

ILLUSTRATION BY JONAS BERGSTRAND

THE FUTURE OF SEX IN ELITE SPORT

Sex has long been used to divide many sporting competitions in the name of fairness, but are the current rules and enforcement practices fit for purpose?

By Julianna Photopoulos

In the excitement of leaving for the 1985 World University Games in Kobe, Japan, Spanish hurdler María José Martínez-Patiño forgot to pack her doctor-issued ‘certificate of femininity’. “You had to prove you were a woman in order to compete,” she explains. Without it, she had to take a simple biological test. But it produced an unexpected result, and so she had to take a more thorough test – one that would take months to process. The team physician advised her to fake an ankle injury to silence suspicion around why she was not running, so she sat in the stands with her foot bandaged and watched, wondering what the test result meant.

Sport has a long history of policing who counts as a woman. Blanket mandatory ‘sex verification’ testing was put in place at events in the 1960s (see ‘Policing sex’) – a time when women’s participation in sport was on the rise and many were making huge performance improvements. Concerns that men might be masquerading as women forced people competing in women’s events to undergo a demeaning visual and physical examination by a panel of doctors.

In 1968, the International Olympic Committee (IOC) adopted a different test to determine

sex, based on chromosomes. People usually have 46 chromosomes arranged in 23 pairs. One of these pairs differs depending on the biological sex of the individual: women typically have two X chromosomes, whereas men typically have an X and a Y. Genetic errors, mutations and interactions between DNA and hormones can, however, cause a panoply of exceptions to this arrangement. Although a person’s chromosomes might indicate one sex, their anatomy might suggest otherwise. This is known as intersex or differences of sex development (DSDs).

The chromosome-based test required by the IOC involved taking cells from inside the cheek. In a cell containing two X chromosomes, one chromosome is inactive and therefore shows up under the microscope as a dark spot in the nucleus, known as a Barr body. If the dark spot was not clearly identifiable, the result could then be checked by cataloguing the chromosomes present in a cell.

Martínez-Patiño’s chromosome testing revealed she was 46,XY – chromosomally male. Further examinations showed that although her outward features were typically female she had internal testes. Her cells, however, were unable to process the hormone testosterone in her body that would

otherwise produce typical male anatomy – a condition known as complete androgen insensitivity syndrome. “I was stunned,” she says.

Following the results, Martínez-Patiño was asked by her national federation to withdraw from sport quietly. But she made a different call, choosing instead to compete in the Spanish Athletics Championships in 1986. She paid the price afterwards, however, when her medical record was leaked to the media. “I lost everything,” she says. She was barred from competition and had her university fellowship, medals and records revoked. She lost her friends, fiancé, privacy and sense of self. “I felt guilty, like I was to blame for a genetic or medical matter,” she says.

But even then, she was not ready to give up. “You see yourself in the mirror every day. You grew up and developed as a woman – that does not change,” she says. “I was going to show I didn’t cheat anyone.” With the support of several scientists, Martínez-Patiño proved to the medical commission at what was then called the International Amateur Athletic Federation (IAAF) that she did not have any unfair advantage over other female athletes. In 1988, her licence to compete was restored, but it was too late for her Olympic dream. After failing to qualify for the 1992 Olympics in Barcelona by one-tenth of a second, she retired to focus on sports science.

Even before chromosome analysis was introduced to determine sex in sport, geneticists warned that it was unreliable, discriminatory and ill-suited for detecting people who might have an ‘unfair’ advantage in the women’s category. Reliance on the presence of multiple X chromosomes to signify being female would not, for example, identify the roughly 0.2% of men born with 47,XXY genetics. Similarly, it would not identify women with hormonal conditions that can cause them to have increased muscle, such as congenital adrenal hyperplasia.

Over the decades, sports governing bodies’ regulations have evolved in an effort to ensure that for a person to participate as a woman, they must be a “biological female”, says Stéphane Bermon, a sports physician and the director of health and science at World Athletics (formerly the IAAF) in Monaco. “The female classification in sports is a protected category,” he says. World Athletics’ current definition of a biological female is largely based on levels of testosterone. But some researchers doubt the validity of using testosterone to segregate athletes. More broadly, the process of sorting athletes by their sex has raised difficult questions around medical ethics and human rights that are a long way from being answered.

Martínez-Patiño was the first woman to

successfully challenge a disqualification from athletics on the grounds of sex. As a result, World Athletics ended blanket genetic sex testing in 1992, although it still investigates female athletes when competitors, coaches or the media raise questions. The IOC continued to routinely test for the *SRY* gene found on the Y chromosome until 2000. These tests have only ever been directed at women with non-typical sex characteristics or intersex traits, never at men, says Katrina Karkazis, a bioethicist at Yale University in New Haven, Connecticut.

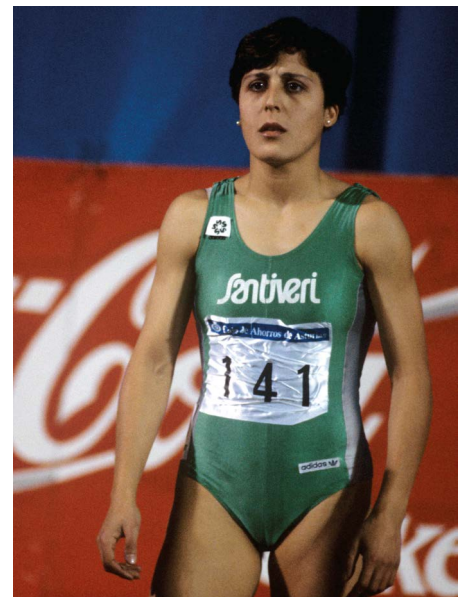
Changing regulations

DSDs are rare, but they have been found to be more common in female athletes than in women generally. A study¹ involving athletes who took part in the 2011 IAAF World Championships in Daegu, South Korea, found that about 7 in 1,000 female competitors were 46,XY – a prevalence that is around 140 times higher than in the general population.

Individuals with this genetic make-up can produce high levels of testosterone. Known as hyperandrogenism, this can also result from other conditions in women, such as polycystic ovary syndrome and congenital adrenal hyperplasia. Testosterone makes muscles bigger, strengthens bones and increases levels of oxygen-carrying haemoglobin in the blood. Its synthetic form is used in doping.

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The typical testosterone level in women ranges from 0.12 to 1.79 nanomoles per litre, whereas in adult men it ranges from 7.7 to 29.4 nanomoles per litre. This difference manifests after puberty, when men typically produce considerably more testosterone than do women. “Testosterone is the main driver explaining the difference between male and female performances,” says Bermon. In 2011, World Athletics became the first international sports federation to adopt regulations governing the competition eligibility of women with hyperandrogenism, stressing that it was not a form of sex testing. The move was triggered by controversy around the sex of South African middle-distance runner Caster Semenya in 2009, which forced her to withdraw from sport for 11 months. The rules adopted by World



Hurdler María José Martínez-Patiño in 1989.

Athletics meant that, to compete in women’s events, individuals had to lower their blood testosterone levels to below 10 nanomoles per litre by either hormone treatment or surgery. Martínez-Patiño, who was part of the IOC Medical Commission that adopted similar rules in 2012, says that although it was not a perfect solution it was an improvement on past attempts to ensure fairness in women’s sport.

However, the policy did not remain in force for long. In 2014, on the eve of the Commonwealth Games in Glasgow, UK, Indian sprinter Dutee Chand discovered that her blood testosterone level was above the 10-nanomole threshold. Rather than take the option of hormone therapy or surgery, as other athletes are thought to have done around this time², she instead chose to fight the ruling at the Court of Arbitration for Sport. In July 2015, the court found in her favour and gave World Athletics two years to present clearer scientific evidence that natural testosterone provides an athletic advantage. The hyperandrogenism rules were suspended, allowing Chand and women with DSDs to compete without restriction.

Controversial evidence

Attempts to use testosterone as a marker of whether an individual can compete in a women’s event or has an unfair sporting advantage have been the subject of much criticism.

One objection is that the typical testosterone ranges for men and women might not be as distinct as they first appear. A 2014 study³ of 693 elite female and male athletes across 15 sports found significant overlap in testosterone levels between the two groups. Around 14% of women had levels higher than what is

considered the typical female range – some even had levels considered high for a man. And around 17% of men had testosterone levels below the typical male range.

Another major concern is a lack of direct evidence linking high levels of testosterone in women to a competitive edge. Among elite athletes, competitors in men's categories seem to run or swim 10–12% faster than those competing in women's categories, and they jump 20% farther or higher. But it is not clear how much testosterone contributes to these differences. This uncertainty was central to the court's decision to uphold Chand's appeal.

In the case of women with DSDs, some anecdotal evidence supports the idea that elevated testosterone levels provide a benefit. Bermon notes that three distance runners who underwent hormone therapy saw their performance drop by nearly 6% over the course of two years, which he thinks suggests that testosterone has a significant role⁴. And David Handelsman, an endocrinologist at ANZAC Research Institute in Sydney, Australia, says that research⁵ involving transgender athletes shows that some people can continue to benefit from past testosterone levels – such as increased height and muscle mass – after hormone therapy.

In the wake of the Chand decision, Bermon and his colleague undertook a study to quantify the influence of testosterone on performance in elite athletes. Published in 2017, the study, which was funded by World Athletics and the World Anti-Doping Agency, found that elite female athletes with the highest testosterone levels performed as much as 3% better in events (including middle-distance races) than did those with the lowest levels⁶. These results formed the basis of new regulations in 2018, requiring women competing in certain events to have testosterone levels of below five nanomoles per litre for at least six months before a competition.

The study has been criticized, however. "It's deeply flawed," says Roger Pielke Jr, a sports governance and policy researcher at the University of Colorado Boulder, who has called



Sprinter Dutee Chand (right) fought a ruling that would have prevented her from competing.

DIBYANGSHU SARKAR/AFP VIA GETTY

for the study to be retracted⁷. "As many as one-third of the data were bad," Pielke says. For example, some performance times were duplicated, other times did not exist in the official competition results, and athletes disqualified for doping were included in the study data set. Bermon says he and his colleagues published a letter⁸ addressing some of these issues in 2018, but Pielke remains dissatisfied.

The 2018 regulations have also come under fire for being unduly discriminatory. Karkazis explains that the rules explicitly exclude women with high testosterone levels due to polycystic ovarian syndrome – the most common cause of high testosterone – and, following a 2019 court challenge, women with congenital adrenal hyperplasia. Now, they target only those with a Y chromosome who are sensitive to testosterone. Those individuals "have an innate physical advantage", says Handelsman.

In addition, the rules apply only to runners competing internationally in 400 metres to one-mile events. "It's bizarre," says Ross Tucker, a sports scientist in Cape Town, South

Africa. "An athlete would be legal on a Saturday and illegal on a Sunday just because she is running in a different event."

Karkazis also points out that the 2017 study⁶ showed a significant performance difference correlated with testosterone in 5 of the 21 events assessed, including hammer throw and pole vault. But these two events were excluded from the final regulations, whereas the 1,500 metres, for which a correlation was not seen, was included.

The details of the regulations have led some to question whether they are targeted at Semenya. Bermon denies this, saying that the limited number of cases in throwing events led World Athletics "to take a conservative approach" for these sports. He also acknowledges criticism about the decision to include the 1,500 metres, but says it was because athletes competing in middle-distance running often run the longer distance, too.

But the debate over what level of testosterone gives an advantage in which sports could be missing the point. Ruth Wood, an endocrinologist at the University of Southern California in

POLICING SEX A HISTORY OF SEX TESTING IN WOMEN'S SPORT

1936

US sprinter Helen Stephens undergoes an examination to verify her sex after journalists questioned her victory in the 100 metres at the Olympic Games in Berlin. The result of the unspecified test, which confirms she is a woman, is announced publicly.

1946

The International Amateur Athletic Federation (IAAF) requires individuals to have a medical certificate proving their eligibility to compete in women's events. The International Olympic Committee (IOC) adopts the same rule for the 1948 games.

1966

Women are subjected to nude inspections by a panel of physicians at the European Athletics Championships, and undergo gynaecological checks at the Commonwealth Games. The tests are unpopular, and some athletes choose not to compete.

1967

Chromosome testing is trialled at the European Cup. Polish sprinter Ewa Kłobukowska is the first to be disqualified as a result. The IOC adopts the tests for the 1968 Winter Olympics, at which Austrian skier Erik Schinegger (who was then living as a woman) is also disqualified.

1985

Spanish hurdler María José Martínez-Patiño is banned from competing after a chromosome test reveals she is 46,XY. She appeals on the grounds that she has androgen insensitivity syndrome and therefore gained no advantage. Her ban is lifted in 1988.

Los Angeles, argues that the issue is whether these naturally occurring hormones need to be regulated in athletics in the first place. “There are no other sports in which we deliberately limit an athlete’s natural abilities in service of some idea of fairness,” she says.

Special treatment

Tucker thinks that the impact testosterone can have makes regulation necessary. “Male attributes are such powerful contributors to performance that, if you didn’t control them, they would dominate and drown out all the other performance contributors,” he says. Wood acknowledges that testosterone improves athletic performance, but stresses that these women are not misrepresenting themselves or using performance-enhancing drugs. “They’ve always been women and they’re competing as women,” she says.

Alun Williams, a sports geneticist at Manchester Metropolitan University, UK, agrees that women with DSDs and hyperandrogenism should be treated no differently from those with any other genetic trait that increases athletic ability. Celebrated Finnish cross-country skier Eero Mäntyranta, who won three gold medals in the early 1960s, had a genetic mutation that increased his red blood cells’ oxygen-carrying capacity by 25–50%, Williams points out. “The mutations found in DSD athletes don’t affect performance to an exceptional degree,” he says.

Many commentators also question the ethics of policing an athlete’s sex. In 2019, the United Nations Human Rights Council condemned the 2018 regulations for failing to be “reasonable and objective”, and the World Medical Association urged physicians to take no part in implementing the new rules, arguing that they violate medical ethics and human rights. Both statements were led by contingents from South Africa, Semenya’s home country. “You are turning healthy people into patients, using protocols that have not been approved or studied for any medical purpose,” says Pielke.

He and others think that the scrutiny given to the sex of someone competing in women’s events is about making women conform to expected norms; the 2011 regulations, he points out, detailed physical features such as breast size and shape that could be used to identify athletes due to be investigated. Some athletes have even been advised to wear padded bras when competing. “Sport is just reflecting the society that we’ve always been, and it’s discriminating against people we’ve always discriminated against,” Pielke says.



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In 2020, international advocacy organization Human Rights Watch documented some of the physical, social and psychological harm inflicted on women whose test results have led to disqualification from events. Indian athlete Santhi Soundarajan, for example, attempted to take her own life after results of a sex test were leaked to the media in 2006. Another Indian athlete ended her life in 2001 after finding out her results.

Sports governing bodies should be legally accountable for their discriminatory actions, says Seema Patel, a sports lawyer at Nottingham Trent University, UK. She has proposed establishing an international independent anti-discrimination sports unit that would act as a watchdog. Other researchers suggest ending sex segregation in individual sport altogether, and adopting a system similar to that used in disability sport. “Our society is structured around sex and gender, but it isn’t inclusive in terms of performance at all – for both men and women,” says Roslyn Kerr, a

sports sociologist at Lincoln University in Canterbury, New Zealand. Kerr suggests that categories could be informed by the physical characteristics required to excel in a particular sport. For example, sprinters could compete against those with similar muscle mass and proportion of fast-twitch fibres, or endurance athletes by muscle mass and lung capacity. Implementing such a system would be hard, she admits – the systems in place in disability sport are not without their critics.

Other researchers propose an approach similar to the golfing handicap system, or a category, alongside men’s and women’s events, for athletes with DSDs. World Athletics has already provisioned for such a category in their regulations, but Bermon thinks society is not ready for it yet and introducing it could cause athletes to be stigmatized. “It’s impossible to find a solution that will satisfy everyone,” he says. “You have to go with the most reasonable, which is based on science, to protect the female category.”

Martínez-Patiño, now a sports science researcher at the University of Vigo in Spain, agrees that only concrete scientific evidence will resolve this debate, just as it helped to overturn her ban. But Patel sees a bigger challenge. “This isn’t just about science,” she says. “For there to be some progress, we have to tackle this issue from a science, ethics, law and human-rights perspective.”

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1. Bermon, S. et al. *J. Clin. Endocrinol. Metab.* **99**, 4328–4335 (2014).
2. Fénichel, P. et al. *J. Clin. Endocrinol. Metab.* **98**, E1055–E1059 (2013).
3. Healy, M. L., Gibney, J., Pentecost, C., Wheeler, M. J. & Sonksen, P. H. *Clin. Endocrinol.* **81**, 294–305 (2014).
4. Bermon, S. *Curr. Opin. Endocrinol. Diabetes Obes.* **24**, 246–251 (2017).
5. Hilton, E. N. & Lundberg, T. R. *Sports Med.* **51**, 199–214 (2021).
6. Bermon, S. & Garnier, P.-Y. *Br. J. Sports Med.* **51**, 1309–1314 (2017).
7. Pielke, R. Jr., Tucker, R. & Boye, E. *Int. Sports Law J.* **19**, 18–26 (2019).
8. Bermon, S., Hirschberg, A. L., Kowalski, J. & Eklund, E. *Br. J. Sports Med.* **52**, 1531–1532 (2018).

1992

The IAAF ends blanket sex testing, instead investigating female athletes only when questions are raised. The IOC, however, introduces a test for all women, based on the SRY gene. This remains a requirement until the 2000 Olympic Games in Sydney, Australia.

2009

Caster Semenya wins the 800 metres at the World Athletics Championships. During the competition, the IAAF and media reveal that the 18-year-old is subject to sex testing. She is forced to withdraw, but is cleared to compete again 11 months later.

2011

The IAAF adopts a policy on testosterone, limiting blood levels for people competing in women’s events to 10 nanomoles per litre. Those above this level who are androgen sensitive have to take testosterone-lowering drugs or undergo surgery to compete.

2014

Indian authorities ban sprinter Dutee Chand, owing to her high testosterone levels. She appeals to the Court of Arbitration for Sport (CAS), which rules in her favour in 2015. The IAAF regulations are suspended, and Chand can compete without restrictions.

2018

The IAAF announces regulations that specify a testosterone limit of 5 nanomoles per litre for people competing in women’s 400 metres to one-mile events. Middle-distance runner Semenya appeals to the CAS, which suspends the rules pending a full hearing.

2019

The CAS rules against Semenya. The following year, she loses again at a Swiss court. Semenya appeals to the European Court of Human Rights and says she will run in the unregulated 200 metres at the 2021 Tokyo Olympics.