EXHIBIT 2

Expert Report of Dr. Chad Thomas Carlson, M.D., FACSM

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INTRODUCTION

Up to the present, much of the news, debate, and even scholarship about transgender participation in female athletics has focused on sports such as swimming or track and field, and the debate has largely concerned questions of fairness and inclusion. However, the transgender eligibility policies of many high school athletic associations in the United States apply with equal force to all sports, including sports in which players frequently collide with each other, or can be forcefully struck by balls, or equipment such as hockey or lacrosse sticks. And in fact, biologically male transgender athletes have competed in a wide range of high school, collegiate, and professional[1] girls' or women's sports, including, at least, basketball,[2] soccer,[3]

[1] *Nyla Rose*, Fandom: Pro Wrestling Wiki, at https://prowrestling.fandom.com/wiki/Nyla_Rose.

[2] Melissa Isaacson, *Whole New Game for Gabrielle Ludwig*, ESPN (Dec. 20, 2013 at 08:58 PT), https://www.espn.com/espnw/athletes-life/story/_/id/10170842/espnw-gabrielle-ludwig-52-year-old-transgender-women-college-basketball-player-enjoying-best-year-life (accessed 6/22/25)); J. Brady McCollough, *A Christian High School's Moral Crisis Over a Transgender Basketball Star*, S.F. Standard (Mar. 1, 2025, at 06:00 PT, https://sfstandard.com/2025/03/01/trump-transgender-basketball-california-waldorf-cornerstone-christian/ (accessed 6/7/26).

[3] Kevin Landrigan, *NH Bill Limits Women's Sports to Girls Born Female*, N.H. Union Leader (Jan. 14, 2020), https://www.unionleader.com/news/education/nh-bill-limits-women-s-sports-to-girls-born-female/article_d1998ea1-a1b9-5ba4-a48d-51a2aa01b910.html (accessed 6/22/25)); Brian C. Bell, *Mara Gomez Becomes First Transgender Player Signed to Argentina's Top Women's Soccer League*, Outsports (Jan. 17, 2020, at 12:00 PT, updated Apr. 6, 2026), https://www.outsports.com/2020/1/17/21069390/womens-soccer-mara-gomez-transgender-player-argentina-primera-division-villa-san-marcos (accessed 6/22/25); Davi Merchan, *Judge Rules Transgender Teen Can Temporarily Play on Girls' Soccer Team Amid New Law*, abcNEWS (Aug. 21, 2025, at 08:05 PT), https://abcnews.com/US/judge-rules-transgender-teen-temporarily-play-girls-soccer/story?id=112944203 (accessed 6/6/26).

volleyball,[4] softball,[5] lacrosse,[6] field hockey,[7] wrestling,[8] rugby[9], and even women's tackle football.[10]

The science of sex-specific differences in physiology, intersecting with the physics of sports injury, leaves little doubt that participation by biological males in

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[4] Public Affairs, *Student Challenges Assumptions About Transgender Athletes*, UC Santa Cruz (Sep. 8, 2016), https://news.ucsc.edu/2016/09/challenging-assumptions.html (accessed 6/22/25); Cyd Zeigler, *Trans Athlete Tia Thompson Approved to Compete in USA Volleyball Events*, Outsports (Mar. 20, 2017, at 05:32 PT), https://www.outsports.com/2017/3/20/14987924/trans-athlete-volleyball-tia-thompson (accessed 6/22/25); James Gordon, US News, *Horrific Moment Female High School Volleyball Player Suffers Serious Head Injury After Transgender Girl in Rival Team Lobbed '70mph' Ball at Her Head and Struck Her*, Daily Mail (Oct. 22, 2022, at 01:43 ET, updated Oct. 23, 2022, at 23:26 ET), https://www.dailymail.com/news/article-11342755/Female-high-school-volleyball-player-suffers-head-injury-transgender-girl-lobbed-ball.html (accessed 6/6/26).

[5] Perry Chiaramonte, *California's Transgender Law Allows Male High Schooler to Make Girls' Softball Team*, Fox News (Feb. 14, 2014, at 15:27 ET), https://www.foxnews.com/us/californias-transgender-law-allows-male-high-schooler-to-make-girls-softball-team (accessed 6/22/25); Jackson Thompson, *Minnesota High School Defends Trans Softball Pitcher's Playoff Dominance Amid Lawsuit*, N.Y. Post (May 31, 2025, at 21:26 PT), https://nypost.com/2025/05/31/sports/minnesota-champlin-park-high-school-transgender-softball-pitcher-dominates-state-playoffs/ (accessed 6/6/26).

[6] 2022 Lacrosse Roster: Erica Smith, Sweet Briar College: Vixen Athletics, https://vixen athletics.com/sports/womens-lacrosse/roster/erica-smith/1592 (accessed 6/20/21); Tom Joyce, *Male Transgender Athlete Excels for Massachusetts Girls' Teams in Lacross, Hockey, and Cross-Country*, NewBostonPost (June 3, 2026, at 07:39 ET), https://www.newbostonpost.com/male-transgender-athlete-excels-for-massachusetts-girls-teams-in-lacrosse-hockey-and-cross-country/ (accessed 6/6/26); *Boy Playing on Girls Lacrosse Team in Michigan Was Transitioned at 6 Years Old by Parents, Altered Birth Certificate to Hide Biological Sex*, Reduxx (May 28, 2026), https://reduxx.info/boy-playing-on-girls-lacrosse-team-in-michigan-was-transitioned-at-6-years-old-by-parents-altered-birth-certificate-to-hide-biological-sex/ (accessed 6/6/26).

[7] Molly Levine, *Dighton-Rehoboth Student Athlete Seriously Injured in Field Hockey Game, Sparking Safety Concerns*, NBC 10 News (Nov. 3, 2023, at 22:07 ET), https://turnto10.com/news/local/dighton-rehoboth-student-athlete-seriously-injured-in-field-hockey-game-sparking-safety-concerns-southern-new-england-massachusetts-november-3-2023.

[8] *Transgender Texas Wrestler Wins Second High School Girls Title*, NBC News (Feb. 25, 2018, at 19:57 PT), https://www.nbcnews.com/feature/nbc-out/transgender-texas-wrestler-wins-second-high-school-girls-title-n851106 (accessed 6/6/26).

[9] Luke Gentile, *WATCH: Transgender Rugby Player Slams Female Athletes, Coach Says Three Injured*, Denv. Gazette (Apr. 14, 2022, updated 4 years ago), https://www.denvergazette.com/2022/04/14/watch-transgender-rugby-player-slams-female-athletes-coach-says-three-injured/.

[10] Cyd Zeigler, *This Trans Athlete Plays Women's Pro Football, and for USA Baseball*, Outsports (Dec. 13, 2017, at 07:43 PT), https://www.outsports.com/2017/12/13/16748322/britney-stinson-trans-football-baseball (accessed 6/22/25); Evan Frost, *Transgender Football Player Prevails in Lawsuit Against Minnesota Team, League*, MPR News (Dec. 22, 2018, at 13:40 ET), https://www.mpr news.org/story/2018/12/22/transgender-football-player-prevails-in-lawsuit (accessed 6/22/25).

these types of girls' or women's sports, based on gender identity, creates significant additional risk of injury for the biologically female participants competing alongside them.

The last several years have brought a growing awareness of these potential risks. In 2020, after an extensive transparent review of the scientific literature,[11] consultation with experts, and modeling of expected injuries, World Rugby published revised rules governing transgender participation, along with a detailed explanation of how the new policy was supported by current evidence. World Rugby concluded that "there is currently no basis with which safety and fairness can be assured to biologically female rugby players should they encounter contact situations with players whose biological male advantages persist to a large degree," and that after puberty, "the lowering of testosterone removes only a small proportion of the documented biological differences." Hence, World Rugby concluded that biological men should not compete in women's rugby. (World Rugby Transgender Women Guidelines 2020) In February 2026, USA Rugby followed suit, aligned their own policies, formally limiting the female category to those born women, and creating an "open" category that could be accessed regardless of sex. World Rugby has been criticized by some for its new guidelines, but those criticisms have often avoided discussions of medical science entirely, or have asserted that modeling scenarios can overstate true risk. What cannot be denied, however, is that World Rugby's approach

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[11] Media Release, *World Rugby Approves Updated Transgender Participation Guidelines*, World Rugby (Oct. 9, 2020), https://www.world.rugby/news/591776/world-rugby-approves-updated-transgender-participation-guidelines.

is evidence-based, and rooted in concern for athlete safety. As a medical doctor who has spent my career in sports medicine, it is my opinion that World Rugby's assessment of the evidence is scientifically sound, and that injury modeling meaningfully predicts that biologically male transgender athletes do constitute a safety risk for the biologically female athlete in women's sports.

In a similar vein, in 2021, the UK Sports Councils' Equality Group released new guidance for transgender inclusion in organized sports. This guidance was formulated after extensive conversations with stakeholders, a review of scientific findings related to transgender athletes in sport through early 2021, and an assessment of the use by some sport national governing bodies of case-by-case assessment to determine eligibility. Noteworthy within these stakeholder consultations was a lack of consensus on any workable solution, as well as concerns related to athlete safety and "adherence to rules which give sport validity." The Literature Review accompanying the guidance document further noted that "[t]here are significant differences between the sexes which render direct competition between males and females . . . unsafe in sports which allow physical contact and collisions." (UK Sports Councils' Equality Group Literature Review 2021 at 1) Their review of the science "made clear that there are retained differences in strength, stamina and physique between the average woman compared with the average transgender woman….*with or without testosterone suppression*." (UK Sports Councils' Equality Group Guidance at 3) This was also reflected in their ten guiding principles, stating that physical differences between the sexes will "impact safety parameters in sports which are combat, collision or contact in nature." (UK Sports Councils' Equality Group Guidance 2021 at 7) Ultimately, UK Sport concluded that the full inclusion of transgender athletes in women's sports "couldn't be reconciled within the existing structure of sport," stating that "the inclusion of transgender people into female sport cannot be balanced regarding transgender inclusion, fairness and safety in gender-affected sport where there is meaningful competition." (UK Sports Councils' Equality Group Guidance 2021 at 5, 6) Finally, UK Sport affirmed the use of sex categorization in sport, along with age and disability, as important for the maintenance of safety and fairness. (UK Sports Councils' Equality Group Guidance 2021 at 7–8)

More recently, in 2024, the Association of Ringside Physicians published a guidance paper, delineating the risks inherent in allowing biological males to participate in women's boxing. Noting the legacy advantages inherent through experiencing male puberty, ARP noted that testosterone levels in isolation are inadequate to ensure fairness in competition, and that because safety should be the primary concern, "gender identity has no role in determining competition classification in combat sports." Drawing on "common sense principles, extrapolation from related research, and decades of combat sports medical experience," and also noting the unique "risk for acute and chronic skeletal, vascular, ophthalmological, and brain injuries" in combat sports," their guidelines recommend limiting competition between boxers of the same biological sex as "necessary and proportionate to the goal of ensuring fair, safe and meaningful competition."

(Bascharon 2023) These recommendations were at least indirectly reflected in World Boxing's August 2025 decision to require genetic testing in order to help determine eligibility.[12]

While there has been recent progress by sport governing organizations in considering fairness and safety, the public discourse, including the policies of many state-based athletic associations, remains somewhat muted on this issue. As a physician who has spent my career caring for athletes, I find this general neglect about athlete safety both surprising and concerning. It is my hope to equip and motivate sports leagues and policy makers to give adequate attention to the issue of safety for female athletes when transgender policies are being considered. In this paper, I first explain the nature and causes of common sports injuries. I then review physiological differences between male and female bodies that affect the risk and severity of injuries to females when biological males compete in the female category, and I explain why testosterone suppression does not eliminate these heightened risks to females. Finally, I explain certain conclusions about those risks.

CREDENTIALS

1. I am a medical doctor practicing Sports Medicine, maintaining an active clinical practice at Stadia Sports Medicine in West Des Moines, Iowa. I received my

[12] Press Release, *World Boxing Confirms Mandatory Sex Testing Will Apply in the Female Category at the Inaugural World Boxing Championships 2025*, World Boxing (Aug. 20, 2025), https://worldboxing.org/world-boxing-confirms-mandatory-sex-testing-will-apply-in-the-female-category-at-the-inaugural-world-boxing-championships-2025/.

M.D. from the University of Nebraska College of Medicine in 1994 and completed a residency in family medicine at the University of Michigan in 1997.

2. Following my time in Ann Arbor, I matched to a fellowship in Sports Medicine at Ball Memorial Hospital in Muncie, Indiana, training from 1997 to 1999, with clinical time split between Central Indiana Orthopedics, the Ball State Human Performance Laboratory, and the Ball State University training room. I received my board certification in Sports Medicine in 1999, which I continue to hold. Since residency training, my practice has focused on Sports Medicine—the treatment and prevention of injuries related to sport and physical activity.

3. Since 1997, I have served in several clinical practices and settings as a treating physician, including time as team physician for both the University of Illinois and Ball State University, where I provided care to athletes in several sports, including football, ice hockey, basketball, field hockey, softball, gymnastics, soccer, and volleyball. In the course of my career, I have provided coverage for NCAA Power Five Conference championships and NCAA National Championship events in basketball, field hockey and gymnastics, among other sports, as well as provided coverage for national championship events for U.S.A. gymnastics, and U.S. Swimming and Diving. I have also covered professional soccer in Des Moines.

4. Since 2006, I have been the physician owner of Stadia Sports Medicine in West Des Moines, Iowa. My practice focuses on treatment of sports and activity-related injury, including concussive injury, as well as problems related to the physiology of sport.

5. I have served in and provided leadership for several professional organizations over the course of my career. In 2004, I was designated a Fellow of the American College of Sports Medicine (ACSM). I have served on ACSM's Health and Science Policy Committee continuously from 2010 to 2026, and for a time chaired their Clinical Medicine Subcommittee. From 2009 to 2013, I served two elected terms on the Board of Directors of the American Medical Society for Sports Medicine (AMSSM), and during that time served as Chair of that body's Practice and Policy Committee. I was subsequently elected to AMSSM's executive committee in 2017, and from 2019 to 2020, I served as AMSSM's President. AMSSM is the largest organization of sports medicine physicians in the world. I gained fellowship status through AMSSM in 2020—my first year of eligibility. My work for ACSM and AMSSM has brought with it extensive experience in public policy as relates to Sports Medicine.

6. In 2020, I was named as AMSSM's first board delegate to the newly-constituted Physical Activity Alliance. I was a named member of an NCAA advisory group on COVID-19, through which I provided input regarding the cancellation of the basketball tournament in 2020. I also serve as a member of the Iowa Medical Society's Sports Medicine Subcommittee.

7. I have served as a manuscript reviewer for organizational policy pronouncements, and for several professional publications, including sports medicine board review books. I have published several articles on topics related to musculoskeletal injuries in sports and rehabilitation, which have been published in

peer-reviewed journals such as Clinical Journal of Sports Medicine, British Journal of Sports Medicine, Current Reviews in Musculoskeletal Medicine, Athletic Therapy Today, and the Journal of Athletic Training. In conjunction with my work in policy advocacy, I have helped write several pieces of legislation, including the initial draft of what became the Sports Medicine Licensure Clarity Act, signed into law by President Trump in 2018, which eases the restrictions on certain practitioners to provide health services to athletes and athletic teams outside of the practitioner's home state. A list of my publications over the past ten (10) years is included as an appendix to this report. In the past four years, I testified as an expert witness by deposition in *B.P.J. v. West Virginia*, S.D. W.V., No. 2:21-cv-00316, *L.E. v. Lee*, No. 3:21-cv-00835, and *Doe v. Horne*, Case No. 4:23-cv-00185-JGZ. I have never testified at trial as an expert.

8. I am being compensated for my services as an expert witness in this case at the rate of $475 per hour.

I. OVERVIEW

9. In this report, I offer information and my own professional opinion on the potential for increased injury risk to females in contact sports (as defined below) when they compete against biologically male athletes.[13] At many points in this report,

[13] In the body of this paper, I use the terms "male" and "female" according to their ordinary medical meaning—that is to say, to refer to the two biological sexes. I also use the word "man" to refer to a biologically male human, and "woman" to refer to a biologically female human. In the context of this opinion, I include in these categories non-syndromic, biologically-normal males and females who identify as a member of the opposite sex, including those who use endogenous hormone suppression to alter their body habitus. In contexts that are not focused on questions of biology and physiology, terms of gender are sometimes used to refer to subjective identities rather than to biological categories—something I avoid for purposes of a paper focused on sports science.

I provide citations to published, peer-reviewed articles that provide relevant and supporting information to the points I make.

10. The principal conclusions that I set out in this report are as follows:

a. Government and sporting organizations have historically considered the preservation of athlete safety as one component of competitive equity.

b. Injury in sport is somewhat predictable based on modeling assumptions that take into account relevant internal and external risk factors.

c. Males exhibit large average advantages in size, weight, and physical capacity over females—often falling far outside female ranges. Even before puberty, males have a performance advantage over females in most athletic events. Since there is no third biological category, a failure to preserve protected female-only categories in contact sports (broadly defined) will ultimately increase both the frequency and severity of injury suffered by female athletes who share playing space with males.

d. Current research supports the conclusion that even confirmed and sustained suppression of testosterone levels by males who have already begun puberty will not fully reverse the effects of testosterone on skeletal size, strength, or muscle hypertrophy, leading to persistence of sex-based differences in power, speed, and force-generating capacity. Put another way, male hormone suppression does not completely reduce or eliminate the increased risk to women that exists when male bodies compete against them in an athletic setting.

11. In this report, I use the term "contact sports" to refer broadly to all sports in which collisions between players, or collisions between equipment such as a stick or ball and the body of a player, occur with some frequency (whether or not permitted by the rules of the game), and are well recognized in the field of sports medicine as causes of sport-related injuries.[14] The 1975 Title IX implementing regulations (34 CFR § 106.41) say that "for purposes of this [regulation] contact sports include boxing, wrestling, rugby, ice hockey, football, basketball, *and other sports* the purpose or major activity of which involves bodily contact." Certainly, all of the sports specifically named in the regulation fall within my definition of "contact sport." Mixed martial arts, field hockey (Barboza 2018), soccer (Kuczinski 2018), rugby (Viviers 2018), lacrosse (Pierpoint 2019), volleyball,[15] baseball, and softball (Lee 2022) also involve collisions (with other athletes or projectiles) that can and do result in injuries, and so also fall within my definition.

[14] It is common to see, within the medical literature, reference to distinctions between "contact" and "collision" sports. For purposes of clarity, I have combined these terms, since in the context of injury risk modeling, there is no practical distinction between them.

[15] *See* Patrick Hruby, *Volleyball Star Hayley Hodson Had It All, Until Blows to Her Head Changed Everything*, L.A. Times (Dec. 8, 2020, at 07:44 PT), https://www.latimes.com/sports/story/2020-12-08/stanford-volleyball-hayley-hodson-concussions-cte-lawsuit (accessed 6/30/25).

II. A BRIEF HISTORY OF THE RATIONALE FOR SEPARATION OF SPORT BY SEX

12. World Rugby and the IOC are correct when they acknowledge that the women's category exists to ensure fairness, safety, and equality" for women. (World Rugby Transgender Women Guidelines 2020; IOC Guidelines 2026) To some extent, those in charge of sport governing bodies in the modern era have always recognized the importance of grouping athletes together based on average physical attributes, in order to ensure both safety and competitive balance. Weight classifications have existed in wrestling since it reappeared as an Olympic event in 1904. Although it is true that until recently, girls who wanted to wrestle competed in the male category, this always was an accommodation to low female participation, and involved females making decisions for themselves, ultimately accepting the attendant risks that come with voluntary competition against male athletes. For the most part, women and men have taken part in separate categories since the advent of intercollegiate sporting clubs early in the 20th century. When Title IX went into effect in 1975, there were just under 300,000 female high school athletes, and fewer than 10,000 female collegiate athletes. With the changes that resulted from Title IX, it was assumed that newly available funds for women in sport would ensure the maintenance of existing, or creation of new, sex-segregated athletic teams that would foster greater participation by women. This has been borne out subsequently; by the first half of the 1980's these numbers had risen to 1.9 million high school, and nearly 100,000

collegiate athletes respectively (Hult 1989) and today exceed 3.5 million[16] and 240,000 (NCAA only).[17] Even in sports such as wrestling, that were once considered exclusively male, rapid rates of adoption of the sport by females around the country has led to girls' wrestling becoming a sanctioned sport in 47 states at the time of this writing.[18] [19] The rationale for ongoing sex-designation was made clear within the language of the original implementing regulations of Title IX, which, acknowledging real, biologically-driven differences between the sexes, created carve-out exceptions authorizing sex-separation of sport for reasons rooted in the maintenance of competitive equity. Importantly, the effect of these innate sex-based differences on the health and safety of the athlete were acknowledged by the express authorization of sex-separated teams for sports with higher perceived injury risk—i.e., "contact sports." (Coleman 2020)

13. In the almost half century since those regulations were adopted, the persistent reality of sex-determined differences in athletic performance and safety has been recognized by the ongoing and nearly universal segregation of men's and women's teams—even those that are not classically defined as being part of a contact

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[16] Press Release, *Participation in High School Sports Hits Record High with Sizable Increase in 2024-25*, NFHS (Sep. 9, 2025), https://nfhs.org/stories/participation-in-high-school-sports-hits-record-high-with-sizable-increase-in-2024-25.

[17] *Women's Sports Reach Record NCAA Participation as Leadership Roles Keep Rising*, NCAA (Mar. 1, 2026), https://www.ncaa.org/media-center-womens-sports-reach-record-ncaa-participation-as-leadership-roles-keep-rising/.

[18] USA Wrestling & NFHS, *NFHS Reports New Records for High School Wrestling Participation for Both Girls and Boys in 2024-25*, USA Wrestling (Aug. 18, 2025, at 01:46 ET), https://www.themat.com/news/2025/august/18/nfhs-reports-new-records-for-high-school-wrestling-participation-for-both-girls-and-boys-in-2024-25.

[19] *Current States Sanctioned for HS Girls Wrestling*, Wrestle Like a Girl: High School State Executive Association Updates, https://wrestlelikeagirl.org/hsseau.

or collision sport Now, however, many schools and sports leagues in this country are permitting males to compete in female athletics—including in contact sports—based on gender identity. In my view, these policies have been adopted without careful analysis of safety implications.

14. Other researchers and clinicians have addressed questions of the negative impact of such policies on fairness, or equality of athletic experiences for girls and women, in published articles, and in court submissions. One recent review of track and field performances, including sprints, distance races and field events, noted that men surpass the top female performance in each category between 1000 and 10,000 times *each year*, with hundreds or thousands of men beating the top women in each event. (Coleman & Shreve; Hunter 2023) Although this was not their primary focus, World Rugby well-summarized the point when it observed that in a ranking list of the top thousand performances in most sports, every year, *every one* will have been achieved by a biological male. (World Rugby Transgender Women Guidelines 2020)

15. These differences do not appear to begin with puberty. Global population-based fitness testing over wide geographical regions and across time reveals consistent measurable performance advantages of boys over girls in tests measuring speed, upper and lower body limb strength and power, reaching statistical significance as early as age three. (Nuzzo 2025; Fuhner 2021; Kasovic 2021; Latorre Roman 2017; Golle 2015; De Miguel-Etayo 2014; Tambalis 2016; Catley 2013) Prospective data from before the implementation of Title IX, involving the training of

eight-year-old boys and girls in kicking and throwing ability showed consistently higher performance of boys over girls at baseline, and similar gains from baseline in both sexes after coaching. (Dohrmann 1964; Ehl 2005) Evidence from a wide variety of sources, including population-based mass testing data, as well as age-stratified competition results, all support the idea that prepubertal males run faster, jump higher and farther, exhibit higher aerobic power output, and have greater upper body strength (evidenced by stronger hand grip and better performance with chin-ups or bent arm hang, shotput, discus or javelin) than comparably aged females. (*See* Atkinson, 2025; Brown 2025) This performance gap is well-documented in population-based physiologic testing data that exists in databases such as the Presidential Fitness Test, the Eurofit Fitness test, and additional mass testing data from the UK and Australia. Collectively, this data reveals that pre-pubertal males outperform comparably aged females in a wide array of athletic tests.[20] Moreover, there is a significant difference in the body composition of males and females before puberty despite no significant difference in years of sport involvement or days of practice per week. (Manzano-Carrasco 2022)

16. Although most easily documented in athletes who have gone through puberty, because these differences are not exclusively limited to post-pubescent athletes, some international sport governing bodies, such as FINA (world swimming)

[20] Including but not limited to the countermovement jump test, drop jump test, change of direction test, long jump, timed sit-up test, the 10x5-meter shuttle run test, the 20-meter shuttle run test, curl-ups, pull-ups, push-ups, one-mile run, standing broad jump, and bent-arm hang test.

and Union Cycliste Internationale (UCI)[21] (cycling), have tightened their policies recently to restrict some transgender athletes who began transition at eleven or twelve years of age from competing in future sanctioned events in their identified gender. (McLarnon 2023) Specifically, both organizations have prohibited biological males from competing in women's events unless they can demonstrate continuous puberty suppression beginning at the later of either Tanner Stage 2 (onset of puberty) or age 12, with an allowance in the case of FINA for no more than one prior year on exogenous testosterone. Continuous testosterone suppression under 2.5 (by liquid chromatography/mass spectrometry) must be demonstrated. (FINA Policy on Eligibility for the Men's and Women's Categories 2022; UCI Eligibility Regulations for Transgender Athletes, 2023) Others, like World Athletics, relying on further evidence of prepubertal male advantage, now simply limit the female category to people born female, regardless of puberty status, with a testing requirement for the SRY gene (denoting presence of the gene on the Y chromosome that triggers testis development) announced in 2025. (Bermon 2026) World Athletics, through their Gender-diverse Working Group, explicitly acknowledged this in their 2025 report recommending this policy, stating that "Evidence has accumulated that makes clear that an exclusive focus on male puberty is wrong." (World Athletics 2025) In sum, a large and unbridgeable performance gap between the sexes is well-studied and equally well-documented, beginning in many cases before puberty. This performance gap is evident in the increasing representation of statistically small numbers of

[21] Union Cycliste Internationale (UCI)

biological males on female championship podiums—something that has been predicted in modeling scenarios (Higerd 2020).[22] [23] In this expert report, I focus on some of these differences as they touch on the question of athlete safety in sport.

III. UNDERSTANDING THE CAUSE OF SPORTS INJURIES.

17. The causes for injury in sport are multifactorial. In recent decades, medical researchers have provided us an evolving understanding of how sports injuries occur, as well as the factors that make them more or less probable, and more or less severe. Broadly speaking, there are two ways of modeling injury: the epidemiological model, and the biomechanical model. These models are not mutually exclusive, but provide complementary conceptual frameworks to help us stratify risk in sport.

A. The epidemiological model of injury.

18. From a practical standpoint, sports medicine researchers and clinicians often use the "epidemiological model" to explain, prevent, and manage sports injuries. Broadly speaking, this model views an injury in sport as the product of internal and external risk factors, triggered by an inciting event. In other words, a given injury is "caused" by a number of different factors that are unique to a given situation. (Meeuwise 1994) When the interplay of these factors exceeds the injury threshold,

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[22] Marisa Ingemi, *Transgender Jurupa Valley Senior AB Hernandez Wins State Track Medals Amid Muted Protest*, L.A. Times, (May 30, 2026, updated May 31, 2026, at 23:30 PT), https://www.latimes.com/sports/highschool/story/2026-05-30/transgender-ab-hernandez-wins-state-track-medal-amid-muted-protest.

[23] Ann E. Marimow, *Plaintiff in Supreme Court Transgender Athlete Case Recently Won a State Shot Put Title*, N.Y. Times (June 30, 2026), https://www.nytimes.com/2026/06/30/us/politics/supreme-court-transgender-athletes-plaintiff.html.

injury occurs. One example of how this interplay might work would be a female distance runner in track who develops a tibial stress fracture, with identified risks of low estrogen state from amenorrhea (suppression of menses), an aggressive winter training program on an indoor tile surface, and shoes that have been used for too many miles, and are no longer providing proper shock absorption. Most risk factors ebb and flow, with the overall injury risk at any given time fluctuating as well. Proper attention to risk factor reduction *before* the start of the sports season (including appropriate rulemaking) is the best way to reduce actual injury rates *during* the season.

19. As alluded to, the risk factors associated with injury can be broadly categorized as internal or external. Internal risk factors are internal to the athlete. These include relatively fixed variables, such as the athlete's age, biological sex, bone mineral density (which affects bone strength), and joint laxity, as well as more mutable variables such as body weight, fitness level, hydration state, current illness, prior injury, or psychosocial factors such as aggression.

20. External risk factors are, as the name suggests, external to the athlete. These include non-human risks such as the condition of the playing surface or equipment, athletic shoe wear, or environmental conditions. Other external risk factors come from opposing competitors, and include such variables as player size, speed, aggressiveness, and overall adherence to the rules of the game. As already mentioned, these risks can be minimized through the proper creation and enforcement of rules, as well as the appropriate grouping of athletes together for

purposes of competition. To the latter point, children don't play contact sports with adults and, in the great majority of cases, men and women compete in categories specific to their own biological sex. Certainly these categorical separations are motivated in part by average performance differences and considerations of fairness and opportunity. But they are also motivated by safety concerns. When properly applied, these divisions enhance safety because, when it comes to physical traits such as body size, weight, speed, muscle girth, and bone strength, although a certain amount of variability exists within each group, the averages and medians differ widely *between* the separated groups.[24]

21. Thus, each of these commonly utilized groupings of athletes represents a pool of individuals with predictable commonalities. Epidemiological risk assessment is somewhat predictable and translatable as long as these pools remain intact. There is always some physical risk inherent to sports, regardless of how participation categories are defined. But the introduction of outside individuals into an exclusive pool of athletes (e.g. an adult onto a youth football team, or males into most women's sports) would change the balance of risk inside that pool, in this case to the detriment of children or women. Simply put, when you introduce larger, faster,

[24] In some cases, safety requires even further division or exclusion. A welterweight boxer would not compete against a heavyweight, nor a heavyweight wrestle against a smaller athlete. In the case of youth sports, when children are at an age where growth rates can vary widely, leagues will accommodate for naturally-occurring large discrepancies in body size by limiting teams by chronological age, or by limiting larger athletes from playing positions where their size and strength is likely to result in injury to smaller players. Thus, in youth football, players exceeding a certain weight threshold may be temporarily restricted to playing on the line and disallowed from carrying the ball, or playing in the defensive secondary, where they could impose high-velocity hits on smaller players.

and stronger athletes from one pool into a second pool of athletes who are *categorically* smaller, slower and weaker (whether as a result of age or sex), you have altered the characteristics of the second pool, and, based on known injury modeling, have statistically increased the injury risk for the original athletes in the second pool.

22. Most clinical studies of the epidemiology of sports injuries use a multivariate approach, identifying multiple independent risk factors and examining how these factors might interact, in order to determine their relative contribution to injury risk, and make educated inferences about causation. (Meeuwise 1994)

23. In applying the multivariate approach, the goal is to keep as many variables as possible the same so as to isolate the potential effect of a single variable (such as age or biological sex) on injury risk, as well as to determine how the isolated variable interacts with the other analyzed variables to affect injury risk. Failure to consider relevant independent variables can lead to error. For example, researchers focusing on differences between male and female athletes should not compare concussion rates of a high school girls' soccer team to concussion rates of a professional men's soccer team, because differences in the concussion rate might be due to a number of variables besides sex, such as age, body mass, relative differences in skill, speed, or power, as well as differences in training volume and intensity.

24. As indicated earlier, an injury event is usually the end product of a number of different risk factors coming together. (Bahr 2005) A collision between two soccer players who both attempt to head the ball, for example, might be the inciting event that causes a concussion. Although the linear and angular forces that occur

through sudden deceleration would be the proximate cause of this injury, the epidemiological model of injury would also factor in "upstream" risks, predicting the possibility of an injury outcome for each athlete differently depending on the sum of these risks. If the collision injury described above occurs between two disparately-sized players, the smaller athlete will tend to decelerate more abruptly than the larger athlete, increasing the smaller athlete's risk for injury (*See* Section IV on the Physics of Sports Injury) But size isn't the only relevant difference between the sexes. As I detail in Section V, there are significant statistical differences between the sexes across several elements of physiology relevant to injury risk. The importance of each element is different for every sport and will lead to different collisions, different force disparities, and different injury risks. For example, in a contact sport like wrestling. where weight is held constant through weight classes, sex-based relative strength and power advantages can remain. What is common across contact and collision sports is that where skeletally mature males and females are playing against one another, there is a higher likelihood that injury will result when collisions occur, and in particular there is a higher likelihood that a female will suffer injury. This is reflected in the recent decision by World Rugby to disallow the crossover of men into women's rugby, regardless of gender identity. (World Rugby Transgender Women Guidelines 2020) The decision-making represented under this model is rational and rooted in objective facts and objective risks of harm, because it takes real, acknowledged, and documented physical differences between the sexes (in many cases before adolescence), and models expected injury risk on the basis of the known differences that persist even after hormone manipulation.

B. The biomechanical model of injury.

25. Sports medicine researchers and clinicians also consider a biomechanical approach when it comes to understanding sports injuries. In the biomechanical model of injury, injury is considered to be analogous to the failure of a machine or other structure. Every bone, muscle, or connective tissue structure in an athlete's body has a certain load tolerance. Conceptually, when an external "load" exceeds the load tolerance of a given structure in the human body, an injury occurs. (Fung 1993 at 1) Thus, researchers focus on the mechanical load—the force exerted on a bone, ligament, joint or other body part—and the load tolerance of that impacted or stressed body part, to understand what the typical threshold for injury is, and how predictable this might be. (McIntosh 2005 at 2–3) Biomechanical models of injury usually consider forces in isolation. The more consistent the movement pattern of an individual, and the fewer the contributions of unexpected outside forces to the athlete, the more accurate biomechanical predictions of injury will be.

26. Biomechanical modeling can be highly predictive in relatively simple settings. For example, in blunt trauma injury from falls, mortality predictably rises the greater the fall. About 50% of people who fall four stories will survive, while only 10% will survive a fall of seven stories. (Buckman 1991) As the complexity of biomechanical models increase, predictability in turn decreases. In baseball, the pitching motion is highly reproducible, and strain injury to the ulnar collateral ligament (UCL) of the elbow can be modeled. The load tolerance of the UCL of a

pitcher's elbow is about 32 Newton-meters, but the failure threshold of a ligament like this in isolation is not the only determinant of whether injury will occur. During the pitching motion, the valgus force imparted to the elbow (gapping stress across the inner elbow that stretches the UCL) routinely reaches 64 Newtons, which is obviously greater than the failure threshold of the ligament. Since not all pitchers tear their UCLs, other variables innate to an athlete must mitigate force transmission to the ligament and reduce risk. The load tolerance of any particular part of an athlete's body is thus determined by other internal factors such as joint stiffness, total ligament support, muscle strength across the joint, or bone mineral density. Injury load can be self-generated, as in the case of a pitcher's elbow, or externally-generated, as in the case of a linebacker hitting a wide receiver. While load tolerance will vary by individual, as described above, and is often reliant on characteristics innate to a given athlete, external load is determined by outside factors such as the nature of the playing surface or equipment used, in combination with the weight and speed of other players or objects (such as a batted ball) with which the player collides. (Bahr 2005) The sex differences discussed in Section V constitute outside factors that are brought to bear on the statistically smaller, slower, and less-powerful female body when a male is placed in competition with them in a contact or collision sport. The male athlete's differences—such as in strength—change the force brought to bear in collisions, such as kicking a ball or throwing an opponent to the mat.

27. As this suggests, the two "models" of sports injuries described above are not in any sense inconsistent or in tension with each other. Instead, they are

complementary ways of thinking about injuries that can provide different insights. But the important point to make regarding these models is that in either model, injury risk (or the threshold for injury) rises and falls depending on the size of an applied force, and the ability of a given athlete to absorb or mitigate that force.

IV. THE PHYSICS OF SPORTS INJURY

28. Sports injuries often result from collisions between players, between a player and a rapidly moving object (e.g. a ball or hockey puck, a lacrosse or hockey stick), or between a rapidly moving athlete and something stationary (such as the wrestling mat). In soccer, for example, most head injuries result from collisions with another player's head or body, collision with the goal or ground, or from an unanticipated blow from a kicked ball. (Boden 1998; Mooney 2020) In basketball, players often collide with each other during screens, while diving for a loose ball, or while driving to the basket. In lacrosse or field hockey, player-to-player, or player-to-stick contact is common.

29. But what are the results of those collisions on the human body? Basic principles of physics can cast light on this question in different ways. A general understanding of these principles can help us identify factors that will predictably increase the relative risk, frequency, and severity of sports injuries, given certain assumptions.

30. First, we can consider **energy**. Every collision involves an object or objects that possess energy. The energy embodied in a moving object (whether a human body, a ball, or anything else) is called kinetic energy.

31. Importantly, the kinetic energy of a moving object is expressed as: $\boldsymbol{E_k} = \frac{\mathbf{1}}{\mathbf{2}}\boldsymbol{mv^2}$. That is, kinetic energy is a function of the mass of the object multiplied by the *square* of its velocity. (Dashnaw 2012) To illustrate with a simple but extreme example: if athletes A and B are moving at the same speed, but athlete A is twice as heavy, athlete A carries twice as much kinetic energy as athlete B. If the two athletes weigh the same amount, but athlete A is going twice as fast, athlete A carries four times as much kinetic energy as athlete B. But as I have noted, the kinetic energy of a moving object is a function of the mass of the object multiplied by the square of its velocity. Thus, if athlete A is twice as heavy, and moving twice as fast, athlete A will carry eight times the kinetic energy of athlete B into a collision.[25]

32. The implication of this equation means that what appear to be relatively minor discrepancies in size and speed can result in major differences in energy imparted in a collision, to the point that more frequent and more severe injuries can occur. To use figures that correspond more closely to average differences between men and women, if Player M weighs only 20% more than Player F, and runs only 15% faster, Player M will bring *58% more kinetic energy* into a collision than Player F.[26]

33. The law of conservation of energy tells us that energy is never destroyed or "used up." If kinetic energy is "lost" by one body in a collision, it is inevitably transferred to another body, or into a different form. In the case of collision between players, between a thrown wrestler and the mat, or between, e.g., a ball and a player's

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[25] $\mathbf{2} \times \mathbf{2^2} = \mathbf{8}$

[26] $\mathbf{1.2} \times (\mathbf{1.15})^{\mathbf{2}} = \mathbf{1.587}$

head, some of the energy "lost" by one player, or by the ball, may be transformed into (harmless) sound; some may result in an increase in the kinetic energy of the player who is struck (through acceleration, which I discuss below); but some of it may result in *deformation* of the player's body—which, depending on its severity, may result in injury. Thus, the greater the kinetic energy brought into a collision, the greater the potential for injury, all other things being equal.

34. Alternately, we can consider force and *acceleration*, which is particularly relevant to concussion injuries.

35. Newton's third law of motion tells us that when two players collide, their bodies experience equal and opposite forces at the point of impact.

36. Acceleration refers to the rate of change in speed (or velocity). When two athletes collide, their bodies necessarily accelerate (or decelerate) rapidly: stopping abruptly, bouncing back, or being deflected in a different direction. Newton's second law of motion tells us that: $\boldsymbol{F} = \boldsymbol{ma}$ (that is, force equals mass multiplied by acceleration). From this equation we see that when a larger and a smaller body collide, and (necessarily) experience equal and opposite forces, the smaller body (or smaller player, in sport) will experience more rapid acceleration.[27] We observe this physical principle in action when we watch a bowling ball strike bowling pins: the heavy bowling ball only slightly changes its course and speed; the lighter pins go flying.

[27] $\boldsymbol{Ma} = \boldsymbol{mA}$

37. This same equation also tells us that if a given player's body or head is hit with a *larger* force (e.g., from a ball that has been thrown or hit faster), it will experience *greater* acceleration, everything else being equal.

38. Of course, sport is by definition somewhat chaotic, and forces are often not purely linear. Many collisions also involve angular velocities, with the production of rotational force, or torque. Torque can be thought of as force that causes rotation around a central point. A different but similar equation of Newtonian physics governs the principles involved.[28] Torque is relevant to injury in several ways. When torque is applied through joints in directions those joints are not able to accommodate, injury can occur. In addition, rotational force can cause different parts of the body to accelerate at different rates—in some cases, very rapid rates, also leading to injury. For example, a collision where the body is impacted at the waist can result in high torque and acceleration on the neck and head.

39. Sport-related concussion—a common sports injury and one with potentially significant effects—is attributable to linear, angular, or rotational acceleration and deceleration forces that result from impact to the head. (Rowson 2016) In the case of a concussive head injury, it is the brain that accelerates or decelerates on impact, colliding with the inner surface of the skull. (Barth 2001 at 255)

[28] In this equation, $\boldsymbol{\tau} = \boldsymbol{I\alpha}$, torque equals moment of inertia multiplied by angular acceleration, where "moment of inertia" is defined as $\boldsymbol{I} = \boldsymbol{mr^2}$, that is, mass multiplied by the square of the distance to the rotational axis.

40. None of this is mysterious: each of us, if we had to choose between being hit by a large, heavy athlete, or by a small, lighter athlete, both running at similar speeds, would intuitively choose collision with the smaller athlete as the lesser of the two evils. And we would be right. One author referred to the "increase in kinetic energy, and therefore imparted forces" resulting from collision with larger, faster players as "profound." (Dashnaw 2012)

V. GENDER DIFFERENCES RELEVANT TO INJURY

41. It is important to state up front that it is self-evident to most people familiar with sport and sport injuries, given the models described above, that if men and women were to consistently participate together in competitive contact sports, there would be higher rates of injury in women. This is one reason that rule modifications often exist in leagues where co-ed participation occurs.[29] Understanding the physics of sports injuries helps provide a theoretical framework for why this is true, but so does common sense and experience. All of us are familiar with basic objective physiological differences between the sexes, some of which exist in childhood, and some of which become apparent after the onset of puberty, and persist throughout adulthood. And as a result of personal experience, all of us also have some intuitive sense of what types of collisions are likely to cause pain or injury. Not surprisingly, our "common sense" on these basic facts about the human condition

[29] *For example, see* https://www.athleticbusiness.com/college/intramural-coed-basketball-playing-rules-vary-greatly.html (detailing variety of rule modifications applied in co-ed basketball). Similarly, coed soccer leagues often prohibit so-called "slide tackles," which are not prohibited in either men's or women's soccer. *See, e.g.*, *8Coed Adult Recreational Soccer Rules*, 8Coed Sports, https://8coedsports.com/soccer-rules/.

is also consistent with the observations of medical science. Below, I provide quantifications of some of these well-known differences between the sexes that are relevant to injury risk when males compete against females, as well as some categorical differences that may be less well known.

A. Height and weight

42. It is an inescapable fact of the human species that males as a group are statistically larger and heavier than females. According to the most recently available Centers for Disease Control and Prevention (CDC) statistics, men are about 8.5% taller as a group than females, and the weight of the average U.S. adult male is 16% greater than that of the average U.S. adult female. (CDC 2025) This disparity persists into the athletic cohort. Researchers find that while athletes tend on average to be lighter than non-athletes, the weight difference between the average adult male athlete and adult female athlete remains within the same range—between 14 and 23%, depending on the sport analyzed. (Santos 2014; Fields 2018) Indeed, World Rugby acknowledged these differences when it banned post-pubescent biological males from competing in women's rugby, noting that the typical male rugby player weighs 20 to 40% more than the typical female rugby player. (World Rugby Transgender Women Guidelines 2020) This size advantage by itself allows men to bring more force to bear in a collision. Relevant to this is the lack of any requirements by the state of Washington for a male who is identifying as female to undergo any hormonal suppression at all.

B. Bone and connective tissue strength.

43. Men have bones in their arms, legs, feet, and hands that are both larger and stronger per unit volume than those of women, due to greater cross-sectional area, greater bone mineral content, and greater bone density. The advantage in bone size (cross-sectional area) holds true in both upper and lower extremities, even when adjusted for lean body mass. (Handelsman 2018 at 818; Nieves 2005 at 530) Greater bone size in men is also correlated with stronger tendons that are more adaptable to training (Magnusson 2007), and an increased ability to withstand the forces produced by larger muscles (Morris 2020 at 5). Male bones are not merely larger, they are stronger per unit of volume. Studies of differences in arm and leg bone mineral density—one component of bone strength—find that male bones are denser, with measured advantages of between 5 and 14%. (Gilsanz 2011; Nieves 2005) In some sense, this means that in a wrestling environment, biological males are "denser," than females at a given weight, with a higher ratio of lean to fat mass. This becomes relevant in a sport that relies on obtaining body leverage on your opponent to generate movement.

44. Men also have larger ligaments than women (Lin 2019 at 5), and stiffer connective tissue (Hilton 2021 at Table 1), providing greater protection against joint injury.

C. Speed

45. When it comes to acceleration from a static position to a sprint, men are consistently faster than women. World record sprint performance gaps between the sexes remain significant at between 7% and 10.5%, with world record times in women

now exhibiting a plateau (no longer rapidly improving with time) similar to the historical trends seen in men. (Cheuvront 2005) This performance gap has to do with, among other factors, increased skeletal stiffness, greater cross-sectional muscle area, higher ratios of type II to type I muscle fibers, (and thus faster muscle contraction), denser muscle fiber composition and greater limb length. (Handelsman 2018, Hunter 2023) Collectively, males, on average, run about 10% faster than females. (Lombardo 2018 at 93) This becomes important as it pertains to injury risk, because males involved in sport will often be travelling at faster speeds than their female counterparts in comparable settings, with resultant faster speed at impact, and thus greater impact force, in a given collision.

D. Strength/Power

46. Compared to women, men have "larger and denser muscle mass, and stiffer connective tissue, with associated capacity to exert greater muscular force more rapidly and efficiently." (Hilton 2021 at 201) Research shows that on average, during the prime athletic years (ages 18–29) men have 54% greater total muscle mass than women (33.7 kg vs. 21.8 kg) including 64% greater muscle mass in the upper body, and 47% greater in the lower body. (Janssen 2000 at Table 1) The cross-sectional area of muscle in women is only 50 to 60% that of men in the upper arm, and 65 to 70% of that of men in the thigh. This translates to women having only 50 to 60% of men's upper limb strength and 60 to 80% of men's lower limb strength. (Handelsman 2018 at 812) In axial musculature, males have more developed cervical musculature than women. Well-developed cervical muscles help transmit head impact forces to the torso and reduce the risk for concussion injury. They also are

ergogenic in a sport like wrestling, where they are used to extend the neck and keep the posterior shoulders off the mat during a match. (Chaabene 2017) The longer limb lengths of males augment strength as well. Statistically, in comparison with women, men also have lower total body fat, differently distributed, and greater lean muscle mass, which increases their power-to-weight ratios and upper-to-lower limb strength ratios as a group. Looking at another common metric of strength, males average 57% greater grip strength (an important predictor of wrestling success) (Bohannon 2019; Chaabene 2017) and 54% greater knee extension torque (Neder 1999). Research shows that sex-based discrepancies in lean muscle mass begin to be established from infancy and persist through childhood to adolescence. (Davis 2019; Kirchengast 2001; Taylor 1997; Taylor 2010; McManus 2011)

47. Aside from absolute strength most research supports the idea that men as a group are relatively stronger than women. Looking at comparative data in athletes, male weightlifters have been shown to be approximately 30% stronger than female weightlifters of equivalent stature and mass, in part related to a greater proportion of fast-contracting type II muscle fibers, and possibly muscle fascicle length, which is longer in males. (Bartolomei 2021; Cidrais 2026) One cross-sectional study looking at relative strength and power performance in male and female athletes in their mid-twenties demonstrated that males had significantly greater maximal bench press and bench press throw when adjusted for lean body mass, and greater upper and lower body strength performance when adjusted for muscle thickness. (Bartolomei 2021) A recent study looking at male and female soldiers in the Army

demonstrated consistently greater physical performance in men on Army combat physical test measures when matched to women by relative strength. (Grier 2024) Another study looking at standardized upper body plyometric training showed greater relative power gains in men than women. (Lu 2024) Even when relative strength is matched between healthy men and women, sex-based differences in muscle power can be found. Although one study looking at lower extremity power performance in males and females who were matched for relative strength did not show differences in percentage of peak force generated (Comfort 2024), another study looking at the load-velocity relationship in upper extremity performance between men and women matched by relative strength did show significant retained differences in upper extremity power by male subjects. In other words, in this study, males had greater propulsive velocity than females, even when matched for relative strength (Pareja-Blanco 2026). This strength/power to weight discrepancy, as well as a tendency toward greater relative upper body power gains despite similar resistance training protocols, would be relevant to weight classification sports like wrestling, predicting probable strength and power discrepancies even when competition between a biological male and female is restricted to a defined weight class. (Gierczuk 2023; Hilton 2021 at 203; Hunter 2024 at 4139; Vardar 2007) In wrestling, when muscle power between sexes is adjusted for lean body mass, male athletes have more arm power than female athletes (43% greater peak and 30% greater mean), and more lower extremity power (17% greater peak and 12% greater mean). (Hübner-Woźniak 2004)

48. In most competitive non-weight categorized athletic events, since the stature and mass of the average male exceeds that of the average female, the actual differences in strength and power between average male and female body types in most sports will, on average, magnify. Using their legs and torso for power generation, men can produce substantially larger forces with their arms and upper body, enabling them to generate more ball velocity through overhead motions, as well as to effect more pushing or punching power. (Loturco 2016) Ultimately, isolated sex-specific differences in muscle strength in one region (even differences that in isolation seem small) can, and do combine to generate even greater sex-specific differences in more complex sport-specific functions. One study looking at moderately-trained individuals found that males can generate 162% more punching power than females. (Morris 2020) Thus, multiple small advantages aggregate into larger ones.

49. In 2014, a male mixed-martial arts fighter identifying as female and fighting under the name Fallon Fox fought a woman named Tamikka Brents, and caused significant facial injuries in the course of their bout. Speaking about their fight later, Brents said:

> I've fought a lot of women and have never felt the strength that I felt in a fight as I did that night. I can't answer whether it's because she was born a man or not because I'm not a doctor. I can only say, I've never felt so overpowered ever in my life, and I am an abnormally strong female in my own right. [30]

[30] *Fallon Fox, Trangender MMA Fighter Who Broke the Skull of Her Opponent*, BJJ World, https://bjj-world.com/transgender-mma-fighter-fallon-fox-breaks-skull-of-her-female-opponent/.

50. So far as I am aware, mixed martial arts is not a collegiate or high school interscholastic sport. Nevertheless, what Brent experienced in an extreme setting is true and relevant to safety in all sports that involve contact. In absolute (and in many cases relative) terms, males as a group are substantially stronger than women.

E. Throwing and kicking speed.

51. One result of the combined effects of these sex-determined differences in skeletal structure is that men are, on average, able to throw objects faster than women. (Lombardo 2018; Chu 2009; Thomas 1985) By age seventeen, a male throwing a ball an average distance for his age group will throw that ball farther than 99% of seventeen-year-old females. Greater throwing distance implies faster throwing speed, assuming a similar angle of ball release. This large difference between the sexes holds despite the fact that factors such as arm length, muscle mass, and joint stiffness individually don't come close to exhibiting this degree of sex-defined advantage. Elite female baseball pitchers studied had maximum pitch velocities that were about 75% of male peer—60 miles per hour vs. 81 miles per hour. The authors of this study attribute this to a sex-specific difference in the ability to generate muscle torque and power. (Chu 2009) A study showing greater throwing velocity in male versus female handball players attributed it to differences in body size, including height, muscle mass, and arm length. (Van Den Tillaar 2012) Interestingly, a significant sex-related difference in throwing ability has been shown to manifest even before puberty (Dohrmann 1964), but the difference increases rapidly during and after puberty. (Thomas 1985 at 266) These sex-determined differences in throwing speed are not limited to sports where a ball is thrown. Bearing

in mind the 43% greater peak arm and 17% greater relative peak leg power in male vs. female wrestlers, these differences can become relevant to sports like wrestling that involve throwing an opponent to the mat. They also include the javelin throw, where studies have shown a 30% difference. (Lombardo 2018 Table 2; Hilton 2021 at 203) As indicated, even in preadolescent children, differences exist. For example, looking at competition records from the USA Track and Field National Youth Outdoor and National Junior Olympic Championships, the average between sex differences for first through fourth place finishers in shot put, javelin and long jump were greater than within sex differences in all but the 9 to 10 year old shot put, and the best performances were always achieved by males. (Brown 2025).

52. Serve and spike velocity in male volleyball players exceeds that of women by about 29 to 34%. (Hilton 2021) Analysis of first and second tier Belgian national elite male volleyball players shows ball spike speeds of 63 mph and 56 mph respectively. (Forthomme 2005) NCAA Division I female volleyball players—roughly comparable to the second-tier male elite group referenced above—average a ball spike velocity of approximately 40 mph (18.1 m/s). (Ferris 1995 at Table 2) Notably, based on the measurements of these studies, male spiking speed in *lower* elite divisions is almost 40% greater than that of NCAA Division I female collegiate players. Separate analyses of serving speed between elite men and women Spanish volleyball players showed that the average power serving speed in men was 54.6 mph (range 45.3 to 64.6 mph), with maximal speed of 76.4 mph. In women, average power serving speed

was 49 mph (range 41 to 55.3 mph) with maximal speed of 59 mph. This translates to an almost 30% advantage in maximal serve velocity in men. (Palao 2014)

53. Recall that kinetic energy is dependent on mass and the square of velocity. A volleyball (with fixed mass) struck by a male, and traveling an average 35% faster than one struck by a female, will deliver 82% more energy to a head upon impact.

54. The greater leg strength and jumping ability of men confer a further large advantage in volleyball that is relevant to injury risk. In volleyball, an "attack jump" is a jump to position a player to spike the ball downward over the net against the opposing team. Researchers evaluating elite male volleyball players showed that athletes at the 50th percentile demonstrate an attack jump height that is 50% greater than equivalent female volleyball players, with average differences across all percentiles ranging from 42 to 80%. (Sattler 2015) Similar data looking at countermovement jumps (to block a shot) in national basketball players reveals a 35% male advantage in jump height. (Kellis 1999) In volleyball, this dramatic difference in jump height means that male players who are competing in female divisions will more often be able to successfully perform a spike, and this will be all the more true considering that the women's net height is seven inches lower than that used in men's volleyball. Confirming this inference, research also shows that the successful attack percentage (that is, the frequency with which the ball is successfully hit over the net into the opponent's court in an attempt to score) is so much higher with men than women that someone analyzing game statistics can consistently identify games

played by men as opposed to women on the basis of this statistic alone. These enhanced and more consistently successful attacks by men directly correlate to their greater jumping ability and attack velocity at the net. (Kountouris 2015)

55. Volleyball as a sport is already associated with one of the highest rates of concussive injury among female athletes. (Whelan 2026) The combination of the innate male-female differences cited above, along with the lower net height in women's volleyball, means that if a reasonably athletic male is permitted to compete against women, the participating female players will likely be exposed to higher ball velocities that are outside the range of what is typically seen in women's volleyball. When we recall that ball-to-head impact is a common cause of concussion among women volleyball players, this fact makes it clear that participation in girls' or women's volleyball by biologically male individuals will increase concussion injury risk for participating girls or women.

56. Male sex-based advantages in leg strength also lead to greater kick velocity. In comparison with women, men kick balls harder and faster. A study comparing university-level male and female soccer players showed that males have an average foot velocity at ball contact that is 32% greater than females, with an average ball velocity that is 20% greater. (Sakamoto 2014) Applying the same principles of physics we have just used above, we see that a soccer ball kicked by a male, travelling an average 20% faster than a ball kicked by a female, will deliver 44% more energy on head impact. Greater force-generating capacity will thus increase the risk of an impact injury such as concussion.

VI. ENHANCED FEMALE VULNERABILITY TO CERTAIN INJURIES

57. Above, I have reviewed physiological differences that result in the male body bringing greater weight, speed, and force to the athletic field, ring, mat, or court, and how these differences can result in a greater risk of injury to females when males compete against them, through the transmission of greater impact forces. That said, it is also true that the female body appears more vulnerable than the male body to certain types of injury even when subject to comparable forces. In general, when sex-specific sports are analyzed, adolescent females are injured at a higher rate than males. (Ritzer 2021)

58. This inherent risk appears to extend to the younger age cohorts as well. An analysis of Finnish student athletes from 1987–1991, analyzing over 600,000 person-years of activity exposures, found, in students under fifteen years of age, higher rates of injury in girls than boys in soccer, volleyball, judo, and karate. (Kujala 1995)

59. Another epidemiological study looking specifically at injury rates in over 14,000 middle schoolers over a 20-year period showed that "in sex-matched sports, middle school girls were more likely to sustain *any* injury (RR = 1.15, 95% CI = 1.1, 1.2) or a time-loss injury (RR = 1.09, 95% CI = 1.0, 1.2) than middle school boys." In analyzed both-sex sports (i.e., sex-separated sports that both girls and boys play, like soccer), girls sustained higher injury rates, and greater rates of time-loss injury. (Beachy 2014)

60. Another study of over 2,000 middle school students at nine schools showed that the injury rate was higher for girls' basketball than for football (39.4 vs.

30.7/1000 AEs), and injury rates for girls' soccer were nearly double that of boys' soccer (26.3 vs. 14.7/1000 AEs). (Caswell 2017)

61. In this regard, I will focus on two areas of heightened female vulnerability to collision-related injury which have been extensively studied: concussions, and anterior cruciate ligament injuries.

A. Concussions

62. Females are generally more likely than males to suffer concussions in comparable sports, and on average suffer more severe and longer lasting disability once a concussion does occur. (Harmon 2013 at 4; Berz 2015; Blumenfeld 2016; Covassin 2003; Rowson 2016; Bretzin 2021; Matias-Soto 2024; Peacock 2025) Between menarche and menopause, females also seem to be at higher risk for post-concussion syndrome than males. (Bazarian 2009; Berz 2015; Blumenfeld 2016; Broshek 2005; Colvin 2009; Covassin 2012; Dick 2009; Marar 2012; Preiss-Farzanegan 2009) Of the six sports with the highest rates of concussion (rugby, football, ice hockey, wrestling, lacrosse, and soccer), four are considered sex-comparable sports.[31] Bearing out World Rugby's concern, the rate of concussion injury in rugby is over three times that of football (28.25/10,000 AEs vs. 8.72/10,000). (VanPelt 2021)

63. Some of the anatomical and physiological differences that we have considered between males and females help to explain the documented differences in

[31] Men's and women's lacrosse rules vary so widely between men (contact) and women (non-contact) that they are not considered comparable.

concussion rates and in symptoms between males and females. (Covassin 2016; La Fountaine 2019; Lin 2019; Tierney 2005; Wunderle 2014) Anatomically, there are significant sex-based differences in head and neck anatomy, with females exhibiting in the range of 30 to 40% less head-neck segment mass and neck girth, and 49% lower neck isometric strength. This means that when a female athlete's lighter head (with less muscle girth to defray impact into the torso) is subjected to the same acceleration force as an analogous male, just like the bowling pins described earlier, there will be a greater tendency for head acceleration, and resultant injury in the female. (Tierney 2005 at 276–277) Perhaps reflecting the risks discussed already regarding contact with struck or thrown objects, some studies show similar rates of concussive injury in females in both contact and limited-contact sports. (Whelan 2026)

64. The most widely-accepted definition of sport-related concussion comes from the Consensus Statement on Concussion in Sport (see below). (Patricios 2023)[32] To summarize, concussion is "a traumatically induced transient disturbance of brain function and involves a complex pathophysiological process" that can manifest in a variety of ways. (Harmon 2013 at 1)

[32] "Sport-related concussion is a traumatic brain injury caused by a direct blow to the head, neck or body resulting in an impulsive force being transmitted to the brain that occurs in sports and exercise- related activities. This initiates a neurotransmitter and metabolic cascade, with possible axonal injury, blood flow change and inflammation affecting the brain. Symptoms and signs may present immediately, or evolve over minutes or hours, and commonly resolve within days, but may be prolonged. No abnormality is seen on standard structural neuroimaging studies (computed tomography or magnetic resonance imaging T1- and T2-weighted images), but in the research setting, abnormalities may be present on functional, blood flow or metabolic imaging studies. Sport-related concussion results in a range of clinical symptoms and signs that may or may not involve loss of consciousness. The clinical symptoms and signs of concussion cannot be explained solely by (but may occur concomitantly with) drug, alcohol, or medication use, other injuries (such as cervical injuries, peripheral vestibular dysfunction) or other comorbidities (such as psychological factors or coexisting medical conditions)."

65. Sport-related concussions have undergone a significant increase in societal awareness and concurrent injury reporting since the initial passage of the Zachery Lystedt Concussion Law in Washington State in 2009 (Bompadre 2014), and the subsequent passage of similar legislation governing return-to-play criteria for concussed athletes in all other states in the United States. (Society of Health and Physical Educators, 2026) Concussion is now widely recognized as a common sport-related injury, occurring in both male and female athletes. (CDC 2007) Sport-related concussions can result from player-surface contact or player-equipment contact in virtually any sport. However, sudden impact via a player-to-player collision, with rapid deceleration and the transmission of linear or rotational forces through the brain, is also a common cause of concussion injury. (Covassin 2012; Marar 2012; Barth 2001; Blumenfeld 2016; Boden 1998; Harmon 2013 at 4)

66. In the adolescent athlete population, higher rates of concussion injury among females are usually, but not always confirmed. A large retrospective study of U.S. high school athletes showed females sustained a higher rate of concussions in soccer (79% higher), volleyball (0.6 concussions/10,000 exposures, with 485,000 reported exposures, vs. no concussions in the male cohort), basketball (31% higher), and softball/baseball (320% higher). (Marar 2012) A similarly-sized, similarly-designed study comparing concussion rates between NCAA male and female collegiate athletes showed, overall, a concussion rate among females 40% higher than that of males. Higher rates of injury were seen across individual sports as well, including ice hockey (10% higher); soccer (54% higher); basketball (40% higher); and

softball/baseball (95% higher). (Covassin 2016) Despite the higher rate of injury, in ice hockey, female athletes sustained fewer impacts than male athletes, with the impacts females did experience of lower magnitude than that of males. (Fahr 2024) Another systematic review found that females had significantly higher risks of concussions in basketball (99% greater risk) and soccer (76% greater risk), but the risk differential was not statistically significant in baseball/softball, ice hockey, lacrosse, swimming/diving, and track and field. This is not surprising, since rules prohibit body checking and stick contact in girls lacrosse, as well as body checking in ice hockey, while corresponding rules in boys sports allow it. (Cheng 2019) A subsequent scoping review identified significantly higher rates of concussion in females in games and practices of ice hockey and soccer. (Farh 2024) Published data from the National High School Sports-Related Injury Surveillance Study also shows that concussion rates are higher in girls than boys in sex-similar sports. (Kerr 2019) Analysis of injury rates among high school athletes in Michigan showed similar findings, with female athletes exhibiting a 1.9 times greater risk for concussion injury than males in sex-comparable sports. (Bretzin 2018)

67. The younger cohort is less well-studied, but research findings tend to be similar. Most epidemiological studies to date looking at sport-related concussion in middle schoolers show that more boys than girls are concussed. There are fewer studies estimating concussion *rate* in this group. This is, in part, because measuring injury rate is more time- and labor-intensive, and younger athletes tend to have less access to certified athletic trainers or team physicians and therefore delayed and

potentially less-accurate injury assessment. (Meehan 2011) In order to study concussion incidence, athlete exposures also have to be recorded. Generally speaking, an athlete exposure is a single practice or game where an athlete is exposed to playing conditions that could reasonably supply the necessary conditions for an injury to occur. Rates of athletic injury, concussion among them, are then, by convention, expressed in terms of injury rate per 1,000 athletic exposures. More recently, some studies have been published that analyze the rates of concussion in the middle school population. Looking at the evidence, the conclusion can be made that females experience increased susceptibility to concussive injuries even before puberty. For example, Ewing-Cobbs, et al. (2018) found elevated post-concussion symptoms in girls across all age ranges studied, including children between the ages of 4 and 8. Kerr's 2017 study of middle school students showed over three times the rate of female vs. male concussion in students participating in sex-comparable sports [0.18 vs. 0.66/1000 AEs]. (Kerr 2017)

68. Later research looking at the incidence of sport-related concussions in U.S. middle schoolers between 2015 and 2020, found that the rate of concussion was higher in middle school athletes than those in high school. In this study, girls had more than twice the rate of concussion injury than males (0.49/1000 athletic exposures vs. 0.23/1000 AEs) in analyzed sports (baseball/softball, basketball, soccer and track), as well as statistically greater time loss. (Hacherl 2021 (Journal of Athletic Training); Hacherl 2021 (Archives of Clinical Neuropsychology)) The authors hypothesized that the increasing incidence of concussion in middle school may relate

to "other distinct differences associated with the middle school sport setting itself, such as, the large variations in player size and skill." [33] More recent research has continued to validate these findings. In a prospective study looking at middle school athletes of diverse ethnicity, researchers studied over 11,000 athletes with 329,000 athlete exposures, resulting in 97 sport-related concussion injuries. Overall, middle school girls were 2.26 times more likely than males to sustain a concussion. Among sex-comparable sports, girls had higher rates of concussion in basketball, softball and soccer. This higher risk persisted in both competition and practice, with concussion rates in soccer practices five time higher for girls than boys. (Hacherl 2026)

69. Even when the heads of female and male athletes are subjected to identical accelerative forces, there are sex-based differences in neural anatomy and physiology, cerebrovascular organization, and cellular response to concussive stimuli that make the female more likely to suffer concussive injury, or more severe concussive injury. For instance, hypothalamic-pituitary disruption is thought to play a role in post-concussion symptomatology that differentially impacts women. (McGroarty 2020; Broshek 2005 at 861) Another study found that elevated progesterone levels during one portion of the menstrual cycle were associated with more severe post-concussion symptomatology that differentially impacted women. (Wunderle 2014)

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[33] Press Release, *Middle School Sports Have Overall Higher Rate of Concussion Than Reported in High School and Collegiate Settings During the 2015-2016 to 2019-2020 School Years*, (NATA), https://www.nata.org/press-release/middle-school-sports-have-overall-higher-rate-concussion-reported-high-school-and-collegiate.

70. Sex appears to be a risk factor for increased axonal injury when a concussion occurs. In vitro analysis of axonal injury patterns from male and female axonal lines seems to confirm that female axons are smaller, more easily disrupted, and more prone to harmful alterations in calcium channel function that can lead to functional breakdown. (Dolle 2018) In animal models of identically-induced rotational concussive injury, anatomical studies of injured brains show that female brains exhibit a greater degree of small neuroaxon loss after concussive injury. This appears to relate to sexual dimorphism in axonal size, with female brains having a higher proportion of small neuroaxons. These injured female swine also exhibited longer recovery than injured males. Brain injury between males and females were similarly distributed, but differed in extent, with females exhibiting more diffuse injury that correlated with recovery duration. The location of these injuries correlate to the areas of the brain responsible for relaying information, injury of which can lead to oculomotor dysfunction and problems with concentration and processing speed. (Song 2024)

71. Perhaps unsurprisingly, females on average appear to suffer materially greater cognitive impairment than males when they do suffer a concussion. Group differences in cognitive impairment between females and males who have suffered concussion have been extensively studied. A study of 2,340 high school and collegiate athletes who suffered concussions determined that females had a 170% higher frequency of cognitive impairment following concussions, and that in comparison with males, female athletes had significantly greater declines in simple and complex

reaction times relative to their preseason baseline levels. Moreover, the females experienced greater objective and subjective adverse effects from concussion even after adjusting for potentially protective effect of helmets used by some groups of male athletes. Females have also been shown to exhibit greater time loss away from sport in comparison to males after a concussion injury, and to exhibit higher rates of persistent post-concussion symptoms, as well as impairments of complex cognitive test performance a half year after injury. (Bretzin 2018 at 2266; Broshek 2005 at 856, 861; Colvin 2009; Covassin 2012; Ellemberg 2007; Rooks 2025; Vedung 2020; Zemek 2016) This large discrepancy in frequency and severity of concussion injury is consistent with my own observations across many years of clinical practice. The large majority of student athletes who have presented to my practice with severe and long-lasting cognitive disturbance have been adolescent girls. I have seen girls remain symptomatic for over a year, lose ground academically, and become isolated from their peer groups due to these ongoing symptoms. For patients who experience these severe effects, post-concussion syndrome can be life-altering.

72. This increased susceptibility to concussive head injury results in magnified risk to female athletes when they are forced to compete against biological males. When modeling the effect of the introduction of male mass, speed, and strength into women's rugby, World Rugby gave particular attention to the resulting increases in forces and acceleration (and injury risk) experienced in the head and neck of female players. Their analysis found that "the magnitude of the known risk factors for head injury are . . . predicted by the size of the disparity in mass between

players," and that "the addition of [male] speed as a biomechanical variable further increases these disparities." Their injury model showed an increase of up to 50% in neck and head acceleration that would be experienced in a typical tackle scenario in women's rugby, with larger and faster male athletes delivering tackles higher up the torso of a smaller female ball carrier. (Tierney 2017) As a result, they determined that "a number of tackles that currently lie beneath the threshold for injury would now exceed it, causing head injury." (World Rugby Transgender Women Guidelines 2020) While rugby is notoriously contact-intensive, similar increases in the risk of head and neck injury to women are predictable in any sport context in which males and females collide at significant speed or with significant force.

73. As it stands, when females compete against each other, they already have higher rates of concussive injury than males, across most sports. The addition of biologically male athletes into women's contact sports will inevitably increase the risk of concussive injury to girls and women for the multiple reasons I have explained above, including, but not limited to, the innate male advantage in speed and lean muscle mass, as well as some degree of inherent female physiologic injury susceptibility. Because the effects of concussion can be severe and long-lasting, particularly for biological females, we can predict with some confidence that if participation by trained biological males in women's contact sports based on gender identity becomes more common, more biological females will suffer substantial concussive injury and the potential for long-term harm as a result.

B. Anterior cruciate ligament injuries

74. The anterior cruciate ligament ("ACL") is a key knee stabilizer that prevents anterior translation of the tibia relative to the femur and also provides rotatory and valgus knee stability.[34] (Lin 2019 at 4) Girls and women are far more vulnerable to ACL injuries than are boys and men. The physics of injury that we have reviewed above makes it inevitable that the introduction of biologically male athletes into the female category will increase still further the occurrence of ACL injuries among girls or women who encounter these players on the field.

75. Sports-related injury to the ACL is so common that it is easy to overlook the significance of it. But it is by no means a trivial injury, as it can end sports careers, require surgery, and usually results in early-onset, post-traumatic osteoarthritis, triggering long-term pain and mobility problems later in life. (Wang 2020)

76. Even in the historic context in which girls and women limit competition to (and so only collide with) other girls and women, the rate of ACL injury is substantially higher among female than male athletes. (Flaxman 2014; Lin 2019; Agel 2005) One meta-analysis of 58 studies reports that female athletes have a 150% relative risk for ACL injury compared with male athletes, with other estimates suggesting as much as a 300% increased risk. (Montalvo 2019; Sutton 2013) Particularly in those sports designated as contact sports, or sports with frequent cutting and sharp directional changes (basketball, field hockey, lacrosse, soccer), females are at greater risk of ACL injury. In some epidemiological studies, wrestling

[34] Valgus force at the knee is a side-applied force that gaps the medial knee open.

has been shown to be commonly associated with ACL injury risk, and women have been shown to have higher rates of sprain injuries than men when they wrestle. (Yu 2013; Hoge 2021) In basketball and soccer, this risk extends across all skill levels, with female athletes between two and eight times more likely to sustain an ACL injury than their male counterparts. (Lin 2019 at 5) These observations are widely validated, and consistent with the relative frequencies of ACL injuries that I see in my own practice.

77. When the reasons underlying the difference in the incidence of ACL injury between males and females were first studied in the early 1990s, researchers speculated that the difference might be attributable to females' relative inexperience in contact sports, or to their lack of appropriate training. However, a follow-up 2005 study looking at ACL tear disparities reported that, "Despite vast attention to the discrepancy between anterior cruciate ligament injury rates between men and women, these differences continue to exist." (Agel 2005 at 524) Inexperience and lack of training do not explain the differences. Sex seems to be an independent predictor of ACL tear risk.

78. In fact, as researchers have continued to study this discrepancy, they have determined that multiple identifiable anatomical and physiological differences between males and females play significant roles in making females more vulnerable to ACL injuries than males. (Flaxman 2014; Lin 2019; Wolf 2015) Summarizing the findings of a number of separate studies, one researcher recently cited as anatomical risk factors for ACL injury smaller ligament size, decreased femoral notch width,

increased posterior-inferior slope of the lateral tibia plateau, increased knee and generalized laxity, and increased body mass index (BMI). With the exception of increased BMI, each of these factors is more likely to occur in female than male athletes. (Lin 2019 at 5) In addition, female athletes often stand in more knee valgus (that is, in a "knock-kneed" posture) due to wider hips and a medially-oriented femur. Often, this is also associated with a worsening of knee valgus during jump landings. The body types and movement patterns associated with these valgus knee postures are more common in females and increase the risk for ACL tear. (Hewett 2005)

79. As with concussion, the cyclic fluctuation of sex-specific hormones in women is also thought to be a possible risk factor for ACL injury. Estrogen acts on ligaments to make them more lax, and it is thought that during the ovulatory phase of menses (when estrogen levels peak), the risk of ACL tear is higher. (Chidi-Ogbolu 2019 at 1; Herzberg 2017; Martinez-Fortuny 2023) Whatever the factors that increase the injury risk for ACL tears in women, the fact that a sex-specific difference in the rate of ACL injury exists is well established and widely accepted.

80. Although non-contact mechanisms are the most common reason for ACL tears in females, tears related to contact are also common, with ranges reported across multiple studies of from 20 to 36% of all ACL injuries in women. (Kobayashi 2010 at 672) For example, when a soccer player who is kicking a ball is struck by another player in the lateral knee of the stance leg, medial and rotational forces can tear the medial collateral ligament (MCL), the ACL, and the meniscus. An analysis of collegiate wrestlers with ACL injury suggested that defending a takedown with the

foot planted and knee extended, is an at-risk posture for ACL tear. (Lightfoot 2005) Thus, as participation in the female category based on identity rather than biology becomes more common (entailing the introduction of trained athletes with characteristics such as greater speed and lean muscle mass), and as collision forces suffered by girls and women across the knee increase accordingly, the risk for orthopedic injury and in particular ACL tears among impacted girls and women will inevitably rise.

81. This sex-weighted risk for ligament injury in the knee probably translates to greater risk in other areas as well. Female athletes have greater risks for ankle sprain injury, and also carry greater risk for more severe injury with resultant time loss from sport. Moreover, the most common cause of ankle sprain injury in female athletes is contact with another player. (Talia 2024)

82. Of course, there exists variation in all these factors within a given group of males or females. However, it is also true that within sex-specific pools, size differential is somewhat predictable and bounded, even considering outliers. When males are permitted to enter into the pool of female athletes based on gender identity rather than biological sex, there is an increased possibility that a statistical outlier in terms of size, weight, speed, and strength—and potentially an extreme outlier—is now entering the female pool. Although injury is not guaranteed, risks to female participants will increase. And as I discuss later, the available evidence together suggests that this will be true even with respect to males who have been on testosterone suppression for a year or more. World Rugby relied heavily upon this

when they were determining their own policy, and I think it is important to reiterate that this policy, rooted in concern for athlete safety, is justifiable based upon current evidence from medical research and what we know about biology.

VII. TESTOSTERONE SUPPRESSION WILL NOT PREVENT HARM TO FEMALE SAFETY IN ATHLETICS

83. An editorial in the New England Journal of Medicine opined that policies governing transgender participation in female athletics "must safeguard the rights of all women—whether cisgender or transgender." (Dolgin 2020) Unfortunately, the physics and medical science reviewed above tell us that this is not practically possible. If biological males are given a "right" to participate in the female category based on gender identity, then biological women will be denied the right to reasonable expectations of safety and injury risk that have historically been guaranteed by ensuring that females compete (and collide) only with other females.

84. Advocates of unquestioning inclusion based on gender identity often contend that hormonal manipulation of a male athlete can feminize the athlete enough that he is comparable with females for purposes of competition. The NCAA's Office of Inclusion asserts (still accessible on the NCAA website as of this writing[35]) that "It is also important to know that any strength and endurance advantages a transgender woman arguably may have as a result of her prior testosterone levels

[35] NCAA transgender policy background, resources, https://www.ncaa.org/.

dissipate after about one year of estrogen or testosterone suppression therapy."[36] (NCAA 2011 at 8) Whether or not this is true is a critically important question.

85. At the outset, we should note that while advocates sometimes claim that testosterone suppression *can* eliminate physiological advantages in a biological male, it is rare for a policy to require any demonstration that it has *actually* achieved that effect in a particular male who seeks admission into the female category. The Washington State policy that is currently at issue in this litigation permits admission to the female category solely on the basis of a student-athlete's expressed gender identity, without requiring any testosterone suppression at all.

86. Washington's policy, essentially allowing unregulated male competition against biologically female athletes, should be critically evaluated in part, by considering what is known about the performance-enhancing effects of even relatively small discrepancies of serum testosterone within the female category. Analysis of elite female international track and field performances shows a statistically significant association between competition results and free testosterone levels, relative to other competitors in the 400m dash, 400m hurdles and 800m dash, with performance differences between the lowest and highest testosterone tertiles of 2.73%, 2.78%, and 1.78% respectively. Similar performance stratification occurred in the hammer throw and pole vault. (Bermon 2017) Female Olympic athletes across multiple sports have been shown to have significantly higher levels of serum

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[36] NCAA Office of Inclusion, *NCAA Inclusion of Transgender Student-Athletes* (Aug. 2011), https://ncaaorg.s3.amazonaws.com/inclusion/lgbtq/INC_TransgenderHandbook.pdf.

androgen precursors than in age-matched sedentary controls (Eklund 2017), and the presence of hyperandrogenic 46 XY DSD in the elite female athletic population has been described as being 140 times higher than expected in the general population (Bermon 2014). Finally, women with polycystic ovarian syndrome have been shown to have greater muscle strength and power in relation to controls, associated with greater levels of bioavailable testosterone. (Guzelce 2019)

87. As Dr. Emma Hilton has observed, the fact that there are over 3,000 sex-specific differences in skeletal muscle alone makes the hypothesis that sex-linked performance advantages are attributable solely to current circulating testosterone levels improbable at best. (Hilton 2021 at 200–01) Indeed, next to breast tissue, there is no tissue in the human body with more sex-differentiated genetic expression than skeletal muscle. (Gershoni 2017)

88. Even if active treatment with gender-affirming therapy actually results in full testosterone suppression, which is not a given (Liang 2018; Miro 2025), the available evidence strongly indicates that no amount of testosterone suppression can eliminate male physiological advantages relevant to performance and safety. Several authors have recently reviewed the data from numerous studies that demonstrate that one year (or more) of testosterone suppression does not substantially eliminate male performance advantages (Hilton 2021; DeVarona 2021; Harper 2021), and it has been reported that nearly 10% of males on testosterone suppression regimens develop no discernable changes in body composition at all. (Van Velzen 2020) As a medical doctor, I will focus on those specific sex-based characteristics of males who have

undergone normal sex-determined pubertal skeletal growth and maturation that are relevant to the *safety* of female athletes. Here, too, the available research tells us that testosterone suppression does not eliminate the increased risk to females or solve the safety problem.

89. The World Rugby organization was the first to reach this same determination based on the available science, concluding that male physiological advantages that "create risks [to female players] appear to be only minimally affected" by testosterone suppression. (World Rugby Transgender Women Guidelines 2020)

90. In their recent guidelines, UK Sports determined that, "based upon current evidence, testosterone suppression is unlikely to guarantee fairness between transgender women and natal females in gender-affected sports." (UK Sports Councils' Equality Group Guidance 2021 at 7) They also warned that migration to a scenario by NGBs where eligibility is determined through case-by-case assessment "is unlikely to be practical nor verifiable for entry into gender-affected sports," in part because "many tests related to sports performance are volitional," and incentives on the part of those tested would align with intentional poor performance. (UK Sports Councils' Equality Group Guidance 2021 at 8)

91. Despite these concerns, this was exactly the route that the IOC took in 2021, with their Framework on Fairness, Inclusion and Non-Discrimination on the

Basis of Gender Identity.[37] In it, the IOC listed two disparate goals. First, that "where sports organizations elect to issue eligibility criteria for men's and women's categories for a given competition, they should do so with a view to . . . [p]roviding confidence that no athlete within a category has an unfair and disproportionate competitive advantage . . . [and] preventing a risk to the physical safety of other athletes." (IOC Framework 2021 § 4.1) At the same time, governing bodies were not to preclude any athlete from competing until evidence existed based upon "robust and peer-reviewed research that . . . demonstrates a consistent, unfair, disproportionate competitive advantage in performance and/or an unpreventable risk to the physical safety of other athletes"—research moreover that "is largely based on data collected *from a demographic group that is consistent in gender and athletic engagement with the group that the eligibility criteria aim to regulate*." (IOC Framework 2021 § 6.1) Finally, affected athletes retained a right to appeal the results of any evidence-based decision-making process through a further "appropriate internal mediation mechanism, such as a Court of Arbitration for Sport." (IOC Framework 2021 § 6.2) Rather than cite any of the growing evidence that testosterone suppression cannot mitigate sex-based performance differences, the IOC's new policy remained aspirational and opaque, and came into early criticism by scholars, who stated that "it is incoherent for the IOC to take a stance of 'no presumption of advantage' when a transitioning transgender woman athlete comes directly from a population with an

[37] *IOC Framework on Fairness, Inclusion and Non-Discrimination on the Basis of Gender Identity and Sex Variations*, Int'l Olympic Comm. (2021), https://stillmed.olympics.com/media/Documents/Beyond-the-Games/Human-Rights/IOC-Framework-Fairness-Inclusion-Non-discrimination-2021.pdf.

inherent and well-established male biological advantage. It would be more logical to assume a biological advantage until proven otherwise, especially as several physical attribute (e.g. stature, heart, lung, bone, and muscle size) have not been shown to be reversed with any treatment," and that "the current body of evidence demonstrating male biological advantage and the lack of evidence for its removal with testosterone suppression provides a compelling basis for sports to adopt a policy that upholds sex-segregated competition to ensure fairness and safety for female athletes." (e.g., Lundberg 2024) Regardless of the intent, the effect of the IOC's policy was to spur grassroots reviews of the available evidence by the national governing bodies of various Olympic sports, in many cases resulting in a tightening of policies to further limit participation of biological males in womens' sports. World Athletics new policy has already been cited. Other sports federations, such as FINA, World Rowing, World Triathlon, and the International Cyclist Union, have since issued policy changes further restricting biological males from participating against natal females.[38] (Pigozzi 2022; World Athletics 2025; FINA Inclusion Policy 2022; Marra 2026) Finally, after convening a working group to review the available evidence in March 2026, the IOC itself announced a requirement for sex-based genetic testing of all athletes as a requirement for eligibility in the female category. (IOC 2026)[39] As of the

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[38] Press Release, *World Athletics Council Decides on Russia, Belarus and Female Eligibility*, World Athletics (Mar. 23, 2023), https://worldathletics.org/news/press-releases/council-meeting-march-2023-russia-belarus-female-eligibility; Matthew Futterman, *FINA Restricts Transgender Women from Competing at Elite Level*, N.Y. Times (June 19, 2022), https://www.nytimes.com/2022/06/19/sports/fina-transgender-women-elite-swimming.html.

[39] "It is universally accepted that providing for a Female Category is necessary to allow equal access to elite sport to both Males and Females. Including athletes who are XY transgender and/or

time of this writing, the NAIA and NCAA have also instituted policies preventing biological males from competing in women's sports. As reflected in the policies and policy statements of the organizations highlighted above, the research relating to hormonal suppression in transgender athletes speaks very clearly to the fact that males retain a competitive advantage over women that cannot be eliminated through testosterone suppression alone. What follows is a brief summary of some of these retained differences as they relate to sport safety.

A. Bone density

92. I start with what is obvious and so far as I am aware undisputed—that after the male pubertal growth spurt, suppression of testosterone does not materially *shrink* bones so as to eliminate height, leverage, performance, and weight differences that follow from simply having longer, larger bones, and being subsequently taller.

93. Bone mass (which includes both size and density) is maintained over *at least* two years of testosterone suppression (Singh-Ospina 2017; Fighera 2019; Ciancia 2026), and one study found it to be preserved even over a median of 12.5 years of suppression (Hilton 2021; Ruetsche 2005).

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androgen-sensitive XY-DSD athletes (whatever their legal sex or gender identity) in the Female Category in sports and events that rely on strength, power and/or endurance runs fundamentally counter to ensuring fairness, safety and integrity in elite competition and to the reliable attainment of the IOC's modern goals. Furthermore, the need for consistency and fairness across sports precludes eligibility criteria that require case-by-case consideration of differences in Male performance advantage. To reliably uphold fairness, safety and integrity in elite sport and to meet these shared goals, and in light of relevant developments since 2021, the IOC is issuing this new Policy on the Protection of the Female (Women's) Category in Olympic Sport and Guiding Considerations for International Federations and Sports Governing Bodies."

B. Size, weight, and lean body mass

94. Males are, on average, larger, and heavier. As we have seen, these facts alone mean that males bring more kinetic energy into collisions, and that lighter females will suffer more abrupt deceleration in collisions with larger bodies, creating heightened injury risk for impacted females. Males also have longer limbs, which allow for greater force generation when throwing. Even when puberty is blocked in advance of hormonal manipulation, males still grow to their predicted male height or nearly so, suggesting that not even standard medical treatment regimens remove this advantage. (Boogers 2022; Ciancia 2023)

95. Multiple studies have found that testosterone suppression may modestly reduce, but does not come close to eliminating the male advantage in muscle mass and lean body mass, which together contribute to the greater average male weight. Studies looking at the effect of GAHT on lean mass are generally split between those showing modest decreases, or no statistical change. (Ford 2021; Sieczkowska 2026) Researchers looking at transitioning adolescents found that the weight of biological male subjects *increased* rather than decreased after treatment with an antiandrogen testosterone suppressor, with no loss in muscle strength. (Tack 2018) Adolescent biological male subjects who were exposed to puberty-halting medications prior to institution of testosterone suppression presented with lean body mass 2.5 standard deviations higher than biological girls, and maintained gains of between 1 to 2 standard deviations at age 22. (Klaver 2018) Another study that looked at patients who underwent puberty blockade followed by testosterone suppression found that subjects only reduced lean body mass by 5%, remaining 15% higher than

both females undergoing masculinizing therapy with testosterone. Similar to Klaver, there were no differences in outcome with respect to body composition in patients starting puberty suppression early or late, leaving the authors to postulate that prepubertal testosterone exposure may contribute to the observed outcomes. (Boogers 2024) In one recent meta-analysis, researchers looking at the musculoskeletal effects of hormonal transition found that even after males had undergone 36 months of therapy, their lean body mass and muscle area remained above those of females. (Harper 2021) Another group in 2004 studied the effects of testosterone suppression to less than 1 nmol/L in men after one or more years, but still found only a 12% total loss of muscle area by the end of thirty-six months. (Gooren 2004) More recently, researchers looking at changes in lean body mass over 5 to 6 years of hormone therapy showed that with feminizing treatment, biological males only reduced their skeletal muscle mass by 7%, and exhibited no statistical change in strength. (Lundberg 2025) These findings represented ongoing retained advantages in both muscle mass and muscle strength over biological women. Moreover, the normally-expected loss of muscle mass of up to 2.5% from five years of aging in this cohort were not considered, perhaps overstating the observed lean muscle loss attributed to hormone therapy. (Lundberg 2025) Finally, a 2022 study comparing biological males on an average of 14.4 years of GAHT to cisgender men and women showed that, despite testosterone levels that were in female range, both skeletal muscle mass and appendicular skeletal mass adjusted for height, as well as handgrip strength, remained statistically greater than cisgender controls. Activity in this study was controlled for, and did not differ between examined groups. (Alvares 2022)

C. Strength

96. In this section, I compare competing studies about the loss of muscle strength in biological men undergoing feminizing hormone treatment. A large number of studies have now observed minimal or no reduction in strength in male subjects following testosterone suppression. In one meta-analysis, strength loss after twelve months of hormone therapy ranged from negligible to 7%, (Harper 2021) while another ranged from negligible to 10% (Norlund 2026). Given the baseline male strength advantage in various muscle groups of from approximately 25 to 100% above female levels that I have noted in Section V.D. above, even a 10% reduction will leave a large retained advantage in strength. Handgrip strength is a proxy for general strength, but also a covariate of lower body strength and impulsive activity (such as sprinting or jumping), and is predictive to some degree of overhead throwing velocity, boxing ranking, and judo or wrestling success. (Cronin 2017) One study analyzing handgrip strength showed a 9% loss of strength after two years of hormonal treatment in males who were transitioning, leaving a 23% retained advantage over the female baseline. (Hilton 2021) Yet another study which found a 17% retained grip strength advantage noted that this placed the median of the group treated with hormone therapy in the 95th percentile for grip strength among age-matched females. (Scharff 2019) Researchers looking at transitioning adolescents showed no loss of grip strength after hormone treatment. (Tack 2018) A more recent study looking at biological males on feminizing hormone therapy for an average of 6.6 years showed

maintenance of handgrip strength in excess of biological female norms, despite lean body mass indices that were in the female range. Of note, 42% of males vs. 19% of females refused the activity monitors that were part of this study, making it difficult to track the effect of exercise patterns on the achieved lean body mass. (Ciancia 2026)

97. Regarding lower extremity strength, an observational cohort study looked at thigh strength and thigh muscle cross-sectional area in men undergoing hormonal transition towards a female body type. After one year of hormonal suppression, this group saw only a 4% decrease in thigh muscle cross-sectional area, and a negligible decrease in thigh muscle strength. Wiik and colleagues looked at isokinetic strength measurements in individuals who had undergone at least 12 months of hormonal transition and found that muscle strength was comparable to baseline, and torque-generating ability actually increased, leaving transitioned males with a 50% strength advantage over reference females. (Wiik 2020) Finally, one cross-sectional study that compared men who had undergone transition at least three years prior to analysis, to age-matched, healthy males found that the transgender individuals had retained enough strength that they were still outside normative values for women. This imbalance continued to hold even after *eight* years of hormone suppression. The authors also noted that since males who identify as women often have lower baseline (i.e., before hormone treatment) muscle mass than the general population of males, and since baseline measures for this study were unavailable, the post-transition comparison may actually represent an overestimate of muscle mass regression in transgender females. (Lapauw 2008; Hilton 2021)

98. A recent study comparing upper body muscle strength changes in biological males just starting feminizing hormone treatment with biological males already on feminizing treatment showed a large drop in upper body strength and power in the first year of treatment in treatment-naïve individuals. The results of this study are difficult to interpret, because although measured maximal power was similar between groups at baseline, the treatment naïve group declined by 23% at one year while the treatment ongoing group improved by 29%—a disparate result that cannot be explained by changes in lean mass alone (4% loss in the naïve group vs. 2% gain in the ongoing group). Because the low row 1RM and power tests are maximal volitional performance tests, the unusually large naïve decline could reflect not only physiologic loss of strength but also differential effort at follow-up. Another potential explanation for this disparity is a difference in participation in strength training between the two groups (7% in the naïve group vs. 30% in the treatment ongoing group), which has been shown to increase muscle gene upregulation and myonuclei density in the context of strength enhancement. (Norlund 2025; Cumming 2024) Counterbalancing the Norlund study, and perhaps providing a window into the effect of regimented physical training, a new study on male Air Force service members undergoing transition showed that they retained more than two thirds of pretreatment performance advantage over females in sit-ups and push-ups after between one and two years of testosterone-reducing hormonal treatment. (Roberts 2020) A similar study in 2022 looking at 228 biologically male, transitioning Air Force personnel showed that these individuals retained statistical advantage over

biological females up to four years for sit-ups, and indefinitely for push-ups, despite the fact that this group started GAHT underperforming to cisgender males in push-ups at baseline. (Chiccarelli 2022) The ability of strength training to increase upper body muscle mass, endurance, power and strength (chest/bench press, seated row) in androgen-deprived individuals has also been well-documented. (Kvorning 2006; Hanson 2013; Cormie 2015)

99. In the last few years, several cross-sectional studies assessing physical performance of biological males, biological females, and biological males undergoing feminizing treatment have been published, as well as one meta-analysis, all meriting comment. Hamilton looked at physical performance in biological males who were transitioning toward a feminized body type, and who had been on hormonal therapy for an average of six years. In this study, transgender subjects exhibited similar handgrip strength to men, retaining greater absolute handgrip strength relative to women. Transgender subjects also exhibited greater peak power and had greater absolute lean mass. Transgender subjects in this study appeared more deconditioned as a group. Further, assessment of physical performance in the transgender group was probably adversely affected, because subjects with higher testosterone levels were excluded from analysis. (Hamilton 2024) Another study looked at sedentary Thai subjects. Transgender individuals had been on feminizing regimens for about 8 to 10 years. Lean mass for transgender subjects remained intermediate between non-transitioning men and biological women. Transgender subjects also exhibited greater peak power on countermovement jumps than biological women, and demonstrated 16

to 20% greater anaerobic power than biological women. It should be stated that in these (and any) sedentary transgender subjects, their greater lean muscle mass implies a greater training capacity, should they choose to leverage it. (Saitong 2024)

100. A 2025 cross-sectional study of Brazilian subjects was published comparing biological male, female, and transgender volleyball players. Although this study did not demonstrate performance advantages of transfemales over biological females, the study can be justifiably criticized and the validity of the study's findings can be reasonably called into question. The first and most obvious criticism of this study is that the biological female cohort was clearly more athletically trained than either biological male or transgender cohorts. The biological female subjects, competing in a more elite division than the biological males, were just as tall as the transgender subjects despite the fact that transgender subjects had gone through male puberty. Further illustrating the atypicality of these biological females as a group, there were no identified statistical differences in lower body strength measurements between biological females and non-transgender biological males. Biologically female players averaged 13.88 (11.35 to 16.41) hours of practice per week compared to 4.07 (3.39 to 4.75) hours in the transgender group, and also had higher competition exposure. In addition, the testosterone levels of the biological females were elevated relative to the transgender subjects such that their confidence intervals did not overlap [Transgender: 0.34 nmol/L (0.11 to 0.57) vs. Biological females: 1.58 (0.67 to 2.49).] Not surprisingly, absolute lean mass and appendicular lean mass was greater in the biological female cohort in comparison to the transgender subjects, and

the biological female athletes exhibited comparable performance on squat jump height and countermovement jump height relative to biological male subjects. (Alvares 2025) This becomes important when interpreting a recent meta-analysis looking at body composition and physical fitness in transgender versus cisgender subjects (Sieczkowska 2026), which reported no significant differences in upper and lower body strength between biological females and transitioned male subjects. Analysis of the forest plots provided in the study clearly demonstrate that the Alvares study alone skews the findings as the sole outlier showing reduced strength in transgender females, in contrast to other cited studies. This results in “substantial” study heterogeneity, suggesting that the reported data is inappropriately skewed, and calling into question the authors’ contention that there is a “convergence of transgender women’s functional performance with cisgender women.” While in transgender women GAHT was associated with a significant decrease in absolute lean mass and upper-body strength during the first year, evidence for continued decline beyond year 1 was inconclusive.

101. The bulk of the available evidence still supports the recently offered conclusion of the IOC, and the earlier conclusion World Rugby came to based on its own review of the literature—testosterone suppression “does not reverse muscle size to female levels,” and in fact that “studies assessing [reductions in] mass, muscle mass, and/or strength suggest that reduction in these variables range between 5% and 10%. Given that the typical male vs. female advantages range from 30 to 100%, these reductions are small.” (World Rugby Transgender Women Guidelines 2020)

102. Not only is loss of actual muscle size relatively limited, there is growing evidence of a muscle memory phenomenon, whereby biological males who have undergone male puberty continue to exhibit a male phenotype for muscle form and function, even if they are hormonally manipulating themselves in an attempt to achieve a female body type. Biologically male muscle develops with more fast-twitch type II fibers, different muscle gene expression, more myonuclei, and a different myonuclear architecture that makes it easier to reacquire muscle mass and strength upon resumption of resistance training, since these increased numbers of muscle myonuclei induced do not appear to be lost during periods of detraining. This greater capacity for functional regain seems to exist independent of male levels of testosterone once male muscle morphology, epigenetics, and other neural adaptations have been established. (Cumming 2024; Joyner 2024; Sitko 2025) Since transgender individuals do not constitute a third biological category, this obviously becomes relevant in the context of sport, where an athlete on gender-affirming hormone therapy is concurrently pursuing an intentional strength training program in an effort to mitigate loss of muscle strength.

103. It is true that most studies of change in physical characteristics or capabilities over time after testosterone suppression involve untrained subjects rather than athletes, or subjects with low to moderate training. It may be assumed that all of the Air Force members who were subjects in the study I mention above were physically fit and engaged in regular physical training. But neither that study nor those studies looking at athletes quantify the volume or type of strength training

athletes are undergoing. The important point to make is that the only effect strength training could have on these athletes is to *counteract* and reduce the limited loss of muscle mass and strength that does otherwise occur to some extent over time with testosterone blockade. Here, I compare various studies about the loss of muscle strength in groups of patients undergoing androgen deprivation treatment. These studies demonstrate the positive effect of strength training in patients undergoing recent androgen deprivation, one of which measured strength during a twelve-week period where testosterone was suppressed to levels of 2 nmol/L. During that time, subjects actually increased leg lean mass by 4%, and total lean mass by 2%, and subject performance on the 10 rep-max leg press improved by 32%, while their bench press performance improved by 17%. (Kvorning 2006)

104. Another prospective study on patients starting androgen deprivation treatment showed mitigation of any lean muscle loss in the treatment group in conjunction with significant strength improvements in both upper and lower body. (Cormie 2015) A recent meta-analysis by Keilani confirms resistance training as a "potent approach" to maintain lean body mass, prevent body fat accumulation, and even increase strength from baseline in biologically male subjects artificially exposed to a state of testosterone suppression and concomitant estrogen therapy. (Keilani 2017) Another study looking at subjects who began an exercise intervention an average of 4 to 7 months after starting androgen deprivation therapy showed similar findings, with statistically significant improvements in muscle cross-sectional area, leg press and leg extension strength over controls. (Houben 2023) Patients on chronic

androgen deprivation seem to respond similarly. A study of patients on androgen deprivation therapy for a mean of 1,136 days showed that a 20-week progressive resistance training program moving from concentric toward eccentric load training resulted in 41% improvements in both chest press and seated rows, and a 96% improvement in leg press. (Galvao 2006) A similar twelve-week trial with subjects an average of six years out from diagnosis, already exhibiting significant loss of muscle mass from baseline, demonstrated a 17% improvement in lower body strength. (Winters-Stone 2015) All of this would seem to be directly correlative to a biologically male athlete undergoing similar hormonal manipulation, in an effort to mitigate the expected negative physical changes that impair performance.

105. A biological male's superior strength and power enables him to apply greater force than a female can against an opponent's body during contact, or to throw, hit, or kick a ball at speeds outside the ranges normally encountered in female-only play, with the attendant increased risks of injury that I have already explained. The key point for safety is that, just like prostate cancer patients on androgen deprivation who use resistance training to mitigate the muscle wasting effects of treatment, there is nothing preventing transgender individuals on feminizing therapy from using regimented strength training to mitigate muscle wasting effects on themselves either. This can only result in a greater degree of retained physical advantage over the biological females he will be competing against.

D. Speed

106. As to speed, the study of transitioning Air Force members found that these males retained a 9% running speed advantage over the female control group

after one year of testosterone suppression, and their average speed had not declined significantly farther by the end of the 2.5 year study period. (Roberts 2020) Again, I have already explained the implications of greater male speed on safety for females on the field and court, particularly in combination with the greater male body weight.

107. This is further illustrated in a recent partly-retrospective, partly longitudinal study of transgender athletes and their changes in performance over time, before and after institution of feminizing hormone therapy. Although this study was limited by small sample size, did not measure strength or power, and relied on self-reporting of testosterone levels, it did analyze relative performance in sprint events versus endurance events. Since sprint skill is translatable to speed, and speed to injury risk, some inferences related to safety can be reasonably drawn. As the authors themselves acknowledge, there was less impact of feminizing hormone therapy on sprint performance, which reflects less treatment-related suppression of lean mass and strength than hemoglobin and VO2max. Indeed, in this study, lean body mass and BMI did not significantly change. Moreover, there was a strong correlation between changes in training and age-grade change, supporting the idea that strength training can only help to mitigate treatment-related performance impairment. Looking at the authors' own restricted analysis, with focus on the case of the sprinter reported in this study who maintained run training and added in additional strength training, time increases ranged from 4.7 to 8.1%, with expected

age-related decrements accounting for between 1 to 2% of that increase.[40] Analyzing the group at-large, average race time increases for competitors in short events was only 5.5%. With an average treatment duration of 44 months at study entry, the reported results corroborate the idea that sprint performance advantage is not significantly reduced over one, two, or even three years despite reported suppression of testosterone to female levels.

108. To summarize this real-world study of athletes, feminizing hormone therapy produced some degree of performance change over time, but it asymmetrically affected endurance performance over sprint performance. Indeed, not only does this study seem to support the idea that in strength-trained athletes particularly, sprint performance changes over time are relatively small, but the authors themselves expressly state this.[41] This has bearing on the physical performance capabilities of biologically male athletes who are competing in sporting events that emphasize sprint speed, and by extension, strength, power and momentum. (Harper 2025)

CONCLUSION

Since the average male athlete is larger and exerts greater power than the average female athlete in similar sports, male-female collisions will produce greater

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[40] World Masters Athletics, *WMA Age Factors and Parameters for Scoring Combined Events and One Year Age Factors* (Jan. 1, 2023), https://world-masters-athletics.org/wp-content/uploads/2023/02/2023-Age-Factors-WMA.pdf.

[41] "Although not able to be confirmed in the current study, it is plausible that in athletes, in whom resistance training is implemented to increase muscular strength, power and muscle size, the GAHT-associated rate of decline in both lean mass and strength in TW may be attenuated. Studies to examine this postulate are needed."

energy at impact, and impart greater risk of injury to a female, than would occur in most female-female collisions. The same is true for collisions between a female and a ball, puck, stick, or other piece of sports equipment thrown, kicked, hit, swung, or otherwise projected by a male athlete. Because of the well-documented physiological testing and elite performance differences in speed and strength, as well as differences in lean muscle mass that exist across all age ranges, the conclusions of this paper can apply to a certain extent before, as well as during, and after puberty. We have seen that males who have undergone hormone therapy in transition toward a female body type nevertheless retain musculoskeletal "legacy" advantages in muscle girth, strength, and size. We have also seen that the additive effects of these individual advantages create multiplied advantages in terms of power, force generation and momentum on the field of play. In contact or collision sports, sports involving projectiles, or sports where a stick is used to strike something, the physics and physiology reviewed above tell us that permitting male-bodied athletes to compete against, or on the same team as females—even when undergoing testosterone suppression—must be expected to create predictable, identifiable, increased, and unequal risks of injuries to the participating women.

Based on its independent and extensive analysis of the literature coupled with injury modeling, World Rugby recognized the following:

- Forces and inertia faced by a smaller and slower player during collisions are significantly greater when in contact with a larger, faster player.
- Discrepancies in mass and speed (such as between two opponents in a tackle) are significant determinants of various head and other musculoskeletal injury risks.

- The risk of injury to females is increased by biological males' greater ability to exert force (strength and power), and also by females' reduced ability to receive or tolerate that force.
- Testosterone suppression results in only "small" reductions in the male physiological advantages. As a result, heightened injury risks remain for females who share the same field or court with biological males.
- These findings together predict a significant increase in injury rates for females in rugby if males are permitted to participate based on gender identity, *with or without testosterone suppression*, since the magnitude of forces and energy transfer during collisions will increase substantially, directly correlated to the differences in physical attributes that exist between the biological sexes.

Summarizing their work, the authors of the World Rugby Guidelines said that, "World Rugby's number one stated priority is to make the game as safe as possible, and so World Rugby cannot allow the risk to players to be increased to such an extent by allowing people who have the force and power advantages conferred by testosterone to play with and against those who do not." (World Rugby Transgender Guidelines 2020)

The 2026 policy reversal by the IOC further validates the fact that transgender athletes are not a third biological category, and that it is unrealistic to expect that female sport integrity can be protected through any policy short of exclusion of biological males from the female category. According to the IOC guidelines, their working group reached consensus that "to protect fairness in (all) such sports and events, as well as safety . . . it is necessary and adequate to base eligibility for competition on biological sex." The IOC's statement went on to summarize the physiologic effects of higher circulating testosterone levels, further stating that "XY transgender athletes . . . have anatomical and physiological advantages in line with being male," and that "there is no current evidence that testosterone suppression or gender-affirming hormone treatment eliminates this advantage." Finally, the IOC expressly acknowledged that "in contact sports, the strength and power differential between males and females increases safety risks to female athletes."

As my own analysis above makes clear, I agree with the concerns of UK Sports, the conclusions of World Rugby, and now the IOC as well regarding risk to female athletes. Importantly, I also agree that it must be a high priority for sports governing bodies (and other regulatory or governmental bodies governing sports) to make each sport as safe as reasonably possible. And in my view, medical practitioners with expertise in this area have an obligation to advocate for science-based policies that promote safety. Unfortunately in the case of Washington State, the only barrier to participation of a biological male in competitive girl's high school athletics is the gender identification of the biological male himself. There is no restriction on athletes who have entered male puberty, and there is no requirement to suppress male testosterone levels. USA Wrestling continues to hold to an unjustifiable policy of allowing biological males to compete in women's wrestling as long as they maintain their serum testosterone levels below 10.0 nmol/L—a level that crosses over into the lower quartile of the normal male range.[42] [43] Neither of these policies can be rationally justified.

In 2019, the International Court of Arbitration for Sport issued a ruling in the Caster Semenya case. In it, they recognized the validity of human biological sex as a category deserving unique protections in sport.[44] But court rulings aren't necessary to prove the obvious. The *performance* advantages retained by males who participate in women's sports based on gender identity are readily recognized by the public. When an NCAA hurdler who ranked 200th while running in the collegiate male division transitions and immediately leaps to a number one ranking in the women's division;[45] when a high school male sprinter who ranked 181st in the state running in the boys' division transitions and likewise takes first place in the girls' division (DeVarona 2021), when a biologically-male collegiate swimmer transitions and moves from 65th place in the men's 500m event, to NCAA champion in the women's 500 meter race, (Senefeld 2023) the problem of fairness and equal opportunities for girls

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[42] There is often a misperception about the original purpose of testosterone testing thresholds. These thresholds were not established with the goal of determining the highest allowable testosterone level that ensured fair competition. They were instead thresholds that were intended to identify non-female competitors, or competitors with 46XY DSD.

[43] *Policies by Organization*, Transathlete.com, https://www.transathlete.com/policies-by-organization.

[44] "The purpose of having separate categories is to protect a class of individuals who lack certain insuperable performance advantages from having to compete against individuals who possess those insuperable advantages. In this regard, the fact that a person is recognised in law as a woman and identifies as a woman does not necessarily mean that they lack those insuperable performance advantages associated with certain biological traits that predominate in individuals who are generally (but not always) recognised in law as males and self-identify as males. It is human biology, not legal status or gender identity, that ultimately determines which individuals possess the physical traits which give rise to that insuperable advantage and which do not." (CAS 2019)

[45] *CeCé Telfer*, Wikipedia.org, https://en.wikipedia.org/wiki/Cece_Telfer (accessed 6/20/21).

and women is immediately apparent, and indeed this problem is being widely discussed today in the media.

The causes of sports injuries, however, are multivariate and not always as immediately apparent. While, as I have noted, some biological males have indeed competed in a variety of girls' and women's contact sports, the numbers up to this point have been small. But recent studies have reported very large increases in the number of children and young people identifying as transgender compared to historical experience.

For example, as of 2023, the CDC found that 3.3% of adolescents nationally identify as transgender and an additional 2.2% are questioning whether they identify as transgender—well over 100 times historical rates. (CDC 2023) Many other sources likewise report this trend. (Johns 2017; Herman 2017) State-specific data from 2025 seems to support a higher incidence of transgender identification in persons 24 and younger.[46] In the state of Washington specifically, 3.39 percent of thirteen to seventeen year olds identify as transgender, slightly above the national average. (Herman 2025)

Faced with this rapid social change, it is my view as a medical doctor that policymakers have an important and pressing duty not to wait while avoidable injuries are inflicted on girls and women, but instead to proactively establish policies governing participation of biological males in female athletics that give proper and

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[46] Jody L. Herman & Andrew R. Flores, UCLA Sch. of L. Wms. Inst., *How Many Adults and Youth Identify as Transgender in the United States?* (Aug. 2025), https://williamsinstitute.law.ucla.edu/wp-content/uploads/Trans-Pop-Update-Aug-2025.pdf.

scientifically-based priority to safety in sport for these girls and women. Separating participants in contact sports based on biological sex preserves competitive equity, but also promotes the safety of female athletes by protecting them from predictable and preventable injury. Otherwise, the hard science that I have reviewed in this report leaves little doubt that eligibility policies based on ideology or gender identity rather than science, will, over time, result in increased, and more serious, injuries to girls and women who are forced to compete against biologically male transgender athletes. When basic science and physiology both predict increased injury, then leagues, policy-makers, and legislators have a responsibility to act to protect girls and women before they get hurt.

I declare under penalty of perjury under the laws of the United States of America that the foregoing expert report is true and correct to the best of my knowledge.

Executed on July 6, 2026.

Chad Carlson, M.D., FACSM
Stadia Sports Medicine
West Des Moines, Iowa
Past-President, AMSSM

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