Sports Medicine Considerations When Caring for the Transgender Athlete

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Abstract: Orthopaedic surgeons and other orthopaedic care providers have expressed a desire to care for transgender patients but have a self-perceived knowledge deficit. Transgender athletes experience many psychosocial barriers to sport that are useful for clinicians to understand. Medical and surgical gender-affirming care can impact musculoskeletal physiology and pathophysiology. Transgender women (TW) have demonstrated an increased risk of insufficiency fractures and thromboembolism in patients receiving exogenous estrogen therapy. The impact of gender-affirming care on sex-based differences in athletic injuries is less well studied.

Introduction

In the United States, approximately 1.6 million (0.6%) individuals ages 13 and older identify as transgender.[1] Unfortunately, clinician bias, deficiency in education, and discrimination contribute to disparities in transgender patient care.[2] In a study by Feroe and colleagues, pediatric orthopaedic surgeons surveyed demonstrate considerable interest and comfort in caring for transgender youth but express a relative knowledge deficit.[2] Specifically, these surgeons desire to better understand how hormone replacement therapy impacts musculoskeletal physiology, such as bone health.[2] Given the discrepancy between desire and perceived knowledge, this article serves as a review for orthopaedic surgeons, orthopaedic care providers, and rehabilitation specialists when caring for transgender athletes.

Organized sports have an unfortunate tradition of exclusion based on identity. Only in the early 1900s were women permitted to participate in the Olympic Games in specific events.[3] Biological sex has been long used as a metric for separation in sports to provide a basis of fairness. In 1948, female competitors were required to bring medical certificates to prove their eligibility to compete as women.[4] Beginning in 1968, Barr Body testing was performed via buccal smear, allowing for visualization of stained chromosomes under the microscope.[4,5] By 1999, the International Olympic Committee (IOC) and the International Amateur Athletic Federation (IAAF), now known as World Athletics, abandoned sex testing.[4] As the number of individuals who identify as transgender increase, policymakers at different levels of sport have worked to increase inclusivity for transgender athletes.

It is important to first define terminology that should be understood when caring for transgender patients. (Table 1).[6] In this paper, cisgender patients will be referred to assigned male at birth (AMAB) and assigned female at birth (AFAB) when discussing physiologic differences.[7]

Gender-Affirming Care

Patients who identify as transgender may elect to proceed with medical or surgical affirming care. Data have demonstrated that gender-affirming care is associated with increased quality of life and decreased gender dysphoria.[6,8,9] Medical forms of gender-affirming care include exogenous hormone supplements and hormone-blocking agents. When initiated at or before puberty, the use of gonadotropin-releasing hormone (GnRH) agonists can suppress gender-incongruent puberty.[6] GnRH agonists paired with

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Table 1. Relevant Definitions

Relevant Definitions*	
Gender Identity	A person's internal self-view with respect to gender
Sex	The sex assigned at birth, based on assessment of external genitalia, as well as chromosomes and gonads. Historically, interchangeably used with gender but there are significant differences
Gender expression	The expression or display of gender by an individual to the world. Examples include clothing, hairstyle, and mannerisms. Gender expression does not have to align with gender identity
Transgender	A person whose gender identity differs from the sex that was assigned at birth. May be abbreviated to trans
Transgender man (TM)	A person whose gender identity is man but was assigned the female sex at birth
Transgender woman (TW)	A person whose gender identity is woman but was assigned the male sex at birth
Cisgender	A person whose gender identity aligns with sex assigned at birth. Assigned male at birth (AMAB) Assigned female at birth (AFAB)
Gender nonconforming / genderqueer	A person whose gender identity differs from the sex that was assigned at birth, but may be more complex, fluid, multifaceted, or otherwise less clearly defined than a transgender person
Nonbinary	Transgender or gender-nonconforming person who identifies as neither man nor woman
Gender Dysphoria	Persistent distress arising from incongruence between gender identity and external expression

*Definitions are referenced from the University of California San Francisco Department of Transgender Care and from Chen and colleagues.[6]

gender-affirming hormones (GAH, testosterone, and estradiol) help attenuate gender-congruent secondary sex characteristic development during puberty.[6] Studies have shown reduction in depression, anxiety, and overall increases in well-being in transgender youth patients receiving gender-affirming hormone treatment.[6]

Hormone treatment for transgender men (TM) consists of exogenous testosterone sometimes paired with GnRH analogs or depot medroxyprogesterone to concomitantly suppress estrogen.[10] Transgender women (TW) may elect to use anti-androgenic medications, such as spironolactone, coupled with estrogen supplementation. Gender-affirming female hormone treatment influences secondary sex characteristics by increasing breast tissue and body fat, while decreasing body hair and testicular size.[9,11] Athletes who undergo hormone treatment must submit therapeutic use exemption (TUE) prior to competition.[10,12] A TUE application is only granted once eligibility and gender have been established with an athletes' sport federation.[13] Any treating physician may complete a report documenting the patient's medical history and hormone therapy.[13] Patients undergoing hormone replacement will experience changes in other physiological factors important to sport, including cardiac output, lean body mass, hemoglobin levels, lipoprotein levels, and change in bone architecture.[14]

There are various gender-affirming surgical care options. TM may undergo top surgeries, such as mastectomy or chest wall reconstruction. Bottom surgeries include hysterectomies, salphingo-oophorectomy, vaginectomy, metoidioplasty, scrotoplasty, phalloplasty, or testicular prosthetic insertion.[10,15] TW additionally have options for top and bottom surgery including breast reconstruction, penectomy, clitoroplasty, labiaplasty, orchiectomy, or vaginoplasty.[10,15]

Participation in Sport and Psychosocial Barriers

Studies have varied, but lower participation rates of transgender individuals in sport in the United States have been found in comparison to cisgender athletes.[16] One study demonstrated TM are significantly more likely to participate in team sports than TW.[17,18] TW have attributed the primary barrier to participation as the absence of an inclusive, comfortable environment.[17] Overt transgender negativity has been documented in sport predominantly through verbal assault and disparagement.[16] Most commonly, this discrimination comes from fellow participants rather than coaches or spectators.[16]

Locker rooms contribute to psychosocial distress with transgender athletes detailing experiences of shame, body incongruence, and concern for reactions from others.[16,19] In 2017, 16 states considered legislative bills regarding restricting access to bathrooms by transgender individuals.[19] These bills ultimately failed; however, data from outreach to the Trevor Project— an organization for suicide prevention services for LGBT youth—showed during this period transgender outreach more than doubled.[19] Without a safe and comfortable place for athletes to change their clothes, including athletes who are restricted from the locker room that matches their gender identity, transgender athletes may feel excluded from participation in athletics.[19]

Certain sports clothing may serve as a barrier to athletic participation due to its revealing nature.

Athletes who do not pursue gender-affirming surgeries can particularly be impacted by uniforms. TW who have not had bottom surgeries may be required to use the "tucking" technique to hide the penis and testicles.[17] Moreover, TM athletes may bind their chests and TW athletes add padding to bras.[17] This can contribute to both discomfort and hinder athletic performace.[17]

Finally, policy serves as a barrier to participation. Governing bodies in different levels of sport have varying regulations regarding who gets to participate. It is imperative for orthopaedic surgeons to remain aware of changing policies, as sports continue to become more inclusive.

Policy Impacting Transgender Athlete Participation

International Olympic Committee

Beginning in 2003, the International Olympic Committee (IOC) created a policy regarding the participation of transgender athletes in Olympic competition.[9] The initial policies allowed for athletes who transitioned from their sex at birth prior to puberty to compete in an alternate gender category. Further criteria, including surgical intervention, hormonal therapy, and legal acknowledgment of transition was required for athletes who transitioned after puberty.[10] These policies elicited mixed public responses regarding the restrictive nature of the criteria.

Following the IOC Consensus Meeting on Sex Reassignment and Hyperandrogenism, less restrictive guidelines were put into place to ensure that transgender athletes would not be excluded from the opportunity to participate in sporting events while maintaining fair competition in these events.[20] On the basis of ensuring AFAB experienced fair competition in sport, the updated guidelines required that athletes maintain a total testosterone level in serum below 10 nmol/L for at least 12 months prior to and throughout competition to be able to compete in the female category.[20] Subsequently, if the athlete is not eligible to compete in the female competition, they remain eligible to compete in the male category. Of note, the IOC does state that testing may occur to ensure compliance of these serum levels. The guidelines also state that TM can compete in the male category. The World Anti-Doping Agency (WADA) has recommended testosterone-dosing guidelines for TM, for example, a maximum dosing of 100-125 mcg weekly of intramuscular testosterone.[13] Physicians and athletes must record and submit testosterone product, dosage, and timing yearly and for review with each dosing change. [13] WADA does leave dosing up to the discretion of the treating physicians but calls for unannounced urine testing (1-2 times per year) and regular hematocrit monitoring in TM athletes.[13] Moreover, physicians must send serum testosterone levels once or twice a year and include with their yearly submission.[13] The US Anti-Doping Agency (USADA) works in accordance with WADA's physician and patient guidelines.

After a two-year consultation process with more than 250 athletes and stakeholders, in 2021, the IOC published an updated statement on an inclusion framework as part of their commitment to human rights and the Olympic Agenda.[21] This framework is grounded in fairness, inclusion, nondiscrimination, and respect for internationally recognized human rights. Although preserving the principles of the Olympic Charter, the IOC's framework is intended to promote a harassment-free environment at the elite level and does so by using a 10-principal approach for individual sports to develop their own sport-specific criteria.[21] The 2021 consensus statement uses an evidence-based approach that relies on peer-reviewed research to inform restrictions that maintain no presumption of advantage for transgender athletes.[22]

Continuing their efforts for maximal inclusivity, the IOC announced a new set of rules and restrictions for transgender athletes prior to the 2024 Paris Olympic Games.[23] The updated rules continue to move away from hormone level regulations and give more autonomy to the governing bodies of each sport and allow them to create "category qualifiers".[23] As an effort to have eligibility go beyond gender identity, sex variation, physical appearance, these sport-specific criteria will consider mental health, social, cultural, ethical, and legal factors prior to determining the eligibility of an athlete. The hope is that this new approach will decrease the pressure that transgender athletes experience to undergo specific treatments to meet sport eligibility criteria.[23] Although not perfect, the IOC is continuously updating guidelines based on new research and education regarding transgender athletes.

World Athletics and World Aquatics

Recently, two of the governing bodies, World Aquatics and World Athletics, recognized by the IOC for administering international swimming and track and field competitions, respectively, updated policies impacting transgender athlete participation. World Aquatics, formerly known as FINA, established parameters that TM may compete in the men's category, but increased restrictions on TW participation in the women's category.[24] TW are only permitted if they did not experience male puberty before age 12 or Tanner Stage 2.[24] Moreover, World Aquatics requires TW must have maintained serum testosterone levels below 2.5 nmol/L.[24] On March 31, 2023, World Athletics adopted the policies of World Aquatics to limit TW participation in the women's category.[25] World Aquatics made reference to universal participation of athletes in "Open Events" once they become available.[24] Of note,

swimming is hypothesized to be the sport with the smallest performance gap between assigned males at birth (AMAB) and assigned females at birth (AFAB).[3]

National Collegiate Athletic Association

The National Collegiate Athletic Association (NCAA) has also prioritized efforts to create inclusive policies for transgender athletes. As of July 2018, the NCAA required that TW athletes complete at least 1 year of hormone therapy in order to compete in the female category.[10] The NCAA also allowed TM athletes who were not undergoing hormone therapy to compete in the female category. The requirements for competing in the male category at this time included TM athletes receiving hormone therapy who have a medical exemption for use of testosterone or not receiving hormone therapy, TW athletes who have completed less than 1 year of hormone therapy, and TW athletes who were not on any hormone therapy.[10]

In January 2022, the NCAA Board of Governors updated the transgender student-athlete participation policy in a multi-phase approach beginning with the Winter and Spring Season Championships. Phase 2 of this policy includes regular season play and subsequent championships. The new regulations build on the 2010 NCAA policies, as described above, and, in addition, required sport-specific testosterone levels to be met by athletes.[26] Phase 3 will begin in August of 2023 and will require that transgender student-athletes submit sport-specific eligibility documentation both prior to the season beginning and 6 months following season's ending. Further, documentation of testosterone levels 4 weeks prior to championship selections will be required for participation of transgender athletes in NCAA Championship events.[26] Continued efforts toward promoting diversity and equity for these athletes remain a priority for the NCAA Board of Governors.

Overall, it is important for orthopaedic surgeons to have general awareness of the IOC and NCAA policies to best help advocate for the health of these athletes. Further, an understanding that these policies are constantly changing and are different from one organization to another is vital to ensuring that guidance and recommendations for these athletes is based on current requirements.

Mental Health

Physical activity is a known protective factor in mental health.[27] Data has shown an association between increased self-esteem and increased physical activity in transgender adolescents.[28] Given the aforementioned psychosocial and policy barriers for participation in athletics, there is concern that transgender individuals may not be afforded equal opportunity for the protective benefits of exercise and sport. Considering the prevalence of suicide among transgender Americans, orthopaedic surgeons advocate for the importance of athletics as an avenue for whole-patient care.[29]

Physiological Considerations

Bone Health

Sex steroids are important mediators in bone homeostasis. In AMAB, testosterone stimulates periosteal apposition, resulting in increased cortical bone.[30] On the contrary, in AFAB, estrogen stimulates endosteal bone formation.[30] Interestingly, AFAB with hyperandrogenism have higher bone mineral density (BMD) than AFAB with androgen insensitivity demonstrating that testosterone also regulates BMD in AFAB.[30] Moreover, AMAB athletes with aromatase deficiency with normal testosterone levels have demonstrated lower BMD, demonstrating the participation of estrogen in bone health in AMAB.[30]

Given this importance of estradiol in bone health for AFAB, there is a theoretical increased risk for poor bone health in TM who receive exogenous testosterone therapy. However, there has been no demonstrated deterioration in bone microarchitecture in TM.[31] Interestingly, TW taking estradiol had lower cortical bone mineral density compared to AMAB controls.[31] This may be due to insufficient levels of estradiol to offset bone loss or that TW had lower baseline bone mineral density levels.[31] There may be a place for bisphosphonate therapy for TW to help increase bone density.[31] Given the decreased bone mineral density and increased bone loss in TW, there is an increased risk for these patients to experience insufficiency fractures. TW under 50 compared to an AFAB cohort younger than 50 demonstrated an increased rate of fractures in TW.[9,30] When transgender patients have gonadectomies, there is a higher risk of bone loss and low bone mineral density in patients who cease hormone therapy.[10] Clinical guidelines recommend bone mineral density evaluation in individuals with risk factors for osteoporosis and for those who stop sex hormone therapy after gonadectomy.[10,32]

Muscle Response and Body Composition in Response to Gender-Affirming Care

At baseline, AMAB have greater muscle length, increased contractile force, and more muscle mass than AFAB.[3] Moreover, AMAB, in general, have longer limb levers, stronger bone, and greater aerobic capacity. AFAB have demonstrated less muscle fatiguability and faster recovery during exercise.[3] Physiological differences have contributed to the sex-based separation in sport. Although there are quantifiable performance-related differences between AMAB and AFAB athletes, there have been no prospective studies on the impact of gender-affirming treatment on performance

in transgender athletes.[33] Testosterone results in higher overall muscle volume and larger muscle fibers creating a higher maximum power output.[3] TW who receive hormonal therapy and testosterone suppression demonstrate significant decreases in strength, lean body mass, and muscle area after 12 months of therapy.[33] These values, however, remained above those of AFAB, even after 36 months of testosterone-suppressing gender-affirming therapy.[33] Handgrip is commonly used as a surrogate for strength. At baseline, nonhormonally treated TW have a 14% weaker handgrip, which is further reduced by another 7% with hormonal treatment.[33] A study examining knee extensor and flexor strength in individuals receiving 12 months of gender-affirming treatment demonstrated a 15% increase in thigh muscle volume in TM and a 5% decrease in thigh muscle volume of TW.[34] One metanalysis found that TM gained on average 3.9 kg of body mass, whereas the TW receiving gender-affirming hormonal treatment lost 2.4 kg of overall body mass.[34,35]

Ligamentous Stability

In further consideration of the physiological impact of hormone treatment on the musculoskeletal system, it is important to discuss the effect on ligamentous stability. Beginning at puberty, there is an increased risk of anterior cruciate ligament (ACL) tears in AFAB in comparison to AMAB due to a balance of fixed and modifiable reasons. Additionally, the change in hormonal balance is thought to contribute to ligamentous laxity. Hormone levels in AFAB fluctuate based on phase of menstrual cycle. Some data have demonstrated association of ACL injuries and the preovulatory phase when estradiol levels are at their highest.[36] Moreover, only in AFAB do fibroblasts in the ACL have receptors for relaxin, a hormone also elevated during the follicular phase.[3] Estrogen is associated with increased ligamentous laxity and decreased strength to failure.[36,37] One prospective study found increased levels of relaxin in patients with ACL tears.[38] Relaxin functions through the release of collagenases to reduce ACL bulk and strength.[3,38] Relaxin is released by the corpus luteum; thus, TM who undergo hysterectomies are theoretically expected to have lower levels of circulating relaxin. Exogenous hormone impact from oral contraceptive pills have not demonstrated any consistent data on change in ligamentous laxity.[39] Oral contraceptives were thought to potentially provide a protective effect against ACL injury due to their stabilization of hormone levels.[39] Theoretically, this could be extrapolated to a consistently elevated ACL injury risk in TW undergoing exogenous hormone treatment given a lack of menstruation. Currently, no studies have specifically explored the phenomenon of exogenous hormone administration or suppression and ligament stability in transgender athletes.[10] In both TW undergoing exogenous hormone treatment and TM, especially TM who have not undergone hysterectomies, it is recommended that orthopaedic care providers focus on modifiable risk factors, such as landing patterns to help prevent ACL injuries.[40]

Thromboembolism Risk

There is a known increased risk of thromboembolism for patients receiving exogenous estrogen therapy. It is clinically recommended to avoid ethinyl estradiol administration, as it is associated with the most significant increased venous thromboembolism (VTE) risk.[10,41] Thrombosis prophylaxis in transgender athletes requiring surgery is necessary.[41] Data are mixed regarding recommendations on halting hormone treatment in the perioperative period. Some recommend stopping hormone therapy at least 2 weeks prior to major surgery and resuming only after 3 to 4 weeks following full mobilization.[41] Another study did not find increased risk of VTE in TW who continued gender-affirming treatment during the perioperative period.[42]

Injury Patterns

There are known sex differences in athletic injuries; however, there have been no studies that explicitly examine injury patterns in transgender athletes. AFAB athletes have an increased risk of ACL tears due to a variety of physiological factors. AFAB tend to jump, cut, and pivot with quadriceps dominant contraction and have less hip and knee flexion.[3] Further, AFAB have less knee joint stiffness and increased anterior tibial translation, all of which contribute to greater stress on the ACL.[3] Moreover, AFAB athletes have increased posterior tibial and meniscal slope with a smaller intercondylar notch and native ligaments, further predisposing them to ACL injuries.[3] AFAB are more predisposed to multidirectional shoulder instability due to smaller glenoids with higher inclination angles, increased shoulder range of motion, and increased prevalence of relative ligamentous laxity.[3] AMAB have higher risk of traumatic anterior shoulder instability with the literature showing ~2.8 times increased risk of shoulder dislocations.[43] Overall, AMAB athletes are at higher risk of injury, most commonly experienced as muscle strains in their upper leg.[3]

Patellofemoral Pain Syndrome (PFPS) is disproportionately more commonly experienced by AFAB.[40] Increased incidence of PFPS is caused by both modifiable risk factors, such as quadriceps and hip abductor weakness and nonmodifiable factors such as Q angle and patellar tracking. Stress fractures associated with relative energy deficiency in sport (RED-S) are more frequently sustained AFAB athletes.[44] One study found low-energy availability in up to 36% of AFAB high

school athletes.[44,45] There are also sex-related differences in femoroacetabular impingement (FAI), with cam lesions are more common in AMAB athletes.[44]

There is a paucity of data that specifically examines differences in injury demographics between TM and TW athletes; however, it is important to keep in mind certain sex differences in injury patterns that may be altered by new body composition secondary to gender-affirming treatment or remain despite it. For example, TM athletes will remain with certain nonmodifiable risk factors for PFPS, such as their Q angle. It is recommended that orthopaedic surgeons and other care providers increase their attention to modifiable risk factors in prevention of common athletic injuries in transgender athletes.

Transgender athletes may have gender-affirming surgery postoperative musculoskeletal complaints. For example, shoulder stiffness is a known potential postoperative complication of mastectomy.[10] Chest reconstruction additionally can be associated with chest tightness.[10] Athletes whose testicles have not been removed should be encouraged to continue to wear athletic cups for protection.

Youth Sports

In youth sports and recreational sports, social and cultural barriers to participate in sport can be costly for transgender athletes' mental and physical health. Feroe et al. discussed a paucity in research regarding clinician attitudes and knowledge that orthopaedic surgeons have of LGBTQ+ children and their adolescent healthcare needs.[2] This study found that 94% of orthopaedic surgeon respondents felt comfortable treating transgender athlete youth; however, only 49% of them felt confident in their knowledge of their healthcare needs.[2] Interestingly, physicians had significantly more knowledge than coaches and physical trainers in caring for transgender youth athletes.[46] To best support transgender athletes, these multidisciplinary teams need to have health knowledge and be aware of appropriate resources.

Since May of 2021 United States legislatures have been introducing bills and policy in an attempt to restrict both gender-diverse and transgender youth in gender-segregated sports.[47] At the university level, equity, diversity, and inclusion (EDI) policies have been developed to minimize discrimination for marginalized groups. Arora et al. sought to analyze the extent and how sports, kinesiology, and physical education focused academic literature engages with EDI concepts and found that there is a major gap in the literature.[48] Legislation restricting youth transgender athletic participation in sports concordant with their gender, forces these athletes to participate in areas discordant with their genders potentially exacerbating fear of discrimination and violence, and may lead to avoidance of gender-segregated athletic spaces.[49]

In transgender adolescents, exogenous sex hormone administration may impact physeal closure through decreasing the speed of bone turnover.[9,50,51] If puberty is delayed by GnRH agonists, older transgender athletes may be at risk for Salter-Harris type fractures.[9] Moreover, puberty is critical in the accumulation of bone mass.[50] GnRH agonists have the potential to decrease bone mineral density in transgender adolescents, but treatment with gender-affirming exogenous hormones seems to permit bone mineral density to remain fairly normal.[50,51] It is prudent for orthopaedic surgeons to survey their pediatric transgender patients' bone health.

Conclusion

In summary, transgender athletes have unique considerations in orthopaedic care (Table 2). TW athletes have demonstrated increased risk of insufficiency fractures, and exogenous estrogen carries an increased risk of venous thromboembolism. Certain sex-based differences in injury may be impacted by gender-affirming medical treatment, but no studies currently exist. Given the paucity of data on this topic and expansion of inclusivity of transgender athletes in sport, we advocate for further research into the impact of gender-affirming

Table 2. Key Considerations and Recommendations for Orthopaedic Surgeons and Specialists

Consideration	Recommendation
Risk for decreased bone mineral density in pediatric patients and delayed physeal closure	Survey pediatric transgender patients' bone health
TW athletes have an increased risk of insufficiency fractures	BMD screening in TW patients
Higher risk of bone loss and low bone mineral density in patients who have gonadectomies and cease hormone therapy	BMD evaluation in individuals with risk factors for osteoporosis and those who stop sex hormone therapy after gonadectomy
TW athletes undergoing estrogen therapy have an increased risk of VTE.	Recommend VTE prophylaxis with any surgical procedure given elevated risk
Athletics are a protective health factor and inclusion policies are changing.	Orthopaedic care providers should remain advocates of their transgender athletes.
Both TW athletes receiving hormone therapy and TM athletes may be at increased risk for ligamentous injury (e.g., ACL injury).	Ensure modifiable risk factors are addressed (e.g., landing pattern modification).

care on the health and injury profile of transgender athletes. Athletics are a known protective factor for health of transgender patients and orthopaedic surgeons can serve as vital advocates for their patients. As sport becomes more inclusive, we recommend sports medicine surgeons remain abreast of policy changes to support their patients.

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