

EXHIBIT 1



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9 **IN THE UNITED STATES DISTRICT COURT**
10 **FOR THE DISTRICT OF ARIZONA**
11 **TUCSON DIVISION**

12 Jane Doe, *et al.*,

13 Plaintiffs,

14
15 v.

16 Thomas C. Home, in his official capacity
17 as State Superintendent of Public
18 Instruction, *et al.*,

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22 Defendants.
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Case No. 4:23-cv-00185-JGZ

**Declaration of Dr. Gregory A. Brown,
Ph.D., FACSM, in Support of
[Intervenors' Proposed] Opposition to
Plaintiffs' Motion for a Preliminary
Injunction**

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TABLE OF CONTENTS

Personal Qualifications and Disclosure 1

Purpose of this Declaration 4

Overview 5

Evidence and Conclusions 7

 I. The scientific reality of biological sex 7

 II. Biological men, or adolescent boys, have large, well-documented performance advantages over women and adolescent girls in almost all athletic contests 10

 A. Men are stronger. 13

 B. Men run faster..... 16

 C. Men jump higher and farther..... 20

 D. Men throw, hit, and kick faster and farther..... 21

 E. Males exhibit faster reaction times 22

 III. Men have large measured physiological differences compared to women which demonstrably or likely explain their performance advantages..... 23

 A. Men are taller and heavier than women 23

 B. Males have larger and longer bones, stronger bones, and different bone configuration..... 24

 C. Males have much larger muscle mass 26

 D. Females have a larger proportion of body fat..... 27

 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..... 28

 IV. The role of testosterone in the development of male advantages in athletic performance..... 31

 A. Boys exhibit advantages in athletic performance even before puberty..... 33

 B. The rapid increase in testosterone across male puberty drives characteristic male physiological changes and the increasing performance advantages..... 53

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V. The available evidence shows that suppression of testosterone in a male after puberty has occurred does not substantially eliminate the male athletic advantage..... 55

A. Empirical studies find that males retain a strong performance advantage even after lengthy testosterone suppression..... 56

B. Testosterone suppression does not reverse important male physiological advantages..... 66

C. 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..... 71

Bibliography 87

Appendix 1 - Data Tables 99

Appendix 2 - Scholarly Publications 108

1
2
3
4
5
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7
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10
11
12
13
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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 am also the Director of the General Studies program. 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.

I have received many awards over the years, including the Mortar Board Faculty Excellence Honors Award, College of Education Outstanding Scholarship / Research Award, and the College of Education Award for Faculty Mentoring of Undergraduate Student Research. I have authored more than 50 refereed publications and more than 70 refereed presentations in the field of Exercise Science. I have 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*.

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

1 testosterone levels in young men. Douglas S. King, Rick L. Sharp, Matthew D.
2 Vukovich, Gregory A. Brown, et al., *Effect of Oral Androstenedione on Serum*
3 *Testosterone and Adaptations to Resistance Training in Young Men: A Randomized*
4 *Controlled Trial*, JAMA 281: 2020-2028 (1999); G. A. Brown, M.A. Vukovich, et
5 al., *Effects of Anabolic Precursors on Serum Testosterone Concentrations and*
6 *Adaptations to Resistance Training in Young Men*, Int J Sport Nutr Exerc Metab 10:
7 340-359 (2000).

- 8 • A study of the effect of ingestion of that same testosterone precursor on circulating
9 testosterone levels in young women. G. A. Brown, J.C. Dewey, et al., *Changes in*
10 *Serum Testosterone and Estradiol Concentrations Following Acute*
11 *Androstenedione Ingestion in Young Women*, Horm Metab Res 36: 62-66 (2004.)
- 12 • A study finding (among other things) that body height, body mass, vertical jump
13 height, maximal oxygen consumption, and leg press maximal strength were higher
14 in a group of physically active men than comparably active women, while the
15 women had higher percent body fat. G. A. Brown, Michael W. Ray, et al., *Oxygen*
16 *Consumption, Heart Rate, and Blood Lactate Responses to an Acute Bout of*
17 *Plyometric Depth Jumps in College-Aged Men And Women*, J. Strength Cond Res
18 24: 2475-2482 (2010).
- 19 • A study finding (among other things) that height, body mass, and maximal oxygen
20 consumption were higher in a group of male NCAA Division 2 distance runners,
21 while women NCAA Division 2 distance runners had higher percent body fat.
22 Furthermore, these male athletes had a faster mean competitive running speed
23 (~3.44 min/km) than women (~3.88 min/km), even though the men ran 10 km while
24 the women ran 6 km. Katherine Semin, Alvah C. Stahlnecker, Kate A. Heelan, G.
25 A. Brown, et al, *Discrepancy Between Training, Competition and Laboratory*
26 *Measures of Maximum Heart Rate in NCAA Division 2 Distance Runners*, Journal
27 of Sports Science and Medicine 7: 455-460 (2008).
- 28 • A presentation at the 2021 American Physiological Society New Trends in Sex and

1 Gender Medicine Conference entitled "Transwomen Competing in Women's
2 Sports: What We Know and What We Don't".

- 3 • I have also authored an August 2021 entry for the American Physiological Society
4 Physiology Educators Community of Practice Blog (PECOP Blog) titled "The
5 Olympics, Sex, and Gender in the Physiology Classroom, and a May 2023 entry for
6 the PECOP Blog titled "The Olympics, sex, and gender in the physiology classroom
7 (part 2): Are there sex based differences in athletic performance before puberty?" I
8 have also authored an April 17, 2023 post for the Center on Sport Policy and
9 Conduct titled "Should Transwomen be allowed to Compete in Women's Sports?
10 A view from an Exercise Physiologist."
- 11 • A presentation at the 2022 annual meeting of the American College of Sports
12 Medicine titled "Comparison of Running Performance Between Division and Sex
13 in NCAA Outdoor Track Running Championships 2010-2019." And a presentation
14 at the 2023 annual meeting of the American College of Sports Medicine titled "Boys
15 and Girls Differ in Running and Jumping Track and Field Event Performance
16 Before Puberty."

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

I have been asked by counsel for Proposed Intervenors Senator Warren Petersen, President of the Arizona Senate, and Representative Ben Toma, Speaker of the Arizona House of Representatives in the matter of *Doe and Roe v. Horne et al.* to offer my opinions about the following: (a) whether males have inherent advantages in athletic performance over females, and if so the scale 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 "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 "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 cases similar to this one 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, and *L.E. vs. Lee* in the state of Tennessee, and in the form of a written declaration in the case of *Hecox vs. Little* in the state of Idaho. 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 have been 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.

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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, gifted, and trained women, adolescent girls, or female children in almost all athletic events;
- Biological male physiology is the 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.

In short summary, men, adolescent boys, and prepubertal male children perform better in almost all sports than equally aged, trained, and gifted women, adolescent girls, and prepubertal female children because of their inherent 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 gifted women, adolescent girls, and prepubertal female children. These advantages become greater during and after male puberty, but they exist before puberty.

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

4 Male advantages in measurements of body composition, tests of physical fitness,
5 and athletic performance have also been shown in children before puberty. These
6 advantages are magnified during puberty, triggered in large part by the higher testosterone
7 concentrations in men, and adolescent boys, after the onset of male puberty. Under the
8 influence of these higher testosterone levels, adolescent boys and young men develop even
9 more muscle mass, greater muscle strength, less body fat, higher bone mineral density,
10 greater bone strength, higher hemoglobin concentrations, larger hearts and larger coronary
11 blood vessels, and larger overall statures than women. In addition, maximal oxygen
12 consumption (VO₂max), which correlates to ~30-40% of success in endurance sports, is
13 higher in both elite and average men and boys than in comparable women and girls when
14 measured in regard to absolute volume of oxygen consumed and when measured relative
15 to body mass.

16 Although androgen deprivation (that is, testosterone suppression) may modestly
17 decrease some physiological advantages that men and adolescent boys have over equally
18 aged, trained, and gifted women and adolescent girls, it cannot fully or even largely
19 eliminate those physiological advantages once an individual has passed through male
20 puberty.

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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 dimorphic sex in the human species. It is now well recognized that dimorphic sex is so fundamental to human development that, as stated in a recent 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 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)" (<https://dictionary.apa.org>, accessed May 5, 2023). 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 at 220), the American Physiological Society (Shah 2014), the Institute of Medicine, and the National Institutes of Health (Miller 2014 at H781-82). 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

1 and testes, and in this way the categories-female and male-can be applied also to
2 individuals who have gonads but do not make gametes ... sex is dichotomous
3 because of the different roles of each sex in reproduction." (Bhargava 2021 at 221.)
4 Furthermore, "sex determination begins with the inheritance of XX or XY
5 chromosomes" (Bhargava 2021 at 221.) And, "Phenotypic sex differences develop
6 in XX and XY embryos as soon as transcription begins. The categories of X and Y
7 genes that are unequally represented or expressed in male and female mammalian
8 zygotes ... cause phenotypic sex differences" (Bhargava 2021 at 222.)

- 9 4. Although disorders of sexual development (DSDs) are sometimes confused with
10 discussions of transgender individuals, the two are different phenomena. DSDs are
11 disorders of physical development. Many DSDs are "associated with genetic
12 mutations that are now well known to endocrinologists and geneticists." (Bhargava
13 2021 at 225) By contrast, a sense of transgender identity is usually not associated
14 with any physical disorder, and "a clear biological causative underpinning of gender
15 identity remains to be demonstrated." (Bhargava 2021 at 226.) The importance of
16 distinguishing between the two is exemplified by the World Athletics Council
17 updating "...the eligibility regulations for transgender and DSD athletes to compete
18 in the female category" in March 2023. (World Athletics)
- 19 5. Further demonstrating the biological importance of sex, Gershoni and Pietrovski
20 (2017) detail the results of an evaluation of "18,670 out of 19,644 informative
21 protein-coding genes in men versus women" and reported that "there are over 6500
22 protein-coding genes with significant S[ex]D[ifferential] E[xpression] in at least
23 one tissue. Most of these genes have SDE in just one tissue, but about 650 have SDE
24 in two or more tissues, 31 have SDE in more than five tissues, and 22 have SDE in
25 nine or more tissues" (Gershoni 2017 at 2-3.) Some examples of tissues identified
26 by these authors that have SDE genes include breast mammary tissue, skeletal
27 muscle, skin, thyroid gland, pituitary gland, subcutaneous adipose, lung, and heart
28 left ventricle. Based on these observations the authors state "As expected, Y-linked

1 genes that are normally carried only by men show SDE in many tissues" (Gershoni
2 2017 at 3.) As stated by Heydari et al. (2022, at 1), "Y chromosome harbors
3 male-specific genes, which either solely or in cooperation with their X-counterpart,
4 and independent or in conjunction with sex hormones have a considerable impact
5 on basic physiology and disease mechanisms in most or all tissues development."
6 As stated out by O'Connor (2023, at 2, quoting Institute of Medicine) "not every
7 difference observed between male and female cells can be attributed to differences
8 in exposure to sex hormones."

- 9 6. In a review of 56 articles on the topic of sex-based differences in skeletal muscle,
10 Haizlip et al., (2015) state that "More than 3,000 genes have been identified as being
11 differentially expressed between male and female skeletal muscle." (Haizlip 2015
12 at 30.) Furthermore, the authors state that "Overall, evidence to date suggests that
13 skeletal muscle fiber-type composition is dependent on species, anatomical
14 location/function, and sex" (Haizlip 2015 at 30.) The differences in genetic
15 expression between males and females influence the skeletal muscle fiber
16 composition (i.e. fast twitch and fast twitch sub-type and slow twitch), the skeletal
17 muscle fiber size, the muscle contractile rate, and other aspects of muscle function
18 that influence athletic performance. As the authors review the differences in skeletal
19 muscle between males and females they conclude, "Additionally, all of the fibers
20 measured in men have significantly larger cross-sectional areas (CSA) compared
21 with women." (Haizlip 2015 at 31.) The authors also explore the effects of thyroid
22 hormone, estrogen, and testosterone on gene expression and skeletal muscle
23 function in males and females. One major conclusion by the authors is that "The
24 complexity of skeletal muscle and the role of sex adding to that complexity cannot
25 be overlooked." (Haizlip 2015 at 37.) The evaluation of SDE in protein coding genes
26 helps illustrate that the differences between men and women are intrinsically part of
27 the chromosomal and genetic makeup of humans which can influence many tissues
28 that are inherent to the athletic competitive advantages of men compared to women.

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

3 7. It should scarcely be necessary to invoke scientific experts to "prove" that men are
4 on average larger, stronger, and faster than women. All of us, along with our siblings
5 and our peers and perhaps our children, have passed through puberty, and we have
6 watched that differentiation between the sexes occur. This is common human
7 experience and knowledge.

8 8. Nevertheless, these differences have been extensively studied and measured. I cited
9 many of these studies in the first paper on this topic that I prepared, which was
10 submitted in litigation in January 2020. Since then, in light of current controversies,
11 several authors have compiled valuable collections or reviews of data extensively
12 documenting this objective fact about the human species, as manifest in almost all
13 sports, each of which I have reviewed and found informative. These include
14 Coleman (2020), Hilton & Lundberg (2021), World Rugby (2020), Harper (2021),
15 Hamilton (2021), and a "Briefing Book" prepared by the Women's Sports Policy
16 Working Group (2021). The important paper by Handelsman et al. (2018) also
17 gathers scientific evidence of the systematic and large male athletic advantage.

18 9. These papers and many others document that men, adolescent boys, and prepubertal
19 male children, substantially outperform comparably aged, gifted, and trained
20 women, adolescent girls and prepubertal female children, in competitions involving
21 running speed, swimming speed, cycling speed, jumping height, jumping distance,
22 and strength (to name a few, but not all, of the performance differences). As I discuss
23 later, it is now clear that these performance advantages for men, adolescent boys,
24 and prepubertal male children, are inherent to the biological differences between the
25 sexes.

26 10. In fact, I am not aware of any scientific evidence today that disproves that after
27 puberty men possess large advantages in athletic performance over women-so large
28 that they are generally insurmountable for comparably gifted and trained athletes at

1 every level (i.e. (a) elite, (b) collegiate, (c) scholastic, and (d) recreational
2 competition). And I am not aware of any scientific evidence today that disproves
3 that these measured performance advantages are at least largely the result of
4 physiological differences between men and women which have been measured and
5 are reasonably well understood.

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

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

- 19 • Handelsman et al. (2018) wrote, "Virtually all elite sports are segregated into
20 male and female competitions. The main justification is to allow women a
21 chance to win, as women have major disadvantages against men who are, on
22 average, taller, stronger, and faster and have greater endurance due to their
23 larger, stronger, muscles and bones as well as a higher circulating hemoglobin
24 level." (803)
- 25 • Millard-Stafford et al. (2018) wrote "Current evidence suggests that women will
26 not swim or run as fast as men in Olympic events, which speaks against
27 eliminating sex segregation in these individual sports" (530) "Given the
28 historical context (2% narrowing in swimming over 44 y), a reasonable

1 assumption might be that no more than 2% of the current performance gap could
2 still potentially be attributed to sociocultural influences.", (533) and
3 "Performance gaps between US men and women stabilized within less than a
4 decade after federal legislation provided equal opportunities for female
5 participation, but only modestly closed the overall gap in Olympic swimming by
6 2% (5% in running)." (533) Dr. Millard-Stafford, a full professor at Georgia
7 Tech, holds a Ph.D. in Exercise Physiology and is a past President of the
8 American College of Sports Medicine.

- 9
- 10 • In 2021, Hilton et al. wrote, "most sports have a female category the purpose of
11 which is the protection of both fairness and, in some sports, safety/welfare of
12 athletes who do not benefit from the physiological changes induced by male
13 levels of testosterone from puberty onwards." (204)
 - 14 • In 2020 the Swiss High Court ("Tribunal Federal") observed that "in most sports
15 . . . women and men compete in two separate categories, because the latter
16 possess natural advantages in terms of physiology."¹
 - 17 • The members of the Women's Sports Policy Working Group wrote that "If
18 sports were not sex-segregated, female athletes would rarely be seen in finals or
19 on victory podiums," and that "We have separate sex sport and eligibility criteria
20 based on biological sex because this is the only way we can assure that female
21 athletes have the same opportunities as male athletes not only to participate but
22 to win in competitive sport. . . . If we did not separate athletes on the basis of
23 biological sex-if we used any other physical criteria-we would never see
24 females in finals or on podiums." (WSPWG Briefing Book 2021 at 5, 20.)
 - 25 • In 2020, the World Rugby organization stated that "the women's category exists
26 to ensure protection, safety and equality for those who do not benefit from the

27 ¹ "dans la plupart des sports . . . les femmes et les hommes concourent dans deux categories
28 se, Parees, ces demiers etant naturellement avantages du point de vue physique." Tribunal
Federal decision of August 25, 2020, Case 4A_248/2019, 4A_398/2019, at 9.8.3.3.

1 biological advantage created by these biological performance attributes."
2 (World Rugby Transgender Women Guidelines 2020.)

- 3 • In 2021 Harper et al. stated "...the small decrease in strength in transwomen
4 after 12-36 months of GAHT [Gender Affirming Hormone Therapy] suggests
5 that transwomen likely retain a strength advantage over cisgender women." (7)
6 and "...observations in trained transgender individuals are consistent with the
7 findings of the current review in untrained transgender individuals, whereby 30
8 months of GAHT may be sufficient to attenuate some, but not all, influencing
9 factors associated with muscular endurance and performance." (8)
- 10 • Hamilton et al (2021), "If a biologically male athlete self-identifies as a female,
11 legitimately with a diagnosis of gender dysphoria or illegitimately to win
12 medals, the athlete already possesses a physiological advantage that undermines
13 fairness and safety. This is not equitable, nor consistent with the fundamental
14 principles of the Olympic Charter and could be a potential danger to the health
15 and safety of athletes." (840)
- 16 • Hamilton et al. (2021), in a consensus statement for the International Federation
17 of Sports Medicine (FIMS) concluded that "Transwomen have the right to
18 compete in sports. However, cisgender women have the right to compete in a
19 protected category." (1409)

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

23 **A. Men are stronger.**

- 24 14. Males exhibit greater strength throughout the body. Both Handelsman et al. (2018)
25 and Hilton & Lundberg (2021) have gathered multiple literature references that
26 document this fact in various muscle groups.
- 27 15. Men have in the neighborhood of 60%-100% greater **arm strength** than women.

28

1 (Handelsman 2018 at 812.)² One study of elbow flexion strength (basically,
2 bringing the fist up towards the shoulder) in a large sample of men and women found
3 that men exhibited 109% greater isometric strength, and 89% higher strength in a
4 single repetition. (Hilton 2021 at 204, summarizing Rubal (2005) at Table 2.)

5 16. **Grip strength** is often used as a useful proxy for strength more generally. In one
6 study, men showed on average 57% greater grip strength than women. (Bohannon
7 2019.) A wider meta-analysis of multiple grip-strength studies not limited to athletic
8 populations found that 18- and 19-year-old males exhibited in the neighborhood of
9 2/3 greater grip strength than females. (Handelsman 2017 Figure 3, summarizing
10 Silverman 2011 Table 1.)³

11 17. Liguori et al. (2021), in the *ACSM's Guidelines for Exercise Testing and*
12 *Prescription* which is the flagship textbook for the American College of Sports
13 Medicine and is considered the industry standard for information on evaluating
14 physical fitness in adults, demonstrates that across all age groups and percentiles
15 when comparing males and females, male handgrip strength is 66.2% higher than
16 females (Table 3.10 at 95). To help illustrate this sex-based difference in handgrip
17 strength, a 20-24-year-old male who ranks in the 95th percentile has 55 kg for
18 handgrip strength in the dominant hand while a 20-24-year-old female who ranks
19 in the 95th percentile has 34 kg for handgrip strength in the dominant hand. For
20 comparison, a 20-24-year-old male with a handgrip strength of 34 kg would be in
21 the 10th percentile for males.

22 18. In an evaluation of maximal isometric handgrip strength in 1,654 healthy men, 533

23
24 ² Handelsman expresses this as women having 50% to 60% of the "upper limb" strength
25 of men. Handelsman cites Sale, *Neuromuscular function*, for this figure and the "lower
26 limb" strength figure. Knox et al., *Transwomen in elite sport* (2018) are probably confusing
27 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.

28 ³ Citing Silverman, *The secular trend for grip strength in Canada and the United States*, *J.*
Ports Sci. 29:599-606 (2011).

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

6 19. Liguori et al. (2021), in the *ACSM's Guidelines for Exercise Testing and*
7 *Prescription* indicates that when measuring upper body strength using bench press
8 and expressing strength as the maximal weight lifted relative to body weight, males
9 exhibit 64% greater strength (Table 3.11 at 96-97). To help illustrate this sex-based
10 difference in upper body strength, an under 20-year-old male who ranks in the 95th
11 percentile can bench press 1.76 kg for every kg of body mass while an under 20-
12 year-old female who ranks in the 95th percentile can bench press 0.88 kg for every
13 kg of body mass. For comparison, an under 20-year-old male with a bench press
14 strength of 0.88 kg per kg of body mass would be between the 15th and 20th
15 percentile for males.

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

20 21. Liguori et al. (2021), in the *ACSM's Guidelines for Exercise Testing and*
21 *Prescription* (Table 3.12 at 98), across all age groups and percentiles when
22 comparing males and females, when measuring leg press strength as the maximal
23 weight lifted relative to body weight, males exhibit 39% greater strength. To help
24 illustrate this sex-based difference in lower body strength, a 20-29-year-old male
25 who ranks in the 90th percentile can leg press 2.27 kg for every kg of body mass
26 while a 20-29-year-old female who ranks in the 90th percentile can leg press 1.82
27 kg for every kg of body mass. For comparison, a 20-29-year-old male who can leg
28 press 1.82 kg for every kg of body mass would be between the 30th and 40th

1 percentiles for males.

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

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

14 "I've fought a lot of women and have never felt the strength
15 that I felt in a fight as I did that night. I can't answer whether
16 it's because she was born a man or not because I'm not a
17 doctor. I can only say, I've never felt so overpowered ever in
18 my life, and I am an abnormally strong female in my own
19 right."⁴

20 **B. Men run faster.**

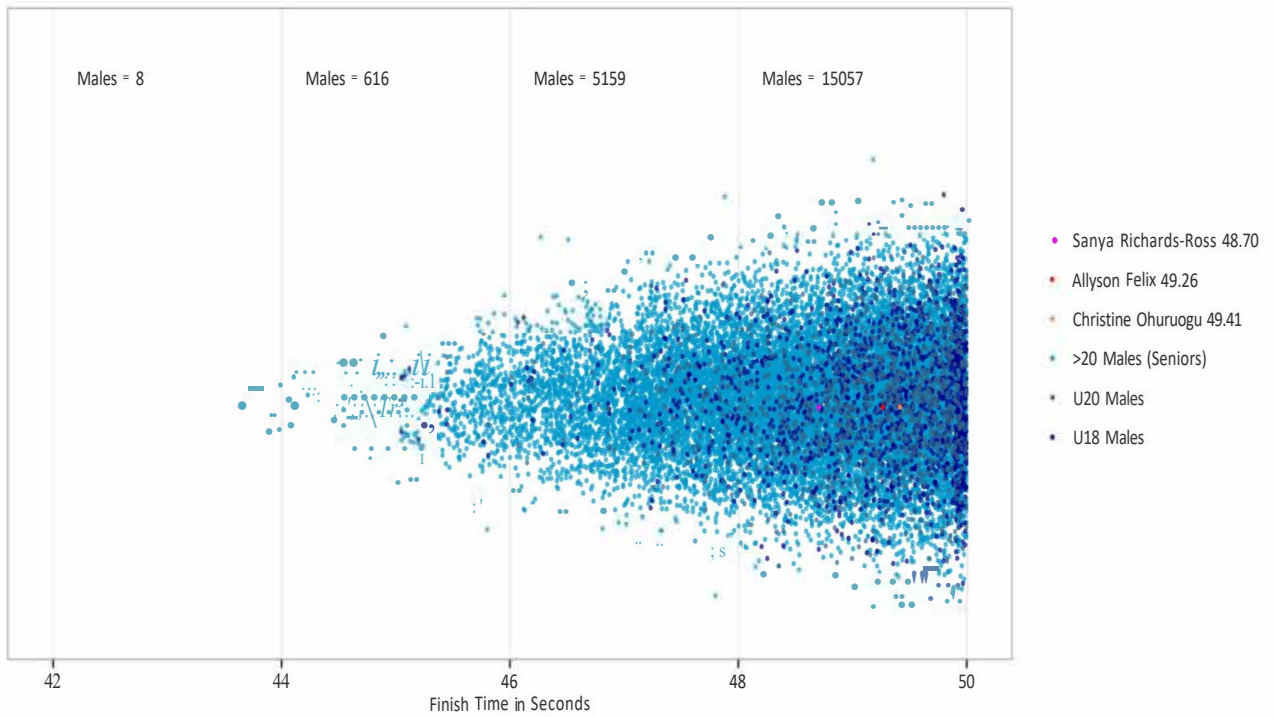
21 24. Many scholars have detailed the wide performance advantages enjoyed by men in
22 running speed. One can come at this reality from a variety of angles.

23 25. Multiple authors report a male speed advantage in the neighborhood of 10%-13%
24 in a variety of events, with a variety of study populations. Handelsman et al. 2018
25 at 813 and Handelsman 2017 at 70 both report a male advantage of about 10% by
26 age 17. Thibault et al. 2010 at 217 similarly reported a stable 10% performance

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28 ⁴ <http://whoatv.com/exclusive-fallon-foxs-latest-opponent-opens-up-to-whoatv/> (last
accessed May 5, 2023).

1 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
3 events after the completion of puberty. They document this for both short sprints
4 and longer distances. One group of authors found that the male advantage increased
5 dramatically in ultra-long-distance competition (Lepers & Knechtle 2013.)

6 26. A great deal of current interest has been focused on track events. It is worth noting
7 that a recent analysis of publicly available sports federation and tournament records
8 found that men enjoy the *least* advantage in running events, as compared to a range
9 of other events and metrics, including jumping, pole vaulting, tennis serve speed,
10 golf drives, baseball pitching speed, and weightlifting. (Hilton 2021 at 201-202.)
11 Nevertheless, as any serious runner will recognize, the approximately 10% male
12 advantage in running is an overwhelming difference. Dr. Hilton calculates that
13 "approximately 10,000 males have personal best times that are faster than the
14 current Olympic 100m female champion." (Hilton 2021 at 204.) Professors Doriane
15 Coleman, Jeff Wald, Wickliffe Shreve, and Richard Clark dramatically illustrated
16 this by compiling the data and creating the figure below (last accessed on May 5,
17 2023, at <https://bit.ly/35yOyS4>), which shows that the *lifetime bestperformances* of
18 three female Olympic champions in the 400m event-including Team USA's Sanya
19 Richards-Ross and Allyson Felix-would not match the performances of "literally
20 thousands of boys and men, including thousands who would be considered second
21 tier in the men's category" *just in 2017 alone*: (data were drawn from the
22 International Association of Athletics Federations (IAAF) website which provides
23 complete, worldwide results for individuals and events, including on an annual and
24 an all-time basis).



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27. Professor Coleman and her colleague Wicklyffe Shreve also created the table below (last accessed on May 5, 2023, at <https://bit.ly/37Els2X>), 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."

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17 **TABLE 2 - World's Best Woman v. Number of Men Outperfonning**

Event	Best Women's Result	Best Men's Result	# of Men Outperfonning
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

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28. 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.)

1 29. Similarly, Coleman and Shreve created the table below (last accessed on May 5,
 2 2023, at <https://bit.ly/37Els2X>), which "compares the number of boys-males
 3 under the age of 18-whose results in each event in 2017 would rank them above
 4 the single very best elite [adult] woman that year:" data were drawn from the
 5 International Association of Athletics Federations (IAAF) website

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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

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14 30. In an analysis I have performed of running events (consisting of the 100 m, 200 m,
15 400 m, 800 m, 1500 m, 5000 m, and 10000 m) in the Division I, Division II, and
16 Division III NCAA Outdoor track championships for the years of 2010-2019, the
17 average performance across all events of the 1st place man was 14.1 % faster than
18 the 1st place woman, with the smallest difference being a 10.2% advantage for men
19 in the Division I 100 m race. The average 8th place man across all events (the last
20 place to earn the title of All American) was 11.2% faster than 1st place woman, with
21 the smallest difference being a 6.5% advantage for men in the Division I 100 m race.
22 Importantly, the only overlap between men's and women's performance occurred
23 only when a male performed exceptionally poorly (Brown et al. presented at the
24 2022 Annual Meeting of the American College of Sports Medicine.)

25 31. Athletic.net® is an internet-based resource providing "results, team, and event
26 management tools to help coaches and athletes thrive." Among the resources
27 available on Athletic.net are event records that can be searched nationally or by state
28 age group, school grade, and state. Higerd (2021) in an evaluation of high school

1 track running performance records from five states (CA, FL, MN, NY, WA), over
2 three years (2017 - 2019) observed that males were 14.38% faster than females in
3 the 100M (at 99), 16.17% faster in the 200M (at 100), 17.62% faster in the 400M
4 (at 102), 17.96% faster in the 800M (at 103), 17.81 % faster in the 1600M (at 105),
5 and 16.83% faster in the 3200M (at 106).

6 **C. Men jump higher and farther.**

7 32. Jumping involves both leg strength and speed as positive factors, with body weight
8 of course a factor working against jump height. Despite their substantially greater
9 body weight, males enjoy an even greater advantage in jumping than in running.
10 Handelsman 2018 at 813, looking at youth and young adults, and Thibault 2010 at
11 217, looking at Olympic performances, both found male advantages in the range of
12 15%-20%. See also Tonnessen 2015 (approximately 19%); Handelsman 2017
13 (19%); Hilton 2021 at 201 (18%). Looking at the vertical jump called for in
14 volleyball, research on elite volleyball players found that males jumped on average
15 50% higher during an "attack" at the net than did females. (Sattler 2015; see also
16 Hilton 2021 at 203 (33% higher vertical jump).)

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

25 34. The combined male advantage of body height and jump height means, for example,
26 that a total of seven women in the WNBA have ever dunked a basketball in the
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1 regulation 10 foot hoop,⁵ while the ability to dunk appears to be almost universal
2 among NBA players: "Since the 1996-97 season (the earliest data is available from
3 Basketball-Reference.com), 1,801 different [NBA] players have combined for
4 210,842 regular-season dunks, and 1,259 out of 1,367 players (or 92%) who have
5 played at least 1,000 minutes have dunked at least once."⁶

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

7 35. Strength, arm-length, and speed combine to give men a large advantage over women
8 in throwing. This has been measured in a number of studies.

9 36. One study of elite male and female baseball pitchers showed that men throw
10 baseballs 35% faster than women-81 miles/hour for men vs. 60 miles/hour for
11 women. (Chu 2009.) By age 12, "boys' throwing velocity is already between 3.5
12 and 4 standard deviation units higher than the girls'." (Thomas 1985 at 276.) By age
13 seventeen, the *average* male can throw a ball farther than 99% of seventeen-year-
14 old females. (Lombardo 2018; Chu 2009; Thomas 1985 at 268.) Looking at publicly
15 available data, Hilton & Lundberg found that in both baseball pitching and the field
16 hockey "drag flick," the *record* ball speeds achieved by males are more than 50%
17 higher than those achieved by females. (Hilton 2021 at 202-203.)

18 37. Men achieve serve speeds in tennis more that 15% faster than women; and likewise
19 in golf achieve ball speeds off the tee more than 15% faster than women. (Hilton
20 2021 at 202.)

21 38. More specifically, Marshall and Llewellyn (at 957) reported that female collegiate
22 golfers at an NCAA Division III school have an average drive distance that is 46
23 yards (16.5%) fewer than males, a maximal drive distance of 33.2 yards (11.1%)
24 fewer, an average club head speed that is 21.9 mph (20.4%) slower, and a maximum
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26 ⁵ https://www.espn.com/wnba/story/_/id/32258450/2021-wnba-playoffs-brittney-griner-owns-wnba-dunking-record-coming-more.

27 ⁶ <https://www.si.com/nba/2021/02/22/nba-non-dunkers-patty-mills-tj-mcconnell-steve-novak-daily-cover>

1 club head speed that is 18 mph (15.3%) slower. Using 3D motion analysis to
2 evaluate the kinematics of 7 male and 5 female golfers with a mean handicap of 6,
3 Egret (at 463) concluded that "The results of this study show that there is a specific
4 swing for women." Horan used 3D motion analysis to evaluate the kinematics of
5 19 male and 19 female golfers with a handicap less than or equal to 4 and concluded
6 "the results suggest that male and female skilled golfers have different kinematics
7 for thorax and pelvis motion" and "What might be considered optimal swing
8 characteristics for male golfers should not be generalized to female golfers." (at
9 1456).

10 39. Males are able to throw a javelin more than 30% farther than females. (Lombardo
11 2018 Table 2; Hilton 2021 at 203.)

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

14 41. Men are also able to kick balls harder and faster. A study comparing collegiate
15 soccer players found that males kick the ball with an average 20% greater velocity
16 than females. (Sakamoto 2014.)

17 **E. Males exhibit faster reaction times.**

18 42. Interestingly, men enjoy an additional advantage over women in reaction time-an
19 attribute not obviously related to strength or metabolism (e.g. V02max). "Reaction
20 time in sports is crucial in both simple situations such as the gun shot in sprinting
21 and complex situations when a choice is required. In many team sports this is the
22 foundation for tactical advantages which may eventually determine the outcome of
23 a game." (Dogan 2009 at 92.) "Reaction times can be an important determinant of
24 success in the 100m sprint, where medals are often decided by hundredths or even
25 thousandths of a second." (Tonnessen 2013 at 885.)

26 43. The existence of a sex-linked difference in reaction times is consistent over a wide
27 range of ages and athletic abilities. (Dykiert 2012.) Even by the age of 4 or 5, in a
28 ruler-drop test, males have been shown to exhibit 4% to 6% faster reaction times

1 than females. (Latorre-Roman 2018.) In high school athletes taking a common
2 baseline "ImPACT" test, males showed 3% faster reaction times than females.
3 (Mormile 2018.) Researchers have found a 6% male advantage in reaction times of
4 both first-year medical students (Jain 2015) and world-class sprinters (Tønnessen
5 2013).

6 44. Most studies of reaction times use computerized tests which ask participants to hit
7 a button on a keyboard or to say something in response to a stimulus. One study on
8 NCAA athletes measured "reaction time" by a criterion perhaps more closely related
9 to athletic performance—that is, how fast athletes covered 3.3 meters after a starting
10 signal. Males covered the 3.3 meters 10% faster than females in response to a visual
11 stimulus, and 16% faster than females in response to an auditory stimulus. (Spierer
12 2010.)

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

17 **III. Men have large measured physiological differences compared to women which**
18 **demonstrably or likely explain their performance advantages.**

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

23 **A. Men are taller and heavier than women**

24 47. In some sports, such as basketball and volleyball, height itself provides competitive
25 advantage. While some women are taller than some men, based on data from 20
26 countries in North America, Europe, East Asia, and Australia, the 50th percentile for
27 body height for women is 164.7 cm (5 ft 5 inches) and the 50th percentile for body
28 height for men is 178.4 cm (5 ft 10 inches). Helping to illustrate the inherent height

1 difference between men and women, from the same data analysis, the 95th percentile
2 for body height for women is 178.9 cm (5 feet 10.43 inches), which is only 0.5 cm
3 taller than the 50th percentile for men (178.4 cm; 5 feet 10.24 inches), while the 95th
4 percentile for body height for men is 193.6 cm (6 feet 4.22 inches). Thus, while
5 some women are taller than some men, the tallest men are taller than the tallest
6 women (Roser 2013.)

7 48. To look at a specific athletic population, an evaluation of NCAA Division I
8 basketball players compared 68 male guards and 59 male forwards to 105 female
9 guards and 91 female forwards, and found that on average the male guards were
10 187.4 ± 7.0 cm tall and weighed 85.2 ± 7.4 kg while the female guards were 171.6
11 ± 5.0 cm tall and weighed 68.0 ± 7.4 kg. The male forwards were 201.7 ± 4.0 cm
12 tall and weighed 105.3 ± 5.9 kg while the female forwards were 183.5 ± 4.4 cm tall
13 and weighed 82.2 ± 12.5 kg. (Fields 2018 at 3.)

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

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

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

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

1 52. Greater height, leg, and arm length themselves provide obvious advantages in
2 several sports. But male bone geometry also provides less obvious advantages. "The
3 major effects of men's larger and stronger bones would be manifest via their taller
4 stature as well as the larger fulcrum with greater leverage for muscular limb power
5 exerted in jumping, throwing, or other explosive power activities." (Handelsman
6 2018 at 818.)

7 53. Male advantage in bone size is not limited to length, as larger bones provide the
8 mechanical framework for larger muscle mass. "From puberty onwards, men have,
9 on average, 10% more bone providing more surface area. The larger surface area of
10 bone accommodates more skeletal muscle so, for example, men have broader
11 shoulders allowing more muscle to build. This translates into 44% less upper body
12 strength for women, providing men an advantage for sports like boxing,
13 weightlifting and skiing. In similar fashion, muscle mass differences lead to
14 decreased trunk and lower body strength by 64% and 72%, respectively in women.
15 These differences in body strength can have a significant impact on athletic
16 performance, and largely underwrite the significant differences in world record
17 times and distances set by men and women." (Knox 2019 at 397.)

18 54. Meanwhile, distinctive aspects of the female pelvis geometry cut against athletic
19 performance. "[T]he widening of the female pelvis during puberty, balancing the
20 evolutionary demands of obstetrics and locomotion, retards the improvement in
21 female physical performance." (Handelsman 2018 at 818.) "[T]he major female
22 hormones, oestrogens, can have effects that disadvantage female athletic
23 performance. For example, women have a wider pelvis changing the hip structure
24 significantly between the sexes. Pelvis shape is established during puberty and is
25 driven by oestrogen. The different angles resulting from the female pelvis leads to
26 decreased joint rotation and muscle recruitment ultimately making them slower."
27 (Knox 2019 at 397.)

28 55. There are even sex-based differences in foot size and shape. Wunderlich &

1 Cavanaugh (2001) observed that a "foot length of 257 mm represents a value that is
2 ... approximately the 20th percentile men's foot lengths and the 80th percentile
3 women's foot lengths." (607) and "For a man and a woman, both with statures of
4 170 cm (5 feet 7 inches), the man would have a foot that was approximately 5 mm
5 longer and 2 mm wider than the woman." (608). Based on these, and other analyses,
6 they conclude that "female feet and legs are not simply scaled-down versions of
7 male feet but rather differ in a number of shape characteristics, particularly at the
8 arch, the lateral side of the foot, the first toe, and the ball of the foot." (605) Further,
9 Fessler et al. (2005) observed that "female foot length is consistently smaller than
10 male foot length" (44) and concludes that "proportionate foot length is smaller in
11 women" (51) with an overall conclusion that "Our analyses of genetically disparate
12 populations reveal a clear pattern of sexual dimorphism, with women consistently
13 having smaller feet proportionate to stature than men." (53)

14 56. Beyond simple performance, the greater density and strength of male bones provide
15 higher protection against stresses associated with extreme physical effort: "[S]tress
16 fractures in athletes, mostly involving the legs, are more frequent in females, with
17 the male protection attributable to their larger and thicker bones." (Handelsman
18 2018 at 818.)

19 **C. Males have much larger muscle mass.**

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

23 58. "On average, women have 50% to 60% of men's upper arm muscle cross-sectional
24 area and 65% to 70% of men's thigh muscle cross-sectional area, and women have
25 50% to 60% of men's upper limb strength and 60% to 80% of men's leg strength.
26 Young men have on average a skeletal muscle mass of >12 kg greater than age-
27 matched women at any given body weight." (Handelsman 2018 at 812. See also
28 Gooren 2011 at 653, Thibault 2010 at 214.)

1 59. "There is convincing evidence that the sex differences in muscle mass and strength
2 are sufficient to account for the increased strength and aerobic performance of men
3 compared with women and is in keeping with the differences in world records
4 between the sexes." (Handelsman 2018 at 816.)

5 60. As stated in the National Strength and Conditioning Association's *Guide to Tests*
6 *and Assessments* "Sport performance is highly dependent on the health- and skill-
7 related components of fitness (power, speed, agility, reaction time, balance, and
8 Body Composition coordination) in addition to the athlete's technique and level of
9 competency in sport-specific motor skills. All fitness components depend on body
10 composition to some extent. An increase in lean body mass contributes to strength
11 and power development. ... Thus, an increase in lean body mass enables the athlete
12 to generate more force in a specific period of time. A sufficient level of lean body
13 mass also contributes to speed, quickness, and agility performance (in the
14 development of force applied to the ground for maximal acceleration and
15 deceleration)." ([https://www.nsc.com/education/articles/kinetic-select/sport-](https://www.nsc.com/education/articles/kinetic-select/sport-performance-and-body-composition/)
16 [performance-and-body-composition/](https://www.nsc.com/education/articles/kinetic-select/sport-performance-and-body-composition/) last accessed May 10, 2023)

17 61. Once again, looking at specific and comparable populations of athletes, an
18 evaluation of NCAA Division I basketball players consisting of 68 male guards and
19 59 male forwards, compared to 105 female guards and 91 female forwards, reported
20 that on average the male guards had 77.7 ± 6.4 kg of fat free mass and 7.4 ± 3.1 kg
21 fat mass while the female guards had 54.6 ± 4.4 kg fat free mass and 13.4 ± 5.4 kg
22 fat mass. The male forwards had 89.5 ± 5.9 kg fat free mass and 15.9 ± 5.6 kg fat
23 mass while the female forwards had 61.8 ± 5.9 kg fat free mass and 20.5 ± 7.7 kg
24 fat mass. (Fields 2018 at 3.)

25 **D. Females have a larger proportion of body fat.**

26 62. While women have smaller muscles, they have proportionately more body fat, in
27 general a negative for athletic performance. "Oestrogens also affect body
28 composition by influencing fat deposition. Women, on average, have higher

1 percentage body fat, and this holds true even for highly trained healthy athletes (men
2 5%-10%, women 8%-15%). Fat is needed in women for normal reproduction and
3 fertility, but it is not performance-enhancing. This means men with higher muscle
4 mass and less body fat will normally be stronger kilogram for kilogram than
5 women." (Knox 2019 at 397.)

6 63. Looking once again to Liguri (2021) in *the ACSM's Guidelines for Exercise Testing*
7 *and Prescription* (Tables 3.4 and 3.5 at 73 and 74), a 20-29-year-old male in the
8 99th percentile will have 4.2% body fat, while a 20-29-year-old female in the 99th
9 percentile will have 11.4% body fat, meaning the female has 170% more fat relative
10 to body mass than the male. Comparing a 20-29-year-old male and female in the
11 50th percentile (that is "average") the male will have 16.7% body fat and the female
12 will have 21.8% body fat, meaning that the female has 30% more fat relative to total
13 body mass than the male.

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

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

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

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

- 1 67. Energy release at the muscles depends centrally on the body's ability to deliver
2 oxygen to the muscles, where it is essential to the complex chain of biochemical
3 reactions that make energy available to power muscle fibers. Men have multiple
4 distinctive physiological attributes that together give them a large advantage in
5 oxygen delivery.
- 6 68. Oxygen is taken into the blood in the lungs. Men have greater capability to take in
7 oxygen for multiple reasons. "[L]ung capacity [is] larger in men because of a lower
8 diaphragm placement due to Y-chromosome genetic determinants." (Knox 2019 at
9 397.) Supporting larger lung capacity, men have "greater cross-sectional area of the
10 trachea"; that is, they can simply move more air in and out of their lungs in a given
11 time. (Hilton 2021 at 201.)
- 12 69. More, male lungs provide superior oxygen exchange even for a given volume: "The
13 greater lung volume is complemented by testosterone-driven **enhanced alveolar**
14 **multiplication** rate during the early years of life. Oxygen exchange takes place
15 between the air we breathe and the bloodstream at the alveoli, so more alveoli allows
16 more oxygen to pass into the bloodstream. Therefore, the greater lung capacity
17 allows more air to be inhaled with each breath. This is coupled with an improved
18 uptake system allowing men to absorb more oxygen." (Knox 2019 at 397.)
- 19 70. "Once in the blood, oxygen is carried by haemoglobin. **Haemoglobin**
20 **concentrations** are directly modulated by testosterone so men have higher levels
21 and can carry more oxygen than women." (Knox 2019 at 397.) "It is well known
22 that levels of circulating hemoglobin are androgen-dependent and consequently
23 higher in men than in women by 12% on average.... Increasing the amount of
24 hemoglobin in the blood has the biological effect of increasing oxygen transport
25 from lungs to tissues, where the increased availability of oxygen enhances aerobic
26 energy expenditure." (Handelsman 2018 at 816.) (See also Lepers 2013 at 853;
27 Handelsman 2017 at 71.) "It may be estimated that as a result the average maximal
28 oxygen transfer will be ~10% greater in men than in women, which has a direct

1 impact on their respective athletic capacities." (Handelsman 2018 at 816.)

2 71. But the male metabolic advantage is further multiplied by the fact that men are also
3 able to **circulate more blood per second** than are women. "Oxygenated blood is
4 pumped to the active skeletal muscle by the heart. The left ventricle chamber of the
5 heart is the reservoir from which blood is pumped to the body. The larger the left
6 ventricle, the more blood it can hold, and therefore, the more blood can be pumped
7 to the body with each heartbeat, a physiological parameter called 'stroke volume'.
8 The female heart size is, on average, 85% that of a male resulting in the stroke
9 volume of women being around 33% less." (Knox 2018 at 397.) Hilton cites
10 different studies that make the same finding, reporting that men on average can
11 pump 30% more blood through their circulatory system per minute ("cardiac
12 output") than can women. (Hilton 2021 at 202.)

13 72. Finally, at the cell where the energy release is needed, men appear to have yet
14 another advantage. "Additionally, there is experimental evidence that testosterone
15 increases . . . **mitochondrial biogenesis**, myoglobin expression, and IGF-1 content,
16 which may augment energetic and power generation of skeletal muscular activity."
17 (Handelsman 2018 at 811.)

18 73. "Putting all of this together, men have a much more efficient cardiovascular and
19 respiratory system." (Knox 2019 at 397.) A widely accepted measurement that
20 reflects the combined effects of all these respiratory, cardiovascular, and metabolic
21 advantages is referred to as "V02max," which refers to the maximum rate at which
22 an individual can consume oxygen during aerobic exercise.⁷ Looking at 11 separate
23 studies, including both trained and untrained individuals, Pate et al. concluded that
24 men have a 50% higher V02max than women on average, and a 25% higher V02max

25
26 ⁷ V02max is "based on hemoglobin concentration, total blood volume, maximal stroke
27 volume, cardiac size/mass/compliance, skeletal muscle blood flow, capillary density and
28 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.

1 in relation to body weight. (Pate 1984 at 92. See also Hilton 2021 at 202.)

2 **IV. The role of testosterone in the development of male advantages in athletic**
3 **performance.**

4 74. The following tables of reference ranges for circulating testosterone in males and
5 females are presented to help provide context for some of the subsequent
6 information regarding athletic performance and physical fitness in children, youth,
7 and adults, and regarding testosterone suppression in transwomen and athletic
8 regulations. These data were obtained from the Mayo Clinic Laboratories (available
9 at [https://www.mayocliniclabs.com/test-catalog/overview/83686#Clinical-and-](https://www.mayocliniclabs.com/test-catalog/overview/83686#Clinical-and-Interpretive)
10 [Interpretive](https://www.mayocliniclabs.com/test-catalog/overview/83686#Clinical-and-Interpretive), accessed May 5, 2023).

11 Reference ranges for serum testosterone concentrations in males and females.

12 Age	Males	Females
13 0-5 months	2.6- 13.9 nmol/l	0.7 -2.8 nmol/l
14 6 months - 9 years	0.2-0.7 nmol/l	0.2 - 0.7 nmol/l
15 10- 11 years	0.2 - 4.5 nmol/l	0.2 - 1.5 nmol/l
16 12 -13 years	0.2 - 27.7 nmol/l	0.2 - 2.6 nmol/l
17 14 years	0.2-41.6 nmol/l	0.2 - 2.6 nmol/l
18 15- 16 years	3.5 - 41.6 nmol/l	0.2 - 2.6 nmol/l
19 17-18 years	10.4- 41.6 nmol/l	0.7 - 2.6 nmol/l
20 19 years and older	8.3 - 32.9 nmol/l	0.3 - 2.1 nmol/l

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

23 75. Tanner Stages can be used to help evaluate the onset and progression of puberty and
24 may be more helpful in evaluating normal testosterone concentrations than age in
25 adolescents. "Puberty onset (transition from Tanner stage I to Tanner stage II)
26 occurs for boys at a median age of 11.5 years and for girls at a median age of 10.5
27 years.... Progression through Tanner stages is variable. Tanner stage V (young
28 adult) should be reached by age 18." (<https://www.mayocliniclabs.com/test->

1 catalog/overview/83686#Clinical-and-Interpretive, accessed May 5, 2023).

2 Reference Ranges for serum testosterone concentrations by Tanner stage

3 Tanner Stage	Males	Females
4 I (prepubertal)	0.2 - 0.7 nmol/l	0.7 - 0.7 nmol/l
5 II	0.3 - 2.3 nmol/l	0.2 - 1.6 nmol/l
6 III	0.9 - 27.7 nmol/l	0.6 - 2.6 nmol/l
7 IV	2.9 - 41.6 nmol/l	0.7 - 2.6 nmol/l
8 V (young adult)	10.4 - 32.9 nmol/l	0.4 - 2.1 nmol/l

9 76. Senefeld et al. (2020 at 99) state that "Data on testosterone levels in children and
10 adolescents segregated by sex are scarce and based on convenience samples or
11 assays with limited sensitivity and accuracy." They therefore "analyzed the timing
12 of the onset and magnitude of the divergence in testosterone in youths aged 6 to 20
13 years by sex using a highly accurate assay" (isotope dilution liquid chromatography
14 tandem mass spectrometry). Senefeld observed a significant difference beginning at
15 age 11, which is to say about fifth grade.

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

Age (y)	Boys			Girls		
	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

21
 22 **A. Boys exhibit advantages in athletic performance even before puberty.**

23 77. It is often said or assumed that boys enjoy no significant athletic advantage over
 24 girls before puberty. However, this is not true. Writing in their seminal work on the
 25 physiology of elite young female athletes, McManus and Armstrong (2011)
 26 reviewed the differences between boys and girls regarding bone density, body
 27 composition, cardiovascular function, metabolic function, and other physiologic
 28 factors that can influence athletic performance. They stated, "At birth, boys tend to

1 have a greater lean mass than girls. This difference remains small but detectable
2 throughout childhood with about a 10% greater lean mass in boys than girls prior to
3 puberty." (28) "Sexual dimorphism underlies much of the physiologic response to
4 exercise," and most importantly these authors concluded that, "Young girl athletes
5 are not simply smaller, less muscular boys." (23)

6 78. Certainly, boys' physiological and performance advantages increase rapidly from
7 the beginning of puberty until around age 17-19. But much data and multiple studies
8 show that significant physiological differences, and significant male athletic
9 performance advantages in certain areas, exist before significant developmental
10 changes associated with male puberty have occurred.

11 79. Starting at birth, girls have more body fat and less fat-free mass than boys. Davis et
12 al. (2019) in an evaluation of 602 infants reported that at birth and age 5 months,
13 infant boys have larger total body mass, body length, and fat-free mass while having
14 lower percent body fat than infant girls. In an evaluation of 20 boys and 20 girls
15 ages 3-8 years old, matched for age, height, and body weight Taylor et al. (Taylor
16 1997) reported that the "boys had significantly less fat, a lower % body fat and a
17 higher bone-free lean tissue mass than the girls" when "expressed as a percentage
18 of the average fat mass of the boys", the girls' fat mass was 52% higher than the
19 boys "...while the bone-free lean tissue mass was 9% lower" (at 1083.) In an
20 evaluation of 376 prepubertal [Tanner Stage 1] boys and girls, Taylor et al. (2010)
21 observed that the boys had 21.6% more lean mass, and 13% less body fat (when
22 expressed as percent of total body mass) than did the girls. In an evaluation of bone
23 mineral density in 1,432 boys and 1,483 girls who were an average of 6.2 years old
24 Medina-Gomez (2016) observed that the boys had 7.6% more lean body mass,
25 15.6% less fat mass, and ~5% higher bone mineral density than the girls (Table 1,
26 at 1102), and concluded that (at 1099), "bone sexual dimorphism is already present
27 at 6 years of age, with boys having stronger bones than girls, the relation of which
28 is influenced by body composition." In a review of 22 peer reviewed publications

1 on the topic, Staiano and Katzmarzyk (2012) conclude that "... girls have more
2 T[otal]B[ody]F[at] than boys throughout childhood and adolescence." (at 4.)

3 80. In the seminal textbook, *Growth, Maturation, and Physical Activity*, Malina et al.
4 (2004) present a summary of data from Gauthier et al. (1983) which present data
5 from "a national sample of Canadian children and youth" demonstrating that from
6 ages 7 to 17, boys have a higher aerobic power output than do girls of the same ages
7 when exercise intensity is measured using heart rate (Malina at 242.) That is to say,
8 that at a heart rate of 130 beats per minute, or 150, or 170, a 7 to 17 year old boy
9 should be able to run, bike, or swim faster than a similarly aged girl.

10 81. Considerable data from school-based fitness testing exists showing that prepubertal
11 boys outperform comparably aged girls in tests of muscular strength, muscular
12 endurance, and running speed. These sex-based differences in physical fitness are
13 relevant to the current issue of sex-based sports categories because, as stated by
14 Lesinski et al. (2020), in an evaluation "of 703 male and female elite young athletes
15 aged 8-18" (1) "fitness development precedes sports specialization" (2) and further
16 observed that "males outperformed females in C[ounter]M[ovement]J[ump],
17 D[rop]J[ump], C[hange]o[f]D[irection] speed] performances and hand grip
18 strength." (5).

19 82. Tambalis et al. (2016) states that "based on a large data set comprising 424,328 test
20 performances" (736) using standing long jump to measure lower body explosive
21 power, sit and reach to measure flexibility, timed 30 second sit ups to measure
22 abdominal and hip flexor muscle endurance, 10 x 5 meter shuttle run to evaluate
23 speed and agility, and multi-stage 20 meter shuttle run test to estimate aerobic
24 performance (738). "For each of the fitness tests, performance was better in boys
25 compared with girls ($p < 0.001$), except for the S[it and] R[each] test ($p < 0.001$)." (739)
26 In order to illustrate that the findings of Tambalis (2016) are not unique to
27 children in Greece, the authors state "Our findings are in accordance with recent
28 studies from Latvia [] Portugal [] and Australia [Catley & Tomkinson

1 (2013)]."(744).

2 83. The 20-m multistage fitness test is a commonly used maximal running aerobic
3 fitness test used in the Eurofit Physical Fitness Test Battery and the FitnessGram
4 Physical Fitness test. It is also known as the 20-meter shuttle run test, PACER test,
5 or beep test (among other names; this is not the same test as the shuttle run in the
6 Presidential Fitness Test). This test involves continuous running between two lines
7 20 meters apart in time to recorded beeps. The participants stand behind one of the
8 lines facing the second line and begin running when instructed by the recording.
9 The speed at the start is quite slow. The subject continues running between the two
10 lines, turning when signaled by the recorded beeps. After about one minute, a sound
11 indicates an increase in speed, and the beeps will be closer together. This continues
12 each minute (level). If the line is reached before the beep sounds, the subject must
13 wait until the beep sounds before continuing. If the line is not reached before the
14 beep sounds, the subject is given a warning and must continue to run to the line,
15 then turn and try to catch up with the pace within two more 'beeps'. The subject is
16 given a warning the first time they fail to reach the line (within 2 meters) and
17 eliminated after the second warning.

18 84. To illustrate the sex-based performance differences observed by Tambalis, I have
19 prepared the following table showing the number of laps completed in the 20 m
20 shuttle run for children ages 6-18 years for the low, middle, and top decile (Tambalis
21 2016 at 740 & 742), and have calculated the percent difference between the boys
22 and girls using the same equation as Millard-Stafford (2018).

23 Performance difference between boys and girls \div Girls performance
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1 **Number of laps completed in the 20m shuttle run for children ages 6-18 years**

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Age	Male			Female			Male-Female% Difference		
	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	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%

19 85. The Presidential Fitness Test was widely used in schools in the United States from
 20 the late 1950s until 2013 (when it was phased out in favor of the Presidential Youth
 21 Fitness Program and FitnessGram, both of which focus on health-related physical
 22 fitness and do not present data in percentiles). Students participating in the
 23 Presidential Fitness Test could receive "The National Physical Fitness Award" for
 24 performance equal to the 50th percentile in five areas of the fitness test, "while
 25 performance equal to the 85th percentile could receive the Presidential Physical
 26 Fitness Award." Tables presenting the 50th and 85th percentiles for the Presidential
 27 Fitness Test for males and females ages 6 - 17, and differences in performance
 28

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

3 86. For both the 50th percentile (The National Physical Fitness Award) and the 85th
4 percentile (Presidential Physical Fitness Award), with the exception of curl-ups in
5 6-year-old children, boys outperform girls. The difference in pull-ups for the 85th
6 percentile for ages 7 through 17 are particularly informative with boys
7 outperforming girls by 100% - 1200%, highlighting the advantages in upper body
8 strength in males.

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

16 88. Hilton et al., also writing in 2021, reached the same conclusion: "An extensive
17 review of fitness data from over 85,000 Australian children aged 9-17 years old
18 showed that, compared with 9-year-old females, 9-year-old males were faster over
19 short sprints (9.8%) and 1 mile (16.6%), could jump 9.5% further from a standing
20 start (a test of explosive power), could complete 33% more push-ups in 30 [seconds]
21 and had 13.8% stronger grip." (Hilton 2021 at 201, summarizing the findings of
22 Catley & Tomkinson 2013.)

23 89. The following data are taken from Catley & Tomkinson (2013 at 101) showing the
24 low, middle, and top decile for 1.6 km run (1.0 mile) run time for 11,423 girls and
25 boys ages 9-17.
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1 **1.6 km run (1.0 mile) run time for 11,423 girls and boys ages 9-17**

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Age	Male			Female			Male-Female % Difference		
	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%

15 90. Tomkinson et al. (2018) performed a similarly extensive analysis of literally
 16 millions of measurements of a variety of strength and agility metrics from the
 17 "Eurofit" test battery on children from 30 European countries. They provide detailed
 18 results for each metric, broken out by decile. Sampling the low, middle, and top
 19 decile, 9-year-old boys performed better than 9-year-old girls by between 6.5% and
 20 9.7% in the standing broad jump; from 11.4% to 16.1 % better in handgrip; and from
 21 45.5% to 49.7% better in the "bent-arm hang." (Tomkinson 2018.)

22 91. The Bent Arm Hang test is a measure of upper body muscular strength and
 23 endurance used in the Eurofit Physical Fitness Test Battery. To perform the Bent
 24 Arm Hang, the child is assisted into position with the body lifted to a height so that
 25 the chin is level with the horizontal bar (like a pull up bar). The bar is grasped with
 26 the palms facing away from body and the hands shoulder width apart. The timing
 27 starts when the child is released. The child then attempts to hold this position for as
 28

1 long as possible. Timing stops when the child's chin falls below the level of the bar,
2 or the head is tilted backward to enable the chin to stay level with the bar.

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

6
7 **Bent Arm Hang time (in seconds) for children ages 9 - 17 years**

Age	Male			Female			Male-Female% Difference		
	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile	%ile	%ile	%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%

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19
20
21 93. Evaluating these data, a 9-year-old boy in the 50th percentile (that is to say a 9-year-
22 old boy of average upper body muscular strength and endurance) will perform better
23 in the bent arm hang test than 9 through 17-year-old girls in the 50th percentile.
24 Similarly, a 9-year-old boy in the 90th percentile will perform better in the bent arm
25 hang test than 9 through 17-year-old girls in the 90th percentile.

26 94. Using data from Tomkinson et al. (2017; table 1 at 1549), the following table
27 sampling the low, middle, and top decile for running speed in the last stage of the
28 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)

Age	Male			Female			Male-Female % Difference		
	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%

95. 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.

96. 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.

97. 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,

1 Germany, Hungary, Italy, Cyprus, Spain, Belgium, and Estonia. (De Miguel-Etayo
2 et al. 2014.) The authors observed " ... that boys performed better than girls in speed,
3 lower- and upper-limb strength and cardiorespiratory fitness." (57) The data showed
4 that for children of comparable fitness (i.e. 99th percentile boys vs. 99th percentile
5 girls, 50th percentile boys vs. 50th percentile girls, etc.) the boys outperform the
6 girls at every age in measurements of handgrip strength, standing long jump, 20-m
7 shuttle run, and predicted VO₂max (pages 63 and 64, respectively). For
8 clarification, VO₂max is the maximal oxygen consumption, which correlates to 30-
9 40% of success in endurance sports.

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

19 99. Using data from De Miguel-Etayo et al. (2014, table 3 at 61), which analyzed
20 physical fitness measurements of 10,302 children aged 6 -10.9 years of age, from
21 the European countries of Sweden, Germany, Hungary, Italy, Cyprus, Spain,
22 Belgium, and Estonia, the following table sampling the low, middle, and top decile
23 for standing long jump for 6- to 9-year-old children can be constructed:
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1 **Standing Broad Jump (cm) for children ages 6-9 years**

2

Age	Male			Female			Male-Female % Difference			
	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile	10th %ile	50th %ile	90th %ile	
3										
4										
5	6-<6.5	77.3	103.0	125.3	69.1	93.8	116.7	11.9%	9.8%	7.4%
6	6.5-<7	82.1	108.0	130.7	73.6	98.7	121.9	11.5%	9.4%	7.2%
7	7-<7.5	86.8	113.1	136.2	78.2	103.5	127.0	11.0%	9.3%	7.2%
8	7.5-<8	91.7	118.2	141.6	82.8	108.3	132.1	10.7%	9.1%	7.2%
9	8-<8.5	96.5	123.3	146.9	87.5	113.1	137.1	10.3%	9.0%	7.1%
10	8.5-<9	101.5	128.3	152.2	92.3	118.0	142.1	10.0%	8.7%	7.1%

11

12 100. Another study of Eurofit results for over 400,000 Greek children reported
 13 similar results. "[C]ompared with 6-year-old females, 6-year-old males completed
 14 16.6% more shuttle runs in a given time and could jump 9.7% further from a
 15 standing position." (Hilton 2021 at 201, summarizing findings of Tambalis et al.
 16 2016.)

17 101. Silverman (2011) gathered hand grip data, broken out by age and sex, from
 18 a number of studies. Looking only at the nine direct comparisons within individual
 19 studies tabulated by Silverman for children aged 7 or younger, in eight of these the
 20 boys had strength advantages of between 13 and 28 percent, with the remaining
 21 outlier recording only a 4% advantage for 7-year-old boys. (Silverman 2011 Table
 22 1.)

23 102. To help illustrate the importance of one specific measure of physical fitness
 24 in athletic performance, Pocek (2021) stated that to be successful, volleyball
 25 "players should distinguish themselves, besides in skill level, in terms of above-
 26 average body height, upper and lower muscular power, speed, and agility. Vertical
 27 jump is a fundamental part of the spike, block, and serve." (8377) Pocek further
 28

1 stated that "relative vertical jumping ability is of great importance in volleyball
2 regardless of the players' position, while absolute vertical jump values can
3 differentiate players not only in terms of player position and performance level but
4 in their career trajectories." (8382)

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

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

	Male			Female			Male-Female % Difference			
	10th	50th	90th	10th	50th	90th	10th	50th	90th	
Age	%ile	%ile	%ile	%ile	%ile	%ile	%ile	%ile	%ile	
13	9	18.0	24.0	29.5	16.0	22.3	29.0	12.5%	7.6%	1.7%
14	10	19.5	25.0	32.0	18.0	24.0	29.5	8.3%	4.2%	8.5%
15	11	21.0	27.0	32.5	19.5	25.0	31.0	7.7%	8.0%	4.8%
16	12	22.0	27.5	34.5	20.0	25.5	31.5	10.0%	7.8%	9.5%
17	13	23.0	30.5	39.0	19.0	25.5	32.0	21.1%	19.6%	21.9%
18	14	23.5	32.0	41.5	20.0	25.5	32.5	17.5%	25.5%	27.7%
19	15	26.0	35.5	43.0	20.2	26.0	32.5	28.7%	36.5%	32.3%
20	16	28.0	36.5	45.1	20.5	26.5	33.0	36.6%	37.7%	36.7%
21	17	28.0	38.0	47.0	21.5	27.0	35.0	30.2%	40.7%	34.3%

22
23 104. Similarly, using data from Taylor (2010; table 2, at 869) which analyzed
24 vertical jump measurements of 1,845 children aged 10 -15 years in primary and
25 secondary schools in the East of England, the following table sampling the low,
26 middle, and top decile for vertical jump can be constructed:
27
28

1 **Vertical Jump Height (cm) for children 10 -15 years**

2

Age	Male			Female			Male-Female% Difference			
	10th	50th	90th	10th	50th	90th	10th	50th	90th	
3										
4	%ile	%ile	%ile	%ile	%ile	%ile	%ile	%ile	%ile	
5	10	16.00	21.00	29.00	15.00	22.00	27.00	6.7%	-4.5%	7.4%
6	11	20.00	27.00	34.00	19.00	25.00	32.00	5.3%	8.0%	6.3%
7	12	23.00	30.00	37.00	21.00	27.00	33.00	9.5%	11.1%	12.1%
8	13	23.00	32.00	40.00	21.00	26.00	34.00	9.5%	23.1%	17.6%
9	14	26.00	36.00	44.00	21.00	28.00	34.00	23.8%	28.6%	29.4%
10	15	29.00	37.00	44.00	21.00	28.00	39.00	38.1%	32.1%	12.8%
11										

12 105. As can be seen from the data from Ramirez-Velez (2017) and Taylor (2010),
 13 males consistently outperform females of the same age and percentile in vertical
 14 jump height. Both sets of data show that an 11-year-old boy in the 90th percentile
 15 for vertical jump height will outperform girls in the 90th percentile at ages 11 and
 16 12, and will be equal to girls at ages 13, 14, and possibly 15. These data indicate
 17 that an 11-year-old would be likely to have an advantage over girls of the same age
 18 and older in sports such as volleyball where "absolute vertical jump values can
 19 differentiate players not only in terms of player position and performance level but
 20 in their career trajectories." (Pocek 2021 at 8382.)

21 106. Boys also enjoy an advantage in throwing well before puberty. "Boys exceed
 22 girls in throwing velocity by 1.5 standard deviation units as early as 4 to 7 years of
 23 age... The boys exceed the girls [in throwing distance] by 1.5 standard deviation
 24 units as early as 2 to 4 years of age." (Thomas 1985 at 266.) This means that the
 25 average 4- to 7-year-old boy can out-throw approximately 87% of all girls of his
 26 age.

27 107. Record data from USA Track & Field indicate that boys outperform girls in
 28

1 track events even in the youngest age group for whom records are kept (age 8 and
2 under).⁸

3 **American Youth Outdoor Track & Field Record times in age groups 8 and under**
4 **{time in seconds}**

5 Event	Boys	Girls	Difference
6 100M	13.65	13.78	0.95%
7 200M	27.32	28.21	3.26%
8 400M	62.48	66.10	5.79%
9 800M	148.59	158.11	6.41%
10 1500M	308.52	314.72	2.01%
11 Mean			3.68%

12
13 108. Looking at the best times within a single year shows a similar pattern of
14 consistent advantage for even young boys. I consider the 2018 USATF Region 8
15 Junior Olympic Championships for the youngest age group (8 and under).⁹

16 **2018 USATF Region 8 Junior Olympic Championships for the 8 and under age group**

17 Event	Boys	Girls	Difference
18 100M	15.11	15.64	3.51%
19 200M	30.79	33.58	9.06%
20 400M	71.12	77.32	8.72%
21 800M	174.28	180.48	3.56%
22 1500M	351.43	382.47	8.83%
23 Mean			6.74%

24
25
26 ⁸<http://legacy.usatf.org/statistics/records/view.asp?division=american&location=outdoor%20track%20%26%20field&age=youth&sport=TF>

27 ⁹ <https://www.athletic.net/TrackAndField/meet/384619/results/m/1/100m>

28 ⁹ <https://www.athletic.net/CrossCountry/Division/List.aspx?DivID=62211>

1 109. Using Athletic.net⁹, for 2021 Cross Country and Track & Field data for boys
2 and girls in the 7-8, 9-10, and 11-12 year old age group club reports, and for 5th,
3 6th, and 7th grade for the whole United States I have compiled the tables for 3000
4 m events, and for the 100-m, 200-m, 400-m, 800-m, 1600-m, 3000-m, long jump,
5 and high jump Track and Field data to illustrate the differences in individual athletic
6 performance between boys and girls, all of which appear in the Appendix. The
7 pattern of males outperforming females was consistent across events, with rare
8 anomalies, only varying in the magnitude of difference between males and females.

9 110. Similarly, using Athletic.net, for 2022 Track & Field data for boys and girls
10 in the 6th grade for the state of Arizona, I have compiled tables, which appear below,
11 comparing the performance of boys and girls for the 100-m, 200-m, 400-m, 800-m,
12 1600-m, and 3200-m running events in which the 1st place boy was consistently
13 faster than the p^t place girl (with the exception of the 1600-m in which the first
14 place girl was 0.9% faster) and the average performance of the top 10 boys was
15 consistently faster than the average performance for the top 10 girls. Based on the
16 finishing times for the 1st place boy and the 1st place girl in the 6th grade in Arizona
17 in the 400-m race, the boy was 7.1 seconds (10.9%) faster than the girl.
18 Extrapolating the running time to a running pace, the boy would be expected to
19 finish 49 m in front of the fastest girl in a single lap race on a standard 400-m track,
20 or almost the length of 1/2 of a football field. In comparison, the 1st place boy would
21 finish 8 m in front of the 2nd place boy, and the p^t place girl would finish 10 m in
22 front of the 2nd place girl.

1 **Top 10 Arizona boys and girls 6th grade outdoor track for 2022 (time in seconds)**

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	100m			200m			400m		
	Boys	Girls		Boys	Girls		Boys	Girls	
1	12.60	12.71	Difference	25.53	26.01	Difference	58.40	65.54	Difference
2	13.14	13.44	between #1	26.84	28.20	between #1	59.59	67.04	between #1
3	13.35	13.60	boy and# 1	27.30	28.77	boy and# 1	61.74	68.27	boy and# 1
4	13.44	14.14	girl	27.44	29.10	girl	62.32	68.64	girl
5	13.44	14.15	0.9%	28.61	29.52	1.8%	63.14	69.87	10.9%
6	13.47	14.4		28.68	30.06		66.38	70.12	
7	13.54	14.41	Average	29.04	30.15	Average	66.46	80.22	Average
8	13.59	14.44	difference	29.14	30.17	difference	66.50	70.73	difference
9	13.78	14.50	boys vs girls	29.17	30.19	boys vs girls	67.35	72.09	boys vs girls
10	13.84	14.53	4.4%	29.59	30.34	3.8%	67.36	72.43	9.3%
	800m			1600m			3200m		
	Boys	Girls		Boys	Girls		Boys	Girls	
1	146.67	154.55	Difference	333.71	331.01	Difference	793.27	835.76	Difference
2	149.47	157.70	between #1	335.23	340.22	between #1	816.60	904.96	between #1
3	150.70	159.31	boy and# 1	338.70	351.70	boy and# 1	818.87	947.81	boy and# 1
4	151.29	165.49	girl	340.97	360.44	girl	840.17	1064.43	girl
5	152.56	167.00	5.1%	344.90	362.47	-0.9%	842.58	1090.2	5.1%
6	153.70	169.89		350.19	369.10		859.92		
7	158.30	170.00	Average	352.20	371.88	Average	861.74		Average
8	158.45	172.40	difference	360.30	375.66	difference	866.30		difference
9	158.70	173.64	boys vs girls	361.31	382.29	boys vs girls	Only 8	Only 5	boys vs girls
10	159.83	173.90	7.5%	364.00	384.00	4.1%	times	times	13.5%
							listed	listed	

1 111. As serious runners will recognize, differences of 3%, 5%, or 8% are not
2 easily overcome. During track competition the difference between first and second
3 place, or second and third place, or third and fourth place (and so on) is often 0.5 -
4 0.7%, with some contests being determined by as little as 0.01 %.

5 112. I performed an analysis of running events (consisting of the 100-m, 200-m,
6 400-m, 800-m, 1500-m, 5000-m, and 10,000-m) in the Division I, Division II, and
7 Division III NCAA Outdoor championships for the years of 2010-2019: the mean
8 difference between 1st and 2nd place was 0.48% for men and 0.86% for women. The
9 mean difference between 2nd and 3rd place was 0.46% for men and 0.57% for
10 women. The mean difference between 3rd place and 4th place was 0.31 % for men
11 and 0.44% for women. The mean difference between 1st place and 8th place (the last
12 place to earn the title of All American) was 2.65% for men and 3.77% for women.
13 (Brown et al. Unpublished observations, presented at the 2022 Annual Meeting of
14 the American College of Sports Medicine.)

15 113. A common response to empirical data showing pre-pubertal performance
16 advantages in boys is the argument that the performance of boys may represent a
17 social-cultural bias for boys to be more physically active, rather than representing
18 inherent sex-based differences in pre-pubertal physical fitness. However, the
19 younger the age at which such differences are observed, and the more egalitarian
20 the culture within which they are observed, the less plausible this hypothesis
21 becomes. Eiberg et al. (2005) measured body composition, VO₂max, and physical
22 activity in 366 Danish boys and 332 Danish girls between the ages of 6 and 7 years
23 old. Their observations indicated that VO₂max was 11% higher in boys than girls.
24 When expressed relative to body mass the boys' VO₂max was still 8% higher than
25 the girls. The authors stated that "...no differences in haemoglobin or sex
26 hormones¹⁰ have been reported in this age group," yet "... when children with the

27
28 ¹⁰ This term would include testosterone and estrogens.

1 same VO₂max were compared, boys were still more active, and in boys and girls
2 with the same P[hysical] A[ctivity] level, boys were fitter." (728). These data
3 indicate that in pre-pubertal children, in a very egalitarian culture regarding gender
4 roles and gender norms, boys still have a measurable advantage in regards to aerobic
5 fitness when known physiological and physical activity differences are accounted
6 for.

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

9 115. When looking at the data on testosterone concentrations previously
10 presented, along with the data on physical fitness and athletic performance
11 presented, boys have advantages in athletic performance and physical fitness before
12 there are marked differences in testosterone concentrations between boys and girls.

13 116. For the most part, the data I review above relate to pre-pubertal children.
14 Today, we also face the question of inclusion in female athletics of males who have
15 undergone "puberty suppression." The UK Sport Councils Literature Review notes
16 that, "In the UK, so-called 'puberty blockers' are generally not used until Tanner
17 maturation stage 2-3 (i.e. after puberty has progressed into early sexual
18 maturation)." (9.) While it is outside my expertise, my understanding is that current
19 practice with regard to administration of puberty blockers is similar in the United
20 States. Tanner stages 2 and 3 generally encompass an age range from 10 to 14 years
21 old, with significant differences between individuals. Like the authors of the UK
22 Sports Council Literature Review, I am "not aware of research" directly addressing
23 the implications for athletic capability of the use of puberty blockers. (UK Sport
24 Councils Literature Review at 9.) As Handelsman documents, the male advantage
25 begins to increase rapidly-along with testosterone levels-at about age 11, or "very
26 closely aligned to the timing of the onset of male puberty." (Handelsman 2017.) It
27 seems likely that males who have undergone puberty suppression will have
28 physiological and performance advantages over females somewhere between those

1 possessed by pre-pubertal boys, and those who have gone through full male puberty,
2 with the degree of advantage in individual cases depending on that individual's
3 development and the timing of the start of puberty blockade.

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

12 118. Klaver et al. (2018 at 256) demonstrated that the use of puberty blockers did
13 not eliminate the differences in lean body mass between biological male and female
14 teenagers. Subsequent use of puberty blockers combined with cross-sex hormone
15 use (in the same subjects) still did not eliminate the differences in lean body mass
16 between biological male and female teenagers. Furthermore, by 22 years of age, the
17 use of puberty blockers, and then puberty blockers combined with cross sex
18 hormones, and then cross hormone therapy alone for over 8 total years of treatment
19 still had not eliminated the difference in lean body mass between biological males
20 and females.

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

27 120. Navabi et al. (2021) observed that teenage natal males who identify as female
28 (average of 15.4 ± 2.0 years), had 9.5 kg more lean body mass than did teenage natal

1 females (15.2 ± 1.8 years) who identified as male (at 4). After 355.2 ± 96.7 days of
2 puberty blockers the natal males who identified as female still had 5.7 kg more lean
3 body mass than did the natal females who identified as male (at 5). It is worth noting
4 that the natal males lost 2.57 kg lean body mass and the natal females gained 1.21
5 kg lean body mass.

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

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

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

1 youth" (at 5).

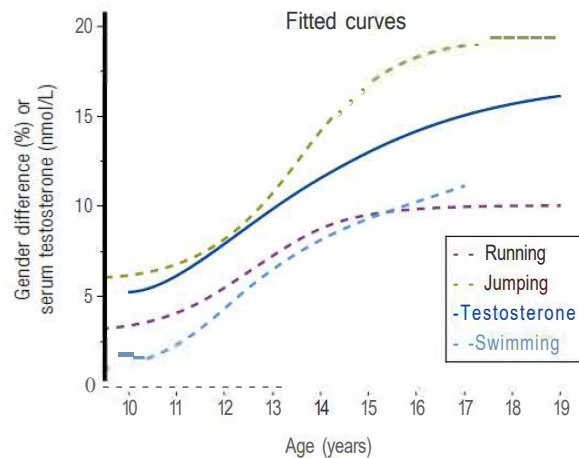
2 124. In Boogers et al. (2022), the researchers studied the effects of puberty
3 suppression followed by cross-sex hormone therapy on the adult height of natal
4 males who identify as female. Analyzing retrospective data collected from 1972 to
5 2018, they concluded that "although P[uberty] S[uppression] and [cross-sex
6 hormones] alter the growth pattern, they have little effect on adult height." (9) In
7 other words, natal males who followed a normal course of puberty suppression
8 followed by cross-sex hormone therapy reached an adult height at or near their
9 predicted height in the absence of such therapy.

10 125. The findings from Schulmeister et al. (2022) and Boogers et al. (2022) are
11 relevant to the question of whether puberty suppression eliminates sex-based
12 performance advantages because these finding provide evidence that an important
13 component of that advantage - male vs. female height - is not eliminated, or even
14 meaningfully affected, by an ordinary course of puberty suppression or puberty
15 suppression followed by cross-sex hormone therapy.

16 **B. The rapid increase in testosterone across male puberty drives characteristic**
17 **male physiological changes and the increasing performance advantages.**

18 126. While boys exhibit some performance advantage even before puberty, it is
19 both true and well known to common experience that the male advantage increases
20 rapidly, and becomes much larger, as boys undergo puberty and become men.
21 Empirically, this can be seen by contrasting the modest advantages reviewed
22 immediately above against the large performance advantages enjoyed by men that I
23 have detailed in Section II.

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



18 128. Handelsman further finds that certain characteristic male changes including
 19 boys' increase in muscle mass do not begin at all until "circulating testosterone
 20 concentrations rise into the range of males at mid-puberty, which are higher than in
 21 women at any age." (Handelsman 2018 at 810.)

22 129. Knox et al. (2019) agree that "[i]t is well recognised that testosterone
 23 contributes to physiological factors including body composition, skeletal structure,
 24 and the cardiovascular and respiratory systems across the life span, with significant
 25 influence during the pubertal period. These physiological factors underpin strength,
 26 speed, and recovery with all three elements required to be competitive in almost all
 27 sports." (Knox 2019 at 397.) "High testosterone levels and prior male physiology
 28 provide an all-purpose benefit, and a substantial advantage. As the IAAF says, 'To

1 the best of our knowledge, there is no other genetic or biological trait encountered
2 in female athletics that confers such a huge performance advantage.'" (Knox 2019
3 at 399.)

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

13 **V. The available evidence shows that suppression of testosterone in a male after**
14 **puberty has occurred does not substantially eliminate the male athletic**
15 **advantage.**

16 131. The 2011 "NCAA Policy on Transgender Student-Athlete Participation"
17 requires only that males who identify as transgender be on unspecified and
18 unquantified "testosterone suppression treatment" for "one calendar year" prior to
19 competing in women's events. In supposed justification of this policy, the NCAA's
20 Office of Inclusion asserts that, "It is also important to know that any strength and
21 endurance advantages a transgender woman arguably may have as a result of her
22 prior testosterone levels dissipate after about one year of estrogen or testosterone-
23 suppression therapy." (NCAA 2011 at 8.)

24 132. Similarly, writing in 2018, Handelsman et al. could speculate that even
25 though some male advantages established during puberty are "fixed and irreversible
26 (bone size)," "[t]he limited available prospective evidence ... suggests that the
27 advantageous increases in muscle and hemoglobin due to male circulating
28 testosterone concentrations are induced or reversed during the first 12 months."

1 (Handelsman 2018 at 824.)

2 133. But these assertions or hypotheses of the NCAA and Handelsman are now
3 strongly contradicted by the available science. In this section, I examine what is
4 known about whether suppression of testosterone in males can eliminate the male
5 physiological and performance advantages over females.

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

8 134. As my review in Section II indicates, a very large body of literature
9 documents the large performance advantage enjoyed by males across a wide range
10 of athletics. To date, only a limited number of studies have directly measured the
11 effect of testosterone suppression and the administration of female hormones on the
12 athletic performance of males. These studies report that testosterone suppression for
13 a full year (and in some cases much longer) does not come close to eliminating male
14 advantage in strength (hand grip, leg strength, and arm strength) or running speed.

15 **Hand Grip Strength**

16 135. As I have noted, hand grip strength is a well-accepted proxy for general
17 strength. Multiple separate studies, from separate groups, report that males retain a
18 large advantage in hand strength even after testosterone suppression to female
19 levels.

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

1 thus still far higher than a female population. (Van Caenegem 2015 at 42.)

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

11 138. Still a third longitudinal study, looking at teen males undergoing testosterone
12 suppression, "noted no change in grip strength after hormonal treatment (average
13 duration 11 months) of 21 transgender girls." (Hilton 2021 at 207, summarizing
14 Tack 2018.)

15 139. A fourth study (Auer et al. 2016) reported no change in handgrip strength in
16 13 transwomen below the age of 45 years following 12 months of cross sex hormone
17 therapy (Table 1, at 3).

18 140. A fifth study (Yun et al. 2021) observed that handgrip strength in the right
19 hand decreased from 31.5 ± 5.8 kg to 29.9 ± 7.4 kg and in the left hand decreased
20 from 31.8 ± 6.5 kg to 30.1 ± 6.9 kg during 6 months of cross sex hormone therapy
21 in 11 males aged 28.5 ± 8.1 years who identify as women or nonbinary (Table 4, at
22 63). It is worth noting that the reduced grip strength in these male bodied individuals
23 would rate in 75th percentile for females (Liguri, at 95).

24 141. Lapauw et al. (2008) looked at the extreme case of testosterone suppression
25 by studying a population of 23 biologically male individuals who had undergone at
26 least two years of testosterone suppression, followed by sex reassignment surgery
27 that included "orchidectomy" (that is, surgical castration), and then at least an
28 additional three years before the study date. Comparing this group against a control

1 of age- and height-matched healthy males, the researchers found that the individuals
2 who had gone through testosterone suppression and then surgical castration had an
3 average hand grip (41 kg) that was 24% weaker than the control group of healthy
4 males. But this remains at least 25% *higher* than the average hand-grip strength of
5 biological females as measured by Bohannon et al. (2019).

6 142. Alvares et al (2022) is a cross-sectional study on cardiopulmonary capacity
7 and muscle strength in biological males who identify as female and have undergone
8 long-term cross-sex hormone therapy. All of the study subjects that were biological
9 males who identify as female had testosterone suppressed through medication
10 (cyproterone acetate) or gonadectomy. (Supplementary materials) And they had
11 taken exogenous estrogen for an average of 14.4 years with a standard deviation of
12 3.5 years. Compared to a control group of cisgender women, the study subjects
13 exhibited 18% higher handgrip strength, confirming the findings of previous studies
14 but extending the information to a longer time period. It is worth noting that the grip
15 strength in these male bodied individuals would rate between the 90th and 95th
16 percentile for females (Liguri, at 95).

17 143. Summarizing these and a few other studies measuring strength loss (in most
18 cases based on hand grip) following testosterone suppression, Harper et al. (2021)
19 conclude that "strength loss with 12 months of [testosterone suppression] ... ranged
20 from non-significant to 7%.... [T]he small decrease in strength in transwomen after
21 12-36 months of [testosterone suppression] suggests that transwomen likely retain
22 a strength advantage over cisgender women." (Hilton 2021 at 870.)

23 **Arm Strength**

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

1 women.

2 145. Roberts et al. have published an interesting longitudinal study, one arm of
3 which considered biological males who began testosterone suppression and cross-
4 sex hormones while serving in the United States Air Force. (Roberts 2020.) One
5 measured performance criterion was pushups per minute, which, while not
6 exclusively, primarily tests arm strength under repetition. *Before* treatment, the
7 biological male study subjects who underwent testosterone suppression could do
8 45% more pushups per minute than the average for all Air Force women under the
9 age of 30 (47.3 vs. 32.5). *After* between one and two years of testosterone
10 suppression, this group could still do 33% more pushups per minute. (Table 4.)
11 Further, the body weight of the study group did not decline at all after one to two
12 years of testosterone suppression (in fact rose slightly) (Table 3), and was
13 approximately 24 pounds (11.0 kg) higher than the average for Air Force women
14 under the age of 30. (Roberts 2020 at 3.) This means that the individuals who had
15 undergone at least one year of testosterone suppression were not only doing 1/3
16 more pushups per minute, but were lifting significantly more weight with each
17 pushup.

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

26 147. Chiccarelli et al. (2022) also published a longitudinal study which considered
27 biological males who began testosterone suppression and cross-sex hormones while
28 serving in the United States Air Force and concluded "Transgender females'

1 performance ... remained superior in push-ups at the study's 4-year endpoint." (at
2 1) with the transwomen completing 16% more pushups than comparable women
3 after 4 years of GAHT.

4 148. It is interesting that Roberts et al. (2020) and Chiccarelli et al. (2022) were
5 comparing the same performance measurements in the same population and came
6 to differing conclusions, which may be due to different sample sizes and study
7 durations

8 **Leg Strength**

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

19 150. Lapauw et al. (2008) found that 3 years after surgical castration, preceded by
20 at least two years of testosterone suppression, subjects had peak knee torque only
21 25% lower than healthy male controls. (Lapauw 2008 at 1018.) Again, given that
22 healthy males exhibit 54% greater maximum knee torque than healthy females, this
23 leaves these individuals with a large average strength advantage over females even
24 years after sex reassignment surgery.

25 **Running and Swimming speed**

26 151. The most striking finding of the recent Roberts et al. study concerned running

27
28 ¹¹ Isometric strength measures muscular force production for a given amount of time at a
specific joint angle but with no joint movement.

1 speed over a 1.5 mile distance—a distance that tests midrange endurance. Before
2 suppression, the MtF study group ran 21 % faster than the Air Force female average.
3 After at least 2 year of testosterone suppression, these subjects still ran 12% faster
4 than the Air Force female average. (Roberts 2020 Table 4.)

5 152. Chiccarelli (2022) reported that "Transgender females' performance showed
6 statistically significantly better performance than cisgender females until 2 years of
7 GAHT in run times..." (at 1) and yet the 1.5 mile run time was, on average, 45
8 seconds (5%) faster in the transwomen at years 2 and 3 than the Air Force female
9 average.

10 153. The specific experience of the well-known case of NCAA athlete Cece Telfer
11 is consistent with the more statistically meaningful results of Roberts et al., further
12 illustrating that male-to-female transgender treatment does not negate the inherent
13 athletic performance advantages of a post-pubertal male. In 2016 and 2017 Cece
14 Telfer competed as Craig Telfer on the Franklin Pierce University men's track team,
15 being ranked 200th and 390th (respectively) against other NCAA Division II men.
16 "Craig" Telfer did not qualify for the National Championships in any events. Telfer
17 did not compete in the 2018 season while undergoing testosterone suppression (per
18 NCAA policy). In 2019 Cece Telfer competed on the Franklin Pierce University
19 *women's* team, qualified for the NCAA Division II Track and Field National
20 Championships, and placed 1st in the women's 400 meter hurdles and placed third
21 in the women's 100 meter hurdles. (For examples of the media coverage of this
22 please see [https://www.washingtontimes.com/news/2019/jun/3/cece-telfer-
23 franklin-pierce-transgender-hurdler-wi/](https://www.washingtontimes.com/news/2019/jun/3/cece-telfer-franklin-pierce-transgender-hurdler-wi/) (last accessed May 5, 2023).
24 [https://triblive.com/sports/biological-male-wins-ncaa-womens-track-
25 championship/](https://triblive.com/sports/biological-male-wins-ncaa-womens-track-championship/) (last accessed May 25, 2023.)

26 154. The table below shows the best collegiate performance times from the
27 combined 2015 and 2016 seasons for Cece Telfer when competing as a man in
28 men's events, and the best collegiate performance times from the 2019 season when

1 competing as a woman in women's events. Comparing the times for the running
 2 events (in which male and female athletes run the same distance) there is no
 3 statistical difference between Telfer's "before and after" times. Calculating the
 4 difference in time between the male and female times, Telfer performed an average
 5 of 0.22% *faster* as a female. (Comparing the performance for the hurdle events
 6 (marked with H) is of questionable validity due to differences between men's and
 7 women's events in hurdle heights and spacing, and distance for the 110m vs. 100
 8 m.) While this is simply one example, and does not represent a controlled
 9 experimental analysis, this information provides some evidence that male-to-female
 10 transgender treatment does not negate the inherent athletic performance advantages
 11 of a postpubertal male. (These times were obtained from
 12 https://www.tfrs.org/athletes/6994616/Franklin_Pierce/Cece_Telfer.html and
 13 <https://www.tfrs.org/athletes/5108308.html>, last accessed May 5, 2023).

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 t	7.98	55 H t	7.91
60 H t	8.52	60 H t	8.33
110 H t	15.17	100 H t	13.41*
400 H t	57.34	400 H t	57.53**

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

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

27 t men's hurdle height is 42 inches with differences in hurdle spacing between men and
 28 women

1 t men's hurdle height is 36 inches, women's height is 30 inches with the same spacing
2 between hurdles

3 155. Harper (2015) has often been cited as "proving" that testosterone suppression
4 eliminates male advantage. And indeed, hedged with many disclaimers, the author
5 in that article does more or less make that claim with respect to "distance races,"
6 while emphasizing that "the author makes no claims as to the equality of
7 performances, pre and post gender transition, in any other sport." (Harper 2015 at
8 8.) However, Harper (2015) is in effect a collection of unverified anecdotes, not
9 science. It is built around self-reported race times from just eight self-selected
10 transgender runners, recruited "mostly" online. How and on what websites the
11 subjects were recruited is not disclosed, nor is anything said about how those not
12 recruited online were recruited. Thus, there is no information to tell us whether these
13 eight runners could in any way be representative, and the recruitment pools and
14 methodology, which could bear on ideological bias in their self-reports, is not
15 disclosed.

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

26 157. Even if we could accept them at face value, the data are largely meaningless.
27 Only two of the eight study subjects reported (undefined) "stable training patterns,"
28 and even with consistent training, athletic performance generally declines with age.

1 As a result, when the few data points span 29 years, it is not possible to attribute
2 declines in performance to asserted testosterone suppression. Further, distance
3 running is usually not on a track, and race times vary significantly depending on the
4 course and the weather. Only one reporting subject who claimed a "stable training
5 pattern" reported "before and after" times on the same course within three years'
6 time," which the author acknowledges would "represent the best comparison
7 points."

8 158. Harper (2015) to some extent acknowledges its profound methodological
9 flaws, but seeks to excuse them by the difficulty of breaking new ground. The author
10 states that, "The first problem is how to formulate a study to create a meaningful
11 measurement of athletic performance, both before and after testosterone
12 suppression. No methodology has been previously devised to make meaningful
13 measurements." (2) This statement was not accurate at the time of publication, as
14 there are innumerable publications with validated methodology for comparing
15 physical fitness and/or athletic performance between people of different ages, sexes,
16 and before and after medical treatment, any of which could easily have been used
17 with minimal or no adaptation for the purposes of this study. Indeed, well before the
18 publication of Harper (2015), several authors that I have cited in this review had
19 performed and published disciplined and methodologically reliable studies of
20 physical performance and physiological attributes "before and after" testosterone
21 suppression.

22 159. More recently, and to her credit, Harper has acknowledged the finding of
23 Roberts (2020) regarding the durable male advantage in running speed in the 1.5
24 mile distance, even after two years of testosterone suppression. She joins with co-
25 authors in acknowledging that this study of individuals who (due to Air Force
26 physical fitness requirements) "could at least be considered exercise trained," agrees
27 that Roberts' data shows that "transwomen ran significantly faster during the 1.5
28 mile fitness test than ciswomen," and declares that this result is "consistent with the

1 findings of the current review in untrained transgender individuals" that even 30
2 months of testosterone suppression does not eliminate all male advantages
3 "associated with muscle endurance and performance." (Harper 2021 at 8.) The
4 Harper (2021) authors conclude overall "that strength may be well preserved in
5 transwomen during the first 3 years of hormone therapy," and that [w]hether
6 transgender and cisgender women can engage in meaningful sport [in competition
7 with each other], even after [testosterone suppression], is a highly debated
8 question." (Harper 2021 at 1, 8.)

9 160. Higerd (2021) "[a]ssess[ed] the probability of a girls' champion being
10 biologically male" by evaluating 920, 11 American high school track and field
11 performances available through the track and field database Athletic.net in five
12 states (CA, FL, MN, NY, WA), over three years (2017 -2019), in eight events; high
13 jump, long jump, 100M, 200M, 400M, 800M, 1600M, and 3200M and estimated
14 that "there is a simulated 81 %-98% probability of transgender dominance occurring
15 in the female track and field event" and further concluded that "in the majority of
16 cases, the entire podium (top of the state) would be MTF [transgender athletes]" (at
17 xii).

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

24 162. Senefeld et al. (2023) compared "the performance times of a transgender
25 woman (male sex, female gender identity) who competed in both men's and
26 women's NCAA freestyle swimming and contextualized her performances relative
27 to the performances of both world class and contemporary NCAA swimmers" (at
28 1035) and observed that this athlete [presumably Lia Thomas based on performance

1 times and the timing of this article] was unranked in 2018-2019 in the 100-yard,
2 ranked 55^p in the 200-yard, 65th in the 500-yard 32nd in the 1650-yards men's
3 freestyle. After following the NCAA protocol for testosterone suppression and
4 competing as a woman in 2021-2022, this swimmer was ranked 13th in the 100-yard,
5 3rd in the 200-yard, 1st in the 500-yard, and 13th in the 1650-yard women's freestyle.
6 The performance times swimming as a female, when compared to swimming as a
7 male, were 0.5% slower in the 100-yard, 2.6% slower in the 200-yard, 5.6% slower
8 in the 500-yard, and 7.3% slower in the 1650-yard events than when swimming as
9 a male (at 1034). The authors concluded "...these data suggest there may be a
10 prolonged "legacy effect" (greater than 2 yr) associated with endogenous male
11 testosterone concentrations or male puberty on freestyle swimming performances
12 after feminizing GAHT, particularly for shorter event distances (100, 200, and 500
13 yards), which are closely associated with anthropometrics and maximal skeletal
14 muscle strength and power" (at 1036).

15 **B. Testosterone suppression does not reverse important male physiological**
16 **advantages.**

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

24 164. Handelsman has well documented that the large increases in physiological
25 and performance advantages characteristic of men develop in tandem with, and are
26 likely driven by, the rapid and large increases in circulating testosterone levels that
27 males experience across puberty, or generally between the ages of about 12 through
28 18. (Handelsman 2018.) Some have misinterpreted Handelsman as suggesting that

1 all of those advantages are and remain entirely dependent-on an ongoing basis-on
2 *current* circulating testosterone levels. This is a misreading of Handelsman, who
3 makes no such claim. As the studies reviewed above demonstrate, it is also
4 empirically false with respect to multiple measures of performance. Indeed,
5 Handelsman himself, referring to the Roberts et al. (2020) study which I describe
6 below, has recently written that "transwomen treated with estrogens after
7 completing male puberty experienced only minimal declines in physical
8 performance over 12 months, substantially surpassing average female performance
9 for up to 8 years." (Handelsman 2020.)

10 165. As to individual physiological advantages, the more accurate and more
11 complicated reality is reflected in a statement titled "The Role of Testosterone in
12 Athletic Performance," published in 2019 by several dozen sports medicine experts
13 and physicians from many top medical schools and hospitals in the U.S. and around
14 the world. (Levine et al. 2019.) This expert group concurs with Handelsman
15 regarding the importance of testosterone to the male advantage, but recognizes that
16 those advantages depend not only on *current* circulating testosterone levels in the
17 individual, but on the "exposure in biological males to much higher levels of
18 testosterone during growth, development, and throughout the athletic career."
19 (*Emphasis added.*) In other words, both past and current circulating testosterone
20 levels affect physiology and athletic capability.

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

27 **Skeletal Configuration**

28 167. It is obvious that some of the physiological changes that occur during

1 "growth and development" across puberty cannot be reversed. Some of these
 2 irreversible physiological changes are quite evident in photographs that have
 3 recently appeared in the news of transgender competitors in female events. These
 4 include skeletal configuration advantages including:

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

8 **Cardiovascular Advantages**

9 168. Developmental changes for which there is no apparent means of reversal, and
 10 no literature suggesting reversibility, also include multiple contributors to the male
 11 cardiovascular advantage, including diaphragm placement, lung and trachea size,
 12 and heart size and therefore pumping capacity.¹²

13 169. In what is, to date, the only evaluation of $\dot{V}O_2\text{max}$ is a cross-sectional study
 14 on cardiopulmonary capacity and muscle strength in biological males who identify
 15 as female and have undergone long-term cross-sex hormone therapy (Alvares 2022).
 16 All of the study subjects that were biological males who identify as female had
 17 testosterone suppressed through medication (cyproterone acetate) or gonadectomy.
 18 (Supplementary materials) And they had taken exogenous estrogen for an average
 19 of 14.4 years with a standard deviation of 3.5 years. Compared to a control group of
 20 cisgender women, even after 14 years of testosterone suppression and estrogen
 21 administration the biological males who identify as female exhibited advantages in
 22 cardio-respiratory capacity measured as higher $\dot{V}O_2$ peak and higher $\dot{V}O_2$ pulse,
 23 which suggests that male advantages are retained in events that are influenced by
 24 cardio-respiratory endurance (e.g. distance running, cycling, swimming, etc.).

25 170. On the other hand, the evidence is mixed as to hemoglobin concentration,

26
 27 ¹²"[H]ormone therapy will not alter ... lung volume or heart size of the transwoman athlete,
 28 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.)

1 which as discussed above is a contributing factor to V02 max. Harper (2021)
2 surveyed the literature and found that "Nine studies reported the levels of Hgb
3 [hemoglobin] or HCT [red blood cell count] in transwomen before and after
4 [testosterone suppression], from a minimum of three to a maximum of 36 months
5 post hormone therapy. Eight of these studies... found that hormone therapy led to
6 a significant (4.6%-14.0%) decrease in Hgb/HCT ($p < 0.01$), while one study found
7 no significant difference after 6 months," but only one of those eight studies
8 returned results at the generally accepted 95% confidence level. (Harper 2021 at 5-
9 6 and Table 5.)

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

12 **Muscle mass**

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

28 173. Taking measurements one month after start of testosterone suppression in

1 male-to-female (non-athlete) subjects, and again 3 and 11 months after start of
2 feminizing hormone replacement therapy in these subjects, Wiik et al. found that
3 total lean tissue (i.e. primarily muscle) did not decrease significantly across the
4 entire period. Indeed, "some of the [subjects] did not lose any muscle mass at all."
5 (Wiik 2020 at 812.) And even though they observed a small decrease in thigh muscle
6 mass, they found that isometric strength levels measured at the knee "were
7 maintained over the [study period]." (808) "At T12 [the conclusion of the one-year
8 study], the absolute levels of strength and muscle volume were greater in [male-to-
9 female subjects] than in [female-to-male subjects] and CW [women who had not
10 undergone any hormonal therapy]." (808)

11 174. Alvares et al. (2022) In a cross-sectional study of 15 natal males aged $34.2 \pm$
12 5.2 years who had taken exogenous estrogen for an average of 14.4 ± 3.5 years, and
13 compared to a control group of comparably aged females, the transwomen exhibited
14 a 40% advantage in skeletal muscle mass confirming the findings of previous
15 studies regarding the minimal reduction in muscle mass due to transgender hormone
16 therapy, but extending the information to a longer time period (Table 3 at 5).

17 175. Other papers including Auer. et al (2016), Auer et al. (2018), Elbers et al.
18 (1999), Gava et al. (2016), Haraldsen et al. (2007), Klaver et al. (2018), Klaver et
19 al. (2017), Lapauw et al. (2008), Mueller et al. (2018), Wiercks (et al. (2014), and
20 Yun et al. (2021) have evaluated the changes in body composition in males
21 undergoing transgender hormone therapy with a common finding that there are large
22 retained male advantages in lean body mass.

23 176. Hilton & Lundberg summarize an extensive survey of the literature as
24 follows:

25 "12 longitudinal studies have examined the effects of
26 testosterone suppression on lean body mass or muscle size in
27 transgender women. The collective evidence from these
28 studies suggests that 12 months, which is the most commonly

1 examined intervention period, of testosterone suppression to
2 female typical reference levels results in a modest
3 (approximately- 5%) loss of lean body mass or muscle size..
4 ..

5 "Thus, given the large baseline differences in muscle mass
6 between males and females (Table 1; approximately 40%), the
7 reduction achieved by 12 months of testosterone suppression
8 can reasonably be assessed as small relative to the initial
9 superior mass. We, therefore, conclude that the muscle mass
10 advantage males possess over females, and the performance
11 implications thereof, are not removed by the currently studied
12 durations (4 months, 1, 2 and 3 years) of testosterone
13 suppression in transgender women. (Hilton 2021 at 205-207.)

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

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

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

27 179. The previous very permissive NCAA policy governing transgender
28 participation in women's collegiate athletics was adopted in 2011, and the previous

1 IOC guidelines were adopted in 2015. At those dates, much of the scientific analysis
2 of the actual impact of testosterone suppression had not yet been performed, much
3 less any wider synthesis of that science. In fact, a series of important peer-reviewed
4 studies and literature reviews have been published only very recently, since I
5 prepared my first paper on this topic, in early 2020.

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

10 181. Importantly, I have found no peer-reviewed scientific paper, nor any
11 respected scientific voice, that is now asserting the contrary—that is, that testosterone
12 suppression can eliminate or even largely eliminate the male biological advantage
13 once puberty has occurred.

14 182. I excerpt the key conclusions from important recent peer-reviewed papers
15 below.

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

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

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

27 186. Hilton & Lundberg 2021: "evidence for loss of the male performance
28 advantage, established by testosterone at puberty and translating in elite athletes to

1 a 10-50% performance advantage, is lacking.... These data significantly
2 undermine the delivery of fairness and safety presumed by the criteria set out in
3 transgender inclusion policies ..." (211)

4 187. Hamilton et al. 2021, "Response to the United Nations Human Rights
5 Council's Report on Race and Gender Discrimination in Sport: An Expression of
6 Concern and a Call to Prioritize Research": "There is growing support for the idea
7 that development influenced by high testosterone levels may result in retained
8 anatomical and physiological advantages If a biologically male athlete self-
9 identifies as a female, legitimately with a diagnosis of gender dysphoria or
10 illegitimately to win medals, the athlete already possesses a physiological advantage
11 that undermines fairness and safety. This is not equitable, nor consistent with the
12 fundamental principles of the Olympic Charter." (840)

13 188. Hamilton et al. 2021, "Consensus Statement of the Federation Internationale
14 de Medecine du Sport" (International Federation of Sports Medicine, or FIMS),
15 signed by more than 60 sports medicine experts from prestigious institutions around
16 the world: The available studies "make it difficult to suggest that the athletic
17 capabilities of transwomen individuals undergoing HRT or GAS are comparable to
18 those of cisgender women." The findings of Roberts et al. "question the required
19 testosterone suppression time of 12 months for transwomen to be eligible to
20 compete in women's sport, as most advantages over ciswomen were not negated
21 after 12 months of HRT."

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

28 Given that the percentage difference between medal placings

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

9 190. Nokoff et al. (2023) is another peer-reviewed literature review examining the
10 evidence to date on whether Gender Affirming Hormone Therapy in transwomen
11 eliminates male sex-based athletic advantages and concludes that "reductions of
12 lean body mass and muscle cross-sectional area in the first 12 to 36 months of
13 GAHT ... are associated with small reductions or no change in limb strength
14 assessed by hand grip or knee flexion/extension." And "After pubertal change begin,
15 sex segregation for sports involving endurance, power, and strength, ... allow
16 adolescent girls and women to excel."

17 191. Outside the forum of peer-reviewed journals, respected voices in sport are
18 reaching the same conclusion.

19 192. The **Women's Sports Policy Working Group** identifies among its members
20 and "supporters" many women Olympic medalists, former women's tennis
21 champion and LGBTQ activist Martina Navratilova, Professor Doriane Coleman, a
22 former All-American women's track competitor, transgender athletes Joanna
23 Harper and Dr. Renee Richards, and many other leaders in women's sports and civil
24 rights. I have referenced other published work of Joanna Harper and Professor
25 Coleman. In early 2021 the Women's Sports Policy Working Group published a
26 "Briefing Book" on the issue of transgender participation in women's sports,¹³ in

27
28 ¹³ <https://womenssportspolicy.org/wp-content/uploads/2021/02/Congressional-Briefing-WSPWG-Transgender-Women-Sports-2.27.21.pdf>

1 which they reviewed largely the same body of literature I have reviewed above, and
2 analyzed the implications of that science for fairness and safety in women's sports.

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

- 4 • "[T]he evidence is increasingly clear that hormones do not eliminate the legacy
5 advantages associated with male physical development" (8) due to "the
6 considerable size and strength advantages that remain even after hormone
7 treatments or surgical procedures." (17)
- 8 • "[T]here is convincing evidence that, depending on the task, skill, sport, or event,
9 trans women maintain male sex-linked (legacy) advantages even after a year on
10 standard gender-affirming hormone treatment." (26, citing Roberts 2020.)
- 11 • "[S]everal peer-reviewed studies, including one based on data from the U.S.
12 military, have confirmed that trans women retain their male sex-linked
13 advantages even after a year on gender affirming hormones. . . . Because of these
14 retained advantages, USA Powerlifting and World Rugby have recently
15 concluded that it isn't possible fairly and safely to include trans women in
16 women's competition." (32)

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

- 23 • "Current policies regulating the inclusion of transgender women in sport are
24 based on the premise that reducing testosterone to levels found in biological
25 females is sufficient to remove many of the biologically-based performance
26 advantages described above. However, peer-reviewed evidence suggests that
27 this is not the case."
- 28 • "Longitudinal research studies on the effect of reducing testosterone to female

1 levels for periods of 12 months or more do not support the contention that
2 variables such as mass, lean mass and strength are altered meaningfully in
3 comparison to the original male-female differences in these variables. The
4 lowering of testosterone removes only a small proportion of the documented
5 biological differences, with large, retained advantages in these physiological
6 attributes, with the safety and performance implications described previously."

- 7 • "... given the size of the biological differences prior to testosterone suppression,
8 this comparatively small effect of testosterone reduction allows substantial and
9 meaningful differences to remain. This has significant implications for the risk
10 of injury "
- 11 • " ... bone mass is typically maintained in transgender women over the course
12 of at least 24 months of testosterone suppression, Height and other skeletal
13 measurements such as bone length and hip width have also not been shown to
14 change with testosterone suppression, and nor is there any plausible biological
15 mechanism by which this might occur, and so sporting advantages due to skeletal
16 differences between males and females appear unlikely to change with
17 testosterone reduction.

18 195. In September 2021 the government-commissioned Sports Councils of the
19 United Kingdom and its subsidiary parts (the five Sports Councils responsible for
20 supporting and investing in sport across England, Wales, Scotland and Northern
21 Ireland) issued a formal "Guidance for Transgender Inclusion in Domestic Sport"
22 (UK Sport Councils 2021), following an extensive consultation process, and a
23 commissioned "International Research Literature Review" prepared by the Carbmill
24 Consulting group (UK Sport Literature Review 2021). The UK Sport Literature
25 Review identified largely the same relevant literature that I review in this paper,
26 characterizes that literature consistently with my own reading and description, and
27 based on that science reaches conclusions similar to mine.

28 196. The UK Sport Literature Review 2021 concluded:

- 1 • "Sexual dimorphism in relation to sport is significant and the most important
2 determinant of sporting capacity. The challenge to sporting bodies is most
3 evident in the inclusion of transgender people in female sport." "[The] evidence
4 suggests that parity in physical performance in relation to gender-affected sport
5 cannot be achieved for transgender people in female sport through testosterone
6 suppression. Theoretical estimation in contact and collision sport indicate injury
7 risk is likely to be increased for female competitors." (10)
- 8 • "From the synthesis of current research, the understanding is that testosterone
9 suppression for the mandated one year before competition will result in little or
10 no change to the anatomical differences between the sexes, and a more complete
11 reversal of some acute phase metabolic pathways such as haemoglobin levels
12 although the impact on running performance appears limited, and a modest
13 change in muscle mass and strength: The average of around 5% loss of muscle
14 mass and strength will not reverse the average 40-50% difference in strength that
15 typically exists between the two sexes." (7)
- 16 • "These findings are at odds with the accepted intention of current policy in sport,
17 in which twelve months of testosterone suppression is expected to create
18 equivalence between transgender women and females." (7)
- 19 197. Taking into account the science detailed in the UK Sport Literature Review
20 2021, the UK Sports Councils have concluded:
- 21 • "[T]he latest research, evidence and studies made clear that there are retained
22 differences in strength, stamina and physique between the average woman
23 compared with the average transgender woman or non-binary person registered
24 male at birth, with or without testosterone suppression." (3)
- 25 • "Competitive fairness cannot be reconciled with self-identification into the
26 female category in gender-affected sport." (7)
- 27 • "As a result of what the review found, the Guidance concludes that the inclusion
28 of transgender people into female sport cannot be balanced regarding

1 transgender inclusion, fairness and safety in gender-affected sport where there
2 is meaningful competition. This is due to retained differences in strength,
3 stamina and physique between the average woman compared with the average
4 transgender woman or non-binary person assigned male at birth, with or without
5 testosterone suppression." (6)

- 6 • "Based upon current evidence, testosterone suppression is unlikely to guarantee
7 fairness between transgender women and natal females in gender-affected
8 sports Transgender women are on average likely to retain physical advantage
9 in terms of physique, stamina, and strength. Such physical differences will also
10 impact safety parameters in sports which are combat, collision or contact in
11 nature." (7)

12 198. On January 15, 2022 the American Swimming Coaches Association (ASCA)
13 issued a statement stating, "The American Swimming Coaches Association urges
14 the NCAA and all governing bodies to work quickly to update their policies and
15 rules to maintain fair competition in the women's category of swimming. ASCA
16 supports following all available science and evidenced-based research in setting the
17 new policies, and we strongly advocate for more research to be conducted" and
18 further stated "The current NCAA policy regarding when transgender females can
19 compete in the women's category can be unfair to cisgender females and needs to
20 be reviewed and changed in a transparent manner." ([https://swimswam.com/asca-
21 issues-statement-calling-for-ncaa-to-review-transgender-rules/](https://swimswam.com/asca-issues-statement-calling-for-ncaa-to-review-transgender-rules/); Accessed January
22 16, 2022.)

23 199. On January 19, 2022, the NCAA Board of Governors approved a change to
24 the policy on transgender inclusion in sport and stated that "...the updated NCAA
25 policy calls for transgender participation for each sport to be determined by the
26 policy for the national governing body of that sport, subject to ongoing review and
27 recommendation by the NCAA Committee on Competitive Safeguards and Medical
28 Aspects of Sports to the Board of Governors. If there is no

1 N[ational]G[overning]B[ody] policy for a sport, that sport's international federation
2 policy would be followed. If there is no international federation policy, previously
3 established IOC policy criteria would be followed"
4 ([https://www.ncaa.org/news/2022/1/19/media-center-board-of-governors-updates-](https://www.ncaa.org/news/2022/1/19/media-center-board-of-governors-updates-transgender-participation-policy.aspx)
5 [transgender-participation-policy.aspx](https://www.ncaa.org/news/2022/1/19/media-center-board-of-governors-updates-transgender-participation-policy.aspx); Accessed January 20, 2022.)

6 200. On February 1, 2022, because" ... a competitive difference in the male and
7 female categories and the disadvantages this presents in elite head-to-head
8 competition ... supported by statistical data that shows that the top-ranked female
9 in 2021, on average, would be ranked 536th across all short course yards (25 yards)
10 male events in the country and 326th across all long course meters (50 meters) male
11 events in the country, among USA Swimming members," USA Swimming released
12 its Athlete Inclusion, Competitive Equity and Eligibility Policy. The policy is
13 intended to "provide a level-playing field for elite cisgender women, and to mitigate
14 the advantages associated with male puberty and physiology." (USA Swimming
15 Releases Athlete Inclusion, Competitive Equity and Eligibility Policy, available at
16 [https://www.usaswimming.org/news/2022/02/01/usa-swimming-releases-athlete-](https://www.usaswimming.org/news/2022/02/01/usa-swimming-releases-athlete-inclusion-competitive-equity-and-eligibility-policy)
17 [inclusion-competitive-equity-and-eligibility-policy](https://www.usaswimming.org/news/2022/02/01/usa-swimming-releases-athlete-inclusion-competitive-equity-and-eligibility-policy).) The policy states:

- 18 • For biologically male athletes seeking to compete in the female category in
19 certain "elite" level events, the athlete has the burden of demonstrating to a panel
20 of independent medical experts that:
 - 21 o "From a medical perspective, the prior physical development of the
22 athlete as Male, as mitigated by any medical intervention, does not
23 give the athlete a competitive advantage over the athlete's cisgender
24 Female competitors" and
 - 25 o There is a presumption that the athlete is not eligible unless the athlete
26 "demonstrates that the concentration of testosterone in the athlete's
27 serum has been less than 5 nmol/L ... continuously for a period of at
28 least thirty-six (36) months before the date of the Application." This

1 presumption may be rebutted "if the Panel finds, in the unique
2 circumstances of the case, that [the athlete's prior physical
3 development does not give the athlete a competitive advantage]
4 notwithstanding the athlete's serum testosterone results (e.g., the
5 athlete has a medical condition which limits bioavailability of the
6 athlete's free testosterone)." (USA Swimming Athlete Inclusion
7 Procedures at 43.)

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

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

20 [I]f gender-affirming male-to-female transition consistent with
21 the medical standard of care is initiated after the onset of
22 puberty, it will blunt some, but not all, of the effects of
23 testosterone on body structure, muscle function, and other
24 determinants of performance, but there will be persistent
25 legacy effects that will give male-to-female transgender
26 athletes (transgender women) a relative performance
27 advantage over biological females. A biological female athlete
28 cannot overcome that advantage through training or nutrition.

1 Nor can they take additional testosterone to obtain the same
2 advantage, because testosterone is a prohibited substance
3 under the World Anti-Doping Code. (2)

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

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

14 203. In June 2022, UCI, the world cycling federation, changed its eligibility
15 criteria for males who identify as female competing in the female category from 12
16 months of testosterone suppression to the level of 5 nmol/L to 24 months of
17 testosterone suppression to the level of 2.5 nmol/L. UCI Rules § 13.5.015.

- 18 • In releasing the new policy, UCI cited a position paper by Prof. Xavier Bigard
19 (2022), which concluded that the "potential [male] advantage on muscle strength
20 *I* power cannot be erased before a period of 24 months." (15) Notably, Prof.
21 Bigard did not assert that the best available evidence shows that male advantage
22 is actually erased after 24 months; he merely asserted that the evidence shows
23 that male advantage is not erased before 24 months.
- 24 • It was reported by Sean Ingle in the Guardian on Thursday, May 4, 2023, that
25 UCI may reconsider its transgender participation policy after a male who
26 identifies as a female won the Tour of the Gila in New Mexico "The UCI also
27 hears the voices of female athletes and their concerns about an equal playing
28 field for competitors, and will take into account all elements, including the

1 evolution of scientific knowledge."

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

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

15 205. In August 2022, the World Boxing Council issued a new policy requiring
16 athletes to compete in accordance with their natal sex. World Boxing Council
17 Statement/Guidelines Regarding Transgender Athletes Participation in Professional
18 Combat Sports. The WBC concluded that any other policy would raise "serious
19 health and safety concerns." *Id.*

20 206. In August 2022, World Triathlon issued a new policy limiting the female
21 category to biological females and to biological males who have suppressed
22 circulating testosterone to 2.5 nmol/L for at least 24 months and have not competed
23 in the male category in at least 48 months. World Triathlon Transgender Policy
24 Process § 3. Previously, it had followed the old IOC guidelines of requiring
25 testosterone suppression to 10 nmol/L for at least 12 months.

- 26 • In issuing this policy, World Triathlon stated that "the potential advantage in
27 muscle strength/power of transgender women cannot be erased before two years
28 of testosterone suppression." World Triathlon Transgender Policy Process § 3.

1 Notably, World Triathlon did not assert that two years of testosterone
2 suppression actually erases male performance advantage, nor did it cite any
3 evidence that would support such a proposition.

- 4 • Although World Triathlon listed sports scientists Drs. Emma Hilton and Ross
5 Tucker as consultants in developing the new policy, both immediately criticized
6 the policy as allowing male advantage into female triathlon competitions.
- 7 • Another sports scientist listed as a consultant to World Triathlon, Dr. Alun
8 Williams, has opined that basing eligibility on circulating testosterone levels is
9 not evidence-based policymaking because of the lack of evidence that
10 testosterone suppression eliminates male performance advantage.

11 207. In March 2023, the World Athletics Council, the governing body for world
12 class track & field competition issued new transgender and DSD (Disorders of Sex
13 Development) regulations. The transgender participation policy is very similar to
14 the policies of World Rugby, World Boxing, and FINA by stating "In regard to
15 transgender athletes, the Council has agreed to exclude male-to-female transgender
16 athletes who have been through male puberty from female World Rankings
17 competition from 31 March 2023." And "For DSD athletes, the new regulations will
18 require any relevant athletes to reduce their testosterone levels below a limit of 2.5
19 nmoVL for a minimum of 24 months to compete internationally in the female
20 category in any event."

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

23 **Conclusions**

24 The research and actual observed data show the following:

- 25 • At the level of (a) elite, (b) collegiate, (c) scholastic, and (d) recreational
26 competition, men, adolescent boys, or male children, have an advantage over
27 equally gifted, aged and trained women, adolescent girls, or female children in
28 almost all athletic events;

- 1 • Biological male physiology is the basis for the performance advantage that men,
2 adolescent boys, or male children have over women, adolescent girls, or female
3 children in almost all athletic events; and
- 4 • The administration of androgen inhibitors and cross-sex hormones to men or
5 adolescent boys after the onset of male puberty does not eliminate the
6 performance advantage that men and adolescent boys have over women and
7 adolescent girls in almost all athletic events. Likewise, there is no published
8 scientific evidence that the administration of puberty blockers to males before
9 puberty eliminates the pre-existing athletic advantage that prepubertal males
10 have over prepubertal females in almost all athletic events.

11 For over a decade sports governing bodies (such as the IOC and NCAA) have
12 wrestled with the question of transgender inclusion in female sports. The previous policies
13 implemented by these sporting bodies had an underlying "premise that reducing
14 testosterone to levels found in biological females is sufficient to remove many of the
15 biologically-based performance advantages." (World Rugby 2020 at 13.) Disagreements
16 centered around what the appropriate threshold for testosterone levels must be-whether the
17 10nmol/liter value adopted by the IOC in 2015, or the 5nmol/liter value adopted by the
18 IAAF.

19 But the science that has become available within just the last few years contradicts
20 that premise. Instead, as the UK Sports Councils, World Rugby, the FIMS Consensus
21 Statement, and the Women's Sports Policy Working Group have all recognized the science
22 is now sharply "at odds with the accepted intention of current policy in sport, in which
23 twelve months of testosterone suppression is expected to create equivalence between
24 transgender women and females" (UK Sports Literature Review 2021 at 7), and it is now
25 "difficult to suggest that the athletic capabilities of transwomen individuals undergoing
26 HRT or GAS are comparable to those of cisgender women." (Hamilton, FIMS Consensus
27 Statement 2021.) It is important to note that while the 2021 "IOC Framework on Fairness,
28 Inclusion, and Non-Discrimination on the Basis of Gender Identity and Sex Variations"

1 calls for an "evidence-based approach," that Framework does not actually reference *any* of
2 the now extensive scientific evidence relating to the physiological differences between the
3 sexes, and the inefficacy of hormonal intervention to eliminate male advantages relevant
4 to most sports. Instead, the IOC calls on other sporting bodies to define criteria for
5 transgender inclusion, while demanding that such criteria simultaneously ensure fairness,
6 safety, and inclusion for all. The recently updated NCAA policy on transgender
7 participation also relies on other sporting bodies to establish criteria for transgender
8 inclusion while calling for fair competition and safety.

9 But what we currently know tells us that these policy goals-fairness, safety, and
10 full transgender inclusion-are irreconcilable for many or most sports. Long human
11 experience is now joined by large numbers of research papers that document that males
12 outperform females in muscle strength, muscular endurance, aerobic and anaerobic power
13 output, VO₂max, running speed, swimming speed, vertical jump height, reaction time, and
14 most other measures of physical fitness and physical performance that are essential for
15 athletic success. The male advantages have been observed in fitness testing in children as
16 young as 3 years old, with the male advantages increasing immensely during puberty. To
17 ignore what we know to be true about males' athletic advantages over females, based on
18 mere hope or speculation that cross sex hormone therapy (puberty blockers, androgen
19 inhibitors, or cross-sex hormones) might neutralize that advantage, when the currently
20 available evidence says it does not, is not science and is not "evidence-based" policy-
21 making.

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

28 Sports have been separated by sex for the purposes of safety and fairness for a

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

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

15
16
17 I swear or affirm under penalty of perjury that the foregoing is true and correct.

18 Dated: May 18, 2023

Signed: Isl Dr. Gregory A. Brown. Ph.D. • FACSM

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Appendix 1 - Data Tables

Presidential Physical Fitness Results¹⁴

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%	

¹⁴ This data is available from a variety of sources, including: <https://gilmore.gvsd.us/documents/Info/Forms/Teacher%20Forms/Presidentialchallengest.pdf>

Shuttle Run (seconds)

					Male-Female		%
Male			Female		Difference		
	50th	85th	50th	85th	50th	85th	
Age	%ile	%ile	%ile	%ile	Age	%ile	%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)

					Male-Female		%
Male			Female		Difference		
	50th	85th	50th	85th	50th	85th	
Age	%ile	%ile	%ile	%ile	Age	%ile	%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%

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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		
	50th	85th	50th	85th	50th	85th	
Age	%ile	%ile	%ile	%ile	Age	%ile	%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%

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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

2021 National 3000 m cross country race time in seconds

Rank	7-8 years old			9-10 years old			11-12 year old		
	Boys	Girls		Boys	Girls		Boys	Girls	
1	691.8	728.4	Difference	607.7	659.8	Difference	608.1	632.6	Difference
2	722.5	739.0	#1 boy vs #	619.6	674.0	#1 boy vs #	608.7	639.8	#1 boy vs #
3	740.5	783.0	1 girl	620.1	674.7	1 girl	611.3	664.1	1 girl
4	759.3	783.5	5.0%	643.2	683.7	7.9%	618.6	664.4	3.9%
5	759.6	792.8		646.8	685.0		619.7	671.6	
6	760.0	824.1		648.0	686.4		631.2	672.1	
7	772.0	825.7	Average	648.8	687.0	Average	631.7	672.3	Average
8	773.0	832.3	difference	658.0	691.0	difference	634.9	678.4	difference
9	780.7	834.3	boys vs girls	659.5	692.2	boys vs girls	635.0	679.3	boys vs girls
10	735.1	844.4	6.2%	663.9	663.3	5.6%	635.1	679.4	6.3%

2021 National 100 m Track race time in seconds

Rank	7-8 years old			9-10 years old			11-12 year old		
	Boys	Girls		Boys	Girls		Boys	Girls	
1	13.06	14.24	Difference	10.87	12.10	Difference	11.37	12.08	Difference
2	13.54	14.41	#1 boy v s #	10.91	12.24	#1 boy v s #	11.61	12.43	#1 boy v s #
3	13.73	14.44	1 girl	11.09	12.63	1 girl	11.73	12.51	1 girl
4	14.10	14.48	8.3%	11.25	12.70	10.2%	11.84	12.55	5.9%
5	14.19	14.49		11.27	12.75		11.89	12.57	
6	14.31	14.58		11.33	12.80		11.91	12.62	
7	14.34	14.69	Average	11.42	12.83	Average	11.94	12.65	Average
8	14.35	14.72	difference	11.43	12.84	difference	11.97	12.71	difference
9	14.41	14.77	boys vs girls	11.44	12.88	boys vs girls	12.08	12.71	boys vs girls
10	14.43	14.86	3.6%	11.51	12.91	11.1%	12.12	12.75	5.7%

2021 National 200 m Track race time in seconds

Rank	7-8 years old			9-10 years old			11-12 year old		
	Boys	Girls		Boys	Girls		Boys	Girls	
1	24.02	28.72	Difference	21.77	25.36	Difference	20.66	25.03	Difference
2	24.03	28.87	#1 boy v s #	22.25	25.50	#1 boy v s #	22.91	25.18	#1 boy v s #
3	28.07	29.92	1 girl	22.48	25.55	1 girl	23.14	25.22	1 girl
4	28.44	29.95	16.4%	22.57	25.70	14.2%	23.69	25.49	17.5%
5	28.97	30.04		22.65	26.08		23.84	25.78	
6	29.26	30.09		22.77	26.22		24.23	25.89	
7	29.34	30.27	Average	23.11	26.79	Average	24.35	26.03	Average
8	29.38	30.34	difference	23.16	26.84	difference	24.58	26.07	difference
9	29.65	30.41	boys vs girls	23.28	26.91	boys vs girls	24.59	26.10	boys vs girls
10	29.78	30.54	6.1%	23.47	26.85	13.1%	24.61	26.13	7.9%

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2021 National 400 m Track race time in seconds

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2021 National 800 m Track race time in seconds

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Rank	7-8 years old			9-10 years old			11-12 year old		
	Boys	Girls		Boys	Girls		Boys	Girls	
1	66.30	67.12	Difference	49.29	56.80	Difference	51.96	55.70	Difference
2	66.88	67.67	#1 boy vs #	50.47	58.57	#1 boy vs #	55.52	57.08	#1 boy vs #
3	67.59	67.74	1 girl	52.28	60.65	1 girl	55.58	57.60	1 girl
4	68.16	68.26	1.2%	52.44	61.45	13.2%	55.59	57.79	6.7%
5	68.51	68.37		53.31	61.81		55.72	58.02	
6	69.13	71.02		53.65	62.03		55.84	58.25	
7	69.75	72.73	Average	53.78	62.32	Average	55.92	59.25	Average
8	69.80	73.25	difference	54.51	62.33	difference	57.12	59.27	difference
9	69.81	73.31	boys vs girls	55.84	62.34	boys vs girls	57.18	59.40	boys vs girls
10	70.32	73.48	2.4%	55.90	62.40	13.0%	57.22	59.49	4.2%

Rank	7-8 years old			9-10 years old			11-12 year old		
	Boys	Girls		Boys	Girls		Boys	Girls	
1	152.2	157.9	Difference	120.8	141.4	Difference	127.8	138.5	Difference
2	155.2	164.6	#1 boy vs #	124.0	142.2	#1 boy vs #	129.7	143.1	#1 boy vs #
3	161.0	164.9	1 girl	125.1	148.8	1 girl	130.5	144.2	1 girl
4	161.1	165.9	3.6%	125.6	151.3	14.5%	133.2	144.2	7.7%
5	161.2	168.5		126.5	151.6		136.2	144.9	
6	161.6	169.9		136.5	152.5		136.5	145.0	
7	161.8	171.5	Average	137.1	153.1	Average	136.7	145.2	Average
8	162.2	173.1	difference	138.5	153.7	difference	136.7	145.6	difference
9	165.3	173.4	boys vs girls	139.5	153.8	boys vs girls	137.0	145.6	boys vs girls
10	166.9	174.7	4.5%	140.2	154.2	12.6%	137.9	145.8	6.9%

2021 National 1600 m Track race time in seconds

Rank	7-8 years old			9-10 years old			11-12 year old		
	Boys	Girls		Boys	Girls		Boys	Girls	
1	372.4	397.6	Difference	307.4	319.3	Difference	297.3	313.8	Difference
2	378.3	400.9	#1 boy v s #	313.7	322.2	#1 boy v s #	298.4	317.1	#1 boy v s #
3	378.4	405.6	1 girl	315.0	322.6	1 girl	307.0	319.9	1 girl
4	402.0	435.2	6.3%	318.2	337.5	3.7%	313.9	323.3	5.2%
5	406.4	445.0		318.4	345.2		319.2	325.3	
6	413.4	457.0		320.5	345.7		320.4	326.2	
7	457.4	466.0	Average	327.0	345.9	Average	321.1	327.0	Average
8	473.3	466.8	difference	330.3	347.1	difference	321.9	330.0	difference
9	498.3	492.3	boys vs girls	333.4	347.5	boys vs girls	325.5	331.1	boys vs girls
10	505.0	495.0	4.0%	347.0	355.6	4.7%	327.1	332.5	2.9%

2021 National 3000 m Track race time in seconds

Rank	7-8 years old			9-10 years old			11-12 year old		
	Boys	Girls		Boys	Girls		Boys	Girls	
1	794.2	859.9	Difference	602.3	679.2	Difference	556.6	623.7	Difference
2	856.3		#1 boy v s #	644.9	709.7	#1 boy v s #	591.6	649.5	#1 boy v s #
3			1 girl	646.6	714.2	1 girl	600.8	651.6	1 girl
4			7.6%	648.2	741.9	11.3%	607.1	654.9	10.8%
5		No		648.4	742.7		609.1	662.9	
6	No	Further		652.8	756.6		611.5	664.1	
7	further	Data	Average	658.9	760.2	Average	615.7	666.3	Average
8	data		difference	660.1	762.5	difference	617.3	666.8	difference
9			boys vs girls	662.7	780.2	boys vs girls	618.4	673.2	boys vs girls
10			NA%	671.6	792.3	12.7%	620.6	674.4	8.2%

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2021 National Long Jump Distance (in inches)

Rank	7-8 years old			9-10 years old			11-12 year old		
	Boys	Girls		Boys	Girls		Boys	Girls	
1	156.0	176.0	Difference	256.8	213.8	Difference	224.0	201.3	Difference
2	156.0	163.8	#1 boy v s #	247.0	212.0	#1 boy v s #	222.5	197.3	#1 boy v s #
3	155.0	153.0	1 girl	241.0	210.8	1 girl	220.5	195.8	1 girl
4	154.3	152.0	-11.4%	236.3	208.8	20.1%	210.3	193.5	11.3%
5	154.0	149.5		231.5	207.0		210.0	193.3	
6	152.8	146.0		225.0	204.8		206.8	192.5	
7	151.5	144.5	Average	224.0	194.5	Average	206.0	192.3	Average
8	150.8	137.5	difference	224.0	192.5	difference	205.5	192.0	difference
9	150.5	137.0	boys vs girls	221.8	192.3	boys vs girls	205.0	191.3	boys vs girls
10		No	1.4%			13.2%			9.1%
		Further							
	150.5	Data		219.0	187.5		204.5	189.0	

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2021 National High Jump Distance (in inches)

Rank	7-8 years old			9-10 years old			11-12 year old		
	Boys	Girls		Boys	Girls		Boys	Girls	
1	38.0	37.5	Difference	72.0	58.0	Difference	63.0	56.0	Difference
2	38.0	34.0	#1 boy v s #	70.0	58.0	#1 boy v s #	61.0	56.0	#1 boy v s #
3	36.0	32.0	1 girl	65.8	57.0	1 girl	60.0	57.0	1 girl
4	36.0	32.0	13	62.0	56.0	24.1%	59.0	56.0	12.5%
5	35.8	32.0		62.0	56.0		59.0	56.0	
6	35.5			62.0	55.0		59.0	55.0	
7	34.0		Average	61.0	54.0	Average	59.0	54.0	Average
8	32.0	No	difference	60.0	54.0	difference	58.0	54.0	difference
9	59.0	further	boys vs girls	59.0	No	boys vs girls	57.8	56.0	boys vs girls
10		Data	21.6%		Further	12.5%			6.9%
	56.0			56.0	Data		57.8	56.0	

Appendix 2 - Scholarly Publications

Refereed Publications

1. Shaw BS, Breukelman G, Millard L, Moran J, Brown G, & Shaw I. Effects of a maximal cycling all-out anaerobic test on visual performance. *Clin Exp Optom.* <https://doi.org/10.1080/08164622.2022.2153583>, 2022
2. Brown GA, Shaw BS, Shaw I. How much water is in a mouthful, and how many mouthfuls should I drink? A laboratory exercise to help students understand developing a hydration plan. *Adv Physiol Educ* 45: 589-593, 2021.
3. Schneider KM and Brown GA (as Faculty Mentor). What's at Stake: Is it a Vampire or a Virus? *International Journal of Undergraduate Research and Creative Activities.* 11, Article 4. 2019.
4. Christner C and Brown GA (as Faculty Mentor). Explaining the Vampire Legend through Disease. *UNK Undergraduate Research Journal.* 23(1), 2019. (*This is an on-campus publication.)
5. Schneekloth B and Brown GA. Comparison of Physical Activity during Zumba with a Human or Video Game Instructor. 11(4):1019-1030. *International Journal of Exercise Science*, 2018.
6. Bice MR, Hollman A, Bickford S, Bickford N, Ball JW, Wiedenman EM, Brown GA, Dinkel D, and Adkins M. Kinesiology in 360 Degrees. *International Journal of Kinesiology in Higher Education*, 1: 9-17, 2017
7. Shaw I, Shaw BS, Brown GA, and Shariat A. Review of the Role of Resistance Training and Musculoskeletal Injury Prevention and Rehabilitation. *Gavin Journal of Orthopedic Research and Therapy.* 1: 5-9, 2016
8. Kahle A, Brown GA, Shaw I, & Shaw BS. Mechanical and Physiological Analysis of Minimalist versus Traditionally Shod Running. *J Sports Med Phys Fitness.* 56(9):974-9, 2016
9. Bice MR, Carey J, Brown GA, Adkins M, and Ball JW. The Use of Mobile Applications to Enhance Learning of the Skeletal System in Introductory Anatomy &

- 1 Physiology Students. *Int J Kines Higher Educ* 27(1) 16-22, 2016
- 2 10. Shaw BS, Shaw I, & Brown GA. Resistance Exercise is Medicine. *Int J Ther Rehab.*
- 3 22:233-237,2015.
- 4 11. Brown GA, Bice MR, Shaw BS, & Shaw I. Online Quizzes Promote Inconsistent
- 5 Improvements on In-Class Test Performance in Introductory Anatomy & Physiology.
- 6 *Adv. Physiol. Educ.* 39: 63-6, 2015
- 7 12. Brown GA, Heiserman K, Shaw BS, & Shaw I. Rectus abdominis and rectus femoris
- 8 muscle activity while performing conventional unweighted and weighted seated
- 9 abdominal trunk curls. *Medicina dello Sport.* 68: 9-18. 2015
- 10 13. Botha DM, Shaw BS, Shaw I & Brown GA. Role of hyperbaric oxygen therapy in the
- 11 promotion of cardiopulmonary health and rehabilitation. *African Journal for Physical,*
- 12 *Health Education, Recreation and Dance (AJPHERD).* Supplement 2 (September), 20:
- 13 62-73,2014
- 14 14. Abbey BA, Heelan KA, Brown, GA, & Bartee RT. Validity of HydraTrend™ Reagent
- 15 Strips for the Assessment of Hydration Status. *J Strength Cond Res.* 28: 2634-9. 2014
- 16 15. Scheer KC, Siebrandt SM, Brown GA, Shaw BS, & Shaw I. Wii, Kinect, & Move.
- 17 Heart Rate, Oxygen Consumption, Energy Expenditure, and Ventilation due to
- 18 Different Physically Active Video Game Systems in College Students. *International*
- 19 *Journal of Exercise Science:* 7: 22-32, 2014
- 20 16. Shaw BS, Shaw I, & Brown GA. Effect of concurrent aerobic and resistive breathing
- 21 training on respiratory muscle length and spirometry in asthmatics. *African Journal for*
- 22 *Physical, Health Education, Recreation and Dance (AJPHERD).* Supplement 1
- 23 (November), 170-183, 2013
- 24 17. Adkins M, Brown GA, Heelan K, Ansorge C, Shaw BS & Shaw I. Can dance
- 25 exergaming contribute to improving physical activity levels in elementary school
- 26 children? *African Journal for Physical, Health Education, Recreation and Dance*
- 27 *(AJPHERD).* 19: 576-585, 2013
- 28 IS. Jarvi MB, Brown GA, Shaw BS & Shaw I. Measurements of Heart Rate and

- 1 Accelerometry to Determine the Physical Activity Level in Boys Playing Paintball.
2 International Journal of Exercise Science: 6: 199-207, 2013
- 3 19. Brown GA, Krueger RD, Cook CM, Heelan KA, Shaw BS & Shaw I. A prediction
4 equation for the estimation of cardiorespiratory fitness using an elliptical motion
5 trainer. West Indian Medical Journal. 61: 114-117, 2013.
- 6 20. Shaw BS, Shaw I, & Brown GA. Body composition variation following diaphragmatic
7 breathing. African Journal for Physical, Health Education, Recreation and Dance
8 (AJPHERD). 18: 787-794, 2012.

9 **Refereed Presentations**

- 10 1. Steinman PM, Steinman PC, Brown GA. Knowledge Of The Female Athlete Triad
11 In Female High School Athletes In Rural Nebraska. Accepted for presentation at the
12 70th Annual Meeting of the American College of Sports Medicine. Denver CO.
13 May 30 - June 2, 2023.
- 14 2. Steinman PC, Steinman PM, Brown GA. Female Athlete Triad Knowledge Among
15 Sports Medicine Rehabilitation Clinicians In Nebraska. Accepted for presentation
16 at the 70th Annual Meeting of the American College of Sports Medicine. Denver
17 CO. May 30 - June 2, 2023.
- 18 3. Brown GA, Brown CJ, Shaw I, Shaw B. Boys And Girls Differ In Running And
19 Jumping Track And Field Event Performance Before Puberty. Accepted for
20 presentation at the 70th Annual Meeting of the American College of Sports
21 Medicine. Denver CO. May 30 - June 2, 2023.
- 22 4. Brown GA, Orr T, Shaw BS, Shaw I. Comparison of Running Performance Between
23 Division and Sex in NCAA Outdoor Track Running Championships 2010-2019.
24 54(5), 2146. 69th Annual Meeting of the American College of Sports Medicine. San
25 Diego, CA. May 31 - June 4, 2022.
- 26 5. Shaw BS, Lloyd R, Da Silva M, Coetzee D, Millard L, Breukelman G, Brown GA,
27 Shaw I. Analysis Of Physiological Determinants During A Single Bout Of German
28 Volume Training. 54(5), 886. 69th Annual Meeting of the American College of

- 1 Sports Medicine. San Diego, CA. May 31 - June 4, 2022.
- 2 6. Shaw I, Turner S, Brown GA, Shaw BS. Effects Of Resistance Exercise Modalities
3 On Chest Expansion, Spirometry And Cardiorespiratory Fitness In Untrained
4 Smokers. Med Sci Sport Exerc. 54(5), 889. 69th Annual Meeting of the American
5 College of Sports Medicine. San Diego, CA. May 31 - June 4, 2022.
- 6 7. Elton D, Brown GA, Orr T, Shaw BS, Shaw I. Comparison Of Running
7 Performance Between Division And Sex In NCAA Outdoor Track Running
8 Championships 2010-2019. Northland Regional Meeting of the American College
9 of Sports Medicine. Held Virtually. April 8, 2022
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EXHIBIT 2



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9 **IN THE UNITED STATES DISTRICT COURT**
10 **FOR THE DISTRICT OF ARIZONA**
11 **TUCSON DIVISION**

12 Jane Doe, *et al.*,

13 Plaintiffs,

14 v.

15
16 Thomas C. Horne, in his official capacity
17 as State Superintendent of Public
18 Instruction, *et al.*,

19
20
21 Defendants.
22

Case No. 4:23-cv-00185-JGZ

**Declaration of James M. Cantor, Ph.D.,
in Support of [Intervenors' Proposed]
Opposition to Plaintiffs' Motion for a
Preliminary Injunction**

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TABLE OF CONTENTS

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28

I. Credentials and Qualifications 0

 A. Education and professional background 0

 B. Clinical expertise vs. scientific expertise..... 2

 C. The professional standard to evaluate treatment models is to rely on objective assessors, not treatment model users in a conflict of interest with its results. 3

II. Multiple international health care systems that had initially expanded medicalized transition to include minors have reversed that policy, as research on safety and effectiveness accumulated, in a growing international trend against the medicalized transition of minors..... 4

 A. England 5

 B. Finland 7

 C. Sweden 8

 D. France..... 10

 E. Norway..... 11

 F. Assertions by U.S. organizations and officials that there is ‘no debate’ over medicalized transition are false. 12

III. Clinical research has a standard *Pyramid of Evidence* that summarizes the relative strength of potential sources of information. 13

 A. Clinical research comprises a standard *Pyramid of Evidence*, wherein studies from higher levels of evidence outrank even more numerous studies from lower levels of research. 14

 B. The highest level of evidence for safety and effectiveness research is the systematic review of clinical experiments. 14

 1. Systematic reviews prevent the ‘cherry-picking’ of studies that favor a particular result. 15

1 2. Systematic reviews prevent biased assessment of individual studies by
2 uniformly applying standard criteria to each study reviewed. The most widely used
3 criteria set is “GRADE.” 16

4 C. The highest level experimental study of clinical safety and
5 effectiveness is the Randomized Controlled Trial (RCT). RCTs can demonstrate that a
6 given treatment causes (rather than only correlates with) a given outcome. 17

7 1. RCTs, but not lower levels of evidence, overcome biases representing
8 ‘regression to the mean’ and other factors that can mimic clinical improvement. ... 18

9 2. When a ‘no treatment control group’ is untenable, RCTs use an ‘active
10 comparator’ group instead..... 19

11 D. Cohort studies are the highest level of evidence about medicalized
12 transition currently available. 19

13 E. Expert opinion represents the least reliable evidence..... 19

14 F. Surveys and cross-sectional studies cannot demonstrate treatment
15 effectiveness. 20

16 IV. Methodological defects limit or negate the evidentiary value of
17 many studies of treatments for gender dysphoria in minors. 20

18 A. In science, to be valid, a claim must be objective, testable, and
19 falsifiable. 20

20 B. Correlation does not imply causation. 20

21 C. When two or more treatments are provided at the same time, one
22 cannot know which treatment caused observed changes (i.e., ‘confounding’). 21

23 D. Extrapolation to dissimilar populations and dissimilar conditions.
24 22

25 E. Mental health assessment used for gate-keeping medicalized
26 transition establishes a *selection bias*, creating a statistical illusion of mental health
27 improvement among the selected. 24

28 V. Childhood-onset gender dysphoria (prepubertal-onset) is characterized by high rates

1 of desistance in the absence of social or medical transition. Of the 11 existing cohort
2 studies, all showed the majority to desist feeling gender dysphoric upon follow-up after
3 puberty. 24

4 VI. Systematic reviews of safety and effectiveness have been
5 conducted by the health care ministries/departments of several governments. They
6 *unanimously* concluded the evidence on medicalized transition in minors to be of poor
7 quality. 27

8 A. Understanding safety and efficacy..... 27

9 B. The McMaster University systematic review of systematic reviews.
10 29

11 C. The quality of the systematic reviews from governmental bodies
12 and professional associations. 30

13 D. United Kingdom..... 33

14 E. Sweden 36

15 F. Finland 36

16 G. Norway..... 37

17 VII. The Endocrine Society, WPATH, and the American Academy of
18 Pediatrics did not conduct systematic reviews of safety and efficacy in establishing clinical
19 guidelines, despite systematic reviews being the foundation and gold standard of evidence-
20 based care. 37

21 A. The Endocrine Society reviewed cross-sex hormones, but not
22 puberty blockers. They reviewed safety, but did not review effectiveness research. ... 38

23 B. WPATH reviewed effectiveness, but not the safety of medicalized
24 transition of minors. 39

25 C. The American Academy of Pediatrics did not conduct a systematic
26 review either of safety or effectiveness..... 42

27 VIII. Definitions of sex, gender identity, and gender dysphoria. 43

28 A. Sex and sex-assigned-at-birth represent objective features. 43

1 B. Gender identity refers to subjective feelings that cannot be defined,
2 measured, or verified by science. 44

3 IX. Suicide and suicidality are distinct phenomena representing
4 different mental health issues and indicating different clinical needs. 44

5 A. Rates of suicidality among all adolescents have skyrocketed with
6 the advent of social media. 45

7 B. *Suicidality* is substantially more common among females, and
8 *suicide*, among males. Sexual orientation is strongly associated with suicidality, but
9 much less associated with suicide. 46

10 C. There is no evidence that medicalized transition reduces rates of
11 suicide or suicidality. 47

12 X. Neuroimaging studies have associated brain features with sex and with sexual
13 orientation, but not gender identity. 49

14 XI. Known and potential harms associated with administration of
15 puberty blockers and cross-sex hormones to children and adolescents. 51

16 A. Hormonal treatments during puberty interfere with
17 neurodevelopment and cognitive development. 51

18 B. Substantially delayed puberty is associated with medical harms. 52

19 C. Reduced bone density. 53

20 D. Short-term/Immediate side-effects of puberty blockers include
21 sterile abscesses, leg pain, headache, mood swings, and weight gain. 54

22 E. Long-term use of cross-sex hormones in adult transsexuals is
23 associated with unfavorable lipid profiles (cholesterol and triglycerides) and other
24 issues. 55

25 XII. Assessment of plaintiffs’ experts’ reports. 55

26 A. Dr. Shumer’s declaration does not include the evidence upon which
27 an expert would rely for developing an expert opinion. 56

28 B. Dr. Shumer’s are unsupported by the research literature and

1 contradict the research literature. 56

2 C. Dr. Budge’s assertions are unsupported by the research literature

3 and contradict the research literature..... 58

4 D. Dr. Budge’s report did not contest, or even address, the pertinent

5 scientific or psychological issues or their implications..... 62

6 References 63

7 **LIST OF APPENDICES** 79

8

9

10

11

12

13

14

15

16

17

18

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1 **I. Credentials and Qualifications**

2 **A. Education and professional background**

3 1. I am a sexual behavior scientist, with an internationally recognized record
4 studying the development of human sexualities, and an expert in research methodology of
5 sexuality. My curriculum vitae is attached as Appendix 1 to this report. My publication
6 record includes both biological and non-biological influences on sexuality, ranging from
7 pre-natal brain development, through adulthood, to senescence. The primary, but not
8 exclusive, focus of my own research studies has been the development of atypical
9 sexualities. In addition to the studies I myself have conducted, I am regularly consulted to
10 evaluate the research methods, analyses, and proposals from sexual behavior scientists
11 throughout the world. The methodologies I am qualified to assess span the neurochemical
12 and neuroanatomic level, individual behavioral level, and social and interpersonal levels.

13 2. I am trained as a clinical psychologist and neuroscientist, and I am the author of
14 over 50 peer-reviewed articles in my field, spanning the development of sexual orientation,
15 gender identity, hypersexuality, and atypical sexualities collectively referred to as
16 *paraphilias*. Although I have studied many atypical sexualities, the most impactful of my
17 work has been MRI and other biological studies of the origins of pedophilia. That work has
18 revolutionized several aspects of the sex offender field, both with regard to the treatment
19 of offenders and to the prevention of sexual abuse of children. In 2022, I received the
20 Distinguished Contribution Award from the Association for the Treatment and Prevention
21 of Sexual Abuse in recognition of my research and its integration into public policy. My
22 efforts in this regard have been the subject of several documentary films.

23 3. Over my academic career, my posts have included Senior Scientist and
24 Psychologist at the Centre for Addiction and Mental Health (CAMH), and Head of
25 Research for CAMH's Sexual Behaviour Clinic. I was on the Faculty of Medicine of the
26 University of Toronto for 15 years and have served as Editor-in-Chief of the peer reviewed
27 journal, *Sexual Abuse*. That journal is one of the top-impact, peer-reviewed journals in
28 sexual behavior science and is the official journal of the Association for the Treatment and

1 Prevention of Sexual Abuse. In that appointment, I was charged to be the final arbiter for
2 impartially deciding which contributions from other scientists in my field merited
3 publication. I believe that appointment indicates not only my extensive experience
4 evaluating scientific claims and methods, but also the faith put in me by the other scientists
5 in my field. I have also served on the Editorial Boards of *The Journal of Sex Research*, the
6 *Archives of Sexual Behavior*, and *Journal of Sexual Aggression*. I am currently the Director
7 of the Toronto Sexuality Centre in Canada. Thus, although I cannot speak for other
8 scientists, I regularly interact with and am routinely exposed to the views and opinions of
9 most of the scientists active in our field today, within the United States and throughout the
10 world.

11 4. For my education and training, I received my Bachelor of Science degree from
12 Rensselaer Polytechnic Institute, where I studied mathematics, physics, and computer
13 science. I received my Master of Arts degree in psychology from Boston University, where
14 I studied neuropsychology. I earned my doctoral degree in psychology from McGill
15 University, which included successfully defending my doctoral dissertation studying the
16 effects of psychiatric medication and neurochemical changes on sexual behavior, and
17 included a clinical internship assessing and treating people with a wide range of sexual and
18 gender identity issues.

19 5. I have a decades-long, international, and award-winning history of advocacy for
20 destigmatizing people with atypical sexualities. While still a trainee in psychology, I
21 founded the American Psychological Association's (APA) Committee for Lesbian, Gay,
22 and Bisexual Graduate Students. Subsequently, I have served as the Chair for the
23 Committee on Science Issues for APA's Division for the Psychology of Sexual Orientation
24 and Gender Diversity and was appointed to its Task Force on Transgender Issues.
25 Throughout my career, my writings and public statements have consistently supported
26 rights for transgender populations and the application of science to help policy-makers best
27 meet their diverse needs. Because my professional background also includes
28 neurobiological research on the development of other atypical sexualities, I have become

1 recognized as an international leader also in the destigmatizing of the broader range of
2 human sexuality patterns.

3 6. I am highly experienced in the application of sex research to forensic
4 proceedings: I have served as the Head of Research for the Law and Mental Health Program
5 of the University of Toronto's psychiatric teaching hospital, the Centre for Addiction and
6 Mental Health, where I was appointed to the Faculty of Medicine.

7 7. I have served as an expert witness in 32 cases in the past four years, as listed on
8 my *curriculum vitae*. These cases included criminal, civil, and custody proceedings,
9 preliminary injunction and Frye hearings, as well as trials. I have testified in courts in
10 Canada and throughout the U.S., including Alabama, Arizona, Florida, Illinois, Indiana,
11 Kansas, Kentucky, Massachusetts, New York, Texas, Utah, and West Virginia. I have
12 provided expert testimony concerning the nature and origins of atypical sexualities, as well
13 as concerning gender dysphoria and gender identity in children.

14 8. For my work in this case, I am being compensated at the hourly rate of \$400 per
15 hour. My compensation does not change based on the conclusions and opinions that I
16 provide here or later in this case or on the outcome of this lawsuit.

17 **B. Clinical expertise vs. scientific expertise**

18 9. In clinical science, there are two kinds of expertise: Clinicians' expertise regards
19 applying general principles to the care of an individual patient and the unique features of
20 that case. A scientist's expertise is the reverse, accumulating information about many
21 individual cases and identifying the generalizable principles that may be applied to all
22 cases. Thus, different types of decisions may require different kinds of experts, such that
23 questions about whether a specific patient represents an exception to the general rule might
24 be better posed to a physician's expertise, whereas questions about establishing the general
25 rules themselves might be better posed to a scientist's.

26 10. In legal matters, the most familiar situation pertains to whether a given clinician
27 correctly employed relevant clinical standards. Often, it is other clinicians who practice in
28 that field who will be best equipped to speak to that question. When it is the clinical

1 standards that are themselves in question, however, it is the experts in the assessment of
2 scientific studies who are the relevant experts.

3 **C. The professional standard to evaluate treatment models is to rely on**
4 **objective assessors, not treatment model users in a conflict of interest**
5 **with its results.**

6 11. I describe in a later section the well-recognized procedures for conducting
7 reviews of literature in medical and scientific fields to evaluate the strength of evidence for
8 particular procedures or treatments. Importantly, the standard procedure is for such
9 evaluations to be conducted by objective assessors with expertise in the science of
10 assessment, and not by those with an investment in the procedure being assessed. Because
11 the people engaged in providing clinical services are necessarily in a conflict of interest
12 when claiming that their services are effective, formal evaluations of evidence are routinely
13 conducted by those *without* direct professional involvement and thus without financial or
14 other personal interest in whether services are deemed to be safe or effective. This routine
15 practice standard is exemplified by all of the only three systematic, comprehensive research
16 reviews that have been conducted concerning the safety and efficacy of puberty blockers
17 and cross-sex hormones as treatments for gender dysphoria in children.

18 12. In 2020, England’s National Health Service (NHS) commissioned a major
19 review of the use of puberty blockers and cross-sex hormones in children and young people
20 and appointed prominent pediatrician Dr. Hilary Cass to lead that review, explicating that
21 “Given the increasingly evident polarization among clinical professionals, Dr. Cass was
22 asked to chair the group as a senior clinician with *no prior involvement* or fixed views in
23 this area.” (Cass 2022 at 35, italics added.) Dr. Cass’s committee in turn commissioned
24 formal systematic reviews of evidence from the England National Institute for Health &
25 Care Excellence (NICE), a government entity of England’s Department of Health and
26 Social Care, established to provide guidance to health care policy, such as by conducting
27 systematic reviews of clinical research, but without direct involvement in providing
28 treatment to gender dysphoric individuals. (<https://www.nice.org.uk/>.) Similarly, the

1 Finnish health care council commissioned its systematic review to an external firm,
2 Summaryx Oy. (Pasternack 2019.) Summaryx Oy is a “social enterprise” (a Finnish
3 organization analogous to a non-profit think-tank) that conducts systematic research
4 reviews and other analyses for supporting that nation’s medical and social systems. Its
5 reviews are conducted by assessment professionals, not by clinicians providing services.
6 (www.summaryx.eu/en/.) The systematic review by Sweden’s National Board of Health
7 and Welfare (NBHW) included four experts. (SBU Scoping Review 2019.) In addition to
8 their own research fields, they provided clinical services in areas adjacent to but apart from
9 gender dysphoric children, such as physical disorders of sexual development (Dr. Berit
10 Kriström) or gender dysphoria in adults (Dr. Mikael Landén).

11 13. My own most-cited peer-reviewed paper relating to gender dysphoria in minors
12 illustrates the expertise in the evaluation of scientific evidence that I have and am
13 recognized for. That is, that paper provided not clinical advice or a clinical study, but rather
14 a review and interpretation of the available evidence concerning desistance in children who
15 suffer from gender dysphoria, as well as of evidence (and lack of evidence) concerning the
16 safety and efficacy of medical transition to treat gender dysphoria in minors. (Cantor 2019.)

17 14. My extensive background in the assessment of sexuality research and in the
18 development of human sexuality places me in exactly the position of objectivity and
19 freedom from conflict-of-interest required by the universal standards of medical research
20 science.

21 15. I do not offer opinions about the best public policy. Multiple jurisdictions have
22 attempted multiple different means of implementing that science into various public
23 policies. Although I accept as an axiom that good public policy must be consistent with the
24 scientific evidence, science cannot objectively assess societal values and priorities.
25 Therefore, my opinions summarize and assess the science on which public policy is based,
26 but I can offer no opinion regarding which public policy mechanisms would be best in light
27 of that science.

28 **II. Multiple international health care systems that had initially expanded**

1 **medicalized transition to include minors have reversed that policy, as**
2 **research on safety and effectiveness accumulated, in a growing international**
3 **trend against the medicalized transition of minors.**

4 16. Medicalized interventions for minors originated in European clinics (most
5 prominently in the Netherlands and Sweden), and these precedents (and in particular the
6 so-called “Dutch Protocol”) are frequently cited by American clinicians. However,
7 growing concerns about safety together with the continuing absence of reliable evidence
8 of benefit even after more than 20 years of experience have led respected and far-from
9 “conservative” European health care ministries to step back and discourage or even cease
10 providing medicalized transition of minors, other than in exceptional and carefully limited
11 circumstances, such as within registered and approved research trials. Instead, these
12 authorities now endorse psychotherapy as the treatment of choice for minors, with medical
13 interventions representing a method of last resort, if permitted at all. These range from
14 medical advisories to outright bans on the medical transition of minors. I provide details
15 concerning these policy changes below, and provide additional details regarding the
16 underlying systematic reviews in Section II and VI below.

17 **A. England**

18 17. The National Health Service (NHS) of the United Kingdom centralized gender
19 counselling and transitioning services into a single clinic, the Gender Identity Development
20 Service (GIDS) of the Tavistock and Portman NHS Foundation Trust. Between 2008 and
21 2018, the number of referrals to the clinic had increased by a factor of 40, leading to a
22 government inquiry into the causes. (Rayner 2018.) The GIDS was repeatedly accused of
23 approving and endorsing medical transition in minors without adequate justification,
24 including by 35 members of the GIDS own staff, who resigned by 2019. (BBC News 2021;
25 Donnelly 2019). An ex-governor and psychotherapist of the Trust who resigned, Marcus
26 Evans, said staff feared being called transphobic, which was impacting their objectivity in
27 their work. (Doward 2019).

28 18. In 2020, a former patient of the GIDS, Keira Bell, brought a lawsuit alleging that

1 the GIDS practices with respect to prescribing puberty blockers for minors were unproven
2 and potentially harmful in ways that meant that it was impossible for minors to give
3 meaningful informed consent. After taking extensive expert evidence, the trial court
4 concluded that puberty blockers might have “potentially irreversible” and “life-changing”
5 effects on a young person (*Bell v. Tavistock*, [2020] EWHC 3274 (Admin), ¶148, 151), that
6 there was “very limited evidence as to its efficacy” (¶134) such that “it is right to call the
7 treatment experimental” (¶148), and that use of puberty blockers almost always led to use
8 of cross-sex hormones that “may well lead to a loss of fertility” (¶¶ 137-138). While an
9 appeals court later concluded that the trial court had exceeded the proper role of the court
10 in making factual findings on these questions, the appeals court acknowledged that
11 “Medical opinion is far from unanimous about the wisdom of embarking on treatment
12 before adulthood. The question raises not only clinical medical issues but also moral and
13 ethical issues, all of which are the subject of intense professional and public debate.” (*Bell*
14 *v. Tavistock* 2021 at ¶3.)

15 19. Perhaps prompted by the Kiera Bell litigation, also in 2020 the English National
16 Health Service (“NHS”) commissioned the thorough independent review of the use of
17 puberty blockers and cross-sex hormones to be chaired by Dr. Cass that I have described
18 above. After an extensive process that included obtaining the systematic reviews of all
19 published studies bearing on safety or efficacy of these hormonal interventions in minors
20 as well as “extensive” listening sessions with clinicians, patients, and families, in February
21 2022 Dr. Cass issued an extensive “Interim Report” summarizing the state of the relevant
22 medical science and in particular highlighting the presence of serious but unstudied risks,
23 and the lack of strong evidence of efficacy. I will quote specific items from Dr. Cass’s
24 Report as relevant to specific topics below. At a high level, Dr. Cass concluded that to date
25 there has been “very limited research on the sexual, cognitive, or broader developmental
26 outcomes” from the use of puberty blockers for gender dysphoria (Cass 2022 at 19), that it
27 is an unanswered question “whether the evidence for the use and safety of [puberty
28 blockers] is strong enough as judged by reasonable clinical standards” (at 37), and that “the

1 available evidence was not strong enough to form the basis of a policy position” with regard
2 to use of both puberty blockers and cross-sex hormones in minors (at 35).

3 20. Following issuance of Dr. Cass’s Interim Report, the English NHS has published
4 a consultation document concerning a proposed revised service specification under which
5 “NHS England will only commission [puberty blockers] in the context of a formal research
6 protocol.” (NHS Interim Service Specification at 12.)

7 **B. Finland**

8 21. In Finland, minors were made eligible for medicalized transition in 2011 by that
9 country’s health care service, the Council for Choices in Health Care in Finland
10 (COHERE). Assessments of mental health and preparedness were centralized by law into
11 two research clinics, Helsinki University Central Hospital and Tampere University
12 Hospital.

13 22. In 2019, the Service Selection Council (Palko) of the Finnish Ministry of Social
14 Affairs and Health commissioned a systematic review of the effectiveness and safety of
15 medicalized transition (Pasternack 2019), and in 2020, Finnish researchers published an
16 analysis of the outcomes of adolescents diagnosed with transsexualism and receiving cross-
17 sex hormone treatment in Finland’s Tampere University Hospital. (Kaltiala 2020.) Despite
18 the purpose of medical transition being to improve mental health, the study showed:

19 Medical gender reassignment is not enough to improve functioning and relieve
20 psychiatric comorbidities among adolescents with gender dysphoria. Appropriate
21 interventions are warranted for psychiatric comorbidities and problems in
22 adolescent development. (Kaltiala 2020 at 213.)

23 They concluded that the youth who were functioning well after transition were those who were
24 already functioning well before transition, and those who were functioning poorly before transition
25 continued to function poorly after transition.

26 23. Importantly, the results of this study exemplify why correlations reported from
27 surveys cannot be interpreted as evidence of causality. Mental health assessment would
28 exclude the most poorly functioning youth from among those permitted to transition, but

1 transition itself did not improve the functioning of those who were permitted to transition.

2 24. Consistent with the results of the independent evidence review by Summaryx
3 Oy and analysis of the ethical issues involved, Finland’s health care service ended the
4 surgical transition of minors, ruling in 2020 that “Surgical treatments are not part of the
5 treatment methods for dysphoria caused by gender-related conflicts in minors.” (COHERE
6 Summary 2020.) The review of the research concluded that “[N]o conclusions can be
7 drawn on the stability of gender identity during the period of disorder caused by a
8 psychiatric illness with symptoms that hamper development.” (COHERE Summary 2020.)
9 COHERE also greatly restricted access to puberty-blocking and cross-sex hormonal
10 treatments, explicating that they may be considered for minors “only if it can be ascertained
11 that their identity as the other sex is of a permanent nature and causes severe dysphoria,”
12 and only “if the need for it continues *after* [any] other psychiatric symptoms have *ceased*
13 and adolescent development is progressing normally.” (COHERE Summary 2020, italics
14 added.) They restricted the procedures to their centralized research clinics. The council was
15 explicit in noting the lack of research needed for decision-making, “There is also a need
16 for more information on the disadvantages of procedures and on people who regret them.”
17 (COHERE Summary 2020.) In light of the special developmental and ethical
18 considerations surrounding minors, COHERE recommended that “no decisions should be
19 made that can permanently alter a still-maturing minor’s mental and physical
20 development.” (COHERE Recommendation 2020 at 7.)

21 C. Sweden

22 25. Sweden’s national health care policy regarding trans issues has developed quite
23 similarly to that of the UK. Already in place 20 years ago, Swedish health care policy
24 permitted otherwise eligible minors to receive puberty-blockers beginning at age 14 and
25 cross-sex hormones at age 16. At that time, only small numbers of minors sought medical
26 transition services. An explosion of referrals ensued in 2013–2014. Sweden’s Board of
27 Health and Welfare (“Socialstyrelsen”) reported that, in 2018, the number of diagnoses of
28 gender dysphoria was 15 times higher than 2008 among girls ages 13–17. (Swedish

1 Socialstyrelsen Support 2022 at 15.)

2 26. Sweden has long been very accepting with regard to sexual and gender diversity.
3 In 2018, a law was proposed to lower the age of eligibility for surgical care from age 18 to
4 15, remove the requirement for parental consent, and lower the legal age for change of
5 gender to age 12. A series of cases of regret and suicide following medical transition were
6 reported in the Swedish media. (Orange 2020.) In 2019, the Swedish Agency for Health
7 Technology Assessment and Assessment of Social Services (SBU) therefore initiated its
8 own systematic review of the research. The SBU released English-language results first
9 as a summary and then published as a peer reviewed article. (Ludvigsson et al., 2023.) Like
10 the UK, the Swedish investigation employed standardized review methods to ensure the
11 encapsulation of the all the relevant evidence and came to the same conclusions: “This
12 systematic review of almost 10 000 screened abstracts suggests that long-term effects of
13 hormone therapy on psychosocial and somatic health are unknown, except that GnRHa
14 treatment seems to delay bone maturation and gain in bone mineral density.” (Ludvigsson
15 2023 at 12.) They emphasized, “The absence of long-term studies is worrying because
16 many individuals start treatment as minors (<18 years) and CSHT is lifelong.” (Ludvigsson
17 2023 at 10.) Regarding the full set of studies, “No randomised controlled trials were found,
18 but we could identify 24 relevant observational studies. However, these were limited by
19 methodological weaknesses, for instance lack of or inappropriate control group, lack of
20 intra-individual analyses, high attrition rates that precluded conclusion to be drawn.”
21 (Ludvigsson 2023 at 9–10.)

22 27. In 2021, the leading Swedish pediatric gender clinic, at the Karolinska Institute,
23 issued a new policy statement in which it stated that the Swedish evidence review “showed
24 a lack of evidence for both the long-term consequences of the treatments, and the reasons
25 for the large influx of patients in recent years.” (Karolinska 2021.) The Karolinska Institute
26 further stated that “These treatments are potentially fraught with extensive and irreversible
27 adverse consequences such as cardiovascular disease, osteoporosis, infertility, increased
28 cancer risk, and thrombosis.” In a dramatic reversal of its policy, the Institute announced

1 that “In light of the above, and based on the precautionary principle, which should always
2 be applied, it has been decided that hormonal treatments (i.e., puberty blocking and cross-
3 sex hormones) will not be initiated in gender dysphoric patients under the age of 16.”
4 Further, the Karolinska clinic announced that patients ages 16–18 would receive such
5 treatments *only* within research settings (clinical trials monitored by the appropriate
6 Swedish research ethics board). (Karolinska 2021.)

7 28. In 2022, the Swedish National Board of Health and Welfare published a major
8 new national policy document concerning “Support, investigation and hormone therapy in
9 gender incongruence in children and youth,” including an English-language summary.
10 (Swedish Socialstyrelsen Support 2022.) The National Board of Health noted “the
11 continued lack of reliable scientific evidence concerning the efficacy and the safety of both
12 [puberty blockers and cross-sex hormones],” and concluded (based on the commissioned
13 evidence reviews) that “the evidence on treatment efficacy and safety is still insufficient
14 and inconclusive for all reported outcomes. Further, it is not possible to determine how
15 common it is for adolescents who undergo gender-affirming treatment to later change their
16 perception of their gender identity or interrupt an ongoing treatment.” As a result, the Board
17 of Health concluded that, “[f]or adolescents with gender incongruence, the . . . risks of
18 puberty suppressing treatment with GnRH-analogues and gender-affirming hormonal
19 treatment currently outweigh the possible benefits.” (Swedish Socialstyrelsen Support
20 2022 at 10-12.) Accordingly, the Swedish Board of Health and Welfare “recommends
21 restraint when it comes to hormone treatment.” (Swedish Socialstyrelsen Updated
22 Recommendations 2/22/22.)

23 **D. France**

24 29. While medical authorities in France have not issued any actual restriction, in
25 2022, the Académie Nationale de Médecine of France issued a strongly worded statement,
26 citing the Swedish ban on hormone treatments:

27 [A] great medical caution must be taken in children and adolescents, given the
28 vulnerability, particularly psychological, of this population and the many

1 undesirable effects, and even serious complications, that some of the available
2 therapies can cause...such as impact on growth, bone fragility, risk of sterility,
3 emotional and intellectual consequences and, for girls, symptoms reminiscent of
4 menopause.” (Académie Nationale de Médecine 2022.)

5 For hormones, the Académie concluded “the greatest reserve is required in their use,” and for
6 surgical treatments, “[T]heir irreversible nature must be emphasized.” The Académie warned “the
7 risk of over-diagnosis is real, as shown by the increasing number of transgender young adults
8 wishing to ‘detransition’.” Rather than medical interventions, it advised health care providers “to
9 extend as much as possible the psychological support phase.” The Académie reviewed and
10 emphasized the evidence indicating the very large and very sudden increase in youth requesting
11 medical transition. It attributed the change, not to society now being more accepting of sexual
12 diversity, but to social media, “underlining the addictive character of excessive consultation of
13 social networks which is both harmful to the psychological development of young people and
14 responsible, for a very important part, of the growing sense of gender incongruence.” (Académie
15 Nationale de Médecine 2022.)

16 **E. Norway**

17 30. In 2022, Norway’s Healthcare Investigation Board (Ukom) began a review of
18 that country’s guidelines for the medicalized transition of minors. (Block, Norway’s
19 Guidance, 2023.) In 2023, it released its report, which concluded that the evidence for the
20 use of puberty blockers and cross-sex hormone treatments in youth was insufficient, and
21 acknowledged the international recognition of the dearth of evidence of safety and
22 effectiveness. The report deemed medicalized transition to be experimental. (Ukom 2023,
23 Summary and Section 11.) The report faulted the existing Norwegian guidelines, published
24 in 2020, for concentrating on “equality and rights” while “deviating from the requirements
25 for the development of knowledge-based guidelines.” (Ukom 2023, Summary.)

26 31. The Norwegian report concluded that “The knowledge base, especially research-
27 based knowledge for gender-affirming treatment (hormonal and surgical), is insufficient
28 and the long-term effects are little known” and that “This applies particularly to the teenage

1 population, which accounts for a large part of the increase in referrals to the specialist
2 health service in the last decade.” (Ukom 2023, Summary and Section 7.)

3 32. In an interview about the report with the *British Medical Journal*, the Ukom
4 Medical Director, Stine Marit Moen, said, “We’re concerned that there may be
5 undertreatment, overtreatment, and the wrong treatment” and added:

6 We’ve seen a marked increase in referrals to specialised healthcare services in
7 Norway for teenagers, as seen in many other western countries, and nobody knows
8 the reason. The stability of the gender dysphoria of these teenagers is not known,
9 and the evidence of long term effects of gender affirming treatments for this young
10 population is insufficient. (Block, Norway’s Guidance, 2023.)

11 33. Ukom noted that referrals to its national treatment service increased by a factor
12 of eight between 2007 and 2018, and that this increase was largely from young biological
13 females. Seventy-five percent of the referrals to its National Treatment Service had other
14 co-morbid psychiatric diagnoses, including not only depression and anxiety but also autism
15 spectrum disorders, ADHD, and Tourette’s Syndrome. (Ukom 2023, Summary and Section
16 7.)

17 **F. Assertions by U.S. organizations and officials that there is ‘no debate’
18 over medicalized transition are false.**

19 34. The international consensus is clearly demonstrated by the multiple recent
20 analyses, statements, and policy decisions from the health care service systems around the
21 world. These include England’s National Health Service, which noted the “Scarce and
22 inconclusive evidence to support clinical decision making [which] has led to a lack of
23 clinical consensus on what the best model of care for children and young people
24 experiencing gender incongruence and dysphoria should be.” (NHS 2022 at 5.)

25 35. As these several recent national policy reviews, statements, and
26 recommendations make very clear, there is a great deal of doubt and debate among the
27 sophisticated international medical and mental health community as to whether the
28 administration of puberty blockers and cross-sex hormones to children and young people

1 is the best clinical practice, and as to whether these treatments have been shown to be safe
2 and effective. Indeed, the lack of scientifically reliable data concerning safety and efficacy
3 highlighted by the systematic evidence reviews commissioned by the English National
4 Health Service, by the Swedish National Board of Health and Welfare, and by the Finnish
5 Council for Choices in Health Care in Finland have caused those national health authorities
6 and others to move sharply away from approving puberty blockers, cross-sex hormones, or
7 surgery for minors.

8 36. In this report, I explain the evidence and lack of evidence behind that doubt, that
9 debate, and the emerging international consensus of caution reflected in the several recent
10 European policy statements or changes.

11 37. I note that the plaintiffs' experts have excluded all mention of the international
12 reversals of policy, falsely suggesting a consensus. In fact, practices at U.S. gender clinics
13 and statements by U.S. advocacy voices increasingly represent an outlier view, failing to
14 update policy despite the mounting evidence.

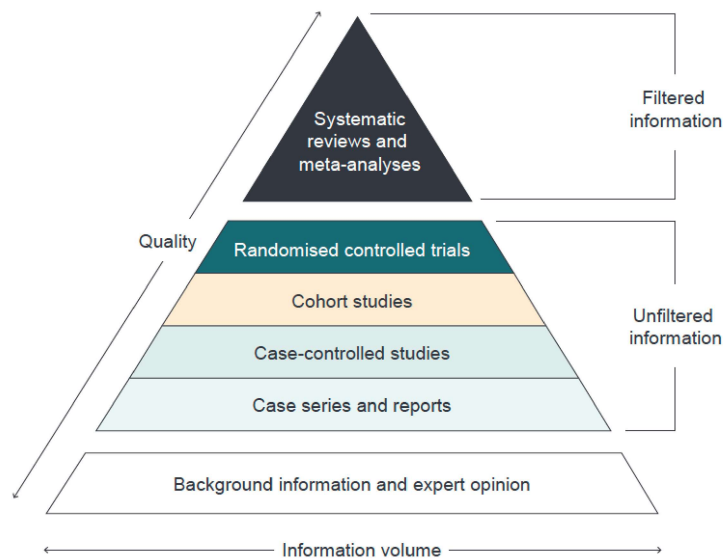
15 **III. Clinical research has a standard *Pyramid of Evidence* that summarizes the**
16 **relative strength of potential sources of information.**

17 38. The widely accepted starting point in evidence-based medicine is the recognition
18 that clinical experiences and recollections of individual practitioners (often called “expert
19 opinion” or “clinical anecdote”) do not and cannot provide a reliable, scientific basis for
20 treatment decisions. Rather, in evidence-based medicine, clinical decision-making is based
21 on objectively demonstrated evidence of outcomes from the treatment options. An essential
22 first step in evidence-based medicine is identifying the relevant findings from among the
23 immense flood of clinical journal articles published each year. Those studies and the
24 evidence they report are then assessed according to the strength offered by the research
25 methods used in each study. The research methods used in a study determine its reliability
26 and generalizability, meaning the confidence one may have that using the same treatment
27 again will have the same result again on other people. In this section, I explain the well-
28 accepted criteria for evaluating the evidentiary value of clinical studies.

1 **A. Clinical research comprises a standard *Pyramid of Evidence*, wherein**
 2 **studies from higher levels of evidence outrank even more numerous**
 3 **studies from lower levels of research.**

4 39. The accepted hierarchy of reliability for assessing clinical outcomes research is
 5 routinely represented as a “Pyramid of Evidence” (Figure 1). Scientific questions are not
 6 resolved by the number of studies coming to one versus another conclusion. Studies
 7 representing higher levels of evidence outrank studies from lower levels. Even large
 8 numbers of lower-level studies cannot overcome a study representing a higher level of
 9 evidence. Indeed, because lower-level studies are generally faster and less expensive to
 10 conduct, it is typical for them to outnumber higher level studies. This is the property meant
 11 to be reflected by the pyramid’s shape, which is larger at the base and smaller at the apex.

12 **Figure 1: Pyramid of Standards of Evidence**



23 **Source: OpenMD. Retrieved from [https://openmd.com/guide/levels-of-](https://openmd.com/guide/levels-of-evidence)**
 24 **evidence.**

25 **B. The highest level of evidence for safety and effectiveness research is the**
 26 **systematic review of clinical experiments.**

27 40. The most reliable and conclusive method of determining what is actually known
 28 not known with respect to a particular treatment is the *systematic review*. Systematic

1 reviews employ standardized procedures to assess comprehensively all available evidence
2 on an issue, minimizing opportunities for bias in gathering and evaluating research
3 evidence. As described by Dr. Gordon Guyatt, the internationally recognized pioneer in
4 medical research who invented the term *evidence-based medicine*, “A fundamental
5 principle to the hierarchy of evidence [is] that optimal clinical decision making requires
6 systematic summaries of the best available evidence.” (Guyatt 2015 at xxvi.)

7 **1. Systematic reviews prevent the ‘cherry-picking’ of studies that**
8 **favor a particular result.**

9 41. Because systematic reviews are designed to prevent researchers from including
10 only the studies they favor and other biases, systematic reviews are the routine starting
11 point for developing clinical practice guidelines. (Moher 2009.) The methods of a
12 systematic review include:

- 13 • Define the scope, including the “PICO”: Population/Patient, Intervention,
14 Comparison/Control, and Outcome(s);
- 15 • Select and disclose the keywords used to search the (massive) available clinical
16 research database(s) for potentially relevant articles, identify the databases they were
17 applied to, and the date(s) of the searches, including any subsequent updates;
- 18 • Select and disclose the inclusion/exclusion criteria to be used to filter the “hits” from
19 the keyword searches to identify research studies to be included in the detailed
20 review;
- 21 • Review abstracts to select the final set of studies, using at least two independent
22 reviewers to allow for measuring inter-rater reliability on the criteria;
- 23 • Code each study’s results impacting the research question(s), disclosing the list of all
24 studies and the results coded from each;
- 25 • Evaluate the reliability of the results [risk of bias] of each included study, applying
26 uniform criteria across them all.

1 **2. Systematic reviews prevent biased assessment of individual studies**
2 **by uniformly applying standard criteria to each study reviewed.**
3 **The most widely used criteria set is “GRADE.”**

4 42. In order to produce unbiased assessment of the studies within the systematic
5 review, all the studies must be evaluated using the same evaluation criteria. Without such
6 criteria, assessments can become influenced by researchers who, intentionally or not, hold
7 the evaluative bar higher or lower for studies according to whether the studies’ conclusions
8 support or challenge that researcher’s perspective. Several such systems have been
9 developed. The most widely used system is the “Grading of Recommendations,
10 Assessment, Development and Evaluations” (GRADE). (Goldet & Howick 2013.) In the
11 GRADE system, studies’ findings are downgraded for:

- 12 • Risk of bias:¹
 - 13 ○ Lack of clearly randomized allocation sequence,
 - 14 ○ Lack of blinding,
 - 15 ○ Lack of allocation concealment,
 - 16 ○ Failure to adhere to intention-to-treat analysis,
 - 17 ○ Trial is cut short,
 - 18 ○ Large losses to follow-up;
- 19 • Inconsistency;
- 20 • Indirectness of evidence;
- 21 • Imprecision; and
- 22 • Publication bias (when studies with ‘negative’ findings remain unpublished).

23 Studies’ ratings are upgraded if their findings identify:

- 24 • A large effect of the treatment;
- 25 • A dose-response relationship (the size of the effect has a systematic association with

26
27 ¹ In science, including in the GRADE system, the term “bias” refers to any external
28 influence leading to a systematic over- or underreporting of the outcome being measured.
That is, in this context “bias” is not used in the sociopolitical sense of personal values.

1 the dose of the treatment given); or

- 2 • That all plausible biases only *reduce* the apparent effect of the treatment (necessarily
3 making the estimated effect sizes conservative estimates).

4 43. GRADE assessments yield a four-point score representing the certainty that a
5 reported treatment effect is true. These certainty scores are (GRADE Handbook, Section
6 5):

7 **Certainty** **Meaning**

8 **High** We are very confident that the true effect lies close to that of the estimate
9 of the effect.

10 **Moderate** We are moderately confident in the effect estimate: The true effect is
11 likely to be close to the estimate of the effect, but there is a possibility
12 that it is substantially different.

13 **Low** Our confidence in the effect estimate is limited: The true effect may be
14 substantially different from the estimate of the effect.

15 **Very Low** We have very little confidence in the effect estimate: The true effect is
16 likely to be substantially different from the estimate of effect.

17 **C. The highest level experimental study of clinical safety and effectiveness**
18 **is the Randomized Controlled Trial (RCT). RCTs can demonstrate**
19 **that a given treatment causes (rather than only correlates with) a given**
20 **outcome.**

21 44. Randomized Controlled Trials are the gold standard method of assessing the
22 effects caused by an experimental treatment. The great scientific weight of RCTs follows
23 from the randomization: People do not pick which research group they are in—a treatment
24 group or a control group. Without random group assignment, it is not possible to identify
25 which, if any, changes are due to the treatment itself or to the factors that led to who did
26 and did not receive treatment.

27 45. Levels of evidence lower than RCTs are unable to distinguish when changes are
28 caused by the experimental treatment, or by factors that can mimic treatment effects, such

1 as ‘regression to the mean’ and the placebo effect.

2 46. In the absence of evidence that X causes Y, it is a scientific error to use language
3 indicating there is causal relationship. In the absence of evidence of causality, it is
4 scientifically unsupportable to describe a correlation with terms such as: increases,
5 improves, benefits, elevates, leads to, alters, influences, results in, is effective for, causes,
6 changes, contributes to, leads to, yields, impacts, decreases, harms, and depresses.
7 Scientifically valid terms for correlations include: relates to, is associated with, predicts,
8 and varies with.

9 **1. RCTs, but not lower levels of evidence, overcome biases**
10 **representing ‘regression to the mean’ and other factors that can**
11 **mimic clinical improvement.**

12 47. ‘Regression to the mean’ arises when researching issues, such as mood,
13 depression, or levels of emotional distress that typically fluctuate over time. People are
14 more likely to seek out treatment during low points rather than high points in their
15 emotional lives. Thus, when tracking emotional states over time, the average of a group of
16 people in a treatment group may often show an increase; however, without an untreated
17 control group to which to compare them, researchers cannot know whether the group
18 average would have increased anyway, with only the passage of time.

19 48. Blinding or masking participants in an RCT from which group they are in has
20 been described as a preferred strategy since the 1950s, in order to exclude the possibility
21 that a person’s expectations of change caused any changes observed (the “placebo effect”).
22 In practice, however, it has often made little or no significant difference. For example, a
23 study using very high quality methods—meta-analysis of meta-analysis research—has
24 revealed no statistical difference in the sizes of the effects detected by blinded/placebo-
25 controlled studies from non-blinded/non-placebo-controlled studies of depression.
26 (Moustgaard 2019.) That is, the pre-/post- treatment differences found in placebo groups
27 are not as attributable to participants’ expectations of improvement as they are to
28 expectable regression to the mean. (Hengartner 2020.)

1 **2. When a ‘no treatment control group’ is untenable, RCTs use an**
2 **‘active comparator’ group instead.**

3 49. It is not always possible to compare a group receiving a treatment to a group
4 receiving only an inactive procedure, such as a placebo treatment or no treatment at all. In
5 such situations, the standard, ethical, clinical research method is to compare two active
6 treatments with each other.

7 50. The systematic reviews from England explicitly called for ‘active comparator’
8 studies to test whether medicalized transition of minors shows mental health benefits
9 superior to those obtained from psychotherapy. (NICE 2020a at 40; NICE 2020b at 47.)
10 Risk:benefit analysis cannot justify the greater risks associated with medicalization without
11 evidence of correspondingly greater benefit.

12 **D. Cohort studies are the highest level of evidence about medicalized**
13 **transition currently available.**

14 51. The highest-level study of medicalized transition of minors conducted thus far
15 are cohort studies: gathering a sample of individuals who chose to undergo treatment and
16 tracking them over time. Cohort studies are able to answer some questions that lower-level
17 studies cannot, such as whether a high-functioning group improved over time versus having
18 been composed of people who were already high-functioning. Cohort studies are, however,
19 unable to demonstrate causality, to identify how much of any change was due to regression
20 to the mean, or to detect any placebo effects.

21 **E. Expert opinion represents the least reliable evidence.**

22 52. As Figure 1 illustrates, evidence-based medicine opinion based on clinical
23 experience is identified as the *least* reliable source of medical knowledge. Among other
24 reasons, this is because non-systematic recollections of unstructured clinical experiences
25 with self-selected clientele in an uncontrolled setting is the most subject to bias. Indeed,
26 mere “clinical experience” was long the basis of most medical and mental health clinical
27 decisions, and it was precisely the scientific and clinical inadequacy of this type of
28 “knowledge” that led to the development and widespread acceptance of the importance of

1 evidence-based medicine. As Dr. Guyatt has written, “EBM places the unsystematic
2 observations of individual clinicians lowest on the hierarchy,” both because EBM “requires
3 awareness of the best available evidence,” and because “clinicians fall prey to muddled
4 clinical reasoning and to neglect or misunderstanding of research findings.” (Guyatt 2015
5 at 10, 15.)

6 **F. Surveys and cross-sectional studies cannot demonstrate treatment**
7 **effectiveness.**

8 53. Surveys represent observational research rather than experimental research. (In
9 science, experiments are studies involving a manipulation, not merely observation, by the
10 researcher.) Surveys and cross-sectional studies can provide only correlational data and
11 cannot demonstrate causality. (See Section IV below.) It is not possible for a survey to
12 yield evidence that a treatment is effective. No number of surveys can test a treatment,
13 advancing it from ‘experimental’ to ‘established’ status.

14 54. Survey studies do not even appear on the *pyramid of evidence*. In accordance
15 with the routine standards, systematic reviews of treatment studies exclude surveys.

16 **IV. Methodological defects limit or negate the evidentiary value of many studies**
17 **of treatments for gender dysphoria in minors.**

18 **A. In science, to be valid, a claim must be objective, testable, and**
19 **falsifiable.**

20 55. In behavioral science, people’s self-reports do not represent objective evidence.
21 It is when emotional and other pressures are strongest that the distinction between and need
22 for objective over subjective evidence is greatest. Surveys do not represent objective
23 evidence. This is especially true of non-random surveys and polls, recruited through online
24 social networks of the like-minded.

25 **B. Correlation does not imply causation.**

26 56. Studies representing lower levels of evidence are often used because they are
27 faster and less expensive than studies representing higher levels. A disadvantage, however,
28 is that they are often limited to identifying which features are *associated* with which other