INTERNATIONAL RESEARCH LITERATURE REVIEW

SCEG Project for Review and Redraft of Guidance for Transgender Inclusion in Domestic Sport 2020

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Confidential – Sports Council

This document is produced specifically as part of the Review and Redraft of the Guidance for Transgender Inclusion in Sport for the Sports Councils' Equality Group of UK.

The literature review includes published scientific research relating to transgender inclusion in sport, and is based largely on peer-reviewed data, but also some pertinent opinion pieces (outlined in the text). It is written in a general chronological order, with reference to important milestones in international sport to provide context and relevance to historical events and policy decisions. In keeping with the remit from UKSport, the document focusses on scientific and medical literature related to performance, rather than sociological or ethical considerations. For simplicity and clarity, the terminology used here is male/female and transgender man/transgender woman/transgender people.

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Executive summary

The research base for the inclusion of transgender people in sport remains limited but is rapidly evolving.

The evidence outlining the sex dimorphism, or physical variance, between the sexes is robust: There are significant differences between the sexes which render direct competition between males and females unfair in most 'gender-affected sports' due to the physical advantages of males, and often unsafe in sports which allow physical contact and collisions.

Recent international guidelines, and subsequent policies, on the inclusion of transgender people (particularly transgender women) have attempted to negate male physical advantage, thereby allowing fair (and safe) competition. However, there is currently no direct evidence that this can be achieved by suppression of hormone levels. On the contrary, there are apparent life-long physiological advantages in the adult male, only some of which can be reversed, and it is not known whether physical benefit(s) may be retained in someone who does not achieve full maturity.

Transgender people face health concerns related to their transition and are prone to chronic side effects which are likely to be ameliorated by physical activity. On the other hand, female athletes are subject to specific health and injury concerns in direct relation to their reproductive physiology and cyclic metabolism. It is not known if these differences create a meaningful disparity in performance sport.

Everyone benefits from physical activity for both physical and mental health, and there are reported advantages in relation to the social aspects of team sports in particular. These benefits should be available to everyone in our community, and it is known that transgender people face barriers in access to sport.

This short review presents a chronological precis of current evidence which impacts decision making on how best to include transgender people in sport.

Introduction

Transgender inclusion transects the established categorisation in sport and, by including those who have transitioned from the alternate sex category, has created challenges. The binary of sex categories in sport has existed for more than a century and arguably since the beginning of sport in ancient times when females were largely excluded. Sports have historically been developed for able-bodied males by able-bodied males, and the opportunity for females, children, masters' athletes, and disabled people has been an evolution of increased opportunity and inclusion through categorisation over many decades. It is important to note that all subsequent categories within competitive sport, including weight categories, have always been underpinned by the sex binary, and inclusion of other groups has been largely by the addition of new and separate competition within that binary.

Research literature for the evidential basis of inclusion for transgender people in sport remains limited. The definitive longitudinal studies tracking prospective gender transition in athletes, with appropriate objective measurements, competition results and with a relevant control population, have not yet been reported. Further, the scientific literature on performance differences between males and females across the sports is also limited because, until now, the relevance of this difference was questionable as the sexes have not routinely competed against each other. Hence much of the known information is laboratory based, rather than specific to sporting competition.

Population-based differences between the sexes – the rationale for gender-affected competition

In adulthood, there are clear differences in muscle mass, strength, and physiological capacity even after controlling for differences in height and weight between the sexes. On average, males have 40-50% greater upper limb strength, 20-40% greater lower limb strength, and an average of 12kg more skeletal muscle mass than age-matched females at any given body weight (Janssen et al 2000, Handelsman et al 2018).

Following full growth, males are measured at an average 13-15cm (5-6 inches) taller than females. The National Health Service in 2018 quotes the average young adult male in England at a height of 178.0cm (5ft 10in) with an estimated standard deviation (SD) of 9.19cm. The average young adult female in England is 164.1cm (5ft 4 1/2in), SD 7.51cm. In the USA the statistics are very similar: Males average 175.9cm, SD 7.42cm, and females average 162.1cm, SD 7.11cm.

When plotted across the population it is evident that 50% of males are taller than some 97% of females. So, in any random grouping of males and females, half of the males will be taller than nearly all females.

Handgrip dynamometry is probably the most commonly used method to characterize overall human muscle strength (Bohannon et al 2019). European data of over 2000 young adult males and females demonstrates "mean maximal hand-grip strength showed …. clear difference between men (541 Newtons) and women (329 Newtons); 90% of females produced less force than 95% of males". And further…. "highly trained female athletes ….. corresponded to only the 25th percentile of the (untrained) male subjects" (Leyk et al, 2007).

Therefore, this would mean that in a random group of ten males and ten females, only the strongest female is likely to be stronger than the weakest male.

Males have a larger, stronger and denser skeleton, with longer levers (arms and legs), and bigger hands and feet. Males also have larger hearts and greater blood volume with higher haemoglobin concentration, and hence greater oxygen carrying capacity, with bigger lungs and airway capacity compared with females. The differences in physical/physiological capacity are synergistic such that males are larger, stronger and faster, with greater aerobic capacity and for which the summation is likely to be greater than the individual differences.

The muscle strength, physiological and size differences between the sexes correlate with significant sporting achievement from around 10-12% for most linear swimming and running events, 20% difference in jumping events, and a 35% difference in weightlifting ability in weight matched males and females. If an average sized male is compared with an average size female (based on the NHS data, 2018) the weightlifting ability increases to 50% greater for males (World Record Snatch; 85kg Male - 187kg lift; 69kg Female - 123kg lift).

It is often assumed that children have similar physical capacity regardless of their sex, and hence mixed competition is allowed in many sports up until the age of around 11 years (to coincide with puberty). However large-scale data reports on children from the age of six show that young males have significant advantage in cardiovascular endurance, muscular strength, muscular endurance, speed/agility and power tests, but score lower on flexibility tests (Tambalis et al, 2016; Catley & Tomkinson, 2013).

In adults the average advantage of 10-12% in running events can be interpreted for both the 'average' competitor, as well as for elite performers where the percentage difference remains the same for similarly trained people. When measured in absolute time, i.e. the difference to reach the finish line, this will vary based on the ability of the athletes; but the distance between the competitors remains the same. In this way a 10-12% better performance by a competitor would see Adam Peaty being beaten by half a length in the short-course 100m breaststroke and Dina Asher Smith by 22m in the 200m track sprint. And Sir Mo Farah would be lapped twice in the 10,000m track race.

While there may be many differences between competitors of the same sex (such as height, skill, and training methods), what is relevant about the advantage between the sexes and the reason for the category division, is the scale of advantage across virtually all sports. World Rugby (2020) has referred to "…the almost perfect sensitivity of biological sex…. since in a ranking list of the top thousand performances in most sport, every year, every single one will be biologically male". The winning margin (the difference in performance by which a competitor misses a gold medal, any medal, or making the final) in elite athletics or swimming events during the last three Olympics is less than just 1% for both male and female events, compared with up to a 50% difference between sex-based performances.

Derivation of performance difference between the sexes in sport

The known dichotomy in athletic performance between the sexes has long been acknowledged to largely be in relation to the difference in gonadal androgens, namely testes derived testosterone and its more potent metabolite dihydrotestosterone in males, and ovarian estrogen in females.

Males are prenatally (before birth) and perinatally (soon after birth) exposed to high level androgens, and then experience a further surge in testosterone levels during puberty, which is maintained throughout adult life. On the other hand, females normally never experience testosterone exposure beyond a basal level at any time during life (<2nmol/L). From the onset of male puberty, the testes secrete 20 times more testosterone, resulting in circulating testosterone levels that are 15 times greater in healthy young males than in age-similar healthy females (Handelsman et al 2018).

However, females enter maturational puberty at least a year before males, and this may create a brief equivalence in the height of children around the age of 10, before males enter puberty from around the age of 11.

Anabolic steroids, of which testosterone is the significant 'natural' form, were one of the original groups of banned drugs when anti-doping practices developed in the 1970s. Both endogenous (made within the body) and exogenous testosterone (delivered into the body from an external source) are identical chemical substances and have equivalent effects in the body. Testosterone concentration positively correlates with leg press strength, thigh muscle volume and haemoglobin levels, and the anabolic response to testosterone can largely be predicted by the dose administered (Bhasin et al 2001). Testosterone is largely responsible for the increased muscle mass through increases in muscle fibre numbers and size, muscle satellite cell numbers, numbers of myonuclei (muscle cells nucleus), and size of motor neurones (nerve cells) as well as advantageous biochemical changes in muscle function in males. Importantly stimulation of myonuclei is life-long (Handelsman et al 2018). This is so-called 'muscle memory' and is one of the reasons why doping sanctions were increased to four years to try to account for this long-term effect on performance.

For ethical and doping control reasons it has not been possible to evaluate the effect of testosterone in healthy young athletes beyond cross sectional studies, but observational reports have lent credence to this understanding. During the era of the former German Democratic Republic, systematic doping of athletes was developed and later confirmed on release of the so-called 'Stasi Files'. Regime scientists stated after the 1972 Munich Olympics: "the effects of the treatment with androgenic hormones were so spectacular, particularly in female athletes in strength dependent events, that few competitors not using the drugs had a chance of winning". Further, the long-term effect of androgenic/anabolic steroids was attested by the acknowledgement that "after a critical period of ….. increase in muscle strength, a higher performance level is reached that does not return to pre-treatment values after the drug is withdrawn" (Franke & Berendonk 1997).

History of sex categories and inclusion of transgender athletes

Previous practices of 'gender (sex) verification' for female athletes were developed "in order to exclude those in which a genetic alteration gives the competitor registered as a female anatomical advantages of masculinization" (Hay 1985). There was no perception that females would pose a competitive threat to male athletes. Genetic testing, which received “great support” from athletes, was contentious within the scientific community and was subsequently abandoned in 2000 for the Sydney Olympics (Ljungqvist 2000). This was largely due to some infamous cases in which inadequate processes resulted in inappropriate disqualification of athletes.

The Stockholm Consensus of the IOC in 2003 established the first international policy for transgender inclusion in international sport. This was not a referenced document; “at the time, there was no published scientific literature that would justify the inclusion of transgender women” (Harper 2015). Transgender people were at this time required to have full surgical transition in order to compete in their acquired gender.

Dr Arne Ljungqvist, the then IOC Medical Commission Chair, is reported (Harper 2015) to have relied heavily on the opinion of Dr Louis Gooren who went on to publish in 2004 the first comparative study of the physical/physiological attributes of transsexual men and women. In this study the metabolic and morphological changes of 17 transgender men and 19 transgender women were studied before and after their gender-affirming medication. The pre-treatment data serves as control groups for the respective treatment groups for statistical analysis. Muscle mass (measured by MRI) and serum haemoglobin were compared across one and then three years of treatment.

Following one year of androgen(testosterone) deprivation, muscle mass decreased significantly in the transgender women, but remained significantly higher than the pre-treatment transgender men (female) group. On the other hand, the transgender men on testosterone supplementation increased muscle mass such that there was no statistical difference between these subjects and the pre-treatment transgender women (male) group. There was no difference between the treatment groups (transgender men and transgender women) after one year of treatment. There was a further non-significant loss of muscle mass following a further two years of treatment of transgender women**.** Haemoglobin levels converted into the respective ranges of the acquired gender in each group within the first year. This would have a corresponding effect on blood oxygen carrying capacity, and hence aerobic ability. It was noted that height was a strong independent predictor of muscle mass in both males and females, and both pre- and post- gender transition (Gooren and Bunck 2004).

Following cessation of gender/sex (chromosomal) testing in 2000, athletes with Disorders (Differences) of Sexual Development (DSD) were successful in major athletic competitions; notably at the Athletics World Championships in 2009. There followed a decade during which several athletes with the genetic disorder ‘46XY 5ARD’ (46 XY chromosome women in which an enzyme abnormality causes testosterone to rise to high levels) were in dispute with the IAAF/World Athletics through lengthy court proceedings in relation to their hyperandrogenic status. While these cases do not have direct relevance to transgender inclusion in sport what is important is that as a result of the requirement for evidence and information for court documentation, there was a significant increase in both the research and academic literature on the effect of testosterone in sports performance over this period.

During the Daegu World Athletics Championships in 2011, research on behalf of the IAAF and WADA on the normative values of serum androgen levels of elite track and field athletes was conducted in order to inform the blood steroidal module of the Athlete Biological Passport for doping control (Bermon et al 2014). This research was able to define the median value of serum testosterone in elite female athletes at 0.69 nmol/L with a 25-75% range of 0.50 to 0.91nmol/L, and a 99th percentile calculated at 3.08nmol/L. The testosterone levels in the DSD group were as high as 29.30nmol/L, while the standard male range of testosterone is 7.7 to 29.4nmol/L (Handelsman 2018). It was calculated that, within the elite athlete population, hyperandrogenism in relation to XY DSD was 140 times more common than in the general population.

Researcher Joanna Harper published comparative data in 2015, around the time that the second IOC Consensus Statement on Sex Reassignment was published. In this study, the race times of eight transgender/transsexual women were recorded both pre- and post- transition. All subjects were recreational distance runners who self-reported race times (which were verified where possible) in equivalent events over a period stretching from one year up to twenty-seven years apart. No testosterone levels were reported for the athletes, either before or after the transition. Calculations were made to compare their race times with those of age-graded performances in the respective gender. The findings indicated that the comparative race times were equivalent pre- and post-transition, and this implies that transition did not give these transgender women a competitive advantage (Harper 2015). This was the first study to attempt to measure physical performance following transition, compared with pre-transition ability and, while there were several acknowledged limitations to the study, this information appears to have been crucial in the subsequent deliberations of the second IOC Consensus Meeting.

The second Consensus Paper of the IOC was published in November 2015. Surgery is no longer required to be eligible to compete, and transgender women are required to suppress testosterone levels to below 10nmol/L for 12 months before competition. This testosterone level is 5-10 times the testosterone level of females of any age and remains within the accepted range for males, and it has not been defined as to how this level was determined by the IOC. Transgender men can enter male competition without requirement.

Over the past two decades there have been a dozen published research papers (five of which were published in 2018-20) for a total of some 800 participants which investigated the effect of testosterone suppression on muscle mass, and in some instances muscle strength, in transgender women.

Post-suppression testosterone levels measured in these studies were all less than 10nmol/L, most being below 5nmol/L, and seven studies where testosterone level was less than 1nmol/L (ie at the level of females). Most studies included estrogen therapy for participants. On review by Hilton and Lundberg, the findings from the composite of existing research was that loss of muscle mass and/or strength following 12 months of testosterone suppression is relatively modest compared with the initial advantage. The average loss of muscle mass across all studies was around 5%, which is less than the 9% loss measured in the seminal work of Gooren and Bunck. In those studies which recorded the retained muscle mass/strength, there was an average of 25% residual advantage for transgender women at 12 months treatment compared with reference a group of females (Hilton and Lundberg 2020).

In the most recent study, by Wiik and colleagues from the Karolinska Institute in Sweden, there was minimal loss of muscle mass or strength in transgender women following 12 months of testosterone suppression, and some subjects gained strength. After treatment transgender women remained 48% stronger, with 35% larger quadriceps mass compared with the control population of females (Wiik et al 2020).

Harper and colleagues also reviewed the available scientific literature and published in the British Journal of Sports Medicine in March 2021. They concluded that “haemoglobin levels rapidly reduce in transwomen” while ‘‘strength may be well preserved during the first 3 years of hormone therapy’ (Harper et al 2021).

Recent research citing retrospective data from military personnel in the US has shown that transgender women retain an advantage in running speed after more than two years of follow-up on testosterone suppression, at a residual of some 12% faster than the known normative values for females. In the same study, values for numbers of 'push-ups' and 'sit-ups' had reverted to female levels, but data on training levels and performance targets was lacking. Results for the transgender men studied exceeded those of the average performance for age-matched males after one year of testosterone supplementation (Roberts et al, 2020).

From the synthesis of current research, the understanding is that testosterone suppression for the mandated one year before competition will result in little or no change to the anatomical differences between the sexes, and a more complete reversal of some acute phase metabolic pathways such as haemoglobin levels although the impact on running performance appears limited, and a modest change in muscle mass and strength: The average of around 5% loss of muscle mass and strength will not reverse the average 40-50% difference in strength that typically exists between the two sexes. These findings are at odds with the accepted intention of current policy in sport, in which twelve months of testosterone suppression is expected to create equivalence between transgender women and females.

It is recognised that research to date has not been carried out in an elite athletic population (although military data includes well-trained individuals), and it is not known if the relative muscle loss will be more or less in those who are undergoing training, relative to the published results in non-athletic populations. It is known however, that males who undergo androgen suppression as part of treatment for prostate cancer can improve muscle strength and mass when also undertaking a training program, whereas the absence of training results in 4% reductions in muscle mass, similar to those observed in trans women whose testosterone is suppressed without training (Galvao et al 2006). The implication is that training during a period of testosterone suppression may attenuate the reductions observed in the longitudinal studies, which would increase the retained advantage when comparisons are made with a reference group of females.

The notion of safety in sport is related to size and maturity of competitors and is one of the reasons that junior athletes are not routinely eligible to play against adults in contact and collision sports. Because the two sexes have not historically competed against each other as adults in these sports, there is not yet experience of the injury risk to which females may be exposed in such competition, nor with the inclusion of transgender people beyond anecdotal reports. Injury risk can be appreciated through analysis of the combination of mass and speed of competitors and hence the force that can be generated, in which the larger and faster opponent will pose a risk to those that are smaller and slower when tackled. At a conference convened by World Rugby in London in February 2020, information was presented (and subsequently published as part of World Rugby Transgender Guideline) of a theoretical framework for injury risk based on validated mechanical modelling, relevant to the size differential of male players compared with female players. While not including the speed of a bigger opponent, nor the neck strength of the smaller, the increased mass alone accounted for an estimated increase in the risk factors for head and neck injury of 20-30%. Given the modest reduction of body mass by testosterone reduction in transgender women this was estimated to pose an unacceptable risk to female players and, in part, resulted in the decision to render transgender women ineligible to compete in international contact rugby union (World Rugby 2020).

Debate about the role of testosterone

Writing an 'Observation' in the Scientific American journal in June 2019, Rebecca Jordan-Young and Katrina Karkazis, authors of "Testosterone; an Unauthorised Biography", question the validity of ascribing the differences between male and female athletes solely to endogenous levels of testosterone. They draw attention to the inconsistency between measured testosterone levels and performance. The research published on behalf of the IAAF (Bermon & Garnier 2017) received criticism from the scientific community and required formal correction. Jordan-Young and Karkazis stress that in three of the eleven running events cited, it was the group with the lowest testosterone levels who performed best, and there was a strong negative association between testosterone levels and 100m race time.

The authors quote published work from Pielke, Tucker and Boye (2019), which questions the validity of IAAF(WA) research which was requisite by the Court of Arbitration in Sport (CAS) to demonstrate that "high androgen levels confer a significant performance advantage over other female competitors, comparable to the performance advantage that male athletes enjoy over female athletes".

In the event, the full evidence base presented by IAAF/World Athletics was ultimately successful at CAS, and this was defended again on appeal. However, the contention remains in the scientific community that the case has not been made that circulating testosterone can fully explain all the observed difference in male/female performance variables (Jordan-Young & Karkazis 2019).

Importantly, the corollary of circulating testosterone levels not being fully accountable for this difference is that there must be another, as yet undefined factor(s), which must account for the remaining differences following testosterone suppression. The retained advantage may mean that previous testosterone exposure is responsible for long-term effects, or there is another explanation, perhaps referable to genetic differences, which has not yet been identified.

Following the legal cases, World Athletics also created policy for the inclusion of transgender women based on suppression of testosterone levels to 5nmol/L. Between 2018 to 2019, several major sporting international governing bodies developed policies at the 5nmol/L level for transgender women, in comparison with the 10nmol/L defined by the IOC.

Medical and Psychosocial Aspects

A review published in 2017 by Bethany Jones and colleagues from Nottingham/Loughborough Universities looked at research that explored the experience of transgender people in sport, as well as the policies which were in place at the time which influenced such experience. While only eight research papers met the criteria for the study, in those which looked at the experience of transgender inclusion, it was acknowledged that the experience of transgender people in sport was largely negative. The authors' assessment of the available literature on physical parameters was to highlight the lack of direct comparative data in athletes on which to base exclusionary policies. They indicate that 'There are several areas of future research required to significantly improve our knowledge of transgender people's experience in sport, inform the development of more inclusive sport policies, and most importantly, enhance the lives of transgender people, both physically and psychosocially" (Jones et al, 2017).

Differences in physiology and health parameters between males and females have long been acknowledged and recent research has shed light on how this affects performance, as well as health, illness and injury. The menstrual cycle creates challenges for many female athletes and the variable nature of ovarian hormones can limit training and performance, and also alter perceptions of wellbeing. Furthermore, amenorrhoea (loss of menstrual cycling) is common in sport due to high training loads and inadequate energy intake. This has secondary consequence of not just altered fertility but increased rates of injury and illness. The naturally lower bone density of females is further reduced with the hormonal deprivation of amenorrhoea and this group is particularly prone to stress fractures, a significant problem in running sports. Female athletes are not immune to gynaecological illnesses, and endometriosis which has an incidence of up to 20% in the general population, has plagued the career of several high-profile athletes who have chosen to go public with their inability to compete as a result of pain and illness.

Recent research has highlighted the relationship of the menstrual cycle and the observed increased injury incidence and slower recovery in women compared with men, in particular for concussion (McGroarty et al 2020), and major ligament injury such as anterior cruciate ligament tears (Wojtys et al 2002). The physical problems related to the menstrual cycle are now so well appreciated that ongoing research in health and hormonal monitoring is taking place in the UK (Football Association) and abroad. This research is designed to define parameters whereby limitations to training and performance can be minimised.

By way of comparison, it is known that transgender people suffer increased risk of ill-health as a result of medication and cross-sex hormone therapy. Transgender women face heightened risk of thrombo-embolic disease, arterial disease, liver dysfunction and breast cancer (although at levels lower than females). Transgender men risk high red cell levels (polycythaemia), hypertension and arterial disease, as well as reproductive cancer. These are chronic conditions for which exercise is both preventive and therapeutic and are unlikely to present any direct negative effects in relation to sporting performance. Certainly, evidence indicates that bone health and density is maintained in transgender women despite testosterone suppression (Van Caenegem et al 2015).

Over time it may become apparent that medically transitioning will lead to health and injury issues specific to transgender athletes, but this will not have the cyclical nature of gynaecological function and any sport specific concerns are likely to be different to those experienced by females and males. It will be important to track and define the health consequence of the required medical treatments required by sports agencies to compete in one's affirmed gender.

We are not aware of research which will allow any conclusions to be drawn on the current medical practice of transition in younger people, and what effect this may have on physical and sporting capacity. In the UK, so-called 'puberty blockers' are generally not used until Tanner maturation stage 2-3 (i.e. after puberty has progressed into early sexual maturation), and medical practice is currently under review. As described above it is evident that current knowledge cannot explain the exact derivation of all the performance differences between the sexes, and correspondingly what, if anything, can be done to reverse these differences in adults.

While exercise and activity are known to positively impact mental health, elite level training and competition are known to increase stress. Both competitive athletes and transgender people have separately reported high levels of mental ill-health, notably anxiety states, depression, and poor coping mechanisms with stress: These include self-harm and eating disorders. It is not known how the stresses of competition may affect transgender athletes.

Reports of suicidality in transgender people are contentious. A recent large-scale meta-analysis of five peer-reviewed papers of over 1000 study subjects found a prevalence of suicide attempts of 14.8% (Surace et al, 2020). This is at odds with other commissioned reports of smaller sample sizes which give much higher estimates.

There is no contention however as to the value of physical activity and community membership on mental health outcomes. These benefits should be available to all.

Ethical Considerations

The notion of ethics within sport is largely based on established theories of fairness and fair play, advantage, inclusion, safety and values. The competing ‘rights’ of individuals can be explored through both legal and philosophical discourse. These writings are beyond the scope of this document; however, it is relevant to consider the implication of sporting rules (such as testosterone suppression or use of puberty blockers) which may or may not have a desired outcome, and which have can have unintended poor health outcomes for the individual. Further, the development of protocols within sport which create an environment whereby ‘case-by-case’ analysis judgements of an individual may restrict their rights, as well as those of others, can be fraught.

Conclusion

Sexual dimorphism in relation to sport is significant and the most important determinant of sporting capacity. The challenge to sporting bodies is most evident in the inclusion of transgender people in female sport.

Current international rules require testosterone suppression to achieve equity in female sporting competition. In the light of existing evidence, the following is likely to be true:

Testosterone supplementation in transgender men results in strength and stamina (haemoglobin) parity with males within twelve months. Skeletal differences (smaller physique) will remain in keeping with female dimensions.

Testosterone suppression has differing effects for different body systems, and this can be correlated with the factors of ‘gender-affected sport’; Strength, Stamina and Physique;

- Strength; Modest change within 12 months: Muscle mass (and perhaps cardiac size) and hence strength - appears retained at significantly higher levels than females.
- Stamina; Restoration of haemoglobin levels to female typical levels within 12 months: with relevant effect on oxygen carrying capacity as yet undefined.
- Physique; Minimal change: Structural features including the skeleton, bone density, height, lung and airway size, and tendon/ligament strength will remain, with modest loss of muscle mass.

This evidence suggests that parity in physical performance in relation to gender-affected sport cannot be achieved for transgender people in female sport through testosterone suppression. Theoretical estimation in contact and collision sport indicate injury risk is likely to be increased for female competitors.

There are significant ethical and legal considerations associated with the requirement for treatment which may not result in the desired outcome. Ongoing research may allow better understanding of comparative data to inform decision making.

The health and social imperative to include transgender people in physical activity and sport is paramount. The task for the National Governing Bodies of sport is to achieve safe, fair and inclusive sport, and/or inclusive, fair and safe sport. How this can be achieved will be explored within this review process.

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