The Unnecessary Use of Gender Verification in Sport

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I. INTRODUCTION

In August 2009, Caster Semenya, an 18-year old runner from South Africa made headlines when she finished first place in the women's 800m at the world track and field championships – 2.45 seconds in front of the second-place competitor.[1] What should have been one of the most exciting moments in Semenya's life quickly turned into a nightmare. News reports soon came out that the International Association of Athletics Federations ("**IAAF**") had forced Semenya to undergo sex testing prior to her race in Berlin.[2] Semenya was subjected to two hours of tests where doctors examined her and photographed her genitalia in order to verify that she was a woman.[3] Not only was the humiliating process heavily documented by the media, Semenya also received backlash from her fellow competitors with some questioning if she was "really" a woman.[4] For the 11-month long investigation Semenya was banned from competition – during which time she hid from the public eye and underwent trauma counselling.[5] The Semenya controversy prompted sport organizations to re-visit the issue of gender verification in sport.

Gender verification has been and continues to be a large problem in athletics. First, this paper will examine the history of sex testing in sport – including the shift from mandatory sex testing to the IAAF's current *Eligibility Regulations for Female Classification* (the "***2018 Eligibility Regulations***")[6] which are being challenged by Semenya. Next, this paper will take a critical look at the traditional

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[1] Christopher Clarey, "Gender Test After a Gold-Medal Finish", *The New York Times* (20 August 2009), online: <https://www.nytimes.com/2009/08/20/sports/20runner.html> [Clarey].
[2] *Ibid.*
[3] Katrina Karkazis et al, "Out of Bounds? A Critique of the New Policies on Hyperandrogenism in Elite Female Athletes" (2012) 12:7 Am J Bioethics 3 at 4 [Karkazis, "Out of Bounds"].
[4] Clarey, *supra* note 1.
[5] Karkazis, "Out of Bounds", *supra* note 3 at 5.
[6] International Association of Athletics Federations, Eligibility Regulations for the Female Classification (Athletes with Differences of Sex Development) (2018), online: <https://www.iaaf.org/download/download?filename=0c7ef23c-10e1-4025-bd0c-e9f3b8f9b158.pdf&urlslug=IAAF%20Eligibility%20Regulations%20for%20the%20Female%20Classification%20%5BAthletes%20with%20Differences%20of%20Sex%20Development%5D%20in%20force%20as%20from%201st%20November%202018> [2018 Eligibility Regulations].

arguments used by the IAAF to justify the use of gender verification in athletics. The IAAF purports that women with elevated levels of testosterone have an inherent advantage and that the regulations are necessary to protect the level playing field in sport. This paper will debunk both myths and argue that the "solutions" offered by the *2018 Eligibility Regulations* subject women to unjustifiable physical and psychological harm. Finally, this paper will argue that the *2018 Eligibility Regulations* are unnecessary and will call for the elimination of gender testing in sports.

II. GENDER VERIFICATION AND SPORTS LAW

A. Early Days of Gender Testing in Sport

In 1900, women were finally permitted to participate in the Olympics.[7] Gender testing was first used because there were concerns about males "masquerading" as females in competition.[8] In 1966, sports organizers implemented standardized gender verification tests for all women competing at international games.[9] This process included "nude parades" in front of doctors and evaluations of genitalia and other supposed markers of sex including hair patterns.[10] Sports organizers received a lot of criticism for these techniques so in 1967, the IAAF adopted the Barr Body Test – a buccal smear which detects the presence of X chromosomes.[11] This method was thought to be less invasive and more comprehensive because it relied on factors more than visuals to determine gender.[12] However, this method had severe limitations because women who were anatomically female but had chromosomal or genetic anomalies such as complete androgen insensitivity syndrome and Turner's syndrome were not identified as female under the test.[13] After severe criticism of the scientific accuracy

[7] Cheryl Cooky & Shari L Dworkin, "Policing the Boundaries of Sex: A Critical Examination of Gender Verification and the Caster Semenya Controversy" (2013) 50(2) J Sex Res 103 at 104 [Cooky].
[8] *Ibid,* at 107.
[9] *Ibid,* at 104.
[10] Karkazis, "Out of Bounds", *supra* note 3 at 6.
[11] *Ibid.*
[12] *Ibid.*
[13] *Ibid.*

behind the chromosomal test, the IOC abandoned mandatory sex testing of female athletes during the 2000 Olympic Games in Sydney.[14] Similarly, the IAAF did not require compulsory gender testing but instead athletes and teams could bring "gender issues" to the attention of authorities.[15]

B. The 2011 Hyperandrogenism Regulations

The IAAF received a lot of backlash with how they handled Semenya's case following the 2009 World Championships. As a result they were forced to re-evaluate their policies surrounding gender verification.[16] In May 2011, the IAAF released the *Regulations Governing Eligibility of Females with Hyperandrogenism to Compete in Women's Competition* (the "***2011 Hyperandrogenism Regulations***")[17] The *2011 Hyperandrogenism Regulations* aimed to create a framework for how sports organizers would respond to situations when an athlete's gender was questioned. This new policy focused on women with hyperandrogenism – a medical condition that results in naturally elevated androgen levels.[18] Females who already have been diagnosed with hyperandrogenism were required to notify the IAAF.[19] Further, the IAAF Medical Manager was also permitted to investigate a female athlete if he had "reasonable grounds" to believe that an athlete had hyperandrogenism – reasonable grounds including any "information received by the IAAF Medical Delegate or other responsible medical official at competition."[20] A female athlete under question was only allowed to return to competition if she had testosterone levels below the normal male range (less than 10nmol/L) or if she had an androgen resistance that resulted in her gaining no competitive advantage from having elevated androgen

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[14] Cooky, *supra* note 7 at 105.
[15] *Ibid.*
[16] Karkazis, "Out of Bounds", *supra* note 3 at 5.
[17] International Association of Athletics Federations, IAAF Regulations Governing Eligibility of Females with Hyperandrogenism to Compete in Women's Competition (2011), online: <https://www.dropbox.com/s/tjc172qod6b9zf2/IAAF%20Hyperandrogenism%20Policy%202011.pdf?dl=0> [2011 Hyperandrogenism Regulations].
[18] *Ibid.*
[19] *Ibid,* s 2.1.
[20] *Ibid,* s 2.2.

levels.[21] Lowering testosterone levels would require either taking anti-androgen drugs or undergoing surgical intervention.[22]

In 2015, the Court of Arbitration for Sport ("**CAS**") suspended the *2011 Hyperandrogenism Regulations* for two years after a legal challenge was brought by Indian sprinter Dutee Chand.[23] Similar to Semenya, Chand was subjected to examinations when there were concerns about whether she was eligible to compete as a female.[24] The CAS ruled that the IAAF failed to establish that the *2011 Hyperandrogenism Regulations* were necessary to maintaining fairness in female athletics.[25] Further, the CAS ruled that there was lack of scientific evidence supporting the claim that female athletes with hyperandrogenism derived a significant performance advantage.[26] The IAAF was given a two year window to present further evidence to support their claims.[27]

C. The 2018 Eligibility Regulations for Female Classification

In April 2018, the IAAF released the new *2018 Eligibility Regulations*. The new regulations cease to use the term "hyperandrogenism" and instead are directed at any female athlete who has a "difference of sexual development" ("**DSD**") resulting in testosterone levels greater than 5 nmol/L.[28] This is a lower threshold than the 10 nmol/L in the *2011 Hyperandrogenism Regulations* and the IAAF states that anything above 5 nmol/L gives female athletes a significant performance advantage.[29] Any female

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[21] *Ibid,* s 6.5(i)-(ii).
[22] Karkazis, "Out of Bounds", *supra* note 3 at 5.
[23] *Dutee Chand v Athletics Federation of India (AFI) & The International Association of Athletics Federations (IAAF)* (2014), CAS 2014/A/3759.
[24] *Ibid,* at 12.
[25] *Ibid,* at 547.
[26] *Ibid.*
[27] *Ibid,* at 548.
[28] 2018 Eligibility Regulations, *supra* note 6, s 2.2(a).
[29] International Association of Athletics Federations, Explanatory Notes: IAAF Regulations for the Female Classification" (26 April 2018) at 5, online: <https://www.iaaf.org/download/download?filename=c402eb5b-5e40-4075-8970-d66fccb10d41.pdf&urlslug=Explanatory%20Notes%3A%20IAAF%20Eligibility%20Regulations%20for%20the%20Female%20Classification> [IAAF Explanatory Notes].

athlete with a DSD must satisfy certain criteria before being allowed to compete in certain restricted events. While the *2011 Hyperandrogenism Regulations* applied to all athletics events, the new rules only apply to certain restricted events.[30] This is limited to "middle distance" track events and includes the 400m, hurdles, 800m, 1500m, one mile and combined events.[31] The IAAF claims that these events are where the performance enhancing benefits of elevated testosterone are most prominently found.[32] However, the IAAF reserves the right to add or remove events to the list of restricted events.[33]

If a female athlete wishes to compete, she must be recognized at law as either female or intersex, reduce her testosterone level below 5nmol/L for a period of six months, and maintain her testosterone level below 5nmol/L for as long as she wishes to compete.[34] This new six month period of lower testosterone was implemented out of concerns of the lingering advantages of elevated testosterone that could be present such as higher haemoglobin levels.[35] If a female athlete does not wish to lower her testosterone, she has three options: (1) compete in the restricted events but not at an international level, (2) compete in the male classification, (3) compete in the intersex classification if available.[36]

The *2018 Eligibility Regulations* were scheduled to come into effect in November 2018 but have been delayed after Semenya brought a legal challenge in June 2018.[37] Semenya and her lawyers argue that the regulations are irrational, unjustifiable, and violate the IAAF Constitution, the Olympic Charter, the laws of Monaco and universally recognized human rights.[38] Recently, a week-long hearing

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[30] 2011 Hyperandrogenism Regulations, *supra* note 17.
[31] 2018 Eligibility Regulations, *supra* note 6, s 2.2(b).
[32] IAAF Explanatory Notes, *supra* note 29 at 4.
[33] *Ibid.*
[34] 2018 Eligibility Regulations, *supra* note 6, s 2.3.
[35] IAAF Explanatory Notes, *supra* note 29 at 6.
[36] *2*018 Eligibility Regulations, *supra* note 6, s 2.6.
[37] David Wharton, "In the case of star South African runner Caster Semenya, a sports arbitration court must determine the definition of a woman", *The Los Angeles Times* (16 March 2019), online: <https://www.latimes.com/sports/la-sp-caster-semenya-gender-20190313-story.html> [Wharton].
[38] Norton Rose Fulbright, "Norton Rose Fulbright advises Olympic champion Caster Semenya to challenge IAAF rules as discriminatory" (18 June 2018), online: <https://www.nortonrosefulbright.com/en/news/115e61b6/norton-rose-fulbright-advises-olympic-champion-caster-semenya-to-challenge-iaaf-rules-as-discriminatory>.

was completed at the CAS in Switzerland and a decision is expected to be released in late March 2019.[39]

III. CRITIQUING THE IAAF'S ELIGIBILITY REGULATIONS

This section will critically examine the *2018 Eligibility Regulations* and critique two arguments used by the IAAF to justify the regulations. First, this section will discuss the IAAF's argument that elevated endogenous levels of testosterone give female athletes an inherent advantage. There is no evidence that higher levels of testosterone result in more successful athletes and using testosterone as a marker of athletic ability is highly flawed. Then, this section will examine the IAAF's argument of sport as a "level" playing field and the notion that gender testing must be implemented for "fairness". Elite sport features many athletes with inherently "unfair" biological advantages and women with elevated natural levels of testosterone should not be treated any differently. Finally, this section will argue that the regulations compel women to undergo invasive and discriminatory intervention.

A. Elevated testosterone does not provide female athletes with an advantage

The *2011 Hyperandrogenism Regulations* and the new *2018 Eligibility Regulations* are both based on the notion that higher than "normal" testosterone levels give female athletes significant performance advantages.[40] The "normal" range of endogenous testosterone in the female body is 0.12 – 01.79 nmol/L while the average level of testosterone in a post-pubescent male ranges anywhere from 7.7 – 29.4 nmol/L.[41] Studies used by the IAAF estimate that the ergogenic advantage conferred on athletes with testosterone levels in the male range is greater than 9% over athletes with testosterone levels in the "normal" female range.[42] As a result, the IAAF states that female athletes with testosterone levels

[39] Wharton, *supra* note 37. **Note**: At the time of writing a decision has not been issued. The CAS has stated that a decision will be issued by March 26, 2019.
[40] IAAF Explanatory Notes, *supra* note 29 at 1.
[41] *Ibid.*
[42] David J Handelsman, Angelica L Hirschberg & Stephane Bermon, "Circulating Testosterone as the Hormonal Basis of Sex Differences in Athletic Performance" (2018) 39:5 Endocr Rev 803 at 821.

greater than 5 nmol/L should lower their testosterone levels to be in the "normal" female range to eliminate the competitive advantage they have over their fellow athletes.[43] However, the *2018 Eligibility Regulations* rest on a faulty assumption that women with naturally elevated levels of testosterone have a superior athletic advantage over women with lower levels of testosterone.

Higher levels of testosterone can help individuals increase their muscle mass and strength and increase oxygen transfer and uptake due to increased levels of circulating haemoglobin.[44] However, there is no evidence to show that athletes with higher levels of endogenous testosterone perform significantly better than those with lower levels.[45] The claim that elevated levels of natural testosterone give female athletes an advantage is further undermined due to the fact that the majority of studies on the correlation between testosterone and athletics has been conducted on men.[46] A study conducted by MacLean et al. found that elevated androgen levels impact women differently than men and that androgens were not required for peak muscle mass in females.[47] How androgens impact a person's body varies greatly from person to person and using testosterone as a measure of athletic ability is meaningless.[48] Ultimately, the human body is a very complex system with many factors at play and testosterone alone does not make one a superior athlete.

Moreover, the data used by the IAAF to justify their position is very problematic. Roger Pielke director of the Centre for Sports Governance at the University of Colorado appeared as an expert witness at Semenya's recent hearing and argued that the research used by the IAAF to support the *2018 Eligibility Regulations* is riddled with errors.[49] This data aimed to show a strong link between high

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[43] IAAF Explanatory Notes, *supra* note 29 at 3.
[44] Shalender Bhasin et al, "The Effects of Supraphysiological Doses of Testosterone on Muscle Size and Strength in Normal Men" (1996) 335:1 N Engl J Med 1 at 1.
[45] Karkazis, "Out of Bounds", *supra* note 3 at 8.
[46] *Ibid.*
[47] HE MacLean et al, "Impaired skeletal muscle development and function in male, but not female, genomic androgen receptor knockout mice" (2008) 22:8 FASEB J 2676.
[48] Karkazis, "Out of Bounds", *supra* note 3 at 8.
[49] Wharton, *supra* note 37.

testosterone levels and performance results at two recent World Championships.[50] Not only did the data have large accounting errors, the IAAF also used its in-house researchers to support its claims.[51] For example, performance times used in the studies were duplicated and "phantom times" that were not in original IAAF competition results were also used.[52] Further, results from athletes that have now been disqualified for doping were also used in the studies, thereby skewing the results.[53] Clearly the science used to back the IAAF's arguments must be further verified and validated by independent researchers. Thus, there is lack of evidence to support the notion that naturally elevated levels of testosterone confer a significant advantage on female athletes, and this cannot be used as a justification for the imposition of the *2018 Eligibility Regulations*.

B. Sport is not a level playing field

In addition, the *2018 Eligibility Regulations* use "fairness" and the need to create a "level playing field" as a justification for placing restrictions on female athletes with DSDs.[54] The IAAF claims that this fairness starts at the division between male and female athletes because of the significant advantages that men have in size, strength and power.[55] However, critics believe that creating a level playing field amongst elite athletes is a "futile endeavour".[56]

Many elite athletes have biological advantages and yet sport organizers do not police them. For example, many swimmers have a longer than average wingspan, while many runners and cyclists have genetic variations that give them superior aerobic capacity and resistance to fatigue.[57] And yet, sports

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[50] *Ibid.*
[51] *Ibid.*
[52] Lisa Marshall, "Testosterone limits for female athletes based on flawed science", *CU Boulder Today* (8 February 2019), online: <https://www.colorado.edu/today/2019/02/08/testosterone-limits-female-athletes-based-flawed-science>.
[53] *Ibid.*
[54] 2018 Eligibility Regulations, *supra* note 6, s 1.1(a).
[55] *Ibid,* s 1.1(a)(ii).
[56] Eric Vilain & Francisco J Sanchez, "Reproductive endocrinology: athletes' bodies, sexed bodies--intersexuality in athletics" (2012) 8 Nat Rev Endocrinol 198 at 198.
[57] Karkazis, "Out of Bounds", *supra* note 3 at 11.

organizers do not test for any of these performance enhancing biological variations. The IAAF acknowledges that many elite athletes have natural genetic advantages and yet there are no restrictions placed on them.[58] The IAAF justifies treating female athletes with DSDs differently because no other biological trait gives female athletes as large of a performance advantage.[59] However, as discussed previously, there is a lack of evidence to support the claim that elevated testosterone confers a large competitive advantage and female athletes with DSDs should not be treated any differently than other elite athletes that have genetic advantages. If sports organizers tolerate natural advantages in elite athletes such as runners, swimmers and cyclists, females with DSDs in athletics should be treated no differently.

Furthermore, "fairness" should not place limitations on naturally occurring advantages. While elevating testosterone levels by injecting hormones to gain a competitive advantage would offend the ideas of "fairness", female athletes with DSDs are born with this condition. DSDs are not the same as doping - the women have not undertaken any practices to obtain an advantage. The idea of fairness should not place such strict limitations on natural conditions and women with higher endogenous levels of testosterone should not be barred from competition. The *2018 Eligibility Regulations* aim to create a level playing field that is simply not a reality and does not justify the harm imposed on female athletes with DSDs.

C. Regulations have an unnecessary detrimental effect on female athletes

The *2018 Eligibility Regulations* give a female athlete with a DSD the option of either lowering her testosterone levels in order to compete, or not lowering her testosterone levels and competing with

[58] IAAF Explanatory Notes, *supra* note 29 at 6.
[59] *Ibid.*

men or intersex athletes.[60] All of these "solutions" compel female athletes to endure humiliating and possibly physically and psychologically harmful experiences.

The *2018 Eligibility Regulations* explicitly state that no athlete will be forced to undergo surgery or anatomical changes such as a gonadectomy to reduce testosterone levels.[61] However, hormonal interventions used to lower testosterone levels can have dangerous side effects on the human body. Anti-androgens have side effects such as diuretic effects that cause excessive thirst, disruption of carbohydrate metabolism, urination and electrolyte imbalances, headache and fatigue – all of which would be extremely detrimental to an elite female athlete.[62]

Furthermore, the options offered by the IAAF test can have severe psychological effects on a woman. Singling out a female athlete for a gender verification test may reveal information to the woman about her body and self that she was previously unaware of.[63] This can be extremely emotional and lead the athlete to question her identity and self. Moreover, the IAAF's suggestion that women who do not wish to lower their testosterone levels compete with men or intersex athletes also puts into question the athlete's social identity as a woman. This is no different than alerting the media and fellow competitors that the athlete has a DSD and violates the woman's privacy and dignity.[64]

In addition to possible physical and psychological harms, the *2018 Eligibility Regulations* also impose a heavy financial burden on female athletes with DSDs. While the IAAF will pay the costs of an initial assessment and diagnosis of the athlete, the athlete herself must pay the costs of her personal physician and any treatment that the physician prescribes.[65] Therefore, the *2018 Eligibility Regulations* impose extremely unnecessary physical, psychological and financial harms on female athletes with DSDs.

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[60] *2*018 Eligibility Regulations, *supra* note 6, s 2.6.
[61] *Ibid,* s 2.4.
[62] Katrina Karkazis & Morgan Carpenter, "The Inherent Harms of Regulating Women's Testosterone in Sport" (2018) 15: J Bioethical Inq 579 at 584 [Karkazis, "The Inherent Harms"].
[63] *Ibid,* at 582.
[64] *Ibid,* at 586.
[65] *2*018 Eligibility Regulations, *supra* note 6, ss 3.15-3.16.

IV. RECOMMENDATIONS

It is recommended that gender testing in athletics be eliminated altogether. Originally, gender verification was used to prevent men from "masquerading" as women in sport and to protect the "real" female athletes.[66] However, there has only been one case in the 1936 Olympics where a German man competed in the women's high jump event disguised as a woman.[67] Since then, there have been no documented cases of a man posing as a woman in elite sport.[68] The fear that men will pose as women for a performance advantage is unfounded and there is no need for gender testing to "protect" female athletes. The *2018 Eligibility Regulations* are not promoting a level-playing field and the restrictions placed on women with DSDs do more harm than good.

When Dutee Chand challenged the *2011 Hyperandrogenism Regulations,* the CAS held that there was a lack of scientific evidence supporting the claim that female athletes with hyperandrogenism derived a significant performance advantage.[69] Many years later, the IAAF has tried to demonstrate that elevated levels of endogenous testosterone is linked to superior athletic performance. However, the scientific data has been widely criticized by geneticists, scientists, and the greater medical community.[70] If it cannot even be proven that high levels of testosterone result in superior athletic performance – the very platform that these rules are based on – then why subject these women to unnecessary medical intervention in the first place?

In the alternative, if the IAAF and other sports organizations wish to continue questioning the gender of female athletes, the same policies should apply to male athletes as well. Arguing that gender testing should be implemented to preserve "fairness" in sport and then only applying these policies to

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[66] Cooky, *supra* note 7 at 107.
[67] *Ibid.*
[68] *Ibid.*
[69] *Ibid.*
[70] Roger Pielke Jr, Ross Tucker & Erik Boye, "Scientific integrity and the IAAF testosterone regulations" (7 February 2019) E Int Sports Law J, online: <https://doi.org/10.1007/s40318-019-00143-w>; (See also: Karkazis, "The Inherent Harms", *supra* note 62)

female athletes is in itself unfair and discriminatory. The logic used by the IAAF is as follows: elevated levels of testosterone give female athletes a superior competitive advantage and thus they should be restricted from competing in order to maintain "fairness" in sport.[71] And yet, sports organizers have never considered what genetic advantages might make a male athlete superior to his competitors and give him an "unfair advantage."[72] Biological advantages should be treated equally in both men and women's athletics, and women should not be the only ones subjected to testing and restrictions on competition. Elite male athletes continue to enjoy competing in sport without being subject to scrutiny about their gender and it is time that sports organizers treat elite female athletes the same.

V. CONCLUSION

For over fifty years female athletes have been subject to gender testing while their male counterparts remain untouched. Elite female athletes such as Caster Semenya and Dutee Chand should not be forced to undergo unnecessary medical intervention and humiliation in order to fit into the IAAF's mould of a "normal" woman. The IAAF's justifications for the *2018 Eligibility Regulations* rest on faulty logic and poor science. There is lack of scientific evidence to support the claim that female athletes with higher levels of endogenous testosterone have a significant competitive advantage over females with lower levels. Further, the IAAF aims to create a level playing field, something that is simply not a reality in elite sport. Finally, the *2018 Eligibility Regulations* subject women to severe physical, psychological and financial harm. To ensure that women in athletics no longer have to endure humiliating and violating experiences, women with DSDs should be free to compete and should not be forced to lower their testosterone levels. It is time that the media, public and officials stop questioning a woman's identity – if she says she is a female that should be enough.

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[71] 2018 Eligibility Regulations, *supra* note 6, s 1.1(a)(ii).
[72] Cooky, *supra* note 7 at 108.

VI. TABLE OF AUTHORITIES AND STATUTES

LEGISLATION

International Association of Athletics Federations, Eligibility Regulations for the Female Classification (Athletes with Differences of Sex Development) (2018), online: <https://www.iaaf.org/download/download?filename=0c7ef23c-10e1-4025-bd0c-e9f3b8f9b158.pdf&urlslug=IAAF%20Eligibility%20Regulations%20for%20the%20Female%20Classification%20%5BAthletes%20with%20Differences%20of%20Sex%20Development%5D%20in%20force%20as%20from%201st%20November%202018>.

International Association of Athletics Federations, IAAF Regulations Governing Eligibility of Females with Hyperandrogenism to Compete in Women's Competition (2011), online: < https://www.dropbox.com/s/tjc172qod6b9zf2/IAAF%20Hyperandrogenism%20Policy%202011.pdf?dl=0>.

JURISPRUDENCE

Dutee Chand v Athletics Federation of India (AFI) & The International Association of Athletics Federations (IAAF) (2014), CAS 2014/A/3759.

SECONDARY MATERIAL

Bhasin, Shalender et al, "The Effects of Supraphysiological Doses of Testosterone on Muscle Size and Strength in Normal Men" (1996) 335:1 N Engl J Med 1.

Clarey, Christopher, "Gender Test After a Gold-Medal Finish", *The New York Times* (20 August 2009), online: <https://www.nytimes.com/2009/08/20/sports/20runner.html>.

Cooky, Cheryl & Dworkin, Shari L, "Policing the Boundaries of Sex: A Critical Examination of Gender Verification and the Caster Semenya Controversy" (2013) 50(2) J Sex Res 103.

Handelsman, David J, Hirschberg, Angelica L & Bermon, Stephane, "Circulating Testosterone as the Hormonal Basis of Sex Differences in Athletic Performance" (2018) 39:5 Endocr Rev 803.

International Association of Athletics Federations, Explanatory Notes: IAAF Regulations for the Female Classification" (26 April 2018), online: <https://www.iaaf.org/download/download?filename=c402eb5b-5e40-4075-8970-d66fccb10d41.pdf&urlslug=Explanatory%20Notes%3A%20IAAF%20Eligibility%20Regulations%20for%20the%20Female%20Classification>.

Karkazis, Katrina & Carpenter, Morgan, "The Inherent Harms of Regulating Women's Testosterone in Sport" (2018) 15: J Bioethical Inq 579.

Karkazis, Katrina et al, "Out of Bounds? A Critique of the New Policies on Hyperandrogenism in Elite Female Athletes" (2012) 12:7 Am J Bioethics 3.

MacLean, HE et al, "Impaired skeletal muscle development and function in male, but not female, genomic androgen receptor knockout mice" (2008) 22:8 FASEB J 2676.

Marshall, Lisa, "Testosterone limits for female athletes based on flawed science", *CU Boulder Today* (8 February 2019), online: <https://www.colorado.edu/today/2019/02/08/testosterone-limits-female-athletes-based-flawed-science>.

Norton Rose Fulbright, "Norton Rose Fulbright advises Olympic champion Caster Semenya to challenge IAAF rules as discriminatory" (18 June 2018), online: <https://www.nortonrosefulbright.com/en/news/115e61b6/norton-rose-fulbright-advises-olympic-champion-caster-semenya-to-challenge-iaaf-rules-as-discriminatory>.

Pielke Jr, Roger, Tucker, Ross & Boye, Erik, "Scientific integrity and the IAAF testosterone regulations" (7 February 2019) E Int Sports Law J, online: <https://doi.org/10.1007/s40318-019-00143-w>.

Vilain, Eric & Sanchez, Francisco J, "Reproductive endocrinology: athletes' bodies, sexed bodies--intersexuality in athletics" (2012) 8 Nat Rev Endocrinol 198.

Wharton, David, "In the case of star South African runner Caster Semenya, a sports arbitration court must determine the definition of a woman", *The Los Angeles Times* (16 March 2019), online: <https://www.latimes.com/sports/la-sp-caster-semenya-gender-20190313-story.html>.