight and strength thresholds.[76] It would also be impossible, particularly in sub-elite sport and through performance pathways from lower level to elite sports, to administer the tests in a workable manner and guarantee accurate and reliable results. In sports where safety is a paramount concern, it would also obligate authorities to rely on imprecise tests with limited predictive accuracy, thereby exposing them to potential liability for adverse outcomes post-clearance.

Adopting a case-by-case approach would require that transgender women who meet the eligibility criteria ensure that performance gains from training do not exceed the test criteria to jeopardize their previously approved eligibility. Athletes would be required to participate in performance testing after training blocks, while in peak physical condition, to ensure they are not too fast or strong for the upcoming competition. This scenario creates a disincentive for training and performance that puts these athletes in opposition to the aspirational Olympic motto "Faster, Higher, Stronger." Thus, case-by-case consideration is flawed in principle, has immense practical limitations, is potentially stigmatizing and unhealthy, would limit the inclusion of all transgender athletes, and would not ensure fair or safe competition.

8 | FEMALE ATHLETES AT ALL LEVELS OF SPORT DESERVE ACCESS TO FAIR COMPETITION

The IOC's fairness principle focuses on "elite-level competition." However, eligibility criteria for sex-segregated competition should not be reserved for elite competition only. While grassroots and amateur sporting organizations can and should create opportunities for transgender athlete participation, this should not be at the expense of a protected female category. Fair and safe competition in sports is a core value for athletes at every level of sport and should be available for all female athletes. There are already significant barriers to sport participation for females, and adolescent female dropout from sports is high.[77,78] Grassroots and amateur sports also provide important pathways to elite levels. These issues of barriers to sports participation for females and access to sporting pathways are not mentioned in the IOC framework.

9 | FEMALE ATHLETES ARE PRIMARY STAKEHOLDERS AND MUST BE CONSULTED

The international human rights framework[79] and the Olympic Charter[80] have established strong, explicit protections against discrimination and the right to equal opportunity for females based on sex. We commend the IOC for their significant advances in promoting and supporting female sport, and we note that almost 49% of athletes participating at the Tokyo Olympics were female.[81]

Although gender identity is not explicitly referred to in the Olympic Charter, we agree that everyone should be welcome in sports, regardless of gender identity. However, this does not entail a right to compete in opposite-sex

16000838, 2024, 3, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.14581 by Sheffield Hallam University, Wiley Online Library on [26/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

categories, as this conflicts with the established human right of female athletes to nondiscrimination and equal opportunities based on sex. Furthermore, eligibility for opposite-sex categories based only on gender identity has an asymmetrical impact on equal opportunities for female athletes at all levels, compared to the effects on male athletes that would result from including transgender men in the male category.[82]

Finally, the fundamental human right to freedom of expression has demonstrably been constrained for female athletes in this discussion. Females have often been excluded from policy development in this area, despite being directly affected, majority stakeholders. The IOC position statement states that the athletes "most directly impacted by eligibility criteria" are transgender athletes and/or athletes with sex variations, while—remarkably—female athletes are not identified as stakeholders.[2] Many female athletes have expressed fearfulness in voicing their concerns within their sporting organizations, and resistance to eligibility for female categories based on gender identity rather than sex.[83,84] The IOC must consider the rights and opinions of all stakeholders, explicitly including female athletes as primary stakeholders. Female athletes should be able to speak freely, without fear of reprisal or punishment. This requires assurances that a "safe space," and anonymity in which to share their concerns are provided in the development of any policy on this issue.

10 | PERSPECTIVES

The IOC framework on fairness, inclusion and nondiscrimination on the basis of gender identity and sex variations is misaligned with current scientific and medical evidence and offers insufficient protection of fair competition for female athletes within a female category. Also, it does not adequately engage female athletes, who are primary stakeholders in their sport. Male pubertal development results in large performance advantages in athletic sports, which necessitates a female category that excludes male advantages, to ensure equal opportunity through fair competition for female athletes at all levels of sport. There is currently no evidence that testosterone suppression in transgender women can reverse male development and negate male advantages. In contrast, there is convincing evidence that the male advantage persists even when testosterone is suppressed. As a result, sports face the uncomfortable reality that the inclusion of transgender women in female sports categories cannot be reconciled with fairness, and in some instances safety, for females in athletic sports. The IOC must reconsider its framework and revise the 10 principles to reflect scientific evidence and fundamental principles of fair competition. We also recommend implementing a system to enable female stakeholders to be consulted in this matter and to have their voices heard, recognized, and valued.

AFFILIATIONS

[1]Division of Clinical Physiology, Department of Laboratory Medicine, Karolinska Institutet, Stockholm, Sweden
[2]Department of Sport Science, Institute of Sport and Exercise Medicine, University of Stellenbosch, Stellenbosch, South Africa
[3]Department of Health Sciences, Swedish Winter Sports Research Centre, Mid Sweden University, Östersund, Sweden
[4]Manchester Metropolitan Institute of Sport, Manchester Metropolitan University, Manchester, UK
[5]Institute of Sport, Exercise and Health, University College London, London, UK
[6]Applied Sports, Technology, Exercise and Medicine Research Centre (A-STEM), Faculty of Science and Engineering, Swansea University, Swansea, UK
[7]Institute of Sport Sciences, University of Lausanne, Lausanne, Switzerland
[8]Department of Neuromedicine and Movement Science, Centre for Elite Sports Research, Norwegian University of Science and Technology, Trondheim, Norway
[9]Sport, Exercise and Rehabilitation, Faculty of Health and Life Sciences, Northumbria University, Newcastle upon Tyne, UK
[10]Water Research Group, North West University, Potchefstroom, South Africa
[11]Department of Kinesiology and Sport Sciences, University of Nebraska at Kearney, Kearney, Nebraska, USA
[12]The Carlson Laboratory, Portland, Maine, USA
[13]Carnegie School of Sport, Leeds Beckett University, Leeds, UK
[14]School of Health and Life Sciences, Teesside University, Middlesbrough, UK
[15]Centre for Public Health, Institute of Clinical Sciences, Queen's University Belfast, Belfast, UK
[16]School of Medicine, Keele University, Newcastle-under-Lyme, UK
[17]Sport and Physical Activity Research Centre, Sheffield Hallam University, Sheffield, UK
[18]Physical Activity for Health Research Centre, Moray House School of Education and Sport, University of Edinburgh, Edinburgh, UK
[19]Centre for Exercise Medicine, Physical Activity and Health, School of Sport, Ulster University, Belfast, UK
[20]Division of Surgery and Interventional Science, University College London, London, UK
[21]School of Sport, Exercise and Rehabilitation Sciences, University of Birmingham, Birmingham, UK
[22]School of Social Sciences, Humanities and Law, Teesside University, Middlesbrough, UK
[23]Department of Physical Education and Sport, University of the Basque Country UPV/EHU, Vitoria-Gasteiz, Spain
[24]Department of Public Health, Aarhus University, Aarhus, Denmark
[25]Department of Kinesiology, McMaster University, Hamilton, Ontario, Canada
[26]Independent, Manchester, UK
[27]Cardiff School of Sport and Health Sciences, Cardiff Metropolitan University, Cardiff, UK
[28]Department of Philosophy, Faculty of Arts and Social Sciences, The Open University, Milton Keynes, UK
[29]School of Biological Sciences, University of Manchester, Manchester, UK

16000838, 2024, 3, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.14581 by Sheffield Hallam University, Wiley Online Library on [26/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

ACKNOWLEDGEMENTS

Tommy Lundberg has been granted a license to publish Figure 1 created by BioRender.com.

CONFLICT OF INTEREST STATEMENT

TRL has received payment to provide expert testimony related to this research for USA Powerlifting and the State of Indiana. RT has received payment for consultation work with World Rugby, including the development of their current transgender policy. For advocating for this body of research, he has been reimbursed for travel expenses and accommodation costs from the Independent Council on Women's Sports. GH has received payment for consultation work relating to sports performance in males and females from FIFA, The FA, GlaxoSmithKline, PepsiCo, and the English Institute of Sport. AGW and GKS are the recipients of project funding from the IOC Medical and Scientific Research Fund (RBU/cftr/2021-31). GAB has received payment to provide expert testimony related to this research for the State of Idaho, the State of West Virginia, the State of Tennessee, the State of Arizona, the State of Florida, and the American Civil Liberties Union. For a presentation regarding this body of research, he has received an honorarium from the Alliance Defending Freedom. CD has received funding for consultation work and contract research activities from Sport Canada. She is an unpaid Director of Woman's Place UK Ltd, UK (company number 13308625; appointed December 2022). JP has received payment to provide expert testimony related to this research for USA Powerlifting and the State of Utah. For advocating for this body of research, he has been reimbursed for travel expenses and accommodation costs from the Independent Council on Women's Sports. He is an unpaid member of the Advisory Group for Sex Matters. ENH has received payment to provide expert testimony related to this research for USA Powerlifting, the State of Indiana and the State of Utah. She is an unpaid Director of Sex Matters Ltd, UK (company number 12974690; appointed January 2021). For advocating for this body of research, she has been reimbursed for travel expenses from the UK House of Lords, and for travel expenses and accommodation costs from the Independent Council on Women's Sports. SMP reports personal fees from Nestle Health Sciences, nonfinancial support from Enhanced Recovery, and patents licensed to Exerkine but reports no financial gains from patents or related work. The other authors declare they have no conflict of interest.

FUNDING INFORMATION

No funding was received for this manuscript.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ORCID

Tommy R. Lundberg https://orcid.org/0000-0002-6818-6230
Ross Tucker https://orcid.org/0000-0002-4294-4822
Kerry McGawley https://orcid.org/0000-0002-1273-6061
Alun G. Williams https://orcid.org/0000-0002-8052-8184
Grégoire P. Millet https://orcid.org/0000-0001-8081-4423
Øyvind Sandbakk https://orcid.org/0000-0002-9014-5152
Glyn Howatson https://orcid.org/0000-0001-8494-2043
Gregory A. Brown https://orcid.org/0000-0002-9928-217X
Lara A. Carlson https://orcid.org/0009-0000-3526-0652
Sarah Chantler https://orcid.org/0000-0003-3215-092X
Mark A. Chen https://orcid.org/0000-0003-3605-2198
Shane M. Heffernan https://orcid.org/0000-0002-3297-9335
Neil Heron https://orcid.org/0000-0002-4123-9806
Christopher Kirk https://orcid.org/0000-0002-6207-027X
Marie H. Murphy https://orcid.org/0000-0003-3482-3323
Noel Pollock https://orcid.org/0000-0003-4660-2835
Andrew Richardson https://orcid.org/0000-0001-7184-5930
Jordan Santos-Concejero https://orcid.org/0000-0001-9467-525X
Georgina K. Stebbings https://orcid.org/0000-0003-0706-2864
Ask Vest Christiansen https://orcid.org/0000-0001-6115-6314
Stuart M. Phillips https://orcid.org/0000-0002-1956-4098
Cathy Devine https://orcid.org/0000-0002-2652-0771
Carwyn Jones https://orcid.org/0000-0003-0033-8098
Jon Pike https://orcid.org/0000-0002-2874-1180
Emma N. Hilton https://orcid.org/0000-0002-3750-577X

REFERENCES

1. IOC. IOC Framework Fairness Inclusion Non-Discrimination on Basis Gender Identity Sex Variations. 2021. Accessed August, 21 2023. https://olympics.com/ioc/documents/athletes/ioc-framework-on-fairness-inclusion-and-non-discrimination-on-the-basis-of-gender-identity-and-sex-variations
2. Martowicz M, Budgett R, Pape M, et al. Position statement: IOC framework on fairness, inclusion and non-discrimination on the basis of gender identity and sex variations. *Br J Sports Med*. 2023;57(1):26-32. doi:10.1136/bjsports-2022-106386
3. Almeida M, Laurent MR, Dubois V, et al. Estrogens and androgens in skeletal physiology and pathophysiology. *Physiol Rev*. 2017;97(1):135-187. doi:10.1152/physrev.00033.2015
4. Fischer B, Mitteroecker P. Allometry and sexual dimorphism in the human pelvis. *Anat Rec (Hoboken)*. 2017;300(4):698-705. doi:10.1002/ar.23549
5. Jelenkovic A, Sund R, Hur YM, et al. Genetic and environmental influences on height from infancy to early adulthood: an individual-based pooled analysis of 45 twin cohorts. *Sci Rep*. 2016;6:28496. doi:10.1038/srep28496

16000838, 2024, 3, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.14581 by Sheffield Hallam University, Wiley Online Library on [26/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

6. Haizlip KM, Harrison BC, Leinwand LA. Sex-based differences in skeletal muscle kinetics and fiber-type composition. *Physiology (Bethesda)*. 2015;30(1):30-39. doi:10.1152/physiol.00024.2014
7. Wells JCK. Sexual dimorphism of body composition. *Best Pract Res Clin Endocrinol Metab*. 2007;21(3):415-430. doi:10.1016/j.beem.2007.04.007
8. Herbst KL, Bhasin S. Testosterone action on skeletal muscle. *Curr Opin Clin Nutr Metab Care*. 2004;7(3):271-277. doi:10.1097/00075197-200405000-00006
9. Brown M. Skeletal muscle and bone: effect of sex steroids and aging. *Adv Physiol Educ*. 2008;32(2):120-126. doi:10.1152/advan.90111.2008
10. Townsend EA, Miller VM, Prakash YS. Sex differences and sex steroids in lung health and disease. *Endocr Rev*. 2012;33(1):1-47. doi:10.1210/er.2010-0031
11. Harms CA. Does gender affect pulmonary function and exercise capacity? *Respir Physiol Neurobiol*. 2006;151(2–3):124-131. doi:10.1016/j.resp.2005.10.010
12. Blair ML. Sex-based differences in physiology: what should we teach in the medical curriculum? *Adv Physiol Educ*. 2007;31(1):23-25. doi:10.1152/advan.00118.2006
13. St Pierre SR, Peirlinck M, Kuhl E. Sex matters: a comprehensive comparison of female and male hearts. *Front Physiol*. 2022;13:831179. doi:10.3389/fphys.2022.831179
14. Warren AM, Grossmann M. Haematological actions of androgens. *Best Pract Res Clin Endocrinol Metab*. 2022;36(5):101653. doi:10.1016/j.beem.2022.101653
15. Hiort O. Androgens and puberty. *Best Pract Res Clin Endocrinol Metab*. 2002;16(1):31-41. doi:10.1053/beem.2002.0178
16. Richmond EJ, Rogol AD. Male pubertal development and the role of androgen therapy. *Nat Clin Pract Endocrinol Metab*. 2007;3(4):338-344. doi:10.1038/ncpendmet0450
17. Senefeld JW, Lambelet Coleman D, Johnson PW, Carter RE, Clayburn AJ, Joyner MJ. Divergence in timing and magnitude of testosterone levels between male and female youths. *JAMA*. 2020;324(1):99-101. doi:10.1001/jama.2020.5655
18. Handelsman DJ, Hirschberg AL, Bermon S. Circulating testosterone as the hormonal basis of sex differences in athletic performance. *Endocr Rev*. 2018;39(5):803-829. doi:10.1210/er.2018-00020
19. Bellott DW, Hughes JF, Skaletsky H, et al. Mammalian Y chromosomes retain widely expressed dosage-sensitive regulators. *Nature*. 2014;508(7497):494-499. doi:10.1038/nature13206
20. Lanciotti L, Cofini M, Leonardi A, Penta L, Esposito S. Up-to-date review about minipuberty and overview on hypothalamic-pituitary-gonadal axis activation in fetal and neonatal life. *Front Endocrinol (Lausanne)*. 2018;9:410. doi:10.3389/fendo.2018.00410
21. Becker M, Hesse V. Minipuberty: why does it happen? *Horm Res Paediatr*. 2020;93(2):76-84. doi:10.1159/000508329
22. Pigozzi F, Bigard X, Steinacker J, et al. Joint position statement of the International Federation of Sports Medicine (FIMS) and European Federation of Sports Medicine Associations (EFSMA) on the IOC framework on fairness, inclusion and non-discrimination based on gender identity and sex variations. *BMJ Open Sport Exerc Med*. 2022;8(1):e001273. doi:10.1136/bmjsem-2021-001273
23. Thibault V, Guillaume M, Berthelot G, et al. Women and men in sport performance: the gender gap has not evolved since 1983. *J Sports Sci Med*. 2010;9(2):214-223.
24. Sandbakk Ø, Solli GS, Holmberg HC. Sex differences in world-record performance: the influence of sport discipline and competition duration. *Int J Sports Physiol Perform*. 2018;13(1):2-8. doi:10.1123/ijspp.2017-0196
25. Hilton EN, Lundberg TR. Transgender women in the female category of sport: perspectives on testosterone suppression and performance advantage. *Sports Med*. 2021;51(2):199-214. doi:10.1007/s40279-020-01389-3
26. Hunter SK, Angadi SS, Bhargava A, et al. The biological basis of sex differences in athletic performance: consensus statement for the American College of Sports Medicine. *Med Sci Sports Exerc*. 2023;55:2328-2360. doi:10.1249/MSS.0000000000003300
27. Millard-Stafford M, Swanson AE, Wittbrodt MT. Nature versus nurture: have performance gaps between men and women reached an asymptote? *Int J Sports Physiol Perform*. 2018;13(4):530-535. doi:10.1123/ijspp.2017-0866
28. Sakamoto K, Sasaki R, Hong S, Matsukura K, Asai T. Comparison of kicking speed between female and male soccer players. *Procedia Eng*. 2014;72:50-55. doi:10.1016/j.proeng.2014.06.011
29. Barfield WR, Kirkendall DT, Yu B. Kinematic instep kicking differences between elite female and male soccer players. *J Sports Sci Med*. 2002;1(3):72-79.
30. USA Powerlifting Records. Accessed March 3, 2023. https://www.usapowerlifting.com/records/
31. Valadés D, Palao JM, Aúnsolo Á, Ureña A. Correlation between ball speed of the spike and the strength condition of a professional women's volleyball team during the season. *Kinesiology*. 2016;48(1):87-94. doi:10.26582/k.48.1.7
32. Forthomme B, Croisier JL, Ciccarone G, Crielaard JM, Cloes M. Factors correlated with volleyball spike velocity. *Am J Sports Med*. 2005;33(10):1513-1519. doi:10.1177/0363546505274935
33. Miller AE, MacDougall JD, Tarnopolsky MA, Sale DG. Gender differences in strength and muscle fiber characteristics. *Eur J Appl Physiol Occup Physiol*. 1993;66(3):254-262. doi:10.1007/BF00235103
34. Stoll T, Huber E, Seifert B, Michel BA, Stucki G. Maximal isometric muscle strength: normative values and gender-specific relation to age. *Clin Rheumatol*. 2000;19(2):105-113. doi:10.1007/s100670050026
35. Thurlbeck WM. Postnatal human lung growth. *Thorax*. 1982;37(8):564-571. doi:10.1136/thx.37.8.564
36. Morais JE, Barbosa TM, Nevill AM, Cobley S, Marinho DA. Understanding the role of propulsion in the prediction of front-crawl swimming velocity and in the relationship between stroke frequency and stroke length. *Front Physiol*. 2022;13:876838. doi:10.3389/fphys.2022.876838
37. Hopker J, Jobson S, Carter H, Passfield L. Cycling efficiency in trained male and female competitive cyclists. *J Sports Sci Med*. 2010;9(2):332-337.
38. Slawinski J, Termoz N, Rabita G, et al. How 100-m event analyses improve our understanding of world-class men's and women's sprint performance. *Scand J Med Sci Sports*. 2017;27(1):45-54. doi:10.1111/sms.12627
39. Schmidt W, Prommer N. Impact of alterations in total hemoglobin mass on VO2max. *Exerc Sport Sci Rev*. 2010;38(2):68-75. doi:10.1097/JES.0b013e3181d4957a
40. McDowell MA, Fryar CD, Ogden CL. Anthropometric reference data for children and adults: United States, 1988-1994. *Vital Health Stat*. 2009;11(249):1-68.

16000838, 2024, 3, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.14581 by Sheffield Hallam University, Wiley Online Library on [26/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

41. Parry J, Martínková I. The logic of categorisation in sport. *Eur J Sport Sci*. 2021;21(11):1485-1491. doi:10.1080/17461391.2021.1943715
42. Coleman DL. Sex in sport. *Law Contemp Probl*. 2017;80:63-126.
43. Clark RV, Wald JA, Swerdloff RS, et al. Large divergence in testosterone concentrations between men and women: frame of reference for elite athletes in sex-specific competition in sports, a narrative review. *Clin Endocrinol (Oxf)*. 2019;90(1):15-22. doi:10.1111/cen.13840
44. Wiik A, Lundberg TR, Rullman E, et al. Muscle strength, size and composition following 12 months of gender-affirming treatment in transgender individuals. *J Clin Endocrinol Metabol*. 2020;105(3):247. doi:10.1210/clinem/dgz247
45. Franke WW, Berendonk B. Hormonal doping and androgenization of athletes: a secret program of the German Democratic Republic government. *Clin Chem*. 1997;43(7):1262-1279.
46. Harper J, O'Donnell E, Sorouri Khorashad B, McDermott H, Witcomb GL. How does hormone transition in transgender women change body composition, muscle strength and haemoglobin? Systematic review with a focus on the implications for sport participation. *Br J Sports Med*. 2021;55(15):865-872. doi:10.1136/bjsports-2020-103106
47. Gooren LJG, Bunck MCM. Transsexuals and competitive sports. *Eur J Endocrinol*. 2004;151(4):425-429. doi:10.1530/eje.0.1510425
48. Haraldsen IR, Haug E, Falch J, Egeland T, Opjordsmoen S. Cross-sex pattern of bone mineral density in early onset gender identity disorder. *Horm Behav*. 2007;52(3):334-343. doi:10.1016/j.yhbeh.2007.05.012
49. Mueller A, Zollver H, Kronawitter D, et al. Body composition and bone mineral density in male-to-female transsexuals during cross-sex hormone therapy using gonadotrophin-releasing hormone agonist. *Exp Clin Endocrinol Diabetes*. 2011;119(2):95-100. doi:10.1055/s-0030-1255074
50. Wierckx K, Van Caenegem E, Schreiner T, et al. Cross-sex hormone therapy in trans persons is safe and effective at short-time follow-up: results from the European network for the investigation of gender incongruence. *J Sex Med*. 2014;11(8):1999-2011. doi:10.1111/jsm.12571
51. Gava G, Cerpolini S, Martelli V, Battista G, Seracchioli R, Meriggiola MC. Cyproterone acetate vs leuprolide acetate in combination with transdermal oestradiol in transwomen: a comparison of safety and effectiveness. *Clin Endocrinol (Oxf)*. 2016;85(2):239-246. doi:10.1111/cen.13050
52. Auer MK, Ebert T, Pietzner M, et al. Effects of sex hormone treatment on the metabolic syndrome in transgender individuals: focus on metabolic cytokines. *J Clin Endocrinol Metab*. 2018;103(2):790-802. doi:10.1210/jc.2017-01559
53. Klaver M, de Blok CJM, Wiepjes CM, et al. Changes in regional body fat, lean body mass and body shape in trans persons using cross-sex hormonal therapy: results from a multicenter prospective study. *Eur J Endocrinol*. 2018;178(2):163-171. doi:10.1530/EJE-17-0496
54. Fighera TM, da Silva E, Lindenau JDR, Spritzer PM. Impact of cross-sex hormone therapy on bone mineral density and body composition in transwomen. *Clin Endocrinol (Oxf)*. 2018;88(6):856-862. doi:10.1111/cen.13607
55. Scharff M, Wiepjes CM, Klaver M, Schreiner T, T'Sjoen G, den Heijer M. Change in grip strength in trans people and its association with lean body mass and bone density. *Endocr Connect*. 2019;8(7):1020-1028. doi:10.1530/EC-19-0196
56. Tack LJW, Craen M, Lapauw B, et al. Proandrogenic and antiandrogenic progestins in transgender youth: differential effects on body composition and bone metabolism. *J Clin Endocrinol Metab*. 2018;103(6):2147-2156. doi:10.1210/jc.2017-02316
57. Van Caenegem E, Wierckx K, Taes Y, et al. Preservation of volumetric bone density and geometry in trans women during cross-sex hormonal therapy: a prospective observational study. *Osteoporos Int*. 2015;26(1):35-47. doi:10.1007/s00198-014-2805-3
58. Nuzzo JL. Narrative review of sex differences in muscle strength, endurance, activation, size, fiber type, and strength training participation rates, preferences, motivations, injuries, and neuromuscular adaptations. *J Strength Cond Res*. 2023;37(2):494-536. doi:10.1519/JSC.0000000000004329
59. Lapauw B, Taes Y, Simoens S, et al. Body composition, volumetric and areal bone parameters in male-to-female transsexual persons. *Bone*. 2008;43(6):1016-1021. doi:10.1016/j.bone.2008.09.001
60. Alvares LAM, Santos MR, Souza FR, et al. Cardiopulmonary capacity and muscle strength in transgender women on long-term gender-affirming hormone therapy: a cross-sectional study. *Br J Sports Med*. 2022;56(22):1292-1298. doi:10.1136/bjsports-2021-105400
61. Bretherton I, Spanos C, Leemaqz SY, et al. Insulin resistance in transgender individuals correlates with android fat mass. *Ther Adv Endocrinol Metab*. 2021;12:2042018820985681. doi:10.1177/2042018820985681
62. Schmidt W, Prommer N. Effects of various training modalities on blood volume. *Scand J Med Sci Sports*. 2008;18(Suppl 1):57-69. doi:10.1111/j.1600-0838.2008.00833.x
63. Kvorning T, Andersen M, Brixen K, Madsen K. Suppression of endogenous testosterone production attenuates the response to strength training: a randomized, placebo-controlled, and blinded intervention study. *Am J Physiol Endocrinol Metab*. 2006;291(6):E1325-E1332. doi:10.1152/ajpendo.00143.2006
64. Chen Z, Zhang Y, Lu C, Zeng H, Schumann M, Cheng S. Supervised physical training enhances muscle strength but not muscle mass in prostate cancer patients undergoing androgen deprivation therapy: a systematic review and meta-analysis. *Front Physiol*. 2019;10:843. doi:10.3389/fphys.2019.00843
65. Senefeld JW, Hunter SK, Coleman D, Joyner MJ. Case studies in physiology: male to female transgender swimmer in college athletics. *J Appl Physiol*. 2023;134(4):1032-1037. doi:10.1152/japplphysiol.00751.2022
66. Pike J. Why 'meaningful competition' is not fair competition. *J Philos Sport*. 2023;50(1):1-17. doi:10.1080/00948705.2023.2167720
67. USA Boxing. USA Boxing Transgender Policy. 2022. Accessed January 4, 2024. https://www.nationalreview.com/wp-content/uploads/2023/12/Oct22USA-Boxing-Transgender-Policy.pdf
68. Bascharon R, Sethi NK, Estevez R, et al. Transgender competition in combat sports: position statement of the association of ringside physicians. *Phys Sportsmed*. 2023;1-8. doi:10.1080/00913847.2023.2286943
69. Nokoff NJ, Senefeld J, Krausz C, Hunter S, Joyner M. Sex differences in athletic performance: perspectives on transgender athletes. *Exerc Sport Sci Rev*. 2023;51(3):85-95. doi:10.1249/JES.0000000000000317

16000838, 2024, 3, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.14581 by Sheffield Hallam University, Wiley Online Library on [26/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

70. Harper J. Race times for transgender athletes. *J Sport Cult Identities*. 2015;6:1-9. doi:10.18848/2381-6678/CGP/v06i01/54079
71. Roberts TA, Smalley J, Ahrendt D. Effect of gender affirming hormones on athletic performance in transwomen and transmen: implications for sporting organisations and legislators. *Br J Sports Med*. 2021;55:577-583. doi:10.1136/bjsports-2020-102329
72. Chiccarelli E, Aden J, Ahrendt D, Smalley J. Fit transitioning: when can transgender airmen fitness test in their affirmed gender? *Mil Med*. 2023;188, 7/8:e1588. doi:10.1093/milmed/usac320
73. Milano W, Ambrosio P, Carizzone F, De Biasio V, Foggia G, Capasso A. Gender dysphoria, eating disorders and body image: an overview. *Endocr Metab Immune Disord Drug Targets*. 2020;20(4):518-524. doi:10.2174/1871530319666191015193120
74. Jones BA, Haycraft E, Murjan S, Arcelus J. Body dissatisfaction and disordered eating in trans people: a systematic review of the literature. *Int Rev Psychiatry*. 2016;28(1):81-94. doi:10.3109/09540261.2015.1089217
75. Muratore LA, Flentje A, Schuster D, Capriotti MR. Disordered eating and body dissatisfaction in transgender and gender-expansive adults: an evaluation and integration of the gender minority stress and resilience and tripartite influence models. *Behav Ther*. 2022;53(5):869-886. doi:10.1016/j.beth.2022.02.006
76. Burke LM, Slater GJ, Matthews JJ, Langan-Evans C, Horswill CA. ACSM expert consensus statement on weight loss in weight-category sports. *Curr Sports Med Rep*. 2021;20(4):199-217. doi:10.1249/JSR.0000000000000831
77. Hopkins CS, Hopkins C, Kanny S, Watson A. A systematic review of factors associated with sport participation among adolescent females. *Int J Environ Res Public Health*. 2022;19(6):3353. doi:10.3390/ijerph19063353
78. Back J, Stenling A, Solstad BE, et al. Psychosocial predictors of drop-out from organised sport: a prospective study in adolescent soccer. *Int J Environ Res Public Health*. 2022;19(24):16585. doi:10.3390/ijerph192416585
79. The Core International Human Rights Instruments and Their Monitoring Bodies. OHCHR. Accessed February 14, 2023. https://www.ohchr.org/en/core-international-human-rights-instruments-and-their-monitoring-bodies
80. Olympic Charter. International Olympic Committee. 2023. Accessed February 14, 2023. https://olympics.com/ioc/olympic-charter
81. Gender Equality Through Time: At the Olympic Games. Accessed August 21, 2023. https://olympics.com/ioc/gender-equality/gender-equality-through-time/at-the-olympic-games
82. Devine C. Female sports participation, gender identity and the British 2010 equality act. *Sport Ethics Philos*. 2022;16(4):503-525. doi:10.1080/17511321.2021.1993982
83. Devine C. Female Olympians' voices: female sports categories and International Olympic Committee transgender guidelines. *Int Rev Sociol Sport*. 2022;57(3):335-361. doi:10.1177/10126902211021559
84. Carbmill Consulting. SCEG Project for Review and Redraft of Guidance for Transgender Inclusion in Domestic Sport 2021. 2021. Accessed August 21, 2023. https://equalityinsport.org/docs/300921/Project%20Report%20on%20the%20Review%20of%20the%20Guidance%20for%20Transgender%20Inclusion%20in%20Domestic%20Sport%202021.pdf
85. World Athletics Records. Accessed January 4, 2024. https://worldathletics.org/records/toplists/sprints/100-metres/all/men/senior/2023?regionType=world&timing=electronic&windReading=regular&page=1&bestResultsOnly=true&maxResultsByCountry=all&eventId=10229630&ageCategory=senior

16000838, 2024, 3, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/sms.14581 by Sheffield Hallam University, Wiley Online Library on [26/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License