EXPERT DECLARATION OF GREGORY A. BROWN, Ph.D., FACSM

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Personal Qualifications and Disclosure

I serve as Professor of Exercise Science in the Department of Kinesiology and Sport Sciences at the University of Nebraska Kearney, where I teach classes in Exercise Physiology among other topics. I have served as a tenured (and nontenured) professor at universities since 2002.

In August 2002, I received a Doctor of Philosophy degree from Iowa State University, where I majored in Health and Human Performance, with an emphasis in the Biological Bases of Physical Activity. In May 1999, I received a Master of Science degree from Iowa State University, where I majored in Exercise and Sport Science, with an emphasis in Exercise Physiology. In June 1997 I received a Bachelor of Science from Utah State University where I majored in Physical Education with an emphasis in Pre-Physical Therapy.

I have received many awards over the years, including the Mortar Board Faculty Excellence Honors Award, College of Education Outstanding Scholarship / Research Award, College of Education Outstanding Faculty Teaching award, and the College of Education Award for Faculty Mentoring of Undergraduate Student Research. I have authored or co-authored more than 60 refereed publications and more than 70 refereed presentations in the field of Exercise Science. I have authored or co-authored chapters for multiple books in the field of Exercise Science. And I have served as a peer reviewer for over 30 professional journals, including *The American Journal of Physiology*, the *International Journal of Exercise Science*, the *Journal of Strength and Conditioning Research*, *Therapeutic Advances in Endocrinology and Metabolism, Sports Medicine*, and *The Journal of Applied Physiology*. Among many topics in exercise science and physiology, my service as a peer reviewer has included reviewing scholarly papers on the topic of transwomen and transgirls competing in female sports. In April 2025 I was invited by Sport New Zealand to evaluate whether their updated Transgender Inclusion Guidelines adequately balanced transgender inclusion with safety and fairness for female athletes.

My areas of research have included the endocrine response to testosterone prohormone supplements in men and women, the effects of testosterone prohormone supplements on health and the adaptations to strength training in men, the effects of energy drinks on the physiological response to exercise, assessment of various athletic training modes in males and females, and sex-based differences in athletic performance. Articles that I have published that are closely related to topics that I discuss in this expert report include:

- Studies of the effect of ingestion of a testosterone precursor on circulating testosterone levels in young men. Douglas S. King, Rick L. Sharp, Matthew D. Vukovich, Gregory A. Brown, et al., *Effect of Oral Androstenedione on Serum Testosterone and Adaptations to Resistance Training in Young Men: A Randomized Controlled Trial*, JAMA 281: 2020-2028 (1999); G. A. Brown, M. A. Vukovich, et al., *Effects of Anabolic Precursors on Serum Testosterone Concentrations and Adaptations to Resistance Training in Young Men*, Int J Sport Nutr Exerc Metab 10: 340-359 (2000).
- A study of the effect of ingestion of that same testosterone precursor on circulating testosterone levels in young women. G. A. Brown, J. C. Dewey, et al., *Changes in Serum Testosterone and Estradiol Concentrations Following Acute Androstenedione Ingestion in Young Women*, Horm Metab Res 36: 62-66 (2004.)
- A study finding (among other things) that body height, body mass, vertical jump height, maximal oxygen consumption, and leg press maximal strength were higher in a group of physically active men than comparably active women, while the women had higher percent body fat. G. A. Brown, Michael W. Ray, et al., *Oxygen Consumption, Heart Rate, and Blood Lactate Responses to an Acute Bout of Plyometric Depth Jumps in College-Aged Men and Women*, J. Strength Cond Res 24: 2475-2482 (2010).
- A study finding (among other things) that height, body mass, and maximal oxygen consumption were higher in a group of male NCAA Division 2 distance runners, while women NCAA Division 2 distance runners had higher percent body fat. Furthermore, these male athletes had a faster mean competitive running speed (~3.44 min/km) than women (~3.88 min/km), even though the men ran 10 km while the women ran 6 km. Katherine Semin, Alvah C. Stahlnecker, Kate A. Heelan, G. A. Brown, et al, *Discrepancy Between Training, Competition and Laboratory Measures of Maximum Heart Rate in NCAA Division 2 Distance Runners*, Journal of Sports Science and Medicine 7: 455-460 (2008).

- A presentation at the 2021 American Physiological Society New Trends in Sex and Gender Medicine Conference entitled "Transwomen Competing in Women's Sports: What We Know and What We Don't".
- I have also authored an August 2021 entry for the American Physiological Society Physiology Educators Community of Practice Blog (PECOP Blog) titled "The Olympics, Sex, and Gender in the Physiology Classroom, and a May 2023 entry for the PECOP Blog titled "The Olympics, sex, and gender in the physiology classroom (part 2): Are there sex based differences in athletic performance before puberty?" I have also authored an April 17, 2023 post for the Center on Sport Policy and Conduct titled "Should Transwomen be allowed to Compete in Women's Sports? A view from an Exercise Physiologist."
- A number of presentations at the annual meeting of the American College of Sports Medicine
    - In 2022 titled "Comparison of Running Performance Between Division and Sex in NCAA Outdoor Track Running Championships 2010-2019."
    - In 2023 titled "Boys and Girls Differ in Running and Jumping Track and Field Event Performance Before Puberty."
    - In 2025 a symposium titled "Sex Differences in Physical and Athletic Performance Among Youths" with a specific presentation titled "Sex Differences in Physical and Athletic Performance before Puberty." Another research presentation titled "Boys Run Faster Than Girls in Preliminary and Championship Track Races" and another research presentation titled "Boys Age 10-and-Under Swim Faster Than Girls in Most Long and Short Course Events."
- A letter to the editor in JAMA Pediatrics in which I and my co-authors point out the inherent male athletic advantages before and after puberty, state that transwomen are biologically male, and that allowing male bodies into female sports is detrimental to female athletes.
- Two recent papers published in the European Journal of Sports Science in which my colleagues and I evaluated competitive sports performance in children aged 10-and-under

in national championship track & field meets in the United States of America. In these papers we report that, when comparing the male and female performances statistically and when comparing the individual best male performance to the best female performances numerically, males in the 8-and-under and 9-10-year-old age groups ran 2.9-6.7% faster than females in the 100m, 200m, 400m, 800m, and 1500m events, jump 3.9-4.7% farther in long jump, and throw 6.5-32.6% farther in shot put and javelin throw. Because running, jumping, and throwing are fundamental skills in many sports these data can be generalized as being indicative of prepubertal male advantages in all sports in which running, jumping, or throwing are determinants of athletic performance.

- Another recent paper published in the European Journal of Sports Science in which my colleagues and I evaluated competitive swimming performance in children aged 10-and-under in national championship short course swim meets in the United States of America. In this paper we report that, when comparing the male and female performances statistically, the males were 1.16-2.63% faster in 8 out of 12 events and the data approached statistical significance (P=0.055) in a ninth event. There were no statistically significant sex-based differences in performance in the remaining 3 events.
- A recent paper entitled "The IOC framework on fairness, inclusion and non-discrimination on the basis of gender identity and sex variations does not protect fairness for female athletes" that has been published in the Scandinavian Journal of Medicine and Science in Sports in which a team of 26 scholars from numerous countries reiterates the importance of sex as a biological determinant of athletic performance that favors males. Furthermore, we point out that research to date indicates that testosterone suppression and cross sex hormone use does not erase male biological athletic advantages.
- A "Rapid Response" in the British Journal of Sports Medicine in which I and a co-author point out some methodological and data interpretation flaws in a paper evaluating the physical fitness of purportedly athletic transgender individuals compared to athletic non-transgender individuals.
- An invited editorial entitled "Fair and Safe Eligibility Criteria for Women's Sport" that has

been published in the Scandinavian Journal of Medicine and Science in Sports. In this paper a team of 31 scholars from numerous countries reiterates the importance of sex as a biological determinant of athletic performance that favors males. Further, we provide suggestions on how to screen athletes to exclude male advantages from the female category. As a team we have also published a response to a critique of this paper in this same journal.

- An invited editorial in the journal Translational Exercise Biomedicine in which my colleagues and I critique the paper "A unique pseudo-eligibility analysis of longitudinal laboratory performance data from a transgender female competitive cyclist" by Hamilton et al. (2024).
- A "Rapid Response" in the British Journal of Sports Medicine in which I and several co-authors point out some major methodological and data interpretation flaws in a paper evaluating the physical fitness of transwomen volleyball players compared to female volleyball players. This Rapid Response has also been published on SportRxiv in its pre-peer review format.
- I am a co-author of a letter to the editor accepted for publication in the journal *Drug Testing and Analysis*, in which eleven experts collectively explain that males possess inherent, biologically based athletic advantages over comparably aged, trained, and talented females across all ages and levels of sport. Based on this evidence, we argue that the principles of fair and safe competition require that male athletes be excluded from the female category in all competitive contexts—including elite, recreational, amateur, junior, and scholastic levels.

A list of my published scholarly work for the past 10 years appears as an Appendix.

Purpose of this Declaration

This declaration represents an updated report in which I have been asked to offer my opinions about the following: (a) whether males have inherent advantages in athletic performance over females, and if so the scale and anatomical and physiological basis of those advantages, to the extent currently understood by science and (b) whether the sex-based performance advantage enjoyed by males is eliminated if feminizing hormones are administered to male athletes who identify as transgender (and in the case of prepubertal children, whether puberty blockers eliminate the advantage). In this declaration, when I use the terms "man," "boy," or "male," I am referring to biological males based on the individual's reproductive biology and genetics as determined at birth. Similarly, when I use the terms "woman," "girl," or "female," I am referring to biological females based on the individual's reproductive biology and genetics as determined at birth. When I use the term transgender, I am referring to persons who are males or females, but who identify as a member of the opposite sex.

I have previously provided expert information in the form of written declarations and depositions in the cases of *Soule vs. CIAC* in the state of Connecticut, *B.P.J. vs. West Virginia State Board of Education* in the state of West Virginia, *L.E. vs. Lee* in the state of Tennessee, *Noe vs UHSAA* in the state of Utah, *Doe vs Horne* in the state of Arizona, and in the form of a written declaration in the cases of and *Hecox vs. Little* in the state of Idaho and *Female Athletes United v. Ellison* in the state of Minnesota. I have not previously testified as an expert in any trials.

The opinions I express in this declaration are my own, and do not necessarily reflect the opinions of my employer, the University of Nebraska.

I am being compensated for my time serving as an expert in this case at the rate of $200 per hour. My compensation does not depend on the outcome in the case.

Overview

In this declaration, I explore three important questions relevant to current discussions and policy decisions concerning inclusion of transgender individuals in women's athletic competitions. Based on my professional familiarity with exercise physiology and my review of the currently available science, including that contained in the many academic sources I cite in this report, I set out and explain three basic conclusions:

- At the level of (a) elite, (b) collegiate, (c) scholastic, and (d) recreational competition, men, adolescent boys, or male children, have an advantage over equally aged, talented, and trained women, adolescent girls, or female children in almost all athletic events. This advantage exists in a wide variety of athletic endeavors before puberty, and it expands substantially during puberty;
- Biological male anatomy and physiology is the primary basis for the performance advantage that men, adolescent boys, or male children have over equally aged, talented, and trained women, adolescent girls, or female children in almost all athletic events; and
- Giving androgen inhibitors (which block male hormones) or cross-sex hormones (such as estrogen) to males—whether adults or adolescents who have already experienced any degree of male puberty—does not remove the physical performance advantages they generally have over females of the same age, skill, and training level in most sports. Similarly, there is no scientific evidence showing that giving puberty blockers to boys before or during puberty removes the athletic advantages that boys have over girls—advantages that exist even before puberty—in most sports.

Subsequently within this document I cite many sources, and provide detailed information from some of these sources, that have been particularly influential in my formation of these three main conclusions. In short summary, men, adolescent boys, and prepubertal male children perform better in almost all sports than equally aged, trained, and talented women, adolescent girls, and prepubertal female children because of their inherent anatomical and physiological advantages. In general, men, adolescent boys, and prepubertal male children, can run faster, output more muscular power, jump higher, and possess greater muscular endurance than equally aged, trained, and talented women, adolescent girls, and prepubertal female children. These advantages become greater during and after male puberty, but they exist before puberty.

Further, while after the onset of puberty males are on average taller and heavier than females, a male performance advantage over females has been measured in weightlifting competitions even between males and females matched for body mass.

Male advantages in measurements of body composition, tests of physical fitness, and athletic performance have also been shown in children before puberty. These advantages are magnified during puberty, triggered in large part by the higher testosterone concentrations in men, and adolescent boys, after the onset of male puberty. Under the influence of these higher testosterone levels, adolescent boys and young men develop even more muscle mass, greater muscle strength, less body fat, higher bone mineral density, greater bone strength, higher hemoglobin concentrations, larger hearts and larger coronary blood vessels, and larger overall statures than women. In addition, maximal oxygen consumption (VO_2max), which correlates to ~30-40% of success in endurance sports, is higher in both elite and average men and boys than in comparable women and girls when measured in regard to absolute volume of oxygen consumed and when measured relative to body mass.

Although androgen deprivation (that is, testosterone suppression) may modestly decrease some physiological advantages that men and adolescent boys have over equally aged, trained, and talented women and adolescent girls, it cannot fully or even largely eliminate those physiological advantages once an individual has passed through male puberty. Furthermore, there is no evidence showing that the use of gonadotropin-releasing hormone agonist drugs (GnRHa aka puberty blockers) eliminates male athletic advantages when these drugs are administered before or during adolescent puberty, or in post-pubertal adults.

Summary of Changes from Initial 2020 Report

This declaration builds upon my original 2020 report filed for *Soule v CIAC* with a broader scope, more detailed evidence, updated references, and a clearer connection to policy-making and legal interpretation. It enhances the scientific foundation laid in 2020 by incorporating recent studies, data on youth athletes, and formal rebuttals to counterarguments on the impact of hormone therapy and puberty blockers.

Both this declaration and my original 2020 report reach the same key conclusions: that sex-based differences in sports performance exist; that these differences are rooted in underlying biological factors; and that hormonal interventions intended to mitigate the effects of male endocrinology do not eliminate the athletic advantages conferred by male physiology. The weight of the scientific evidence published since 2020—much of which is cited here—simply buttresses these conclusions, which were known and available in the literature at the time of the first report.

Key Differences in Content and Scope:

1. Scope of Analysis:

- 2020 Report: Focused on male vs. female performance differences, especially post-puberty. Primarily addressed three points: male athletic advantage, its physiological basis, and the limited impact of hormone therapy post-puberty.
- Current Declaration: Broadens the scope to more explicitly include elite, collegiate, scholastic, and recreational competition levels. Adds detailed sections on prepubertal differences, biological sex, testosterone's role, and the evidence showing that puberty blockers and testosterone suppression do not eliminate inherent male advantages.

2. Scientific Evidence:

- 2020 Report: Cited ~11 scientific sources, with detailed summaries of key peer-reviewed studies relevant to sex-based performance differences.
- Current Declaration: Includes citations to ~200 peer reviewed publications. Adds evidence from over 100 other sources including international sport governing bodies, (e.g., from World Aquatics, World Boxing, World Aquatics), news media, and broader datasets (e.g.,

prepubertal competition data).

3. Prepubertal Athlete Comparisons:

   - 2020 Report: Mentions only post-pubertal performance.
   - Current Declaration: Introduces extensive analysis of sex differences in prepubertal children, including peer reviewed research on running, swimming, and throwing events in youth competition. Concludes that male athletic advantages exist before puberty, and there is no reliable evidence they are eliminated by puberty blockers.

4. Policy and Safety Discussions:

   - Current Declaration includes substantial discussion of sports policy, safety concerns for female athletes, and critiques of current inclusion standards (e.g., hormone level thresholds). The 2020 Report does not address these areas in depth.

Evidence and Conclusions

I. The scientific reality of biological sex

1. The scientific starting point for the issues addressed in this report is the biological fact of binary and dimorphic sex in the human species. Human sexual reproduction requires the joining of the small male gamete (i.e. sperm) with the large female gamete (i.e. ova) and is thus binary, meaning there are only male and female gametes. Humans are also dimorphic, meaning there are two distinct body forms (i.e. male and female), each based around the formation of its respective gametes. It is now well recognized that dimorphic sex is so fundamental to human development that, as stated in a position paper issued by the Endocrine Society, it "must be considered in the design and analysis of human and animal research. . . . Sex is dichotomous, with sex determination in the fertilized zygote stemming from unequal expression of sex chromosomal genes." (Bhargava et al. 2021 at 220). As stated by Sax (2002 at 177), "More than 99.98% of humans are either male or female." All humans who do not suffer from some genetic or developmental disorder are unambiguously male or female.
2. Although sex and gender are used interchangeably in common conversation, government documents, and in the scientific literature, the American Psychological Association (2025) defines sex as "physical and biological traits" that "distinguish between males and females" whereas gender "implies the psychological, behavioral, social, and cultural aspects of being male or female (i.e., masculinity or femininity)". The concept that sex is an important biological factor determined at conception is a well-established scientific fact that is supported by statements from a number of respected organizations including, but not limited to, the Endocrine Society (Bhargava et al. 2021), the American Physiological Society (Shah 2014), the Institute of Medicine (Institute of Medicine 2001), the National Institutes of Health (Miller 2014 at H781-82), and the American College of Sports Medicine (Hunter et al, 2023). Collectively, these and other organizations have stated that every cell has a sex and every system in the body is influenced by sex. Indeed, "sex often influences gender, but gender cannot influence sex." (Bhargava 2021 at 228.)

3. To further explain: “The classical biological definition of the **2 sexes** is that females have ovaries and make larger female gametes (eggs), whereas males have testes and make smaller male gametes (sperm) … the definition can be extended to the ovaries and testes, and in this way the categories—female and male—can be applied also to individuals who have gonads but do not make gametes … sex is dichotomous because of the different roles of each sex in reproduction.” (Bhargava 2021 at 221.) Furthermore, “sex determination begins with the inheritance of XX or XY chromosomes” (Bhargava 2021 at 221.) And, “Phenotypic sex differences develop in XX and XY embryos as soon as transcription begins. The categories of X and Y genes that are unequally represented or expressed in male and female mammalian zygotes … cause phenotypic sex differences” (Bhargava 2021 at 222.)
4. Goymann, Brumm, and Kappeler (2023) more firmly defend the importance of recognizing the binary nature of human sex by saying “Biological sex is defined as a binary variable in every sexually reproducing plant and animal species.” (at 2). And further state that “As much as the concept of biological sex remains central to recognize the diversity of life, it is also crucial for those interested in a profound understanding of the nature of gender in humans. Denying the biological sex, for whatever noble cause, erodes scientific progress. In addition, and probably even worse, by rejecting simple biological facts influential science journals may open the flood gates for “alternative truths.”” (at 5).
5. Richard Dawkins is an evolutionary biologist and author. Due to his seminal book *The Selfish Gene* and other influential and award-winning works, Dr. Dawkins can be considered the preeminent evolutionary biologist of our time. In various media interviews and in a 2022 essay, he has clearly stated that “Sex is Pretty Damn Binary.” (Dawkins, 2022).
6. Although disorders of sexual development (DSDs) are sometimes confused with discussions of transgender individuals, the two are different phenomena. DSDs are disorders of physical development. Many DSDs are “associated with genetic mutations that are now well known to endocrinologists and geneticists.” (Bhargava 2021 at 225) By

contrast, a sense of transgender identity is usually not associated with any physical disorder, and "a clear biological causative underpinning of gender identity remains to be demonstrated." (Bhargava 2021 at 226.) The importance of distinguishing between the two is exemplified by the World Athletics Council releasing a policy on Eligibility Regulations For Transgender Athletes in March 2023. Within this policy it states that "The substantial sex difference in sports performance that emerges from puberty onwards means that the only way to [give equal opportunities to all athletes to participate in and excel at the sport, and to provide them with fair and meaningful competition conditions, so that they are motivated to make the huge commitment and sacrifice required to excel in the sport, and so inspire new generations to join the sport and aspire to the same excellence] is to maintain separate classifications (competition categories) for male and female athletes." Within these policies it is stated that in order to compete in the female category an athlete with the gender identity of a woman or girl "… must not have experienced any part of male puberty either beyond Tanner Stage 2 or after age 12 (whichever comes first)." (World Athletics Council, 2023[1]). But these regulations expressly do not apply to athletes with DSDs, which are governed by an entirely separate eligibility policy—recognizing that DSDs and adopting a transgender identity are different things. As stated by my colleagues and I, "The participation of male-born competitors (e.g., transgender women) and athletes with certain XY DSDs in female sport is a growing concern. These athletes experience male-typical development from testes producing testosterone, with resultant physiological differences creating athletic advantages and safety risks." (Tucker et al., 2024; at 1).

7. Further demonstrating the biological importance of sex, Gershoni and Pietrokovski (2017) detail the results of an evaluation of "18,670 out of 19,644 informative protein-coding genes in men versus women" and reported that "there are over 6500 protein-coding genes with significant SDE [Sex Differential Expression] in at least one tissue. Most of these

[1] It is important to note that on February 10, 2025, World Athletics initiated a stakeholder consultation process to consider that the female category is only for those whose sex at birth is female, and also emphasizing that "exclusive focus on male puberty is wrong." https://worldathletics.org/news/press-releases/world-athletics-launches-new-stakeholder-consultation-on-female-eligibility.

genes have SDE in just one tissue, but about 650 have SDE in two or more tissues, 31 have SDE in more than five tissues, and 22 have SDE in nine or more tissues" (Gershoni 2017 at 2-3.) Some examples of tissues identified by these authors that have SDE genes include breast mammary tissue, skeletal muscle, skin, thyroid gland, pituitary gland, subcutaneous adipose, lung, and heart left ventricle. Based on these observations the authors state, "As expected, Y-linked genes that are normally carried only by men show SDE in many tissues" (Gershoni 2017 at 3.) As stated by Heydari et al. (2022, at 1), "Y chromosome harbors male-specific genes, which either solely or in cooperation with their X-counterpart, and independent or in conjunction with sex hormones have a considerable impact on basic physiology and disease mechanisms in most or all tissues development." Skaletsky et al. (2003) put the importance of the sex chromosomes in perspective when she wrote "If one compares a female with a male, the second X chromosome … is replaced by the largely dissimilar Y chromosome ... This common substitution of the Y chromosome for the second X chromosome dwarfs all other DNA polymorphism in the human genome" (at 836). As stated by O'Connor (2023, at 2, quoting Institute of Medicine) "not every difference observed between male and female cells can be attributed to differences in exposure to sex hormones."

8. In a review of 56 articles on the topic of sex-based differences in skeletal muscle, Haizlip et al., (2015) state that "More than 3,000 genes have been identified as being differentially expressed between male and female skeletal muscle." (Haizlip 2015 at 30.) Furthermore, the authors state that "Overall, evidence to date suggests that skeletal muscle fiber-type composition is dependent on species, anatomical location/function, and sex" (Haizlip 2015 at 30.) The differences in genetic expression between males and females influence the skeletal muscle fiber composition (i.e. fast twitch and fast twitch sub-type and slow twitch), the skeletal muscle fiber size, the muscle contractile rate, and other aspects of muscle function that influence athletic performance. As the authors review the differences in skeletal muscle between males and females they conclude, "Additionally, all of the fibers measured in men have significantly larger cross-sectional areas (CSA) compared with

women." (Haizlip 2015 at 31.) The authors also explore the effects of thyroid hormone, estrogen, and testosterone on gene expression and skeletal muscle function in males and females. One major conclusion by the authors is that "[t]he complexity of skeletal muscle and the role of sex adding to that complexity cannot be overlooked." (Haizlip 2015 at 37.) The evaluation of SDE in protein coding genes helps illustrate that the differences between men and women are intrinsically part of the chromosomal and genetic makeup of humans which can influence many tissues that are inherent to the athletic competitive advantages of men compared to women.

9. The determination of sex chromosomes, known as karyotyping, provides no useful insight into the diagnosis of a transgender identity (Auer et al. 2013, Liang et a. 2022). Similarly, there is no known biologically based test that can be used to determine if an individual is transgender (Bhargava et al. 2021). All of this leads up to the key point that transwomen (also called transgender women) and transgirls (also called transgender girls) are male based on their biology.

II. Biological men, or adolescent boys, have large, well-documented performance advantages over women and adolescent girls in almost all athletic contests.

10. It should scarcely be necessary to invoke scientific experts to "prove" that adult human males (i.e. men) are on average larger, stronger, and faster than adult human females (i.e. women). All of us, along with our siblings and our peers and perhaps our children, have passed through puberty, and we have watched that differentiation between the sexes occur. This is common human experience and knowledge.

11. Examples of the recognition of the sex-based differences in anatomy and physiology in sports policies include (but are not limited to) the following:

- The net height for men's volleyball is set at 7 feet 11 5/8 inches, while the net height for women's volleyball is set at 7 feet 4 1/8 inches (Athlete+, 2024).
- For the running events of 55 meter and 60 meter hurdles, the High School boys' hurdle height is 39 inches while the High School girls' hurdle height is 33 inches, the men's (College/International) hurdle height is 42 inches while the women's

(College/International) hurdle height is 33 inches. In all the distances the men's hurdle height is higher than the women's (USA Track & Field New England, 2009).

- In the NBA (male professional basketball league) the basketball is 29.5 inches in circumference while in the WNBA (female professional basketball league) the basketball is 28.5 inches in circumference (Adidas, 2024).

12. Nevertheless, these sex-based differences have been extensively studied and measured. I cited many of these studies in the first paper on this topic that I prepared, which was submitted in litigation in January 2020. Since then, in light of current controversies, several authors have compiled valuable collections or reviews of data extensively documenting this objective fact about the human species, as manifest in almost all sports, each of which I have reviewed and found informative. These include, but are not limited to, Handelsman et al. (2018), Coleman (2020), Hilton & Lundberg (2021), World Rugby (2020), Harper (2021), Hamilton (2021), a "Briefing Book" prepared by the Women's Sports Policy Working Group (2021), Heather (2022), Bascharon (2024), Hunter (2023), Nuzzo (2023), Tidmas (2023), and Joyner (2025). Collectively, these papers have gathered a tremendous amount of scientific evidence of the systematic and large male athletic advantage.

13. These papers and many others document that men, adolescent boys, and prepubertal male children, substantially outperform comparably aged, talented, and trained women, adolescent girls and prepubertal female children, in competitions involving running speed, swimming speed, cycling speed, jumping height, jumping distance, and strength (to name a few, but not all, of the performance differences). As I discuss later, these performance advantages for men, adolescent boys, and prepubertal male children, are based in large part on the biological differences between the sexes.

14. In fact, I'm not aware of any scientific evidence currently available that disproves the idea that, after puberty, men have significant athletic advantages over women. The male advantages are so large that they are often insurmountable for comparably aged, trained, and talented female athletes at every level (i.e. (a) elite, (b) collegiate, (c) scholastic, and (d) recreational competition). I'm also not aware of any scientific evidence currently

available that disproves the idea that these observed performance advantages are largely due to anatomical and physiological differences between men and women—differences that have been measured and are reasonably well understood.

15. My use of the term "advantage" in this paper must not be read to imply any normative judgment. The adult female physique is simply different from the adult male physique. Obviously, it is optimized in important respects for the difficult task of childbearing. On average, women require far fewer calories for healthy survival. Evolutionary biologists can and do theorize about the survival value or "advantages" provided by these and other distinctive characteristics of the female physique, but I will leave that to the evolutionary biologists. I use "advantage" to refer merely to performance advantages in athletic competitions.

16. I find in the literature a widespread consensus that the large performance, anatomical, and physiological advantages possessed by males—rather than social considerations or considerations of identity—are precisely *the primary reason* that most athletic competitions are separated by sex, with women treated as a "protected class." To cite only a few statements accepting this as the justification:

    - Handelsman et al. (2018) wrote, "Virtually all elite sports are segregated into male and female competitions. The main justification is to allow women a chance to win, as women have major disadvantages against men who are, on average, taller, stronger, and faster and have greater endurance due to their larger, stronger, muscles and bones as well as a higher circulating hemoglobin level." (803)
    - Millard-Stafford et al. (2018) wrote "Current evidence suggests that women will not swim or run as fast as men in Olympic events, which speaks against eliminating sex segregation in these individual sports" (530) "Given the historical context (2% narrowing in swimming over 44 y), a reasonable assumption might be that no more than 2% of the current performance gap could still potentially be attributed to sociocultural influences.", (533) and "Performance gaps between US men and women stabilized within less than a decade after federal legislation provided equal

opportunities for female participation, but only modestly closed the overall gap in Olympic swimming by 2% (5% in running)." (533) Dr. Millard-Stafford, a full professor at Georgia Tech, holds a Ph.D. in Exercise Physiology and is a past President of the American College of Sports Medicine. Thibault et al. (2010), Senefeld et al. (2021), Jobe et al. (2022), Hunter et al. (2023), and Rohrer (2024), have also documented that the size of the male sex-based advantages in athletic performance have remained largely unchanged since the 1980s.

- In 2021, Hilton et al. wrote, "most sports have a female category the purpose of which is the protection of both fairness and, in some sports, safety/welfare of athletes who do not benefit from the physiological changes induced by male levels of testosterone from puberty onwards." (204)
- In 2020 the Swiss High Court ("Tribunal Fédéral") observed that "in most sports … women and men compete in two separate categories, because the latter possess natural advantages in terms of physiology."[2]
- The members of the Women's Sports Policy Working Group wrote that "If sports were not sex-segregated, female athletes would rarely be seen in finals or on victory podiums," and that "[w]e have separate sex sport and eligibility criteria based on biological sex because this is the only way we can assure that female athletes have the same opportunities as male athletes not only to participate but to win in competitive sport. … If we did not separate athletes on the basis of biological sex–if we used any other physical criteria–we would never see females in finals or on podiums." (WSPWG Briefing Book 2021 at 5, 20.)
- In 2020, the World Rugby organization stated that "the women's category exists to ensure protection, safety and equality for those who do not benefit from the biological advantage created by these biological performance attributes." (World Rugby Transgender Women Guidelines 2020.)

[2] "dans la plupart des sports . . . les femmes et les hommes concourent dans deux catégories séparées, ces derniers étant naturellement avantagés du point de vue physique." Tribunal Fédéral decision of August 25, 2020, Case 4A_248/2019, 4A_398/2019, at §9.8.3.3.

- In 2021 Harper et al. stated "…the small decrease in strength in transwomen after 12–36 months of GAHT [Gender Affirming Hormone Therapy] suggests that transwomen likely retain a strength advantage over cisgender women." (7) and "…observations in trained transgender individuals are consistent with the findings of the current review in untrained transgender individuals, whereby 30 months of GAHT may be sufficient to attenuate some, but not all, influencing factors associated with muscular endurance and performance." (8)
- Hamilton et al. (2021), "If a biologically male athlete self-identifies as a female, legitimately with a diagnosis of gender dysphoria or illegitimately to win medals, the athlete already possesses a physiological advantage that undermines fairness and safety. This is not equitable, nor consistent with the fundamental principles of the Olympic Charter and could be a potential danger to the health and safety of athletes." (840)
- Hamilton et al. (2021), in a consensus statement for the International Federation of Sports Medicine (FIMS) concluded that "Transwomen have the right to compete in sports. However, cisgender women have the right to compete in a protected category." (1409)
- World Aquatics, formerly known as FINA, is the international federation recognized by the International Olympic Committee (IOC) for administering international competitions in Aquatics, and stated on June 19, 2022 "Historically, Aquatics sport has been separated into men's and women's competition categories. The separation reflects the sport's commitment to: (1) ensuring equal opportunity for both male and female athletes to participate and succeed in the sport, including through the equal representation in its programs and competitions of athletes of both biological sexes; (2) ensuring competitive fairness and physical safety within its competition categories; and (3) developing the sport and promoting its popular appeal and commercial value." (FINA 2022). This policy indicates that the only way to achieve the objectives set out above is to maintain separate classifications (competition categories) for male and

female athletes. The policy cites the physical advantages conferred on male athletes by the testes producing much higher levels of circulating testosterone than ovaries produce from puberty onwards in female athletes.

- On September 29, 2023, the American College of Sports Medicine (ACSM) published a special communication titled "The Biological Basis of Sex Differences in Athletic Performance: Consensus Statement for the American College of Sports Medicine." (Hunter, 2023) The first three sentences in the abstract are "Biological sex is a primary determinant of athletic performance because of fundamental sex differences in anatomy and physiology dictated by sex chromosomes and sex hormones. Adult men are typically stronger, more powerful, and faster than women of similar age and training status. Thus, for athletic events and sports relying on endurance, muscle strength, speed, and power, males typically outperform females by 10%–30% depending on the requirements of the event." (at 1) and "The fastest and most powerful males outperform the fastest and most powerful females." (at 23) and "The direct and indirect effects of testosterone in males (relative to females) during puberty that impact athletic performance include increased skeletal muscle mass due to larger muscle fiber cross-sectional area especially fast, type II M[yosin]H[eavy]C[hain] fibers, lower percentage body fat, higher hemoglobin concentration and mass, larger ventricular mass and myocardial contractility, larger airways and lungs, greater body height, and longer limbs." (at 23) This consensus statement makes many of the same conclusions and is in agreement with the information set forth in this report regarding the nature and magnitude of sex-based differences in athletic performance between adult males and females.
- Dr. Michael Joyner is a distinguished researcher at the Mayo Clinic, and is one of the preeminent exercise scientists of our time having been repeatedly recognized by the American College of Sports Medicine and the American Physiological Society for excellence in research for his work on exercise physiology and human performance. His paper *Evidence On Sex Differences In Sports Performance* (Joyner et al. 2025)

includes the following statement in the abstract "There are profound sex differences in human performance in athletic events determined by strength, speed, power, endurance, and body size such that males outperform females. These sex differences in athletic performance exist before puberty and increase dramatically as puberty progresses. The profound sex differences in sports performance are primarily attributable to the direct and indirect effects of sex-steroid hormones and provide a compelling framework to consider for policy decisions to safeguard fairness and inclusion in sports."

17. While the sources I mention above gather more extensive scientific evidence of this uncontroversial truth, I provide here a summary of representative facts concerning the male advantage in athletic performance.

A. Men are stronger.

18. Males exhibit greater strength throughout the body. Both Handelsman et al. (2018) and Hilton & Lundberg (2021) have gathered multiple literature references (pre-dating 2020) that document this fact in various muscle groups.

19. A recent narrative review by Nuzzo (2023a) evaluated the sex-based differences in strength in almost all muscle groups and many different exercises and reported that males are 40–120% stronger than women, with an overall mean difference of 73%, depending on the muscle groups and exercises being compared.

20. Men have in the neighborhood of 60%–100% greater **arm strength** than women. (Handelsman 2018 at 812.)[3] One study of elbow flexion strength (basically, bringing the fist up towards the shoulder) in a large sample of men and women found that men exhibited 109% greater isometric strength[4], and 89% higher strength in a single repetition. (Hilton

[3] Handelsman expresses this as women having 50% to 60% of the "upper limb" strength of men. Handelsman cites Sale, *Neuromuscular function*, for this figure and the "lower limb" strength figure. Knox et al., *Transwomen in elite sport* (2018) are probably confusing the correct way to state percentages when they state that "differences lead to decreased trunk and lower body strength by 64% and 72% respectively, in women" (397): interpreted literally, this would imply that men have **almost 4x as much** lower body strength as do women.

[4] Isometric strength measures muscular force production for a given amount of time at a specific joint angle but with no joint movement.

2021 at 204, summarizing Hubal (2005) at Table 2.)

21. Hunter (2024) reviews the sex-based differences in muscle function and states "The limb muscles of males are stronger, faster, and more powerful than females because males possess a larger and faster contracting muscle mass: these differences range from 20-40% depending on the muscle group []. A larger muscle mass of males than females is primarily due to larger fiber size of all fibers with even larger sex differences in the myosin heavy chain (MHC) Type II fibers that are fast contracting []. The faster contracting muscles of males than females are due to a proportionally larger area of MHC Type II fibers within the whole muscle…" (at 8)

22. **Grip strength** is often used as a useful proxy for strength more generally. In one study, men showed on average 57% greater grip strength than women. (Bohannon 2017.) A wider meta-analysis of multiple grip-strength studies not limited to athletic populations found that 18- and 19-year-old males exhibited in the neighborhood of 2/3 greater grip strength than females. (Handelsman 2017 Figure 3, summarizing Silverman 2011 Table 1.)[5]

23. The *ACSM's Guidelines for Exercise Testing and Prescription* (ACSM 2025), which is the flagship textbook for the American College of Sports Medicine and is considered the industry standard for information on evaluating physical fitness in adults, demonstrates that across all age groups and percentiles when comparing males and females, male handgrip strength is 66.2% higher than females (Table 3.10 at 98). To help illustrate this sex-based difference in handgrip strength, a 20–24-year-old male who ranks in the 95th percentile has 55 kg for handgrip strength in the dominant hand while a 20–24-year-old female who ranks in the 95th percentile has 34 kg for handgrip strength in the dominant hand. For comparison, a 20–24-year-old male with a handgrip strength of 34 kg would be in the 10th percentile for males[6].

[5] Citing Silverman, *The secular trend for grip strength in Canada and the United States*, J. Sports Sci. 29:599-606 (2011).

[6] All previous versions of the *Guidelines* that I am aware of—particularly the 9th (2014), 10th (2018), and 11th (2022) editions—similarly show that males have greater muscular strength than females. And that's true for all of the references to the *2025 Guidelines* throughout this report.

24. In an evaluation of maximal isometric handgrip strength in 1,654 healthy men, 533 healthy women aged 20-25 years and 60 "highly trained elite female athletes from sports known to require high hand-grip forces (judo, handball)," Leyk et al. (2007) observed that, "The results of female national elite athletes even indicate that the strength level attainable by extremely high training will rarely surpass the 50th percentile of untrained or not specifically trained men." (Leyk 2007 at 415.)

25. The *ACSM's Guidelines for Exercise Testing and Prescription* (ACSM 2025) indicates that when measuring upper body strength using bench press and expressing strength as the maximal weight lifted relative to body weight, males exhibit 64% greater strength than females (Figure 3.3 at 99). To help illustrate this sex-based difference in upper body strength, an under 20-year-old male who ranks in the 95th percentile can bench press 1.76 kg for every kg of body mass while an under 20-year-old female who ranks in the 95th percentile can bench press 0.88 kg for every kg of body mass. For comparison, an under 20-year-old male with a bench press strength of 0.88 kg per kg of body mass would be between the 15th and 20th percentile for males.

26. Men have in the neighborhood of 25%–60% greater **leg strength** than women. (Handelsman 2018 at 812.) In another measure, men exhibit 54% greater knee extension torque, and this male leg strength advantage is consistent across the lifespan. (Neder 1999 at 120-121.)

27. The ACSM's Guidelines for Exercise Testing and Prescription (ACSM 2025) indicates that across all age groups and percentiles when comparing males and females, when measuring leg press strength as the maximal weight lifted relative to body weight, males exhibit 39% greater strength than females (Figure 3.4 at 100). To help illustrate this sex-based difference in lower body strength, a 20–29-year-old male who ranks in the 90th percentile can leg press 2.27 kg for every kg of body mass while a 20–29-year-old female who ranks in the 90th percentile can leg press 1.82 kg for every kg of body mass. For comparison, a 20–29-year-old male who can leg press 1.82 kg for every kg of body mass would be between the 30th and 40th percentiles for males.

28. When male and female Olympic weightlifters of the same body weight are compared, the top males lift weights between 30% and 40% greater than the females of the same body weight. But when top male and female performances are compared in powerlifting, without imposing any artificial limitations on bodyweight, the male record is 65% higher than the female record. (Hilton 2021 at 203.)

29. In the sport of powerlifting, winning in competition depends on lifting the most possible weight in squat, bench press, and deadlift. In an evaluation of 571,650 male competition performances and 238,336 female competition performances, the strength to body weight ratio for squat was 2.17 ± 0.47 for males and was 1.64 ± 0.42 for females for a 32% greater weight lifted for males. The strength to body weight ratio for bench press was 1.50 ± 0.34 for males and 0.95 ± 0.28 for females for a 58% greater weight lifted for male. The strength to body weight ratio for deadlift was 2.51 ± 0.52 for males and 1.98 ± 0.47 for females for a 27% greater weight lifted for males. (Van den Hoek, 2024, table 2, at 736)

30. Providing further insight to the sex-based differences in muscle strength, Kataoka et al. (2022) in an evaluation of "pair-match females with males who had a muscle thickness value within 2%." and a comparison of "the smallest male weight class within the International Powerlifting Federation (IPF) to different weight classes in females" reports that "[o]verall, 76%–88% of the strength assessments were greater in males than females with pair-matched muscle thickness, regardless of contraction types (i.e., isotonic, isometric, isokinetic). Additionally, males in the lightest weight division in the IPF largely outperformed females in heavier weight divisions." (at 1)

31. In another measure that combines many muscle groups as well as weight and speed, moderately trained males generated 162% greater punching power than females even though men do not possess this large an advantage in any single biomechanical variable. (Morris 2020.) This objective reality was subjectively summed up by women's mixed-martial arts fighter Tamikka Brents, who suffered significant facial injuries when she fought against a biological male who identified as female and fought under the name of Fallon Fox. Describing the experience, 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." (Murphy, 2014)

32. Similar to the experience of Tamikka Brents, in the 2024 Summer Olympic games held in Paris, France, there was considerable controversy and news coverage of two athletes (Imane Khelif and Lin Yu-ting) competing in women's boxing who had previously been disqualified from the International Boxing Association 2023 Women's World Boxing Championships due to failing "gender eligibility tests" due to having male chromosomes (Lavietes, 2024). It does not seem that either of these athletes is transgender but instead may have unspecified DSDs. This is relevant to this report since biologically male boxers would still retain male athletic advantages such as male pattern muscle mass, bone mineral density, and body height (Tucker 2024). After only 46 seconds and receiving two punches, Angela Carini ended her bout with Khelif and was quoted as saying:

> "This is unjust" and "I'm used to suffering. I've never taken a punch like that, it's impossible to continue" (Bhatia and Cotterill, 2024).

B. Men run faster.

33. Many scholars have detailed the wide performance advantages enjoyed by men in running speed. One can come at this reality from a variety of angles.

34. Multiple authors report a male speed advantage in the neighborhood of 10%–13% in a variety of events, with a variety of study populations. Handelsman et al. 2018 at 813 and Handelsman 2017 at 70 both report a male advantage of about 10% by age 17. Thibault et al. 2010 at 217 similarly reported a stable 10% performance advantage across multiple events at the Olympic level. Tønnessen et al. (2015 at 1-2) surveyed the data and found a consistent male advantage of 10%–12% in running events after the completion of puberty. They document this for both short sprints and longer distances. One group of authors found that the male advantage increased dramatically in ultra-long-distance competition such that

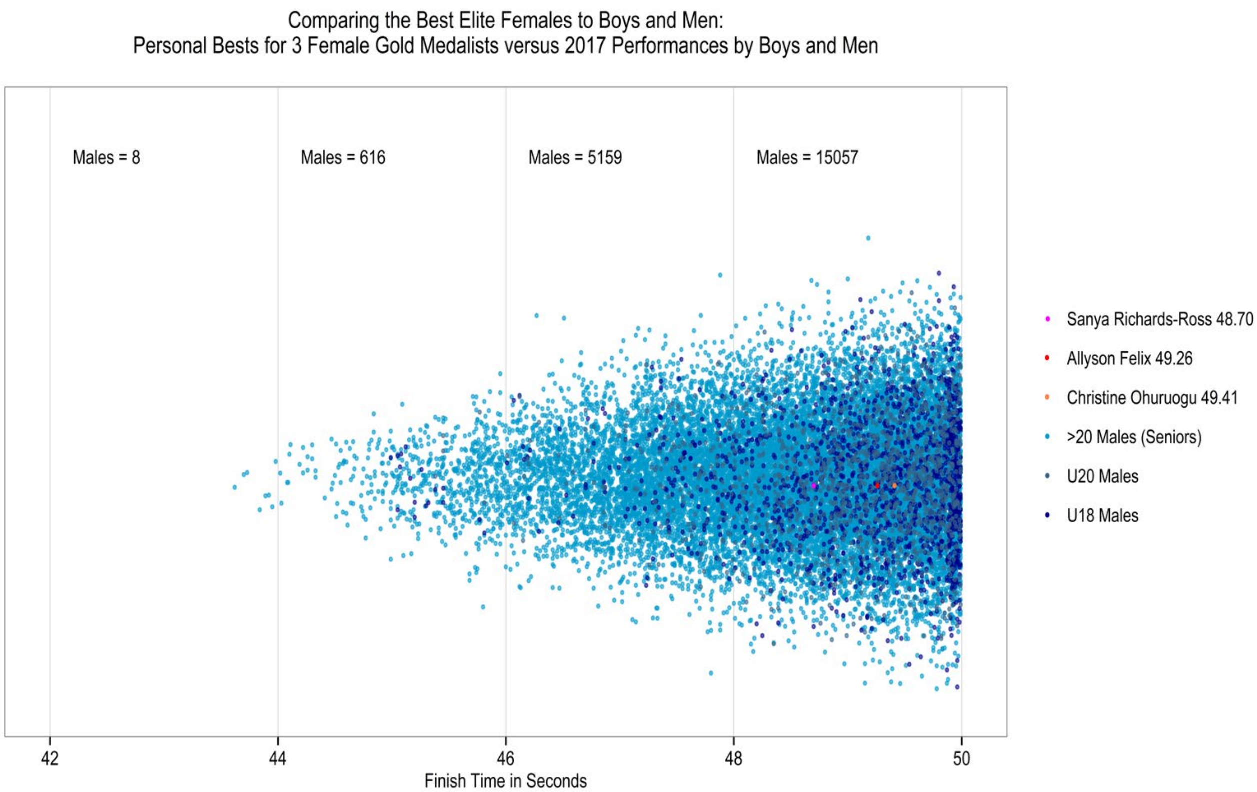
males were 20-30% faster than females at distances greater than 100 km (Lepers & Knechtle 2013.)

35. "The Biological Basis of Sex Differences in Athletic Performance: Consensus Statement for the American College of Sports Medicine" (Hunter, 2023) figure 5 (at 8) displays "Sex differences in performance between the top 100 men and top 100 women in track and field outdoor events." Showing sex-based differences for the distances of 100m, 200m, 400m, 800m, 1500m, 3000m, 5000m, 5km road, 10km road, half marathon, marathon, 10km walk, 20km walk, 35km walk, and 50km walk demonstrates that men are faster than women by 9.8–20.2% in all of these events.

- A great deal of current interest has been focused on track events. It is worth noting that a recent analysis of publicly available sports federation and tournament records found that men enjoy the *least* advantage in running events, as compared to a range of other events and metrics, including jumping, pole vaulting, tennis serve speed, golf drives, baseball pitching speed, and weightlifting. (Hilton 2021 at 201–202.) Nevertheless, as any serious runner will recognize, the approximately 10% male advantage in running is an overwhelming difference. Indeed, in a 2024 paper Handelsman (at 17) states that "A key benchmark against which an unfair advantage needs to be calibrated is the winning margin. Defined as the margin by which an Olympic athlete misses a gold medal, or any medal (podium finish), or makes the final, the winning margin in Olympic swimming and athletic events is consistently <1% []. As a result, individuals may claim that any systematic (dis)advantage of even 1% can be considered unfair against individual or identifiable groups of competitors."

36. Dr. Hilton calculates that "approximately 10,000 males have personal best times that are faster than the current Olympic 100m female champion." (Hilton 2021 at 204.) Professors Doriane Coleman, Jeff Wald, Wickliffe Shreve, and Richard Clark dramatically illustrated this by compiling the data and creating the figure below (Colemen 2019), which shows that the *lifetime best performances* of three female Olympic champions in the 400m event—including Team USA's Sanya Richards-Ross and Allyson Felix—would not match the

performances of "literally thousands of boys and men, including thousands who would be considered second tier in the men's category" *just in 2017 alone*: (data were drawn from the International Association of Athletics Federations (IAAF) website which provides complete, worldwide results for individuals and events, including on an annual and an all-time basis).



37. Professor Coleman and her colleague Wicklyffe Shreve also created the table below (Coleman and Shreve, n.d.), which "compares the number of men—males over 18—competing in events reported to the International Association of Athletics Federation whose results in each event in 2017 would have ranked them above the very best elite woman that year."

TABLE 2 – World's Best Woman v. Number of Men Outperforming			
Event	Best Women's Result	Best Men's Result	# of Men Outperforming
100 Meters	10.71	9.69	2,474
200 Meters	21.77	19.77	2,920
400 Meters	49.46	43.62	4,341
800 Meters	1:55.16*	1:43.10	3,992+
1500 Meters	3:56.14	3:28.80	3,216+
3000 Meters	8:23.14	7:28.73	1307+
5000 Meters	14:18.37	12:55.23	1,243
High Jump	2.06 meters	2.40 meters	777
Pole Vault	4.91 meters	6.00 meters	684
Long Jump	7.13 meters	8.65 meters	1,652
Triple Jump	14.96 meters	18.11 meters	969

38. The male advantage becomes insuperable well before the developmental changes of puberty are complete. Dr. Hilton documents that even "schoolboys"—defined as age 15 and under—have beaten the female world records in running, jumping, and throwing events. (Hilton 2021 at 204.)

39. Similarly, Coleman and Shreve created the table below (n.d.), which "compares the number of boys—males under the age of 18—whose results in each event in 2017 would rank them above the single very best elite [adult] woman that year:" data were drawn from the International Association of Athletics Federations (IAAF) website.

TABLE 1 – World's Best Woman v. Under 18 Boys			
Event	Best Women's Result	Best Boys' Result	# of Boys Outperforming
100 Meters	10.71	10.15	124+
200 Meters	21.77	20.51	182
400 Meters	49.46	45.38	285
800 Meters	1:55.16*	1:46.3	201+
1500 Meters	3:56.14	3:37.43	101+
3000 Meters	8:23.14	7:38.90	30
5000 Meters	14:18.37	12:55.58	15
High Jump	2.06 meters	2.25 meters	28
Pole Vault	4.91 meters	5.31 meters	10
Long Jump	7.13 meters	7.88 meters	74
Triple Jump	14.96 meters	17.30 meters	47

40. In an analysis I have performed of running events (consisting of the 100 m, 200 m, 400 m, 800 m, 1500 m, 5000 m, and 10000 m) in the Division I, Division II, and Division III

NCAA Outdoor track championships for the years of 2010–2019, the average performance across all events of the 1st place man was 14.1% faster than the 1st place woman, with the smallest difference being a 10.2% advantage for men in the Division I 100 m race. The average 8th place man across all events (the last place to earn the title of All American) was 11.2% faster than 1st place woman, with the smallest difference being a 6.5% advantage for men in the Division I 100 m race. Importantly, the only overlap between men's and women's performance occurred only when a male performed exceptionally poorly (Brown et al. 2022).

41. Athletic.net® is an internet-based resource providing "results, team, and event management tools to help coaches and athletes thrive." Among the resources available on Athletic.net are event records that can be searched nationally or by state age group, school grade, and state. Higerd (2021) in an evaluation of high school track running performance records from five states (CA, FL, MN, NY, WA), over three years (2017–2019) observed that males were 14.38% faster than females in the 100m (at 99), 16.17% faster in the 200m (at 100), 17.62% faster in the 400m (at 102), 17.96% faster in the 800m (at 103), 17.81% faster in the 1600m (at 105), and 16.83% faster in the 3200m (at 106).

42. It is interesting to note that the current women's world record in the 100-meter run is 10.49 seconds, set by Florence Griffith Joyner in 1988. Based on data available on Athletic.net in 2024 alone there were 179 faster times recorded for high school boys. Similarly, the current women's world record in the 200-meter run is 21.34 seconds, also set by Florence Griffith Joyner in 1988. Once again, based on data available on Athletic.net there were 212 faster times recorded for high school boys in 2024 alone.

43. For context, in 2018, there were 82 recorded high school boys' performances in the 100-meter event that were faster than the women's world record of 10.49 seconds, and 118 boys' performances in the 200-meter event that surpassed the women's world record of 21.34 seconds. The fact that fewer boys exceeded women's world records in 2018 compared to 2024 does not reflect a change in the underlying male–female performance difference. Rather, it is attributable to the increased use of Athletic.net for reporting track

and field performances over time.

44. Using data on Athletic.net to compare the performance of all high school boys and girls in outdoor track in the United States, the following information comes to light:

- In 2024 the fastest time reported for a high school girl in the 100-meter run was 11.16 seconds. At the time this report was prepared this database only listed 4,039 high school boys 100-meter times for 2024, with the slowest time being 11.02 seconds. The fastest time for a boy was 9.93 seconds.
- In 2024 the fastest time reported for a high school girl in the 200-meter run was 22.66 seconds. There were 5,655 faster times recorded for high school boys in 2024 with the fastest being 20.40 seconds.
- In 2024 the fastest time reported for a high school girl in the 400-meter run was 51.66 seconds. There were 6,690 faster times recorded for high school boys in 2024 with the fastest being 44.20 seconds.
- In 2024 the fastest time reported for a high school girl in the 800-meter run was 2:03.48 (2 minutes, 3.48 seconds). There were 9,076 faster times recorded for high school boys in 2024 with the fastest being 1:47.55.
- In 2024 the fastest time reported for a high school girl in the 1500-meter run was 4:08.86. There were 580 faster times recorded for high school boys in 2024 with the fastest being 3:36.25.
- Collectively, the data show that in 2024, the fastest high school girl in the U.S. for each outdoor track distance from 100 to 800 meters ran slower than thousands of high school-aged boys. Even in the 1500-meter event—where there were the fewest boys faster than the fastest girl—more than 500 boys still recorded faster times than the top-performing girl.

45. To demonstrate that the 2024 data are not an anomaly reflecting an unusually fast cohort of male athletes or an unusually slow cohort of female athletes, some comparable data from Athletic.net for the year 2018 were also evaluated and are presented below.

- The fastest recorded 100-meter time by a high school girl in 2018 was 11.12 seconds, achieved by Sha'Carri Richardson (who later set the NCAA Division I Women's 100-meter record in 2019, became the U.S. Women's 100-meter Champion and World Champion in 2023, and earned a silver medal in the 100-meter event at the 2024 Summer Olympics). In comparison, the data from 2018 show that 3,329 high school boys recorded 100-meter times faster than 11.12 seconds, with the fastest recorded time being 10.04 seconds.

- Similarly, the fastest 200-meter time recorded for a female in 2018 was 22.48 seconds. There were 2,501 boys 200-meter times faster than 22.48 seconds, with the fastest being 20.41 seconds.
- The fastest 400-meter time recorded for a female in 2018 was 51.21 seconds. There were 3,733 boys 400-meter times faster than 51.21 seconds, with the fastest being 45.42 seconds.
- The fastest 800-meter time recorded for a female in 2018 was 2 minutes 0.85 seconds. There were 3,766 boys 800-meter times faster than 2 minutes 0.85 seconds, with the fastest being 1 minute 49.10 seconds.
- While fewer male performances were recorded as faster than the fastest female performance in 2018 compared to 2024 (e.g., 2,501 boys faster than the fastest girl in the 200-meter event in 2018 versus 5,655 in 2024), this discrepancy reflects the increased use of Athletic.net for reporting track and field results over time. It does not indicate a change in the underlying sex-based differences in athletic performance. Notably, even with the comparatively lower reporting volume in 2018, the fastest female athletes in the 100-meter, 200-meter, 400-meter, and 800-meter events were still outperformed by thousands of male athletes in each event, underscoring the well-established and consistent performance differences between the sexes.

46. Hallam and Amorim (2021) analyzed the sex-based differences (they termed it the "sex gap") for the top 20 running performances in the world for each year between 2001 and 2020 for the distances of 100 m, 200 m, 400 m, 800 m, 1,500 m, 5,000 m, 10,000 m, and Marathon. They concluded that "The sex gap increases with rank position i.e. at a lower

performance level, in events 400 m and longer." (at 10) These findings suggest that sex-based differences in running speed are even more pronounced in lower-level competition than in the more commonly evaluated elite performance.

47. Rohrer (2024) provides a very detailed and in-depth explanation of the enduring sex-based difference in running performance between men and women. Insightfully he states "This record gap does not mean that most men can outrun the fastest women. Indeed, the world's fastest woman at any distance can outpace nearly all men. Still, the difference between the fastest men and the fastest women is large. In most Olympic track events, the world record for women is worse than the world record for 15-year-old boys." He further adds that "The mean men-women record gap in Olympic events equaled 10.2% in January 1990 and 11.2% in January 2024." (at 01) clearly demonstrating the long standing and well-known disparity in running performance between men and women.

48. In addition to sex, age is an important factor to consider when evaluating sports performance. Most people would consider it unfair for a 17-18-year-old to compete against an 11-12-year-old. Evaluating the records of all-time best performances from the USA Track & Field Junior Olympic Championships provides some very valuable insight in the age and sex-based differences in athletic performance (USA Track & Field 2019).

    - In the 200 m running event, the record for all-time best performance for an 11-12-year-old girl is 24.47 seconds, while the record for an 11-12 year-old boy is 23.37 seconds. The record for all-time best performance for a 17-18-year-old girl is 23.24 seconds, while the record for a 17-18-year-old boy is 20.50 seconds. Thus, the all-time best performance for an 11-12-year-old boy is only 0.13 seconds slower than for a 17-18-year-old girl, while the record for a 17-18-year-old girl is 2.74 seconds slower than for a 17-18-year-old boy in the 200 m run.
    - In the 400 m running event, the record for all-time best performance for an 11-12-year-old girl is 55.01 seconds, while the record for an 11-12 year-old boy is 50.75 seconds. The record for all-time best performance for a 17-18-year-old girl is 51.31 seconds, while the record for a 17-18-year-old boy is 45.63 seconds. Thus, the all-time best

performance for an 11-12 year-old boy is 0.56 seconds *faster* than for a 17-18-year-old girl in the 400 m run.

- In the 800 m running event, the record for all-time best performance for an 11-12-year-old girl is 2 minutes 13.12 seconds, while the record for an 11-12 year-old boy is 2 minutes 6.51 seconds. The record for all-time best performance for a 17-18-year-old girl is 2 minutes 5.27 seconds, while the record for a 17-18-year-old boy is 1 minute 49.49 seconds. Thus, the all-time best performance for an 11-12-year-old boy is only 1.24 seconds slower than for a 17-18-year-old girl, while the record for a 17-18-year-old girl is 16.08 seconds slower than for a 17-18-year-old boy in the 800 m run.
- Taken together, these records suggest that it would be fairer competition for 17-18-year-old girls to race against 11-12-year-old boys than for 17-18-year-old girls to race against 17-18-year-old boys.

49. On the topic of sex-based differences in running performance, it is worth noting that Armstong et al. (2023) reported that, in an analysis of running times for 166 nonbinary athletes in the New York Road Runners Database who had previously registered as male or female, those who registered as male prior to the option of identifying as nonbinary ran faster than those who had registered as female leading the authors to conclude that "…identifying as non-binary does not reduce gender disparities. This provides evidence against the theory that an individual's gender-identity plays a significant role in these disparities in addition to their natal sex." (at 1)

C. Men jump higher and farther.

50. Jumping involves both leg strength and speed as positive factors, with body weight of course a factor working against jump height. Despite their substantially greater body weight, males enjoy an even greater advantage in jumping than in running.

51. Evaluating performance on a countermovement jump test, which is commonly used for physical fitness testing of muscular power (aka explosiveness) in athletes and non-athletes, males outperform females by 40-173% in all matched age groups from 15-69 years old (ACSM 2025, Table 3.12 at 104). Illustrating the sex-based differences in jumping

performance, a 15-19-year-old female rated as excellent would have a countermovement jump of 40 cm or greater while a countermovement jump equal to 41 cm or less would be rated as poor for a 15-19-year-old male. A 20-29-year-old female who is rated as excellent would have a countermovement jump of 38 cm or greater while a countermovement jump equal to 41 cm or less would be rated as poor for a 20-29-year-old male.

52. Evaluating competitive performance, Handelsman 2018 (at 813), looking at youth and young adults, and Thibault 2010 (at 217), looking at Olympic performances, both found male advantages in the range of 15%–20%. See also Tønnessen 2015 (approximately 19%); Handelsman 2017 (19%); Hilton 2021 (at 201; 18%). Looking at the vertical jump called for in volleyball, research on elite volleyball players found that males jumped on average 50% higher during an "attack" at the net than did females. (Sattler 2015; see also Hilton 2021 (at 203; 33% higher vertical jump).)

53. In the "The Biological Basis of Sex Differences in Athletic Performance: Consensus Statement for the American College of Sports Medicine" (Hunter, 2023) figure 5 (at 8) displays "Sex differences in performance between the top 100 men and top 100 women in track and field outdoor events." Showing that men high jump 17.6% higher, pole vault 25.4% higher, long jump 19.5% farther, and triple jump 19.2% farther than women.

54. Higerd (2021) in an evaluation of high school high jump performance available through the track and field database Athletic.net®, which included five states (CA, FL, MN, NY, WA), over three years (2017–2019) (at 82) observed that in 23,390 females and 26,843 males, females jumped an average of 1.35 m and males jumped an average of 1.62 m, for an 18.18% performance advantage for males (at 96). In an evaluation of long jump performance in 45,705 high school females and 54,506 high school males, the females jumped an average of 4.08 m and males jumped an average of 5.20 m, for a 24.14% performance advantage for males (at 97).

55. Using data on Athletic.net to compare the jumping performance of all high school boys and girls in the United States in 2024 in outdoor track, the following information comes to light:

- In 2024 the longest distance reported for a high school girl for the long jump was 21 feet 2.25 inches. There were 3,929 longer jumps recorded for high school boys in 2024, with the longest being 25 feet 7.25 inches.
- In 2024 the highest distance reported for a high school girl for the high jump was 6 feet 2 inches. At the time this report was written this database only listed 1,415 high jump performance for high school boys in 2024 with the shortest being 6 feet 4 inches. The highest high jump performance for boys in 2024 was 7 feet 4.25 inches.
- Overall, the data from 2024 show that thousands of boys jump higher in the high jump and jump farther in the long jump than the top-performing high school girl.

56. To demonstrate that the 2024 data are not anomalous—either due to an unusually high-performing cohort of male athletes or an unusually low-performing cohort of female athletes—long jump data from Athletic.net for the year 2018 indicate that the longest distance recorded for a high school girl in long jump was 21 feet 0.25 inches. In comparison, the data from 2018 show that 3,935 high school boys recorded long jump distances greater than 21 feet 0.25 inches, with the longest distance being 25 feet 3.25 inches.
57. The combined male advantage of body height and jump height means, for example, that a total of eight women in the WNBA have ever dunked a basketball in the regulation 10 foot hoop (Dozier, 2024), while the ability to dunk appears to be almost universal among NBA players: "Since the 1996–97 season (the earliest data is available from Basketball-Reference.com), 1,801 different [NBA] players have combined for 210,842 regular-season dunks, and 1,259 out of 1,367 players (or 92%) who have played at least 1,000 minutes have dunked at least once" (Samman 2021).

D. Men throw, hit, and kick faster and farther.

58. Strength, arm-length, and speed combine to give men a large advantage over women in throwing. This has been measured in a number of studies.
59. One study of elite male and female baseball pitchers showed that men throw baseballs 35% faster than women—81 miles/hour for men vs. 60 miles/hour for women. (Chu 2009.) By

age 12, "boys' throwing velocity is already between 3.5 and 4 standard deviation units higher than the girls'." (Thomas 1985 at 276.) By age seventeen, the *average* male can throw a ball farther than 99% of seventeen-year-old females. (Lombardo 2018; Chu 2009; Thomas 1985 at 268.) Looking at publicly available data, Hilton & Lundberg found that in both baseball pitching and the field hockey "drag flick," the *record* ball speeds achieved by males are more than 50% higher than those achieved by females. (Hilton 2021 at 202-203.) It is worth noting that research has demonstrated an "…inability of training or cultural influences to erase the sex differences in throwing,…" (Lombardo 2018, at 91)

60. Men achieve serve speeds in tennis more that 15% faster than women; and likewise in golf achieve ball speeds off the tee more than 15% faster than women. (Hilton 2021 at 202.)

61. More specifically, Marshall and Llewellyn (at 957) reported that female collegiate golfers at an NCAA Division III school have an average drive distance that is 46 yards (16.5%) shorter than males, a maximal drive distance of 33.2 yards (11.1%) shorter, an average club head speed that is 21.9 mph (20.4%) slower, and a maximum club head speed that is 18 mph (15.3%) slower. Using 3D motion analysis to evaluate the kinematics of 7 male and 5 female golfers with a mean handicap of 6, Egret (at 463) concluded that "[t]he results of this study show that there is a specific swing for women." Horan used 3D motion analysis to evaluate the kinematics of 19 male and 19 female golfers with a handicap less than or equal to 4 and concluded "the results suggest that male and female skilled golfers have different kinematics for thorax and pelvis motion" and "[w]hat might be considered optimal swing characteristics for male golfers should not be generalized to female golfers." (at 1456).

62. Males are able to throw a javelin more than 30% farther than females. (Lombardo 2018 Table 2; Hilton 2021 at 203.)

63. Men serve and spike volleyballs with higher velocity than women, with a performance advantage in the range of 29–34%. (Hilton 2021 at 204 Fig. 1.)

64. Using data on Athletic.net to compare the performance of all high school boys and girls in outdoor track the United States in 2024, the following information comes to light:

- In 2024 the longest distance reported for a high school girl for the shot put was 54 feet 10.75 inches using a 4 kg (8.8 pound) shot. There were 471 longer throws recorded for high school boys in 2024 using a heavier 12-pound shot, with the longest being 75 feet 1 inch.
- In 2024 the longest distance reported for a high school girl for the javelin was 169 feet 6 inches using a 600-gram javelin. There were 425 longer throws recorded for high school boys in 2024 using a heavier 800-gram javelin, with the longest being 234 feet 1 inch.
- In 2024 the longest distance reported for a high school girl for the discus was 175 feet 7 inches using a 1-kilogram discus. There were 211 longer throws recorded for high school boys in 2024 using a heavier 1.6-kilogram discus, with the longest being 213 feet 0 inches.
- Taken together, these data show that in 2024 hundreds of high school age boys have thrown heavier implements farther than the longest recorded throws by a high school age girl in shot put, javelin, and discus.

65. To once again demonstrate that the 2024 data are not anomalous—whether due to an exceptionally high-performing cohort of male athletes or an unusually low-performing cohort of female athletes—shot put data from Athletic.net for the year 2018 were examined. The longest recorded distance for a high school girl in 2018 was 51 feet 0 inches, using the 4 kg (8.8-pound) shot. In comparison, 1,058 high school boys recorded shot put distances exceeding 51 feet 0 inches, despite competing with the heavier 12-pound shot, with the farthest recorded distance reaching 71 feet 8.75 inches.
66. Men are also able to kick balls harder and faster. A study comparing collegiate soccer players found that males kick the ball with an average 20% greater velocity than females. (Sakamoto 2014.)

E. Males exhibit faster reaction times.

67. Interestingly, men enjoy an additional advantage over women in reaction time—an attribute not obviously related to strength or metabolism (e.g. VO_2max). "Reaction time in

sports is crucial in both simple situations such as the gun shot in sprinting and complex situations when a choice is required. In many team sports this is the foundation for tactical advantages which may eventually determine the outcome of a game." (Dogan 2009 at 92.) "Reaction times can be an important determinant of success in the 100m sprint, where medals are often decided by hundredths or even thousandths of a second." (Tønnessen 2013 at 885.)

68. The existence of a sex-linked difference in reaction times is consistent over a wide range of ages and athletic abilities. (Dykiert 2012.) Even by the age of 4 or 5, in a ruler-drop test, males have been shown to exhibit 4% to 6% faster reaction times than females. (Latorre-Roman 2018.) In high school athletes taking a common baseline "ImPACT" test, males showed 3% faster reaction times than females. (Mormile 2018.) Researchers have found a 6% male advantage in reaction times of both first-year medical students (Jain 2015) and world-class sprinters (Tønnessen 2013).

69. Most studies of reaction times use computerized tests which ask participants to hit a button on a keyboard or to say something in response to a stimulus. One study on NCAA athletes measured "reaction time" by a criterion perhaps more closely related to athletic performance—that is, how fast athletes covered 3.3 meters after a starting signal. Males covered the 3.3 meters 10% faster than females in response to a visual stimulus, and 16% faster than females in response to an auditory stimulus. (Spierer 2010.)

70. Researchers have speculated that sex-linked differences in brain structure, as well as estrogen receptors in the brain, may be the source of the observed male advantage in reaction times, but at present this remains a matter of speculation and hypothesis. (Mormile at 19; Spierer at 962.)

F. Mixed sex sports raise concerns regarding the safety of female athletes.

71. Absent the inclusion of male bodies in female sports, Lin et al. (2018) indicate that girls and women have a higher incidence of overuse injuries, injuries to the anterior cruciate ligament (ACL) due to the sharper angle of the hips to the knee (the Q angle), injuries due to low energy availability triggering the female-athlete-triad (a situation where insufficient

energy intake impairs endocrine function relevant to the menstrual cycle resulting in impaired bone mineral density), and have a higher incidence of concussions than do boys and men. Interestingly girls and women suffer more concussions due to contact with sporting implements than do boys and men.

72. The differences between males and females put females at an increased risk for injury when competing in mixed sex sports. Included throughout this report are statements from scholarly reviews (e.g. Hilton and Lundberg, 2021, Hamilton et al. 2021), the Women's Sports Policy Working Group, and numerous sport governing bodies (e.g. FINA, World Rugby, the Association of Ringside Physicians, the World Boxing Council, the UK Sports Council, and Sport Ireland) all of which include concerns for the safety of female athletes as part of the rationale for protecting single sex sports for females. Because women have less neck strength and stability compared to males, head-to-head collisions or head contact with sporting implements between females and males are likely to result in the female being injured in situations where males would not.

73. Within the United Nations "Report of the Special Rapporteur on violence against women and girls, its causes and consequences", it is particularly interesting and pertinent that the Special Rapporteur specifically includes males competing in female sports as a form of violence against women and girls. Within this report the Special Rapporteur documents instances of female athletes being injured when competing against transgirls and transwomen, with these injuries including "knocked-out teeth, concussions resulting in neural impairment, broken legs and skull fractures." (Alsalem 2024 at 4)

III. Men have large measured anatomical and physiological differences compared to women which demonstrably or likely explain their performance advantages.

74. No single physiological characteristic alone accounts for all or any one of the measured advantages that men enjoy in athletic performance. However, scientists have identified and measured a number of anatomical and physiological factors that contribute to superior male performance.

A. Men are taller and heavier than women.

75. In some sports, such as basketball and volleyball, height itself provides a competitive advantage. While some women are taller than some men, based on data from 20 countries in North America, Europe, East Asia, and Australia, the 50th percentile for body height for women is 164.7 cm (5 ft 5 inches) and the 50th percentile for body height for men is 178.4 cm (5 ft 10 inches). Helping to illustrate the inherent height difference between men and women, from the same data analysis, the 95th percentile for body height for women is 178.9 cm (5 feet 10.43 inches), which is only 0.5 cm taller than the 50th percentile for men (178.4 cm; 5 feet 10.24 inches), while the 95th percentile for body height for men is 193.6 cm (6 feet 4.22 inches). Thus, while some women are taller than some men, the tallest men are taller than the tallest women (Roser 2013.)

76. To look at a specific athletic population, an evaluation of NCAA Division I basketball players compared 68 male guards and 59 male forwards to 105 female guards and 91 female forwards, and found that on average the male guards were 187.4 ± 7.0 cm tall and weighed 85.2 ± 7.4 kg while the female guards were 171.6 ± 5.0 cm tall and weighed 68.0 ± 7.4 kg. The male forwards were 201.7 ± 4.0 cm tall and weighed 105.3 ± 5.9 kg while the female forwards were 183.5 ± 4.4 cm tall and weighed 82.2 ± 12.5 kg (Fields 2018 at 3.)

77. These sex-based differences in body height are also clearly present in professional basketball, where the average male NBA player is 199.3 cm (6 feet 6.5 inches) tall and weighs 97.5 kg (215 pounds) (NBA 2023) while the average female WNBA player is 183.5 cm (6 feet 0.25 inches tall) and weighs 78.0 kg (172 pounds) (WNBA 2024).

78. Another sport in which body height is of considerable importance is volleyball. Toselli and Campa (2018) evaluated the anthropometry (which is the scientific study of the measurements and proportions of the human body, such as arm length, leg length, body height, body composition) and reported that one of the primary differences between elite and sub-elite volleyball players was a mere 3 cm (1.18 inches) in body height (Table 1, at 2602). It is also interesting to compare the body height of the elite male volleyball players

(195.28 ± 8.31 cm) reported by Toselli and Campa with the body height of elite female volleyball players (179.8 ± 7.1 cm) evaluated by Martin-Matillas et al. (2014; Table 1 at 140), which once again highlights male sex-based athletic advantages.

79. While volleyball and basketball are sports in which body height provides an obvious advantage, swimming is also a height affected sport, as reviewed by Kjendlie and Stallman (2011) "A taller swimmer will generally swim faster" (at 1). As men are, on average taller than women and the tallest men are taller than the tallest women, sex-based differences in body height provide men with a biologically based advantage not attainable by women.

B. Males have larger and longer bones, stronger bones, and different bone configuration.

80. Obviously, males on average have longer bones. "Sex differences in height have been the most thoroughly investigated measure of bone size, as adult height is a stable, easily quantified measure in large population samples. Extensive twin studies show that adult height is highly heritable with predominantly additive genetic effects that diverge in a sex-specific manner from the age of puberty onwards." (Handelsman 2018 at 818.) "Pubertal testosterone exposure leads to an ultimate average greater height in men of 12–15 centimeters, larger bones, greater muscle mass, increased strength and higher hemoglobin levels." (Gooren 2011 at 653.)

81. "Men have distinctively greater bone size, strength, and density than do women of the same age." (Handelsman 2018 at 818.)

82. "[O]n average men are 7% to 8% taller with longer, denser, and stronger bones, whereas women have shorter humerus and femur cross-sectional areas being 65% to 75% and 85%, respectively, those of men." (Handelsman 2018 at 818.)

83. Greater height, leg, and arm length themselves provide obvious advantages in several sports. But male bone geometry also provides less obvious advantages. "The major effects of men's larger and stronger bones would be manifest via their taller stature as well as the larger fulcrum with greater leverage for muscular limb power exerted in jumping, throwing, or other explosive power activities." (Handelsman 2018 at 818.)

84. Male advantage in bone size is not limited to length, as larger bones provide the mechanical

framework for larger muscle mass. "From puberty onwards, men have, on average, 10% more bone providing more surface area. The larger surface area of bone accommodates more skeletal muscle so, for example, men have broader shoulders allowing more muscle to build. This translates into 44% less upper body strength for women, providing men an advantage for sports like boxing, weightlifting and skiing. In similar fashion, muscle mass differences lead to decreased trunk and lower body strength by 64% and 72%, respectively in women. These differences in body strength can have a significant impact on athletic performance, and largely underwrite the significant differences in world record times and distances set by men and women." (Knox 2019 at 397.)

85. Meanwhile, distinctive aspects of the female pelvis geometry cut against athletic performance. Leong explains that sex-based differences in the width of the bones forming the base of each half of the pelvis and the hip socket region ("… there are significant sex differences in breadth of the ischium and acetabular regions …") are evident by 8 years old (Leong 2006, at 62). Handelsman (2018) further explains the effects of puberty by stating that "the widening of the female pelvis during puberty, balancing the evolutionary demands of obstetrics and locomotion, retards the improvement in female physical performance." (at 818.) "[T]he major female hormones, oestrogens, can have effects that disadvantage female athletic performance. For example, women have a wider pelvis changing the hip structure significantly between the sexes. Pelvis shape is established during puberty and is driven by oestrogen. The different angles resulting from the female pelvis leads to decreased joint rotation and muscle recruitment ultimately making them slower." (Knox 2019 at 397.)

86. There are even sex-based differences in foot size and shape. Wunderlich & Cavanaugh (2001) observed that a "foot length of 257 mm represents a value that is … approximately the 20th percentile men's foot lengths and the 80th percentile women's foot lengths." (607) and "For a man and a woman, both with statures of 170 cm (5 feet 7 inches), the man would have a foot that was approximately 5 mm longer and 2 mm wider than the woman." (608). Based on these, and other analyses, they conclude that "female feet and legs are not simply

scaled-down versions of male feet but rather differ in a number of shape characteristics, particularly at the arch, the lateral side of the foot, the first toe, and the ball of the foot." (605) Further, Fessler et al. (2005) observed that "female foot length is consistently smaller than male foot length" (44) and concludes that "proportionate foot length is smaller in women" (51) with an overall conclusion that "[o]ur analyses of genetically disparate populations reveal a clear pattern of sexual dimorphism, with women consistently having smaller feet proportionate to stature than men." (53)

87. Beyond simple performance, the greater density and strength of male bones provide higher protection against stresses associated with extreme physical effort: "[S]tress fractures in athletes, mostly involving the legs, are more frequent in females, with the male protection attributable to their larger and thicker bones." (Handelsman 2018 at 818.)

C. Males have much larger muscle mass.

88. The fact that, on average, men have substantially larger muscles than women is as well known to common observation as men's greater height. But the male advantage in muscle size has also been extensively measured. The differential is large.

89. Based on a meta-analysis of 110 studies comparing muscle biopsy samples in 2875 men and 2452 women "The results reveal that men exhibit greater cross-sectional areas for all muscle fiber types and greater area percentages for Type II muscle fibers" (Nuzzo 2023 at 5). (To help clarify, Type II Muscle Fibers are what are commonly referred to as fast twitch muscle fibers, or muscle cells.) These sex-based differences in the size of muscle cells show that men exhibit approximately 36% greater muscle cell cross-sectional area.

90. "On average, women have 50% to 60% of men's upper arm muscle cross-sectional area and 65% to 70% of men's thigh muscle cross-sectional area, and women have 50% to 60% of men's upper limb strength and 60% to 80% of men's leg strength. Young men have on average a skeletal muscle mass of >12 kg greater than age-matched women at any given body weight." (Handelsman 2018 at 812. See also Gooren 2011 at 653, Thibault 2010 at 214.)

91. "There is convincing evidence that the sex differences in muscle mass and strength are

sufficient to account for the increased strength and aerobic performance of men compared with women and is in keeping with the differences in world records between the sexes." (Handelsman 2018 at 816.)

92. As stated in the National Strength and Conditioning Association's *Guide to Tests and Assessments*, "Sport performance is highly dependent on the health- and skill-related components of fitness (power, speed, agility, reaction time, balance, and Body Composition coordination) in addition to the athlete's technique and level of competency in sport-specific motor skills. All fitness components depend on body composition to some extent. An increase in lean body mass contributes to strength and power development. … Thus, an increase in lean body mass enables the athlete to generate more force in a specific period of time. A sufficient level of lean body mass also contributes to speed, quickness, and agility performance (in the development of force applied to the ground for maximal acceleration and deceleration)." (National Strength and Conditioning Association 2017).

93. Illustrating the importance of lean body mass on athletic performance, in an evaluation of 50 competitive teenage swimmers to determine which body characteristics (i.e. limb length, body height, body mass, body composition) contribute to 100-meter freestyle swimming performance, Nevill et al. (2015) concluded that "lean body mass was the single most important whole-body size characteristic" (at 1716). Similarly, Barbieri et al. (2017) concluded that "… greater fat free mass and strength, can explain significant differences in sprinting performances." (at 1142)

94. Once again, looking at specific and comparable populations of athletes, an evaluation of NCAA Division I basketball players consisting of 68 male guards and 59 male forwards, compared to 105 female guards and 91 female forwards, reported that on average the male guards had 77.7 ± 6.4 kg of fat free mass and 7.4 ± 3.1 kg fat mass while the female guards had 54.6 ± 4.4 kg fat free mass and 13.4 ± 5.4 kg fat mass. The male forwards had 89.5 ± 5.9 kg fat free mass and 15.9 ± 5.6 kg fat mass while the female forwards had 61.8 ± 5.9 kg fat free mass and 20.5 ± 7.7 kg fat mass. (Fields 2018 at 3.)

95. And, once again, if we compare the body composition of elite male volleyball (Toselli and

Campa 2018; Table 1 at 2602) who had 12.2 ± 3.1% body fat, 11.3 ± 2.9 kg fat mass, and 79.4 ± 8.3 kg fat free body mass, with the body composition of elite female volleyball (Martin-Matillas et al. 2014; Table 1 at 140), who had 24.0 ± 3.1 % body fat, 17.4 ± 3.7 kg fat mass, and 54.9 ± 5.7 kg fat free body mass, there is a clear and large difference in the amount of fat and fat-free body mass between comparable male and female athletes.

96. As the average man has more muscle mass than the average woman, and as the most muscular men have considerably more muscle mass than the most muscular women, sex-based differences in muscle mass provide men with a biologically based advantage not attainable by women.

D. Females have a larger proportion of body fat.

97. While women have smaller muscles, they have proportionately more body fat, in general a negative for athletic performance. "Oestrogens also affect body composition by influencing fat deposition. Women, on average, have higher percentage body fat, and this holds true even for highly trained healthy athletes (men 5%–10%, women 8%–15%). Fat is needed in women for normal reproduction and fertility, but it is not performance-enhancing. This means men with higher muscle mass and less body fat will normally be stronger kilogram for kilogram than women." (Knox 2019 at 397.)

98. Looking once again to the *ACSM's Guidelines for Exercise Testing and Prescription* (ACSM 2025) (Tables 3.4 and 3.5 at 74 and 75), a 20–29-year-old male in the 99th percentile will have 4.2% body fat, while a 20–29-year-old female in the 99th percentile will have 11.4% body fat, meaning the female has 170% more fat relative to body mass than the male. Comparing a 20–29-year-old male and female in the 50th percentile (that is "average") the male will have 16.7% body fat and the female will have 21.8% body fat, meaning that the female has 30% more fat relative to total body mass than the male.

99. "[E]lite females have more (<13 vs. <5 %) body fat than males. Indeed, much of the difference in [maximal oxygen uptake] between males and females disappears when it is expressed relative to lean body mass. . . . Males possess on average 7–9 % less percent body fat than females." (Lepers 2013 at 853.) [In this statement Lepers means percentage

points, e.g. 13% vs 6% body fat represents 7 percentage points]

100. Joyner et al. (2025) state that "…increased relative (or percentage) body fat…" (at 8) experienced by female athletes during puberty is one of the factors that disadvantages female athletes when compared to males.

101. Knox et al. observe that both female pelvis shape and female body fat levels "disadvantage female athletes in sports in which speed, strength and recovery are important," (Knox 2019 at 397), while Tønnessen et al. describe the "ratio between muscular power and total body mass" as "critical" for athletic performance. (Tønnessen 2015 at 7.)

102. Demonstrating the detrimental effects of body fat on athletic performance, in an evaluation of anthropometric factors that influence athletic performance (i.e. limb length, body height, body mass, body composition) in 85 competitive teenage swimmers Dos Santos et al. (2021) reported that body fat was the strongest negative influence on 50-meter freestyle swim performance. Similarly, in an evaluation of 167 competitive teenage swimmers, Sammoud et al. (2018) reported that body fat was the strongest negative influence on 100-meter butterfly swimming performance. Barbieri et al. (2017) also reported that body fat negatively influences sprint running performance.

E. Males are able to metabolize and release energy to muscles at a higher rate due to larger heart and lung size, and higher hemoglobin concentrations.

103. While advantages in bone size, muscle size, and body fat are easily perceived and understood by laymen, scientists also measure and explain the male athletic advantage at a more abstract level through measurements of metabolism, or the ability to deliver energy to muscles throughout the body.

104. "The Biological Basis of Sex Differences in Athletic Performance: Consensus Statement for the American College of Sports Medicine" (Hunter, 2023) states, "At the same relative intensities of exercise however, there are sex differences in whole-body substrate utilization during endurance exercise: females oxidize more fat and fewer carbohydrates and amino acids than males during similar-intensity endurance exercise []

originating in part from sex differences within the muscle typology." Hunter concludes: "This sex difference in whole muscle energy metabolism is related to differences in the proportional area of type II (and I) fibers in the skeletal muscle affecting both aerobic and anaerobic power." (at 10).

105. Energy release at the muscles depends centrally on the body's ability to deliver oxygen to the muscles, where it is essential to the complex chain of biochemical reactions that make energy available to power muscle fibers. Men have multiple distinctive physiological attributes that together give them a large advantage in oxygen delivery.

106. Oxygen is taken into the blood in the lungs. Men have greater capability to take in oxygen for multiple reasons. "**[L]ung capacity** [is] larger in men because of a lower diaphragm placement due to Y-chromosome genetic determinants." (Knox 2019 at 397.) Supporting larger lung capacity, men have "greater cross-sectional area of the trachea"; that is, they can simply move more air in and out of their lungs in a given time. (Hilton 2021 at 201.)

107. More, male lungs provide superior oxygen exchange even for a given volume: "The greater lung volume is complemented by testosterone-driven **enhanced alveolar multiplication** rate during the early years of life. Oxygen exchange takes place between the air we breathe and the bloodstream at the alveoli, so more alveoli allows more oxygen to pass into the bloodstream. Therefore, the greater lung capacity allows more air to be inhaled with each breath. This is coupled with an improved uptake system allowing men to absorb more oxygen." (Knox 2019 at 397.)

108. In a very thorough review, Dominelli and Molgat-Seon (2022) examine the sex-based morphological and functional differences in the pulmonary system, and conclude, "The pulmonary system's response to dynamic, whole-body, and isolated exercise in healthy males and females, though largely similar, is known to differ based on sex. These sex differences are most apparent during intense exercise, especially in highly trained athletes." (at 9)

109. "Once in the blood, oxygen is carried by haemoglobin. **Haemoglobin**

concentrations are directly modulated by testosterone so men have higher levels and can carry more oxygen than women." (Knox 2019 at 397.) "It is well known that levels of circulating hemoglobin are androgen-dependent and consequently higher in men than in women by 12% on average…. Increasing the amount of hemoglobin in the blood has the biological effect of increasing oxygen transport from lungs to tissues, where the increased availability of oxygen enhances aerobic energy expenditure." (Handelsman 2018 at 816.) (See also Lepers 2013 at 853; Handelsman 2017 at 71.) "It may be estimated that as a result the average maximal oxygen transfer will be ~10% greater in men than in women, which has a direct impact on their respective athletic capacities." (Handelsman 2018 at 816.)

110. But the male metabolic advantage is further multiplied by the fact that men are also able to **circulate more blood per second** than are women. "Oxygenated blood is pumped to the active skeletal muscle by the heart. The left ventricle chamber of the heart is the reservoir from which blood is pumped to the body. The larger the left ventricle, the more blood it can hold, and therefore, the more blood can be pumped to the body with each heartbeat, a physiological parameter called 'stroke volume'. The female heart size is, on average, 85% that of a male resulting in the stroke volume of women being around 33% less." (Knox 2018 at 397.) Hilton cites different studies that make the same finding, reporting that men on average can pump 30% more blood through their circulatory system per minute ("cardiac output") than can women. (Hilton 2021 at 202.) Chung (2023) observed that observed that "Left ventricular E[nd]D[iastolic]V[olume] [the amount of blood in the left chamber of the heart before a heartbeat] and end-systolic volume [the amount of blood in the left chamber of the heart after a heartbeat] indexed to body surface area were smaller in women than in men (P<0.001 for both)." This means that a woman's heart holds less blood and pumps less blood per heartbeat than a man's, even when sex-based differences in body size are accounted for.

111. Finally, at the cell where the energy release is needed, men appear to have yet another advantage. "Additionally, there is experimental evidence that testosterone increases … **mitochondrial biogenesis**, myoglobin expression, and IGF-1 content, which

may augment energetic and power generation of skeletal muscular activity." (Handelsman 2018 at 811.)

112. "Putting all of this together, men have a much more efficient cardiovascular and respiratory system." (Knox 2019 at 397.) A widely accepted measurement that reflects the combined effects of all these respiratory, cardiovascular, and metabolic advantages is referred to as "VO_2max," which refers to the maximum rate at which an individual can consume oxygen during aerobic exercise.[7] Looking at 11 separate studies, including both trained and untrained individuals, Pate et al. concluded that men have a 50% higher VO_2max than women on average, and a 25% higher VO_2max in relation to body weight. (Pate 1984 at 92. See also Hilton 2021 at 202.)

IV. Even before puberty, boys have demonstrable athletic advantages when compared to similarly aged, trained, and talented girls.

113. "The onset of puberty typically occurs around age 10 yr for girls (range, 8–13 yr) and at age 11.5 yr in boys (range, 9–14 yr)." (Hunter et al., 2023, at 12). It is often said or assumed that boys enjoy no significant athletic advantage over girls before puberty. However, this is not true. Scientific research and real-world examples of physical fitness and sports performance indicate that boys run faster, jump further, swim faster, and throw further than same-aged girls even before the onset of male puberty. As stated by Joyner et al. (2025) "There are profound sex differences in human performance in athletic events determined by strength, speed, power, endurance, and body size such that males outperform females. These sex differences in athletic performance exist before puberty and increase dramatically as puberty progresses." (at 1)

114. In a symposium at the 2025 Annual Meeting of the American College of Sports Medicine titled *Sex Differences in Physical and Athletic Performance Among Youths* Michael Joyner, Sandra Hunter, Jonathon Senefeld, and I presented a summary of recent

[7] VO_2max is "based on hemoglobin concentration, total blood volume, maximal stroke volume, cardiac size/mass/compliance, skeletal muscle blood flow, capillary density, and mitochondrial content." International Statement, *The Role of Testosterone in Athletic Performance* (January 2019), available at https://law.duke.edu/sites/default/files/centers/sportslaw/Experts_T_Statement_2019.pdf.

research demonstrating " … that before the onset of puberty, boys outperform girls of similar age, training status, and talent – boys run and swim faster, throw farther, and jump higher and longer." This symposium included data substantiating that these differences are underpinned by sex-based biological factors.

115. Sex-based differences in athletic performance prior to puberty have been consistently documented for decades. The following sections present evidence from a broad range of physical fitness assessments and organized sporting competitions, encompassing both small-scale datasets and large-scale studies involving tens of thousands to hundreds of thousands of children. These data consistently demonstrate that boys outperform girls across nearly all standardized measures and competitive events that depend on muscular strength, muscular endurance, power, speed, cardiorespiratory fitness, and aerobic endurance at virtually every prepubertal age.

A. Boys exhibit advantages in physical fitness testing even before puberty.

116. The American Association for Health, Physical Education and Recreation (AAHPER) was started in 1885 and was the largest professional organization for those in the fields of physical education, recreation, fitness, sport and coaching, dance, health education and promotion. AAHPER changed its name to the American Association for Health, Physical Education, Recreation and Dance (AAHPERD) in 1979, and then to the Society of Health and Physical Educators America (SHAPE America) in 2013 (SHAPE America remains the largest professional organization for those in the fields of health and physical education). The AAHPER first produced a Youth Fitness Test manual in 1958, which was revised in 1965 and again in 1976. The Youth Fitness Test manual included instructions for conducting physical fitness tests on school aged children from ages 9 through 17 years old and included normative data to rank the fitness of these children. Below are tables of data for the low, middle, and top decile (10^{th}, 50^{th}, and 90^{th} percentiles; representing very low, average, and very high physical fitness, respectively) for boys and girls ages 9-10 years old (who can reasonably be assumed to be prepubertal) for tests of sit ups in 1 minute, a 30-foot shuttle run, standing long jump, 50-yard dash, 600-yard run, and

9 minute run (Hunsicker and Reiff, 1976). As can be seen from these data, the performances for boys are better than similarly ranked girls in all tests except for the 50-yard dash for the 90th percentile in which there is no sex-based difference. I calculated the percent difference between boys and girls using this equation (which is the same equation used by Handelsman, 2017).

Percent difference = performance difference between boys and girls ÷ girls performance

Number of sit ups completed in 60 seconds for boys and girls ages 9-10 years old

	Male			Female			Male-Female % Difference	
10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile
19	31	44	14	27	40	35.7%	14.8%	10.0%

30 foot shuttle run, time in seconds for boys and girls ages 9-10 years old

	Male			Female			Male-Female % Difference	
10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile
13.0	11.2	10.2	13.8	11.8	10.5	5.8%	5.1%	2.9%

Standing long jump, in feet and inches for boys and girls ages 9-10 years old

	Male			Female			Male-Female % Difference	
10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile
4’0”	4’11”	5’10”	3’8”	4’8”	5’8”	6.8%	5.4%	2.9%

50-yard dash, time in seconds for boys and girls ages 9-10 years old

	Male			Female			Male-Female % Difference	
10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile
9.5	8.2	7.5	9.6	8.6	7.5	1.0%	4.7%	0.0%

600 yard run, minutes and seconds for boys and girls ages 9-10 years old

Male			Female			Male-Female % Difference		
10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile
3:14	2:33	2:09	3:38	2:56	2:26	11.0%	13.1%	11.6%

9 minute run, distance in yards for boys and girls ages 9-10 years old

Male			Female			Male-Female % Difference		
10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile
1268	1717	2166	1161	1514	1867	9.2%	13.4%	16.0%

117. Using the AAHPER data as a historical reference, and then comparing the data to information from other sources in the subsequent paragraphs, it becomes clear that male prepubertal sex-based advantages in physical fitness have persisted for more than five decades in spite of the tremendous improvements in access to, and acceptance of, female sports. While there may be some variation in the magnitude of differences between boys and girls in performance on physical fitness tests from one source to the next, it is clear that boys perform better than girls on tests of muscular strength, muscular power, speed, and endurance even before puberty.

118. The Presidential Fitness Test was widely used in schools in the United States from the late 1950s until 2013 (when it was phased out in favor of the Presidential Youth Fitness Program and FitnessGram, both of which focus on health-related physical fitness and do not present data in percentiles). Students participating in the Presidential Fitness Test could receive "The National Physical Fitness Award" for performance equal to the 50th percentile in five areas of the fitness test, while performance equal to the 85th percentile could receive the Presidential Physical Fitness Award. Tables presenting the 50th and 85th percentiles for the Presidential Fitness Test for males and females ages 6–17, and differences in

performance between males and females, for curl-ups, shuttle run, 1 mile run, push-ups, and pull-ups appear in the Appendix.

119. For both the 50th percentile (The National Physical Fitness Award) and the 85th percentile (Presidential Physical Fitness Award), with the exception of curl-ups in 6-year-old children, boys outperform girls. The difference in pull-ups for the 85th percentile for ages 7 through 17 are particularly informative with boys outperforming girls by 100%–1200%, highlighting the advantages in upper body strength in males.

120. In the seminal textbook, *Growth, Maturation, and Physical Activity*, Malina et al. (2004) present a summary of data from Gauthier et al. (1983) which present data from "a national sample of Canadian children and youth" demonstrating that from ages 7 to 17, boys have a higher aerobic power output than do girls of the same ages when exercise intensity is measured using heart rate (Malina at 242.) That is to say, at a heart rate of 130 beats per minute, or 150, or 170, a 7 to 17 year old boy should be able to run, bike, or swim faster than a similarly aged girl.

121. I have identified numerous papers presenting considerable data from school-based fitness testing showing that prepubertal boys outperform comparably aged girls in tests of muscular strength, muscular endurance, and running speed. Below I provide details from some of these publications demonstrating that prepubertal boys outperform girls of the same age in measurements of physical fitness that are relevant to sports performance. Many of these studies used a very large number of subjects (tens of thousands or hundreds of thousands) which give them inherently high statistical power.

122. These sex-based differences in physical fitness are relevant to the current issue of sex-based sports categories because, as stated by Lesinski et al. (2020), "fitness development precedes sports specialization" (2). These authors further observed that in an evaluation "of 703 male and female elite young athletes aged 8–18" (1) "males outperformed females in C[ounter]M[ovement]J[ump], D[rop]J[ump], C[hange]o[f]D[irection speed] performances and hand grip strength." (5).

123. Tambalis et al. (2016) examined "a large data set comprising 424,328 test

performances" of Greek children (736) using standing long jump to measure lower body explosive power, sit and reach to measure flexibility, timed 30 second sit ups to measure abdominal and hip flexor muscle endurance, 10 x 5 meter shuttle run to evaluate speed and agility, and multi-stage 20 meter shuttle run test to estimate aerobic performance (738). "For each of the fitness tests, performance was better in boys compared with girls ($p < 0.001$), except for the S[it and] R[each] test ($p < 0.001$)." (739) The authors noted, "Our findings are in accordance with recent studies from Latvia [ ] Portugal [ ] and Australia [Catley & Tomkinson (2013)]."(744).

124. The 20-m multistage fitness test is a commonly used maximal running aerobic fitness test used in the Eurofit Physical Fitness Test Battery and the FitnessGram Physical Fitness test. It is also known as the 20-meter shuttle run test, PACER test, or beep test (among other names; this is not the same test as the shuttle run in the Presidential Fitness Test). This test involves continuous running between two lines 20 meters apart in time to recorded beeps. The participants stand behind one of the lines facing the second line and begin running when instructed by the recording. The speed at the start is quite slow. The subject continues running between the two lines, turning when signaled by the recorded beeps. After about one minute, a sound indicates an increase in speed, and the beeps will be closer together. This continues each minute (level). If the line is reached before the beep sounds, the subject must wait until the beep sounds before continuing. If the line is not reached before the beep sounds, the subject is given a warning and must continue to run to the line, then turn and try to catch up with the pace within two more 'beeps'. The subject is given a warning the first time he or she fails to reach the line (within 2 meters) and eliminated after the second warning.

125. To illustrate the sex-based performance differences observed by Tambalis, I have prepared the following table showing the number of laps completed in the 20 m shuttle run for children ages 6–18 years for the low, middle, and top decile (Tambalis 2016 at 740 & 742), and have

Number of laps completed in the 20m shuttle run for children ages 6-18 years

Age	Male 10th %ile	Male 50th %ile	Male 90th %ile	Female 10th %ile	Female 50th %ile	Female 90th %ile	Male-Female % Difference 10th %ile	Male-Female % Difference 50th %ile	Male-Female % Difference 90th %ile
6	4	14	31	4.0	12.0	26.0	0.0%	16.7%	19.2%
7	8	18	38	8.0	15.0	29.0	0.0%	20.0%	31.0%
8	9	23	47	9.0	18.0	34.0	0.0%	27.8%	38.2%
9	11	28	53	10.0	20.0	40.0	10.0%	40.0%	32.5%
10	12	31	58	11.0	23.0	43.0	9.1%	34.8%	34.9%
11	15	36	64	12.0	26.0	48.0	25.0%	38.5%	33.3%
12	15	39	69	12.0	26.0	49.0	25.0%	50.0%	40.8%
13	16	44	76	12.0	26.0	50.0	33.3%	69.2%	52.0%
14	19	50	85	12.0	26.0	50.0	58.3%	92.3%	70.0%
15	20	53	90	12.0	25.0	47.0	66.7%	112.0%	91.5%
16	20	54	90	11.0	24.0	45.0	81.8%	125.0%	100.0%
17	18	50	86	10.0	23.0	50.0	80.0%	117.4%	72.0%
18	13	48	87	8.0	23.0	39.5	62.5%	108.7%	120.3%

126. A recent literature review commissioned by the five United Kingdom governmental Sport Councils concluded that while "[i]t is often assumed that children have similar physical capacity regardless of their sex, … large-scale data reports on children from the age of six show that young males have significant advantage in cardiovascular endurance, muscular strength, muscular endurance, speed/agility and power tests," although they "score lower on flexibility tests," such as the sit and reach test. (UK Sports Councils' Literature Review 2021 at 3.)

127. Hilton et al., also writing in 2021, reached the same conclusion: "An extensive review of fitness data from over 85,000 Australian children aged 9–17 years old showed that, compared with 9-year-old females, 9-year-old males were faster over short sprints (9.8%) and 1 mile (16.6%), could jump 9.5% further from a standing start (a test of

explosive power), could complete 33% more push-ups in 30 [seconds] and had 13.8% stronger grip." (Hilton 2021 at 201, summarizing the findings of Catley & Tomkinson 2013.)

128. The following data are taken from Catley & Tomkinson (2013 at 101) showing the low, middle, and top decile for 1.6 km run (1.0 mile) run time (in seconds) for 11,423 girls and boys ages 9–17.

1.6 km run (1.0 mile) run time for 11,423 girls and boys ages 9-17

	Male			Female			Male-Female % Difference		
Age	**10th %ile**	**50th %ile**	**90th %ile**	**10th %ile**	**50th %ile**	**90th %ile**	**10th %ile**	**50th %ile**	**90th %ile**
9	684	522	423	769.0	609.0	499.0	11.1%	14.3%	15.2%
10	666	511	420	759.0	600.0	494.0	12.3%	14.8%	15.0%
11	646	500	416	741.0	586.0	483.0	12.8%	14.7%	13.9%
12	621	485	408	726.0	575.0	474.0	14.5%	15.7%	13.9%
13	587	465	395	716.0	569.0	469.0	18.0%	18.3%	15.8%
14	556	446	382	711.0	567.0	468.0	21.8%	21.3%	18.4%
15	531	432	373	710.0	570.0	469.0	25.2%	24.2%	20.5%
16	514	423	366	710.0	573.0	471.0	27.6%	26.2%	22.3%
17	500	417	362	708.0	575.0	471.0	29.4%	27.5%	23.1%

129. Can et al. (2025) evaluated 118 Turkish children ages 9-14 years old for performance in maximal repeated sprint running using the "Children's Repetitive and Intermittent Sprinting Performance (CRISP) test", which is a test using "six 30-meter sprints with 10-second rest intervals." The authors observed that boys at each age ran faster than the girls, particularly in the second half of the test. The authors concluded that "…significant differences were observed in running performance, with older children producing more power and boys generally running faster than girls." (at 11)

130. Tomkinson et al. (2018) performed a similarly extensive analysis of millions of measurements of a variety of strength and agility metrics from the "Eurofit" test battery on

children from 30 European countries. They provide detailed results for each metric, broken out by decile. Sampling the low, middle, and top decile, 9-year-old boys performed better than 9-year-old girls by between 6.5% and 9.7% in the standing broad jump; from 11.4% to 16.1% better in handgrip; and from 45.5% to 49.7% better in the "bent-arm hang." (Tomkinson 2018.)

131. The Bent Arm Hang test is a measure of upper body muscular strength and endurance used in the Eurofit Physical Fitness Test Battery. To perform the Bent Arm Hang, the child is assisted into position with the body lifted to a height so that the chin is level with the horizontal bar (like a pull up bar). The bar is grasped with the palms facing away from body and the hands shoulder width apart. The timing starts when the child is released. The child then attempts to hold this position for as long as possible. Timing stops when the child's chin falls below the level of the bar, or the head is tilted backward to enable the chin to stay level with the bar.

132. Using data from Tomkinson (2018; table 7 at 1452), the following table sampling the low, middle, and top decile for bent arm hang for 9- to 17-year-old children can be constructed:

Bent Arm Hang time (in seconds) for children ages 9–17 years

	Male			Female			Male-Female % Difference		
Age	**10th %ile**	**50th %ile**	**90th %ile**	**10th %ile**	**50th %ile**	**90th %ile**	**10th %ile**	**50th %ile**	**90th %ile**
9	2.13	7.48	25.36	1.43	5.14	16.94	48.95%	45.53%	49.70%
10	2.25	7.92	26.62	1.42	5.15	17.06	58.45%	53.79%	56.04%
11	2.35	8.32	27.73	1.42	5.16	17.18	65.49%	61.24%	61.41%
12	2.48	8.79	28.99	1.41	5.17	17.22	75.89%	70.02%	68.35%
13	2.77	9.81	31.57	1.41	5.18	17.33	96.45%	89.38%	82.17%
14	3.67	12.70	38.39	1.40	5.23	17.83	162.14%	142.83%	115.31%
15	5.40	17.43	47.44	1.38	5.35	18.80	291.30%	225.79%	152.34%
16	7.39	21.75	53.13	1.38	5.63	20.57	435.51%	286.32%	158.29%
17	9.03	24.46	54.66	1.43	6.16	23.61	531.47%	297.08%	131.51%

133. Evaluating these data, a 9-year-old boy in the 50th percentile (that is to say a 9-year-old boy of average upper body muscular strength and endurance) will perform better in the bent arm hang test than 9 through 17-year-old girls in the 50th percentile. Similarly, a 9-year-old boy in the 90th percentile will perform better in the bent arm hang test than 9 through 17-year-old girls in the 90th percentile.

134. Using data from a different paper by Tomkinson et al. (2017; table 1 at 1549), evaluating data from 50 countries from Africa, Asia, Europe, Latin America, the Caribbean, Northern America, and Oceania, the following table sampling the low, middle, and top decile for running speed in the last stage of the 20 m shuttle run for 9- to 17-year-old children can be constructed.

20 m shuttle running speed (km/h at the last completed stage)

	Male			Female			Male-Female % Difference		
Age	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile
9	8.94	10.03	11.13	8.82	9.72	10.61	1.36%	3.19%	4.90%
10	8.95	10.13	11.31	8.76	9.75	10.74	2.17%	3.90%	5.31%
11	8.97	10.25	11.53	8.72	9.78	10.85	2.87%	4.81%	6.27%
12	9.05	10.47	11.89	8.69	9.83	10.95	4.14%	6.51%	8.58%
13	9.18	10.73	12.29	8.69	9.86	11.03	5.64%	8.82%	11.42%
14	9.32	10.96	12.61	8.70	9.89	11.07	7.13%	10.82%	13.91%
15	9.42	11.13	12.84	8.70	9.91	11.11	8.28%	12.31%	15.57%
16	9.51	11.27	13.03	8.71	9.93	11.14	9.18%	13.49%	16.97%
17	9.60	11.41	13.23	8.72	9.96	11.09	10.09%	14.56%	19.30%

135. Evaluating these data, a 9-year-old boy in the 50th percentile (that is to say a 9-year-old boy of average running speed) will run faster in the final stage of the 20 m shuttle run than 9 through 17-year-old girls in the 50th percentile. Similarly, a 9-year-old boy in the 90th percentile will run faster in the final stage of the 20-m shuttle run than 9 through

15, and 17-year-old girls in the 90th percentile and will be 0.01 km/h (0.01%) slower than 16-year-old girls in the 90th percentile.

136. Just using these two examples for bent arm hang and 20-m shuttle running speed (Tomkinson 2107, Tomkinson 2018) based on large sample sizes (thus having tremendous statistical power) it becomes apparent that a 9-year-old boy will be very likely to outperform similarly trained girls of his own age and older in athletic events involving upper body muscle strength and/or running speed.

137. Another report published in 2014 analyzed physical fitness measurements of 10,302 children aged 6–10.9 years of age, from the European countries of Sweden, Germany, Hungary, Italy, Cyprus, Spain, Belgium, and Estonia. (De Miguel-Etayo et al. 2014.) The authors observed "… that boys performed better than girls in speed, lower- and upper-limb strength and cardiorespiratory fitness." (57) The data showed that for children of comparable fitness (i.e. 99th percentile boys vs. 99th percentile girls, 50th percentile boys vs. 50th percentile girls, etc.) the boys outperform the girls at every age in measurements of handgrip strength, standing long jump, 20-m shuttle run, and predicted VO_2max (pages 63 and 64, respectively).

138. The standing long jump, also called the Broad Jump, is a common and easy to administer test of explosive leg power used in the Eurofit Physical Fitness Test Battery and in the NFL Combine. In the standing long jump, the participant stands behind a line marked on the ground with feet slightly apart. A two-foot take-off and landing is used, with swinging of the arms and bending of the knees to provide forward drive. The participant attempts to jump as far as possible, landing on both feet without falling backwards. The measurement is taken from takeoff line to the nearest point of contact on the landing (back of the heels) with the best of three attempts being scored.

139. Using data from De Miguel-Etayo et al. (2014, table 3 at 61), which analyzed physical fitness measurements of 10,302 children aged 6–10.9 years of age, from the European countries of Sweden, Germany, Hungary, Italy, Cyprus, Spain, Belgium, and Estonia, the following table sampling the low, middle, and top decile for standing long

jump for 6- to 9-year-old children can be constructed:

Standing Broad Jump (cm) for children ages 6-9 years

	Male			Female			Male-Female % Difference		
Age	**10th %ile**	**50th %ile**	**90th %ile**	**10th %ile**	**50th %ile**	**90th %ile**	**10th %ile**	**50th %ile**	**90th %ile**
6-<6.5	77.3	103.0	125.3	69.1	93.8	116.7	11.9%	9.8%	7.4%
6.5-<7	82.1	108.0	130.7	73.6	98.7	121.9	11.5%	9.4%	7.2%
7-<7.5	86.8	113.1	136.2	78.2	103.5	127.0	11.0%	9.3%	7.2%
7.5-<8	91.7	118.2	141.6	82.8	108.3	132.1	10.7%	9.1%	7.2%
8-<8.5	96.5	123.3	146.9	87.5	113.1	137.1	10.3%	9.0%	7.1%
8.5-<9	101.5	128.3	152.2	92.3	118.0	142.1	10.0%	8.7%	7.1%

140. Another study of Eurofit results for over 400,000 Greek children reported similar results. "[C]ompared with 6-year-old females, 6-year-old males completed 16.6% more shuttle runs in a given time and could jump 9.7% further from a standing position." (Hilton 2021 at 201, summarizing findings of Tambalis et al. 2016.)

141. Silverman (2011) gathered hand grip data, broken out by age and sex, from a number of studies. Looking only at the nine direct comparisons within individual studies tabulated by Silverman for children aged 7 or younger, in eight of these the boys had strength advantages of between 13 and 28 percent, with the remaining outlier recording only a 4% advantage for 7-year-old boys. (Silverman 2011 Table 1.)

142. Beunen and Thomis (2000) reviewed a number of studies on sex-based differences in strength in children before puberty and observed that at age 7 hand grip strength is 20% higher in boys than in girls. These authors further stated that "During childhood and adolescence boys have greater strength per unit of body size, especially in the upper body and trunk, than girls." (at 176) (these authors defined childhood from age 3 until puberty).

143. To help illustrate the importance of one specific measure of physical fitness in athletic performance, Pocek (2021) stated that to be successful, volleyball "players should distinguish themselves, besides in skill level, in terms of above-average body height, upper

and lower muscular power, speed, and agility. Vertical jump is a fundamental part of the spike, block, and serve." (8377) Pocek further stated that "relative vertical jumping ability is of great importance in volleyball regardless of the players' position, while absolute vertical jump values can differentiate players not only in terms of player position and performance level but in their career trajectories." (8382)

144. Using data from Ramírez-Vélez (2017; table 2 at 994) which analyzed vertical jump measurements of 7,614 healthy Colombian schoolchildren aged 9–17.9 years of age the following table sampling the low, middle, and top decile for vertical jump can be constructed:

Vertical Jump Height (cm) for children ages 9–17 years

	Male			**Female**			**Male-Female % Difference**		
Age	**10th %ile**	**50th %ile**	**90th %ile**	**10th %ile**	**50th %ile**	**90th %ile**	**10th %ile**	**50th %ile**	**90th %ile**
9	18.0	24.0	29.5	16.0	22.3	29.0	12.5%	7.6%	1.7%
10	19.5	25.0	32.0	18.0	24.0	29.5	8.3%	4.2%	8.5%
11	21.0	27.0	32.5	19.5	25.0	31.0	7.7%	8.0%	4.8%
12	22.0	27.5	34.5	20.0	25.5	31.5	10.0%	7.8%	9.5%
13	23.0	30.5	39.0	19.0	25.5	32.0	21.1%	19.6%	21.9%
14	23.5	32.0	41.5	20.0	25.5	32.5	17.5%	25.5%	27.7%
15	26.0	35.5	43.0	20.2	26.0	32.5	28.7%	36.5%	32.3%
16	28.0	36.5	45.1	20.5	26.5	33.0	36.6%	37.7%	36.7%
17	28.0	38.0	47.0	21.5	27.0	35.0	30.2%	40.7%	34.3%

145. Similarly, using data from Taylor (2010; table 2, at 869) which analyzed vertical jump measurements of 1,845 children aged 10–15 years in primary and secondary schools in the East of England, the following table sampling the low, middle, and top decile for vertical jump can be constructed:

Vertical Jump Height (cm) for children 10–15 years

Male	**Female**	**Male-Female %**

								Difference	
Age	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile
10	16.00	21.00	29.00	15.00	22.00	27.00	6.7%	-4.5%	7.4%
11	20.00	27.00	34.00	19.00	25.00	32.00	5.3%	8.0%	6.3%
12	23.00	30.00	37.00	21.00	27.00	33.00	9.5%	11.1%	12.1%
13	23.00	32.00	40.00	21.00	26.00	34.00	9.5%	23.1%	17.6%
14	26.00	36.00	44.00	21.00	28.00	34.00	23.8%	28.6%	29.4%
15	29.00	37.00	44.00	21.00	28.00	39.00	38.1%	32.1%	12.8%

146. As can be seen from the data from Ramírez-Vélez (2017) and Taylor (2010), males consistently outperform females of the same age and percentile in vertical jump height. Both sets of data show that an 11-year-old boy in the 90th percentile for vertical jump height will outperform girls in the 90th percentile at ages 11 and 12, and will be equal to girls at ages 13, 14, and possibly 15. These data indicate that an 11-year-old boy would be likely to have an advantage over girls of the same age and older in sports such as volleyball where "absolute vertical jump values can differentiate players not only in terms of player position and performance level but in their career trajectories." (Pocek 2021 at 8382.)

147. Other papers demonstrating sex-based differences in performance on physical fitness and motor skills tests before puberty, for which I will provide fewer details, include:

- A longitudinal assessment of physical fitness in 152 boys and 88 girls from the age of 9 until 12 years old indicating that at each age the boys had physical fitness advantages in upper body strength and power and greater agility while the girls had advantages in flexibility (Golle 2015).
- A longitudinal assessment of grip strength in 29 boys and 22 girls using children "from local kindergarten and nursery schools" who were between 3.5 and 4.5 years of age at the beginning of the study. The boys were stronger than the girls at each time point even though there were not sex-based difference in muscle size, with the authors concluding "This indicates that something other than hormones are likely driving this

difference between sexes or that the transient surge of testosterone during infancy in boys ("minipuberty") has long lasting performance effects "

- An assessment of 108,295 8-year-old third graders in which the boys outperformed the girls in tests of cardiorespiratory endurance (6-minute run test), speed (20-meter linear sprint test), lower body power (standing long jump), and upper body power (ball push test), leading the authors to conclude that "boys outperformed girls to a larger extent in tests requiring muscle mass for successful performance." (Fuhner, 2021) (at 1)
- An evaluation of 31,484 children (16,023 boys and 15,461 girls) ages 6-11 years old from a representative sample of the French population with boys performing better on tests of cardiorespiratory fitness, muscular endurance, and speed (Vanhelst et al. 2020).
- An evaluation of 1,682 children and adolescents aged 6–17 years from central Spain, divided into prepubertal and pubertal groups based on Tanner stages demonstrating that pre-pubertal boys had more muscle mass, less fat mass, and performed better than girls on tests of countermovement jump, handgrip strength, and 20 m shuttle run (Manzano-Carrasco et al. 2022).
- An evaluation of 128 boys and 65 girls between the ages of 6 and 12 years old reported that "…sex [explained] 9.5%, 10.7%, 6.3% and 2.0% of variance in the 30-m dash, seated chest pass, standing long jump, and flamingo balance test, respectively" with the data demonstrating that the boys performed better than the girls on 30-m dash, seated chest press, and standing long jump, with no statistically significant sex-based difference in the flamingo balance test (Milanese 2020) (at 1).
- An evaluation of 434 preschool children from Santiago, Chile (246 boys; 5.48 ± 0.31 years) showing that boys were heavier and taller than girls, with boys performing better on handgrip strength test, standing long jump, and 20 m sprint (Cadenas-Sanchez, 2015).
- An assessment of physical fitness in 168 boys and 138 girls aged 4.48 ± 0.15 years old demonstrated that the boys had higher hand grip strength (Henriksson 2016).
- An evaluation of 3,179 preschool children (1,678 boys, 1,501 girls) ages 2.8–6.4 years

from 10 different cities and towns in Spain finding that boys outperformed girls in the 20 m shuttle run, handgrip strength, standing long jump, and 4 X 10 m shuttle run (Cadenas-Sanchez, 2019).

- An evaluation of 1961 boys and 1907 girls between the ages of 3- and 6-years old concluding that "boys showed a greater performance on cardio respiratory endurance, reaction time, strength and running speed" and that "[s]ex differences in physical fitness are evident at an early age." (Latorre-Roman, 2017) (at 267)
- A systematic review and meta-analysis of 38 studies from 19 different countries (Australia, Belgium, Brazil, Britain, China, Croatia, Germany, Iran, Indonesia, Ireland, Japan, Korea, Myanmar, Poland, Portugal, Puerto Rico, Singapore, South Africa, and the USA) representing data for 8394 children ages 3–6 years old who were assessed for object control skills (such as kicking and throwing) favoring boys vs. girls at ages 3, 4, 5, and 6 with at least some of the differences attributable to biology (Zheng et al, 2022).
- A study of 341 young Nigerian children (ages 3 to 5) revealing that at each age level the boys consistently performed better than the girls on tests of catching, standing long jump, tennis ball throw, and speed run (Toriola and Ingokwe, 1986).

148. Boys also enjoy an advantage in throwing well before puberty. "Boys exceed girls in throwing velocity by 1.5 standard deviation units as early as 4 to 7 years of age. . . The boys exceed the girls [in throwing distance] by 1.5 standard deviation units as early as 2 to 4 years of age." (Thomas 1985 at 266.) This means that the average 4- to 7-year-old boy can out-throw approximately 87% of all girls of his age. Lombardo and Deaner (2018) evaluated many factors related to sex differences in throwing, including studies showing that training girls to have better throwing mechanics does not erase the sex-based differences in throwing velocity, and concluded that "sex differences in anatomical traits associated with throwing are partly responsible for male throwing superiority." Gromeier et al. (2017) demonstrated that males 6-16 years of age have better qualitative throwing performance than same aged females. Particularly, the males possess better performance "in trunk, stepping and backswing action." (at 1)

149. The scientific evidence for prepubertal male advantages in physical fitness described in the preceding paragraphs comes from countries of many different levels of economic affluence, a wide variety of cultures, and from studies across the past three or more decades. The fact that prepubertal males consistently outperform females of the same age in tests of cardiorespiratory fitness, muscular strength, muscular endurance, speed, and power across so many different cultures and have done so for the past several decades provides strong evidence that these sex-based differences are biologically based and not due to culture. Confirming this conclusion, a meta-analyses by Nuzzo (2025), has documented that prepubertal male sex-based advantages in hand grip strength are comparable across countries and have been consistent since the 1960s, leading to the conclusion that "Various biological factors explain why, on average, boys are stronger than girls from birth onward" (at 1). Another meta-analysis by Nuzzo (2024) documents that female sex-based advantages in flexibility have been consistent since the 1960s, leading to the conclusion that the sex-based differences are biologically based. In a third meta-analysis Nuzzo and Pinto (2025) documents prepubertal male advantages when compared to girls of the same age in both upper and lower body strength, once again with the conclusion that biological factors explain the differences in strength.

150. A common response to empirical data showing pre-pubertal performance advantages in boys is the argument that the performance of boys may represent a social–cultural bias for boys to be more physically active, rather than representing inherent sex-based differences in pre-pubertal physical fitness. However, the younger the age at which such differences are observed, and the more egalitarian the culture within which they are observed, the less plausible this hypothesis becomes. Eiberg et al. (2005) measured body composition, VO_2max, and physical activity in 366 Danish boys and 332 Danish girls between the ages of 6 and 7 years old. Their observations indicated that VO_2max was 11% higher in boys than girls. When expressed relative to body mass the boys' VO_2max was still 8% higher than the girls. The authors stated that "…no differences in haemoglobin or

sex hormones[8] have been reported in this age group," yet "… when children with the same VO_2max were compared, boys were still more active, and in boys and girls with the same P[hysical] A[ctivity] level, boys were fitter." (728). It is also very interesting to note that, on average, the boys had 9.1% more lean body mass and 22% lower body fat percentage than the girls (Table 2, at 727). These data indicate that in pre-pubertal children, in a very egalitarian culture regarding gender roles and gender norms (Georgetown University, 2023, United Nations Development Programme, n.d), boys still have a measurable advantage in regard to aerobic fitness when known physiological and physical activity differences are accounted for.

151. Further demonstrating pre-pubertal sex-based differences in physical fitness and physiologic function in an evaluation of 140 boys and 108 girls aged 7.9–11.1 years old who were measured for body composition, VO_2peak, physical activity, left ventricular inner diastolic diameter, and lung function, the authors reported, "Boys had between 8 and 18% higher values than girls for VO_2peak, dependent upon whether VO_2peak was expressed in absolute values or scaled to body mass, L[ean]B[ody]M[ass] or if allometric scaling was used." And then concluded, "Existing gender differences in VO_2peak cannot be explained only by differences in body composition, physical activity, or heart size" Dencker (2007) (at 19)

152. And, as I have mentioned above, even by the age of 4 or 5, in a ruler-drop test, boys exhibit 4% to 6% faster reaction times than girls. (Latorre-Roman 2018.)

153. When looking at the data on testosterone concentrations presented later in this report, along with the data on physical fitness and athletic performance presented, boys have advantages in athletic performance and physical fitness before there are marked differences in testosterone concentrations between boys and girls. These physical fitness and athletic advantages are largely due to the male advantages in lean body mass, cardiorespiratory function, and other anatomical and physiological advantages observed in pre-pubertal males (as explained later in this report). It is presently unclear if these

[8] This term would include testosterone and estrogens.

anatomical and physiological factors favoring boys' physical fitness and athletic performance are caused by the lingering effects of elevated fetal and neonatal testosterone exposure in boys, or if these advantages are due to the effects of Y-chromosome linked genes. However, one of the main points raised by Joyner et al. (2025) is that "The male-female performance gap is evident before puberty." And subsequently states that "…differences in early childhood body composition indicate that at least some of the male-female performance gap among prepubertal children is due to intrinsic biological factors." (at 5)

154. The fourth sentence of the abstract of the ACSM special communication titled "The Biological Basis of Sex Differences in Athletic Performance: Consensus Statement for the American College of Sports Medicine." (Hunter, 2023) states "These sex differences in performance emerge with the onset of puberty and coincide with the increase in endogenous sex steroid hormones, in particular testosterone in males" (at 1) and "Exposure to high levels of endogenous testosterone in males at the onset of puberty (~12 yr) is the *primary* determinant for the large sex difference in athletic performance during puberty and in adulthood. Before puberty, the sex difference in athletic performance is minimal." (at 23; emphasis added). As explained in preceding paragraphs, I do not agree completely with this statement. I agree that male puberty and the large increases in testosterone magnify the sex-based differences in physical fitness and athletic performance, but as I have shown in the previous paragraphs, there is considerable evidence indicating that there are statistically significant and meaningful sex-based differences in physical fitness before puberty. And as I demonstrate in subsequent paragraphs there are statistically significant and meaningful sex-based differences in athletic performance before puberty. It is also important to point out that the use of the word "minimal" is not the same as nonexistent, is not a term that is consistent with a statistical evaluation in which sex-based differences are or are not present and would therefore be denoted with a P value or F ratio (or similar objective quantitative assessment), and, as previously pointed out, within athletic competitions small differences can mean the difference between a gold medal and no

medal.

155. Within the consensus statement it is stated that "[o]ther studies show that boys outperformed girls for tasks such as handgrip strength, modified pull ups, 30-m dash and long jump" (at 11-12; citing Milanese et al. 2020, which was previously described in this report) and "Comparison of the top 10 boys and girls USA running track records (2019–2021) in 100, 200, 400, and 800 m also show that boys were ~4%–5% faster than girls in the age categories of 7–8, 9–10, and 11–12 yr and rose to >8% by 13–14 yr" (at 12; citing Atkinson et al. 2023, also described later in this report). Thus, the consensus statement acknowledges that there are data demonstrating male sex-based athletic advantages before puberty.

156. The consensus statement recognizes that there are sex-based differences in body composition before puberty "in midchildhood, girls accumulate more fat mass than boys, a difference that becomes more pronounced during puberty." (at 11) Although the consensus statement cites McManus and Armstrong (2010), it does not in any way address any of the other sex-based pre-pubertal anatomical and physiological differences identified by McManus and Armstrong (and explained later in this report), including males having more lean body mass, larger hearts and lungs, larger blood volumes, and so forth.

157. An example of a weakness in the consensus statement is the study of youth weightlifters by Mizuguchi et al. (2021). This study used only 1 female and no males aged 9-years-old, 5 females and 2 males aged 10-years-old, and 7 females and 4 males aged 11-years-old, which represent a subject sample size that is too small for supportive evidence. Furthermore, the statistical power, reliability, and validity are severely compromised due to the unequal numbers of males and females in the comparison groups, particularly having no males in the 9-year-old group. Finally, it could be reasonably concluded that the 11-year-old females are not truly prepubertal.

158. It appears the authors of the ACSM consensus statement gave only cursory attention to pre-pubertal sex-based differences in physical fitness and athletic performance. For example, out of 23 ½ pages of text, tables, and figures, only one paragraph and 2 figures

are devoted to pre-pubertal sex-based differences in physical fitness and athletic performance, and the two figures are from a single source on swimming performance in children and adolescents. Furthermore, the consensus statement did not evaluate the youth best all-time performance records from USA Track & Field, USA Swimming, the Amateur Athletic Union, or School Sport Australia that are cited later in this report. In short, the authors cited a very small portion of the available literature and data concerning pre-pubertal differences. A more thorough review of the available evidence, as is presented in this report and in Joyner et al. (2025), demonstrates that pre-pubertal athletic differences are statistically significant, competitively meaningful, biologically based, and found across a wide range of sports and age groups.

B. Boys exhibit advantages in athletic competition even before puberty.

159. The 2017 paper by Handelsman (Handelsman 2017) titled "Sex differences in athletic performance emerge coinciding with the onset of male puberty" is often cited as evidence that there are minimal, or no, sex-based differences in athletic performance before puberty. However, when describing sex-based differences in track and field events the author states that there is a "prepubertal difference of 3.0%" in running (at 70) and a "prepubertal difference of 5.8%" in jumping (at 70), both of which favor boys. In this paper figure 1 also clearly shows that prepubertal males swim 1–2% faster than females in freestyle, backstroke, butterfly, and individual medley (IM) events (at 69). Included below is Figure 2 from this paper (at 70) which clearly shows the male sex-based advantages in running, jumping, and swimming are present before the male puberty associated increases in testosterone. While it can be argued whether a 1.0%, 3.0% or 5.8% performance difference between boys and girls is small or minimal, one cannot say that the difference is nonexistent. And, as previously stated and as can be clearly recognized by competitive athletes, a small difference in performance can be highly meaningful when it comes to winning or placing in competition.

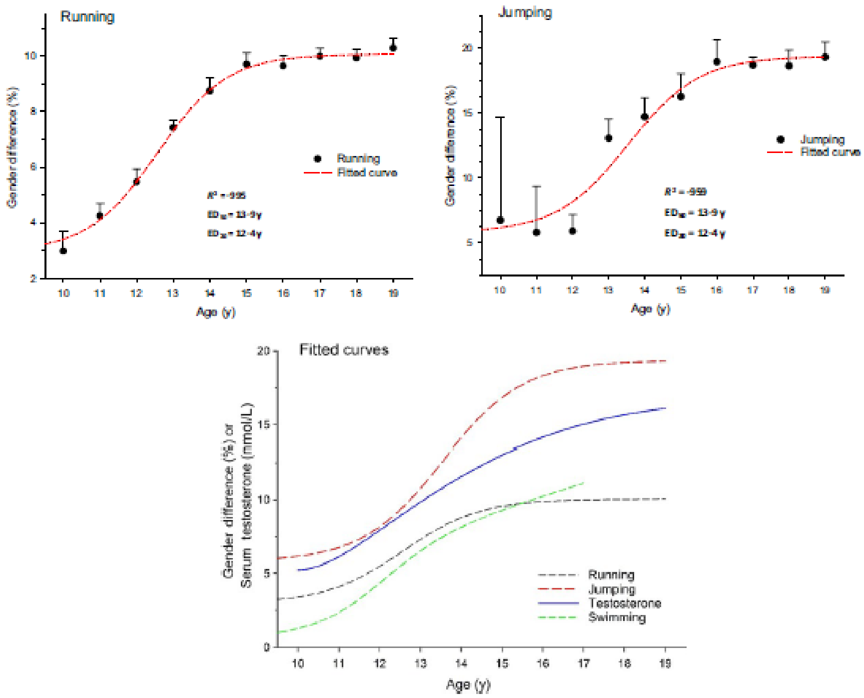


FIGURE 2 Gender differences in performance (in percentage) according to age (in years) in running events including 50 m, 60 m, 100 m, 200 m, 300 m, 400 m, 500 m, 600 m, 800 m, 1000 m, 1500 m, 1 mile, 2000 m, 3000 m and 2 miles (upper left panel) and in jumping events including high jump, pole vault, triple jump, long jump and standing long jump (upper right panel). Fitted sigmoidal curve plot of gender differences in performance (in percentage) according to age (in years) in running, jumping and swimming events as well as serum testosterone (lower panel). Data shown as mean and standard error of the mean of the pooled gender differences by age. [Colour figure can be viewed at wileyonlinelibrary.com]

160. I have also found considerable real-world performance data from track and field competitions showing male sex-based performance advantages. Hunter (2024) describes this kind of research as "top down" (at 5) and indicates that this kind of research is very useful for identifying performance differences between categories of athletes (such as age groups or sexes).

161. Record data for all-time best performances from USA Track & Field indicate that boys outperform girls in track and field events even in the youngest age group for whom records are kept (age 8 and under). (USA Track and Field, 2018).

USATF American Youth Outdoor Track & Field All-Time Best Performance Record times in the 8-and-under age group (time in seconds)

Event	Boys	Girls	Difference
100M	13.65	13.78	0.95%
200M	27.32	28.21	3.26%
400M	62.48	66.10	5.79%

800M	148.59	158.11	6.41%
1500M	308.52	314.72	2.01%
Mean Running Difference			3.68%
Long Jump (meters)	4.46	3.99	11.8%
Shot Put (meters)	10.41	8.99	15.8%
Javelin (meters)	33.29	24.05	38.4%

162. Other record data for all-time best performances from USA Track and Field during the USA Track & Field Junior Olympic Championships also indicate that boys outperform girls in track and field events in the youngest age group for whom records are kept (age 8 and under)(USA Track and Field 2019)

USATF Junior Olympic Track & Field Championships All-Time Best Performance Record times in the 8-and-under age group (time in seconds)

Event	**Boys**	**Girls**	**Difference**
100M	13.69	14.11	2.98%
200M	28.13	28.48	1.23%
400M	63.30	66.53	4.85%
800M	149.55	158.26	5.50%
1500M	308.52	332.33	7.16%
Mean Running Difference			4.34%
Long Jump (meters)	4.46	3.73	19.6%
Shot Put (meters)	8.39	7.34	14.3%
Javelin (meters)	33.29	23.15	43.8%

163. The Amateur Athletic Union (AAU) is another organization that sanctions track and field meets. Record data for all-time best performance from the AAU Junior Olympics also indicate that boys outperform girls in track events in the youngest age group for whom records are kept (age 8 and under) (Amateur Athletic Union Track and Field, n.d.)

AAU Junior Olympic Track & Field All-Time Best Performance Record times in the 8-and-under age group (time in seconds)

Event	Boys	Girls	Difference
100M	13.46	13.85	2.82%
200M	27.80	28.29	1.73%
400M	62.29	65.04	4.23%
800M	147.02	152.00	3.28%
1500M	307.14	318.44	3.55%
Mean Running Difference			3.12%
Long Jump (meters)	4.51	4.17	8.2%
Shot Put (meters)	10.62	8.68	22.3%
Javelin (meters)	29.97	23.88	25.5%

164. Looking at the best times within a single year shows a similar pattern of consistent advantage for even young boys. Below I consider the results for my home state from the 2023 USATF Nebraska Association Junior Olympics for the youngest age group (8 and under). (Athletic.net)

Fastest Times in the 2023 USATF Nebraska Association Junior Olympics for the 8-and-under age group (time in seconds)

Event	Boys	Girls	Difference
100M	14.67	15.65	6.26%
200M	31.16	34.19	8.86%
400M	72.97	79.70	8.44%
800M	165.86	191.34	13.32%
1500M	No data to compare for this event		
Mean Running Difference			9.22%
Long Jump (meters)	3.69	3.19	15.67%
Shot Put (meters)	6.71	4.06	65.27%

Javelin (meters)	19.21	9.55	101.15%

165. Results from Arizona lead to the same conclusion. Below I consider the results for the state of Arizona from the 2023 USATF Arizona Association Junior Olympics Championships for the youngest age group (8 and under). (Athletic.net)

Fastest Times in the 2023 USATF Arizona Association Junior Olympics for the 8-and-under age group (time in seconds)

Event	**Boys**	**Girls**	**Difference**
100M	14.76	15.21	3.0%
200M	30.46	31.78	4.2%
400M	71.24	72.56	1.8%
800M	164.59	195.65	15.9%
1500M	347.77	378.74	8.2%
Mean Running Difference			7.4%
Long Jump (meters)	3.88	3.12	24.4%
Shot Put (meters)	6.47	4.09	58.2%
Javelin (meters)	23.59	16.04	47.1%

166. Results from California lead to yet again the same conclusion. Below I consider the results for the more populous state of California from the 2023 USATF Southern California Association Junior Olympics Championships for the youngest age group (8 and under). (Athletic.net).

Fastest Times in the 2023 USATF Southern California Association Junior Olympics for the 8-and-under age group (time in seconds)

Event	**Boys**	**Girls**	**Difference**
100M	14.12	14.74	4.21%
200M	30.00	32.31	7.15%
400M	71.00	75.28	5.69%

800M	162.44	162.49	0.03%
1500M	317.68	341.26	6.91%
Mean Running Difference			4.80%
Long Jump (meters)	3.90	3.32	17.47%
Shot Put (meters)	6.24	4.51	38.36%
Javelin (meters)	19.18	13.75	42.07%

167. The national data overall agree with the Nebraska, Arizona, and California data. Below I consider the results for the 2023 USATF National Junior Olympics Championships for the youngest age group (8 and under) which drew elite young athletes from numerous states. (Athletic.net)

<u>Fastest Times in the 2023 USATF National Junior Olympics Championships for the 8-and-under age group (time in seconds)</u>

Event	Boys	Girls	Difference
100M	14.18	14.70	3.54%
200M	28.65	29.91	4.21%
400M	65.79	71.34	7.78%
800M	153.80	164.90	6.73%
1500M	318.94	342.62	6.91%
Mean Running Difference			5.83%
Long Jump (meters)	3.91	4.00	-2.25%
Shot Put (meters)	8.31	6.35	30.87%
Javelin (meters)	29.99	16.78	78.72%

168. To help demonstrate that the pre-pubertal male athletic advantages are not limited to just the first place finishers, for the 2023 USA Track & Field National Junior Olympics Championships I have compiled tables, which appear below, comparing the performance of the fastest eight boys and girls in the final heat in the 8-and-under age group for the 100-

m, 200-m, 400-m, 800-m, and 1500-m running events. In these events, the 1st place boy was consistently faster than the 1st place girl (by an average of 5.8%) and the average performance of the 8 fastest boys was consistently faster than the average performance for the 8 fastest girls (by an average of 5.9%). In the 400-m race, the fastest boy was 5.55 seconds (7.9%) faster than the fastest girl. Extrapolating the running time to a running pace, the boy would be expected to finish 33.74 m in front of the fastest girl in a single lap race on a standard 400-m track, or almost the length of 1/3 of a football field. In comparison, the 1st place boy would finish 12 m in front of the 2nd place boy, and the 1st place girl would finish 10 m in front of the 2nd place girl.

Top 8 boys and girls in the 8-and-under age group for the 2023 USA Track & Field Junior Olympics Championships (time in seconds)

	100m			**200 m**			**400m**		
Place	**Boys**	**Girls**	Difference	**Boys**	**Girls**	Difference	**Boys**	**Girls**	Difference
1	14.18	14.70	between 1st	28.65	29.91	between 1st	65.79	71.34	between 1st
2	14.38	14.72	place boy	29.20	30.77	place boy	67.77	72.92	place boy
3	14.43	15.00	and girl	29.22	31	and girl	68.94	73.56	and girl
4	14.51	15.03	3.5%	29.25	31.02	4.2%	69.57	73.75	7.8%
5	14.67	15.21	difference	29.71	31.15	difference	69.86	74.53	difference
6	14.72	15.23	between	29.75	31.34	between	70.01	74.59	between
7			boys and			boys and			boys and
	14.80	15.26	girls (mean)	29.78	31.42	girls (mean)	70.47	74.70	girls (mean)
8	14.81	15.48	3.4%	30.63	32.05	5.0%	DNS	78.33	6.4%

	800m			**1500 m**		
Place	**Boys**	**Girls**	Difference	**Boys**	**Girls**	Difference
1	153.80	164.90	between 1st	301.95	342.62	between 1st
2	155.13	167.16	place boy	313.46	342.64	place boy

3	156.84	167.78	and girl	318.94	345.01	and girl
4	159.54	168.34	6.7%	321.12	356.21	11.9%
5	160.50	168.87	difference	321.94	360.01	difference
6	167.09	169.51	between	328.00	361.37	between
7			boys and			boys and
	167.24	171.34	girls (mean)	332.89	362.93	girls (mean)
8	167.28	184.23	5.5%	334.4	366.58	9.3%

169. Similar to USA Track and Field, the AAU also sanctions a National Championship style track meet titled the AAU Junior Olympic Games. For the running distances of 100-m, 200-m, 400-m, 800-m, and 1500-m at the national championship, the 8-and-under fastest boy was faster than the fastest girl in every event and the average time for the 8 fastest boys was 4.8% faster than the average time for the 8 fastest girls across all 5 events combined. (Athletic.net)

170. Using Athletic.net, for 2023 Cross Country and Track & Field data for boys and girls in the 7–8, 9–10, and 11–12 year old age group club reports for the whole United States, I have compiled the tables for the top 10 performances in the 100-m, 200-m, 400-m, 800-m, 1500-m, 3000-m, long jump, and shot put data to illustrate the differences in individual athletic performance between boys and girls, all of which appear in the Appendix. The pattern of males outperforming females was consistent across events, with rare anomalies, only varying in the magnitude of difference between males and females.

171. As serious runners will recognize, differences of 3%, 5%, or 8% are not easily overcome. During track competition, the difference between first and second place, or second and third place, or third and fourth place (and so on) is often 0.5–0.7%, with some contests being determined by as little as 0.01%.

172. In an analysis of running events (consisting of the 100-m, 200-m, 400-m, 800-m, 1500-m, 5000-m, and 10,000-m) in the Division I, Division II, and Division III NCAA

Outdoor championships for the years of 2010–2019, the mean difference between 1st and 2nd place was 0.48% for men and 0.86% for women. The mean difference between 2nd and 3rd place was 0.46% for men and 0.57% for women. The mean difference between 3rd place and 4th place was 0.31% for men and 0.44% for women. The mean difference between 1st place and 8th place (the last place to earn the title of first-team All American) was 2.65% for men and 3.77% for women. (Brown et al., 2022.)

173. USA Swimming maintains a list of youth best all-time performance record times, with 10-and-under being the youngest age group. As of April 8, 2024 the all-time fastest record times for boys are faster than for girls in 11 out of 12 short course events, with the average male advantage being 1.64% (shown below) (USA Swimming National Age Group Records SCY 10 & Under) Short course swimming events are typically competed in a 25-yard pool.

USA Swimming records of All-Time best short course performances for boys and girls in the 10-and-under age group.

Event	Boys	Girls	Percent Difference
50 freestyle	24.42	24.90	1.97%
100 freestyle	53.12	54.89	3.33%
200 freestyle	116.41	118.20	1.54%
500 freestyle	306.32	313.45	2.33%
50 backstroke	26.91	27.27	1.34%
100 backstroke	58.62	57.96	-1.13%
50 breaststroke	31.09	31.73	2.06%
100 breaststroke	66.95	67.30	0.52%
50 butterfly	26.58	26.64	0.23%
100 butterfly	58.36	59.67	2.24%
100 IM	60.89	61.50	1.00%
200 IM	130.12	131.99	1.44%

Distances are in yards. Times are in seconds. IM – Individual medley.

174. Similarly, as of April 8, 2024 the all-time fastest record times for boys are faster than for girls in 10 out of 11 long course events, with the average male advantage being 5.50% (shown below) (USA Swimming National Age Group Records LCM 10 & Under). In these data the 50 freestyle and 100 breaststroke display surprisingly large male-female differences; if those 2 events are removed from the calculations the male advantage is 1.97%. Long course events are typically competed in a 50 meter, or "Olympic length" pool.

USA Swimming records of All-Time best long course performances for boys and girls in the 10-and-under age group.

Event	Boys	Girls	Percent Difference
50 freestyle	27.42	28.15	2.66%
100 freestyle	60.67	61.29	1.02%
200 freestyle	131.32	134.39	2.34%
400 freestyle	276.22	277.41	0.43%
50 backstroke	30.82	32.18	4.41%
100 backstroke	67.40	69.36	2.91%
50 breaststroke	35.65	36.06	1.15%
100 breaststroke	62.83	72.22	14.95%
50 butterfly	29.91	29.48	-1.44%
100 butterfly	65.98	67.70	2.61%
200 IM	147.38	148.70	0.90%

Distances are in meters. Times are in seconds. IM – Individual medley.

175. USA Swimming also produces a chart of "Motivational Times" that set marks for swimmers in both sexes and every age group, which then classify the swimmers into progressively faster categories of B, BB, A, AA, AAA, and AAAA. The motivational times can be used by athletes to help them progress into higher levels of competition. These classifications can also be used by meet directors to limit participation to specific categories. For the 10-and-under age group in all categories across 21 events the boys'

motivational times are faster than girls' by an average 1.8%, with the exceptions of the 50-meter backstroke where the girls' times are 0.4% faster for the long course and 1.0% faster for the short course. (SwimSwam.com).

176. The Amateur Athletic Union (AAU) also maintains a record of the best all-time performance record swimming times for boys and girls in 8-and-under and 10-and-under age groups. At the time of this writing, these records demonstrate that the 8-and-under boys' fastest times are faster than girls in the 50 yard butterfly by 2.90%, 50 yard freestyle 2.14%, and 50 yard backstroke by 2.35% with the girls' time being 3.55% faster for the 50 breaststroke. The record times for 10-and-under boys are faster than girls for the 50 yard freestyle by 4.23%, 100 yard freestyle by 5.42%, 200 yard freestyle by 1.19%, 50 yard backstroke by 4.74%, 100 yard backstroke by 1.24%, 100 yard breaststroke by 5.50%, 50 yard butterfly by 8.90%, 100yard butterfly by 10.76%, and 200 yard Individual Medley by 1.15%, with the girls' time being 3.06% faster for the 50 yard breaststroke (Amateur Athletic Union. Swimming n.d.).

177. Swimming is a learned skill that requires access to facilities and coaching (Olaisen, 2018) much more than do running, jumping, and throwing. Therefore, the smaller prepubertal male sex-based advantages in swimming performance (when compared to running, jumping, and throwing) can likely be explained by the importance of "age, socio-economic status, school type, N[egative]P[rior]A[quatic]E[xperience], disability and medical condition, and frequency of participation in aquatic activity" in addition to sex contributing to swimming ability (Duke et al, 2023 at 17). Interestingly more girls participate in competitive swimming as children than do boys, girls are more likely to focus solely on swimming, and girls are more likely to enjoy training for competitive swimming (Steinbach 2007). It is important to reiterate that, while many of the factors that determine swimming ability in youth are social-cultural and swimming seems to present a social-cultural bias in favor of young girls, the data indicate that boys outperform girls in the vast majority of swimming events. It is therefore reasonable to conclude that there are inherent male sex-based advantages in athletic performance even in a sport that seems to have a

social-cultural bias towards females.

178. It is also important to note that sports do not consider social-cultural factors when determining category eligibility or competition outcomes. For example, at a youth wrestling tournament the athletes may be categorized based on sex, age, and body weight, but not socioeconomic status or geographic location. In a youth soccer tournament, the athletes may be categorized based on sex, age, or possibly the team skill rating, but not socioeconomic status or location. Even in scholastic sports the teams are typically categorized based on enrollment numbers within the school, but not the socioeconomic standing or cultural practices of the students.

179. The data presented in the preceding paragraphs and tables from best all-time performances and track meets in 2023, from three different states and two national championship meets with participants from many states, show that the fastest 8-and-under boys were faster than the fastest girls in all of the running events. The boys jumped longer than the girls in all but one meet and threw farther than the girls in all of the events. Collectively, these data all demonstrate prepubertal male sex-based sports performance advantages.

180. I note that while the preceding paragraphs, data tables of all-time best performance, and data from individual competitions do not present a statistical evaluation of prepubertal sex-based differences in athletic performance, they demonstrate that boys in the 8-and-under and 10-and-under age groups (who can very reasonably be considered as prepubertal) run faster, jump further, and throw further than girls of the same age competing in the same events at the same track meets. These "real-world" data do not require the use of inferential statistics or complicated math (Tong, 2018; Wasserstein et al. 2019) to understand the very clear pattern of males outperforming females even in the 8-and-under age group. Indeed, correctly evaluating which time is faster or distance is further and calculating the percent difference between the times is a sixth-grade math learning outcome (Nebraska Mathematics Standards, Common Core Standards).

181. The simple clarity of a winner running faster, swimming faster, throwing further,

or jumping further is one of the profound beauties of sports. Arguments about who is the better athlete can be clearly addressed based on a simple evaluation of who had the fastest time or furthest distance.

182. The following paragraphs present summaries from a growing body of scientific literature demonstrating that even before puberty, boys do indeed exhibit male sex-based advantages in athletic performance when compared to similarly aged, trained, and talented girls. It is important to note once again that the typical age for the onset of puberty is 10 years old for females and 11.5 years old for males (Hunter et al. 2023).

183. In an evaluation of "the all-time top 100 U.S. freestyle swimming performance times of boys and girls age 5 to 18 years for the 50m to 1500m events" (at 1), Senefeld et al. (2019) observed that before age 10 the top 5 girls were 3.0% faster than the top 5 boys, and there were no differences in swimming times between the 10th-50th ranked boys and girls. However, at age 10, the top 5 boys were 2.5% faster than the top 5 girls, and the 10th – 50th ranked boys were 1.0% faster than the girls. These data indicate that male advantages already exist by age 10 (which is most likely before the onset of male puberty) and then increase following the onset of puberty.

184. Some colleagues and I presented an evaluation of the sex-based differences in athletic performance before puberty at the 2023 Annual Meeting of the American College of Sports Medicine (Brown 2023). Drawing upon a national database of track and field performance (Athletic.net) and evaluating the top 10 performances for boys and girls in the 8-and-under and 9–10-year-old age groups over a 5-year period, we observed that the boys consistently (and statistically) ran almost 5% faster, long jumped 6% farther, threw the shot put 20% farther, and threw the javelin 40% farther than girls of the same age. These sex-based differences resulted in effect sizes of 0.632–0.834, which are considered moderate to large effect sizes, indicating these differences are not just statistically significant but are also of meaningful practical importance. Also at the 2023 Annual Meeting of the American College of Sports Medicine there was another group of researchers who used the same database with slightly different evaluation techniques and came to similar conclusions

about the existence of 4–5% male sex-based athletic advantages before puberty (Atkinson et al. 2023).

185. My colleagues and I have recently published a paper (Brown et al., 2024) evaluating sex-based differences in finalist times from the USA Track and Field National Youth Outdoor Championships and National Junior Olympic Championships during the years 2016-2023 for running distances of 100m, 200m, 400m, 800m, and 1500m in the 8-and-under and 9-10-year-old age groups (who can reasonably be assumed to be prepubertal). In an evaluation of 2,182 race times this paper demonstrates that "[i]n the 8-and-under age group for running distances of 100m, 200m, 400m, 800m, and 1500m, the male finalists (i.e. the 8 fastest based on qualifying heats) were 5.4 ± 1.1% faster than the female finalists. In the 9-10-year-old age group for running distances of 100m, 200m, 400m, 800m, and 1500m, the male finalists (i.e. the 8 fastest based on qualifying heats) were 4.3 ± 1.1% faster than the female finalists. Over the seven years evaluated, the fastest males were 3.7 ± 2.3% faster than the fastest females, with the fastest male performance being faster than the fastest female in every event." (at 1)

186. My colleagues and I have recently published another paper in the European Journal of Sport Science in which we evaluated the 8 fastest times for boys and girls in the 10-and-under-age group in the National Club Swimming Association Age Group Championships in all events for the years 2016-2023 (Brown et al, 2025b). These data indicate that males were statistically significantly (P<0.05) faster than females in the 50 yards (yd), 100 yd, and 200 yd freestyle, 100 yd backstroke, 50 yd breaststroke, 100 yd butterfly, and 100 yd and 200 yd individual medley by 1.16-2.63%. There were no significant sex-based differences in the 500 yd freestyle, 50 yd backstroke, 100 yd breaststroke, or 50 yd butterfly (although male times in the 50 yd backstroke were nearly significantly faster at P=0.055). These data indicate that prepubertal boys swim faster than girls of the same age in 9 out of 12 short-course swimming events, with no sex-based differences in the remaining 3 events. The lack of sex-based differences in 500 yd freestyle, 100 yd breaststroke, and 50 yd butterfly appear to be due to a few outlying data points of particularly fast females or slow

males which, if removed, result in faster male times in all events.

187. My colleagues and I also have recently published another paper in the European Journal of Sport Science in which sex-based differences for the 8 farthest distances from the USA Track and Field National Youth Outdoor Championships and National Junior Olympic Championships during the years 2016-2023 for long jump, shot put, and javelin throw for the 8-and-under and 9-10-year-old age groups were evaluated (Brown et al, 2025a). These data indicate that, statistically significantly when comparing the males and females and when comparing the individual best performance for each sex, the boys threw the javelin 23.5-32.6% farther, shot put 4.7-21.8% farther, and long jump 3.3-4.7% farther than the girls.

188. Atkinson et al. (2024) evaluated track and field records of the top 50 performances for elite USA youth ages 7-18 years for 2019, 2021, and 2022 and observed that prepubertal males in the 100m, 200m, 400m, and 800m track running, long jump, and high jump were 5% faster or further than females of the same age. This led these authors to observe that "… there were sex differences in performance across all track and field events and age groups … except there was no significant difference between male and female youth for high jump at 7 years which was likely explained by small sample size (n=7)"

189. James et al. (2025) analyzed datasets for the top 10 and top 100 performances in running and swimming "for four running (100 m-800 m) and six freestyle swimming events (50 m-1500 m)" for youth ages 5-18 years old. The results indicate that "Males represented a greater proportion of the top 10 performances starting at 7 years in running ($P = 0.023$) and 12 years in swimming ($P = 0.023$) (averaged across events). Males represented a greater proportion of the top 100 performances starting at 6 years in running ($P < 0.001$) and 7 years in swimming ($P < 0.001$) (averaged across events). Females were no longer represented within the top 10 performances starting at ~12 years in running and ~ 13 years in swimming and no longer represented within the top 100 starting at ~14 years in running and ~ 15 years in swimming." These authors concluded that "Our findings suggest males are more likely to be represented "on the podium" in open sporting events (not categorized

by sex) than females starting at age 6." (at 1)

190. At the 2025 Annual Meeting of the American College of Sports Medicine, I made two presentations of new research further demonstrating sex-based differences in athletic performance before the onset of puberty. One presentation was an evaluation of all race times in fifteen regions in the USA Track & Field Regional Junior Olympic Championships from 2022, 2023, and 2024 demonstrating that males in the 8-and-under and 9-10-year-old age groups typically run faster than females of the same age by 4.1%-6.8% for running distances of 100m, 200m, 400m, 800m, and 1500m when the data were evaluated for all runners, preliminary heats, and for finalists. In this evaluation there were no running events in which the fastest female was faster than the fastest male (Brown et al, 2025c). The second presentation was an evaluation of the finalist times for males and females for the USA Swimming Eastern Zone Long Course Age Group Championship and Short Course Age Group Championship for the years 2013-2023 for the 10-and-under age group. In this evaluation the data indicate that for the long course (meters) events the males were 1.10% faster ($P<0.05$; Cohen's d 0.336-0.473) than females in the 50m freestyle, 100m freestyle, 200m freestyle, 400m freestyle, 50m backstroke, 100m backstroke, and 100m butterfly. Furthermore, for the short course (yards) events the males were ~1.36% faster ($P<0.05$; Cohen's d 0.308-0.638) than females in the 50y freestyle, 100y freestyle, 200y freestyle, 500y freestyle, 50y butterfly, and 100y butterfly. The average times for males were numerically faster than those for females in all 23 events evaluated and were statistically significantly faster in 13 of the events (Brown et al. 2025d).

191. Christensen and Griffiths (2025) evaluated 1600 -meter running race times in 3,621 children aged 6-12 years and concluded that "Male children [at each age group] are faster than female children at running 1600 m at ages 6–12 yr [by 7.7%]. This sex difference was not a result of lower female participation and suggests that innate physiological sex differences may be responsible." (at 1)

192. Tønnessen et al. (2015) is another frequently cited paper to support the argument that sex-based differences in athletic performance emerge at the onset of male puberty.

While the performance differences between males and females are magnified by male puberty, the figures in Tønnessen (at 4) clearly show that at age 11 (the youngest age in the dataset analyzed) males run faster in 60m and 800m sprints, long jump farther, and high jump higher than females.

193. In an invited review for the Edward F. Adolph Distinguished Lectureship, Hunter (2024) described age and sex differences in human performance and fatigue, and states "Prior to adolescence sex differences in performance are primarily thought to be minimal, although recent studies indicate otherwise []" (at 15)

194. In an editorial for the Washington Post, Doriane Lambelet Coleman states "Even a trans girl who doesn't experience male puberty holds athletic advantages from experiencing male sexual development in childhood. The 3-to-5 percent prepubertal performance gap is well documented." (Coleman 2024) and cites the papers by Atkinson et al. (2024) and Brown et al. (2024).

195. Supporting the notion that male prepubertal sex-based athletic advantages may have an inherent biological basis can be found in the ACSM Consensus statement on *The Biological Basis of Sex Differences in Athletic Performance* which states that a key question is "whether there is an influence of the testosterone surges during infancy in males (minipuberty) on their development, growth, and athletic performance over the life span (including puberty and into adulthood) compared with females" (Hunter et al. 2023, at 12). In a subsequent publication, Hunter (2024) states "The role of mini puberty and exposure to high levels of testosterone in boys and their potential influence on sports performance during development is unknown but may confer some advantage for boys and remains an area of opportunity for study" (at 17).

196. Further supporting the notion that male prepubertal sex-based athletic advantages have an inherent biological basis Hunter and Senefeld (2024) and Senefeld and Hunter (2024) connect minipuberty and/or the Y chromosome to greater lean body mass in males with the inherent male sex-based athletic advantages.

197. And, as previously stated one of the main points raised by Joyner et al. (2025) is

that "The male-female performance gap is evident before puberty." And subsequently states that "For example, among the best prepubescent athletes in the US, the male-female performance gap is about 3 to 5% in track and field running events and about 5 to 10% in jumping events []. The magnitude of the male-female performance gap is smaller in swimming (about 1 to 5%) than in track and field". These authors then explain that "…differences in early childhood body composition indicate that at least some of the male-female performance gap among prepubertal children is due to intrinsic biological factors." (at 5) Joyner et al. further explain "There are several bioplausible explanations for the male-female performance gaps seen before puberty in these sports. First, transient increases in sex hormones during early life (so called "minipuberty") are associated with increased growth velocity [] and reduced adipose accumulation [] among male infants compared with female infants, and greater muscle mass [] and muscle strength [] among boys compared to girls."

198. Another very important concept in the paper by Joyner et al. (2025) about the facts that males run faster, jump farther and throw farther than similar aged, trained, and talented females is "Because running, jumping, and throwing are foundational elements for many sports, this evidence is undoubtedly generalizable to sports and athletic events that require these elements as a part of the overall success in performance." (at 4)

C. Boys exhibit anatomical and physiological advantages even before puberty.

199. As previously described in this report, after the onset of male puberty anatomical and physiological factors largely explain why males perform better than females in athletic competition. The male advantages in lean body mass, bone mineral density, heart size and function, and lung size and function (among other factors) all contribute to male athletic advantages after the onset of puberty. In the following paragraphs I describe research indicating that, when compared to same aged females, males have sex-based advantages in lean body mass, bone mineral density, heart size and function, and lung size and function *before* puberty. It is therefore quite reasonable to conclude that the male sex-based advantages in lean body mass, bone mineral density, heart size and function, and lung size

and function (among other factors) before puberty also largely explain why males perform better than females in athletic competition before puberty.

200. Writing in their seminal work on the physiology of elite young female athletes, McManus and Armstrong (2011) reviewed the differences between boys and girls regarding body composition, cardiovascular function, metabolic function, and other physiologic factors that can influence athletic performance.

- Regarding sex-based differences in body composition before puberty they stated, "At birth, boys tend to have a greater lean mass than girls. This difference remains small but detectable throughout childhood with about a 10% greater lean mass in boys than girls prior to puberty." (at 30)
- Regarding cardiorespiratory function, they wrote "In comparison to boys, girls are characterised with a smaller absolute peak VO_2. Predicted values range from 1.5 to 2.2 litres•min^{-1} in 10- to 16-year-old girls and are lower than boys by 11, 19, 23 and 27% at ages 10, 12, 14 and 16 years of age, respectively." For clarification, peak VO_2 is a way of presenting maximal oxygen consumption or VO_2max, which correlates to 30–40% of success in endurance sports. Specifically regarding lung function, they stated "In children, like adults, exercise pulmonary gas exchange depends on pulmonary ventilation (VE) and at maximal work rates high rates of ventilation are usual. Maximal values of 49–95 litres•min^{-1} have been recorded for girls between the ages of 9 and 16 years [] and there is a consistent sex difference with values somewhat higher in boys (58–105 litres•min^{-1}) for the same age span." They further found, "Maximum ventilation remains higher in boys, whether controlled for body size using a ratio standard or allometric adjustment with either stature and/or body mass []. Thus, the higher peak VO_2 in boys is indeed supported by a higher VE." (at 31) When describing differences in blood volume per unit of body mass "differences between girls and boys were apparent from about 6 years of age, with values lower in the girls." (at 32)
- Regarding heart function they stated "There are clear differences in cardiac function at rest and during exercise between girls and boys, with differences apparent even prior

to puberty. The electrical conduction system is influenced by sex steroid hormones, with girls normally having higher resting heart rates than boys - somewhere in the magnitude of 90 beats per minute at around 10-12 years of age []. This is thought to relate to intrinsic differences in the sinus node pacemaker [], a difference notable at birth with newborn boys displaying lower baseline heart rates than girls []. The higher resting heart rate in girls is often explained as an artefact of differences in cardiac dimensions, and indeed the ratio of heart mass to body mass has been found to be higher in boys than girls at birth, remaining so through adolescence []. Heart volume has also been found to be greater in boys with values of 342 and 403 ml for pre-pubertal girls and boys, respectively…" (at 32) "Data recently published from a thoracic impedance measure of peak C[ardiac]I[ndex] and MRI markers of cardiac size [] demonstrated that pre-pubertal boys had a 16.7% higher (a- v O_2) difference than girls." (at 34) Cardiac index is an assessment of the cardiac output value based on the patient's size. Cardiac output is the volume of blood the heart pumps per minute. (a-v O_2) difference is the arterio-venous oxygen difference, and measures how well the tissues extract oxygen from the blood stream. (a-v O_2) difference accounts for roughly 40–50% of maximal oxygen consumption. "Results showed phase II pVO_2 kinetics were approximately 20% slower in pre-pubertal girls compared to boys … This is suggestive of a lower tolerance of fatigue in the girls." (at 35) pVO_2 stand for Pulmonary Oxygen Uptake, and pVO_2 kinetics provides an insight into the integrated capacity of an organism to transport and utilize oxygen to support an increased rate of energy turnover in contracting muscle cells. "To summarise, there are differences between boys and girls in the aerobic responses to exercise which cannot be accounted for solely by size." (at 35) "Sexual dimorphism underlies much of the physiologic response to exercise," and, most importantly, these authors concluded that, "[y]oung girl athletes are not simply smaller, less muscular boys." (23)

201. Although McManus and Armstrong state that "[b]one characteristics differ little between boys and girls prior to puberty" (at 29), subsequent research indicates that "bone

sexual dimorphism is already present at 6 years of age, with boys having stronger bones than girls" (Medina-Gomez et al. 2016, at 1099). Similarly, Wang et al. (1999) reported that even at 6 years of age boys had higher bone mineral density than girls of the same age and weight.

202. Certainly, boys' physiological and performance advantages increase rapidly from the beginning of puberty until around age 17–19. But much data and multiple studies show that significant physiological differences, and significant male athletic performance advantages in certain areas, exist before puberty.

203. Starting at birth, girls have more body fat and less fat-free mass than boys. Davis et al. (2019) in an evaluation of 602 infants reported that at birth and age 5 months, infant boys have larger total body mass, body length, and fat-free mass while having lower percent body fat than infant girls. In an evaluation of 20 boys and 20 girls ages 3–8 years old, matched for age, height, and body weight Taylor et al. (Taylor 1997) reported that the "boys had significantly less fat, a lower % body fat and a higher bone-free lean tissue mass than the girls." The girls' average fat mass was 52% higher than the boys' "…while the bone-free lean tissue mass was 9% lower" (at 1083.) In an evaluation of 376 prepubertal [Tanner Stage 1] boys and girls, Taylor et al. (2010) observed that the boys had 21.6% more lean mass, and 13% less body fat (when expressed as percent of total body mass) than did the girls.

204. In an evaluation of bone mineral density in 1,432 boys and 1,483 girls who were an average of 6.2 years old, Medina-Gomez (2016) observed that the boys had 7.6% more lean body mass, 15.6% less fat mass, and ~5% higher bone mineral density than the girls (Table 1, at 1102), and concluded that (at 1099), "bone sexual dimorphism is already present at 6 years of age, with boys having stronger bones than girls, the relation of which is influenced by body composition." These findings of Medina-Gomez echo previous findings of Wang et al. (1999), who observed higher bone mineral density and skeletal muscle mass in boys compared to girls of the same weight as young as 6 years old. Furthermore, in a review of 22 peer reviewed publications on the topic, Staiano and

Katzmarzyk (2012) conclude that "… girls have more T[otal]B[ody]F[at] than boys throughout childhood and adolescence." (at 4.) Staiano and Katzmarzyk noted that, of the 22 studies reviewed, four of them found similar body fat between boys and girls. Staiano suggested that these four studies were influenced by a failure to control for "other influences like age, maturational status and obesity status." (at 5)

205. Providing further evidence that males have advantages in lean body mass, contributing to male advantages in athletic performance even before puberty, Hunter and Senefeld (2024), wrote "Available evidence suggests that newborn boys weigh more and have more fat-free mass than girls [], boys accumulate less fat mass than girls during childhood [], and boys may have faster growth velocities than girls during early infancy, associated with higher postnatal testosterone surges []. These sex differences in body composition may confer an athletic advantage among boys compared with girls before ages associated with puberty and adolescence []" (at 4136).

206. Joyner et al. (2025) also agree that inherent biological sex-based factors predispose prepubescent boys to better athletic performance than girls when they state "… differences in early childhood body composition indicate that at least some of the male-female performance gap among prepubertal children is due to intrinsic biological factors." (at 5)

207. Beunen and Thomis (2000), in an evaluation of genetic factors that influence muscle strength, indicate that strength in children is affected by sex when they state, "Gender effects from sib[ling] and family studies more frequently point to a higher male similarity (heritability) than female similarity within the studied relationships." (at 186). These authors also state that "Strength heritability indices are lower in girls, tended to decrease with age, and became more variable in adolescence." (at 186)

208. The preceding information on the sex-based differences in athletic performance before puberty, and the underlying biological causes, are well summarized by Joyner et al. (2025) who wrote "There are profound sex differences in human performance in athletic events determined by strength, speed, power, endurance, and body size such that males outperform females. These sex differences in athletic performance exist before puberty and

increase dramatically as puberty progresses."

D. Research indicates that puberty blockers do not erase all male advantages

209. For the most part, the data I review above relate to pre-pubertal children. Today, we also face the question of inclusion in female athletics of males who have undergone "puberty suppression." The UK Sport Councils Literature Review notes that, "In the UK, so-called 'puberty blockers' are generally not used until Tanner maturation stage 2-3 (i.e. after puberty has progressed into early sexual maturation)." (at 9.) While prescribing medication is outside my expertise, my understanding is that current practice with regard to administration of puberty blockers is similar in the United States. And I am not aware of any literature suggesting that puberty blockers be prescribed *before* Tanner stage 2 or 3. Tanner stages 2 and 3 generally encompass an age range from 10 to 14 years old, with significant differences between individuals. Like the authors of the UK Sports Council Literature Review, I am "not aware of research" directly addressing the implications for athletic capability of the use of puberty blockers. (UK Sport Councils Literature Review at 9.) As Handelsman documents, the male advantage begins to increase rapidly—along with testosterone levels—at about age 11, or "very closely aligned to the timing of the onset of male puberty." (Handelsman 2017.) It seems likely that males who have undergone puberty suppression will have physiological and performance advantages over females somewhere between those possessed by pre-pubertal boys, and those who have gone through full male puberty, with the degree of advantage in individual cases depending on that individual's development and the timing of the start of puberty blockade.

210. Klaver et al. (2018) demonstrated that the use of puberty blockers did not eliminate the differences in lean body mass between biological males (transwomen in the paper) and females (ciswomen in the paper). In this paper the authors observe that approximately 2 years of puberty blockers and approximately 6 years of cross-sex hormones increased body fat in transwomen, but did not eliminate the sex-based differences in lean body mass. At baseline, the comparison females had approximately 63% lean body mass (figure 2 at 256) while the transgirls (aged 14.5 ± 1.8 years) had 75% lean body mass (table 2 at 255). After

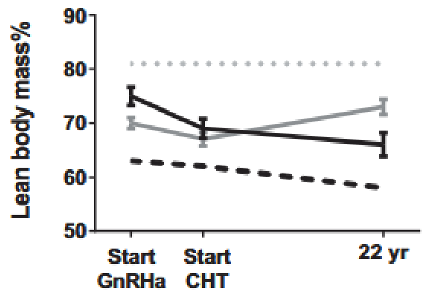


Figure 2 from Klaver et al. 2018, at 256. Female data are shown as a black dashed line and transgirls are shown as a solid black line. The grey dashed line represents males while the solid gray line represents trans boys

2 years the comparison females had approximately 61% lean body mass (figure 2 at 256) while after 2 years of puberty blockers the transwomen had 69% lean body mass (Table 2 at 255). Subsequent use of puberty blockers combined with cross-sex hormone use (in the same subjects) still did not eliminate the differences in lean body mass between biological male and female teenagers. By 22 years of age the comparison females had approximately 59% lean body mass (figure 2 at 256; shown above), while the transwomen, after the use of puberty blockers, and then puberty blockers combined with cross sex hormones, and then cross hormone therapy alone for over 8 total years of treatment had 66% lean body mass (Table 2 at 255). In terms of athletic performance, lean body mass is of considerable importance because it is the muscles (which are the major constituent of lean body mass) that move the bones to move the body, produce force, and otherwise perform athletically. So, while the transwomen experienced increases in body fat (which are detrimental to athletic performance) the retained male advantages in lean body mass are likely to also convey upon the transwomen male sex-based advantages in athletic performance.

211. Nokoff et al. (2021) observed that teenage natal males who identified as female, (average of 13.7 ± 1.7 years) and who were on puberty blockers for an average of 11.3 ± 7 months, had numerically higher percent lean body mass and lower percent body fat than the comparison group of natal females (figure 1 at 116). (These authors did not statistically compare the natal males who identified as female to the natal females).

212. Navabi et al. (2021) observed that teenage natal males who identify as female (average of 15.4 ± 2.0 years), had 9.5 kg more lean body mass than did teenage natal females (15.2 ± 1.8 years) who identified as male (at 4). After 355.2 ± 96.7 days of puberty blockers the natal males who identified as female still had 5.7 kg more lean body mass than did the natal females who identified as male (at 5). It is worth noting that the natal males lost 2.57 kg lean body mass and the natal females gained 1.21 kg lean body mass.

213. Nokoff et al. (2020) observed 14 teenage natal males who identified as female (average of 16.3 ± 1.4 years) and "were taking an average estradiol dose of 1.5 ± 1.0 mg/day with an average treatment duration of 12.3 ± 9.9 months (5 on oral, 9 on sublingual). Four were on a GnRHa (puberty blocker) at the time of the study visit and a total of 6 had been on a GnRHa in the past. Seven were on spironolactone for androgen blockade and 1 was on IM medroxyprogesterone acetate for puberty suppression." (at e707) The natal males had higher lean body mass and lower body fat than the comparison group of natal females (at e708).

214. The effects of puberty blockers on growth and development, including muscle mass, fat mass, or other factors that influence athletic performance, have been minimally researched. As stated by Roberts and Carswell (2021), "No published studies have fully characterized the impact of [puberty blockers on] final adult height or current height in an actively growing TGD youth." (1680). Likewise, "[n]o published literature provides guidance on how to best predict the final adult height for TGD youth receiving GnRHa and gender- affirming hormonal treatment." (1681). Thus, the effect of prescribing puberty blockers to a male child before the onset of puberty on the physical components of athletic performance is largely unknown. There is not any scientific evidence that such treatment eliminates the pre-existing performance advantages that prepubertal males have over prepubertal females.

215. Schulmeister et al. (2022) evaluated natal males with an average age of 11.9 (range 10.2 – 14.5) years at the start of puberty blockade and concluded that "youth treated with GnRHa for 12 months have growth rates similar to those of prepubertal youth" (at 5).

216. In Boogers et al. (2022), the researchers studied the effects of puberty suppression followed by cross-sex hormone therapy on the adult height of natal males who identify as female. Analyzing retrospective data collected from 1972 to 2018, they concluded that "although P[uberty] S[upression] and [cross-sex hormones] alter the growth pattern, they have little effect on adult height." (9) In other words, natal males who followed a normal course of puberty suppression followed by cross-sex hormone therapy reached an adult height at or near their predicted (male) height in the absence of such therapy.

217. Ciancia et al. (2023), in a retrospective study of "22 trans girls at F[final]H[eight]" (at 396) indicated that the use of puberty blockers and subsequent cross-sex hormone therapy starting at 13 years old did not impact adult body height. Indeed, these authors concluded that "F[inal]H[eight] is a sexually dimorphic trait, which cannot be altered by gender-affirming treatments." (at 399)

218. The findings from Schulmeister et al. (2022), Boogers et al. (2022), and Ciancia (2023) are relevant to the question of whether puberty suppression eliminates sex-based performance advantages because they show that an important component of that advantage—male vs. female height—is not eliminated, or even meaningfully affected, by an ordinary course of puberty suppression or puberty suppression followed by cross-sex hormone therapy. The advantages of male height include both simply being taller as well as the advantages that come with having longer limbs.

219. Further evidence that puberty blockers and estrogen do not eliminate male sex-based athletic advantages comes from Boogers et al. (2025), who found that shoulder width remains unchanged in transwomen even after several years of treatment. Only those transwomen who began puberty blockers at an early stage showed any reduction in shoulder width, and even then, their adult shoulder width was still 2 cm wider, on average, than that of the comparison females. This finding is particularly relevant to sex-based differences in athletic performance, as one of the primary distinctions between males and females is greater upper-body muscle mass in males, which is supported by a broader skeletal structure in the shoulders.

220. On May 16, 2024, Ciancia et al. (2024) published what is, to my knowledge, the first evaluation of the effects of puberty blockers on muscle strength (in this case handgrip strength). In this study, 26 transgirls (adolescent males who identify as girls) received gonadotropin-releasing hormone analogues starting at Tanner stage 2-3 (age 13.3 ± 1.27 y) and continuing for 2.7 ± 1.1 y (age 16.0 ± 0.28 y), handgrip strength increased from 20.79 ± 4.31 kg to 25.40 ± 3.49 kg (at 6). This study did not include a control group, and calculated z-scores compared to standards of the same natal sex. However, if the values for handgrip strength are compared to established standards (Wong et al. 2016) at age 13 the transgirls ranked between the 25th (19.0 kg) and 50th (21.5 kg) percentile for females, whereas at age 16 the transgirls ranked between the 50th (25.0 kg) and 75th percentile (27.7 kg) for females indicating that the transgirls experienced 31.7% greater increases in strength than would be expected for similarly aged females who were similarly ranked by percentile for handgrip strength.

221. At the present time, there is very limited research on how puberty blockers affect physical fitness and none on sports performance. As very recently stated by Moreland et al. (2023) "no studies exist comparing fitness and performance measures between trans individuals who commenced before and after the onset of puberty, and the related effects of puberty blockers." (at page 10). However, the existing data demonstrate that puberty blockers do not eliminate male advantages in lean body mass, muscle strength, or body height, all of which unquestionably contribute meaningfully to male athletic advantages.

222. The Cass Review (NHS 2024), is an extensive report prepared for the National Health Services in the United Kingdom that reviewed the available research based evidence, including six published systematic review articles, regarding the use of puberty blockers, cross sex hormones, and surgical processes in the clinical treatment of children and adolescents who are transgender. The Cass Review does not address sports or athletic performance. However, a key point from the Cass Review is that "While a considerable amount of research has been published in this field, systematic evidence reviews demonstrated the poor quality of the published studies, meaning there is not a reliable

evidence base upon which to make clinical decisions, or for children and their families to make informed choices." The Cass Review goes on to state that there are many unknowns regarding the safety and efficacy of using puberty blockers, cross sex hormones, and surgical processes in the clinical treatment of children and adolescents who are transgender.

223. Furthermore, a report titled "*the WPATH Files*"(Environmental Progress 2024), an amicus brief in the U.S. Supreme Court filed by the Alabama Attorney General (AL Attorney General Steve Marshall 2024), and an investigative report in the British Medical Journal (Block 2024) all raise concerns regarding the legitimacy of the guidelines set forth by the World Professional Association for Transgender Health (WPATH) which advocate for the use of puberty blockers, cross sex hormones, and surgical processes in the clinical treatment of children and adolescents who are transgender.

224. A January 13, 2025 paper by Gorin et al. (2025) briefly reviewed the current scientific knowledge regarding the surgical and hormonal treatment of juveniles who identify as transgender. Within this article the authors also review the discrepancies between the United States and many European countries regarding their approach to the surgical and hormonal treatment of juveniles who identify as transgender. A noteworthy quote from the article is that "Sweden's National Board of Health and Welfare concluded that 'the risks of puberty blockers and gender-affirming treatment are likely to outweigh the expected benefits of these treatments.'" (at E1). Along these same lines, a key conclusion from this paper is that "Given this state of knowledge, it is ethically problematic to view the routine use of hormonal or surgical interventions in youth with gender dysphoria as evidence-based." (at E2)

225. In January 2025, the authors of a systematic review of the research on the effects of puberty blockers in transgender young people stated that there is "considerable uncertainty" if these drugs cause "help or harm" for "gender dysphoria, global function, depression, and B[one]M[ineral]D[ensity]." (Miroshnychenko et al. 2025; at 2). These authors emphasized the dearth of even moderate quality research on the effects of puberty blockers in transgender young people.

226. In May 2025, the United State Dept of Health and Human Services (2025) released a 409-page report titled *Treatment for Pediatric Gender Dysphoria: Review of Evidence and Best Practices*. This report "…summarizes, synthesizes, and critically evaluates the existing literature on best practices for promoting the health and well-being of children and adolescents with distress related to their sex or to social expectations associated with their sex." (at 11) Overall, this report presents conclusions similar to those of the previous reviews, which are that there is very low evidence of benefit from the use of hormonal interventions for transgender youth. This reports also states that "Evidence for harms associated with pediatric medical transition in systematic reviews is also sparse, but this finding should be interpreted with caution…" because of "the relatively short period of time since the widespread adoption of the medical/surgical treatment model; the failure of existing studies to systematically track and report harms; and publication bias" (at 13) The risks of hormonal interventions for transgender youth "…include infertility/sterility, sexual dysfunction, impaired bone density accrual, adverse cognitive impacts, cardiovascular disease and metabolic disorders, psychiatric disorders, surgical complications, and regret." (at 14)

227. McDeavitt et al. (2025) reviewed the "… outcomes for risks and benefits of puberty blockers and gender-affirming hormones for pediatric gender dysphoria or gender-related distress" (at 11) and concluded that "There are real and significant risks associated with pubertal-stage provision of hormonal interventions in gender-distressed minors (e.g., infertility, sexual dysfunction), and the existing research data is woefully insufficient to inform on the question of whether P[uberty]B[lockers]s/G[ender]A[ffirming]H[ealthcare] mitigate distress and lead to favorable mental health outcomes (including with respect to gender dysphoria or suicidality/suicide risk)." (at 17)

228. Collectively, the Cass Review, the WPATH Files, the amicus brief from the Alabama Attorney General, the investigative report in the British Medical Journal, the paper by Gorin et al., the review by Miroshnychenko et al., the report from the US Dept of Health and Human Services, and the review by McDeavitt et al. all indicate that there is

not a foundation of even moderate quality research to support the use of puberty blockers to enhance the mental or physical health of young people with gender dysphoria, and that there are many concerns and unanswered questions regarding the safety of administering puberty blockers to children. I would add that even less is known about the effects of puberty blockers on physical fitness and athletic performance due to a near complete absence of research on the topic, and to claim that these drugs will erase male athletic advantages is not a statement that is evidence based.

229. While there is considerable debate and many unanswered questions regarding the safety and efficacy of puberty blockers in children, and how puberty blockers affect sports performance, it is also important to note that current data indicate that only 14% of transgender youth receive hormonal treatment (Green et al., 2022). Thus, advocating for all transgirls to compete in girls' sports is advocating for males with unchanged anatomy and physiology to be able to compete in the female sporting category in spite of well documented biologically based male athletic advantages before and after puberty. Advocating for transgirls to be allowed to compete in girls' sports only if puberty blockers are used is not advocating from a position based on evidence and could be considered as coercion for parents and children to make a hasty and uninformed decision to undergo potentially unsafe and ineffective medical procedures.

V. The role of testosterone in the development of male advantages in athletic performance.

230. The following tables of reference ranges for circulating testosterone in males and females are presented to help provide context for some of the subsequent information regarding athletic performance and physical fitness in children, youth, and adults, and regarding testosterone suppression in transwomen and athletic regulations. These data were obtained from the Mayo Clinic Laboratories (n.d.).

Reference ranges for serum testosterone concentrations in males and females.

Age	Males	Females
0 – 5 months	2.6 – 13.9 nmol/l	0.7 – 2.8 nmol/l

6 months – 9 years	0.2 – 0.7 nmol/l	0.2 – 0.7 nmol/l
10 – 11 years	0.2 – 4.5 nmol/l	0.2 – 1.5 nmol/l
12 -13 years	0.2 – 27.7 nmol/l	0.2 – 2.6 nmol/l
14 years	0.2 – 41.6 nmol/l	0.2 – 2.6 nmol/l
15 – 16 years	3.5 – 41.6 nmol/l	0.2 – 2.6 nmol/l
17 – 18 years	10.4 – 41.6 nmol/l	0.7 – 2.6 nmol/l
19 years and older	8.3 – 32.9 nmol/l	0.3 – 2.1 nmol/l

Please note that testosterone concentrations are sometimes expressed in units of ng/dl, and 1 nmol/l = 28.85 ng/dl.

231. The elevated testosterone concentrations in males from birth to 5 months has been termed minipuberty, which "allows for the maturation of sexual organs and forms a platform for future fertility, but the long-term significance is still not absolutely clear." Renault, 2020, at 1).

232. Tanner Stages can be used to help evaluate the onset and progression of puberty and may be more helpful in evaluating normal testosterone concentrations than age in adolescents. "Puberty onset (transition from Tanner stage I to Tanner stage II) occurs for boys at a median age of 11.5 years and for girls at a median age of 10.5 years. … Progression through Tanner stages is variable. Tanner stage V (young adult) should be reached by age 18." (Mayo Clinic Labs, n.d.)

Reference Ranges for serum testosterone concentrations by Tanner stage

Tanner Stage	**Males**	**Females**
I (prepubertal)	0.2 – 0.7 nmol/l	0.7 – 0.7 nmol/l
II	0.3 – 2.3 nmo/l	0.2 – 1.6 nmol/l
III	0.9 – 27.7 nmol/l	0.6 – 2.6 nmol/l
IV	2.9 – 41.6 nmol/l	0.7 – 2.6 nmol/l
V (young adult)	10.4 – 32.9 nmol/	0.4 – 2.1 nmol/l

233. Senefeld et al. (2020 at 99) state that "Data on testosterone levels in children and

adolescents segregated by sex are scarce and based on convenience samples or assays with limited sensitivity and accuracy." They therefore "analyzed the timing of the onset and magnitude of the divergence in testosterone in youths aged 6 to 20 years by sex using a highly accurate assay" (isotope dilution liquid chromatography tandem mass spectrometry). Senefeld observed a significant difference beginning at age 11, which is to say about fifth grade.

Serum testosterone concentrations (nmol/L) in youths aged 6 to 20 years measured using isotope dilution liquid chromatography tandem mass spectrometry (Senefeld et al., 2020, at 99)

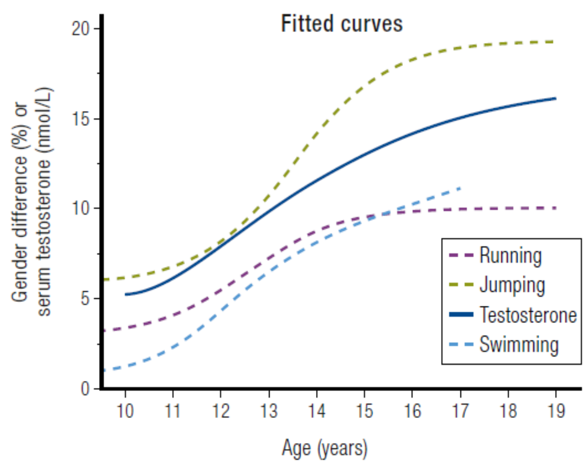
	Boys			Girls		
Age (y)	**5th**	**50th**	**95th**	**5th**	**50th**	**95th**
6	0.0	0.1	0.2	0.0	0.1	0.2
7	0.0	0.1	0.2	0.0	0.1	0.3
8	0.0	0.1	0.3	0.0	0.1	0.3
9	0.0	0.1	0.3	0.1	0.2	0.6
10	0.1	0.2	2.6	0.1	0.3	0.9
11	0.1	0.5	11.3	0.2	0.5	1.3
12	0.3	3.6	17.2	0.2	0.7	1.4
13	0.6	9.2	21.5	0.3	0.8	1.5
14	2.2	11.9	24.2	0.3	0.8	1.6
15	4.9	13.2	25.8	0.4	0.8	1.8
16	5.2	14.9	24.1	0.4	0.9	2.0
17	7.6	15.4	27.0	0.5	1.0	2.0
18	9.2	16.3	25.5	0.4	0.9	2.1
19	8.1	17.2	27.9	0.4	0.9	2.3
20	6.5	17.9	29.9	0.4	1.0	3.4

A. The rapid increase in testosterone across male puberty drives characteristic male physiological changes and the increasing performance advantages.

234. While boys exhibit some performance advantages even before puberty, it is both

true and well known to common experience that the male advantage increases rapidly, and becomes much larger, as boys undergo puberty and become men. Empirically, this can be seen by contrasting the modest advantages reviewed immediately above against the large performance advantages enjoyed by men that I have detailed in Section II.

235. Multiple studies (along with common observation) document that the male performance advantage begins to increase during the early years of puberty, and then increases rapidly across the middle years of puberty (about ages 12–16). (Tønnessen 2015; Handelsman 2018 at 812-813.) Since it is well known that testosterone levels increase by more than an order of magnitude in boys across puberty, it is unsurprising that Handelsman finds that these increases in male performance advantage correlate to increasing testosterone levels, as presented in his chart reproduced below. (Handelsman 2018 at 812-13.)



236. Knox et al. (2019) agree that "[i]t is well recognised that testosterone contributes to physiological factors including body composition, skeletal structure, and the cardiovascular and respiratory systems across the life span, with significant influence during the pubertal period. These physiological factors underpin strength, speed, and recovery with all three elements required to be competitive in almost all sports." (Knox 2019 at 397.) "High testosterone levels and prior male physiology provide an all-purpose

benefit, and a substantial advantage. As the IAAF says, ‘To the best of our knowledge, there is no other genetic or biological trait encountered in female athletics that confers such a huge performance advantage.’” (Knox 2019 at 399.)

237. However, the undisputed fact that high (that is, normal male) levels of testosterone drive the characteristically male physiological changes that occur across male puberty does not at all imply that artificially *depressing* testosterone levels after those changes occur will reverse all or most of those changes so as to eliminate the male athletic advantage. This is an empirical question. As it turns out, the answer is that while some normal male characteristics can be changed by means of testosterone suppression, others cannot be, and all the reliable evidence indicates that males retain large athletic advantages even after long-term testosterone suppression.

VI. The available evidence shows that suppression of testosterone in a male after puberty has occurred does <u>not</u> substantially eliminate the male athletic advantage.

238. The 2011 “NCAA Policy on Transgender Student-Athlete Participation” required only that males who identify as transgender be on unspecified and unquantified “testosterone suppression treatment” for “one calendar year” prior to competing in women’s events. In supposed justification of this policy, the NCAA’s Office of Inclusion asserts 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 dissipate after about one year of estrogen or testosterone-suppression therapy.” (NCAA 2011 at 8.)

239. Similarly, writing in 2018, Handelsman et al. speculated that even though some male advantages established during puberty are “fixed and irreversible (bone size),” “[t]he limited available prospective evidence . . . suggests that the advantageous increases in muscle and hemoglobin due to male circulating testosterone concentrations are induced or reversed during the first 12 months.” (Handelsman 2018 at 824.)

240. These claims made by the NCAA and Handelsman—that testosterone suppression would eliminate male athletic advantages—were not supported by evidence at the time they were made, but they also ignored or discounted existing data indicating otherwise.

Even then, research showed that testosterone suppression could not fully negate male physiological advantages. Today, the scientific consensus is even more definitive: testosterone suppression does not eliminate the biologically rooted athletic advantages males possess over females. In this section, I critically examine the overwhelming evidence demonstrating that male performance advantages persist despite testosterone suppression.

A. Empirical studies find that males retain a strong performance advantage even after lengthy testosterone suppression.

241. As my review in Section II indicates, a very large body of literature documents the large performance advantage enjoyed by males across a wide range of athletics. To date, only a limited number of studies have directly measured the effect of testosterone suppression and the administration of female hormones on factors that influence the athletic performance of males. These studies consistently demonstrate that transwomen are taller, weigh more, have more lean body mass, less body fat, are stronger and faster than comparable women before any hormonal intervention. These studies also report that testosterone suppression for a full year (and in some cases much longer) does not reduce body height and does not come close to eliminating male advantages in lean body mass, strength (hand grip, leg strength, and arm strength), or running speed.

242. There has not been any published research that I am aware of demonstrating that testosterone suppression, with or without estrogen administration, erases all inherent biologically based male athletic advantages. In the next few bullet points I succinctly summarize the evidence to date indicating that testosterone suppression, with or without estrogen administration, does not erase inherent biologically based male athletic advantages (many of these papers are described in more detail later in this report)

- Nineteen papers demonstrating that male advantages in lean body mass are not erased by 6 months-14 years of testosterone suppression in transwomen, with or without estrogen administration (Alvares et al. 2022, Auer et al. 2016, Auer et al. 2018, Elbers et al. 1999; Gava et al. 2016, Gooren 2004, Gooren 2008, Hamilton et al. 2024, Haraldsen et al. 2007, Klaver et al. 2018, Klaver et al. 2017, Lapauw et al. 2008, Mueller et al. 2011, Sanchez et al. 2024, Tack et al. 2018, Van Caenegem, et al. 2015, Van Caenegem et al. 2015, Wierckx et al. 2014, and Yun et al. 2021). I once again note that much of the sex-based difference in athletic performance is due to male advantages in lean body mass.

- Eight papers demonstrating that 6 months–14 years of testosterone suppression, with or without estrogen administration, in transwomen does not erase the male advantages in grip strength (Alvares et al. 2022, Auer et al. 2016, Hamilton et al. 2024, Lapauw et al. 2008, Scharff M et al. 2019, Tack et al. 2018, Van Caenegem et al. 2015, and Yun et al. 2021). Grip strength is an often used measurement of upper body muscle strength.
- One paper demonstrating that isometric and isokinetic thigh muscle strength was not reduced due to 1 year of testosterone suppression in transwomen, and the strength in transwomen was ~50% higher than in comparable females (Wiik et al. 2020). A follow up paper (Lundberg et al. 2024) evaluating these same transwomen after 5 years of testosterone suppression reports still no change in muscle strength and only 7% reduction in muscle size.
- Two papers on transgender U.S. Air Force personnel (Roberts et al. 2020, Chiccarelli et al. 2023), with one paper concluding that transwomen were still faster after 2 years of testosterone suppression, with or without estrogen administration and the other paper concluding that TW still performed more sit ups after 3 years and more pushups after 4 years testosterone suppression, with or without estrogen administration
- Three cross sectional papers demonstrating that testosterone suppression, with or without estrogen administration for up to 14 years, does not erase male advantages in VO_2max (Alvares et al. 2022, Cortes-Puentes et al. 2024, Hamilton et al. 2024)
- One case study paper showing that 1 year of testosterone suppression in a NCAA D1 transwoman swimmer did not reduce performance as much as would be necessary to eliminate male advantage (Senefeld et al. 2023)

Hand Grip Strength

243. As I have noted, hand grip strength is a well-accepted proxy for general strength.

Multiple separate studies, from separate groups, report that males retain a large advantage in hand strength even after testosterone suppression to female levels.

244. In a longitudinal study, Van Caenegem et al. reported that males who underwent standard testosterone suppression protocols lost only 7% hand strength after 12 months of treatment, and only a cumulative 9% after two years. (Van Caenegem 2015 at 42.) As I note above, on average men exhibit in the neighborhood of 60% greater hand grip strength than women, so these small decreases do not remotely eliminate that advantage. Van Caenegem et al. document that their sample of males who elected testosterone suppression began with less strength than a control male population. Nevertheless, after one year of suppression, their study population still had hand grip only 21% less than the control male population, and thus still far higher than a female population. (Van Caenegem 2015 at 42.)

245. Scharff et al. (2019) measured grip strength in a large cohort of male-to-female subjects from before the start of hormone therapy through one year of hormone therapy. The hormone therapy included suppression of testosterone to less than 2 nml/L "in the majority of the transwomen," (1024), as well as administration of estradiol (1021). These researchers observed a small decrease in grip strength in these subjects over that time (Fig. 2), but mean grip strength of this group remained far higher than mean grip strength of females—specifically, "After 12 months, the median grip strength of transwomen [male-to-female subjects] still falls in the 95th percentile for age-matched females." (1026).

246. Still a third longitudinal study, Tack et al. (2018) observed that in 21 transgender-identifying biological males, administration of antiandrogens for 5-31 months (commencing at 16.3 ± 1.21 years of age), resulted in nearly, but not completely, halting of normal age-related increases in muscle strength. Importantly, muscle strength did not decrease after administration of antiandrogens. Rather, despite antiandrogens, these individuals retained higher muscle mass, lower percent body fat, higher body mass, higher body height, and higher grip strength than comparable girls of the same age. (Supplemental tables).

247. A fourth study (Auer et al. 2016) reported no change in handgrip strength in 13

transwomen below the age of 45 years following 12 months of cross sex hormone therapy (Table 1, at 3).

248. A fifth study (Yun et al. 2021) observed that handgrip strength in the right hand decreased from 31.5 ± 5.8 kg to 29.9 ± 7.4 kg and in the left hand decreased from 31.8 ± 6.5 kg to 30.1 ± 6.9 kg during 6 months of cross sex hormone therapy in 11 males aged 28.5 ± 8.1 years who identify as women or nonbinary (Table 4, at 63). It is worth noting that the reduced grip strength in these male bodied individuals would rate in 75th percentile for females (ACSM 2025, at 98).

249. Lapauw et al. (2008) looked at the extreme case of testosterone suppression by studying a population of 23 biologically male individuals who had undergone at least two years of testosterone suppression, followed by sex reassignment surgery that included "orchidectomy" (that is, surgical castration), and then at least an additional three years before the study date. Comparing this group against a control of age- and height-matched healthy males, the researchers found that the individuals who had gone through testosterone suppression and then surgical castration had an average hand grip (41 kg) that was 24% weaker than the control group of healthy males. But this remains at least 25% *higher* than the average hand-grip strength of biological females as measured by Bohannon et al. (2019).

250. Alvares et al (2022) is a cross-sectional study on cardiopulmonary capacity and muscle strength in biological males who identify as female and have undergone long-term cross-sex hormone therapy. All of the study subjects that were biological males who identify as female had testosterone suppressed through medication (cyproterone acetate) or gonadectomy. (Supplementary materials) And they had taken exogenous estrogen for an average of 14.4 years with a standard deviation of 3.5 years. Compared to a control group of cisgender women, the study subjects exhibited 18% higher handgrip strength, confirming the findings of previous studies but extending the information to a longer time period. It is worth noting that the grip strength in these male bodied individuals would rate between the 90th and 95th percentile for females (ACSM 2025, at 98).

251. Summarizing these and a few other studies measuring strength loss (in most cases based on hand grip) following testosterone suppression, Harper et al. (2021) conclude that "strength loss with 12 months of [testosterone suppression] … ranged from non-significant to 7%. … [T]he small decrease in strength in transwomen after 12-36 months of [testosterone suppression] suggests that transwomen likely retain a strength advantage over cisgender women." (Hilton 2021 at 870.)

252. Cuadrado Clemente et al. (2025) echoed the findings of Harper when they reviewed the available research and concluded that long term measurements of hand grip strength and other measures of upper body strength "… remained higher in T[ranswomen]…" when compared to females (at 8).

253. In an evaluation of handgrip strength in 23 transwomen who were purported to be athletes who averaged 34 years of age and had undergone GAHT for an average 6 years in comparison to a group of 21 very athletic females who averaged 30 years of age, Hamilton et al. (2024) reports that the transwomen had 18% higher handgrip strength (on average; Table 2 at 5) than the very athletic women. It is also very important to note that this was a cross sectional study, so there is no way to know how GAHT affected handgrip strength in the transwomen. Furthermore, no data regarding the frequency, intensity, duration, exercise, or sports activity of the research participants was provided that would allow for an understanding of whether this was a comparison of similarly trained individuals. I say the women were very athletic because they ranked in the 90th percentile for handgrip strength for 30-39-year-old women, the 80th percentile for percent body fat, and had values for VO_2max that were off the chart of reference data and were on par with elite female endurance athletes. I say the transwomen were purportedly athletic because their handgrip strength was below the 20th percentile for 30-39-year-old men, their percent body fat was below the 40th percentile, but their VO_2max was in the 60th percentile. I and others have written more detailed criticisms of this paper elsewhere, including two rapid responses published online by the British Journal of Sports Medicine. (Brown & O'Connor 2024a, Brown & O'Connor 2024b. Pollock et al. 2024).

Arm Strength

254. Lapauw et al. (2008) found that 3 years after surgical castration, preceded by at least two years of testosterone suppression, biologically male subjects had 33% less bicep strength than healthy male controls. (Lapauw (2008) at 1018.) Given that healthy men exhibit between 89% and 109% greater arm strength than healthy women, this leaves a very large residual arm strength advantage over biological women.

255. Roberts et al. (2020) have published an interesting longitudinal study, one arm of which considered biological males who began testosterone suppression and cross-sex hormones while serving in the United States Air Force. One measured performance criterion was pushups per minute, which, while not exclusively, primarily tests arm strength under repetition. *Before* treatment, the biological male study subjects who underwent testosterone suppression could do 45% more pushups per minute than the average for all Air Force women under the age of 30 (47.3 vs. 32.5). *After* between one and two years of testosterone suppression, this group could still do 33% more pushups per minute. (Table 4, at 4.) Further, the body weight of the study group did not decline at all after one to two years of testosterone suppression (in fact rose slightly) (Table 3, at 3), and was approximately 24 pounds (11.0 kg) higher than the average for Air Force women under the age of 30. (Roberts 2020 at 3.) This means that the individuals who had undergone at least one year of testosterone suppression were not only doing 1/3 more pushups per minute, but were lifting significantly more weight with each pushup.

256. After two years of testosterone suppression, the study sample in Roberts et al. was only able to do 6% more pushups per minute than the Air Force female average. But their weight remained unchanged from their pre-treatment starting point, and thus about 24 pounds higher than the Air Force female average. As Roberts et al. explain, "as a group, transwomen weigh more than CW [cis-women]. Thus, transwomen will have a higher power output than CW when performing an equivalent number of push-ups. Therefore, our study may underestimate the advantage in strength that transwomen have over CW." (Roberts 2020 at 4.)

257. Chiccarelli et al. (2023) also published a longitudinal study which considered biological males who began testosterone suppression and cross-sex hormones while serving in the United States Air Force and concluded “Transgender females’ performance … remained superior in push-ups at the study’s 4-year endpoint.” (at 1) The transwomen completed 16% more pushups and 8% more sit ups than natal women after 4 years of GAHT. It’s important to note that this project experienced considerable loss of subjects, from 456 scores from 223 subjects at baseline down to only 11 scores from 15 subjects after 4 years, with no analysis or explanation of how the remaining subjects compared to the subjects for whom fitness testing scores were not available, which impairs the ability to draw firm conclusions from the data.

258. It is interesting that Roberts et al. (2020) and Chiccarelli et al. (2023) were comparing the same performance measurements in the same population and came to differing conclusions, which may be due to different sample sizes, study durations, and data analysis techniques.

Leg Strength

259. Wiik et al. (2020), in a longitudinal study that tracked 11 males from the start of testosterone suppression through 12 months after treatment initiation, found that isometric strength levels measured at the knee “were maintained over the [study period].” (808) “At T12 [the conclusion of the one-year study], the absolute levels of strength and muscle volume were greater in [male-to-female subjects] than in … CW [women who had not undergone any hormonal therapy].” (Wiik 2020 at 808.) In fact, Wiik et al. reported that “muscle strength after 12 months of testosterone suppression was comparable to baseline strength. As a result, transgender women remained about 50% stronger than … a reference group of females.” (Hilton 2021 at 207, summarizing Wiik 2020.)

260. In a follow up longitudinal study (Lundberg et al. 2024) evaluated these same transwomen after 5 years of testosterone suppression and reported still no loss of muscle strength.

261. Lapauw et al. (2008) found that 3 years after surgical castration, preceded by at

least two years of testosterone suppression, subjects had peak knee torque only 25% lower than healthy male controls. (Lapauw 2008 at 1018.) Again, given that healthy males exhibit 54% greater maximum knee torque than healthy females, this leaves these individuals with a large average strength advantage over females even years after sex reassignment surgery.

262. In an evaluation of vertical jump in 23 transwomen who were purported to be athletes who averaged 34 years of age and had undergone GAHT for an average of 6 years in comparison to a group of 21 very athletic females who averaged 30 years of age, Hamilton et al. (2024) reports that the women had a 1.7-inch higher vertical jump (on average; Table 2 at 5). It is important to put this jumping data into perspective by pointing out the transwomen were almost 8 inches taller than the women, outweighed the women by 51 pounds and had 26 pounds more body fat (Table 1, at 3). In a sport such as basketball the taller, heavier, and fatter transwomen would easily outcompete the women for a rebound by virtue of their 7.9 inch advantage in body height more than compensating for the women's 1.7 inch advantage in jump height. The same would be true in volleyball, high jump, and other height affected sports. Further illustrating the retained leg strength of the transwomen, they had 15% higher power output during vertical jump (on average; Table 2 at 5) than the comparison group of athletic women. This was a cross sectional study, so we have no idea what the vertical jump, leg strength, or muscle power of the transwomen were before initiating GAHT. Furthermore, the authors provide no data regarding the frequency, intensity, duration, exercise, or sports activity of their research participants, so it is not possible to discern what type of athletes were compared. (As previously stated, I and others have written a more detailed criticism of this paper elsewhere (Brown and O'Connor 2024a, 2024b, Pollock et al. 2024)).

Running and Swimming speed

263. The most striking finding of the recent Roberts et al. study concerned running speed over a 1.5 mile distance—a distance that tests midrange endurance. Before suppression, the MtF study group ran 21% faster than the Air Force female average. After at least 2 years of testosterone suppression, these subjects still ran 12% faster than the Air Force

female average. (Roberts 2020 Table 4.)

264. Chiccarelli (2023) reported that prior to cross-sex hormones the transwomen ran 1.5 miles 18% faster than comparably aged female Air Force personnel, and were still 9% faster after 2 years and 5% after 3 years. After 4 years of testosterone suppression combined with estrogen administration the transwomen were only 0.2% faster than comparably aged female Air Force personnel (Table 1, at 3). It's important to note that this project experienced considerable loss of subjects, from 456 scores from 223 subjects at baseline down to only 11 scores from 15 subjects after 4 years, with no analysis or explanation of how the remaining subjects compared to the subjects for whom fitness testing scores were not available, which impairs the ability to draw firm conclusions from the data.

265. The specific experience of the well-known case of NCAA athlete Cece Telfer is consistent with the more statistically meaningful results of Roberts et al., further illustrating that male-to-female transgender treatment does not negate the inherent athletic performance advantages of a post-pubertal male. In 2016 and 2017 Cece Telfer competed as Craig Telfer on the Franklin Pierce University men's track team, being ranked 200th and 390th (respectively) against other NCAA Division II men. "Craig" Telfer did not qualify for the National Championships in any events. Telfer did not compete in the 2018 season while undergoing testosterone suppression (per NCAA policy). In 2019 Cece Telfer competed on the Franklin Pierce University *women's* team, qualified for the NCAA Division II Track and Field National Championships, and placed 1st in the women's 400 meter hurdles and placed third in the women's 100 meter hurdles (Morton 2019, Pastrick 2019).

266. The table below shows the best collegiate performance times from the combined 2016 and 2017 seasons for Cece Telfer when competing as a man in men's events, and the best collegiate performance times from the 2019 season when competing as a woman in women's events. Comparing the times for the running events (in which male and female athletes run the same distance) there is no statistical difference between Telfer's "before and after" times. Calculating the difference in time between the male and female times,

Telfer performed an average of 0.22% *faster* as a female. (Comparing the performance for the hurdle events (marked with H) is of questionable validity due to differences between men's and women's events in hurdle heights and spacing, and distance for the 110m vs. 100 m.) While this is simply one example, and does not represent a controlled experimental analysis, this information provides some evidence that male-to-female transgender treatment does not negate the inherent athletic performance advantages of a postpubertal male (TFRRS n.d.).

As Craig Telfer (male athlete)		**As Cece Telfer (female athlete)**	
Event	Time (seconds)	Event	Time (seconds)
55	7.01	55	7.02
60	7.67	60	7.63
100	12.17	100	12.24
200	24.03	200	24.30
400	55.77	400	54.41
55 H †	7.98	55 H†	7.91
60 H †	8.52	60 H†	8.33
110 H†	15.17	100 H†	13.41*
400 H‡	57.34	400 H‡	57.53**

* women's 3rd place, NCAA Division 2 National Championships

** women's 1st place, NCAA Division 2 National Championships

† men's hurdle height is 42 inches with differences in hurdle spacing between men and women

‡ men's hurdle height is 36 inches, women's height is 30 inches with the same spacing between hurdles

267. Harper (2015) has often been cited as "proving" that testosterone suppression eliminates male advantage. And indeed, hedged with many disclaimers, the author in that article does more or less make that claim with respect to "distance races," while emphasizing that "the author makes no claims as to the equality of performances, pre and post gender transition, in any other sport." (Harper 2015 at 8.) However, Harper (2015) is

in effect a collection of unverified anecdotes, not science. It is built around self-reported race times from just eight self-selected transgender runners, recruited “mostly” online. How and on what websites the subjects were recruited is not disclosed, nor is anything said about how those not recruited online were recruited. Thus, there is no information to tell us whether these eight runners could in any way be representative, and the recruitment pools and methodology, which could bear on ideological bias in their self-reports, is not disclosed.

268. Further, the self-reported race times relied on by Harper (2015) *span 29 years*. It is well known that self-reported data, particularly concerning emotionally or ideologically fraught topics, is unreliable, and likewise that memory of distant events is unreliable. Whether the subjects were responding from memory or from written records, and if so what records, is not disclosed, and does not appear to be known to the author. For six of the subjects, the author claims to have been able to verify “approximately half” of the self-reported times. Which scores these are is not disclosed. The other two subjects responded only anonymously, so nothing about their claims could be or was verified. In short, neither the author nor the reader knows whether the supposed “facts” on which the paper’s analysis is based are true.

269. Even if we could accept them at face value, the data are largely meaningless. Only two of the eight study subjects reported (undefined) “stable training patterns,” and even with consistent training, athletic performance generally declines with age. As a result, when the few data points span 29 years, it is not possible to attribute declines in performance to asserted testosterone suppression. Further, distance running is usually not on a track, and race times vary significantly depending on the course and the weather. Only one reporting subject who claimed a “stable training pattern” reported “before and after” times on the same course within three years’ time,” which the author acknowledges would “represent the best comparison points.”

270. Harper (2015) to some extent acknowledges its profound methodological flaws, but seeks to excuse them by the difficulty of breaking new ground. The author states that, “The

first problem is how to formulate a study to create a meaningful measurement of athletic performance, both before and after testosterone suppression. No methodology has been previously devised to make meaningful measurements." (2) This statement was not accurate at the time of publication, as there are innumerable publications with validated methodology for comparing physical fitness and/or athletic performance between people of different ages, sexes, and before and after medical treatment, any of which could easily have been used with minimal or no adaptation for the purposes of this study. Indeed, well before the publication of Harper (2015), several authors that I have cited in this review had performed and published disciplined and methodologically reliable studies of physical performance and physiological attributes "before and after" testosterone suppression.

271. More recently, and to her credit, Harper has acknowledged the finding of Roberts (2020) regarding the durable male advantage in running speed in the 1.5 mile distance, even after two years of testosterone suppression. Harper joins with co-authors in acknowledging that this study of individuals who (due to Air Force physical fitness requirements) "could at least be considered exercise trained," agrees that Roberts' data shows that "transwomen ran significantly faster during the 1.5 mile fitness test than ciswomen," and declares that this result is "consistent with the findings of the current review in untrained transgender individuals" that even 30 months of testosterone suppression does not eliminate all male advantages "associated with muscle endurance and performance." (Harper 2021 at 8.) The Harper (2021) authors conclude overall "that strength may be well preserved in transwomen during the first 3 years of hormone therapy," and that [w]hether transgender and cisgender women can engage in meaningful sport [in competition with each other], even after [testosterone suppression], is a highly debated question." (Harper 2021 at 1, 8.)

272. Higerd (2021) "[a]ssess[ed] the probability of a girls' champion being biologically male" by evaluating 920,111 American high school track and field performances available through the track and field database Athletic.net in five states (CA, FL, MN, NY, WA), over three years (2017–2019),in eight events; high jump, long jump, 100M, 200M, 400M,

800M, 1600M, and 3200M and estimated that "there is a simulated 81%-98% probability of transgender dominance occurring in the female track and field event" and further concluded that "in the majority of cases, the entire podium (top of the state) would be MTF [transgender athletes]" (at xii).

273. The well-publicized case of Lia Thomas is also worth noting. University of Pennsylvania swimmer Lia Thomas began competing in the women's division in the fall of 2021, after previously competing for U. Penn. in the men's division. Thomas promptly set school, pool, and/or league women's records in 200 yard freestyle, 500 yard freestyle, and 1650 yard freestyle competitions, beating the nearest female in the 1650 yard by an unheard of 38 seconds.

274. Senefeld et al. (2023) compared "the performance times of a transgender woman (male sex, female gender identity) who competed in both men's and women's NCAA freestyle swimming and contextualized [Thomas's] performances relative to the performances of both world class and contemporary NCAA swimmers" (at 1035) and observed that this athlete [presumably Lia Thomas based on performance times and the timing of this article] was unranked in 2018-2019 in the 100-yard, ranked 551st in the 200-yard, 65th in the 500-yard, and 32nd in the 1650-yards men's freestyle. After following the NCAA protocol for testosterone suppression and competing as a woman in 2021-2022, this swimmer was ranked 13th in the 100-yard, 3rd in the 200-yard, 1st in the 500-yard, and 13th in the 1650-yard women's freestyle. The performance times swimming as a female, when compared to swimming as a male, were 0.5% slower in the 100-yard, 2.6% slower in the 200-yard, 5.6% slower in the 500-yard, and 7.3% slower in the 1650-yard events than when swimming as a male (at 1034). The authors concluded "…these data suggest there may be a prolonged 'legacy effect' (greater than 2 yr) associated with endogenous male testosterone concentrations or male puberty on freestyle swimming performances after feminizing GAHT, particularly for shorter event distances (100, 200, and 500 yards), which are closely associated with anthropometrics and maximal skeletal muscle strength and power" (at 1036).

B. Testosterone suppression does not reverse important male physiological advantages.

275. We see that, once a male has gone through male puberty, later testosterone suppression (or even castration) leaves large strength and performance advantages over females in place. It is not surprising that this is so. What is now a fairly extensive body of literature has documented that many of the specific male physiological advantages that I reviewed in Sections II and III are not reversed by testosterone suppression after puberty, or are reduced only modestly, leaving a large advantage over female norms still in place.

276. Handelsman has well documented that the large increases in physiological and performance advantages characteristic of men develop in tandem with, and are likely driven by, the rapid and large increases in circulating testosterone levels that males experience across puberty, or generally between the ages of about 12 through 18. (Handelsman 2018.) Some have misinterpreted Handelsman as suggesting that all of those advantages are and remain entirely dependent—on an ongoing basis—on *current* circulating testosterone levels. This is a misreading of Handelsman, who makes no such claim. As the studies reviewed above demonstrate, it is also empirically false with respect to multiple measures of performance. Indeed, Handelsman himself, referring to the Roberts et al. (2020) study which I describe below, has recently written that "transwomen treated with estrogens after completing male puberty experienced only minimal declines in physical performance over 12 months, substantially surpassing average female performance for up to 8 years." (Handelsman 2020.)

277. As to individual physiological advantages, the more accurate and more complicated reality is reflected in a statement titled "The Role of Testosterone in Athletic Performance," published in 2019 by several dozen sports medicine experts and physicians from many top medical schools and hospitals in the U.S. and around the world. (Levine et al. 2019.) This expert group concurs with Handelsman regarding the importance of testosterone to the male advantage, but recognizes that those advantages depend not only on *current* circulating testosterone levels in the individual, but on the "exposure in biological males to much higher levels of testosterone <u>during growth, development</u>, and throughout the

athletic career." (*Emphasis added.*) In other words, both past and current circulating testosterone levels affect physiology and athletic capability.

278. Available research enables us to sort out, in some detail, which specific physiological advantages are immutable once they occur, which can be reversed only in part, and which appear to be highly responsive to later hormonal manipulation. The bottom line is that very few of the male physiological advantages I have reviewed previously are reversible by testosterone suppression once an individual has passed through male puberty.

Skeletal Configuration

279. It is obvious that some of the physiological changes that occur during "growth and development" across puberty cannot be reversed. Some of these irreversible physiological changes are quite evident in photographs that have recently appeared in the news of transgender competitors in female events. These include skeletal configuration advantages including:

- Longer and larger bones that give height, weight, and leverage advantages to men;
- More advantageous hip shape and configuration as compared to women.

Cardiovascular Advantages

280. Developmental changes for which there is no apparent means of reversal, and no literature suggesting reversibility, also include multiple contributors to the male cardiovascular advantage, including diaphragm placement, lung and trachea size, and heart size and therefore pumping capacity.[9]

281. To date, there are only three evaluations of VO_2max in biological males who identify as female and have undergone long-term cross-sex hormones. In addition to the aforementioned measurement of muscle strength, Alvares et al. (2022) evaluated 15 biological males who identify as female and had testosterone suppressed through medication (cyproterone acetate) or gonadectomy. (Supplementary materials) The subjects had taken exogenous estrogen for an average of 14.4 years with a standard deviation of 3.5

[9] "[H]ormone therapy will not alter … lung volume or heart size of the transwoman athlete, especially if [that athlete] transitions postpuberty, so natural advantages including joint articulation, stroke volume and maximal oxygen uptake will be maintained." (Knox 2019 at 398.)

years. Compared to a control group of cisgender women, even after 14 years of testosterone suppression and estrogen administration, the biological males who identify as female exhibited advantages in cardio-respiratory capacity measured as higher VO_2 peak and higher O_2 pulse, which suggests that male advantages are retained in events that are influenced by cardio-respiratory endurance (e.g. distance running, cycling, swimming, etc.).

282. The second evaluation of VO_2max in biological males who identify as female and have undergone long-term cross-sex hormones is Cortes-Puentes et al. (2024) who evaluated functional aerobic capacity in 8 transwomen who had been treated for various health issues that limited their cardiorespiratory health. The results indicate that when compared to male normative data the subjects had 69.7% of normal functional aerobic capacity but when compared to female normative data they had 87.8% of normal functional aerobic capacity, indicating a higher rating for aerobic fitness when classified by gender identity rather than by biological sex, which highlights the sex-based differences in capacity for endurance type exercise.

283. In an evaluation of VO_2max in 23 transwomen who were purported to be athletes who averaged 34 years of age and had undergone GAHT for an average of 6 years, Hamilton et al. (2024) reports that their VO_2max was 45.1 ± 7.6 ml of oxygen per kg of body mass per minute (Table 2, at 5), which ranks in the 60th percentile for 30–39-year-old men and is over the 90th percentile for women in the same age group. This was a cross sectional study, so we have no idea what the fitness levels of the transwomen were before initiating GAHT, and the authors do not provide enough information about the exercise habits of the transwomen to determine anything about their expected levels of aerobic fitness or any other measure of physical fitness. Importantly, these authors also observed that the hemoglobin concentrations in the transwomen were not lower men with unaltered testosterone concentrations (at 3). This is the same paper previously mentioned that I and others have written more detailed criticisms of this paper elsewhere (Brown and O'Connor 2024a, 2024b, Pollock et al 2024).

284. Overall, the evidence is mixed as to hemoglobin concentration, which as discussed above is a contributing factor to VO_2 max. Harper (2021) surveyed the literature and found that "Nine studies reported the levels of Hgb [hemoglobin] or HCT [red blood cell count] in transwomen before and after [testosterone suppression], from a minimum of three to a maximum of 36 months post hormone therapy. Eight of these studies … found that hormone therapy led to a significant (4.6%–14.0%) decrease in Hgb/HCT ($p<0.01$), while one study found no significant difference after 6 months," but only one of those eight studies returned results at the generally accepted 95% confidence level. (Harper 2021 at 5–6 and Table 5.)

285. I have not found any study of the effect of testosterone suppression on the male advantage in mitochondrial biogenesis.

Respiratory Advantages

286. Testosterone suppression and the use of cross-sex hormones does not eliminate or even meaningfully reduce inherent male advantages in lung volume or lung function. In an evaluation in 23 transwomen who were purported to be athletes who averaged 34 years of age and had undergone GAHT for an average of 6 years in comparison to 21 athletic women who averaged 30 years of age, Hamilton et al. (2024) reports that the transwomen had retained male typical values for forced vital capacity (FVC), which is a measure of lung size. The transwoman also had male typical values for forced expiratory volume in one second (FEV_1) and peak expiratory flow (PEF) which are both measures of respiratory function (Table 2, at 5). The values for FVC for the transwomen were 30% higher than in the comparison women, the FEV_1 was 20% higher, and the PEF was 23% higher. (This is the same paper previously mentioned that I and others have written more detailed criticisms of elsewhere (Brown and O'Connor 2024a, 2024b, Pollock et al 2024)). Collectively, these findings corroborate Knox's previously referenced statement that "H]ormone therapy will not alter … lung volume or heart size of the transwoman athlete, especially if [that athlete] transitions postpuberty."

Muscle mass

287. Finkelstein et al. (2013) examined testosterone suppression in healthy males over 16 weeks in combination with testosterone replacement at various doses to compare dose-response effects. They found that muscle mass and strength were generally reduced slightly more when testosterone was lowered to the level of females (i.e. T suppression reaching 1.5 nmol/L) compared with the group that ended up with an average of 6.6 nmol/L (table 1 at 1016; figure 3, at 1019). Even with testosterone suppression to the level of females the changes in total lean mass, thigh muscle area, and leg press strength were only in the range of -2.5% to -6% after the 16-week testosterone suppression. At serum testosterone concentrations equivalent to 11.7 nmol/L, there were essentially no effects on muscle mass and strength values.

288. Multiple studies have found that muscle mass decreases modestly or not at all in response to testosterone suppression. Knox et al. report that "healthy young men did not lose significant muscle mass (or power) when their circulating testosterone levels were reduced to 8.8 nmol/L (lower than the 2015 IOC guideline of 10 nmol/L) for 20 weeks." (Knox 2019 at 398.) Gooren found that "[i]n spite of muscle surface area reduction induced by androgen deprivation, after 1 year the mean muscle surface area in male-to-female transsexuals remained significantly greater than in untreated female-to-male transsexuals." (Gooren 2011 at 653.) An earlier study by Gooren found that after one year of testosterone suppression, muscle mass at the thigh was reduced by only about 10%, exhibited "no further reduction after 3 years of hormones," and "remained significantly greater" than in his sample of untreated women. (Gooren 2004 at 426-427.) Van Caenegem et al. found that muscle cross section in the calf and forearm decreased only trivially (4% and 1% respectively) after two years of testosterone suppression. (Van Caenegem 2015 Table 4.)

289. Taking measurements one month after the start of testosterone suppression in male-to-female (non-athlete) subjects, and again 3 and 11 months after start of feminizing hormone replacement therapy in these subjects, Wiik et al. found that total lean tissue (i.e. primarily muscle) did not decrease significantly across the entire period. Indeed, "some of the [subjects] did not lose any muscle mass at all." (Wiik 2020 at 812.) And even though

they observed a small decrease in thigh muscle mass, they found that isometric strength levels measured at the knee "were maintained over the [study period]." (808) "At T12 [the conclusion of the one-year study], the absolute levels of strength and muscle volume were greater in [male-to-female subjects] than in [female-to-male subjects] and CW [women who had not undergone any hormonal therapy]." (808). A follow up paper (Lundberg et al. 2024) evaluating these same transwomen after 5 years of testosterone suppression reported only 7% reduction in muscle size.

290. Alvares et al. (2022), in a cross-sectional study of 15 natal males aged 34.2 ± 5.2 years who had taken exogenous estrogen for an average of 14.4 ± 3.5 years compared to a control group of comparably aged females, showed that the transwomen exhibited a 40% advantage in skeletal muscle mass confirming the findings of previous studies regarding the minimal reduction in muscle mass due to transgender hormone therapy, but extending the information to a longer time period (Table 3 at 5).

291. In an evaluation of body composition in 23 transwomen who were purported to be athletes who averaged 34 years of age and had undergone GAHT for an average 6 years, Hamilton et al. (2024) reports that the transwoman had 10.8 kg more fat-free body mass (on average; Table 2 at 5) than a comparison group of athletic women. This was a cross sectional study which provides no data on the body composition of the transwomen before initiating GAHT.

292. Saitong et al. (2024) in a cross sectional study reported that 15 transwomen who had undergone testes removal and 15 transwomen who had undergone chemical testosterone suppression had taller body height and more lean body mass than comparably aged females.

293. Alvares et al. (2025) performed an evaluation of 7 transwomen volleyball players compared to 8 female volleyball players and concluded that "TW athletes displayed similar exercise performance and biomarkers compared with CW." However, as pointed out in a Rapid Response published on the British Journal of Sports Medicine website (Kirk et al, 2025), the transwomen trained only 4.1 hours per week while the female athletes trained

13.9 hours per week. Furthermore, the transwomen were, on average, 5 years older, 5 cm (2 inches) shorter, and 8 kg (17.6 pounds) lighter than the female comparison group. Thus, this paper was a comparison of "short, light males to tall, athletic females who are 5 years younger", which does not provide data that allow any kind of meaningful comparison between transwomen and females.

294. Other papers including Auer et al. (2016), Auer et al. (2018), Elbers et al. (1999), Gava et al. (2016), Hamilton et al. (2024_a, and 2024_b), Haraldsen et al. (2007), Klaver et al. (2018), Klaver et al. (2017), Lapauw et al. (2008), Mueller et al. (2018), Wiercks et al. (2014), and Yun et al. (2021) have evaluated the changes in body composition in males undergoing transgender hormone therapy with a common finding that there are large retained male advantages in lean body mass. Lean body mass is primarily muscle tissue.

295. Hilton & Lundberg summarize an extensive survey of the literature as follows:

> "12 longitudinal studies have examined the effects of testosterone suppression on lean body mass or muscle size in transgender women. The collective evidence from these studies suggests that 12 months, which is the most commonly examined intervention period, of testosterone suppression to female typical reference levels results in a modest (approximately 5%) loss of lean body mass or muscle size. . . .
>
> "Thus, given the large baseline differences in muscle mass between males and females (Table 1; approximately 40%), the reduction achieved by 12 months of testosterone suppression can reasonably be assessed as small relative to the initial superior mass. We, therefore, conclude that the muscle mass advantage males possess over females, and the performance implications thereof, are not removed by the currently studied durations (4 months, 1, 2 and 3 years) of testosterone suppression in transgender women." (Hilton 2021 at 205–07.)

To date, there has not been any new research countering the conclusions of Hilton and Lundberg. Indeed, research in the intervening years corroborates their conclusions.

296. When we recall that "women have 50% to 60% of men's upper arm muscle cross-sectional area and 65% to 70% of men's thigh muscle cross-sectional area" (Handelsman 2018 at 812), it is clear that Hilton's conclusion is correct. In other words, biologically male subjects possess substantially larger muscles than biologically female subjects after undergoing a year or even three years of testosterone suppression.

297. I note that outside the context of transgender athletes, the testosterone-driven increase in muscle mass and strength enjoyed by these male-to-female subjects would constitute a disqualifying doping violation under the league anti-doping rules with which I am familiar.

Mathematically Adjusting for Body Size is not Applicable to Sports

298. Some (e.g. Cheung et al. 2024, Hamilton et al. 2024) have suggested that by mathematically calculating a ratio of speed, strength or power to anthropometric variables (e.g. body height, body mass, lean body mass) the inherent male advantages retained by transwomen are erased thus demonstrating equivalence between transwomen and women. As pointed out by Kirk and Stebbings (2024) mathematically adjusting performance variables for anthropometric characteristics is a statistical deception that mathematically removes major sexually dimorphic characteristics of humans, that is the larger and more muscular overall body size of men when comparted to women.

299. Furthermore, the measurement of strength relative to anthropometric variables has been used in research for many years to compare males to females, and to compare individuals of different body sizes, with the overall conclusion that one of the major determinants of muscle strength is the size of the muscle. Hence a person with more muscle mass should have greater absolute muscle strength but not necessarily greater relative muscle strength. Indeed, as stated in the textbook *Physiology of Sport and Exercise* by Kenney et al. (2022) when the difference in lower body strength between males and females is expressed relative to fat free mass "the difference disappears" (page 564).

Similarly, in the textbook *Exercise Physiology: Nutrition, Energy, and Human Performance* by McArdle et al. (2023) it states that "In general, strength ratio scores based on body mass or fat free mass considerably reduce if not eliminate the large absolute strength differences usually observed between genders" (page 553). These authors then go on to state, "We emphasize that this traditional ratio adjustment may not equalize females with males based on their underlying physiology."

300. Overall, a mathematical calculation of strength relative to anthropometric variables has little to no relevance in sports competitions. It is a statistical deception that removes sex differences from the calculation. If this concept was applied in sports, we would measure the strength relative to body mass of a 265-pound heavyweight wrestler and allow him to compete against a similarly strength ratioed 104-pound lightweight wrestler and call it a fair competition.

C. Case-by-case evaluation of eligibility to compete in the female category is untenable

301. The *International Olympic Committee (IOC) framework on fairness, inclusion, and nondiscrimination on the basis of gender identity and sex variations* makes the very unscientific statement that there should be "No Presumption of Advantage" (Martowicz et al., 2022. at 3) regarding the sports performance of transwomen (i.e. males) when compared to similarly aged, trained, and talented females. The IOC framework suggests that transwomen athletes could somehow be evaluated on a case-by-case basis to determine if they could safely and fairly compete in the female category yet gives no suggestions on how such an evaluation would be performed.

302. As part of a team of 26 sport scientists from around the world we refuted the IOC framework based on the immense amount of research showing that males do indeed possess inherent biologically based athletic advantages when compared to similarly aged, trained, and talented females (Lundberg et al. 2024). Furthermore, we refuted the concept of a case-by-case determination of eligibility to compete in the female category by stating "case-by-case consideration is flawed in principle, has immense practical limitations, is potentially stigmatizing and unhealthy, would limit the inclusion of all transgender athletes, and would

not ensure fair or safe competition." (at 7).

303. Hamilton et al. (2024b) have similarly proposed a case-by-case evaluation to determine if transwomen can be safely and fairly included in the female category. I along with four colleagues have published a detailed critique of the Hamilton paper (Lundberg et al. 2024b) in which we stated, "The suggestion that the eligibility of transwomen in female sports could be determined on a case-by-case basis is a fundamental misconception and fraught with significant practical and ethical problems." (at 2) Among the problems with a case-by-case assessment are the following:

- If eligibility to compete in the female category requires performing below a certain measure of performance (e.g. race slower than a set time standard, jump or throw less distance than a set standard, etc.), this would open the possibility for many sub-elite male athletes to compete in the elite female category. This would also incentivize male athletes to intentionally refrain from performing at their full capability to thus be eligible to compete in the female category
- If eligibility to compete in the female category is based on a reduction in male performance, who determines the magnitude of reduction necessary for a male to then fairly compete in the female category? How is this reduction verified? How is it verified that the reduction is due solely to puberty blockers, testosterone suppression, and/or cross sex hormones and not due to other factors such as poor training, poor nutrition, transient illness, or intentionally underperforming?
- If eligibility to compete in the female category is based on laboratory-based testing, who decides which tests to perform and what criteria are used to determine that a male has satisfactorily intentionally impaired his performance enough to be eligible to compete in the female category? "Fairness in female competition is not about a 'plus/ minus' balance of various physiological or other factors, but about whether the inherent male advantage is completely removed." (Lundberg et al. 2024b, at 2) Some of the challenges with lab-based testing to determine if a transwoman has impaired VO_2max sufficiently to compete in the female category are explained in detail by Sarah Barker

and me (Barker 2025).

- If eligibility to compete in the female category is set at meeting some metric of feminine appearance or body dimensions, this would exclude many female athletes and transwomen athletes who do not meet an arbitrarily selected set of standards.
- Mandating hormonal interventions that can increase the risks for untoward health so that a male athlete can be eligible for the female category is fraught with ethical concerns regarding informed consent, coercion and body autonomy.
- Furthermore, as noted by Miro et al. (2024), one in four trans women do not keep their serum testosterone levels below 2.5 nmol/L, which is the upper limit for eligibility in the female category set by some sporting organizations. Thus, frequent random testing of testosterone concentrations would be required to ensure that transwomen athletes are complying with eligibility requirements if serum testosterone concentrations are part of the eligibility criteria.

304. In summary, although a case-by-case approach to determining the eligibility of transwomen or transgirls to compete in the female category has been given the facade of plausibility by the IOC and some scholars, it is not a practical, ethical, or fair solution for either transwomen or female athletes. A case-by-case approach would certainly exclude some transwomen, could exclude some females, would enable males to elevate their competitive ranking by competing in the female category, and raises considerable ethical concerns.

D. Resistance Training may counteract the loss of muscle mass and strength associated with testosterone suppression.

305. Presently there is no research on how testosterone suppression and estrogen administration in transwomen affect the response to a structured exercise program. However, androgen deprivation therapy (i.e. testosterone suppression) is a commonly used part of the healthcare regimen in men undergoing treatment for prostate cancer. Testosterone suppression for prostate cancer treatment therapy can be accomplished through removal of the testes or through chemical castration, thereby reducing circulating

testosterone to typical female levels. It is recognized that muscle mass and strength can be lost due to testosterone suppression for prostate cancer treatment. Therefore, participation in resistance training (i.e. strength training, weight training, lifting weights) is strongly encouraged to help prevent the loss of muscle mass due to testosterone suppression (Winters-Stone 2023). It has been demonstrated in males undergoing testosterone suppression for prostate cancer treatment that muscle strength and mass can be maintained and even increased by engaging in strength training.

306. Kvorning (2006) indicated that 8 weeks of three times per week resistance training in men undergoing testosterone suppression experienced a 4% increase in leg lean mass, a 2% increase in total lean body mass, a measurable (although insignificant) increase in isometric knee extension strength, and 10 repetition maximum leg press increased by 32% and 10 repetition maximum bench press increased by 17%. It is important to note that the resistance training program used in this study was suitable for enhancing health, muscle mass, and strength, but was certainly not as rigorous as would be expected for a competitive athlete.

307. Chen (2019) conducted a meta-analysis of seven randomized controlled trials of resistance training in men undergoing testosterone suppression and determined that there was no change in lean mass, but there were increases in upper and lower body strength due to the resistance training in spite of testosterone suppression.

308. Houben (2023) reported that in prostate cancer patients, 20 weeks of resistance training twice per week prevented loss of muscle mass during testosterone suppression and increased leg strength by 10–20%. Once again, it is important to note that the resistance training program used in this study was suitable for enhancing health, muscle mass, and strength, but was certainly not as rigorous as would be expected for a competitive athlete.

309. Overkamp (2023) evaluated muscle biopsies in a subsample of the subjects used in the project by Houben (2023) and observed there was a 16% increase in type 1 (i.e. slow twitch) muscle cell size and a 21% increase in type 2 (i.e. fast twitch) muscle cell size with 20 weeks of twice per week resistance training in men undergoing testosterone suppression.

Once again, it is important to note that the resistance training program used in this study was suitable for enhancing health, muscle mass, and strength, but was certainly not as rigorous as would be expected for a competitive athlete.

310. These studies conducted in men undergoing testosterone suppression for prostate cancer involve older men. However, there is no reason to expect that young men undergoing testosterone suppression would not experience the same or even greater improvements in strength and muscle cell size when engaged in resistance training, as suggested by the results from Kvorning (2006).

E. Responsible voices internationally are increasingly recognizing that suppression of testosterone in a male after puberty has occurred does not substantially reverse the male athletic advantage.

311. The previous very permissive NCAA policy governing transgender participation in women's collegiate athletics was adopted in 2011, and the previous IOC guidelines were adopted in 2015. Both of these policies allowed transwomen to participate in women's sports provided a certain level of testosterone suppression at the time of competition. At those dates, much of the scientific analysis of the actual impact of testosterone suppression had not yet been performed, much less any wider synthesis of that science. Thus, these policies were not evidence-based, but rather were based on a guess (that turned out to be wrong) that testosterone suppression would neutralize male advantage. Since then, quite a number of studies measuring the effects of testosterone suppression have been published.

312. These new scientific publications reflect a remarkably consistent consensus: once an individual has gone through male puberty, testosterone suppression does not substantially eliminate the physiological and performance advantages that that individual enjoys over female competitors.

313. Importantly, the majority of evidence based reviews on this topic come to the same conclusion that testosterone suppression cannot eliminate or even largely eliminate the male biological advantage once puberty has occurred.

314. I excerpt the key conclusions from important recent peer-reviewed papers below.

315. But first, it is important to note that the new evidence on the effects of testosterone suppression only informs the fairness of policies that actually require testosterone suppression. Policies that do not require testosterone suppression and allow males to compete in women's sports based on gender identity alone—like the CIAC policy at issue in this case—would allow a postpubertal male with normal male levels of circulating testosterone and having experienced all the athletic performance benefits of male puberty to compete in women's sports. As detailed more fully above, the science has been clear for decades that postpubertal males have substantial athletic advantages over females.

316. Roberts 2020: "In this study, we confirmed that … the pretreatment differences between transgender and cis gender women persist beyond the 12-month time requirement currently being proposed for athletic competition by the World Athletics and the IOC." (6)

317. Wiik 2020: The muscular and strength changes in males undergoing testosterone suppression "were modest. The question of when it is fair to permit a transgender woman to compete in sport in line with her experienced gender identity is challenging." (812)

318. Harper 2021: "[V]alues for strength, LBM [lean body mass], and muscle area in transwomen remain above those of cisgender women, even after 36 months of hormone therapy." (1)

319. Hilton & Lundberg 2021: "evidence for loss of the male performance advantage, established by testosterone at puberty and translating in elite athletes to a 10–50% performance advantage, is lacking. … These data significantly undermine the delivery of fairness and safety presumed by the criteria set out in transgender inclusion policies . . ." (211)

320. Hamilton et al. 2021, "Response to the United Nations Human Rights Council's Report on Race and Gender Discrimination in Sport: An Expression of Concern and a Call to Prioritize Research": "There is growing support for the idea that development influenced by high testosterone levels may result in retained anatomical and physiological advantages . . . . If a biologically male athlete self-identifies as a female, legitimately with a diagnosis of gender dysphoria or illegitimately to win medals, the athlete already possesses a

physiological advantage that undermines fairness and safety. This is not equitable, nor consistent with the fundamental principles of the Olympic Charter." (840)

321. Hamilton et al. 2021, "Consensus Statement of the Fédération Internationale de Médecine du Sport" (International Federation of Sports Medicine, or FIMS), signed by more than 60 sports medicine experts from prestigious institutions around the world: The available studies "make it difficult to suggest that the athletic capabilities of transwomen individuals undergoing HRT or GAS are comparable to those of cisgender women." The findings of Roberts et al. "question the required testosterone suppression time of 12 months for transwomen to be eligible to compete in women's sport, as most advantages over ciswomen were not negated after 12 months of HRT." Although these authors suggest that "A testosterone concentration threshold of 5 nmol/L in DSD women and transwomen athletes should be used as a global recommendation for sport's governing bodies at this present time and may be modified as new evidence arises for an event or sport-specific concentrations", this appears to be a value judgment and is not supported by research available when the Hamilton paper was published, nor at the present time.

322. Heather (2022) is another peer-reviewed literature review examining the evidence to date on whether testosterone suppression eliminates the physiological building blocks of male athletic advantage. In this review, Dr. Heather studied the existing literature on male advantages in brain structure, muscle mass, bone structure, and the cardio-respiratory system, and the effects of testosterone suppression on those advantages. She concluded:

> Given that the percentage difference between medal placings at the elite level is normally less than 1%, there must be confidence that an elite transwoman athlete retains no residual advantage from former testosterone exposure, where the inherent advantage depending on sport could be 10-30%. Current scientific evidence can not provide such assurances and thus, under abiding rulings, the inclusion of transwomen in the elite female division needs to be reconsidered for fairness to female-born athletes. (at 8)

323. Nokoff et al. (2023) is another peer-reviewed literature review examining the evidence to date on whether hormone therapy in transwomen eliminates male sex-based athletic advantages. As part of the background information on the importance of sex in athletic performance these authors state that "it is well established that the best males always outperform the best females when the sport relies on muscle power, muscle endurance, or aerobic power" (at 88) and "After pubertal change begins, sex segregation for sports involving endurance, power, and strength, … allow adolescent girls and women to excel." (at 92) As these authors review and summarize the research on hormone therapy in transwomen they conclude that "reductions of lean body mass and muscle cross-sectional area in the first 12 to 36 months of [hormone therapy] … are associated with small reductions or no change in limb strength assessed by hand grip or knee flexion/extension." And also "swimming performance still may surpass that of cisgender women after 2 yr of [hormone therapy]" (at 91)

324. Moreland et al. (2023) reviewed the studies on the effects of testosterone suppression and estrogen administration in transwomen that have been previously reviewed in this report and concluded, "…transwomen also experience decreases in lean body mass, which, on average, remain higher than expected female values after 12 months." (at 6). Other findings in this review include that the current evidence indicates that transwomen retain greater muscle strength and faster running speed than comparably aged women, with the acknowledgement that there are many limitations to the research in this and that "..more robust data…" are needed to guide policy decisions.

325. Tidmas et al. (2023) also reviewed the studies on the effects of testosterone suppression and estrogen administration in transwomen that have been previously reviewed in this report, and did so with an eye specific to the sport of fencing. The conclusions of these authors include that "the literature highlights that once male puberty has been experienced, testosterone suppression does not reduce all the physiological advantages, such as lean mass, strength, power, and stature, to a degree that equals cis female values" and that "at this time the literature suggests that there is an unfair retained

physiological advantage for trans women who have experienced male puberty when participating in female fencing competitions" (at 11).

326. "The Biological Basis of Sex Differences in Athletic Performance: Consensus Statement for the American College of Sports Medicine" reviewed the published research on the effects of testosterone suppression and estrogen administration in transwomen. Included within its key points are the following "Testosterone suppression in adult males resulting in initial decreases in muscle mass, increased fat mass, although the loss of lean mass and strength is not to the levels of adult females at least up to 3 yr post"; "Biologic males who undergo partial or complete male puberty followed by testosterone suppression retain some advantage in power and endurance performance over biological females, at least up to 2 yr post"; and "Nonhormonal factors that may impact the sex differences in height determination and thus athletic performance include possession of the Y chromosome (greater height) and or the X chromosome (shorter height)." (Hunter et al. 2023, at 23). All of these key points support the conclusions presented within this report.

327. On December 1, 2023, the Association of Ringside Physicians published a position statement on transgender competition in combat sports (Bascharon et al, 2024). This position statement reviewed many of the same sources and data previously cited within this report, including the biological basis of sex, sex-based differences in athletic performance, and the information showing that testosterone suppression and cross sex hormone use does not erase male athletic advantages. Among some key statements in the position are the following:

- "Differentiation between male and female begins in utero, driven by differential expression of several thousand genes on autosomal and sex chromosomes as well as hormonal actions" and "Small differences in athletic performance demonstrated between the sexes in childhood [] may be due to social factors [], as well as the phenomenon known as 'minipuberty.'" (at 2)
- "Sports have historically been split into categories (age, sex, weight class, ability) to promote a competitive environment that is fair, safe, and inclusive." (at 2)

- "Research has identified anatomical, physiological, and hormonal differences between males and females, translating into objective performance advantages for males that range from 10% to 30%. These advantages are present in activities relying on muscular strength and/or cardiorespiratory endurance but are more pronounced in activities relying heavily on muscular strength and power, especially in the upper extremities." (at 2)
- "Testosterone levels in isolation are inadequate to ensure fairness at the time of a competition. A transgender woman combatant who has gone through male puberty, thus conferring her with a male's musculature and bony structure, still has an unfair advantage over a similarly sized cis-woman combatant."
- "From a medical-ethical point of view, it is questionable whether a solitary requirement to lower testosterone below a certain level to ensure sporting fairness in competition can be justified" (at 4)
- "It is essential to recognize that the biological factors underpinning athletic performance are unequivocally established. Hence the potential performance implications in combat sports are applicable despite the lack of direct sport-specific studies in this athletic group. Therefore, restricting transgender women from the female category of combat sport and transgender men from the male category is necessary and proportionate to the goal of ensuring fair, safe, and meaningful competition." (at 4–5)
  "Since athlete safety is the most important priority above considerations such as inclusion, conducting a proper risk assessment is imperative within combat sports that continue to include transgender women in the female category, or transgender men in the male category" (at 5)

328. Based on the conclusions drawn in the review by Cheung et al. (2024), some may cite this paper as evidence that two-to-four years of testosterone suppression and estrogen administration in transwomen can erase male sex based athletic advantages. However, Table 1 (at 6) provides data showing that even after 14 years of testosterone suppression and estrogen administration transwomen retain higher body height, body mass, and

VO_2peak than comparably aged females. Furthermore, Figure 1 of this paper (at 7) clearly shows that after two years of testosterone suppression and estrogen administration the transwomen were 11.9 cm (4.7 inches) taller, weighed 11 kg (24.2 lbs.) more, and could perform 31% more pushups, 17% more sit-ups, and ran 12% faster than similarly aged females. This figure also shows that even after 4 years or hormonal treatment the transwomen could perform 18% more pushups than similarly aged females. It should be noted that Table 1, Figure 1, and the conclusions of this review are heavily based on the data in the papers by Roberts et al. (2020), Chiccarelli et al. (2023), and Alvares et al. (2022), which have been previously described in this report.

329. In a paper on which I am a co-author, along with 25 other scholars in the fields of exercise and sport science from numerous countries (Lundberg et al, 2024a), we draw the following conclusions:

- There are important biological differences between males and females which give males a category level athletic advantage when compared to similarly aged, talented, and trained females
- Testosterone exposure during puberty plays a major role in sex differentiation and the development of the large male sex-based advantages during and after puberty
- Testosterone suppression post-puberty does not negate the male performance advantages

330. The sixth (out of seven points) in the paper *Evidence on Sex Differences in Sports Performanc*e by Joyner et al. (2025) states "Endogenous testosterone suppression among XY athletes who have experienced masculinizing puberty, modestly reduces athletic performance, but a large male-female performance gap remains" (at 9) and then summarizes the research supporting their conclusion, which is from the same sources presented within this report.

331. A systematic review examining the effects of feminizing hormone therapy (i.e. testosterone suppression and estrogen administration) on muscle strength found mixed results among six longitudinal studies that met inclusion criteria for the systematic

review[10]. Three studies reported a decrease in muscle strength following hormone therapy, while the other three observed no significant reduction (Norlund et al. 2025). The review also included three cross-sectional studies. Two of these found that transgender women had greater handgrip strength than comparable cisgender women, while the third study found no significant difference in strength between the two groups.[11] Despite these mixed findings, the authors concluded that although feminizing hormone therapy may reduce muscle strength, transgender women generally remained stronger than comparable females.

332. Outside the forum of peer-reviewed journals, respected voices in sport are reaching the same conclusions.

333. The Women's Sports Policy Working Group identifies among its members and "supporters" many women Olympic medalists, former women's tennis champion and LGBTQ activist Martina Navratilova, Professor Doriane Coleman, a former All-American women's track competitor, transgender athletes Joanna Harper and Dr. Renee Richards, and many other leaders in women's sports and civil rights. I have referenced other published work of Joanna Harper and Professor Coleman. In 2023 the Women's Sports Policy Working Group published a "Position" on the issue of transgender participation in women's sports (Women's Sports Policy Working Group 2021), in which they reviewed largely the same body of literature I have reviewed above and analyzed the implications of that science for fairness and safety in women's sports.

334. Among other things, the Women's Sports Policy Working Group concluded:

- "Female Sports Are for Female Athletes. Period."
- "[C]ompetitive sport is one of the few places where biological sex differences matter. Men have greater strength, size, speed, and muscle mass. Men have larger hearts, lungs, hands, feet, and skulls. Women have greater body fat, and it is distributed differently

[10] These papers are Scharff et al. 2019, Van Caenegem et al. 2015, Yun et al. 2021, Wiik et al. 2020, Lundberg et al. 2024, and Auer et al. 2016, all of which are described in this report.
[11] These papers are Hamilton et al. 2024, Alvares et al. 2022, and Saitong et al. 2024, all of which are described in this report.

than men's body fat." (Citing Hilton and Lundberg) "These enormous sex differences result in performance advantages for men in almost every sport."

- "Pre-Puberty, Male and Female Children Show Marked Differences in Sport Performance." (citing Catley and Tomkinson 2013, Tambalis et al. 2016, and Eiberg 2005)
- "Post-Puberty, The Gap Between Male and Female Sport Performance Explodes. Medication and Surgery Do Not Remove the Male Sport Advantages, Even After Many Years" (Citing Hilton and Lundberg)
- "Sport Governing Bodies, Nationally and Internationally, Are Quickly Affirming Sex Segregation in Sport"

335. The Women's Sport Policy Working Group currently has a "Sport-by-Sport Listing of US & International Policies Governing Who Can Compete in the Female Category — with Grades" (Women's Sport Policy Working Group 2025). This list provides a brief summary and ranking of eligibility policies for female sports. Sports that are ranked as "Gold" are considered "Fair for women and girls at all levels. No boys or men are eligible for the female competition category regardless of age, competitive level, gender identity, hormones, surgery." Among the Gold rated sports are CIPS (Confédération Internationale de la Pêche Sportive — Sport Fishing), the International Mixed Martial Arts Federation, NXXT Women's Tour (Pro Golf), and USA Powerlifting. The following paragraphs provide a review of the policies for many national and international sport governing bodies that have determined that the female sporting category should be free from males.

336. As has been widely reported, in 2020, after an extensive scientific consultation process, the World Rugby organization issued its Transgender Guidelines (World Rugby 2020), finding that it would not be consistent with fairness or safety to permit biological males to compete in World Rugby women's matches, no matter what hormonal or surgical procedures they might have undergone. Based on their review of the science, World Rugby concluded:

- "Current policies regulating the inclusion of transgender women in sport are based on the premise that reducing testosterone to levels found in biological females is sufficient to remove many of the biologically-based performance advantages described above. However, peer-reviewed evidence suggests that this is not the case."

- "Longitudinal research studies on the effect of reducing testosterone to female levels for periods of 12 months or more do not support the contention that variables such as mass, lean mass and strength are altered meaningfully in comparison to the original male-female differences in these variables. The lowering of testosterone removes only a small proportion of the documented biological differences, with large, retained advantages in these physiological attributes, with the safety and performance implications described previously."
- "[G]iven the size of the biological differences prior to testosterone suppression, this comparatively small effect of testosterone reduction allows substantial and meaningful differences to remain. This has significant implications for the risk of injury . . . ."
- "[B]one mass is typically maintained in transgender women over the course of at least 24 months of testosterone suppression …. Height and other skeletal measurements such as bone length and hip width have also not been shown to change with testosterone suppression, and nor is there any plausible biological mechanism by which this might occur, and so sporting advantages due to skeletal differences between males and females appear unlikely to change with testosterone reduction.

337. In September 2021 the government-commissioned Sports Councils of the United Kingdom and its subsidiary parts (the five Sports Councils responsible for supporting and investing in sport across England, Wales, Scotland, and Northern Ireland) issued a formal "Guidance for Transgender Inclusion in Domestic Sport" (United Kingdom Sports Councils 2021), following an extensive consultation process, and a commissioned "International Research Literature Review" prepared by the Carbmill Consulting group (United Kingdom Sports Councils, International Research Literature Review 2021). The UK Sport Literature Review identified largely the same relevant literature that I review in this paper, characterized that literature consistently with my own reading and description,

and based on that science reached conclusions similar to mine.

338. The UK Sport Literature Review 2021 concluded:

- "Sexual dimorphism in relation to sport is significant and the most important determinant of sporting capacity. The challenge to sporting bodies is most evident in the inclusion of transgender people in female sport." "[The] evidence suggests that parity in physical performance in relation to gender-affected sport cannot be achieved for transgender people in female sport through testosterone suppression. Theoretical estimation in contact and collision sport indicate injury risk is likely to be increased for female competitors." (at 10)
- "From the synthesis of current research, the understanding is that testosterone suppression for the mandated one year before competition will result in little or no change to the anatomical differences between the sexes, and a more complete reversal of some acute phase metabolic pathways such as haemoglobin levels although the impact on running performance appears limited, and a modest change in muscle mass and strength: The average of around 5% loss of muscle mass and strength will not reverse the average 40-50% difference in strength that typically exists between the two sexes." (at 7)
- "These findings are at odds with the accepted intention of current policy in sport, in which twelve months of testosterone suppression is expected to create equivalence between transgender women and females." (at 7)

339. Taking into account the science detailed in the UK Sport Literature Review 2021, the UK Sports Councils have concluded:

- "[T]he latest research, evidence and studies made clear that there are retained differences in strength, stamina and physique between the average woman compared with the average transgender woman or non-binary person registered male at birth, with or without testosterone suppression." (at 3)
- "Competitive fairness cannot be reconciled with self-identification into the female category in gender-affected sport." (at 7)

- “As a result of what the review found, the Guidance concludes 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. This is due to retained differences in strength, stamina and physique between the average woman compared with the average transgender woman or non-binary person assigned male at birth, with or without testosterone suppression.” (at 6)
- “Based upon current evidence, testosterone suppression is unlikely to guarantee fairness between transgender women and natal females in gender-affected sports. . . . Transgender women are on average likely to retain physical advantage in terms of physique, stamina, and strength. Such physical differences will also impact safety parameters in sports which are combat, collision or contact in nature.” (at 7)

340. On January 15, 2022, the American Swimming Coaches Association (ASCA) issued a statement stating, “The American Swimming Coaches Association urges the NCAA and all governing bodies to work quickly to update their policies and rules to maintain fair competition in the women’s category of swimming. ASCA supports following all available science and evidenced-based research in setting the new policies, and we strongly advocate for more research to be conducted” and further stated, “The current NCAA policy regarding when transgender females can compete in the women’s category can be unfair to cisgender females and needs to be reviewed and changed in a transparent manner.” (Lepesant 2022)

341. On January 19, 2022, the NCAA Board of Governors approved a change to the policy on transgender inclusion in sport and stated that “the updated NCAA policy calls for transgender participation for each sport to be determined by the policy for the national governing body of that sport, subject to ongoing review and recommendation by the NCAA Committee on Competitive Safeguards and Medical Aspects of Sports to the Board of Governors. If there is no N[ational]G[overning]B[ody] policy for a sport, that sport’s international federation policy would be followed. If there is no international federation policy, previously established IOC policy criteria would be followed” (NCAA Media

Center 2022)[12].

342. On February 1, 2022, because "a competitive difference in the male and female categories and the disadvantages this presents in elite head-to-head competition … supported by statistical data that shows that the top-ranked female in 2021, on average, would be ranked 536th across all short course yards (25 yards) male events in the country and 326th across all long course meters (50 meters) male events in the country, among USA Swimming members," USA Swimming released its Athlete Inclusion, Competitive Equity and Eligibility Policy. The policy is intended to "provide a level-playing field for elite cisgender women, and to mitigate the advantages associated with male puberty and physiology." (USA Swimming 2022) The policy states:

- For biologically male athletes seeking to compete in the female category in certain "elite" level events, the athlete has the burden of demonstrating to a panel of independent medical experts that:
    - "From a medical perspective, the prior physical development of the athlete as Male, as mitigated by any medical intervention, does not give the athlete a competitive advantage over the athlete's cisgender Female competitors" and
    - There is a presumption that the athlete is not eligible unless the athlete "demonstrates that the concentration of testosterone in the athlete's serum has been less than 5 nmol/L . . . continuously for a period of at least thirty-six (36) months before the date of the Application." This presumption may be rebutted "if the Panel finds, in the unique circumstances of the case, that [the athlete's prior physical development does not give the athlete a competitive advantage] notwithstanding the athlete's serum testosterone results (e.g., the athlete has a medical condition which limits bioavailability of the athlete's free testosterone)." (USA Swimming Athlete Inclusion

[12] This is an important historical perspective on transgender inclusion policies. The NCAA updated its policy in 2025, which is discussed later

Procedures at 43.)

343. FINA, the international aquatics (swimming and diving) federation, issued a new policy in June 2022 allowing biological males to compete in the female category of aquatics only if they can establish that they "had male puberty suppressed beginning at Tanner Stage 2 or before age 12, whichever is later, and they have since continuously maintained their testosterone levels in serum (or plasma) below 2.5 nmol/L." (FINA Policy on Eligibility for the Men's and Women's Categories § F.4.b.ii. 2022) A biologically male athlete who cannot meet these criteria is prohibited from competing in the female category.

- This policy is based on the review of the scientific literature conducted by an independent panel of experts in physiology, endocrinology, and human performance, including specialists in transgender medicine. This panel concluded:

> [I]f gender-affirming male-to-female transition consistent with the medical standard of care is initiated after the onset of puberty, it will blunt some, but not all, of the effects of testosterone on body structure, muscle function, and other determinants of performance, but there will be persistent legacy effects that will give male-to-female transgender athletes (transgender women) a relative performance advantage over biological females. A biological female athlete cannot overcome that advantage through training or nutrition. Nor can they take additional testosterone to obtain the same advantage, because testosterone is a prohibited substance under the World Anti-Doping Code. (2)

344. In June 2022, British Triathlon adopted a new policy limiting competition in the female category to "people who are the female sex at birth." (British Triathlon Transgender Policy § 7.2 2022).

- This policy is based on its review of the scientific literature and conclusions that "the scientific community broadly agrees that the majority of the physiological/biological advantages brought about by male puberty are retained (either wholly or partially) by transwomen post transition" and that testosterone suppression does not "sufficiently remove[] the retained sporting performance advantage of transwomen." British Triathlon Transgender Policy § 2 (emphasis in original).

345. In July 2023, UCI, the world cycling federation, announced that "female transgender athletes who have transitioned after (male) puberty will be prohibited from participating in women's events on the UCI International Calendar—in all categories—in the various disciplines." According to Professor Xavier Bigard, the Medical Director for UCI, this policy reflects "the current knowledge on the effects of gender-affirming treatment on markers of performance in transgender female cyclists." (Ingle S, 2023)

346. In July 2022, England's Rugby Football Union and Rugby Football League both approved new policies limiting the female category to players whose sex recorded at birth is female for contact rugby for the under 12 age group and above. Rugby Football League Gender Participation Policy § 4.2(d); Rugby Football Union Gender Participation Policy § 4.2(d). (Rugby Football League 2022, Rugby Football Union 2022)

- In August 2022, the Irish Rugby Football Union adopted the same policy. Irish Rugby Football Union Gender Participation Policy §§ 4.5(b) & (f). (Irish Rugby Football Union 2022)
- In September 2022, the Welsh Rugby Union also adopted the same policy. (Welsh Rugby Union 2022)
- These bodies based their policy on a review of the scientific research, which showed that male advantage "cannot be sufficiently addressed even with testosterone suppression." Rugby Football Union Gender Participation Policy § 3.4; see also Rugby Football League Gender Participation Policy § 3.4; Irish Rigby Football Union Gender Participation Policy § 4.3.

347. In August 2022, the World Boxing Council (2022) issued a new policy requiring athletes to compete in accordance with their natal sex. World Boxing Council Statement/Guidelines Regarding Transgender Athletes Participation in Professional Combat Sports. The WBC concluded that any other policy would raise "serious health and

safety concerns.'

348. In March 2023, the World Athletics Council, the governing body for world class track & field competition issued new transgender and DSD (Disorders of Sex Development) regulations. The transgender participation policy is very similar to the policies of World Rugby, World Boxing, and FINA, stating "[i]n regard to transgender athletes, the Council has agreed to exclude male-to-female transgender athletes who have been through male puberty from female World Rankings competition from 31 March 2023." And "For DSD athletes, the new regulations will require any relevant athletes to reduce their testosterone levels below a limit of 2.5 nmol/L for a minimum of 24 months to compete internationally in the female category in any event."

- These policies are particularly noteworthy as there is a clear separation of the concerns regarding athletes who are transgender and those who have a DSD.

349. The North American Grappling Association (a grappling and Brazilian Jiu-Jitsu promotion started in 1995) updated the "NAGA Transgender Athlete Policy" (2025) on October 28, 2023. This policy states that

- "We, as an organization, strive to ensure fairness, inclusivity, and respect for all competitors within our events. With regards to transgender females competing in NAGA, the following policy shall be implemented:
    - Division for Cisgender Females:
        - We will have divisions for only cisgender females. Transgender females will not be entered into these divisions.
    - Division Options for Transgender Females:
    - Transgender females must compete in the men's division. We hope that the simplicity of this revised policy will help to avoid any future occurrences where transgender females enter women divisions. If NAGA staff is informed that a transgender female is in a women's division, they will be given the choice to go to the men's division or given a refund."

350. On November 21, 2023, the International Cricket Council (ICC) "approved new

gender eligibility regulations for the international game following a 9-month consultation process with the sport's stakeholders" (International Cricket Council 2023). These guidelines state that "Male to Female participants who have been through any form of male puberty will not be eligible to participate in the international women's game regardless of any surgery or gender reassignment treatment they may have undertaken."

351. On March 28, 2024 Sport Ireland, which "is the statutory authority tasked with leading, advocating and providing directed investment for the development of sport in Ireland" released the document *Guidance for Transgender and Non-Binary Inclusion in Sport* (Sport Ireland 2024). Some of the key points from this document include the following:

- Sports are generally divided into categories for men and women, boys and girls. Historically this has been both for social reasons and also for fairness and safety in competition. Men generally outperform women in most sports in which the outcome is affected by physical size, strength, speed or endurance. This difference can be measured in those sports which record objective outcomes, such as the race times in swimming or running, as well as jumping, lifting or throwing.
- Currently, the scientific evidence points to retention of some of the physical determinants of sports performance after transition, and these may last for several years after therapy begins. On average, transgender women retain the majority of muscle size and strength, as well as physical stature, after transition. … While research to date has generally been carried out in healthcare settings to monitor the outcomes of transition on untrained adults, there is no reason to consider that the physical and physiological effects of transition would be demonstrably different in trained athletes, except that muscle mass is likely to be greater in this population.
- While there is a wide range of abilities across the population, males generally outperform females in sport; physical differences are likely to persist in those who transition, whereby transgender women may retain a performance advantage

352. On April 8, 2024, the National Association of Intercollegiate Athletics (NAIA)

Council of Presidents approved a policy in a 20-0 vote which states that "Only NAIA student-athletes whose biological sex is female may participate in NAIA-sponsored female sports." (2024)

353. Also on April 8, 2024, World Netball (WN) (2024) released its Policy on 'Participation and Inclusion', stating that "All International Level Women's Netball Competitions is single Sex." Using the rational that "… International Level Women's Netball Competition is a Gender- Affected activity in which the average strength, stamina and physique of one Sex (female) will put them at a disadvantage compared with the other Sex (male)." WN established this policy on the basis that Netball is gender affected activity and explained that "A gender affected activity is activity in which the average strength, stamina and physique of one Sex (female) will put them at a disadvantage compared with the other Sex (male)." A very important statement regarding the development of this policy is "World Netball believes that the research on which it has relied is robust, it comprises many research studies, all of which have been published in peer-reviewed journals and come from multiple distinct research groups around the world."

354. On September 18, 2024, British Fencing (2024) approved policy updates indicating that "Only people who are female sex at birth and have not started female to male hormone treatment will be eligible to compete in the Female category."

355. On October 8, 2024, the United Nations Special Rapporteur on violence against women and girls, Reem Alsalem, stated in a report to the United Nations Secretary General and General Assembly that "Women and girls already have many odds stacked against them that impede their equal and effective participation in sports. In addition, their ability to play sport in conditions of safety, dignity and fairness has been further eroded by the intrusion of males who identify as female in female-only sports and related spaces." (Alsalem 2024) Within her report Ms. Alsalem documented a number of instances of females being injured when competing against transgirls and transwomen, a number of instances of female athletes quitting sports due to the presence of transgirls or transwomen, and six hundred examples of female athletes who have lost trophies, medals,

championships, or other opportunities due to the presence of transwomen (i.e. males) competing in the female category. Within her report Ms. Alsalem called for sex verification screening to ensure that only females compete in girls' and women's sports. It is of particular relevance to note that Ms. Alsalem includes male participation in female sport as a form of violence against women and girls even if the male identifies as a woman or girl. ("Women and girls in sport face widespread, overlapping and grave forms and manifestations of violence at all levels." and "When eligibility norms are deliberately violated and when the risk of injury to athletes is knowingly increased, the physical harms sustained can be characterized as 'violence'" at 3)

356. On December 4, 2024 the Ladies Professional Golf Association (LPGA) updated its "Gender Policy for Competition Eligibility." (2024) The communication for this policy update was "formed by a working group of top experts in medicine, science, sport physiology, golf performance and gender policy law—was developed with input from a broad array of stakeholders and prioritizes the competitive integrity of women's professional tournaments and elite amateur competitions." And further states "This working group has advised that the effects of male puberty confer competitive advantages in golf performance compared to players who have not undergone male puberty." The policy states that "athletes who are assigned female at birth are eligible to compete on the LPGA Tour, Epson Tour, Ladies European Tour, and in all other elite LPGA competitions. Players assigned male at birth and who have gone through male puberty are not eligible to compete in the aforementioned events."

357. It has been reported that the nation of Spain will limit participation in girls' and women's sports only "people with a female biological sex" (Badcock 2024). This is particularly noteworthy as Spain has extremely permissive laws regarding legal recognition of changes to a person's gender identity.

358. On December 20, 2024 the administration of US President Joe Biden withdrew a previous policy statement requiring schools to allow transgender athletes to participate in sports based on their gender identity rather than based on biological sex (Mills 2024).

359. In January 2025, World Triathlon (2025) updated their transgender participation policy to require transwomen (those who are biologically male but identify as a woman) to submit a "Written declaration of gender identity and intention to participate in the female elite category", suppress their testosterone below 2.5 nmol·L^{-1} for 4 years prior to being eligible to compete in the elite female category, and also "…participate in [the World Triathlon] academic research for the final 3 years of that eligibility This updated policy also creates an open category where "Transgender athletes can compete, without the need for any legal or medical criteria". Interestingly, this policy "Retains the Age-Group Female category for women assigned female at birth", which means that the non-elite World Triathlon female category is only those who are biologically female.

360. England Hockey is the national governing body for field hockey in England, managing the sport from grassroots to elite levels, and is a member of the Federation of International Hockey and the European Hockey Federation. On January 8, 2025, England Hockey released an "Update on trans and non-binary participation policy" (England Hockey 2025) which states that "Participants recorded female at birth will be eligible to compete in the Female category. However, once a participant (whose birth sex is recorded as female) has commenced or undergone transgender hormone therapy then they will no longer be eligible to participate in the Female category" and "Participants who were recorded male at birth, are transgender or non-binary, or who were recorded female at birth (regardless of whether they have undergone hormone therapy) will be eligible to compete in the Open category."

361. The 2025 Crossfit Games rulebook states in section 9.01 that "All athletes are welcome to participate in CrossFit Games events. However, to maintain fairness and the integrity of the competition, athletes must compete in the division corresponding to their **gender assigned at birth**." (CrossFit Games 2025). (bold font included in policy statement as shown). This policy applies to all stages of competition and is a change from the 2024 policy that allowed participation based on gender identity with rules regarding testosterone concentrations for transwomen.

362. On February 6, 2025 the NCAA updated their "transgender student-athlete participation policy" so that it now states "A student-athlete assigned male at birth may not compete for an NCAA women's team." (National Collegiate Athletic Association, 2025) However, this policy states that "A student-athlete assigned male at birth may practice on an NCAA women's team and receive all other benefits applicable to student-athletes." The determination of an athlete's sex will be based on the athlete's birth certificate, and it is important to note that sex/gender on birth certificates can be changed in 44 states (US Birth Certificates 2025). The updated NCAA policy also states that "NCAA schools are subject to local, state and federal legislation and such policy supersedes the rules of the NCAA."

363. On February 10, 2025, based on an ongoing review of scientific developments the World Athletics Working Group on Gender Diverse Athletes released recommendations for updating the regulations regarding the participation of transgender athletes and athletes with disorder of sex development (World Athletics 2025). Of key importance is that these recommendations state that "eligibility for its [World Athletics'] Female Category is restricted to athletes whose biological sex is female; and athletes whose biological sex is male should be ineligible for competition in its Female Category unless they are completely insensitive to androgens." It is worth noting that the scientific review for World Athletics cites the same sources used in this report to come to the following conclusions:

- "New evidence has clarified that testosterone suppression in 46XY DSD and 46XY transgender individuals can only ever partly mitigate the overall male advantage in the sport of Athletics"
- "New evidence clarifies that there is already an athletically significant performance gap before the onset of puberty. The childhood or pre-pubertal performance gap in the sport of Athletics specifically is 3 to 5% in running events, and higher in throwing and jumping events." (importantly, in support of this statement the working group cites my research [Brown et al. 2024, Brown et al. 2025a, and Brown et al. 2025b] as evidence supporting this decision)
- "New evidence establishes that athletic disadvantages associated with female body

structure and physiology contribute to the performance gap."

364. Furthermore, on March 25, 2025, World Athletics announced that a cheek swab test will be used to limit participation in the female category to those who are biologically female (BBC, 2025). This policy was positively influenced by the paper "Fair and Safe Eligibility Criteria for Women's Sport" (Tucker 2024), on which I am an author.

365. On March 7, 2025, Ice Hockey UK (the national governing body for ice hockey in the United Kingdom) announced a new "Sex and Gender Participation Policy" that resulted from "an extensive 18-month review led by Ice Hockey UK, which involved consultation with multiple stakeholders, including players, coaches, officials, advisory groups and medical professionals." This new policy "aims to prioritise safety and fairness in competition." (Ice Hockey UK, 2025). This policy includes an extensive list of definitions and explanation of how the policy was developed, with the key relevant conclusion that "Players are only permitted to play in the female category if the Sex that was originally recorded at birth was female and they are not undergoing hormone treatment."

366. On April 16, 2025, the Supreme Court of the United Kingdom (2025) ruled in the case of For Women Scotland Ltd (Appellant) v The Scottish Ministers (Respondent) that the word sex in law refers to biological sex, and that the word woman refers to an adult human female. This decision has obvious implications for sports, some of which are explained within the decision. For example, the decision states "There are other provisions whose proper functioning requires a biological interpretation of "sex"." Included with these provisions are " … women's fair participation in sport…" (at 86). This decision resulted in a number of sport governing bodies updating their policies regarding the participation of transwomen in the female category.

- On April 23, 2025 Ultimate Pool Group (UPG; 2025), the professional body for worldwide eight-ball pool, updated their "Group Standard Terms and Conditions" terms which include a revised eligibility policy that states "With effect from 23rd April 2025 trans women will not be eligible to participate in the women's series nor will trans women be eligible to be selected for international events in the female category."

- Also on April 23, the International Eightball Pool Federation (IEPF, 2025) updated their "Eligibility Policy For Women's Events" to recognize that eightball pool is a sex affected sport, therefore, "With effect from 23rd April 2025 trans women will not be eligible to participate in IEPF women sanctioned individual events nor will trans women be eligible to be selected for international team events in the female category"
- On May 1, 2025, Football Association (FA; 2025) "the governing body of the national sport [in England]" updated the policy to recognize that football is a sex affected sport by stating "Transgender women will no longer be able to play in women's football in England, and this policy will be implemented from 1 June 2025." (Football is known in the United States as soccer, but is known as football to most of the rest of the world)
- Also on May 1, 2025 the Scottish Football Association (SFA; 2025) updated their participation policy to state "As a gender-affected sport, the Scottish FA board has determined that from the start of season 2025/26 only biological females will be permitted to play in competitive girls' and women's football which is governed by the Scottish FA."
- Also, on May 1, England Netball (2025) updated their "Gender Eligibility and Participation Policy and Documents" to state that "The female category will be exclusively for players born female, irrespective of their gender identity."
- On May 2, 2025, the England and Wales Cricket Board (ECB; 2025) updated their transgender participation policy by stating "With immediate effect, only those whose biological sex is female will be eligible to play in women's cricket and girls' cricket matches. Transgender women and girls can continue playing in open and mixed cricket."

367. World Boxing (which is not the same organization as World Boxing Council), is the sport governing body for amateur boxing and is recognized by the International Olympic Committee as the regulatory body for Olympic boxing. On May 30, 2025, World Boxing introduced "mandatory sex testing, to determine the eligibility of male and female athletes that want to take part in its competitions." (World Boxing, 2025). The sex testing

will utilize the same technique as described by my colleagues an I in Tucker et al. (2024). The World Boxing sex testing policy was "… crafted by a specially convened Working Group of the World Boxing Medical and Anti-Doping Committee, which has examined data and medical evidence from an extensive range of sources and consulted widely with other sports and experts across the world." The motivation for this sex testing policy was "…concerns over the safety and wellbeing of all boxers…"

368. In summary, a growing number of sporting organizations, professional societies associated with sports, women's advocacy groups, and even national governments recognize that allowing male athletes (regardless of their gender identity) into female sports is detrimental to the safety and fairness of female sports. Almost universally these organizations oppose allowing athletes who have experienced male puberty to compete in female sports. There is less agreement on policies for male children who undergo puberty blockade. But this is also changing as more information is published on prepubertal male athletic advantages and how puberty blockers affect these male athletic advantages. Thus, a growing number of organizations are stating that only those whose biological sex is female may compete in the female category.

369. As can be seen from the preceding paragraphs, the determination of who is eligible to compete in the female category has been undergoing considerable change since 2011, with an initial swing towards allowing transwomen (i.e. males who have the gender identity of a girl or woman) to compete in the female category and now a swing towards limiting the female category to only those of the female sex. Sport governing bodies, such as World Athletics, FINA, World Triathlon, Ice Hockey UK, the NAIA, World Boxing, and so forth, establish the athlete eligibility policies within their respective sports for national or international competitions. However, within the United States most scholastic sports for grades 6-12 are regulated by state scholastic sport governing bodies and are not required to adhere to National or International policies. Similarly recreational sports leagues often operate under only local policies.

F. Female athletes and the public understand that sex matters in sports.

370. Scholarly research and information in the news media indicates that the vast majority of female athletes and the general public understand the importance of biological sex as a determinant of athletic performance and oppose allowing transwomen (e.g. males) to compete in the female category.

371. A national survey in June 2023 indicated that 69% of Americans oppose allowing transwomen to compete in the female sporting category (Lavietes 2023). Results of another national survey conducted by the New York Times in January 2025 indicates that 79% of Americans oppose allowing transwomen (i.e. males who identify as women) to compete in the female sporting category (New York Times 2025). A third poll taken by NBC News in April 2025 ".. of 19,682 adults aged 18 and over, including 2,230 adults aged 18-29" 75% of the respondents disagree that "transgender women athletes should be permitted to compete in female sports" (Francis, 2025). Taken together, these three polls indicate that a large and growing majority of Americans think that the female sporting category should be only for those who are biologically females.

372. In a survey of 928 female athletes competing in the 1996 summer Olympics, 82% of the athletes supported sex verification testing and only 6% reported anxiety due to the sex verification testing. In spite of this, the 1996 Olympic games were the last time the IOC performed sex verification testing (Elsas et al., 2000).

373. Cathy Devine (2022) reports that 19 female Olympic athletes all felt that transwomen had retained male athletic advantages when compared to similarly, aged, trained, and talented females.

374. Shaw et al. (2024) reports that 77% of elite female athletes consider it unfair to allow males to compete in the female category.

375. Very recently, female athletes have been withdrawing from competition in protest of the inclusion of transwomen (e.g. male) athletes in female sports. For example, in April 2024 five middle school aged girls forfeited in shot put competition rather than compete against a transgirl (New York Post 2024). In the 2024 season, five NCAA Division 1

Women's volleyball teams (McGinnis et al. 2024) and a girl's high school soccer team (Biederman 2024) have forfeited games rather than play against teams that included a transwoman. Also, recently, 275 female golfers sent a letter to the Ladies Professional Golf Association (LPGA) arguing against allowing transwomen to compete in the LPGA (Sport Resolutions 2024). In April 2025 a female fencer took a knee in a women's fencing competition rather than compete against a transwoman and was disqualified from competition (Rose 2025).

376. It is very concerning that female athletes and coaches who choose to speak out in favor of sex segregated sports are being punished for doing so by athletic administrators. Female athletes who have opposed the inclusion of transwomen in female sports have been told by athletic administrators that speaking out would be damaging to their career and that they should receive psychological counseling to learn to accept transwomen in female sports (Mew n.d., Harding 2024, Kay 2024). Furthermore, the head women's Lacrosse coach at Oberlin college was terminated from her coaching position due to her opposition to transwomen competing in female sports (Blake 2023). Similarly, when a San Jose State University assistant women's volleyball coach filed a Title IX complaint because a transwoman was allowed to compete on the school's women's volleyball team (Kay 2024) the coach was suspended (NBC Bay Area 2024).

Conclusions

The research and actual observed data show the following:

- At the level of (a) elite, (b) collegiate, (c) scholastic, and (d) recreational competition, men, adolescent boys, or male children, have an advantage over equally aged, gifted, and trained women, adolescent girls, or female children in almost all athletic events. This advantage exists in a wide variety of athletic endeavors before puberty, and it expands substantially during puberty;
- Biological male anatomy and physiology is the primary basis for the performance advantage that men, adolescent boys, or male children have over women, adolescent girls, or female children in almost all athletic events; and

- The administration of androgen inhibitors and cross-sex hormones to men or adolescent boys after the onset of male puberty does not eliminate the performance advantage that men and adolescent boys have over women and adolescent girls in almost all athletic events. Likewise, there is no published scientific evidence that the administration of puberty blockers to males before puberty eliminates the pre-existing athletic advantage that prepubertal males have over prepubertal females in almost all athletic events.

For over a decade sports governing bodies (such as the IOC and NCAA) have wrestled with the question of transgender inclusion in female sports. The previous policies implemented by these sporting bodies had an underlying "premise that reducing testosterone to levels found in biological females is sufficient to remove many of the biologically-based performance advantages." (World Rugby 2020 at 13.) Disagreements centered around what the appropriate threshold for testosterone levels must be—whether the 10nmol/liter value adopted by the IOC in 2015, or the 5nmol/liter value adopted by the IAAF.

But scientific evidence has never supported that premise, and growing research continues to show that it is false. Instead, as the UK Sports Councils, World Rugby, the FIMS Consensus Statement, the Women's Sports Policy Working Group, World Athletics, and others have all recognized, the science is now sharply "at odds with the accepted intention of current policy in sport, in which twelve months of testosterone suppression is expected to create equivalence between transgender women and females" (UK Sports Literature Review 2021 at 7), and it is now "difficult to suggest that the athletic capabilities of transwomen individuals undergoing HRT or GAS are comparable to those of cisgender women." (Hamilton et al., FIMS Consensus Statement 2021.) It is important to note that while the 2023 "IOC Framework on Fairness, Inclusion, and Non-Discrimination on the Basis of Gender Identity and Sex Variations" (Martowicz et al. 2023) calls for an "evidence-based approach," that Framework does not actually reference *any* of the now extensive scientific evidence relating to the physiological differences between the sexes, and the inefficacy of hormonal intervention to eliminate male advantages relevant to most sports. Instead, the IOC calls on other sporting bodies to define criteria for transgender inclusion, while demanding that such criteria simultaneously ensure fairness, safety, and inclusion for all.

But what we currently know tells us that these policy goals—fairness, safety, and full transgender inclusion—are irreconcilable for many or most sports. Long human experience is now joined by large numbers of research papers that document that males outperform females in muscle strength, muscular endurance, aerobic and anaerobic power output, VO_2max, running speed, swimming speed, vertical jump height, reaction time, and most other measures of physical fitness and physical performance that are essential for athletic success. The male advantages have been observed in fitness testing in children as young as 3 years old, and in sports competition as young as 6 years old, with the male advantages increasing immensely during puberty. To ignore what we know to be true about males' athletic advantages over females, based on mere hope or speculation that cross sex hormone therapy (puberty blockers, androgen inhibitors, or cross-sex hormones) might neutralize that advantage, when the currently available evidence does not support that proposition, is not science and is not "evidence-based" policy-making.

Because of the recent research and analysis in the general field of transgender athletics, many sports organizations have revised their policies or are in the process of doing so. As a result, there is not any universally recognized policy among sports organizations, and transgender inclusion policies are in a state of flux, likely because of the increasing awareness that the goals of fairness, safety, and full transgender inclusion are irreconcilable.

Sports have been separated by sex for the purposes of safety and fairness for a considerable number of years. The values of safety and fairness are endorsed by numerous sports bodies, including the NCAA and IOC. The existing evidence of durable physiological and performance differences based on biological sex provides a strong evidence-based rationale for keeping rules and policies for such sex-based separation in place (or implementing them as the case may be).

As set forth in detail in this report, there are anatomical and physiological differences between males and females that result in males having a significant performance advantage over similarly gifted, aged, and trained females in nearly all athletic events before, during, and after puberty. There is not scientific evidence that any amount or duration of cross sex hormone therapy (puberty blockers, androgen inhibitors, or cross-sex hormones) eliminates all physiological advantages that result in males performing better than females in nearly all athletic events. Males who have received such therapy retain sufficient male physiological traits that enhance athletic performance vis-à-vis similarly aged females and are thus, from a physiological perspective, more accurately categorized as male and not female.

Pragmatically, I acknowledge that in some cases—such as recreational, community-based sports or programs focused primarily on promoting physical activity—sex-segregated competition may be impractical or unfeasible. There are also sports in which mixed sex sports are desirable, such as mixed doubles in tennis. In these instances, it is essential that the sport is clearly labeled as mixed-sex so participants can make informed choices about potential injury risks and fairness. However, whenever feasible, sex-segregation promotes fairness and safety. When girls are exposed to physical harm, injury, or unfairness from competing against boys during early stages of participation, they may become discouraged from continuing in sport. This can reduce female participation overall, shrinking the talent pipeline, limiting opportunities at all levels, and negatively impacting public health, physical activity rates, and the competitiveness of women's elite sports

I swear or affirm under penalty of perjury of the laws of the United States that the foregoing is true and correct.

Dated: June 25, 2025 Signed: (signed electronically)

Dr. Gregory A. Brown, Ph.D., FACSM

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Appendix 1 – Data Tables

Presidential Physical Fitness Test Results[13]

Curl-Ups (# in 1 minute)

	Male		Female			Male-Female % Difference	
Age	**50th %ile**	**85th %ile**	**50th %ile**	**85th %ile**	**Age**	**50th %ile**	**85th %ile**
6	22	33	23	32	**6**	-4.3%	3.1%
7	28	36	25	34	**7**	12.0%	5.9%
8	31	40	29	38	**8**	6.9%	5.3%
9	32	41	30	39	**9**	6.7%	5.1%
10	35	45	30	40	**10**	16.7%	12.5%
11	37	47	32	42	**11**	15.6%	11.9%
12	40	50	35	45	**12**	14.3%	11.1%
13	42	53	37	46	**13**	13.5%	15.2%
14	45	56	37	47	**14**	21.6%	19.1%
15	45	57	36	48	**15**	25.0%	18.8%
16	45	56	35	45	**16**	28.6%	24.4%
17	44	55	34	44	**17**	29.4%	25.0%

[13] This data is available from a variety of sources. including: https://gilmore.gvsd.us/documents/Info/Forms/Teacher%20Forms/Presidentialchallengetest.pdf

Shuttle Run (seconds)

Age	Male 50th %ile	Male 85th %ile	Female 50th %ile	Female 85th %ile	Age	Male-Female % Difference 50th %ile	Male-Female % Difference 85th %ile
6	13.3	12.1	13.8	12.4	**6**	3.6%	2.4%
7	12.8	11.5	13.2	12.1	**7**	3.0%	5.0%
8	12.2	11.1	12.9	11.8	**8**	5.4%	5.9%
9	11.9	10.9	12.5	11.1	**9**	4.8%	1.8%
10	11.5	10.3	12.1	10.8	**10**	5.0%	4.6%
11	11.1	10	11.5	10.5	**11**	3.5%	4.8%
12	10.6	9.8	11.3	10.4	**12**	6.2%	5.8%
13	10.2	9.5	11.1	10.2	**13**	8.1%	6.9%
14	9.9	9.1	11.2	10.1	**14**	11.6%	9.9%
15	9.7	9.0	11.0	10.0	**15**	11.8%	10.0%
16	9.4	8.7	10.9	10.1	**16**	13.8%	13.9%
17	9.4	8.7	11.0	10.0	**17**	14.5%	13.0%

1 mile run (seconds)

Age	Male 50th %ile	Male 85th %ile	Female 50th %ile	Female 85th %ile	Age	Male-Female % Difference 50th %ile	Male-Female % Difference 85th %ile
6	756	615	792	680	**6**	4.5%	9.6%
7	700	562	776	636	**7**	9.8%	11.6%
8	665	528	750	602	**8**	11.3%	12.3%
9	630	511	712	570	**9**	11.5%	10.4%
10	588	477	682	559	**10**	13.8%	14.7%
11	560	452	677	542	**11**	17.3%	16.6%
12	520	431	665	503	**12**	21.8%	14.3%
13	486	410	623	493	**13**	22.0%	16.8%

14	464	386	606	479	**14**	23.4%	19.4%
15	450	380	598	488	**15**	24.7%	22.1%
16	430	368	631	503	**16**	31.9%	26.8%
17	424	366	622	495	**17**	31.8%	26.1%

Pull Ups (# completed)

	Male		**Female**			**Male-Female % Difference**	
Age	**50th %ile**	**85th %ile**	**50th %ile**	**85th %ile**	**Age**	**50th %ile**	**85th %ile**
6	1	2	1	2	**6**	0.0%	0.0%
7	1	4	1	2	**7**	0.0%	100.0%
8	1	5	1	2	**8**	0.0%	150.0%
9	2	5	1	2	**9**	100.0%	150.0%
10	2	6	1	3	**10**	100.0%	100.0%
11	2	6	1	3	**11**	100.0%	100.0%
12	2	7	1	2	**12**	100.0%	250.0%
13	3	7	1	2	**13**	200.0%	250.0%
14	5	10	1	2	**14**	400.0%	400.0%
15	6	11	1	2	**15**	500.0%	450.0%
16	7	11	1	1	**16**	600.0%	1000.0%
17	8	13	1	1	**17**	700.0%	1200.0%

Data Compiled from Athletic.Net

2023 National top 10 performances in 3000 m cross country race time in seconds

	7-8 years old			9-10 years old			11-12 years old		
Rank	Boys	Girls		Boys	Girls		Boys	Girls	
1	752.8	785.7	Difference	628.8	677.8	Difference	597.2	638.4	Difference
2	772.7	814.5	#1 boy vs	641.3	680.5	#1 boy vs	601.2	639.1	#1 boy vs
3	774.0	827.7	# 1 girl	642.3	683.4	# 1 girl	603.6	641.3	# 1 girl
4	781.8	861.4	4.2%	643.7	686.0	7.2%	604.9	648.8	6.5%
5	786.1	879.8		646.0	689.0		605.9	649.2	
6	791.6	884.7	Average	651.0	690.8	Average	606.2	649.7	Average
7	800.3	886.5	difference	654.9	692.6	difference	607.6	650.5	difference
8	802.8	924.0	boys vs	656.2	697.2	boys vs	608.0	659.8	boys vs
9	810.6	937.7	girls	662.6	698.0	girls	611.1	660.9	girls
10	814.1	958.2	10.0%	663.8	698.5	5.8%	611.3	664.6	6.8%

2023 National top 10 performances in Outdoor 100 m Track race time in seconds

	7-8 years old			9-10 years old			11-12 years old		
Rank	Boys	Girls		Boys	Girls		Boys	Girls	
1	13.70	13.85	Difference	11.44	12.82	Difference	11.67	11.67	Difference
2	13.80	13.93	#1 boy vs	11.79	13.07	#1 boy vs	11.81	11.97	#1 boy vs
3	13.92	14.28	# 1 girl	12.64	13.27	# 1 girl	11.81	11.97	# 1 girl
4	13.94	14.41	1.1%	12.77	13.31	10.8%	11.84	12.23	0.0%
5	14.11	14.46		12.82	13.36		11.90	12.27	
6	14.12	14.48	Average	12.83	13.36	Average	11.94	12.43	Average
7	14.13	14.58	difference	12.91	13.39	difference	11.96	12.49	difference
8	14.14	14.62	boys vs	12.94	13.40	boys vs	11.98	12.51	boys vs
9	14.17	14.63	girls	12.95	13.41	girls	12.04	12.52	girls
10	14.17	14.69	2.6%	12.95	13.43	5.1%	12.09	12.55	2.9%

2023 National top 10 performance in Outdoor 200 m Track race time in seconds

	7-8 years old			9-10 years old			11-12 years old		
Rank	Boys	Girls		Boys	Girls		Boys	Girls	
1	28.63	29.10	Difference	25.76	26.20	Difference	23.69	24.10	Difference
2	28.65	29.17	#1 boy vs	25.90	26.51	#1 boy vs	23.80	24.61	#1 boy vs
3	28.76	29.68	# 1 girl	26.16	26.90	# 1 girl	23.95	24.95	# 1 girl
4	28.78	29.70	1.6%	26.45	27.13	1.7%	24.03	24.98	1.7%
5	28.97	30.11		26.52	27.18		24.19	25.14	
6	29.00	30.12	Average	26.57	27.19	Average	24.23	25.51	Average
7	29.15	30.20	difference	26.64	27.31	difference	24.23	25.59	difference
8	29.22	30.32	boys vs	26.64	27.45	boys vs	24.26	25.59	boys vs
9	29.23	30.32	girls	26.71	27.47	girls	24.39	25.60	girls
10	29.23	30.83	3.3%	26.86	27.61	2.5%	24.42	25.71	4.2%

2023 National top 10 performances in Outdoor 400 m Track race time in seconds

	7-8 years old			9-10 years old			11-12 years old		
Rank	Boys	Girls		Boys	Girls		Boys	Girls	
1	64.18	66.75	Difference	57.02	59.53	Difference	53.58	56.90	Difference
2	64.28	68.65	#1 boy vs	57.41	60.53	#1 boy vs	53.66	57.02	#1 boy vs
3	65.85	70.07	# 1 girl	59.18	61.30	# 1 girl	54.34	57.74	# 1 girl
4	66.45	71.21	3.9%	59.35	61.80	4.2%	54.68	57.88	5.8%
5	66.58	71.35		59.99	62.77		55.77	58.49	
6	66.68	71.89	Average	60.16	62.81	Average	55.83	58.72	Average
7	66.80	71.98	difference	60.17	63.02	difference	55.98	58.79	difference
8	67.19	72.25	boys vs	60.47	63.61	boys vs	56.04	58.95	boys vs
9	67.75	72.28	girls	61.06	63.85	girls	56.48	59.02	girls
10	67.81	72.29	6.4%	61.95	64.16	4.3%	56.67	59.05	5.1%

2023 National top 10 performances in Outdoor 800 m Track race time in seconds

	7-8 years old			9-10 years old			11-12 years old		
Rank	Boys	Girls		Boys	Girls		Boys	Girls	
1	153.2	154.9	Difference	139.4	143.7	Difference	126.4	138.7	Difference
2	153.8	162.5	#1 boy vs	139.8	146.5	#1 boy vs	126.7	141.0	#1 boy vs
3	155.1	164.9	# 1 girl	141.5	147.3	# 1 girl	132.1	141.6	# 1 girl
4	156.8	167.2	1.1%	144.4	149.3	3.0%	132.1	141.9	8.9%
5	158.6	167.8		144.8	150.0		133.2	142.8	
6	159.5	168.9	Average	145.4	150.6	Average	133.7	143.4	Average
7	160.5	169.2	difference	145.6	150.9	difference	134.7	143.6	difference
8	161.9	169.5	boys vs	146.4	152.0	boys vs	134.8	143.6	boys vs
9	162.2	170.6	girls	146.6	152.1	girls	135.3	144.2	girls
10	162.4	172.1	5.0%	146.9	152.2	3.6%	135.8	144.7	7.1%

2023 National top 10 performances in Outdoor 1500 m Track race time in seconds

	7-8 years old			9-10 years old			11-12 years old		
Rank	Boys	Girls		Boys	Girls		Boys	Girls	
1	301.8	336.2	Difference	291.6	302.7	Difference	257.7	292.0	Difference
2	313.5	340.6	#1 boy vs	293.0	305.2	#1 boy vs	261.1	292.1	#1 boy vs
3	315.7	341.3	# 1 girl	295.0	307.1	# 1 girl	267.9	292.7	# 1 girl
4	320.1	342.6	10.2%	295.1	307.6	3.7%	270.5	293.2	11.7%
5	321.9	343.7		300.5	307.8		270.6	297.7	
6	325.8	345.8	Average	302.0	309.1	Average	271.2	298.3	Average
7	332.8	350.1	difference	302.5	309.7	difference	272.7	299.8	difference
8	332.9	352.0	boys vs	302.5	312.9	boys vs	276.2	301.2	boys vs
9	334.3	352.8	girls	303.1	313.0	girls	276.5	301.3	girls
10	334.4	353.8	6.5%	303.2	313.1	3.2%	278.3	302.6	9.0%

2023 National top 10 performances in Outdoor Long Jump Distance (in inches)

	7-8 years old			9-10 years old			11-12 years old		
Rank	Boys	Girls		Boys	Girls		Boys	Girls	
1	179.0	157.5	Difference	187.5	186.5	Difference	220.0	204.8	Difference
2	176.0	155.5	#1 boy vs	187.5	185.8	#1 boy vs	219.3	204.8	#1 boy vs
3	174.0	147.8	# 1 girl	186.5	174.8	# 1 girl	215.0	201.3	# 1 girl
4	161.8	146.8	13.7%	182.8	170.0	0.5%	214.5	200.8	7.4%
5	159.5	146.8		182.5	167.0		213.5	197.3	
6	158.8	143.8	Average	181.0	166.3	Average	210.8	195.8	Average
7	157.8	143.3	difference	180.8	165.3	difference	209.8	195.3	difference
8	156.0	143.0	boys vs	179.3	165.3	boys vs	208.8	194.5	boys vs
9	154.3	142.5	girls	178.0	165.3	girls	208.3	192.0	girls
10	154.0	142.5	11.0%	178.0	165.0	6.6%	207.8	191.8	7.6%

2023 National top 10 performances in Outdoor Shot Put Distance (in inches, 6 pound shot)

	7-8 years old			9-10 years old			11-12 years old		
Rank	Boys	Girls		Boys	Girls		Boys	Girls	
1	303.3	226.8	Difference	418.0	368.0	Difference	624.5	471.8	Difference
2	303.0	222.8	#1 boy vs	417.8	336.5	#1 boy vs	563.5	459.5	#1 boy vs
3	292.5	213.5	# 1 girl	392.5	325.3	# 1 girl	556.8	449.3	# 1 girl
4	283.0	211.0	33.7%	384.8	323.5	13.6%	549.3	441.0	32.4%
5	277.3	210.0		375.3	316.8		545.0	439.5	
6	267.0	209.8	Average	372.5	316.3	Average	538.5	432.3	Average
7	265.8	207.0	difference	369.8	315.0	difference	525.5	426.8	difference
8	264.3	206.0	boys vs	412.3	311.8	boys vs	497.8	411.5	boys vs
9	264.0	202.8	girls	363.8	309.8	girls	482.0	410.8	girls
10	262.5	197.8	32.0%	362.5	298.5	20.1%	493.5	407.0	23.6%

Appendix 2 – Scholarly Publications

Refereed Publications

1. Brown GA, Shaw B, Shaw I, Joyner MJ, Hunter SK, Senefeld JW, Tucker R, Hilton E, Lundberg T, Carlson S, Kirk C. Comment on "Biology and Management of Male-Bodied Athletes in Elite Female Sports" by Handelsman & Bermon. Drug Test Anal. (In Press, 2025)
2. Kirk C, McGawley K, Abt G, Lundberg T, Devine C, Brown G, Carneiro E. Concerns regarding the research design, participant selection, and data interpretation of 'Body composition, exercise-related performance parameters and associated health factors of transgender women, cisgender women and cisgender men volleyball players' BJSM Rapid Response. May 20, 2025 https://bjsm.bmj.com/content/early/2025/02/17/bjsports-2024-108601.responses
3. Brown GA, Shaw BS, Shaw I. Sex-based differences in shot put, javelin throw, and long jump in 8-and-under and 9-10-year-old athletes. Eur J Sport Science 25: e12241, 2025. https://doi.org/10.1002/ejsc.12241
4. Brown GA, Shaw BS, Shaw I. Sex-based differences in swimming performance in under-10-year-old athletes in short course national competition. Eur J Sport Science 25: e12234, 2025. https://doi.org/10.1002/ejsc.12237
5. Lundberg TR, O'Connor MI, Kirk C, Pollock N, Brown GA. Comment on: "A unique pseudo-eligibility analysis of longitudinal laboratory performance data from a transgender female competitive cyclist." Transl. Exerc. Biomed. https://doi.org/10.1515/teb-2024-0026 (this is an invited letter to the editor)
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Refereed Presentations

1. Joyner M, Hunter S, Brown, GA, Senefeld J. Symposium title Sex Differences in Physical and Athletic Performance Among Youths. Presentation title: Sex Differences in Physical and Athletic Performance before Puberty. Accepted for Presentation at the 72nd Annual Meeting of the American College of Sports Medicine. Atlanta, GA. May 27 - May 30, 2025.
2. Brown GA, Brown CJ, Shaw I, Shaw BS. Boys Run Faster Than Girls in Preliminary and Championship Track Races. Presented at the 72nd Annual Meeting of the American College of Sports Medicine. Atlanta, GA. May 27 - May 30, 2025.
3. Brown CJ, Brown GA, Shaw I, Shaw BS. Boys Age 10-and-Under Swim Faster Than Girls in Most Long and Short Course Events. Presented at the 72nd Annual Meeting of the American College of Sports Medicine. Atlanta, GA. May 27 - May 30, 2025.
4. Steinman PM, Steinman PC, Brown GA. Knowledge Of The Female Athlete Triad In Female High School Athletes In Rural Nebraska. Presented at the 70th Annual Meeting of the American College of Sports Medicine. Denver CO. May 30 - June 2, 2023.
5. Steinman PC, Steinman PM, Brown GA. Female Athlete Triad Knowledge Among Sports Medicine Rehabilitation Clinicians In Nebraska. Presented at the 70th Annual Meeting of the American College of Sports Medicine. Denver CO. May 30 - June 2, 2023.
6. Brown GA, Brown CJ, Shaw I, Shaw B. Boys And Girls Differ In Running And Jumping Track And Field Event Performance Before Puberty. Presented at the 70th Annual Meeting of the American College of Sports Medicine. Denver CO. May 30 - June 2, 2023.
7. Brown GA, Orr T, Shaw BS, Shaw I. Comparison of Running Performance Between Division and Sex in NCAA Outdoor Track Running Championships 2010-2019. 54(5), 2146. 69th Annual Meeting of the American College of Sports Medicine. San Diego, CA. May 31 - June 4, 2022.
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9. Shaw I, Turner S, Brown GA, Shaw BS. Effects Of Resistance Exercise Modalities On Chest Expansion, Spirometry And Cardiorespiratory Fitness In Untrained Smokers. Med

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10. Elton D, Brown GA, Orr T, Shaw BS, Shaw I. Comparison Of Running Performance Between Division And Sex In NCAA Outdoor Track Running Championships 2010-2019. Northland Regional Meeting of the American College of Sports Medicine. Held Virtually. April 8, 2022.

11. Brown GA. Transwomen competing in women's sports: What we know, and what we don't. American Physiological Society New Trends in Sex and Gender Medicine conference. Held virtually due to Covid-19 pandemic. October 19 - 22, 2021.

12. Shaw BS, Boshoff VE, Coetzee S, Brown GA, Shaw I. A Home-based Resistance Training Intervention Strategy To Decrease Cardiovascular Disease Risk In Overweight Children Med Sci Sport Exerc. 53(5), 742. 68th Annual Meeting of the American College of Sports Medicine. Held virtually due to Covid-19 pandemic. June 1-5, 2021.

13. Shaw I, Cronje M, Brown GA, Shaw BS. Exercise Effects On Cognitive Function And Quality Of Life In Alzheimer'S Patients In Long-term Care. Med Sci Sport Exerc. 53(5), 743. 68th Annual Meeting of the American College of Sports Medicine. Held virtually due to Covid-19 pandemic. June 1-5, 2021.

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17. Adkins M, Bice M, Bickford N, Brown GA. Farm to Fresh! A Multidisciplinary Approach to Teaching Health and Physical Activity. 2018 spring SHAPE America central district conference. Sioux Falls, SD. January 2018.

18. Shaw I, Kinsey JE, Richards R, Shaw BS, and Brown GA. Effect Of Resistance Training During Nebulization In Adults With Cystic Fibrosis. International Journal of Arts & Sciences' (IJAS). International Conference for Physical, Life and Health Sciences held at FHWien University of Applied Sciences of WKW, at Währinger Gürtel 97, Vienna, Austria, from 25-29 June 2017.

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21. Brown GA, Shaw BS, and Shaw I. Effects of a 6 Week Conditioning Program on Jumping, Sprinting, and Agility Performance In Youth. Med Sci Sport Exerc. 48(5), 3730. 63rd Annual Meeting of the American College of Sports Medicine. Boston, MA. June 2016.
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24. Bice MR, Cary JD, Brown GA, Adkins M, and Ball JW. The use of mobile applications to enhance introductory anatomy & physiology student performance on topic specific in-class tests. National Association for Kinesiology in Higher Education National Conference. January 8, 2016.
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26. Shaw BS, Shaw I, McCrorie C, Turner S., Schnetler A, and Brown GA. Concurrent Resistance and Aerobic Training in the Prevention of Overweight and Obesity in Young Adults. Med Sci Sport Exerc. 47(5), 223. 62nd Annual Meeting of the American College of Sports Medicine. San Diego, CA. May 2015.

Book Chapters

1. Shaw BS, Shaw I, Brown G.A. Importance of resistance training in the management of cardiovascular disease risk. In Cardiovascular Risk Factors. IntechOpen, 2021.
2. Brown, G.A. Chapters on Androstenedione and DHEA. In: Nutritional Supplements in Sport, Exercise and Health an A-Z Guide. edited by Linda M. Castell, Samantha J. Stear, Louise M. Burke. Routledge 2015.

Refereed Web Content

1. Brown GA and Lundberg TL. Should Transwomen be allowed to Compete in Women's Sports? A view from an Exercise Physiologist Center on Sport Policy and Conduct (accepted on April 18, 2023) https://www.sportpolicycenter.com/news/2023/4/17/should-transwomen-be-allowed-to-compete-in-womens-sports
2. Brown GA. The Olympics, sex, and gender in the physiology classroom (part 2): Are there sex based differences in athletic performance before puberty? Physiology Educators

Community of Practice blog (PECOP Blog), managed by the Education group of the American Physiological Society. (May 16, 2022) https://blog.lifescitrc.org/pecop/2022/05/16/the-olympics-sex-and-gender-in-the-physiology-classroom-2/

3. Brown GA. Looking back and moving forward. The importance of reflective assessment in physiology education. (January 13, 2022) https://blog.lifescitrc.org/pecop/2022/01/13/looking-back-and-moving-forward-the-importance-of-reflective-assessment-in-physiology-education/
4. Brown GA. The Olympics, sex, and gender in the physiology classroom. Physiology Educators Community of Practice, managed by the Education group of the American Physiological Society (August 18, 2021) https://blog.lifescitrc.org/pecop/2021/08/18/the-olympics-sex-and-gender-in-the-physiology-classroom/
5. Kirk C. McGawley K, Abt G, Lundberg T, Devine C, Brown G, Carneiro E. Concerns regarding the research design, participant selection, and data interpretation of ‘Body composition, exercise-related performance parameters and associated health factors of transgender women, cisgender women and cisgender men volleyball players’ https://doi.org/10.51224/SRXIV.547 Posted May 9, 2025.