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UNITED STATES DISTRICT COURT

DISTRICT OF ARIZONA

Jane Doe, by her next friends and parents Helen Doe and James Doe; and Megan Roe, by her next friends and parents, Kate Roe and Robert Roe, **Plaintiffs,** **v.** **Thomas C. Horne, in his official capacity as State Superintendent of Public Instruction; Laura Toenjes, in her official capacity as Superintendent of the Kyrene School District; Kyrene school District; the Gregory School; and Arizona Interscholastic Association, Inc.,** **Defendants.**	**Case No. 4:23-cv-00185-JGZ** **DEFENDANT HORNE'S RESPONSE TO PLAINTIFFS' MOTION FOR A PRELIMINARY INJUNCTION**

I. FACTS

This case turns on one crucial fact: can plaintiffs prove that pre-puberty boys have no sports advantage over girls? They cannot. Attached as Exhibit "A" is a sworn declaration submitted in a similar lawsuit in Idaho by Dr. Gregory Brown, which states under oath at page 16: "A number of studies indicate that males' athletic advantages over females begin before puberty, and may be apparent as early as six years of age." **Ex. A** (06-03-20 Expert Declaration of Gregory A. Brown, Ph.D FACSM submitted in *Hecox v. Little*, Case No. 1:20-cv-00184-DCN in the United States District Court for the District of Idaho). Other scientific studies show that increased testosterone in males aged one to six months during mini-puberty correlates with higher growth velocity, BMI and bodyweight. **Ex. B** (Lanciotti, L., et al., *Up-to-date review about minipuberty and overview on hypothalamic-pituitary-gonadal axis activation in fetal and neonatal life,* Frontiers in Endocrinology, (July 23, 2018). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6070773/). A study of 9 to 17-year-old children showed that compared to 9 year old females, 9 year old males were faster over short sprints (9.8%) and 1 mile (16.6%), could jump 9.5% further from a standing start, could complete 33% more push-ups in 30 seconds and had a 13.8% stronger grip. **Ex. C** (Catley, Mark Jon et al., *Normative health-related fitness values for children: analysis of 85347 test results on 9-17 year old Australians since 1985*, British J. of Sports Med., (October 21, 2011)). In another study of 6-year-olds, the males completed 16.6% more shuttle runs in a given time and could jump 9.7% further from a standing position. **Ex. D** (Tambalis KD, et al., *Physical fitness normative values for 6-18-year-old Greek boys and girls, using the empirical distribution and the lambda, mu, and sigma statistical method*, Eur. J. Sport Sci. 2016; 16(6):736-46). Even if Plaintiffs could prove that pre-puberty boys had no advantage, which they cannot, the state had a valid public purpose for passing the statute at issue.

Regardless of the fact dispute discussed above, the Save Women's Sport Act, A.R.S. § 15-120.02 (the "Act") is valid under intermediate scrutiny. As discussed below, under intermediate scrutiny, the government only needs to show an important purpose and that the challenged action is "substantially related" to the purpose. We cite Supreme Court authority that most legislation classifies for one purpose or another, with resulting disadvantage to various groups or persons.

Perfection is not always obtainable. Legislatures are presumed to have acted within their constitutional power despite the fact that, in practice, their laws result in some inequality.

We will be submitting more evidence in support of the above cited scientific evidence that pre-puberty males have advantages over girls. Timing is significant with respect to this attempt to obtain a preliminary injunction. The case is brought by two major national organizations, represented by major NY law firms. Defendant Horne at this time is the only Defendant defending the Act and the Arizona Attorney General has both refused to defend him, despite being her client, and has refused to pay for his independent counsel. When Defendant Horne was Attorney General, he had that office pay for independent defense costs where he claimed conflict of interest. In addition, Plaintiffs have even small-mindedly opposed intervention by the Arizona legislative leaders. In order for this to be a fair contest, national organizations may want to become involved to counter the national organizations and major law firms behind this case. In addition, Defendant Horne will need at least 90 days to fully develop more evidence in support of the scientific evidence referenced above. Defendant Horne therefore respectfully requests that, in the interest of justice and fairness, consideration of the preliminary injunction be postponed for at least 90 days, or, in the alternative, that the motion be denied. The following facts support the conclusion that, even if Plaintiffs could prove that pre-puberty boys have no advantage (which they cannot) the legislature had a proper purpose in enacting the Save Women's Sports Act.

A. <u>Facts Supporting the Reasonableness of the Statute Being Challenged.</u>

Imagine if Dennis Rodman, who likes to dress as a woman, suddenly announced that he was transgender and would compete in the WNBA, or if Floyd Mayweather said he is transgender and now will compete in women's boxing? They would dominate every competition, and cause serious injuries if competitions did occur. Progress in women's sports would be wiped out and the enactment of Title IX would be relegated to a historical footnote.

We don't have to imagine these scenarios because they are today's reality. Transgender athletes like Lia Thomas are beating some of our best women athletes, notably Olympic silver medalists Emma Weyant and Erica Sullivan. High school female athletes Selina Souie, Alanna Smith, Chelsea Mitchell and Ashley Nicoletti are having their championships and potential college scholarships thwarted by transgender competitors. **Ex. E** (Casey Harper, *'No Chance of Winning'" Four female athletes challenge high school transgender policy,* thecentersquare.com (September 30, 2022) https://www.thecentersquare.com/national/article_eef6fe80-40d4-11ed-b716-ef3255a8ad7e.html). Arizona's Save Women's Sports Act prevents these scenarios by maintaining a level playing field for biological women while still allowing transgender females claiming no physical advantage to play on coed teams.

In recent years, a number of instances of biologically-female athletes being defeated or injured by biological males/transgender female athletes have aroused serious public concern. For example, transgender woman Lia Thomas had previously competed as a male swimmer on the University of Pennsylvania's men's swim team from 2017 to 2020. When Thomas competed in the 500-yard freestyle on the men's swim team, Thomas was 65th in the country in that event. **Ex. F** (Samarveer Singh, *What Rank Did Lia Thomas Stand at While Competing in Men's Swimming Division*, Essentially Sports (March 22, 2022), https://www.essentiallysports.com/us-sports-ncaa-news-what-rank-did-lia-thomas-stand-at-while-competing-in-the-mens-swimming-division/) Thomas then transitioned and competed on the University of Pennsylvania's women's swim team from 2021 to 2022. In March 2022, Thomas won the national championship in the women's 500-yard freestyle event, meaning that Thomas was faster than every female collegiate swimmer in the country. **Ex. G** (Katie Barnes, *Amid protests, Penn swimmer Lia Thomas becomes first known transgender athlete to win Division I national championship*, ESPN.com (March 17, 2022) https://www.espn.com/college-sports/story/_/id/33529775/amid-protests-pennsylvania-swimmer-lia-thomas-becomes-first-known-transgender-athlete-win-division-national-championship). Absent Thomas's participation, one of the biological women who had devoted extraordinary time and effort to achieving their sports goals would have won the national championship. But Thomas's participation deprived those biological women of a fair opportunity to prove they were the best female collegiate swimmer in that event. This is cosmically unfair to women athletes.

In Connecticut, Selina Soule was a dedicated high school track athlete who had devoted extensive time training to shave fractions of a second off her race times. Selina trained to win and deserved a fair opportunity to prove her ability. However, after the Connecticut Interscholastic Athletic Conference allowed biological males/transgender girls to compete on their high school track team, two transgender athletes won 15 state titles that were previously held by nine different girls. After months of training for the 55-meter dash, Selina was one spot away from qualifying for the final race and to compete for a spot in the New England regional championships, where college scouts would be in attendance to determine which athletes should be offered collegiate sports scholarships. Two transgender girls took first place and second place in the race, depriving Selina of the opportunities that otherwise would have been available to her. **Ex. H** (Maureen Collins, *Why Male Athletes Who Identify as Transgender Should Not Compete in Women's Sports*, adflegal.org (September 23, 2022, revised March 10, 2023) https://adflegal.org/article/why-male-athletes-who-identify-transgender-should-not-compete-womens-sports).

Biological girls forced to compete against biological males/transgender girls in contact sports, are at a potentially higher risk of physical injury due to the average size, speed, and strength advantages males have over females. And unlike a biological girl who **chooses** to play on a boys' team, such risks are being **imposed** on female athletes who are simply competing in what they thought was a female sport. There are many examples of women sustaining potentially permanent injuries from transgender athletes.

High school volleyball player Payton McNabb suffered a concussion and neck injury in September 2022 when a biologicalmale/transgender female hit the ball into her face. She testified before the North Carolina legislature that her "life has forever been changed" as she still struggles with the side effects of her injuries, including impaired vision, partial paralysis of the right side of her body, headaches, anxiety and depression. **Ex. I** (*High School Volleyball Player Payton McNabb Urges Ban on Transgender Athletes After Serious Injury,* Marca.com (April 21, 2023) https://www.marca.com/en/ncaa/2023/04/22/64435531e2704e-470a8b45ed.html).

Biological male/transgender female mixed martial arts competitor Fallon Fox broke the skull of her opponent Tamikka Brents who later remarked "I have struggled with many women and I have never felt the strength I felt in a fight like that night…I've never felt so overpowered ever in my life. . . . I could usually move around in the clinch against… females but couldn't move at all in Fox's clinch." **Ex. J** (Laura Meyers, *Transgender MMA Fighter Destroys Female Opponent*, thelibertarianrepublic.com https://thelibertarianrepublic.com/transgender-mma-fighter-destroys-female-opponent/).

A biological male/transgender female hockey player recently caused serious and possibly permanent injury to a biological female player when the larger, heavily-muscled player collided with the smaller opponent. One reporter described the incident, noting "the size imbalance between the two skaters was so great that the [far smaller] Team player ended up being propelled head first into the boards with enough force to deliver a concussion." **Ex. K** (Holt Hackney, *Professor Maintains that Trans Athletes Causing Serious Injuries to Girls*, sportslawexpert.com (December 12, 2022) https://sportslawexpert.com/-2022/12/12/professor-maintains-that-trans-athletes-causing-serious-injuries-to-girls/?utm_source=rss&utm-medium=rss&utm-campaign=professor-maintains-that-trans-athletes-causing-serious-injuries-to-girls).

B. Legislative History Supports This Single Goal.

Motivated by the well documented, diminished opportunities for women athletes and high physical risks created by transgender participation in women's sports, the Arizona legislature enacted the Save Women's Sports Act, A.R.S. § 15-120.02, ("the Act"). It was intended to protect biological female student athletes from being compelled to compete against biological males, who identify as females, and who are, on average, larger, stronger, and faster than biological females.

In its form as Senate Bill 1165, the legislation was praised in public remarks by Jadis Argiope who identified herself as a transgender woman and said the measure simply deals with "biological reality." We agree. Argiope said, "[t]he reality is we're stronger. We have bigger bones, can take in more oxygen . . . have a better fat distribution that gives us an advantage in taking hits. We have stronger ligaments." **Ex. L** (Howard Fisher, *AZ Senate Advances Bill to Ban Transgender Kids from School Sports,* KAWC.org (January 21, 2022) https://www.kawc.org/2022-01-21/az-senate-advances-bill-to-ban-transgender-kids-from-school-sports).

Arizona Senate President Warren Petersen described the purposes of the Save Women's Sports Act as protecting female student athletes: "Female athletes deserve equal opportunities in sporting events, which will not happen so long as males are allowed to compete against them." **Ex. M** (Gloria Rebecca Gomez, *Top Arizona Republicans ask to defend trans athlete ban in court,* TucsonSentinel.com (May 2, 2023) https://www.tucsonsentinel.com/local/report/050223_trans-ban_defense/top-arizona-republicans-ask-defend-trans-athlete-ban-court/).

Representative Nancy Barto, who introduced the bill similarly described the purpose of the Save Women's Sports Act: "Women are being displaced in their own sport. The playing field is no longer level." **Ex. N** (Sophie Lewis, *Arizona House passes bill banning transgender student athletes from participating in girls sports,* CBSNews.com (March 4, 2020) https://www.cbsnews.-com/news/arizona-house-passes-bill-banning-transgender-student-athletes-girls-sports/). These statements express the important government purpose behind the legislation: not to discriminate, but rather to **prevent** discrimination in the form of unfairness against females in sports.

II. LAW AND ARGUMENT

A. Plaintiffs' Position is Illogical on its Face.

Plaintiffs' position can be shown to be incorrect with logic alone. Almost all of life is integrated between males and females. Sport is an exception PRECISELY because biological boys have an advantage over girls, so girls need their own teams to be able to compete fairly against pre-pubescent males. The point of enacting Title IX fifty years ago was to provide women with the same opportunities in sports as men. Allowing transgender females to participate in women's teams eliminates that level playing field and erodes all the progress celebrated in women's sports. The alternative is not only illogical but unfair.

If pre-puberty biological males have an advantage over females, then they should not be allowed to ruin girls' chances to succeed by unfairly competing on girls' teams. If, on the other hand, they have no advantage, as Plaintiffs' assert, then there should be co-ed teams. The whole reason sports is an exception to the rest of life is negated if, indeed, males have no advantage in sports. Even if that were true, the logical solution then is not to put biological males on girls' teams, but to make those sports like the rest of life, coed. That is the solution that best addresses the needs of transgender females wishing to participate in sports who claim no physical advantage over biological females while still maintaining a level field for women's sports.

B. Standard for a Preliminary Injunction.

The Supreme Court has called preliminary injunctions "drastic and extraordinary". *Weinberger v. Romero-Barcelo,* 456 U.S. 305, 311-12 (1982) ("An injunction is a drastic and extraordinary remedy, which should not be granted as a matter of course."). A preliminary injunction therefore "should not be granted unless the movant, *by a clear showing,* carries the burden of persuasion." *Mazurek v. Armstrong,* 520 U.S. 968, 972 (1997) (quotations and citation omitted) (emphasis added in *Mazurek); accord Winter,* 555 U.S. at 22 (recognizing that a preliminary injunction is "an extraordinary remedy that may only be awarded upon a clear showing that the plaintiff is entitled to such relief") (citing *Mazurek).*

"A plaintiff seeking a preliminary injunction must establish (1) that [the plaintiff] is likely to succeed on the merits, (2) that [the plaintiff] is likely to suffer irreparable harm in the absence of preliminary relief, (3) that the balance of equities tips in [the plaintiffs] favor, and (4) that an injunction is in the public interest." *Winter v. Nat. Res. Def Council, Inc.*, 555 U.S. 7, 20 (2008) (citations omitted). Plaintiffs here do not establish these factors. A preliminary injunction "is an extraordinary remedy . . . that grants relief *pendente lite* of the type available after the trial." *Blackwelder Furniture Co. of Statesville v. Seilig Mfg. Co.,* 550 F.2d 189 (4th Cir. 1977)), *cert. granted, judgment vacated on other grounds and remanded,* 559 U.S. 1089 (2010). Preliminary injunctions are "never awarded as of right .... " *Munaf v. Geren,* 553 U.S. 674,690 (2008).

C. Plaintiffs Are Unlikely to Succeed on the Merits Because the Save Women's Sports Act Does Not Violate the Equal Protection Clause or Title IX.[1]

1. *Title IX Actually Was Adopted to Promote Sex Equality by Permitting Sex-Separated Sports and the Act Does Not Violate Title IX*.

First, Regulations adopted under Title IX expressly permit separation of athletes by sex determined at birth. A Title IX recipient is permitted to "operate or sponsor **separate [sports] teams for members of each sex** where selection for such teams is based upon competitive skill or the activity involved is a contact sport." 34 C.F.R. § 106.4l(b) (emphasis added). The regulations also require recipients to "provide equal athletic opportunity for members of both

[1] Plaintiffs do not cite the ADA and Horne therefore does not address the ADA.

sexes," including by considering whether the "levels of competition effectively accommodate the interests and abilities of members of both sexes." 34 C.F.R. § 106.41(c). *Lafler v. Athletic Bd. of Control*, 536 F. Supp. 104, 106 (W.D. Mich. 1982) ("Although many courts have recognized a woman's right to an equal opportunity to participate in sports, . . . courts have also recognized that such equal opportunity may be provided through separate teams or competitions for men and women .... The regulations promulgated under Title IX ... specifically permit the establishment of separate male and female teams in contact sports. The United States Congress, in calling for the provision of 'equal opportunity to amateur athletes ... to participate ... without discrimination on the basis of ... sex ...' in the Amateur Sports Act, 36 U.S.C. § 391(b)(6), anticipated that such equal opportunity would sometimes be provided through the use of separate programs for men and women ....") (citations omitted).

And the Ninth Circuit has recognized cases that affirm the exclusion of biologic boys from biologic girls' teams as "a legitimate means of providing athletic opportunities for girls" due to physical differences between boys and girls. *Clark, By and Through Clark v. Arizona Interscholastic Ass'n*, 695 F.2d 1126, 1130 (9th Cir. 1982). *See also, O'Connor v. Bd. of Ed. of Sch. Dist. No. 23*, 645 F.2d 578, 582 (7th Cir. 1981) ("Title IX aims to provide equal opportunity in educational programs" and permits "separate-sex teams and ... exclusion of girls from" certain boys' teams).

Plaintiffs ignore these sex differences and the absence of any established alternative standards to apply. Plaintiffs instead deny they have a competitive advantage over biological girls, because Plaintiffs also identify as girls, and take medication to prevent male puberty. The legislature properly chose to avoid these kinds of non-uniform criteria, and instead to limit teams to either biological boys, girls or alternative coeducational participation.

Title IX permits such sex-separated teams for the very purpose of promoting sex equality, because sex-related physical differences effect the fairness of sports competition and it is understood that girls would generally have a competitive disadvantage. Requiring girls to compete against boys was understood to be inherently unfair, because girls would likely lose out on opportunities for participation. For example, opportunities to start on or even play for a team create an overall sense of responsibility and well-being, and opportunities for scholarships. Here, it is undisputed that the plaintiffs are biologically born as males, and that they or their parents have chosen to provide them drugs to try to inhibit their puberty. Girls competing against biological males in contact sports may cause girls to suffer more physical injuries and a loss of self- esteem. The whole point of Title IX would be frustrated by what Plaintiffs seek here.

Sex-separated sports are lawful, and have been upheld for these important reasons, and far from violating Title IX, the "Save Women's Sports Act" powerfully promotes the same goal of sex equality in athletics, in compliance with, and consistent with, Title IX. Plaintiffs therefore are not likely to prevail on their Title IX claim, and the Court should deny the requested preliminary injunction based on this.

2. *The Save Women's Sports Act Does Not Violate the Equal Protection Clause Because it is Substantially Related to an Important Government Purpose.*

The Equal Protection Clause of the Fourteenth Amendment provides that "[n]o State shall ... deny to any person within its jurisdiction the equal protection of the laws. It is essentially a direction that all persons similarly situated should be treated alike." *City of Cleburne v. Cleburne Living Ctr.*, 473 U.S. 432,439 (1985)). Here, biological boys are to be treated the same as biological girls in being able to participate in their relative sports teams based on their sex. They are not discriminated on the basis of sex. The Act allows them to be similarly situated to others of the same sex. And the Supreme Court instructs judges to recognize "the practical necessity that most legislation classifies for one purpose or another, with resulting disadvantage to various groups or persons." *Romer v. Evans*, 517 U.S. 620, 631 (1996). "[L]egislatures are presumed to have acted within their constitutional power despite the fact that, in practice, their laws result in some inequality." *Nordlinger v. Hahn*, 505 U.S. 1, 10 (1992) (quotations omitted). In assessing an Equal Protection claim a court must therefore first determine whether the statute at issue fails to treat all "similarly-situated" persons equally. If it does not, then the Equal Protection claim fails under any scrutiny.

However, even if it is shown that the challenged statute does treat similarly-situated persons differently, then the government must show: (1) the government's action has a purpose, and (2) the government action is sufficiently tailored to the purpose. Based on the type of classification at issue, the test is refined to address (1) the importance of the government's purpose (e.g., a "compelling" or "important" purpose), and (2) how closely related the challenged statute is to achieving that purpose (e.g., "narrowly tailored" or "substantially related"). *United States v. Virginia*, 518 U.S. 515, 533 (1996). Equal Protection challenges based on sex, as here, are subject to intermediate scrutiny. *Clark v. Jeter,* 486 U.S. 456, 461, (1988) (applying intermediate scrutiny under the Equal Protection Clause to sex-based classifications). Under intermediate scrutiny, the governmental purpose need only be "important," and the challenged governmental action need only be "substantially related" to that purpose. *United States v. Virginia*, 518 U.S. at 524. While we contend that similarly situated persons are treated alike here, even were it otherwise, there is an important government purpose here closely related to the Act's rational distinctions between the sexes. The fact that Plaintiffs assert an as applied challenge does not help them. An as applied challenge is usually made with respect to an application inconsistent with an otherwise valid constitutional statute. In this case, the application is completely consistent with the intention of a valid constitutional statute.

a) The Save Women's Sports Act Treats Similarly-Situated Students Equally.

All biological boys are prevented from competing on girls' teams under the Act—regardless of their gender identity. The Save Women's Sports Act closes biological girls' teams to all biological boys, *regardless of their gender identity*, because it is not the athlete's <u>gender identity</u> that causes the harm the Act aims to prevent, but the physical reality of being <u>biologically male</u> with the attendant physical advantages over females. Even though Plaintiffs allege they are repressing their sexual development as males through drugs, their individual treatments are not uniformly applied universally to all transgender girls, and such disparate, individualized treatments cannot be fully monitored or tested under any uniform standard known. Instead, it is the athlete's biological sex that is undeniable, that raises the unfairness and safety issues the Save Women's Sports Act seeks to remedy, particularly here for young growing female athletes.

Because the Save Women's Sports Act excludes ***all biological boys*** from girls' teams, ***regardless of their voluntary choice of gender identity*** (i.e., both (1) biological boys who identify as girls and (2) biological boys who identify as boys), the Act does not discriminate on the basis of gender identity. In addition, choosing to identify as another sex does not render the Act violative of any federal law or constitutional right to force participation on a girls' sports team. Rather, the Plaintiffs "situation" is that by virtue of *being biological boys*—not by virtue of their gender identity—allowing them to play on girls' teams with biological girls will be physically unfair and dangerous to biological girls. Not only are these Plaintiffs not being treated differently from similar persons who identify as girls, but even were that so, there is an important governmental purpose to protect girls' sports teams as such that Title IX was adopted to also protect.

b) ***<u>Safety and Fairness in School Sports are Important Governmental Interests.</u>***

The purposes of the Save Women's Sports Act is to prevent the physical differences between biological boys (regardless of their gender identity) and biological girls from causing a competitive disadvantage and/or injury to biological girls of equivalent physical development. While Plaintiffs demand perfection in the Act, the Court should bear in mind that the Act need not have perfect or even "compelling" purposes (as is the case with strict scrutiny). To pass muster under intermediate scrutiny, the Save Women's Sports Act need only have "important" goals. *Mazurek v. Armstrong,* 520 U.S. 968, 972 (1997).

The goal of the Act is important. It is clear that providing safety and fairness to girls in sports competition are important governmental purposes. *United States v. Virginia,* 518 U.S. at 533 ("The heightened review standard our precedent establishes does not make sex a proscribed classification. Supposed 'inherent differences' are no longer accepted as a ground for race or national origin classifications. Physical differences between men and women, however, are enduring: '[T]he two sexes are not fungible; a community made up exclusively of one [sex] is different from a community composed of both.'") (citations omitted).

c) Limiting Girls' Sports to Biological Girls is Substantially Related to Safety and Fairness in School Sports.

(1) Biological boys are, on average, bigger, stronger, and faster than biological girls.

The Ninth Circuit has already determined that biological males have inherent and real physical advantages over biological girls in sports competition:

> "The record makes clear that due to average physiological differences, males would displace females to a substantial extent if they were allowed to compete for positions on the volleyball team. Thus, athletic opportunities for women would be diminished. As discussed above, there is no question that the Supreme Court allows for these average real differences between the sexes to be recognized or that they allow gender to be used as a proxy in this sense if it is an accurate proxy."

Clark, By & Through Clark v. Ariz. Interscholastic Ass'n, 695 F.2d 1126, 1129-31 (9th Cir. 1982) (collecting cases).[2] It follows then that biological girls who are forced to play against biological boys, regardless of their gender identity, will more likely face unfairness and danger and injuries more often than if they played only against, and with, other biological girls of their age in competition. Classifications in the Save Women's Sports Act only need to be "substantially" related to its goals. They are substantially related and serve important fairness and safety purposes for the different biological sexes. That is sufficient to uphold the statute.

A classification that relies to some degree on generalizations about the class averages can be "substantially" related to its end and satisfy the requirements of intermediate scrutiny correctly

[2] *See also O'Conner v. Board of Education*, 645 F.2d 578 (7th Cir.) (examining other cases excluding participation based on a student's sex and holding "the exclusion was a legitimate means of providing athletic opportunities for girls," noting "that the classification of teams based on sex was based on the innate physical differences between the sexes, [rather than on] generalizations that are archaic [or attitudes of] romantic paternalism," acknowledging "that the sexual classification could be avoided by classifying directly on the basis of physical differences such as height or weight, but concluded that such classifications would be too difficult to devise, primarily because of strength differentials between the sexes," noting that "[h]andicapping competitions ... would be difficult and contrary to the interest of achieving the best competition possible," noting that "multi-tiered teams ... [would be] too expensive to impose on the schools," and concluding "that sex was the only feasible classification to promote the legitimate and substantial state interest of providing for interscholastic athletic opportunities for girls") (quotations, citations, and parallel citations omitted), cert. denied, 454 U.S. 1084 (1981).

applied. A classification based on average differences such as the one here can withstand intermediate scrutiny. *Califano v. Webster*, 430 U.S. 313, 318 n.5 (1977) (social security rule that favored women satisfied intermediate scrutiny because "women *on the average* received lower retirement benefits than men."). For that reason, it does not matter that any particular students—including Plaintiffs—might not have yet gone through puberty. A perfect, or even best-possible, fit between a government's chosen means (*i.e.*, the classification) and its important goals is not required under intermediate scrutiny. Intermediate scrutiny tolerates classifications based on averages even though they may be imperfect.[3] Therefore, making reasonable distinctions based on biological sex is at least substantially related to fairness and safety in sports.

(2) Plaintiffs' focus on testosterone levels is misplaced.

Plaintiffs' factual argument against the Save Women's Sports Act relies almost entirely on the notion that participation on girls' sports teams should be determined—not based on biological sex—but on voluntarily applied testosterone levels. The scientific evidence cited above proves that male advantage relates to more than post-puberty testosterone levels.

D. Plaintiffs Will Not Suffer Irreparable Harm Absent Preliminary Relief.

Plaintiffs are also required to prove that they would be "irreparably harmed" if they are not permitted to try out for and presumably join an all-girls' sports team. Plaintiffs primarily argue *per se* irreparable harm based on the alleged violations of the Equal Protection Clause and Title IX. Pl. Br. at 12-13. But as explained above, the Save Women's Sports Act does not violate either the Equal Protection Clause or Title IX. Therefore, no irreparable harm exists on that basis.

Plaintiffs also allege irreparable harm in the form of mental, physical, and emotional harm, and dignitary or stigmatic injury, ignoring the very harm their participation might cause girls (of which the number is much larger than biological males/transgender females who seek to compete against biological girls) in being forced to compete against biological males/transgender females.

[3] A rule limiting draft registration to men, for example, satisfied intermediate scrutiny even "assuming that a small number of women could be drafted for noncombat roles" because "Congress simply did not consider it worth the added burdens of including women in draft and registration plans." *Rostker v. Goldberg*, 453 U.S. 57, 81 (1981).

Pl. Br. at 13. A recent Title IX case rejected such claims as this of Plaintiffs. That case involved a female student who wanted to participate on the boys' team, instead of the girls', soccer team at her high school. *Gregor v. W. Va. Secondary Sch. Activities Comm'n,* No. 2:20-CV-00654, 2020 WL 6292813, at *1 (S.D. W. Va. Oct. 27, 2020). The Court noted that the plaintiff had no other option "for playing soccer because she had missed any opportunity to try out for the girls' team or private club team." *Id.* at *4. The Court nevertheless found that the plaintiff would not be irreparably harmed if she was not permitted to play on the boys' team:

> "Courts are divided over whether not being able to participate in athletics constitutes irreparable harm. **But most courts seem to lean toward the harm being irreparable only when the person cannot participate in the sport at all.** *Reed v. Nebraska School Activities Assoc.*, 341 F. Supp. 258 (D. Neb. 1972) (finding irreparable harm when a girl would not be able to play golf at all if not permitted to play on the boys' golf team); *D.M. by Bao Xing v. Minnesota State High School League,* 917 F.3d 994, 1003 (8th Cir. 2019) (finding irreparable harm when boys would have no school dance team to compete on if not permitted to join the girls' dance team). Other courts have found that students are not irreparably harmed even when the student is barred from competition for an entire season."

2020 WL 6292813, at *4 (emphasis added). Addressing the same issue, another District Court likewise stated that "[t]his Court, as well as all other federal courts, have previously and consistently held that ineligibility for participation in interscholastic athletic competitions alone does not constitute irreparable harm." *Dziewa v. Penn. Interscholastic Athletic Ass'n, Inc.,* No. 08-CV-5792, 2009 WL 113419, at *7 (E.D. Pa. Jan. 16, 2009); *see also Revesz ex rel. Revesz v. Penn. Interscholastic Athletic Ass'n, Inc.*, 798 A.2d 830, 837 (Pa. Commw. Ct. 2002) (holding that "the loss of an opportunity to play interscholastic athletics for one year does not constitute irreparable harm"). Because Plaintiffs will not be irreparably harmed according to the relevant caselaw, the Court should deny the Preliminary Injunction Motion for this reason as well.

E. <u>The Balance of Equities and the Public Interest Favor Denying Preliminary Relief</u>

We have discussed above the public interest behind the Save Women's Sports Act. In *Yakus v. United States*, 321 U.S. 414, 440-41 (1944), the U.S. Supreme Court held "where an injunction is asked which will adversely affect a public interest for whose impairment, even temporarily, an injunction bond cannot compensate, the court may in the public interest withhold relief until a final determination of the rights of the parties, though the postponement may be burdensome to the plaintiff."

Moreover, although Plaintiffs allege they refuse to play sports on the boys' teams, they do have that option. They can also seek an order requiring a co-ed team if this Court ultimately finds that pre-puberty males have no advantage, which would be a much more reasonable proposed remedy. The Save Women's Sports Act in no way precludes them from obtaining the benefits of sports competition they claim to be deprived of, that would accrue from participation on the boys' teams or coed teams. That Plaintiffs decline to avail themselves of those benefits in no way indicts the Act. Respectfully, this case is about more than Plaintiffs' voluntary choices and decisions. It is about the fairness to and safety of many, many biological girls who, absent the Save Women's Sports Act, may have to compete against biological boys and be precluded from excelling. Those girls may face emotional injury, physical injury, and competitive disadvantage from such a situation as Plaintiffs demand. Superintendent Horne and the State also face harm if a preliminary injunction is issued. There are simply no other uniform standards established to monitor the mess that would be created by Plaintiffs were they to succeed here.

Plaintiffs finally argue that "it is always in the public interest to prevent the violation of a party's constitutional rights." Pl. Br. at 13-14. What about the rights of girls who cannot compete against biological boys? Plaintiffs' argument is circular and should be applied in reverse. It requires assuming up front something that has not been decided yet: *i.e.*, that Plaintiffs have a valid claim. Accepting this argument would render the equity balancing and public interest factors a complete nullity.

The public interest also supports not interfering with the implementation of a law that will provide substantial benefits to female athletes. The disruption and unfairness caused to others by Plaintiffs insisting on unfairly competing against biological girls is undeniable. If the preliminary injunction were to be granted, a number of schools would permit biological males/transgender females to compete against girls. The Department of Education has a vital interest in the well-being of its students. This would be devastating to girls who hope to excel, but cannot because they're competing against biological boys and being deprived of scholarships.

In addition, the issuance of a preliminary injunction would be an encouragement to those boys who desire to excel in sports, and may be willing to transition to girls in order to do so. If they resort to puberty blockers, or other medical treatment to make them into what appear to be girls, this could do tremendous physical and psychological damage to those boys. With the dramatic rise of adolescents experiencing gender dysphoria in recent years often attributed to peer influence, social media, as well as social and political pressure, we should be mindful of the fluid nature of adolescence. At least one recent study found that 60% of the participants who detransitioned did so because they became more comfortable with their natal sex. 40% of the detransitioners stated their gender dysphoria was caused by a mental health condition and 62% felt medical professionals did not investigate whether trauma was a factor in their transition decisions. **Ex. O** (Lisa Littman, *Individuals Treated for Gender Dysphoria with Medical and/or Surgical Transition Who Subsequently Detransitioned: A Survey of 100 Detransitioners,* Archives of Sexual Behavior, (October 5, 2020) https://link.springer.com/content/pdf/10.1007/s10508-021-02163-w.pdf). Recognizing the dangers, many European countries have halted hormone treatments for adolescents experiencing gender dysphoria. In February 2022, Sweden halted hormone therapy for minors except in very rare cases. **Ex. P** (*Sweden puts brakes on treatments for trans minors*, france24.com (February 8, 2023) https://www.france24.com/en/live-news/20230208-sweden-puts-brakes-on-treatments-for-trans-minors.) As the first country in the world to allow a legal option for gender reassignment in 1972, Sweden's decision should give those pushing hormone therapy pause. Finland made a similar decision and France called for "the utmost reserve" on hormone treatments for young people. A policy that encourages fast-track, irreversible medical treatments for young people who are still developing their own identity is not only irresponsible but will cause irreparable harm.

CONCLUSION

Defendant Horne respectfully requested to grant Defendant an additional 90 days to compile evidence as Plaintiffs did at leisure, and then deny the Motion for Preliminary Injunction.

RESPECTFULLY SUBMITTED on May 18, 2023.

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CERTIFICATE OF SERVICE

I hereby certify that on May 18, 2023, I electronically transmitted the attached document to the Clerk's Office using the CM/ECF System for filing and transmittal of a Notice of Electronic Filing to the CM/ECF registrant:

By:/s/ Hilary Myers

EXHIBIT A

WILENCHIK & BARTNESS
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IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF IDAHO

LINDSAY HECOX, and JANE DOE with her next friends JEAN DOE and JOHN DOE, Plaintiffs, v. BRADLEY LITTLE, in his official capacity as Governor of the State of Idaho, *et al.*, Defendants.	Case No. 1:20-cv-00184-DCN **EXPERT DECLARATION OF GREGORY A. BROWN, Ph.D. FACSM**

I, Dr. Gregory A. Brown, declare as follows:

<u>Qualifications</u>

1. I serve as Professor of Exercise Science in the Department of Kinesiology and Sport Sciences at the University of Nebraska Kearney. I have served as a tenured (and non-tenured) professor at universities since 2002.

2. I teach classes in Exercise Physiology and in Research Methods. I have previously taught courses in Human Anatomy & Physiology and in Sports Nutrition.

3. 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.

4. 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.

5. I have authored more than 40 refereed publications and more than 50 refereed presentations in the field of Exercise Science. And I have served as a peer reviewer for over 25 professional journals, including The American Journal of Physiology, the International Journal of Exercise Science, the Journal of Strength and Conditioning Research, and The Journal of Applied Physiology.

6. 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, and assessment of various athletic training modes in males and females. Articles that I have published that are closely related to topics that I discuss in this declaration, and to articles by other researchers that I cite and discuss in this declaration, include:

a. Studies of the effect of ingestion of a testosterone precursor on circulating testosterone levels in young men. Douglas S. King, Rick L. Sharp, Matthew D. Vukovich, Gregory A. Brown, et al., *Effect of Oral Androstenedione on Serum Testosterone and Adaptations to Resistance Training in Young Men: A Randomized Controlled Trial*, JAMA 281: 2020-2028 (1999); G. A. Brown, M. A. Vukovich, et al., *Effects of Anabolic Precursors on Serum Testosterone Concentrations and Adaptations to Resistance Training in Young Men*, INT J SPORT NUTR EXERC METAB 10: 340-359 (2000).

b. A study of the effect of ingestion of that same testosterone precursor on circulating testosterone levels in young women. G. A. Brown, J. C. Dewey, et al., *Changes in Serum Testosterone and Estradiol Concentrations Following Acute Androstenedione Ingestion in Young Women*, HORM METAB RES 36: 62-66 (2004).

c. A study finding (among other things) that body height, body mass, vertical jump height, maximal oxygen consumption, and leg press maximal strength were higher in a group of physically active men than comparably active women, while the women had higher percent body fat. G. A. Brown, Michael W. Ray, et al., *Oxygen Consumption, Heart Rate, and Blood Lactate Responses to an Acute Bout of Plyometric Depth Jumps in College-Aged Men And Women*, J. STRENGTH COND RES 24: 2475-2482 (2010).

d. A study finding (among other things) that height, body mass, and maximal oxygen consumption were higher in a group of male NCAA Division 2 distance runners, while women NCAA Division 2 distance runners had higher percent body fat. Furthermore, these male athletes had a faster mean competitive running speed (~3.44 min/km) than women (~3.88 km/min), even though the men ran 10 km while the women ran 6 km. Katherine Semin, Alvah C. Stahlnecker, Kate A. Heelan, G. A. Brown, et al, *Discrepancy Between Training, Competition and Laboratory Measures of Maximum Heart Rate in NCAA Division 2 Distance Runners*, JOURNAL OF SPORTS SCIENCE AND MEDICINE 7: 455-460 (2008).

7. I attach a copy of my current Professional Vita, which lists my education, appointments, publications, research, and other professional experience. I am also currently providing expert information on a case similar to this one in the state of Connecticut.

8. I have been asked by counsel for defendants in the matter of *Hecox et al. v. Little et al.* to offer my opinions about 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. I have also been asked to offer my opinion as to whether the sex-based performance advantage enjoyed by males is eliminated if feminizing hormones are administered to male athletes who identify as transgender.

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

10. I have been compensated for my time spent in preparing this declaration at the rate of $150 per hour, and may be further compensated for time spent in subsequent testimony in this action.

Overview

11. Based on my professional familiarity with exercise physiology and my review of the currently available science, including that contained in the sources I cite in this declaration, and the competition results and records presented here, I offer three primary professional opinions:

a. At the level of elite, college, high school, and recreational competition, men or boys have an advantage over comparably aged women or girls, in almost all athletic contests;

b. Biological male physiology and anatomy is the basis for the performance advantage that men or boys have over women or girls, in almost all athletic contests; and

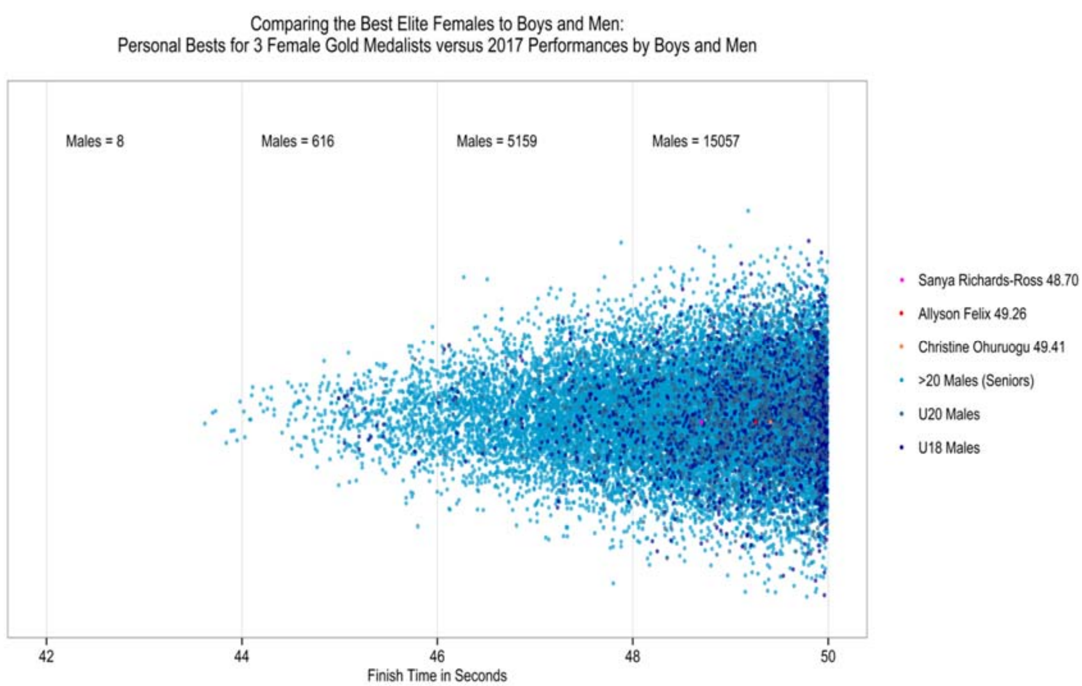
c. Administration of androgen inhibitors and cross-sex hormones to men, or adolescent boys, after male puberty, and administration of testosterone to women or adolescent girls, after female puberty, does not eliminate the performance advantage of men or adolescent boys over women or adolescent girls in almost all athletic contests.

In this declaration, I also provide supporting details, facts, and opinions relating to each of these primary opinions . Each of these opinions is based on my general professional expertise and experience, as well as on particular academic articles, and the competition results and records, that I refer to herein.

12. In short summary, men, and adolescent boys, perform better in almost all sports than women, and adolescent girls, because of their inherent physiological advantages that develop during male puberty. In general, men, and adolescent boys, can run faster, output more physical power, jump higher, and exercise greater physical endurance than women, and adolescent girls.

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

14. These performance advantages are also very substantial, such that large numbers of men and even adolescent boys are able to outperform the very top-performing women. To illustrate, Doriane Coleman, Jeff Wald, Wickliffe Shreve, and Richard Clark created the figure below (last accessed on Monday, December 23, 2019 at https://bit.ly/35yOyS4), which shows that the *lifetime best performances* of three female Olympic champions in the 400m event—including Team USA's Sanya Richards-Ross and Allyson Felix—would not match the performances of literally thousands of boys and men, *just in 2017 alone*, including many who would not be considered top tier male performers:



15. Coleman and Shreve also created the table below (last accessed on Monday, December 23, 2019 at https://bit.ly/37E1s2X), which "compares the number of boys—males under the age of 18—whose results in each event in 2017 would rank them above the single very best elite [adult] woman that year:"

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

16. Coleman and Shreve also created the table below (last accessed on Monday, December 23, 2019 at https://bit.ly/37E1s2X), which compares the number of men—males over 18—whose results in each event in 2017 would have ranked them above the very best elite woman that year.

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

17. These advantages result, in large part (but not exclusively), from higher testosterone concentrations in men, and adolescent boys, after the onset of male puberty. Higher testosterone levels cause men, and adolescent boys, to develop more muscle mass, greater muscle strength, less body fat, higher bone mineral density, greater bone strength, higher hemoglobin concentrations, larger hearts and larger coronary blood vessels, and larger overall statures than women, and adolescent girls. In addition, maximal oxygen consumption (VO_2max), which correlates to ~30-40% of success in endurance sports, is higher in both elite and average men and boys than in comparable women and girls when measured in regards to absolute volume of oxygen consumed and when measured relative to body mass. Testosterone is also associated with increased aggressiveness, which may offer competitive advantages for men over women.

18. Although androgen deprivation may modestly decrease some physiological advantages that men and adolescent boys have over women and adolescent girls, it cannot fully eliminate those physiological advantages once an individual has passed through male puberty. For example, androgen deprivation does not reduce bone size, does not alter bone structure, and does not decrease lung volume or heart size. Nor does androgen deprivation in adult men completely reverse the increased muscle mass acquired during male puberty.

19. In this declaration, I present, in the headings marked with Roman numerals, certain of my opinions about sex-based differences in human physiology and the impact of those differences on the athletic performance of men and women. For each of these opinions, I then provide a brief overview, and a non-exhaustive summary of studies published in science journals or other respected sources that support and provide in part the basis of my opinion, also quoting relevant findings of each article.

20. In particular, in addition to the article by Coleman and Schreve that I discuss above, I cite twenty-two articles published in scientific journals. I provide capsule summaries of those articles below. These studies form part of the basis of the opinions I set forth in this declaration, which are also informed by my general professional expertise and experience. In support of the opinions I offer, I expect to explain and testify concerning the findings and conclusions of these articles that I detail in this declaration. I expect to use any or all of the tables and charts that I have reproduced in this declaration, as well as any other tables or charts contained in the articles I reference, to present and explain my opinions to the court.

a. The first resource I cite is David J. Handelsman, Angelica L. Hirschberg, et al., *Circulating Testosterone as the Hormonal Basis of Sex Differences in Athletic Performance*, 39:5 ENDOCRINE REVIEWS 803 (2018). This article correlates data about performance differences between males and females with data from over 15 liquid chromatography-mass spectrometry studies of circulating testosterone in adults, as a function of age. The authors conclude, among other things, that "[f]rom male puberty onward, the sex difference in athletic performance emerges as circulating concentrations rise as the testes produce 30 times more testosterone than before puberty, resulting in men having 15- to 20-fold greater circulating testosterone than children or women at any age." (804)

b. The second resource I cite is Valérie Thibault, Marion Guillaume, et al., *Women & Men in Sport Performance: The Gender Gap Has Not Evolved Since 1983*, 9 J. OF SPORTS SCIENCE & MEDICINE 214 (2010). This article analyzes results from 82 athletic events since the beginning of the modern Olympic era, and concludes in part that while a wide sex-based performance gap existed before 1983, due to a likely combination of physiological and non-physiological reasons, the sex-based performance gap stabilized in 1983, at a mean difference of 10.0 % ± 2.94 between men and women for all events. (214)

c. The third resource I cite is Beat Knechtle, Pantelis T. Nikolaidis, et al., *World Single Age Records in Running from 5 km to Marathon*, 9 FRONTIERS IN PSYCHOLOGY 1 (2013). This article analyzes results from a study of the relationship between performance and age in races of several lengths, and reports in part that "[i]n all races [studied], women were significantly slower than men." (7)

d. The fourth resource I cite is Romuald Lepers, Beat Knechtle, et al., *Trends in Triathlon Performance: Effects of Sex & Age*, 43 SPORTS MED 851 (2013). This article analyzes results from various triathlon events over the course of about 15 years, and reports in part a sex-based performance gap between the sexes of no less than 10% in every component event, with this sex-based performance gap increasing with age.

e. The fifth resource I cite is Espen Tønnessen, Ida Siobhan Svendsen, et al., *Performance Development in Adolescent Track & Field Athletes According to Age, Sex, and Sport Discipline*, 10:6 PLOS ONE 1 (2015). This article analyzes the 100 all-time best Norwegian male and female track and field results (in persons aged 11 to 18) from the 60m and 800m races, and the long jump and high jump events. The results show that sex-specific differences that arise during puberty significantly affect event results, with males regularly outperforming females after age 12.

f. The sixth resource I cite is David J. Handelsman, *Sex Differences in Athletic Performance Emerge Coinciding with the Onset of Male Puberty*, 87 CLINICAL ENDOCRINOLOGY 68 (2017). This article analyzes results from a secondary quantitative analysis of four published sources that report performance measures in swimming meets, track and field events, and hand-grip strength. The results show in part that the onset and tempo of sex-based performance divergence were very similar for all performance measures, and that this divergence closely paralleled the rise of circulating testosterone in adolescent boys.

g. The seventh article I cite is Moran Gershoni & Shmuel Pietrokovski, *The landscape of sex-differential transcriptome and its consequent selection in human adults*, 15 BMC BIOL 7 (2017). This article details the results of an evaluation of the differences in genetic expression between men and women. The results show that in humans, out of 18,670 protein coding genes that were evaluated, over 6,500 are differentially expressed based on the sex of the person. The main relevance of this article to the case at hand is to help illustrate that the differences between males and females cannot be eliminated by reducing testosterone and increasing estrogen concentrations in a biological male.

h. The eighth article I cite is K. M. Haizlip, et al., *Sex-based differences in skeletal muscle kinetics and fiber-type composition*, 30 PHYSIOLOGY (BETHESDA) 30 (2015). This is a review article summarizing the findings of 56 other articles evaluating the differential expression of genes in skeletal muscles in males and females and how these differences in gene expression influence (among many things) muscle mass, muscle fiber type, and muscle function. The main relevance of this article to the case at hand is to help illustrate that the current scientific evidence indicates that the genetic differences in skeletal muscle size and function between males and females that give males an athletic performance advantage cannot be eliminated by reducing testosterone and increasing estrogen concentrations in a biological male.

i. The ninth, tenth, and eleventh resources I cite are Konstantinos D. Tambalis, et al., *Physical fitness normative values for 6-18-year-old Greek boys and girls, using the empirical distribution and the lambda, mu, and sigma statistical method*, 16 EUR J SPORT SCI 736 (2016). Mark J. Catley & G. R. Tomkinson, *Normative health-related fitness values for children: analysis of 85347 test results on 9-17-year-old Australians since 1985*, 47 BR J SPORTS MED 98 (2013).Grant R. Tomkinson, et al., *European normative values for physical fitness in children and adolescents aged 9-17 years: results from 2 779 165 Eurofit performances representing 30 countries*, 52 BR J SPORTS MED 1445 (2018). Individually and combined these articles illustrate that boys as young as six years old perform better than comparable age matched girls in health related measures of physical fitness including strength, speed, endurance, and jumping ability. These advantages in health related measures of fitness translate to improved athletic performance in boys when compared to girls likely before and certainly during and after puberty.

j. The twelfth and thirteenth resources I cite are Daniel M. Fessler, et al., *Sexual dimorphism in foot length proportionate to stature*, 32 ANN HUM BIOL 44 (2005). Roshna E. Wunderlich & P. R. Cavanagh, *Gender differences in adult foot shape: implications for shoe design*, 33 MED SCI SPORTS EXERC 605 (2001). These articles evaluate and describe the differences in the feet of men and women, particularly noting that the differences between the sexes are not just a matter of stature but also include morphological traits that can influence runner performance.

k. The fourteenth, fifteenth, and sixteenth resources I cite are Daichi Tomita, et al., *A pilot study on the importance of forefoot bone length in male 400-m sprinters: is there a key morphological factor for superior long sprint performance?,* 11 BMC RES NOTES 583 (2018). Hiromasa Ueno, et al., *The Potential Relationship Between Leg Bone Length and Running Performance in Well-Trained Endurance Runners*, 70 J HUM KINET 165 (2019). Hiromasa Ueno, et al., *Association between Forefoot Bone Length and Performance in Male Endurance Runners*, 39 INT J SPORTS MED 275 (2018). Building upon the information from Fessler (2005) and Wunderlich (2001), these studies collectively illustrate that the length of the bones in the foot and lower leg can contribute to successful competitive running performance, which likely gives men a performance advantage over women in running due to the differences in lower limb sizes described by Fessler et al. (2005) and Wunderlich and Cavanaugh (2001).

l. The seventeenth resource I cite is Louis Gooren, *The Significance of Testosterone for Fair Participation of the Female Sex in Competitive Sports*, 13 ASIAN J. OF ANDROLOGY 653 (2011). This article highlights specific research that indicates pubertal testosterone increases result in significant physiological advantages for men and adolescent boys, compared to women and adolescent girls, after the onset of male puberty.

m. The eighteenth resource I cite is Taryn Knox, Lynley C. Anderson, et al., *Transwomen in Elite Sport: Scientific & Ethical Considerations*, 45 J. MED ETHICS 395 (2019). This article confirms from available science that higher testosterone levels provide an all-purpose benefit in sport, and that the current International Olympic Guidelines rule requiring males who identify as transgender to keep testosterone levels under 10 nmol/L for one year does not eliminate (or even come close to eliminating) the performance advantage of their male physiology.

n. The nineteenth resource I cite is Louis J. G. Gooren & Mathijs C. M. Bunck, *Transsexuals & Competitive Sports*, 151 EUROPEAN J. OF ENDOCRINOLOGY 425 (2004). This article analyzes results from a study that compared pretreatment physiological measurements in 17 female-to-male transsexuals with the measurements after one year of cross-sexual treatment in 19 male-to-female transsexuals undergoing sex reassignment therapy. The results in part confirmed that androgen deprivation in male-to-female transsexuals decreases muscle mass to some extent but does not eliminate the male muscular advantage and does not reverse certain other effects of androgenization that had occurred during male puberty.

o. The twentieth resource I cite is Anna Wiik et al., *Muscle Strength, Size, and Composition Following 12 Months of Gender-affirming Treatment in Transgender Individuals*, J. CLIN. METAB., 105(3):e805-e813 (2020). This article analyzes the impact of (a) suppression of endogenous hormones and (b) hormone replacement therapy on metrics of transgender individuals including strength, muscle size, and radiological density. After 12 months, strength in male-to-female subjects did not decrease, and muscle volume remained higher in male-to-female subjects than in female-to-male subjects after the latter subjects had undergone 12 months of testosterone injections.

p. The twenty-first resource I cite is Miranda Scharff et al., *Change in Grip Strength in Trans People and Its Association with Lean Body Mass and Bone Density*, ENDOCRINE CONNECTIONS (2019) 8, 1020-1028. This article measured grip strength and multiple parameters of lean body mass and bone density in both male-to-female and female-to-male populations across their first year of hormone therapy. After 12 months, "the median grip strength in [male-to-female] subjects still [fell] into the 95th percentile for age-matched females."

q. The twenty-second resource I cite is Johanna Harper. *Race Times for Transgender Athletes.* J Sporting Cultures and Identities 6 (2019) 1. This article is oft cited as evidence supporting a lack of performance advantage for male-to-female transgender athletes. Herein I provide a critique of the methodological shortcomings of this study for the purpose of demonstrating the extreme lack of scientific validity or reliability of the results.

21. I explain my opinions and the results of these studies in more detail below.

Opinions

I. Biological men or boys have an advantage over women or girls, in almost all athletic contests.

22. As one team of researchers has recently written, "Virtually all elite sports are segregated into male and female competitions. The main justification is to allow women a chance to win, as women have major disadvantages against men who are, on average, taller, stronger, and faster and have greater endurance due to their larger, stronger, muscles and bones as well as a higher circulating hemoglobin level." David J. Handelsman, Angelic L. Hirschberg, et al., *Circulating Testosterone as the Hormonal Basis of Sex Differences in Athletic Performance*, 39:5 ENDOCRINE REVIEWS 803 (2018).

23. In fact, biological men, and adolescent boys, substantially outperform comparably aged women, and adolescent girls, in competitions involving running speed, swimming speed, cycling speed, jumping height, jumping distance, and strength (to name a few, but not all, of the

performance differences). These performance advantages for men, and adolescent boys, are inherent to the biological differences between the sexes and are not due to social or cultural factors, as evidenced by minimal to no change in the percentage differences between males and females in world class and record setting performances in the past 40 years. In addition, a number of studies indicate that males' athletic advantages over females begin before puberty, and may be apparent as early as six years of age.

24. I highlight below key findings about male performance advantages from eighteen studies or datasets.

A. David J. Handelsman, Angelica L. Hirschberg, et al., *Circulating Testosterone as the Hormonal Basis of Sex Differences in Athletic Performance*, 39:5 ENDOCRINE REVIEWS 803 (2018):

25. The Handelsman et al. (2018) authors demonstrate a consistent pattern of divergence of athletic performance, in favor of males, across the years of puberty and strongly correlating to increasing testosterone levels in adolescent males. The pattern is observed in events exercising a variety of muscle systems. In sum, the Handelsman et al. (2018) authors report: "Corresponding to the endogenous circulating testosterone increasing in males after puberty to 15 to 20 nmol/L (sharply diverging from the circulating levels that remain <2 nmol/L in females), male athletic performances go from being equal on average to those of age-matched females to 10% to 20% better in running and swimming events, and 20% better in jumping events." (812)

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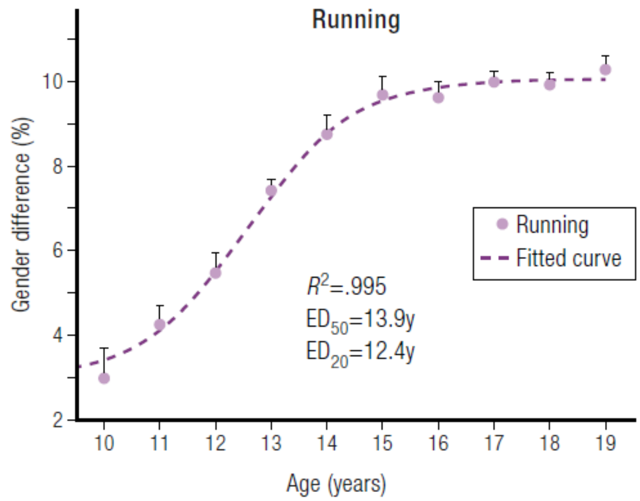
26. Taken from Handelsman's Figure 1, the chart below indicates "sex differences in performance (in percentage) according to age (in years) in running events, including 50m to 2 miles." (813)



27. Taken from Handelsman's Figure 1, the chart below indicates "sex differences in performance (in percentage) according to age (in years) … in jumping events, including high jump, pole vault, triple jump, long jump, and standing jump." (813)

28. Taken from Handelsman's Figure 1, the chart below indicates "a fitted sigmoidal curve plot of sex differences in performance (in percentage) according to age (in years) in running, jumping, and swimming events, as well as the rising serum testosterone concentrations from a large dataset of serum testosterone of males. Note that in the same dataset, female serum testosterone concentrations did not change over those ages, remaining the same as in prepubertal

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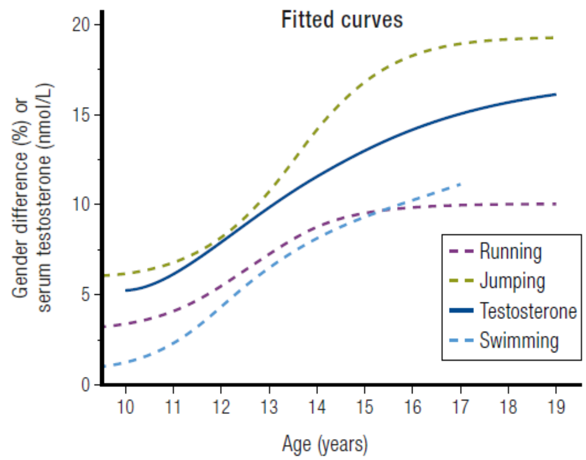
boys and girls. Data are shown as mean and SEM of the pooled sex differences by age." (813)



29. These authors also note the significance, for athletic competition, of the subjective nature of "gender identity" in current understanding: "Prompted by biological, personal, and societal factors, volitional expression of gender can take on virtually any form limited only by the imagination, with some individuals asserting they have not just a single natal gender but two genders, none, a distinct third gender, or gender that varies (fluidly) from time to time…." For this reason, the authors conclude: "[I]f gender identity were the basis for eligibility for female sports, an athlete could conceivably be eligible to compete at the same Olympics in both female and male events. These features render the unassailable personal assertion of gender identity incapable of forming a fair, consistent sex classification in elite sports." (804)

B. Valérie Thibault, Marion Guillaume, et al., *Women & Men in Sport Performance: The Gender Gap has not Evolved Since 1983*, 9 J. OF SPORTS SCIENCE & MEDICINE 214 (2010):

30. The Thibault et al. (2010) authors note that there was a large but narrowing sex-based performance gap between men's and women's Olympic athletic performances before 1983, which could hypothetically be attributed to a combination of social, political, or other non-physiological reasons, in addition to physiological reasons. However, "the gender gap in

Olympic sport performance has been stable since 1983" (219) "at a mean difference of 10.0% ± 2.94 between men and women for all [Olympic] events." (222)

31. Since then, even when performances improve, the "progressions are proportional for each gender." (219-20)

32. The results of this study "suggest that women's performances at the high level will never match those of men" (219) and that "women will not run, jump, swim or ride as fast as men." (222) The authors conclude that this gap, now stable for 30+ years, is likely attributable to physiology, and thus that "[s]ex is a major factor influencing best performances and world records." (222)

33. Breaking these performance advantages out by event, the authors report the following sex-based performance gaps in Olympic sport competitions since 1983:

a. "The gender gap ranges from 5.5% (800-m freestyle, swimming) to 36.8% (weightlifting)." (222)

b. Olympic world records in running events indicate that men perform "10.7% (± 1.85)" better than women since gender gap stabilization. (217)

c. Olympic world records in jumping events indicate that men perform "17.5% (± 1.11)" better than women since gender gap stabilization. (217)

d. Olympic world records in swimming events indicate that men perform "8.9 % (± 1.54)" better than women since gender gap stabilization. (218)

e. Olympic world records in cycling sprint events indicate that men perform "6.95% (± 0.16)" better than women since gender gap stabilization. (219)

f. Olympic world records in weightlifting events indicate that men perform "36.8% (± 6.2)" better than women since gender gap stabilization. Note that the

Olympics first introduced women's weightlifting events in 1998, and "no breakpoint date has been detected yet." (219)

34. "The top ten performers' analysis reveals a similar gender gap trend with a stabilization in 1982 at 11.7%" when averaged across all events. (222)

C. Beat Knechtle, Pantelis T. Nikolaidis, et al., *World Single Age Records in Running from 5 km to Marathon*, 9 FRONTIERS IN PSYCHOLOGY 1 (2013):

35. A comparison of performances in races of a variety of distances showed that "[i]n all races, women were significantly slower than men. The estimated sex differences … were increasing" as race distances increased from 8 km.[1]

D. Romuald Lepers, Beat Knechtle, et al., *Trends in Triathlon Performance: Effects of Sex & Age*, 43 SPORTS MED 851 (2013):

36. Based on data from a variety of elite triathlon and ultra-triathlon events spanning 22 years, the Lepers et al. (2013) authors reported that "elite males appear to run approximately 10–12 % faster than elite females across all endurance running race distances up to marathon, with the sex difference narrowing as the race distance increases. However, at distances greater than 100 km, such as the 161-km ultramarathon, the difference seems even larger, with females 20–30 % slower than males." (853)

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[1] Throughout this declaration, in the interest of readability I have omitted internal citations from my quotations from the articles I cite. The sources cited by these authors may of course be found by reference to those articles.

37. Lepers and Knechtle Table 1 below shows the "[m]ean sex differences in time performance for swimming, cycling, running and total time at different national and international triathlons." (854)

Event	Sex difference in time performance (%)			
	Swim	Cycle	Run	Total
Short distance (1.5–40–10 km): [30, 79]				
Zurich (Switzerland) from 2000 to 2010				
Top five elite overall	15.2	13.4	17.1	14.8
Top five AG, from 18 to 54 years	18.5	15.5	18.5	17.1
World Championship from 2009 to 2011				
Top ten AG, from 18 to 64 years	13.3	10.7	7.5	12.0
Half Ironman (1.9–90–21 km): [31, 79]				
Rapperswil (Switzerland) from 2007 to 2010				
Top five elite overall	14.1	12.3	12.5	12.6
Top five AG, from 18 to 54 years	22.3	16.4	19.2	17.6
World Championship from 2009 to 2011				
Top ten AG, from 18 to 64 years	12.4	11.2	14.5	12.6
Off-road triathlon (1.5–30–10 km): [9]				
World championship (Maui, USA) from 2007 to 2009				
Top ten elite overall	12.4	19.6	18.4	18.2
Ironman (3.8–180–42 km): [2, 32, 34]				
World championship (Kona, Hawaii, USA) from 1988 to 2007				
Top ten elite overall	9.8	12.7	13.3	12.6
Top ten AG, from 18 to 64 years	12.1	15.4	18.2	15.8
Zurich (Switzerland) from 1995 to 2010				
Top ten elite overall	14.0	13.2	18.2	14.9

38. "[F]or ultratriathlons, it has been shown that with increasing length of the event, the best females became relatively slower compared with the best males. Indeed, if the world's best performances are considered, males were 19 % faster than the females in both Double and Triple Ironman distance, and 30 % faster in the Deca-Ironman distance." (854)

39. "The average sex difference in swimming performance during triathlon for race distances between 1.5 and 3.8 km ranged between approximately 10 and 15 % for elite triathletes." (854)

40. Lepers and Knechtle Table 2 below shows the "[m]ean percentage differences in times for swimming, cycling, running and total event between the top ten females and males … in 2012 at four international triathlons:" (855)

Event	Sex difference in performance in top ten athletes in 2012 (mean ± SD)			
	Swim	Cycle	Run	Total
Hawaii Ironman Triathlon (3.8–180–42 km)	14.1 ± 7.9	13.1 ± 2.3	7.3 ± 2.9	11.3 ± 0.5
Olympics Triathlon (1.5–40–10 km) with drafting	11.8 ± 2.0	11.3 ± 0.6	14.7 ± 0.8	14.1 ± 7.9
Hy-Vee Triathlon (1.5–40–10 km) without drafting	8.6 ± 4.8	10.2 ± 3.5	8.6 ± 4.4	9.3 ± 0.5
World Championship Off-Road Triathlon (1.5–30–10 km)	15.2 ± 15.5	22.6 ± 4.4	15.1 ± 6.7	17.3 ± 2.9

41. "[T]he sex difference in performance between the best male and female ultraswimmers is more generally close to 11–12 %, which corresponds to values observed for swimming in triathlon." (855)

42. "Sex differences in triathlon cycling vary from 12 to 16% according to the level of expertise of participating triathletes for road-based triathlons." (855)

43. "In track cycling, where females are generally weaker than males in terms of power/weight ratios, the performance gap between males and females appears to be constant (<11 %) and independent of the race distance from 200 to 1,000 m." (855)

44. "In ultra-cycling events, such as the 'Race Across America,' sex difference in performance was around 15 % among top competitors. Greater muscle mass and aerobic capacity in males, even expressed relative to the lean body mass, may represent an advantage during long-distance cycling, especially on a relatively flat course such as Ironman cycling, where cycling approximates to a non-weight-bearing sport. Indeed, it has been shown that absolute power output (which is greater for males than for females) is associated with successful cycling

endurance performance because the primary force inhibiting forward motion on a flat course is air resistance." (855-56)

45. "Interestingly, for elite triathletes, the sex difference in mountain bike cycling during off-road triathlon (<20 %) is greater than cycling sex differences in conventional road-based events. Mountain biking differs in many ways from road cycling. Factors other than aerobic power and capacity, such as off-road cycling economy, anaerobic power and capacity, and technical ability might influence off-road cycling performance. Bouts of high-intensity exercise frequently encountered during the mountain biking leg of off-road triathlon (lasting <1 h 30 min for elite males and <2 h for elite females) can result from (1) having to overcome the constraints of gravity associated with steep climbs, (2) variable terrain necessitating wider tires and thus greater rolling resistance, and (3) isometric muscle contractions associated with the needs of more skilled bike-handling skills, not so often encountered in road cycling. However, in particular, lower power-to-weight ratios for female than for male triathletes inevitably leave them at a disadvantage during steep climbs." (856)

46. "During the 1988–2007 period, the top ten elite males have run the Hawaii Ironman marathon on average 13.3 % faster than the top ten females." (856)

E. Espen Tønnessen, Ida Siobhan Svendsen, et al., *Performance Development in Adolescent Track & Field Athletes According to Age, Sex & Sport Discipline*, 10:6 PLoS ONE 1 (2015):

47. While both sexes increase performance across the teen years, the Tønnessen et al. (2015) authors found performance advantages for male athletes associated with the onset of puberty and becoming increasingly larger across the years of puberty, in a chronological progression that was closely similar across diverse track and field events.

48. “The current results indicate that the sex difference evolves from < 5% to 10–18% in all the analyzed disciplines from age 11 to 18 yr. The gap widens considerably during early adolescence before gradually stabilizing when approaching the age of 18. This evolution is practically identical for the running and jumping disciplines. The observed sex differences at the age of 18 are in line with previous studies of world-class athletes where a sex difference of 10–12% for running events and ~19% for jumping events has been reported.” (8)

49. “Male and female athletes perform almost equally in running and jumping events up to the age of 12. Beyond this age, males outperform females. Relative annual performance development in females gradually decreases throughout the analyzed age period. In males, annual relative performance development accelerates up to the age of 13 (for running events) or 14 (for jumping events) and then gradually declines when approaching 18 years of age. The relative improvement from age 11 to 18 was twice as high in jumping events compared to running events. For all of the analyzed disciplines, overall improvement rates were >50% higher for males than for females. The performance sex difference evolves from < 5% to 10-18% in all the analyzed disciplines from age 11 to 18 yr.” (1)

50. “Recent studies of world-class athletes indicate that the sex difference is 10–12% for running events and ~19% for jumping events.” (2)

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51. Tønnessen and Svendsen's Table 1 below shows the "[e]xpected progressions in running and jumping performance for 11-18 [year] old males and females," as deduced from "[t]he 100 all-time best Norwegian male and female 60-m, 800-m, long jump and high jump athletes in each age category . . . ." (1, 4)

Table 1. Expected progressions in running and jumping performance for 11–18 yr old males and females.

Age *(yr)*	60 m		800 m		Long Jump		High Jump	
	Boys *Progression (s and %)*	Girls *Progression (s and %)*	Boys *Progression (s and %)*	Girls *Progression (s and %)*	Boys *Progression m (%)*	Girls *Progression m (%)*	Boys *Progression m (%)*	Girls *Progression m (%)*
11–12	-0.35 (4.1)	-0.35 (4.0)	-6.4 (4.4)	-7.3 (4.8)	+0.35 (7.4)	+0.36 (7.9)	+0.11 (7.4)	+0.10 (7.2)
12–13	-0.48 (5.8)	-0.25 (2.9)	-8.7 (6.2)	-5.5 (3.8)	+0.43 (8.6)	+0.30 (6.0)	+0.12 (7.9)	+0.09 (6.3)
13–14	-0.29 (3.7)	-0.16 (2.0)	-5.9 (4.5)	-3.6 (2.6)	+0.50 (9.0)	+0.21 (4.1)	+0.13 (8.1)	+0.06 (3.6)
14–15	-0.10 (1.3)	-0.02 (0.2)	-5.2 (4.1)	-2.2 (1.6)	+0.34 (5.6)	+0.13 (2.4)	+0.08 (4.3)	+0.04 (2.4)
15–16	-0.17 (2.3)	-0.08 (1.0)	-3.2 (2.7)	-1.6 (1.2)	+0.28 (4.4)	+0.10 (1.8)	+0.07 (3.6)	+0.03 (1.8)
16–17	-0.10 (1.4)	-0.07 (0.8)	-2.3 (1.9)	-1.5 (1.2)	+0.19 (2.9)	+0.06 (1.1)	+0.05 (2.5)	+0.01 (0.6)
17–18	-0.05 (0.7)	-0.02 (0.2)	-1.5 (1.4)	-0.6 (0.4)	+0.17 (2.5)	+0.02 (0.4)	+0.04 (1.9)	+0.01 (0.5)

Data are mean (standard deviation) for top 100 Norwegian male and female performers in each discipline.

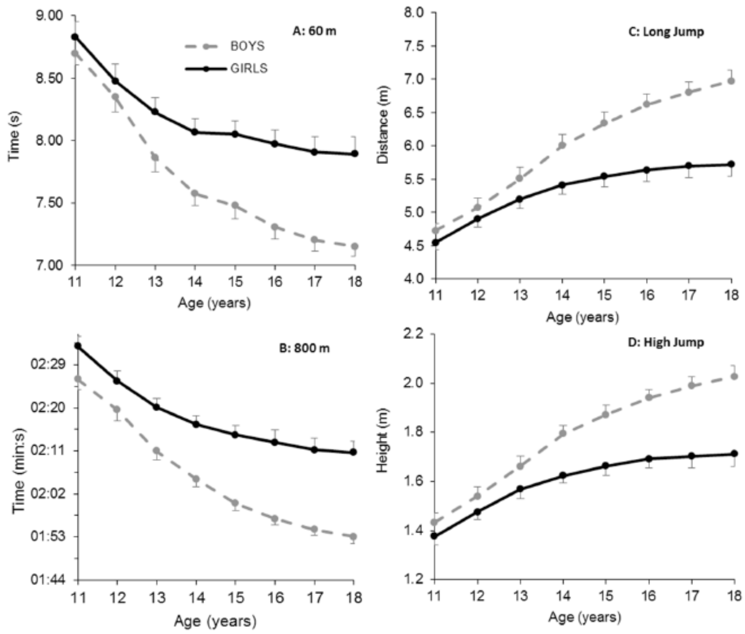
52. Tønnessen and Svendsen's Table 2 below shows the "[s]ex ratio in running and jumping performance for 11-18 [year] old males and females," as deduced from "[t]he 100 all-time best Norwegian male and female 60-m, 800-m, long jump and high jump athletes in each age category . . . ." (1, 6)

Table 2. Sex ratio in running and jumping performance for 11–18 yr old males and females.

	60 m	*800 m*	*Long Jump*	*High Jump*
11	0.99	0.95	0.96	0.97
12	0.98	0.96	0.97	0.96
13	0.96	0.93	0.94	0.95
14	0.94	0.92	0.90	0.90
15	0.93	0.89	0.87	0.89
16	0.92	0.88	0.85	0.87
17	0.91	0.87	0.84	0.85
18	0.91	0.86	0.82	0.84

Data are calculated from mean results of top 100 Norwegian male and female performers in each discipline.

53. Tønnessen and Svendsen's Figure 1 below shows "[p]erformance development from age 11 to 18 in running and jumping disciplines. Data are mean ± [standard deviation] for 60 m, 600 m, long jump, and high jump for top 100 Norwegian male and female performers in



each discipline:" (4)

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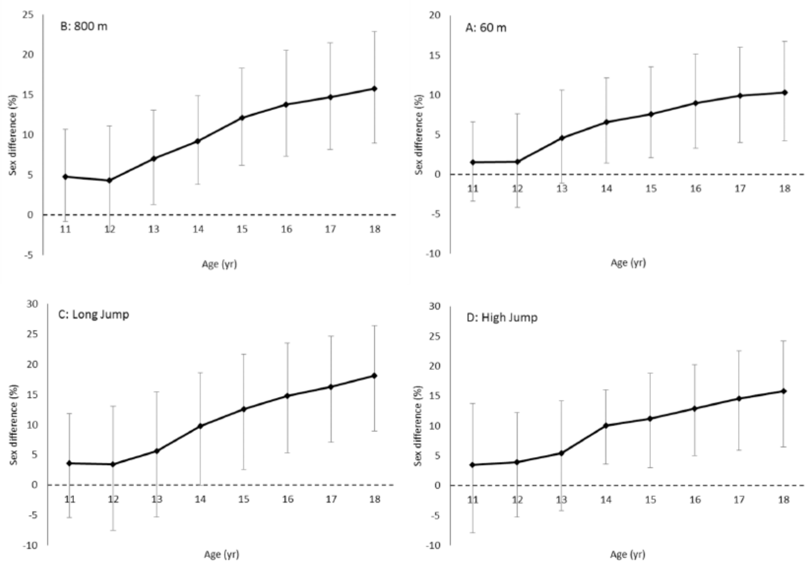
54. Tønnessen and Svendsen's Figure 3 below shows the "[s]ex difference for performance in running and jumping disciplines from age 11 to 18. Data are mean and 95% [confidence intervals] for 60 m, 600 m, long jump, and high jump for top 100 Norwegian male and female performers in each discipline:" (6)



55. As for the 60m race, the tables and charts above illustrate:

a. "[B]oys improve 0.3–0.5 [seconds] over 60 m sprint each year up to the age of 14 [years] (very large to nearly perfect annual effect), 0.1–0.2 [seconds] annually from 14 to 17 [years] (moderate to large annual effect), and 0.05 [seconds] from age 17 to 18 [years] (moderate effect). Relative annual improvement peaks between 12 and 13 [years] (5.8%; nearly perfect effect), and then gradually declines to 0.7% between age 17 and 18 [years] (moderate effect)." (3)

b. "On average, boys improve their 60 m performance by 18% from age 11 to 18 [years]. Girls improve 0.35 [seconds] over 60 m from age 11 to 12 [years] (4%; very large effect). Then, absolute and relative annual improvement gradually slows and almost plateaus between age 14 and 15 (0.02 s; 0.2%; trivial effect). From age 15 to 17, annual improvement increases somewhat to 0.07–0.08 [seconds] (~1%; moderate effect) before plateauing again between age 17 and 18 (0.02 s; 0.2%; trivial effect). In total, girls improve their 60-m performance by 11% from age 11 to 18 [years]…. [T]he sex difference for 60 m sprint evolves from 1.5% at age 11 to 10.3% at the age of 18…. [T]he sex ratio for 60 m running performance develops from 0.99 at age 11 to 0.91 at age 18." (4-5)

56. As for the 800m race, the tables and charts above illustrate:

a. "[B]oys improve 6–9 [seconds] over 800 m each year up to age 14 [years] (very large to nearly perfect annual effect). Relative annual improvement peaks between age 12 and 13 (6.2%; nearly perfect effect), then gradually decreases to 1.5 [seconds] between age 17 and 18 (1.4%; moderate effect)." (5)

b. "On average, boys enhance their 800-m performance by 23% from age 11 to 18. For girls, both absolute and relative annual performance development gradually decreases across the analysed age stages. The improvement is slightly above 7 [seconds] between age 11 and 12 [years] (4.8%: very large effect), decreasing to only 0.6 [seconds] from age 17 to 18 (0.4%; small effect)…. [G]irls enhance their 800-m performance by 15% from age 11 to 18. The 800 m performance sex difference evolves from 4.8% at the age of 11 to 15.7% at the age of 18…. [T]he sex ratio for 800 m running performance develops from 0.95 at age 11 to 0.86 at age 18." (5)

57. As for the long jump, the tables and charts above illustrate:

a. "[A]nnual long jump improvement among boys gradually increases from 35 cm between age 11 and 12 [years] (7.4%; very large effect) to 50 cm between age 13 and 14 (9%; very large effect). Both absolute and relative annual development then gradually falls to 17 cm between age 17 and 18 (2.5%; moderate effect).” (5)

b. “[B]oys, on average, improve their long jump performance by 48% from age 11 to 18 yr. For girls, both absolute and relative annual performance enhancement gradually falls from age 11 to 12 [years] (36 cm; 7.9%; very large effect) until nearly plateauing between 17 and 18 [years] (2 cm; 0.4%; trivial effect). Overall, girls typically improve their long jump performance by 26% throughout the analysed age stages. The sex difference in long jump evolves from 3.6% at the age of 11 to 18% at the age of 18…. [T]he sex ratio for long jump performance develops from 0.96 at age 11 to 0.82 at age 18.” (5)

58. As for the high jump, the tables and charts above illustrate:

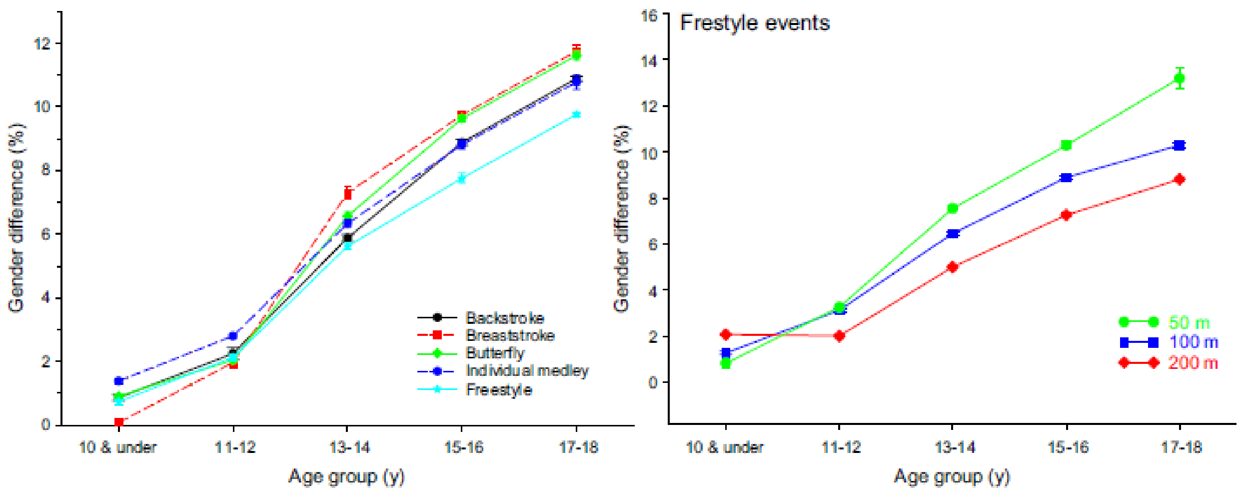
a. “[B]oys improve their high jump performance by 11–13 cm each year up to the age of 14 (7–8%; very large annual effects). Both absolute and relative annual improvement peaks between age 13 and 14 (13 cm; 8.1%; very large effect), then gradually decreases to 4 cm from age 17 to 18 (1.9%; moderate annual effect).” (6)

b. “Overall, boys improve their high jump performance by, on average, 41% from age 11 to 18. For girls, both absolute and relative annual improvement decreases from 10 cm from age 11 to 12 [years] (7.2%; very large effect) until it plateaus from age 16 (1 cm; ~0.5%; small annual effects). Overall, girls typically improve their high jump performance by 24% from age 11 to 18. The sex difference in high jump performance evolves from 3.5% at the age of 11 to 16% at the age of 18…. [T]he sex ratio for high jump performance develops from 0.97 at age 11 to 0.84 at age 18.” (6-7)

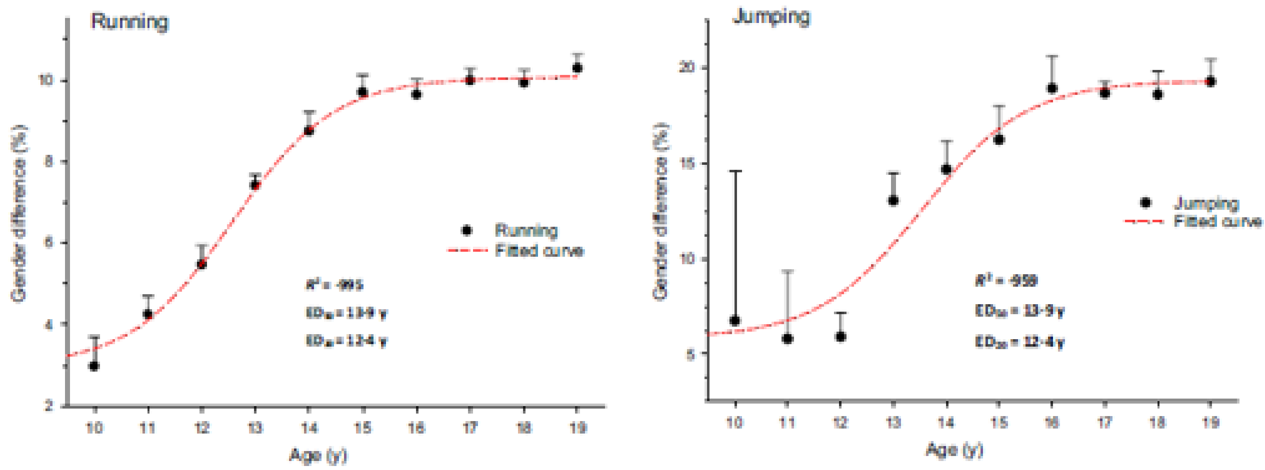
F. David J. Handelsman, *Sex Differences in Athletic Performance Emerge Coinciding with the Onset of Male Puberty*, 87 CLINICAL ENDOCRINOLOGY 68 (2017):

59. Analyzing four separate studies, Handelsman (2017) found very closely similar trajectories of divergence of athletic performance between the sexes across the adolescent years, in all measured events.

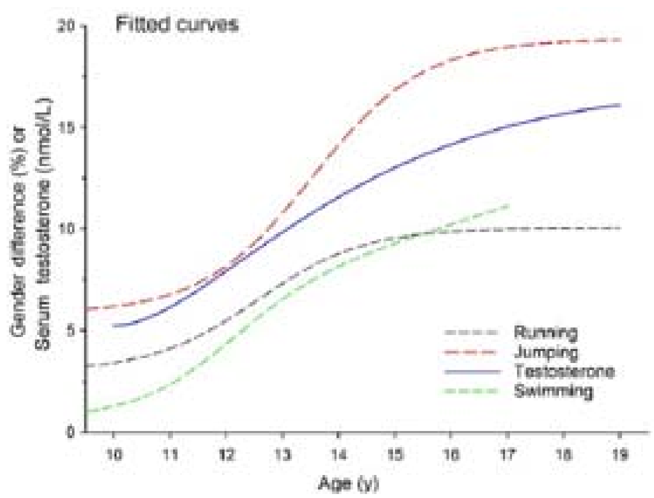
60. As illustrated by Figure 1 of Handelsman (2017) below, study results showed that "[i]n swimming performance, the overall gender differences were highly significant . . . ." (69)



61. As illustrated by Figure 2 of Handelsman (2017) below, "[i]n track and field athletics, the effects of age on running performance showed that the prepubertal differences of 3.0% increased to a plateau of 10.1% with an onset (ED_{20}) at 12.4 years and reaching midway (ED_{50}) at 13.9 years. For jumping, the prepubertal difference of 5.8% increased to 19.4% starting at 12.4 years and reaching midway at 13.9 years." (70)



62. As also illustrated in Figure 2 of Handelsman (2017), the author found a strong correlation between the increasing male performance advantage and blood serum testosterone levels, and reported: "The timing of the male advantage in running, jumping and swimming was similar [across events] and corresponded to the increases in serum testosterone in males." (70)



G. Moran Gershoni & Shmuel Pietrokovski, *The landscape of sex-differential transcriptome and its consequent selection in human adults*, 15 BMC BIOL 7 (2017):

63. The authors of this article evaluated "18,670 out of 19,644 informative protein-coding genes in men versus women" (2) and reported that "there are over 6500 protein-coding

genes with significant S[ex-]D[ifferential]E[xpression] in at least one tissue. Most of these genes have SDE in just one tissue, but about 650 have SDE in two or more tissues, 31 have SDE in more than five tissues, and 22 have SDE in nine or more tissues." (2) Some examples of tissues identified by these authors that have SDE genes include breast mammary tissue, skeletal muscle, skin, thyroid gland, pituitary gland, subcutaneous adipose, lung, and heart left ventricle. Based on these observations the authors state "As expected, Y-linked genes that are normally carried only by men show SDE in many tissues." (3) This evaluation of SDE in protein coding genes helps illustrate that the differences between men and women are intrinsically part of the chromosomal and genetic makeup of humans which can influence many tissues that are inherent to the athletic competitive advantages of men compared to women.

H. K. M. Haizlip, et al., Sex-based differences in skeletal muscle kinetics and fiber-type composition, 30 PHYSIOLOGY (BETHESDA) 30 (2015):

64. In a review of 56 articles on the topic of sex-based differences in skeletal muscle, the authors state that "More than 3,000 genes have been identified as being differentially expressed between male and female skeletal muscle []." (30) Furthermore, the authors state that "Overall, evidence to date suggests that skeletal muscle fiber-type composition is dependent on species, anatomical location/function, and sex." (30) The differences in genetic expression between males and females influence the skeletal muscle fiber composition (i.e. fast twitch and fast twitch sub-type and slow twitch), the skeletal muscle fiber size, the muscle contractile rate, and other aspects of muscle function that influence athletic performance. As the authors review the differences in skeletal muscle between males and females they conclude "Additionally, all of the fibers measured in men have significantly larger cross-sectional areas (CSA) compared with women []." (31) The authors also explore the effects of thyroid hormone, estrogen, and

testosterone on gene expression and skeletal muscle function in males and females. One major conclusion by the authors is that "The complexity of skeletal muscle and the role of sex adding to that complexity cannot be overlooked." (37).

I. Konstantinos D. Tambalis, et al., Physical fitness normative values for 6-18-year-old Greek boys and girls, using the empirical distribution and the lambda, mu, and sigma statistical method, 16 EUR J SPORT SCI 736 (2016). Mark J. Catley & G. R. Tomkinson, Normative health-related fitness values for children: analysis of 85347 test results on 9-17-year-old Australians since 1985, 47 BR J SPORTS MED 98 (2013). Grant R. Tomkinson, et al., *European normative values for physical fitness in children and adolescents aged 9-17 years: results from 2 779 165 Eurofit performances representing 30 countries*. 52 Br J Sports Med. 1445 (2018):

65. The purpose in citing these sources is to illustrate that males possess physical fitness traits that likely provide an advantage in athletic performance, that these male advantages may be apparent in children starting as young as six years of age, and in agreement with previously cited sources the differences become more apparent at the onset of puberty.

66. Tambalis et al. (2016) states that "based on a large data set comprising 424,328 test performances" (736) using standing long jump to measure lower body explosive power, sit and reach to measure flexibility, timed 30 second sit ups to measure abdominal and hip flexor muscle endurance, 10 X 5 meter shuttle run to evaluate speed and agility, and multi-stage 20 meter shuttle run test to estimate aerobic performance (738) "For each of the fitness tests, performance was better in boys compared with girls ($p < 0.001$), except for the S[it and] R[each] test ($p < 0.001$)." (739) In order to illustrate that the findings of Tambalis (2016) are not unique to children in Greece, the authors state "Our findings are in accordance with recent studies from Latvia [ ] Portugal [ ] and Australia [Catley & Tomkinson (2013)].(744)

67. Catley & Tomkinson (2013) observed that "Boys consistently scored higher than girls on health-related fitness tests, except on the sit-and-reach test, with the magnitude of the

differences typically increasing with age and often accelerating from about 12 years of age. Overall, the magnitude of differences between boys and girls was large for the 1.6 km run, 20 m shuttle run, basketball throw and push-ups; moderate for the 50-m sprint, standing broad jump and sit-and-reach; and small for sit-ups and hand-grip strength." (106)

68. Evaluating performance on the "Eurofit tests (measuring balance, muscular strength, muscular endurance, muscular power, flexibility, speed, speed-agility and cardiorespiratory fitness)" in "2,779,165 results on children and adolescents [ages 9-17 years] from 30 European countries" Tomkinson et al. (2018) observed that "On average, boys performed substantially better than girls at each age group on muscular strength (E[ffect]S[ize]: large), muscular power (E[ffect]S[ize]: large), muscular endurance (E[ffect]S[ize]: moderate to large), speed-agility (E[ffect]S[ize]: moderate) and C[ardio]R[espiratory]F[itness] (E[ffect]S[ize]: large) tests, with the magnitude of the sex-specific differences increasing with age and accelerating from about 12 years"" (1451). Given the number of subjects analyzed and that the data represent 30 different European countries, these findings particularly highlight the sex related differences in athletic performance potential between boys and girls both before and during adolescence.

J. Daniel M. Fessler, et al., *Sexual dimorphism in foot length proportionate to stature*, 32 ANN HUM BIOL 44 (2005). Roshna E. Wunderlich & P. R. Cavanagh, *Gender differences in adult foot shape: implications for shoe design*, 33 MED SCI SPORTS EXERC (2001):

69. Combined, these two articles evaluate and demonstrate clear differences in the foot length and structure of men and women. Of relevance to the case at hand is that to the best of my knowledge, no data are available demonstrating that male-to-female transgender hormone or surgical treatment alters the inherent sex related difference in foot structure.

70. Fessler et al. (2005) observes that "female foot length is consistently smaller than male foot length" (44) and conclude that "proportionate foot length is smaller in women"(51) with an overall conclusion that "Our analyses of genetically disparate populations reveal a clear pattern of sexual dimorphism, with women consistently having smaller feet proportionate to stature than men." (53)

71. Wunderlich & Cavanaugh (2001) observe that "a foot length of 257 mm represents a value that is … approximately the 20th percentile men's foot lengths and the 80th percentile women's foot lengths." (607) and "For a man and a woman, both with statures of 170 cm (5 feet 7 inches), the man would have a foot that was approximately 5 mm longer and 2 mm wider than the woman" (608). Based on these, and other analyses, they conclude that "female feet and legs are not simply scaled-down versions of male feet but rather differ in a number of shape characteristics, particularly at the arch, the lateral side of the foot, the first toe, and the ball of the foot." (605)

K. Daichi. Tomita, et al., *A pilot study on the importance of forefoot bone length in male 400-m sprinters: is there a key morphological factor for superior long sprint performance?*, 11 BMC RES NOTES 583 (2018). Hiromasa Ueno, et al., *The Potential Relationship Between Leg Bone Length and Running Performance in Well-Trained Endurance Runners*, 70 J HUM KINET 165 (2019). Hiromasa Ueno, et al., *Association between Forefoot Bone Length and Performance in Male Endurance Runners*, 39 INT J SPORTS MED 275 (2018):

72. As men have longer feet and legs than women as part of their overall larger body stature, collectively these articles build upon the work of Fessler et al. (2005) and Wunderlich & Cavanaugh (2001) by providing some evidence that "morphological factors such as long forefoot bones may play an important role in achieving superior long sprinting performance" (Tomito, 583), "longer forefoot bones may be advantageous for achieving higher running performance in

endurance runners" (Ueno 2018, 275)" and "the leg bone length, especially of the tibia, may be a potential morphological factor for achieving superior running performance in well-trained endurance runners." (Ueno 2019, 165)

L. International Weightlifting Federation "World Records"

73. I accessed weightlifting records as posted by the International Weightlifting Federation at https://www.iwf.net/results/world-records/. The records collected below are as of November 1, 2019.

74. As the chart below illustrates, junior men's and women's world records (age 15-20) for clean and jerk lifts indicate that boys or men perform better than girls or women even when they are matched for body mass. Similar sex differences can be found for the snatch event on the International Weightlifting Federation website.

Junior Men's and Women's World Records (ages 15-20) for Clean and Jerk

Men's weight (kg)	Record (kg)	Women's weight (kg)	Record (kg)
56	171	58	142
62	183	63	147
69	198	69	157
77	214	75	164
85	220	90	160
94	233	+90	193

M. Selected Results from the 2019 NCAA Division 1 and Division 2 Track & Field Championships

75. I accessed the results for the NCAA 2019 Division 1 Track and Field Championships at https://www.flotrack.org/results/6515701-2019-D1-ncaa-outdoor-championships/26635 on May 14, 2020. I also accessed the results for the NCAA Divisions 2 Track and Field Championships at http://leonetiming.com/2019/Outdoor/NCAAD2/Results.htm on May 14, 2020.

76. A shown in the table below, in this small sampling of Track & Field events at the elite collegiate level of Division 1, the men's eighth place finisher and often all 24 men's qualifiers, outperformed the first place women's athlete in the same event. Furthermore, at the Division 2 level, which is arguably a less elite level of performance than Division 1, in most (if not all) events, the top eight men's finishers outperformed the first place division 1 woman in the same event.

Comparison of selected performance in Men's and Women's events in the 2019 NCAA Division 1 and Division 2 Track and Field Championships.		
100 meter run (seconds)		
D1 Women	D1 Men	D2 Men
10.75	9.86	10.17
10.95	9.93	10.22
10.98	9.97	10.32
11.00	10.01	10.38
11.02	10.06	10.47
11.04	10.06	10.48
11.12	10.12	10.53
11.65	10.12	FS
D1 Men's slowest time in 100 m prelims: 10.67 (23rd place; 24th place DNS)		
D1 Women's fastest time in 100 m prelims: 10.99		
1500 m run (minutes: seconds)		
D1 Women	D1 Men	D2 Men
4:05.98	3:41.39	3:58.24
4:06.27	3:41.39	3:58.74
4:11.96	3:42.14	3:58.90
4:13.02	3:42.29	3:59.02
4:13.57	3:42.32	3:59.47
4:13.62	3:42.73	3:59.55
4:14.30	3:42.77	3:59.65
4:14.73	3:42.81	3:59.93
D1 Men's slowest time in 1500 m prelims: 3:53.53 (24th place)		
D1 Women's fastest time in 1500 m prelims: 4:12.02		
10,000 m run (minutes: Seconds)		
D1 Women	D1 Men	D2 Men
33:10.84	29:16.60	30:12.3
33:11.56	29:18.10	30:59.78

33:17.81	29:19.85	31:05.87
33:20.68	29:19.93	31:07.37
33:20.70	29:20.73	31:11.07
33:25.91	29:25.35	31:13.39
33:32.80	29:26.34	31:14.69
33:34.20	29:30.88	31:18.75
D1 Men's slowest time in 10,000 m prelims: 31:20.16 (24th place)		
Long Jump (meters)		
D1 Women	D1 Men	DII Men
6.84	8.2	8.16
6.71	8.18	8.08
6.63	8.12	7.96
6.55	8.05	7.86
6.49	8.00	7.79
6.44	7.88	7.72
6.43	7.87	7.72
6.40	7.83	7.71
D1 Men's 21st place longest jump 7.38 m (22nd foul, 23rd & 24th DNS)		
Shot Put (meters) Note that men use 7.26 kg (16 lbs.) shot, women use 4 kg (8.82 lbs.) shot		
D1 Women	D1 Men	D II Men
18.14	21.11	21.47
18.11	20.77	19.58
17.88	20.31	18.71
17.67	19.89	18.62
17.46	19.73	18.43
17.24	19.65	18.34
17.13	19.65	18.30
16.94	19.52	18.03
D1 Men's 23rd place longest put 16.90 m (24th Foul)		

II. Biological male physiology is the basis for the performance advantage that men, or adolescent boys, have over women, or adolescent girls, in almost all athletic contests.

77. Common observation and knowledge tell us that, across the years of puberty, boys experience distinctive physical developments that largely explain the performance advantages I have detailed above. These well-known physical developments have now also been the subject of scientific measurement and study.

78. At the onset of male puberty the testes begin to secrete greatly increased amounts of testosterone. Testosterone is the primary "androgenic" hormone. It causes the physical traits associated with males such as facial and body hair growth, deepening of the voice, enlargement of the genitalia, increased bone mineral density, increased bone length in the long bones, and enhanced muscle growth (to name just a few of testosterone's effects). The enhanced muscle growth caused by testosterone is the "anabolic" effect often discussed when testosterone is called an anabolic steroid.

79. Women lack testes and instead have ovaries, so they do not experience similar increases in testosterone secretion. Instead, puberty in women is associated with the onset of menstruation and increased secretion of "estrogens." Estrogens, most notably estradiol, cause the feminizing effects associated with puberty in women which include increased fat tissue growth in the hips, thighs, and buttocks, development of the mammary glands, and closure of the growth plates in long bones. The smaller amount of muscle growth typically seen in women during puberty explains in part the athletic performance gap between men, and boys after the onset of puberty, and women and girls.

A. Handelsman, Hirschberg, et al. (2018):

80. In addition to documenting objective performance advantages enjoyed by males as I have reviewed above, Handelsman and his co-authors also detail physiological differences caused by male puberty—and by developments during puberty under the influence of male levels of testosterone in particular—that account for those advantages. These authors state: "The striking male postpubertal increase in circulating testosterone provides a major, ongoing, cumulative, and durable physical advantage in sporting contests by creating larger and stronger bones, greater muscle mass and strength, and higher circulating hemoglobin as well as possible

psychological (behavioral) differences. In concert, these render women, on average, unable to compete effectively against men in power-based or endurance-based sports." (805)

81. First, Handelsman et al. explain that all of these physiological differences appear to be driven by male levels of circulating testosterone. "The available, albeit incomplete, evidence makes it highly likely that the sex difference in circulating testosterone of adults explains most, if not all, of the sex differences in sporting performance. This is based on the dose-response effects of circulating testosterone to increase muscle mass and strength, bone size and strength (density), and circulating hemoglobin, each of which alone increases athletic capacity, as well as other possible sex dichotomous, androgen-sensitive contributors such as mental effects (mood, motivation, aggression) and muscle myoglobin content. These facts explain the clear sex difference in athletic performance in most sports, on which basis it is commonly accepted that competition has to be divided into male and female categories." (823)

82. "Prior to puberty, levels of circulating testosterone as determined by LC-MS are the same in boys and girls . . . . They remain lower than 2 nmol/L in women of all ages. However, from the onset of male puberty the testes secrete 20 times more testosterone resulting in circulating testosterone levels that are 15 times greater in healthy young men than in age-similar women." (806) "[T]he circulating testosterone of most women never reaches consistently >5 nmol/L, a level that boys must sustain for some time to exhibit the masculinizing effects of male puberty." (808)

83. "The characteristic clinical features of masculinization (e.g., muscle growth, increased height, increased hemoglobin, body hair distribution, voice change) appear only if and when circulating testosterone concentrations rise into the range of males at mid-puberty, which

are higher than in women at any age even after the rise in circulating testosterone in female puberty." (810)

84. "[The] order-of-magnitude difference in circulating testosterone concentrations is the key factor in the sex difference in athletic performance due to androgen effects principally on muscle, bone, and hemoglobin." (811)

85. "Modern knowledge of the molecular and cellular basis for androgen effects on skeletal muscle involves effects due to androgen (testosterone, DHT) binding to the AR that then releases chaperone proteins, dimerizes, and translocates into the nucleus to bind to androgen response elements in the promoter DNA of androgen-sensitive genes. This leads to increases in (1) muscle fiber numbers and size, (2) muscle satellite cell numbers, (3) numbers of myonuclei, and (4) size of motor neurons. Additionally, there is experimental evidence that testosterone increases skeletal muscle myostatin expression, mitochondrial biogenesis, myoglobin expression, and IGF-1 content, which may augment energetic and power generation of skeletal muscular activity." (811)

86. **Muscle mass** is perhaps the most obvious driver of male athletic advantage. "On average, women have 50% to 60% of men's upper arm muscle cross-sectional area and 65% to 70% of men's thigh muscle cross-sectional area, and women have 50% to 60% of men's upper limb strength and 60% to 80% of men's leg strength. Young men have on average a skeletal muscle mass of >12 kg greater than age-matched women at any given body weight. Whereas numerous genes and environmental factors (including genetics, physical activity, and diet) may contribute to muscle mass, the major cause of the sex difference in muscle mass and strength is the sex difference in circulating testosterone." (812)

87. “Dose-response studies show that in men whose endogenous testosterone is fully suppressed, add-back administration of increasing doses of testosterone that produce graded increases in circulating testosterone causes a dose-dependent (whether expressed according to testosterone dose or circulating levels) increase in muscle mass (measured as lean body mass) and strength. Taken together, these studies prove that testosterone doses leading to circulating concentrations from well below to well above the normal male range have unequivocal dose-dependent effects on muscle mass and strength. These data strongly and consistently suggest that the sex difference in lean body mass (muscle) is largely, if not exclusively, due to the differences in circulating testosterone between men and women. These findings have strong implications for power dependent sport performance and largely explain the potent efficacy of androgen doping in sports.” (813)

88. “Muscle growth, as well as the increase in strength and power it brings, has an obvious performance enhancing effect, in particular in sports that depend on strength and (explosive) power, such as track and field events. There is convincing evidence that the sex differences in muscle mass and strength are sufficient to account for the increased strength and aerobic performance of men compared with women and is in keeping with the differences in world records between the sexes.” (816)

89. Men and adolescent boys also have distinct athletic advantages in **bone size, strength, and configuration**.

90. “Sex differences in height have been the most thoroughly investigated measure of bone size, as adult height is a stable, easily quantified measure in large population samples. Extensive twin studies show that adult height is highly heritable with predominantly additive genetic effects that diverge in a sex-specific manner from the age of puberty onwards, the effects

of which are likely to be due to sex differences in adult circulating testosterone concentrations." "Men have distinctively greater bone size, strength, and density than do women of the same age. As with muscle, sex differences in bone are absent prior to puberty but then accrue progressively from the onset of male puberty due to the sex difference in exposure to adult male circulating testosterone concentrations." (818)

91. "The earlier onset of puberty and the related growth spurt in girls as well as earlier estrogen-dependent epiphyseal fusion explains shorter stature of girls than boys. As a result, on average men are 7% to 8% taller with longer, denser, and stronger bones, whereas women have shorter humerus and femur cross-sectional areas being 65% to 75% and 85%, respectively, those of men. These changes create an advantage of greater bone strength and stronger fulcrum power from longer bones." (818)

92. **Male bone geometry** also provides mechanical advantages. "The major effects of men's larger and stronger bones would be manifest via their taller stature as well as the larger fulcrum with greater leverage for muscular limb power exerted in jumping, throwing, or other explosive power activities." (818) Further, "the widening of the female pelvis during puberty, balancing the evolutionary demands of obstetrics and locomotion, retards the improvement in female physical performance, possibly driven by ovarian hormones rather than the absence of testosterone." (818)

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

94. In addition to advantages in muscle mass and strength, and bone size and strength, men and adolescent boys have **greater hemoglobin levels** in their blood as compared to women and girls, and thus a greater capability to transport oxygen within the blood, which then provides bioenergetic benefits. “It is well known that levels of circulating hemoglobin are androgen-dependent and consequently higher in men than in women by 12% on average…. Increasing the amount of hemoglobin in the blood has the biological effect of increasing oxygen transport from lungs to tissues, where the increased availability of oxygen enhances aerobic energy expenditure.” (816) “It may be estimated that as a result the average maximal oxygen transfer will be ~10% greater in men than in women, which has a direct impact on their respective athletic capacities.” (816)

B. Louis Gooren, *The Significance of Testosterone for Fair Participation of the Female Sex in Competitive Sports,* 13 Asian J. of Andrology 653 (2011):

95. Gooren et al. like Handelsman et al., link male advantages in height, bone size, muscle mass, strength, and oxygen carrying capacity to exposure to male testosterone levels: “Before puberty, boys and girls hardly differ in height, muscle and bone mass. Pubertal testosterone exposure leads to an ultimate average greater height in men of 12–15 centimeters, larger bones, greater muscle mass, increased strength and higher hemoglobin levels.” (653)

C. Thibault, Guillaume, et al. (2010):

96. In addition to the testosterone-linked advantages examined by Handelsman et al. (2018), Thibault et al. note sex-linked differences in body fat as impacting athletic performance: “Sex has been identified as a major determinant of athletic performance through the impact of height, weight, body fat, muscle mass, aerobic capacity or anaerobic threshold as a result of genetic and hormonal differences [].” (214)

D. Taryn Knox, Lynley C. Anderson, et al., *Transwomen in Elite Sport: Scientific & Ethical Considerations*, 45 J. MED ETHICS 395 (2019):

97. Knox et al. analyze specific testosterone-linked physiological differences between men and women that provide advantages in athletic capability, and conclude that "[E]lite male athletes have a performance advantage over their female counterparts due to physiological differences." (395) "Combining all of this information, testosterone has profound effects on key physiological parameters that underlie athletic performance in men. There is substantial evidence regarding the effects on muscle gain, bone strength, and the cardiovascular and respiratory system, all of which drive enhanced strength, speed and recovery. Together the scientific data point to testosterone providing an all-purpose benefit across a range of body systems that contribute to athletic performance for almost all sports." (397-98)

98. "It is well recognised that testosterone contributes to physiological factors including body composition, skeletal structure, and the cardiovascular and respiratory systems across the life span, with significant influence during the pubertal period. These physiological factors underpin strength, speed and recovery with all three elements required to be competitive in almost all sports. An exception is equestrian, and for this reason, elite equestrian competition is not gender-segregated. As testosterone underpins strength, speed and recovery, it follows that testosterone benefits athletic performance." (397)

99. "High testosterone levels and prior male physiology provide an all-purpose benefit, and a substantial advantage. As the IAAF says, 'To the best of our knowledge, there is no other genetic or biological trait encountered in female athletics that confers such a huge performance advantage.'" (399)

100. These authors, like others, describe sex-linked advantages relating to **bone size and muscle mass.** "Testosterone also has a strong influence on bone structure and strength. From puberty onwards, men have, on average, 10% more bone providing more surface area. The larger surface area of bone accommodates more skeletal muscle so, for example, men have broader shoulders allowing more muscle to build. This translates into 44% less upper body strength for women, providing men an advantage for sports like boxing, weightlifting and skiing. In similar fashion, muscle mass differences lead to decreased trunk and lower body strength by 64% and 72%, respectively in women. These differences in body strength can have a significant impact on athletic performance, and largely underwrite the significant differences in world record times and distances set by men and women." (397)

101. Knox et al. also identify the relatively higher percentage of **body fat** in women as both inherently sex-linked, and a disadvantage with respect to athletic performance. "Oestrogens also affect body composition by influencing fat deposition. Women, on average, have higher percentage body fat, and this holds true even for highly trained healthy athletes (men 5%–10%, women 8%–15%). Fat is needed in women for normal reproduction and fertility, but it is not performance enhancing. This means men with higher muscle mass and less body fat will normally be stronger kilogram for kilogram than women." (397)

102. Knox et al. detail the relative performance disadvantage arising from the oestrogen-linked **female pelvis shape**: "[T]he major female hormones, oestrogens, can have effects that disadvantage female athletic performance. For example, women have a wider pelvis changing the hip structure significantly between the sexes. Pelvis shape is established during puberty and is driven by oestrogen. The different angles resulting from the female pelvis leads to decreased joint rotation and muscle recruitment ultimately making them slower." (397)

103. “In short, higher testosterone levels lead to larger and stronger bones as well as more muscle mass providing a body composition-related performance advantage for men for almost all sports. In contrast, higher oestrogen levels lead to changes in skeletal structure and more fat mass that can disadvantage female athletes, in sports in which speed, strength and recovery are important.” (397)

104. Knox et al. break out multiple sex-linked contributions to a male advantage in **oxygen intake and delivery**, and thus to energy delivery to muscles. “Testosterone also influences the cardiovascular and respiratory systems such that men have a more efficient system for delivering oxygen to active skeletal muscle. Three key components required for oxygen delivery include lungs, heart and blood haemoglobin levels. Inherent sex differences in the lung are apparent from early in life and throughout the life span with lung capacity larger in men because of a lower diaphragm placement due to Y-chromosome genetic determinants. The greater lung volume is complemented by testosterone-driven **enhanced alveolar multiplication rate** during the early years of life.” (397)

105. “Oxygen exchange takes place between the air we breathe and the bloodstream at the alveoli, so more alveoli allows more oxygen to pass into the bloodstream. Therefore, the greater lung capacity allows more air to be inhaled with each breath. This is coupled with an improved uptake system allowing men to absorb more oxygen. Once in the blood, oxygen is carried by haemoglobin. Haemoglobin concentrations are directly modulated by testosterone so men have higher levels and can carry more oxygen than women. Oxygenated blood is pumped to the active skeletal muscle by the heart. The left ventricle chamber of the heart is the reservoir from which blood is pumped to the body. The larger the left ventricle, the more blood it can hold, and therefore, the more blood can be pumped to the body with each heartbeat, a

physiological parameter called ‘stroke volume’. The female heart size is, on average, 85% that of a male resulting in the stroke volume of women being around 33% less. Putting all of this together, men have a much more efficient cardiovascular and respiratory system, with testosterone being a major driver of enhanced aerobic capacity.” (397)

E. Lepers, Knechtle, et al. (2013):

106. Lepers et al. point to some of these same physiological differences as explaining the large performance advantage they found for men in triathlon performance. “Current explanations for sex differences in [maximal oxygen uptake] among elite athletes, when expressed relative to body mass, provide two major findings. First, elite females have more (<13 vs. <5 %) body fat than males. Indeed, much of the difference in [maximal oxygen uptake] between males and females disappears when it is expressed relative to lean body mass. Second, the hemoglobin concentration of elite athletes is 5–10 % lower in females than in males.” (853)

107. “Males possess on average 7–9 % less percent body fat than females, which is likely an advantage for males. Therefore, it appears that sex differences in percentage body fat, oxygen-carrying capacity and muscle mass may be major factors for sex differences in overall triathlon performance. Menstrual cycle, and possibly pregnancy, may also impact training and racing in female athletes, factors that do not affect males.” (853)

F. Tønnessen, Svendsen, et al. (2015):

108. Tønnessen et al. likewise point to some of the same puberty and testosterone-triggered physiological differences discussed above to explain the increasing performance advantage of boys across the adolescent years, noting that “[T]here appears to be a strong mechanistic connection between the observed sex-specific performance developments and hormone-dependent changes in body composition during puberty.” (7) “Beyond [age 12], males

outperform females because maturation results in a shift in body composition. Our results are in line with previous investigations exploring physical capacities such as [maximal oxygen uptake] and isometric strength in non-competitive or non-specialized adolescents." (7)

109. "[S]ex differences in physical capacities (assessed as [maximal oxygen uptake] or isometric strength in the majority of cases) are negligible prior to the onset of puberty. During the adolescent growth spurt, however, marked sex differences develop. This can primarily be explained by hormone dependent changes in body composition and increased red blood cell mass in boys." (2)

110. "Sexual dimorphism during puberty is highly relevant for understanding sex-specific performance developments in sports. The initiation of the growth spurt in well-nourished girls occurs at about 9–10 yrs of age. Age at peak height velocity (PHV) and peak weight velocity (PWV) in girls is 11–12 and 12–13 yrs, respectively, with an average 7–9 cm and 6–9 kg annual increase. The growth spurt and PHV in girls occurs approximately 2 years earlier than for boys. However, the magnitude of the growth spurt is typically greater in boys, as they on average gain 8–10 cm and 9–10 kg annually at PHV and PWV, respectively. Girls experience an escalation in fat mass compared to boys. Fat free mass (FFM) (also termed lean muscle mass) is nearly identical in males and females up to the age of 12–13 yrs. FFM plateaus in females at 15–16 years of age, but continues increasing in males up to the age of 19–20 yrs. On average, boys and girls increase their FFM by 7.2 and 3.5 kg/year^{-1}, respectively, during the interval near peak height velocity. Corresponding estimates for changes in absolute fat mass are 0.7 and 1.4 kg/year^{-1}, while estimates for relative fatness are -0.5% and +0.9%/year^{-1} in boys and girls, respectively." (2)

111. “During puberty, boys begin to produce higher levels of circulating testosterone. This affects the production of muscle fibers through direct stimulation of protein synthesis. Higher testosterone levels result in more muscle mass, which in turn facilitates greater power production and more advantageous ground reaction forces during running and jumping. Adolescent weight gain in boys is principally due to increased height (skeletal tissue) and muscle mass, while fat mass remains relatively stable. In contrast, during puberty girls begin to produce higher levels of circulating estrogen and other female sex hormones. Compared to their male counterparts, they experience a less pronounced growth spurt and a smaller increase in muscle mass, but a continuous increase in fat mass, thereby lowering the critical ratio between muscular power and total body mass.” (7)

112. “The relatively greater progress in jumping exercises can also be explained by growth and increased body height during puberty. The increase in body height means that the center of gravity will be higher, providing better mechanical conditions for performance in jumping events.” (8)

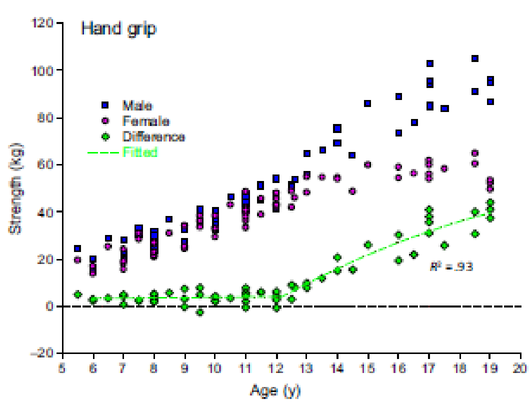
G. Louis J. G. Gooren & Mathijs C. M. Bunck, *Transsexuals & Competitive Sports*, 151 European J. of Endocrinology 425 (2004):

113. In their study of performance of transsexual athletes, Louis et al. note that “[b]efore puberty, boys and girls do not differ in height, muscle and bone mass. Recent information shows convincingly that actual levels of circulating testosterone determine largely muscle mass and strength.” (425) “Testosterone exposure during puberty leads ultimately to an average greater height in men of 12–15 cm, larger bones and muscle mass, and greater strength.” (425)

H. Handelsman (2017):

114. Handelsman (2017) notes the existence of a “stable and robust” performance gap between males and females, with no narrowing “over more than three decades” (71), observing that “[i]t is well known that men’s athletic performance exceeds that of women especially in power sports because of men’s greater strength, speed and endurance. This biological physical advantage of mature males forms the basis for gender segregation in many competitive sports to allow females a realistic chance of winning events. This physical advantage in performance arises during early adolescence when male puberty commences after which men acquire larger muscle mass and greater strength, larger and stronger bones, higher circulating haemoglobin as well as mental and/or psychological differences. After completion of male puberty, circulating testosterone levels in men are consistently 10-15 times higher than in children or women at any age.” (68)

115. To illustrate, Figure 3 of Handelsman (2017) below indicates, “the age trends in hand-grip strength showed a difference in hand-grip strength commencing from the age of 12.8 years onwards (Figure 3). Prior to the age of 13 years, boys had a marginally significant greater grip strength than girls (n=45, t=2.0, P=.026), but after the age of 13 years, there was a strong significant relationship between age and difference in grip strength (n=18, r=.89, P<.001).” (70)



116. Handelsman (2017) in particular focuses on the correlation between the development of this performance gap and the progress of male adolescence and circulating testosterone levels in boys. "The strength of the present study is that it includes a wide range of swimming as well as track and field running and jumping events as well as strength for nonathletes for males and females across the ages spanning the onset of male puberty. The similar timing of the gender divergence in each of these settings to that of the rise in circulating testosterone to adult male levels strongly suggests that they all reflect the increase in muscular size and strength although the impact of other androgen-dependent effects on bone, haemoglobin and psychology may also contribute." (71-72)

117. "In this study, the timing and tempo of male puberty effects on running and jumping performance were virtually identical and very similar to those in swimming events. Furthermore, these coincided with the timing of the rise in circulating testosterone due to male puberty. In addition to the strikingly similar timing and tempo, the magnitude of the effects on performance by the end of this study was 10.0% for running and 19.3% for jumping, both consistent with the gender differences in performance of adult athletes previously reported to be 10%-12% for running and 19% for jumping." (71)

118. "In the swimming events, despite the continued progressive improvements in individual male and female event records, the stability of the gender difference over 35 years shown in this study suggests that the gender differences in performance are stable and robust." (71)

119. "The similar time course of the rise in circulating testosterone with that of the gender divergences in swimming and track and field sports is strongly suggestive that these effects arise from the increase in circulating testosterone from the start of male puberty." (71) "It

is concluded that the gender divergence in athletic performance begins at the age of 12-13 years and reaches adult plateau in the late teenage years. Although the magnitude of the divergence varies between athletic skills, the timing and tempo are closely parallel with each other and with the rise in circulating testosterone in boys during puberty to reach adult male levels." (72)

120. Handelsman (2017) notes several specific physiological effects of male levels of circulating testosterone that are relevant to athletic performance:

a. "Adult male circulating testosterone also has marked effects on bone development leading to longer, stronger and denser bone than in age-matched females." (71)

b. "A further biological advantage of adult male circulating testosterone concentrations is the increased circulating haemoglobin. Men have ~10 g/L greater haemoglobin than women with the gender differences also evident from the age of 13-14 years." (71)

121. Handelsman (2017) also observes that "exposure to adult male testosterone concentrations is likely to produce some mental or psychological effects. However, the precise nature of these remains controversial and it is not clear whether, or to what extent, this contributes to the superior elite sporting performance of men in power sports compared with the predominant effects on muscle mass and function." (71)

I. Centers for Disease Control & Prevention, "National Health Statistics Reports Number 122," CDC (2018):

122. To obtain data on height, weight, and body mass differences between men and women, I accessed the "National Health Statistics Reports Number 122" published by the

Centers for Disease Control & Prevention, at https://www.cdc.gov/nchs/data/nhsr/nhsr122-508.pdf, which is based on data through 2016.

123. The average height for a U.S. adult man is 5 feet 9 inches and for a U.S. adult woman the average height is 5 feet 4 inches. (3)

124. The average weight for a U.S. adult man is 197.8 lbs. and for a U.S. adult woman the average weight is 170.5 lbs. (6)

125. The average body mass index for a U.S. adult man is 29.1 kg/m^2, and the average body mass index for a U.S. adult woman is 29.6 kg/m^2. (3)

III. Administration of cross-sex hormones to men, or adolescent boys, after male puberty does not eliminate their performance advantage over women, or adolescent girls, in almost all athletic contests.

126. At the collegiate level, the "NCAA Policy on Transgender Student-Athlete Participation" requires only that such males be on unspecified and unquantified "testosterone suppression treatment" for "one calendar year" prior to competing in women's events.

127. Studies have demonstrated that hormone administration of testosterone suppression does not eliminate the physical advantages males have over females in athletics. Although such studies have not focused specifically on elite athletes, there is no scientific evidence or principle suggesting that the effects of hormone administration of testosterone suppression on elite athletes should be different than they are in the general population.

128. It is obvious that some effects of male puberty that confer advantages for athletic performance—in particular bone size and configuration—cannot be reversed once they have occurred.

129. In addition, some studies have now determined that other physiological advantages conferred by male puberty are also not fully reversed by later hormonal treatments

associated with gender transition. Specifically, studies have shown that the effects of puberty in males including increased muscle mass, increased bone mineral density, increased lung size, and increased heart size, are not completely reversed by suppressing testosterone secretion and administering estrogen during gender transition procedures in males.

130. For example, suppressing testosterone secretion and administering estrogen in post pubescent males does not shrink body height to that of a comparably aged female, nor does it reduce lung size or heart size. Indeed, while testosterone suppression and estrogen administration reduce the size and density of skeletal muscles, the muscles remain larger than would be expected in a typical female even when matched for body height or mass. A general tenet of exercise science is that larger muscles are stronger muscles due to larger muscles containing more contractile proteins. Thus, while gender transition procedures may impair a male's athletic potential, in my opinion it is still highly unlikely to be reduced to that of a comparably aged and trained female due to these physiological factors.

131. Supporting my opinion in this regard, at least two recent prospective studies involving substantial numbers of subjects have found that measured strength did not decrease, or decreased very little, in male-to-female subjects after a full year of hormone therapy including testosterone suppression, leaving these populations with a large strength advantage over baseline female strength.

132. I review relevant findings in more detail below.

A. Handelsman, Hirschberg, et al. (2018):

133. Handelsman et al. (2018) note that in "transgender individuals, the developmental effects of adult male circulating testosterone concentrations will have established the sex difference in muscle, hemoglobin, and bone, some of which is fixed and irreversible

(bone size) and some of which is maintained by the male circulating testosterone concentrations (muscle, hemoglobin).” (824)

134. “[D]evelopmental bone effects of androgens are likely to be irreversible.” (818)

135. With respect to muscle mass and strength, Handelsman et al. (2018) observe that suppression of testosterone in males to levels currently accepted for transgender qualification to compete in women’s events will still leave those males with a large strength advantage. “Based on the established dose-response relationships, suppression of circulating testosterone to <10 nmol/L would not eliminate all ergogenic benefits of testosterone for athletes competing in female events. For example, according to the Huang *et al.* [] study, reducing circulating testosterone to a mean of 7.3 nmol/L would still deliver a 4.4% increase in muscle size and a 12% to 26% increase in muscle strength compared with circulating testosterone at the normal female mean value of 0.9 nmol/L. Similarly, according to the Karunasena *et al*. [] study, reducing circulating testosterone concentration to 7 nmol/L would still deliver 7.8% more circulating hemoglobin than the normal female mean value. Hence, the magnitude of the athletic performance advantage in DSD athletes, which depends on the magnitude of elevated circulating testosterone concentrations, is considerably greater than the 5% to 9% difference observed in reducing levels to <10 nmol/L.” (821)

B. Gooren (2011):

136. In addition to noting that the length and diameter of bones is unchanged by post-pubertal suppression of androgens (including testosterone) (653), Gooren found that “[i]n spite of muscle surface area reduction induced by androgen deprivation, after 1 year the mean muscle surface area in male-to- female transsexuals remained significantly greater than in untreated

female-to-male transsexuals." (653) "Untreated female-to-male transsexuals" refers to biological females, who will have hormonal levels ordinarily associated with women.

137. As I have explained above, greater muscle surface area translates into greater strength assuming comparable levels of fitness.

C. Knox, Anderson, et al. (2019):

138. In their recent article, Knox et al. reviewed the physiological effects of reducing circulating testosterone levels below 10nmol/L, the level current accepted by the International Olympic Committee (IOC) (2015) guidelines as adequate to permit males to enter as women in Olympic competition.

139. Knox et al. note the unarguable fact that 10nmol/L is a far higher level of circulating testosterone than occurs in women, including elite women athletes. "Transwomen [meet IOC guidelines] to compete with testosterone levels just under 10 nmol/L. This is more than five times the upper testosterone level (1.7 nmol/L) of healthy, premenopausal elite cis-women athletes. Given that testosterone (as well as other elements stemming from Y-chromosome-dependent male physiology) provides an all-purpose benefit in sport, suggests that transwomen have a performance advantage." (398)

140. As to **bone strength**, Knox et al. report that a "recent meta-analysis shows that hormone therapy provided to transwomen over 2 years maintains bone density so bone strength is unlikely to fall to levels of cis-women, especially in an elite athlete competing and training at high intensity. Increased bone strength also translates into protection against trauma, helping with recovery and prevention of injury." (398)

141. Based on a review of multiple studies, Knox et al. report that, in addition to bone size, configuration, and strength, "hormone therapy will not alter … **lung volume or heart size**

of the transwoman athlete, especially if [that athlete] transitions postpuberty, so natural advantages including joint articulation, stroke volume and maximal oxygen uptake will be maintained." (398)

142. With respect to **muscle mass and strength**, Knox et al. found that "healthy young men did not lose significant muscle mass (or power) when their circulating testosterone levels were reduced to 8.8 nmol/L (lower than the IOC guideline of 10 nmol/L) for 20 weeks. Moreover, retention of muscle mass could be compensated for by training or other ergogenic methods. In addition, the phenomenon of muscle memory means muscle mass and strength can be rebuilt with previous strength exercise making it easier to regain muscle mass later in life even after long intervening periods of inactivity and mass loss." (398)

143. Indeed, Knox et al. observe that oestradiol—routinely administered as part of hormone therapy for transwomen—is actually known to *increase* muscle mass, potentially providing an *additional* advantage for these athletes over women. "While testosterone is the well-recognised stimulator of muscle mass gain, administration of oestradiol has also been shown to activate muscle gain via oestrogen receptor-β activation. The combination of oestradiol therapy and a baseline testosterone of 10 nmol/L arguably provides transwomen athletes with an added advantage of increased muscle mass, and therefore power." (398)

144. Summing up these facts, Knox et al. observe: "A transwoman athlete with testosterone levels under 10 nmol/L for 1 year will retain at least some of the physiological parameters that underpin athletic performance. This, coupled with the fact that [under IOC rules] transwomen athletes are allowed to compete with more than five times the testosterone level of a cis-woman, suggests transwomen have a performance advantage." (398) Indeed, considering the magnitude of the advantages involved, Knox et al. conclude that the physiological advantages

resulting from male puberty that are not negated by post-pubertal hormonal therapy "provide a strong argument that transwomen have an intolerable advantage over cis-women." (399)

D. Gooren & Bunck (2004):

145. Measuring the concrete significance of the fact that bone size and configuration cannot be changed after puberty, Gooren and Bunk reported that "[Male-to-female transsexuals] were on average 10.7 cm taller (95% CI 5.4–16.0 cm) than [female-to-male transsexuals] (7)." (427)

146. With respect to muscle mass, Gooren and Bunk reported what other authors have since described in more detail: "After 1 year of androgen deprivation, mean muscle area in [male-to-female transsexuals] had decreased significantly but remained significantly greater than in [female-to-male transsexuals] before testosterone treatment." (427) To be clear, female-to-male transsexuals "before testosterone treatment" are biological females with natural female hormone levels.

> "The conclusion is that androgen deprivation in [male-to-female transsexuals] increases the overlap in muscle mass with women but does not reverse it, statistically." (425) In other words, for the overall sample of 19 male-to female transsexuals, before ("306.9 ± 46.5 cm^2") and after ("277.8 ± 37.0 cm^2") 1 year of cross-sex hormone administration these subjects had statistically significantly more muscle mass than the 17 untreated females ("238.8 ± 33.1 cm^2") (427). Before treatment, an unstated number of male-to-female transsexuals on the low end of the range for muscle mass in this sample were similar to an unstated number of untreated females on the high end of the range for muscle mass. As the muscle mass decreased in male-to-female transsexuals due to cross-sex hormone treatment there were an unstated number of male-to-female subjects whose

muscle mass was similar to the untreated women on the high end of the range for muscle mass. But, the overlap in muscle mass between male-to-female and untreated female subjects was insufficient to alter the statistical analysis.

147. Gooren and Bunk provide an insightful conclusion regarding whether it is fair for male-to-female transgender individuals to compete with biological females "The question of whether reassigned M–F can fairly compete with [biological] women depends on what degree of arbitrariness one wishes to accept". (425)

E. Wiik et al. (2020):

148. Taking measurements one month after start of testosterone-suppression in male-to-female subjects, and again 3 and 11 months after start of feminizing hormone replacement therapy in these subjects, Wiik et al. found that total lean tissue (i.e. primarily muscle) did not decrease significantly across the entire period. And even though they observed a small decrease in thigh muscle mass, they found that isometric strength levels measured at the knee "were maintained over the [study period]." (e808) "At T12 [the conclusion of the one-year study], the absolute levels of strength and muscle volume were greater in [male-to-female subjects] than in [female-to-male subjects] and CW [women who had not undergone any hormonal therapy]." (e808)

149. While female-to-male subjects "experienced robust changes in lower-limb muscle mass and strength" after 11 months of testosterone injection (e812), even after the female-to-male subjects had undergone testosterone injection, and the male-to-female subjects had undergone testosterone suppression and feminizing hormone replacement therapy, the male-to-female subjects "still had larger muscle volumes and quadriceps area" (e811).

150. In other words, biologically male subjects remained stronger than biologically female subjects after undergoing a year of testosterone suppression, and even remained stronger than biologically female subjects who had undergone 11 months of testosterone-driven "robust" increases in muscle mass and strength. I note that outside the context of transgender athletes, the testosterone-driven increase in strength enjoyed by these female-to-male subjects would constitute a disqualifying doping violation under all league anti-doping rules with which I am familiar.

F. Scharff et al. (2019):

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

152. As further evidence that male-to-female transgender treatment does not negate the inherent athletic performance advantages of a post-pubertal male, I present race times for the well-publicized sports performance of Cece Telfer. In 2016 and 2017 Cece Telfer competed as Craig Telfer on the Franklin Pierce University men's track team being ranked 200th and 390th (respectively) against other NCAA Division 2 men and did not qualify for the National Championships in any events. Cece Telfer did not compete in the 2018 season while undergoing male-to-female transgender treatment (per NCAA policy). In 2019 Cece Telfer competed on the

Franklin Pierce University women's team, qualified for the NCAA Division 2 Track and Field National Championships, and placed 1st in the women's 400 meter hurdles and placed third in the women's 100 meter hurdles. (for examples of the media coverage of this please see https://www.washingtontimes.com/news/2019/jun/3/cece-telfer-franklin-pierce-transgender-hurdler-wi/ last accessed May 29, 2020. https://www.newshub.co.nz/home/sport/2019/06/athletics-transgender-woman-cece-telfer-who-previously-competed-as-a-man-wins-ncaa-track-championship.html last accessed May 29, 2020.)

153. The table below shows the best collegiate performance times from the combined 2015 and 2016 seasons for Cece Telfer when competing as a man (Craig Telfer) in men's events, and the best collegiate performance times from the 2019 season when competing as a woman in women's event. Comparing the times for the running events (in which male and female athletes run the same distance) using a two tailed paired sample test there is no statistical difference (P=0.51) between the times. Calculating the difference in time between the male and female times for the best performances in the same running events and dividing that difference by the male performance times, as a female Cece Telfer performed an average of 0.22% *faster* as a female. (Comparing the performance for the hurdle events (marked with H) is of questionable validity due to differences between men's and women's events in hurdle heights and spacing, and distance for the 110m vs. 100 m.) While this is simply one example, and does not represent a controlled experimental analysis, this information provides some evidence that male-to-female transgender treatment does not negate the inherent athletic performance advantages of a post-pubertal male. (these times were obtained from https://www.tfrrs.org/athletes/6994616/Franklin_Pierce/CeCe_Telfer.html and https://www.tfrrs.org/athletes/5108308.html, last accessed May 29, 2020)

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

* women's 3rd place, NCAA Division 2 National Championships
** women's 1st place, NCAA Division I2 National Championships
† men's hurdle height is 42 inches with differences in hurdle spacing between men and women
‡ men's hurdle height is 36 inches, women's height is 30 inches with the same spacing between hurdles

G. Johanna Harper. (2015):

154. This article is oft cited as evidence supporting a lack of performance advantage for male-to-female transgender athletes (*for an example see the Expert Declaration by Joshua D. Safer, MD, FACP, FACE. Case 1:20-cv-00184-CWD Document 22-9, point 51*). This article purports to show that male-to-female transgender distance runners do not retain post-pubertal athletic advantages over biological females. However, this paper has numerous methodical shortcomings rendering the data and conclusions to be of little to no scientific validity. Herein I provide a detailed critique of a number of the methodical shortcomings of this paper.

155. Of major concern is that the paper does not mention any type of approval from a research ethics committee, documentation of informed consent from the participants, or otherwise state that the study was conducted in accordance with the ethical principles of the World Medical Association Declaration of Helsinki, which raises the specter of overall ethical concerns with this paper (This may simply be an oversight on the part of the journal in not

requiring such a statement, but such an oversight is very unusual given the publication date of 2015). As the data were gathered with the intent of contributing to the scientific knowledge, and there was interaction between the researcher and the subjects with exchange of identifiable and sensitive information, Institutional Review Board approval and documentation of consent are necessary for this type of project.

156. The author states that "The first problem is how to formulate a study to create a meaningful measurement of athletic performance, both before and after testosterone suppression. No methodology has been previously devised to make meaningful measurements." (2) This statement is not correct as there are innumerable publications with validated methodology for comparing physical fitness and/or athletic performance between people of different ages, sexes (some of which have previously been discussed), medical conditions, and before and after medical treatment, any of which could easily have been used with minimal or no adaptation for the purposes of this study (many even before the initiation of the Harper study, which apparently started in 2006).

157. The overall methods as explained within the manuscript are of limited scientific validity and reliability, starting with subject recruitment. The author states "The collection process consisted of seeking out female transgender distance runners, mostly online, and then asking them to submit race times. Even in 2014 few people are open about being transgender, so the submission of race times represented a large leap of faith for the participants." (3) There is no further information regarding how the subjects were recruited (i.e. sampling techniques). Furthermore, based on this description of sampling techniques there is no way to know if these 8 subjects are in any way representative of any population of men, women, or transgender individuals, and especially the overall transgender distance running population. For example,

what websites were used to identify possible subjects? How were the subjects solicited to participate? Was any compensation or coercion offered to the subjects? What inclusion or exclusion criteria were used in subject selection? How were the subjects who were not recruited online identified and enrolled into the research? How many were recruited online vs. not online? Furthermore, no indication is given if the subjects have undergone only hormone treatment, surgical treatment, or both. Furthermore, there is no indication of any verification of testosterone concentrations, compliance with hormone treatments, or other relevant endocrine or transgender treatment information. Lastly, no descriptive data are provided for the subjects' body height, body mass, or other relevant anthropometric characteristics.

158. Similar to the sampling techniques the methods for collecting race times are lacking in validity, reliability, or detailed description. The author states "Race times from eight transgender women runners were collected over a period of seven years and, when possible, verified." And "When possible, race times were then verified using online services listing race results. For six of the eight runners, online checking made it possible to verify approximately half of the submitted times. Two of the subjects, runners three and four, would only participate anonymously, creating an ethical dilemma over the use of their times, versus respect their privacy." (3) No further information regarding which race times were verified is presented, thus the verified race times could be only pre-transition, only post transition, all coming from 3 of the subjects, or some combination thereof. The validity and reliability of self-reported data are overall very questionable, which the author acknowledges by stating "The times submitted by the eight runners were self-selected and self-reported. The self- reporting by the subjects certainly affects the strength of the findings. As mentioned previously, almost half of the race times were double checked by the author for accuracy. None of the subjects incorrectly reported any result"

(6). However, verifying "almost half" of the race times does not validate the other "almost half." The author does not state which race times the runners were asked to self-report (i.e. these could have been the slowest times as a man and the fastest times as a woman, or vice versa. Or the reported races time could be some form of non-representative sample of the subjects' race times). As some of the data represent a span of 29 years between reported race times, and the mean time between reported race times is 7.3 ± 8.4 years the accuracy of the non-verified self-reported race times are very questionable [The means ± sd are not presented in the paper; they were calculated by the author of this declaration]. The author further states that only three of the pairs of race times "were run over the same course within three years' time and represent the best comparison points" (5) (i.e. Runner No. 4 provided one pair of pre-post transition 5K times, Runner No. 6 provided one pair of pre-post transition 10K times, and Runner No 6 provided one pair of pre-post transition Half-marathon times). Runner No 4 was one of the previously described "ethical dilemma" (3) subjects with no verified race times. Once again, it is not stated if any of "the best comparison points" (5) represents verified data. Furthermore, while the race may have been run over the same course, no mention of environmental conditions for the comparison performance is made. To put this in perspective, the 2018 Boston Marathon was run in rain and headwinds resulting in a men's winning time of 2:15:54 (the slowest time since 1976) and a women's winning time of 2:39:54 (the slowest time for a women's winner since 1978). To help further illustrate the challenges in year to year comparison of race time that may be exacerbated by weather, in 2017 the men's winning time for the Boston Marathon was 2:09:37 and the women's winning time was 2:21:52.

159. The author notes that "both runner two and runner six reported stable training patterns over this time range" (5), but once again, there is no indication of how these data were

collected or verified. Furthermore, what does a "stable training pattern mean"? Is it mileage, or pace, or combination of training techniques? This also further illustrates the methodological weaknesses in the study as runner two did not provide times for the "same course within three years' time", which, to quote the author "represent the best comparison points".

160. There is no experimental control for, or mention of, habitual nutrition, pre-event or during-event nutrition, any which (especially hydration and carbohydrate intake) can have a major impact on the outcome of endurance competition.

161. The description of the statistical analysis is insufficient. The author states that "Two tailed t tests were run on both the mean and peak AGs." (5) This is an ambiguous statement. Typically an author would report what kind of t-test was performed. Were these paired sample t-tests, independent sample t-tests, or one-sample t-tests?

162. Despite these methodological shortcomings, the author makes some insightful statements in the discussion. In the discussion section of the paper the author states "Transgender women are taller and larger, on average, than 46,XX women [], and these differences probably would result in performance advantages in events in which height and strength are obvious precursors to success" (7). The author further reasonably states that "It should be noted that this conclusion only applies to distance running and the author makes no claims as to the equality of performances, pre and post gender transition, in any other sport. As such, the study cannot, unequivocally, state that it is fair to allow transgender women to compete against 46,XX women in all sports…" to which the author adds "…although the study does make a powerful statement in favor of such a position."(8) This latter statement cannot be supported based on the data contained in this paper or any presently known research.

Conclusion

163. Once again, based on my professional familiarity with exercise physiology and my review of the currently available science, including that contained in the sources I cite and summarize in this declaration, and the competition results and records presented here, I offer three primary professional opinions:

a. At the level of elite, sub elite, high school, and recreational competition, men or boys have an advantage over comparably aged women or girls, in almost all athletic contests;

b. Biological male physiology and anatomy is the basis for the performance advantage that men or boys have over women or girls, in almost all athletic contests; and

c. Administration of androgen inhibitors and cross-sex hormones to men, or adolescent boys, after male puberty, and administration of testosterone to women or adolescent girls, after female puberty, does not eliminate the performance advantage of men or adolescent boys over women or adolescent girls in almost all athletic contests.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed this 3rd day of June, 2020.

/s/ Gregory A. Brown
Professor Gregory A. Brown, Ph.D.

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on June 4, 2020, I electronically filed the foregoing with the Clerk of the Court using the CM/ECF system which sent a Notice of Electronic Filing to the following persons:

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ATTACHMENT

EXPERT DECLARATION OF
GREGORY A. BROWN, Ph.D. FACSM
Hecox, et al. v. Little, et al.
Case No. 1:20-cv-00184-DCN

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Academic Preparation

Doctor of Philosophy, Iowa State University. August 2002 -- Major in Health and Human Performance, Emphasis in the Biological Bases of Physical Activity, dissertation title: "Androgenic supplementation in men: Effects of age, herbal extracts, and mode of delivery."

Master of Science, Iowa State University, May 1999 -- Major in Exercise and Sport Science, Emphasis in Exercise Physiology, thesis title: "Oral anabolic-androgenic supplements during resistance training: Effects on glucose tolerance, insulin action, and blood lipids."

Bachelor of Science, Utah State University, June 1997 -- Major in Physical Education, Emphasis in Pre-physical Therapy.

Awards

College of Education Outstanding Faculty Teaching Award. University of Nebraska at Kearney 2019

Mortar Board Faculty Excellence Honors. Xi Phi Chapter, University of Nebraska at Kearney, Honored in 2006, 2007, 2008, 2012, 2013, 2015, and 2019

Profiled in New Frontiers, the University of Nebraska Kearney annual publication highlighting excellence in research, scholarship, and creative activity. 2009, 2017

College of Education Outstanding Scholarship / Research Award. University of Nebraska at Kearney 2009, 2014

College of Education Award for Faculty Mentoring of Undergraduate Student Research University of Nebraska at Kearney, 2007, 2010, & 2013

"Pink Tie" award from the Susan G. Komen Nebraska Affiliate, for outstanding service to the Central Nebraska Race for the Cure, 2013

Star Reviewer for the American Physiological Society and Advances in Physiology Education. 2010.

Fellow of the American College of Sports Medicine. Awarded April 23, 2008

UNK Senior Appreciation Program honoree, the University of Nebraska at Kearney

Iowa State University Research Excellence Award, Iowa State University, 2002

The Zaffarano Prize for Graduate Student Research, Iowa State University, 2002

Helen Hilton Lebaron Excellence in Research Award, Dept. of Health and Human Performance, Iowa State University, 2002

Best Paper Award, 2nd Annual Education Research Exchange. Iowa State University Education Research Exchange, 2001

Helen Hilton Lebaron Excellence in Research Award, Dept. of Health and Human Performance, Iowa State University, 2000

Professional Experience

Professor: University of Nebraska Kearney, Dept. of Kinesiology and Sport Sciences (2012-)

Associate Professor: University of Nebraska Kearney, HPERLS Dept. (2007-2012)

Assistant Professor: University of Nebraska Kearney, HPERLS Dept. (2004- 2007) Full Graduate Faculty status awarded on hire, 2004

Assistant Professor: Georgia Southern University, Jiann-Ping Hsu School of Public Health. (2002-2004) Full Graduate Faculty status awarded Nov. 26, 2002

Laboratory Director: Human Performance Laboratory, Georgia Southern University, Jiann-Ping Hsu School of Public Health. (2002-2004)

Research Assistant: Exercise Biochemistry and Physiology Laboratory, Iowa State University, Department of Health and Human Performance. (1997-2002)

Graduate Teaching Assistant: Iowa State University, Department of Health and Human Performance. (1997-2002)

Temporary Instructor: Iowa State University, Department of Health and Human Performance. (1999-2002)

Temporary Adjunct Faculty: Des Moines Area Community College. (2000)

Undergraduate Teaching Intern: Department of Biology, Utah State University. (1995-1996)

Refereed Publications

1. 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.
2. 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
3. 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.
4. 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

5. 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
6. 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
7. 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 & Physiology Students. Int J Kines Higher Educ 27(1) 16-22, 2016
8. Shaw BS, Shaw I, & Brown GA. Resistance Exercise is Medicine. Int J Ther Rehab. 22: 233-237, 2015.
9. Brown GA, Bice MR, Shaw BS, & Shaw I. Online Quizzes Promote Inconsistent Improvements on In-Class Test Performance in Introductory Anatomy & Physiology. Adv. Physiol. Educ. 39: 63-6, 2015
10. Brown GA, Heiserman K, Shaw BS, & Shaw I. Rectus abdominis and rectus femoris muscle activity while performing conventional unweighted and weighted seated abdominal trunk curls. Medicina dello Sport. 68: 9-18. 2015
11. Botha DM, Shaw BS, Shaw I & Brown GA. Role of hyperbaric oxygen therapy in the promotion of cardiopulmonary health and rehabilitation. African Journal for Physical, Health Education, Recreation and Dance (AJPHERD). Supplement 2 (September), 20: 62-73, 2014
12. Abbey BA, Heelan KA, Brown, GA, & Bartee RT. Validity of HydraTrend™ Reagent Strips for the Assessment of Hydration Status. J Strength Cond Res. 28: 2634-9. 2014
13. Scheer KC, Siebrandt SM, Brown GA, Shaw BS, & Shaw I. Wii, Kinect, & Move. Heart Rate, Oxygen Consumption, Energy Expenditure, and Ventilation due to Different Physically Active Video Game Systems in College Students. International Journal of Exercise Science: 7: 22-32, 2014
14. Shaw BS, Shaw I, & Brown GA. Effect of concurrent aerobic and resistive breathing training on respiratory muscle length and spirometry in asthmatics. African Journal for Physical, Health Education, Recreation and Dance (AJPHERD). Supplement 1 (November), 170-183, 2013
15. Adkins M, Brown GA, Heelan K, Ansorge C, Shaw BS & Shaw I. Can dance exergaming contribute to improving physical activity levels in elementary school children? African Journal for Physical, Health Education, Recreation and Dance (AJPHERD). 19: 576-585, 2013
16. Jarvi MB, Brown GA, Shaw BS & Shaw I. Measurements of Heart Rate and Accelerometry to Determine the Physical Activity Level in Boys Playing Paintball. International Journal of Exercise Science: 6: 199-207, 2013
17. Brown GA, Krueger RD, Cook CM, Heelan KA, Shaw BS & Shaw I. A prediction equation for the estimation of cardiorespiratory fitness using an elliptical motion trainer. West Indian Medical Journal. 61: 114-117, 2013.

18. Shaw BS, Shaw I, & Brown GA. Body composition variation following diaphragmatic breathing. African Journal for Physical, Health Education, Recreation and Dance (AJPHERD). 18: 787-794, 2012.

19. Shaw I, Shaw BS, & Brown GA. Concurrent Training and Pulmonary Function in Smokers. Int J Sports Med. 32:776-80, 2011

20. Nienhueser J, Brown, GA, Shaw BS & I Shaw. Effects of Energy Drinks on Metabolism at Rest and During Submaximal Treadmill Exercise in College Age Males. Int J Exerc Sci 4: 321-332, 2011

21. Shaw I, Shaw BS, & Brown GA. Relationship between Resistance Training and Self-Reported Habitual Nutrient Intake. South African Journal for Research in Sport, Physical Education and Recreation. 32: 109-116, 2010

22. Brown GA, Swendener AM, Shaw I, & Shaw BS. Comparison of anthropometric and metabolic responses to a short term carbohydrate restricted diet and exercise versus a traditional diet and exercise. African Journal for Physical, Health Education, Recreation and Dance (AJPHERD). 16: 535-544, 2010

23. Brown GA, Ray M, Abbey BA, Shaw BS, & Shaw I. Oxygen Consumption, Heart Rate and Blood Lactate Responses to an Acute Bout of Plyometric Depth Jumps in College Aged Men and Women. J Strength Cond Res. 24:275-82. 2010

24. Shaw I, Shaw BS, Brown GA, & Cilliers JF. Concurrent Resistance and Aerobic Training as Protection against Heart Disease. Cardiovasc J Afr 21: 196-199, 2010

25. Brown GA, Cook CM, Krueger RD, & Heelan KA Comparison of energy expenditure on a treadmill vs. an elliptical device at a self-selected exercise intensity. J Str Cond Res 24:1643-9, 2010

26. Shaw I, Shaw BS, & Brown GA. Role of Diaphragmatic Breathing and Aerobic Exercise in Improving Maximal Oxygen Consumption in Asthmatics. Science & Sports 25:139-145, 2010

27. Shaw I, Shaw BS, & Brown GA. Comparison of Resistance and Concurrent Resistance and Endurance Training Regimes in the Development of Strength. J Str Cond Res. 23: 2507-2514, 2009

28. Castell LM, Burke LM, Stear SJ, Wolfe RR, Newsholme EA, Trudeau F, Curi R, Brown GA, Vukovich MD, and DS King. BJSM reviews: A–Z of supplements: dietary supplements, sports nutrition foods and ergogenic aids for health and performance Part 2. Br. J. Sports Med. 43:807-810. 2009

29. Shaw BS, Shaw I, & Brown GA. Resistance Training and its Effect on Total, Central and Abdominal Adiposity. South African Journal for Research in Sport, Physical Education and Recreation. 31: 97-108. 2009

30. Shaw I, Shaw BS, & Brown GA. Influence of Strength Training on Cardiac Risk Prevention in Individuals without Cardiovascular Disease. African Journal for Physical, Health Education, Recreation and Dance (AJPHERD). 15: 424-432. 2009

31. Shaw BS, Shaw I, & Brown GA. Resistance Training and Predicted Risk of Coronary Heart Disease in Sedentary Males. African Journal for Physical, Health Education, Recreation and Dance (AJPHERD). Supplement: 247-257. 2009
32. Stahlnecker IV AC, Brown GA, Shaw BS, & Shaw I. Acute Effects of a Weight Loss Supplement on Resting Metabolic Rate and Anaerobic Exercise Performance. African Journal for Physical, Health Education, Recreation and Dance (AJPHERD). Supplement: 237-247. 2009
33. McWha JA, Horst S, Brown GA, Shaw I, & Shaw BS. Metabolic Changes Associated with Playing an Active Video Game Against a Human and Computer Opponent. African Journal for Physical, Health Education, Recreation and Dance (AJPHERD). Supplement: 219-228. 2009
34. Semin K, Stahlnecker IV AC, Heelan KA, Brown GA, Shaw BS, & Shaw I. Discrepancy between Training, Competition and Laboratory Measures of Maximum Heart Rate in NCAA Division 2 Distance Runners. J Sports Sci & Med. 7: 455 – 460, 2008
35. Brown GA, Rebok MP, Scott ML, Harris III J, Colaluca MK, Shaw I, & Shaw BS. Physiological and Biomechanical Responses of Running with and Without a Stroller. African Journal for Physical, Health Education, Recreation and Dance (AJPHERD). 14: 240-249, 2008
36. Brown GA, McFarland SP, Ray MW, Abbey BM, Shaw I, & Shaw BS. A Single Session of Brisk Walking Does Not Alter Blood Glucose Homeostasis in Overweight Young Men. African Journal for Physical, Health Education, Recreation and Dance (AJPHERD). 14: 250-264, 2008
37. Brown GA, Lynott F, & Heelan KA. A Service Learning Model for Teaching Fitness Assessment and Research Techniques to Undergraduate Exercise Science Students. Adv Physiol Educ. 32: 212-218, 2008
38. Carstensen C, Brown GA, Shaw I, & Shaw BS. Freely-Paced Walking in Healthy Adults Does Not Meet Minimum Intensity Guidelines for Health Improvement. African Journal for Physical, Health Education, Recreation and Dance (AJPHERD), 14: 178-187, 2008
39. Shaw BS, Shaw I, and Brown GA. Self-Reported Dietary Intake Following Endurance, Resistance And Concurrent Endurance And Resistance Training. J Sports Sci & Med 7: 255-259, 2008
40. Brown, GA. Teaching skeletal muscle adaptations to aerobic exercise using an APS classic paper by Dr. Philip Gollnick and colleagues. Adv Physiol Educ. 30: 113-118, 2006
41. Brown GA, Vukovich MD, & King DS. Testosterone Prohomone Supplements. Med. Sci. Sports Exerc. Med Sci Sports Exerc. 38: 1451-1461, 2006
42. Brown GA, & MacKenzie D. Resistance Exercise Does Not Change The Hormonal Response To Sublingual Androstenediol. Eur J Appl Physiol. 97:404-412, 2006
43. Brown GA, Vukovich MD, and King DS. Urinary excretion of steroid metabolites following chronic androstenedione ingestion. J. Clin. Endocrinol. Metab. 12:6235 – 6338, 2004

44. Brown GA, Dewey JC, Brunkhorst J, Vukovich MD, & King DS. Changes in serum testosterone and estradiol concentrations following acute androstenedione ingestion in young women. Horm Metab Res. 1:62-66, 2004

45. Kohut ML, Thompson JR, Campbell J, Brown GA, Vukovich MD, Jackson DA, & King DS. Ingestion of a Dietary Supplement Containing Dehydroepiandrosterone (DHEA) and Androstenedione Has Minimal Effect on Immune Function in Middle-Aged Men. J Am Coll Nutr. 22: 363-71, 2003

46. Brown GA, Martini ER, Roberts BS, Vukovich MD, & King DS. Acute hormonal responses to sublingual androstenediol intake in young men. J Appl Physiol. 92: 142-146, 2002.

47. Brown GA, Vukovich MD, Martini ER, Kohut ML, Franke WL, Jackson DA, & King DS. Effects of androstenedione-herbal supplements on serum sex hormone concentrations in 30-59 year old men. Int J Vitam Nutr Res. 71: 293-301, 2001

48. Brown GA, Vukovich MD, Martini ER, Kohut ML, Franke WL, Jackson DA, & King DS. Endocrine and lipid responses to chronic androstenediol-herbal supplementation in 30 to 58 year old men. J Am Coll Nutr. 20: 520-528, 2001.

49. Brown GA, Vukovich MD, Martini ER, Kohut ML, Franke ML, Jackson DA, & King DS. Endocrine response to chronic androstenedione intake in 30-56 year old men. J Clin Endocrinol Metab. 85: 4074-4080, 2000.

50. Brown GA, Vukovich MD, Reifenrath TA, Uhl NL, Parsons KA, Sharp RL, & King DS. Effects of anabolic precursors on serum testosterone concentrations and adaptations to resistance training in young men. Int J Sport Nutr Exerc Metab. 10: 342-362, 2000.

51. Brown GA, Vukovich MD, Sharp RL, Reifenrath TA, Parsons KA, & King DS. Effect of oral DHEA on serum testosterone and adaptations to resistance training in young men. J Appl Physiol. 87: 2274-2283, 1999.

52. King DS, Sharp RL, Vukovich MD, Brown GA, Reifenrath TA, Uhl NL, & Parsons KA. Effect of oral androstenedione on serum testosterone and adaptations to resistance training in young men: a randomized controlled trial. JAMA. 281: 2020-2028, 1999.

Refereed Presentations

1. Brown GA, Jackson B, Szekely B, Schramm T, Shaw BS, Shaw I. A Pre-Workout Supplement Does Not Improve 400 M Sprint Running or Bicycle Wingate Test Performance in Recreationally Trained Individuals. Med Sci Sport Exerc. 50(5), 2932. 65th Annual Meeting of the American College of Sports Medicine. Minneapolis, MN. June 2018.

2. Paulsen SM, Brown GA. Neither Coffee Nor A Stimulant Containing "Pre-workout" Drink Alter Cardiovascular Drift During Walking In Young Men. Med Sci Sport Exerc. 50(5), 2409. 65th Annual Meeting of the American College of Sports Medicine. Minneapolis, MN. June 2018.

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

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

5. Bongers M, Abbey BM, Heelan K, Steele JE, Brown GA. Nutrition Education Improves Nutrition Knowledge, Not Dietary Habits In Female Collegiate Distance Runners. Med Sci Sport Exerc. 49(5), 389. 64th Annual Meeting of the American College of Sports Medicine. Denver, CO. May 2017.

6. Brown GA, Steele JE, Shaw I, Shaw BS. Using Elisa to Enhance the Biochemistry Laboratory Experience for Exercise Science Students. Med Sci Sport Exerc. 49(5), 1108. 64th Annual Meeting of the American College of Sports Medicine. Denver, CO. May 2017.

7. Brown GA, Shaw BS, and Shaw I. Effects of a 6 Week Conditioning Program on Jumping, Sprinting, and Agility Performance In Youth. Med Sci Sport Exerc. 48(5), 3730. 63rd Annual Meeting of the American College of Sports Medicine. Boston, MA. June 2016.

8. Shaw I, Shaw BS, Boshoff VE, Coetzee S, and Brown GA. Kinanthropometric Responses To Callisthenic Strength Training In Children. Med Sci Sport Exerc. 48(5), 3221. 63rd Annual Meeting of the American College of Sports Medicine. Boston, MA. June 2016.

9. Shaw BS, Shaw I, Gouveia M, McIntyre S, and Brown GA. Kinanthropometric Responses To Moderate-intensity Resistance Training In Postmenopausal Women. Med Sci Sport Exerc. 48(5), 2127. 63rd Annual Meeting of the American College of Sports Medicine. Boston, MA. June 2016.

10. Bice MR, Cary JD, Brown GA, Adkins M, and Ball JW. The use of mobile applications to enhance introductory anatomy & physiology student performance on topic specific in-class tests. National Association for Kinesiology in Higher Education National Conference. January 8, 2016.

11. Shaw I, Shaw BS, Lawrence KE, Brown GA, and Shariat A. Concurrent Resistance and Aerobic Exercise Training Improves Hemodynamics in Normotensive Overweight and Obese Individuals. Med Sci Sport Exerc. 47(5), 559. 62nd Annual Meeting of the American College of Sports Medicine. San Diego, CA. May 2015.

12. Shaw BS, Shaw I, McCrorie C, Turner S., Schnetler A, and Brown GA. Concurrent Resistance and Aerobic Training in the Prevention of Overweight and Obesity in Young Adults. Med Sci Sport Exerc. 47(5), 223. 62nd Annual Meeting of the American College of Sports Medicine. San Diego, CA. May 2015.

13. Schneekloth B, Shaw I, Shaw BS, and Brown GA. Physical Activity Levels Using Kinect™ Zumba Fitness versus Zumba Fitness with a Human Instructor. Med Sci Sport Exerc. 46(5), 326. 61st Annual Meeting of the American College of Sports Medicine. Orlando, FL. June 2014.

14. Shaw I, Lawrence KE, Shaw BS, and Brown GA. Callisthenic Exercise-related Changes in Body Composition in Overweight and Obese Adults. Med Sci Sport Exerc. 46(5), 394. 61st Annual Meeting of the American College of Sports Medicine. Orlando, FL June 2014.

15. Shaw BS, Shaw I, Fourie M, Gildenhuys M, and Brown GA. Variances In The Body Composition Of Elderly Woman Following Progressive Mat Pilates. Med Sci Sport Exerc. 46(5), 558. 61st Annual Meeting of the American College of Sports Medicine. Orlando, FL June 2014.
16. Brown GA, Shaw I, Shaw BS, and Bice M. Online Quizzes Enhance Introductory Anatomy & Physiology Performance on Subsequent Tests, But Not Examinations. Med Sci Sport Exerc. 46(5), 1655. 61st Annual Meeting of the American College of Sports Medicine. Orlando, FL June 2014.
17. Kahle, A. and Brown, G.A. Electromyography in the Gastrocnemius and Tibialis Anterior, and Oxygen Consumption, Ventilation, and Heart Rate During Minimalist versus Traditionally Shod Running. 27th National Conference on Undergraduate Research (NCUR). La Crosse, Wisconsin USA. April 11-13, 2013
18. Shaw, I., Shaw, B.S., and Brown, G.A. Resistive Breathing Effects on Pulmonary Function, Aerobic Capacity and Medication Usage in Adult Asthmatics Med Sci Sports Exerc 45 (5). S1602 2013. 60th Annual Meeting of the American College of Sports Medicine, Indianapolis, IN USA, May 26-30 3013
19. Shaw, B.S. Gildenhuys, G.A., Fourie, M. Shaw I, and Brown, G.A. Function Changes In The Aged Following Pilates Exercise Training. Med Sci Sports Exerc 45 (5). S1566 60th Annual Meeting of the American College of Sports Medicine, Indianapolis, IN USA, May 26-30 2013
20. Brown, G.A., Abbey, B.M., Ray, M.W., Shaw B.S., & Shaw, I. Changes in Plasma Free Testosterone and Cortisol Concentrations During Plyometric Depth Jumps. Med Sci Sports Exerc 44 (5). S598, 2012. 59th Annual Meeting of the American College of Sports Medicine. May 29 - June 2, 2012; San Francisco, California
21. Shaw, I., Fourie, M., Gildenhuys, G.M., Shaw B.S., & Brown, G.A. Group Pilates Program and Muscular Strength and Endurance Among Elderly Woman. Med Sci Sports Exerc 44 (5). S1426. 59th Annual Meeting of the American College of Sports Medicine. May 29 - June 2, 2012; San Francisco, California
22. Shaw B.S., Shaw, I., & Brown, G.A. Concurrent Inspiratory-Expiratory and Aerobic Training Effects On Respiratory Muscle Strength In Asthmatics. Med Sci Sports Exerc 44 (5). S2163. 59th Annual Meeting of the American College of Sports Medicine. May 29 - June 2, 2012; San Francisco, California
23. Scheer, K., Siebrandt, S., Brown, G.A, Shaw B.S., & Shaw, I. Heart Rate, Oxygen Consumption, and Ventilation due to Different Physically Active Video Game Systems. Med Sci Sports Exerc 44 (5). S1763. 59th Annual Meeting of the American College of Sports Medicine. May 29 - June 2, 2012; San Francisco, California
24. Jarvi M.B., Shaw B.S., Shaw, I., & Brown, G.A. (2012) Paintball Is A Blast, But Is It Exercise? Heart Rate and Accelerometry In Boys Playing Paintball. Med Sci Sports Exerc 44 (5). S3503. 59th Annual Meeting of the American College of Sports Medicine. May 29 - June 2, 2012; San Francisco, California
25. Shaw, I., Shaw, B.S., and Brown G.A. Effort-dependent Pulmonary Variable Improvements Following A Novel Breathing Retraining Technique In Asthmatics. Med Sci Sports Exerc

43 (5). S617, 2011. 58th Annual Meeting of the American College of Sports Medicine. May 31-June 4, 2011 Denver, Colorado

26. Brown G.A. Shaw, B.S., and Shaw, I. Exercise and a Low Carbohydrate Diet Reduce Body Fat but Not PYY and Leptin Concentrations. Med Sci Sports Exerc 43 (5). S4627, 2011. 58th Annual Meeting of the American College of Sports Medicine. May 31-June 4, 2011 Denver, Colorado
27. Shaw, B.S., Shaw, I, and Brown G.A. Pulmonary Function Changes In Response To Combined Aerobic And Resistance Training In Sedentary Male Smokers. Med Sci Sports Exerc 43 (5). S492, 2011. 58th Annual Meeting of the American College of Sports Medicine. May 31-June 4, 2011 Denver, Colorado
28. Heiserman, K., Brown G.A., Shaw, I., and Shaw, B.S. Seated Weighted Abdominal Exercise Activates the Hip Flexors, But Not Abdominals, More Than Unweighted Crunches. A Med Sci Sports Exerc 43 (5). S277, 2011 58th Annual Meeting of the American College of Sports Medicine. May 31-June 4, 2011 Denver, Colorado
29. Brown, G.A., Nienhueser, J., Shaw, I., and Shaw, B.S. Energy Drinks Alter Metabolism at Rest but not During Submaximal Exercise in College Age Males. Med Sci Sports Exerc. 42 (5): S1930. 57th Annual Meeting American College of Sports Medicine, June 1-5, 2010. Baltimore, MD
30. Shaw, I, Shaw, B.S., and Brown G.A. Abdominal and Chest Wall Compliance in Asthmatics: Effects of Different Training Modes. Med Sci Sports Exerc. 42 (5): S1588. 57th Annual Meeting American College of Sports Medicine, June 1-5, 2010. Baltimore, MD.
31. Shaw, B.S., Shaw, I, and Brown G.A. Exercise Effects on Lipoprotein Lipids in the Prevention of Cardiovascular Disease in Sedentary Males Smokers. Med Sci Sports Exerc. 42 (5): S1586. 57th Annual Meeting American College of Sports Medicine, June 1-5, 2010. Baltimore, MD.
32. Brown, G.A. Collaborative Research at a Primarily Undergraduate University. Med Sci Sports Exerc. 42 (5): S424. 57th Annual Meeting American College of Sports Medicine, June 1-5, 2010. Baltimore, MD.
33. Nienhueser, J., Brown, G.A., Effects of Energy Drinks on Resting and Submaximal Metabolism in College Age Males. NCUR 24 (24th National Conference on Undergraduate Research). Missoula, MT. April 15-17, 2010
34. Brown, G.A., N. Dickmeyer, A. Glidden, C. Smith, M. Beckman, B. Malicky, B.S. Shaw and I. Shaw. Relationship of Regional Adipose Tissue Distribution to Fasting Plasma PYY Concentrations in College Aged Females. 56th Annual Meeting American College of Sports Medicine, May 27-30, 2009. Seattle, WA. Med Sci Sports Exerc. 41 (5): S1333
35. Shaw, B.S., I. Shaw, and G.A. Brown. Contrasting Effects Of Exercise On Total And Intra-abdominal Visceral Fat. 56th Annual Meeting American College of Sports Medicine, May 27-30, 2009. Seattle, WA. Med Sci Sports Exerc. 41 (5): S1718
36. Shaw, I., B.S. Shaw, and G.A. Brown. Role of Endurance and Inspiratory Resistive Diaphragmatic Breathing Training In Improving Asthmatic Symptomology. 56th Annual

Meeting American College of Sports Medicine, May 27-30, 2009. Seattle, WA. Med Sci Sports Exerc. 41 (5): S2713

37. McWha, J., S. Horst, G.A. Brown, B.S. Shaw, and I. Shaw. Energy Cost of Physically Active Video Gaming Against a Human or Computer Opponent. 56th Annual Meeting American College of Sports Medicine, May 27-30, 2009. Seattle, WA. Med Sci Sports Exerc. 41 (5): S3069
38. Horst, S., J. McWha, G.A. Brown, B.S. Shaw, and I. Shaw. Salivary Cortisol and Blood Lactate Responses to Physically Active Video Gaming in Young Adults. 56th Annual Meeting American College of Sports Medicine, May 27-30, 2009. Seattle, WA. Med Sci Sports Exerc. 41 (5): S3070
39. Glidden A., M. Beckman, B. Malciky, C. Smith, and G.A. Brown. Peptide YY Levels in Young Women: Correlations with Dietary Macronutrient Intake and Blood Glucose Levels. 55th Annual Meeting American College of Sports Medicine, May 28-31, 2008. Indianapolis, IN. Med Sci Sports Exerc. 40 (5): S741
40. Smith C., Glidden A. M. Beckman, B. Malciky, and G.A. Brown. Peptide YY Levels in Young Women: Correlations with Aerobic Fitness & Resting Metabolic Rate. 55th Annual Meeting American College of Sports Medicine, May 28-31, 2008. Indianapolis, IN. Med Sci Sports Exerc. 40 (5): S742
41. Brown, G.A. M. Holoubeck, B. Nylander, N. Watanabe, P. Janulewicz, M. Costello, K.A. Heelan, and B. Abbey. Energy Costs of Physically Active Video Gaming in Children: Wii Boxing, Wii tennis, and Dance Dance Revolution. 55th Annual Meeting American College of Sports Medicine, May 28-31, 2008. Indianapolis, IN. Med Sci Sports Exerc. 40 (5): S2243
42. McFarland, S.P. and G.A. Brown. One Session of Brisk Walking Does Not Alter Blood Glucose Homeostasis In Overweight Young Men. 53rd annual meeting of the American College of Sports Medicine, Denver, CO. Med Sci Sports Exerc 38: S205, 2006
43. Stahlnecker IV, A.C. and G.A. Brown Acute Effects of a Weight Loss Supplement on Resting Metabolic Rate and Anaerobic Exercise Performance. 53rd annual meeting of the American College of Sports Medicine, Denver, CO. Med Sci Sports Exerc 38: S403, 2006
44. Brown, G.A. and A. Swendener. Effects of Exercise and a Low Carbohydrate Diet on Serum PYY Concentrations 53rd annual meeting of the American College of Sports Medicine, Denver, CO.. Med Sci Sports Exerc 38: s461, 2006
45. Swendener, A.M. and G.A. Brown. Effects of Exercise Combined with a Low Carbohydrate Diet on Health. 53rd annual meeting of the American College of Sports Medicine, Denver, CO. Med Sci Sports Exerc 38: s460, 2006
46. Swendener, A.M. and G.A. Brown. Effects Of Exercise Combined With A Low Carbohydrate Diet On Health. NCUR® 20, 2006
47. Stahlnecker IV, A.C. and G.A. Brown. Acute Effects Of A Weight Loss Supplement On Resting Metabolic Rate And Anaerobic Exercise. NCUR® 20, 2006

48. Eck, L. M. and G.A. Brown. Preliminary Analysis of Physical Fitness Levels in Kinesiology Students. Southern Regional Undergraduate Honors Conference. March 31, 2005.
49. Brown, G.A., J.N. Drouin, and D. MacKenzie. Resistance Exercise Does Not Change The Hormonal Response To Sublingual Androstenediol. 52nd Annual Meeting of the American College of Sports Medicine, June 1-4, 2005, Nashville, TN. Med Sci Sports Exerc 37(5): S40, 2005
50. Brown, G.A., M.P Rebok, M.L. Scott, M.K. Colaluca, and J Harris III. Economy of Jogging Stroller Use During Running. 51st Annual Meeting of the American College of Sports Medicine, June 2-5, 2004, Indianapolis, IN. Med Sci Sports Exerc 36(5): S1714, 2004
51. M.P. Rebok, M.L. Scott, J. Harris III, M.K. Colaluca, and G.A. Brown. Economy of Jogging Stroller use During Running. Georgia Southern University Legislative Wild Game Supper, 2004.
52. M.P. Rebok, M.L. Scott, J. Harris III, M.K. Colaluca, and G.A. Brown. Energy cost of jogging stroller use during running. Annual Meeting of the Southeastern Chapter of the American College of Sports Medicine, 2004.
53. Brown, G.A., Effect of 8 weeks androstenedione supplementation and weight training on glucose tolerance and isokinetic strength. Annual Meeting of the Southeastern Chapter of the American College of Sports Medicine, 2004.
54. Brown, G.A., Vukovich, M.D., Kohut, M.L., Franke, W.D., Jackson, D.A., King, D.S., and Bowers, L.D. Urinary excretion of steroid metabolites following chronic androstenedione ingestion. 50th Annual Meeting of the American College of Sports Medicine, May 27-31 2003, San Francisco, CA. Med Sci Sports Exerc 35(5): S1835
55. Brown, G.A., E.R. Martini, B.S. Roberts, M.D. Vukovich, and D.S. King. Effects of Sublingual androstenediol-cyclodextrin on serum sex hormones in young men. 48th Annual Meeting American College of Sports Medicine, May 30 – June 2, 2001. Baltimore, MD. Med Sci Sports Exerc. 33(5): S1650
56. Kohut, M.L., J.R. Thompson, J. Campbell, G.A. Brown, and D.S. King. Ingestion of a dietary supplement containing androstenedione and dehydroepiandrosterone (DHEA) has a minimal effect on immune response. International Society of Exercise and Immunology, 3rd Annual Convention May 29-30, 2001. Baltimore, MD. Med. Sci. Sports Exerc. 33(5): SISEI12
57. Brown, G.A., E.R. Martini, B.S. Roberts, and D.S. King. Effects of Sublingual androstenediol-cyclodextrin on serum sex hormones in young men. Iowa State University Educational Research Exchange, March 24, 2001. Ames, IA.
58. Martini, E.R., G.A. Brown, M.D. Vukovich, M.L. Kohut, W.D. Franke, D.A. Jackson, and D.S. King. Effects of androstenedione-herbal supplementation on serum sex hormone concentrations in 30-59 year old men. Iowa State University Educational Research Exchange, March 24, 2001. Ames, IA.

59. King, D.S., G.A. Brown, M.D. Vukovich, M.L. Kohut, W.D. Franke, and D.A. Jackson. Effects of Chronic Oral Androstenedione Intake in 30-58 year Old Men. 11th International Conference on the Biochemistry of Exercise. June 4-7, 2000. Little Rock, Arkansas
60. Brown, G.A., M.L. Kohut, W.D. Franke, D. Jackson, M.D. Vukovich, and D.S. King. Serum Hormonal and Lipid Responses to Androgenic supplementation in 30 –59 year old men. 47TH Annual Meeting American College of Sports Medicine, May 31-June 3, 2000. Indianapolis, IN. Med Sci Sports Exerc. 32(5): S486
61. Brown, G.A., T.A. Reifenrath, N.L. Uhl, R.L. Sharp, and D.S. King. Oral anabolic-androgenic supplements during resistance training: Effects on glucose tolerance, insulin action, and blood lipids. 1999 Annual Meeting American College of Sports Medicine, Seattle, WA. Med Sci Sports Exerc. 31(5): S1293
62. Reifenrath, T.A., R.L. Sharp, G.A. Brown, N.L. Uhl, and D.S. King. Oral anabolic-androgenic supplements during resistance training: Effects on body composition and muscle strength. 1999 Annual Meeting American College of Sports Medicine, Seattle, WA. Med Sci Sports Exerc. 31(5): S1292
63. King, D.S., R.L. Sharp, G.A. Brown, T.A. Reifenrath, and N.L. Uhl. Oral anabolic-androgenic supplements during resistance training: Effects on serum testosterone and estrogen concentrations. 1999 Annual Meeting American College of Sports Medicine, Seattle, WA. Med Sci Sports Exerc. 31(5): S1291
64. Parsons, K.A., R.L. Sharp, G.A. Brown, T.A. Reifenrath, N.L. Uhl, and D.S. King. Acute effects of oral anabolic-androgenic supplements on blood androgen and estrogen levels in man. 1999 Annual Meeting American College of Sports Medicine, Seattle, WA. Med Sci Sports Exerc. 31(5): S1290

Book Chapters

Brown, G.A. Chapters on Androstenedione and DHEA. In: Nutritional Supplements in Sport, Exercise and Health an A-Z Guide. edited by Linda M. Castell, Samantha J. Stear, Louise M. Burke. Routledge 2015.

Brown, G.A. Evaluating a Nutritional Supplement with SOAP Notes to Develop Critical Thinking Skills. In: Teaching Critical Thinking and Clinical Reasoning in the Health Sciences, edited by Facione NC and Facione PA. Millbrae, CA: California Academic Press 2008

Non Refereed Publications

Brown, G.A. and King, D.S. Sport Dietary Supplement Update on DHEA supplementation. Human Kinetics Publishers, Inc. October, 2000.

Brown, G.A. Getting in Shape for Paintball in the Winter. Paintball Sports International, January, 1999

Invited Presentations

Brown G.A. Collaborative experiences with researchers in South Africa. Africa Summit 2019 (March 28, 2019). Presented by the University of Nebraska and the University of Nebraska Medical Center.

Peer Reviewer for the Following Journals

Advances in Physiology Education. http://www.the-aps.org/publications/advan/

African Journal For Physical, Health Education, Recreation and Dance (AJPHERD). ISSN: 1117-4315 http://www.ajol.info/journal_index.php?jid=153

Anatomical Sciences Education. http://www.asejournal.com

Asian Journal of Sports Medicine. http://asjsm.tums.ac.ir/index.php/asjsm

CardioVascular Journal of Africa. http://www.cvjsa.co.za/

Complementary Therapies in Medicine. http://ees.elsevier.com/ctim/

European Journal of Sport Science. http://www.tandf.co.uk/journals/titles/17461391.asp

Games for Health Journal. http://www.liebertpub.com/overview/games-for-health-journal/588/

Global Journal of Health and Physical Education Pedagogy. http://js.sagamorepub.com/gjhpep

Interactive Learning Environments. https://www.tandfonline.com/toc/nile20/current

International Journal of Exercise Science. http://digitalcommons.wku.edu/ijes/

Journal of Sports Sciences. http://www.tandf.co.uk/journals/titles/02640414.html

Journal of Strength and Conditioning Research. http://journals.lww.com/nsca-jscr/pages/default.aspx

Lung. http://www.springer.com/medicine/internal/journal/408

Pediatrics. http://pediatrics.aappublications.org/

Scandinavian Journal of Medicine and Science in Sports. http://www.blackwellpublishing.com/journal.asp?ref=0905-7188

South African Journal of Diabetes and Vascular Disease http://www.diabetesjournal.co.za/

The American Journal of Physiology - Endocrinology and Metabolism. http://ajpendo.physiology.org/

The American Journal of Physiology - Heart and Circulatory Physiology. http://ajpheart.physiology.org/

The American Journal of Physiology - Regulatory, Integrative and Comparative Physiology. http://ajpregu.physiology.org/

The International Journal of Sport Nutrition & Exercise Metabolism. http://www.humankinetics.com/IJSNEM/journalAbout.cfm

The Journal of Sports Science and Medicine (JSSM) http://www.jssm.org/

The International Journal of Nutrition and Metabolism ww.academicjournals.org/IJNAM

The Open Sports Sciences Journal. http://benthamscience.com/open/tossj/index.htm

The Journal of Applied Physiology. http://jap.physiology.org/

African Health Sciences. http://www.ajol.info/index.php/ahs

Menopause. http://journals.lww.com/menopausejournal/pages/default.aspx

Membership in Professional Organizations

American College of Sports Medicine

American Physiological Society

National Strength and Conditioning Association

Graduate Student Advisement/Mentoring

Kourtney Woracek. MAEd Thesis Committee. in progress

Marissa Bongers. MAEd Thesis Committee Director. Dietary Habits and Nutrition Knowledge in Female Collegiate Distance Runners. Degree Awarded Spring 2016.

Justin Thiel. MAEd Advisor. Degree Awarded Spring 2016.

Mitchell Sasek. MAEd Advisor. Degree Awarded Summer 2015

Chad Keller. MAEd Advisor. Degree Awarded Summer 2014

Faron Klingehoffer. MAEd Advisor. Degree Awarded Summer 2014

Joe Scharfenkamp. MAEd Internship Advisor. Degree Awarded Summer 2014

Andrew Hudson. MAEd Thesis Committee. Thesis Title. valuation of Weight Loss in Parents Participating in a Pediatric Obesity Treatment Intervention Degree Awarded Fall 2012

Megan Adkins. Doctoral Dissertation Committee. An Examination of Changes in Sedentary Time with the Integration of Technology for Children Participating in a Morning Fitness Program. Degree Awarded Summer 2011

Christopher Campbell. MAEd Advisor. Degree Awarded Spring 2011

Logan Brodine. MAEd Advisor. Degree Awarded Spring 2010

Megan Costello. MAEd Thesis Committee. Changes in the Prevalence of at risk of overweight or overweight in children. Degree Awarded Spring 2009

Pamela Janulewciz, MAEd Thesis Committee. Effects of Exercise Balls as Chair Replacements in a Fourth Grade Classroom. Degree Awarded Spring 2008

Melissa Shelden. MAEd Advisor.

Michael Bell. MAEd Advisor.

Karen DeDonder. MAEd Thesis Committee. Confidence Levels of Certified Athletic Trainers Regarding Female Athlete Triad Syndrome. Degree Awarded Spring 2008

Benjamin Nylander. MAEd Comprehensive Project Director. Degree Awarded Summer 2007

Eme Ferro. MAEd advisor. Degree Awarded Summer 2007

Julie McAlpin. MAEd Thesis Committee. Children Escorted to School; effect on Parental Physical Activity Degree awarded fall 2006

Michael Ray. MAEd Comprehensive Project Director. Degree Awarded Summer 2006

Seth McFarland. MAEd Thesis Committee Director. The Effects of Exercise Duration on Glucose Tolerance and Insulin Sensitivity in Mildly Overweight Men. Degree Awarded Summer 2005

Drew McKenzie. MS Academic Advisor. Degree Awarded Spring 2005

Matthew Luckie. MS Academic Advisor. Degree Awarded Spring 2005

Todd Lane. MS Academic Advisor

Leilani Lowery. MS Internship committee, Degree Awarded Spring 2003

Johnna Ware. MS Internship committee, Degree Awarded Spring 2003

David Bass. MS Internship committee, Degree Awarded Spring 2003

Crystal Smith. MS Internship committee, Degree Awarded Summer 2003

Undergraduate Student Research Mentoring

Cassidy Johnson. Project to be determined. Undergraduate Research Fellowship (Fall 2019 -)

Taylor Wilson. A comparison of High Intensity Interval Exercise on a bicycle ergometer to a treadmill on Resting Metabolic Rate the next day. Undergraduate Research Fellowship (Fall 2018 -)

Dakota Waddell. The effect of yoga versus mindful meditation on stress in physically active and non-physically active female college-aged students Undergraduate Research Fellowship (Fall 2018 -)

Dakota Waddell. A case study of the effects of the *osteostrong* program on bone mineral density and lean body mass in a paraplegic male. Undergraduate Research Fellowship (Fall 2017 – Spring 2018)

Andrew Fields. The effects of retraining running cadence on oxygen consumption in experienced runners. Undergraduate Research Fellowship. (Fall 2017 – Spring 2019)

Logan Engel. The effects of Tart Cherry Juice on Delayed Onset Muscle Soreness following Eccentric Exercise. Undergraduate Research Fellowship. Fall 2017 -

Stephanie Paulsen. Comparing the effects of coffee to a pre-workout drink on cardiovascular drift. Summer Student Research Program. University of Nebraska Kearney. Summer 2017.

Stephanie Paulsen. Comparing the effects of coffee to a pre-workout drink on resting and exercise metabolic rate. Undergraduate Research Fellowship. Spring 2017 - .

Rachael Ernest. Comparing the effects of coffee to a pre-workout drink on resting and exercise metabolic rate. Undergraduate Research Fellowship. Fall 2016 - Spring 2017.

Aleesha Olena. Evaluating the role of body composition on abdominal muscle definition. Undergraduate Research Fellowship. University of Nebraska Kearney. Fall 2016 - Spring 2017.

Marco Escalera. Evaluating the role of body composition on abdominal muscle definition. Undergraduate Research Fellowship. University of Nebraska Kearney. Fall 2015 - Spring 2017.

Trevor Schramm. Effects of "pre-workout' drinks on 400 m sprint performance and salivary cortisol concentrations. Undergraduate Research Fellowship. University of Nebraska Kearney. Spring 2016.

Taylor Turek. Evaluating the role of body composition on abdominal muscle definition. Undergraduate Research Fellowship. University of Nebraska Kearney. Fall 2015 - Spring 2016.

Brian Szekely. Effects of "pre-workout" drinks on Wingate test performance and blood lactate concentrations. Undergraduate Research Fellowship. University of Nebraska Kearney. Fall 2014 - Spring 2016.

Brianna Jackson. Effects of "pre-workout' drinks on 400 m sprint performance and salivary cortisol concentrations. Undergraduate Research Fellowship. University of Nebraska Kearney. Fall 2014 – Fall 2015.

Ashley Pearson. Changes in resting metabolic rate over a semester in undergraduate students. Undergraduate Research Fellowship. University of Nebraska Kearney. Fall 2013 - Spring 2015.

Tricia Young. Changes in resting metabolic rate over a semester in undergraduate students. Undergraduate Research Fellowship. University of Nebraska Kearney. Fall 2013 - Spring 2014.

Gavin Schneider. Effects of "pre-workout" drinks on resistance training performance. Undergraduate Research Fellowship. University of Nebraska Kearney. Fall 2013 - Spring 2014.

Bridgette Schneekloth. Physical Activity while engaging in a Zumba dance class or Microsoft Kinect Zumba. Summer Student Research Program. University of Nebraska Kearney. Summer 2013.

Bridgette Schneekloth. Physical Activity while engaging in Microsoft Kinect Track & Field running vs. free running on an indoor track. Undergraduate Research Fellowship. University of Nebraska Kearney. Fall 2012 - Spring 2014.

Adam Kahle. Evaluating changes in running mechanics with "barefoot" footwear. Summer Student Research Program. University of Nebraska Kearney. Summer 2012

Michelle Jarvi. Quantifying paintball as a form of physical activity in Boys. Undergraduate Research Fellowship. University of Nebraska Kearney. Fall 2011 - Spring 2012.

Benjamin Lentz, Krista Scheer, & Sarah Siebrandt. Wii, Kinect, and Move for Physical Activity: Analysis of Energy Expenditure, Heart Rate, and Ventilation. Undergraduate Research Fellowship. University of Nebraska Kearney. Fall 2010 - Spring 2012.

Katlyn Heiserman. Comparison of EMG activity in the rectus abdominis and rectus femoris during supine un-weighted abdominal crunch exercise and a seated abdominal crunch exercise weight machine. Summer Student Research Program. University of Nebraska Kearney. Summer 2010

Janae Nienhueser. Effects of Energy drink on resting and submaximal exercise metabolism in college age men. Summer Student Research Program. University of Nebraska Kearney. Summer 2009

Jessica McWha. Metabolic changes while playing active video gaming against a human and computer opponent. Summer Student Research Program and Undergraduate Research Fellowship. University of Nebraska Kearney. Summer 2008 – Spring 2009

Sarah Horst. Changes in blood lactate and salivary cortisol concentrations while "exergaming" against a human or computer opponent. Summer Student Research Program. University of Nebraska Kearney. Summer 2008

Craig Carstensen. Differences in the Physiological Response to Treadmill versus Freely Paced Walking. Summer Student Research Program. University of Nebraska Kearney. Summer 2006

Alvah Stahlnecker Acute effects of a weight loss supplement on resting metabolic rate and anaerobic exercise performance. Summer Student Research Program. University of Nebraska Kearney. Summer 2005

Allison Swendener. Effects of exercise combined with a low carbohydrate diet on health. Summer Student Research Program. University of Nebraska Kearney. Summer 2005

Kamilah Whipple. A measurement of the physical activity and fitness of undergraduate Georgia Southern University students. Ronald E. McNair Post-Baccalaureate Achievement Program. Georgia Southern University. Summer 2004.

Lindsey Eck. Preliminary Analysis of Physical Fitness Levels in Kinesiology Students. Independent undergraduate research project. Georgia Southern University. Summer 2004.

Description of Graduate Courses Taught

PE 870: Advanced Exercise Physiology Course presumes a student has had a basic course in exercise physiology. The content of cardiorespiratory fitness, body composition, muscular strength/flexibility, body fluids and metabolism is presented beyond the introductory level. (University of Nebraska at Kearney)

PE 866P: Nutrition for Health and Sport. (Dual listed/taught with PE 469) Metabolism and metabolic regulation, the influence of dietary practices on health and human performance, and mechanisms and consequences of weight loss and gain.. (University of Nebraska Kearney)

PE 861P: Physiology of Exercise. (Dual listed/taught with PE 461) Physiological processes of body as pertain to physical activity. How trained and untrained individuals differ, and importance of training. (University of Nebraska at Kearney)

TE 800: Education Research. This introductory web-based course in educational research focuses on evaluating and interpreting educational research and applying its findings to educational practice. (University of Nebraska at Kearney)

KINS 7230: Exercise Physiology. Focuses on the study of the effects of exercise on the physiological functions of the human organism with emphasis on theoretical orientations. (Georgia Southern University)

KINS 7231: Laboratory Techniques in Exercise Physiology. Acquaints the student with the use of typical laboratory equipment used in exercise physiology. (Georgia Southern University)

KINS 7238: Human Performance and Nutrition. Examines the interaction between nutrition and physical activity, including exercise and athletic performance. (Georgia Southern University)

KINS 7431: Applied Sport Physiology. Focuses on the study of exercise physiology principles applied to developing training and conditioning programs for enhancing health related fitness and performance (Georgia Southern University)

KINS 7899: Directed Independent Study. Provides the student with an opportunity to investigate an area of interest under the direction of faculty mentor (Georgia Southern University)

EXSP 551: Advanced Exercise Physiology 2. Analysis of factors affecting work capacity and performance. Human energy metabolism concepts and measurement. (Iowa State University)

Description of Undergraduate Courses Taught

PE 498: Special Topics. (University of Nebraska at Kearney)

PE 475: Research Methods in Exercise Science. This course is designed to introduce advanced undergraduate students to the processes of research in the field of Exercise Science including the processes of finding, reading and understanding Exercise Science research; data collection; data analysis; and data interpretation. (University of Nebraska at Kearney)

PE 469: Sports Nutrition. Metabolism and metabolic regulation, the influence of dietary practices on human performance. (University of Nebraska at Kearney)

PE 461: Physiology of Exercise. Physiological processes of body as pertain to physical activity. How trained and untrained individuals differ, and importance of training. (University of Nebraska at Kearney)

PE 388: General Studies Capstone - The Living Dead in Fact & Fiction. The Living Dead, such as Zombies and Vampires, are pervasive in fictional literature, television, and movies. During this course, novels, television episodes, and movies will be used to identify disease symptoms displayed by the living dead, and these symptoms will then be evaluated regarding what type of medical condition might cause the symptoms.

PE 310: Introduction to Exercise Physiology. Provides a foundation of scientific basis for understanding the body's anatomical structures and physiologic responses to acute exercise, as well as its adaptations to chronic exercise. (University of Nebraska at Kearney)

PE 107. This course is designed to introduce students to the field of Exercise Science as an area of academic study and as a professional career. Students majoring in Exercise Science should take this course in their first year. (University of Nebraska at Kearney)

KINS 4231: Fitness Evaluation and Exercise Prescription. Provides the student with an in-depth study of fitness appraisal and exercise prescription and the development, interpretation, implementation and management of fitness programs (with laboratory). (Georgia Southern University)

KINS 3133: Physiological Aspects of Exercise. Provides an in-depth perspective of physiological and biochemical responses of the human body when subjected to exercise (with laboratory). (Georgia Southern University)

GSU 1210: University Orientation 1. Designed to help first year students understand the purpose of a college education, learn about college requirements, explore values and interests, learn to make decisions and realistic choices, explore career objectives and programs of study, and establish supportive relationships with faculty and staff. Required of all new students during their first semester. (Georgia Southern University)

EX SP 462: Medical Aspect of Exercise. The role of exercise in preventive medicine. Impact of exercise on various diseases, and the effect of various medical conditions on the ability to participate in vigorous exercise and competitive sports. Principles of exercise testing and prescription for individuals with these conditions. Environmental and nutritional aspects of exercise. (Iowa State University)

EX SP 458: Principles of Exercise Testing and Prescription. Physiological principles of physical fitness; design and administration of fitness programs; testing, evaluation, and prescription; cardiac risk factor modification. (Iowa State University)

EX SP 455 (Renumbered as EX SP 358 for Fall 2001). Physiology of Exercise. Physiological basis of human performance; effects of physical activity on body functions (with laboratory). (Iowa State University)

EX SP 355: Biomechanics (Laboratory). Mechanical basis of human performance; application of mechanical principles to exercise, sport and other physical activities. (Iowa State University)

EX SP 258: Physical Fitness and Conditioning. Development of personal fitness using a variety of conditioning and exercise techniques such as aerobics, weight training, and aquatic fitness. Introduction to acute and chronic responses to exercise, and the role of exercise in health promotion and weight management. (Iowa State University)

EX SP 236: Fundamentals of Archery, Badminton, Bowling (Archery Segment). (Iowa State University)

EX SP 119: Archery 1. (Iowa State University)

EX SP 220: Physical Fitness and Conditioning. Development of personal fitness using a variety of conditioning and exercise techniques such as aerobics, weight training, and aquatic fitness. Introduction to acute and chronic responses to exercise, and the role of exercise in health promotion and weight management. (Des Moines Area Community College)

PE 157: Introduction to Athletic training. Introduction to methods of prevention and immediate care of athletic injuries. Basic information concerning health supervision of athletes, and some basic wrapping and strapping techniques for common injuries. (Des Moines Area Community College)

PE 144: Introduction to Physical Education. History and development of physical education as an academic discipline. Principles and current practices of teaching physical education. (Des Moines Area Community College)

PHYSL 130: Human Physiology. Principles of the regulation and maintenance of human physiology. (Utah State University; Volunteer Undergraduate TA)

PHYSL 103 Human Anatomy. Introduction to the structure and location of bones, muscles, and organs in the human body. (Utah State University; Volunteer Undergraduate TA)

Service

Service to the Profession

Associate Editor, Asian Journal of Sports Medicine (2019-).

Director, North American Chapter, International Physical Activity Projects (IPAP) (2009-)

Fellow, American College of Sports Medicine (2008-_)

National Research Foundation (South Africa) peer evaluator for grant applicants

National Research Foundation (South Africa) evaluator of applications for funding in Thuthuka Programme

External Evaluator for Master's Theses and Doctoral Dissertations, University of Johannesburg, Johannesburg South Africa.

Grant proposal reviewer for NASPE/ING Run for Something Better School Awards Program.

Session Chair. Special Event. Undergraduate Research Experiences in Exercise Science. ACSM Annual Meeting, 2010

Session Chair. 2nd Annual Education Research Exchange. Iowa State University Education Research Exchange, 2001

Current Service at the University of Nebraska at Kearney

University Wide

Faculty Senate Parliamentarian (April 2019 – April 2022)

Faculty Senate Oversight Committee Chair (April 2019 – April 2022)

Faculty Senate Executive Committee (April 2019 – April 2022)

Faculty Senate, At Large representative (Fall 2018-)

University Student Conduct Appeals Board (Fall 2019 - May 2020)

General Studies Council (fall 2013-)

University Safety Committee (Fall 2018 -)

University Student Travel Policy Committee (Fall 2019-)

University Retention Council (Fall 2019 -)

External Evaluator, Promotion Committee, Department of Social Work & Criminal Justice (Fall 2019-)

College of Education Dean Search Committee Member (Fall 2019 -)

College of Education

College of Education Promotion and Tenure Committee, Chair (Fall 2012 – present) Member (fall 2008 – spring 2012)

Department of Kinesiology and Sport Sciences

Kinesiology Lecturer Search Committee Member (Fall 2019 -)

Nebraska Kids Fitness and Nutrition Day, volunteer educator and student coordinator. (fall 2005-present)

Academic Advisor for Undergraduate exercise Science Students (Fall 2005 - present)

Previous Service at the University of Nebraska at Kearney

Recreation Faculty Search Committee Member (Spring 2019)

University Student Conduct Board (Fall 2016- May 2017, Fall 2018 – May 2019)

Faculty Senate Athletic Committee (Fall 2018-May 2019)

External Evaluator, Promotion & Tenure, Department of Social Work & Criminal Justice (Fall 2018)

External Evaluator, Faculty Annual Performance Reviews, Department of Social Work & Criminal Justice (Spring 2018)

University Graduate Council. (Fall 2014 – spring 2017)

University Graduate Council Standing Committee I: Policy & Planning Committee (fall 2014 – spring 2017)

Faculty Senate (April 2012- April 2016)

Faculty Senate Executive Council, (April 2014 – April 2016)

Faculty Senate representative to the Oversight Committee (September 2014 – April 2016)

Faculty Senate representative to the Grievance Committee (September 2014 – April 2016)

Faculty Senate representative to the Professional Conduct committee (September 2013 - April 2016)

Youth Agility Speed & Quickness program director (2011-2015)

Faculty Senate ad-hoc committee on best practices in peer evaluation (2013-2014)

Director of General Studies search committee, committee member (2013-2014)

Director of the Office of Sponsored Programs search committee member (2012-2013; 2013-2014)

College peer mentor for implementing Critical Thinking in the classroom (2013-2014)

Chair, Ad-hoc committee for the evaluation of a new Student Evaluation of Instruction survey (2012-2014 academic years)

Ad-hoc committee to enhance communication effectiveness within department faculty and staff (2013-2014)

Exercise Science faculty search (2012-2013)

Undergraduate Research and Creative Activity program review team (2011-2012)

Institutional Review Board for the protection of Human Research Subjects. (Service period 2006 - 2011)

Undergraduate Research Committee (Service fall 2008 – spring 2011)

University Graduate Council. (Service period 2006 - 2010)

Homecoming Hustle (HPERLS Fun Run) Race Director and Coordinator (Service period beginning Fall 2007 – fall 2009)

Ad-hoc Committee on Enhancing Enrollment and Course Offerings in PE 110 Dept. of HPERLS (Service period beginning fall 2006)

Graduate Council Standing Committee 1: Policy and Planning Committee. (Service period beginning fall 2006; Chair in 2007 – 2008 and 2009-2010)

General Studies Roundtable 2 (spring 2006-spring 2007)

Academic Affairs Committee on Teaching Continuity (Service period beginning fall 2006)

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Health Science Program Assistant Director Search Committee, University of Nebraska at Kearney. (Service period summer 2006)

Graduate Program Chair, HPERLS Department, University of Nebraska at Kearney (Service period beginning summer 2006 - 2010)

Graduate Dean Search Committee. University of Nebraska at Kearney (Service period 2005 – 2006 academic year)

Assistant HPERLS Department Graduate Coordinator. (Service period 2005 – 2006 academic year)

University of Nebraska at Kearney Centennial Run committee. (Service period fall 2005)

Senior College of Central Nebraska, Fit after 50 course coordinator. (Service period 2005 – 2006 academic year)

Health Science Program Assistant Advisor Search Committee. (Service period summer 2005)

HPERLS Furniture Committee (Service period spring 2005)

Academic Advisor for Undergraduate exercise Science Students (Service period Beginning Fall 2005 academic year; ongoing)

Other Prior University Service

Institutional Review Board, Georgia Southern University (2003- 2004)

GSU Exercise Science undergraduate student advisor (2002 – 2004)

GSU Jiann-Ping Hsu School of Public Health extramural funding task force (2003-2004)

GSU Jiann-Ping Hsu School of Public Health Curriculum Committee (2003-2004)

GSU Jiann-Ping Hsu School of Public Health Assistant Graduate program director (2003-2004)

GSU Jiann-Ping Hsu School of Public Health Laboratory Director's Committee (2002-2004)

GSU Jiann-Ping Hsu School of Public Health Exercise Science Graduate program coordinator (2003-2004)

GSU Recreation and Athletic Center advisor to the personal training program (2003-2004)

Institutional Biosafety Committee, Georgia Southern University (2003-2004)

Kinesiology Cluster Area, Georgia Southern University, Jiann-Ping Hsu School of Public Health (2002-2004)

Biostatistics Faculty Search Committee. Georgia Southern University, Jiann-Ping Hsu School of Public Health (2002-2003, 2003-2004)

Computer Advisory Committee, Iowa State University, University-Wide, College of Education, and Dept. of Health and Human Performance (2000-2002)

Computer Fee Allocation Committee, Iowa State University (2000-2001)

Dept. of Health and Human Performance Graduate Student Association (Founding Officer and 1st President; 2001-2002)

Sport Management Faculty Search Committee, Iowa State University Dept. of Health and Human Performance (2001-2002)

Previous Community Involvement

Race Director, Central Nebraska Susan G. Komen Race for the Cure (2011, 2012, 2013 events)

Webelos Den Leader, Boy Scouts of America Pack 132, Kearney, NE. Chartered to the Church of Jesus Christ of Latter Day Saints

Scoutmaster, Boy Scouts of America Troop 132, Kearney, NE. Chartered to the Church of Jesus Christ of Latter Day Saints

Tiger Den Coach, Boy Scouts of America Pack 135, Kearney, NE. Chartered to Faith United Methodist Church.

Personal Fitness Merit Badge Counselor. Boy Scouts of America, Overland Trails Council Covered wagon District.

Certifications

American College of Sports Medicine: ACSM Certified Exercise Physiologist (05/21/1998 - 12/31/2021)

USA Track and Field: Level One Coach

American Red Cross: Community First Aid and CPR

Funding

Research Funding

Brown GA, Bice MR, Abbey BM. Shaw I, Shaw BS. Effects of aerobic exercise, resistance exercise, and combined aerobic & resistance exercise on food choices and endocrine signals of satiety in middle aged adults. Submitted 6/26/2017 to National Institutes of Health [PA16-200] - Academic Research Enhancement Award (Parent R15) (Application #1R15DK117436-01). Total Amount Requested: $367,708. (Resubmission of revised proposal; Pending Review.)

Brown GA, Bice MR, Abbey BM. Shaw I, Shaw BS. Effects of aerobic exercise, resistance exercise, and combined aerobic & resistance exercise on food choices and endocrine signals of satiety in middle aged adults. Submitted 6/26/2017 to National Institutes of Health [PA16-200] - Academic Research Enhancement Award (Parent R15) (Application #1R15DK117436-01). Total Amount Requested: $351,708. Pending Review.

Brown GA, Bice MR, Adkins MM, Hollman A, Bickford S, Bickford N, Ranglack D. HEAT it up (Health, Exercise, Aquaponics, Technology) summer camps to grow future health professionals in Rural Nebraska. Submitted 5/25/2017 to National Institutes of Health [PAR17-183] - NICHD Research Education Programs (R25) (Application # 1R25 HD094673-01) Total Amount Requested: $777,006. Pending Review.

Brown GA, Bice MR, Adkins MM, Hollman A, Bickford S, Bickford N, Ranglack D. Teaching Health, Exercise, Technology, & Aquaponics (THETA) Day Camps to Grow Future Health Professionals. University of Nebraska Rural Futures Institutes (RFI) $20,000 – Funded (July 1, 2017 – June 30, 2019)

Brown GA, Bice MR, Adkins MM, Hollman A, Bickford S, Bickford N, Ranglack D. Teaching Health, Exercise, Technology, & Aquaponics (THETA) Day Camps to Grow Future Health Professionals. University of Nebraska Rural Futures Institutes (RFI) and McCook Economic Development Council $11,400 – Funded (May 1, 2017 – August 30, 2017)

Brown GA, Abbey BM, Bice MR. **"**Is milk an effective rehydration beverage during repeated days of dehydrating exercise?" to the Dairy Research Institute® (DRI) $125,560 – Not funded.

Brown GA & Steele J. "Biochemistry Laboratory Experiences for Exercise Science Students" to the Kelly Fund, University of Nebraska. $23,947. Funded. August 2014- June 2016

Brown GA. "Horizon After School Quickness Program" to Blue Cross & Blue Shield of Nebraska for a Community Wellness grant. $14,106. Not funded

Brown GA. "Effects of chocolate milk taken immediately post exercise on the adaptations to strength training in men" to the Dairy Research Institute® (DRI) $123,192 – not funded.

Brown GA., Heelan KA, Bartee RT, & Maughan S. "Active Video Games as an Alternative to Traditional Group Exercise Classes" to the Robert Wood Johnson Health Games Research program. $297,201 – not funded

Brown GA., Nylander B, Heelan KA. Energy Expenditure for Active Video Game Systems: Dance Dance Revolution and Nintendo Wii. University of Nebraska at Kearney Research Services Council. $3,432. Funded

Brown G.A. Effects of green tea extract on fasting plasma insulin, glucose, leptin, and PYY concentrations in humans. University of Nebraska at Kearney Research Services Council. $3,822. Funded

Brown G.A. Dose response relationship between resistance exercise and changes in the hormonal regulation of blood glucose homeostasis. American Diabetes Association Junior faculty Award. $443,293. Not Funded.

Brown G.A., and K. Heelan. Health benefits of green tea extract in women. NIH NCCAM Exploratory/Developmental Grant for Clinical Studies (R21), PAR-03-153. $485,163. Not Funded.

Brown, G.A. Changes In Biomarkers Of Satiety, Aerobic Fitness, And Body Composition While On A Low Fat Or Low Carbohydrate Diet. University of Nebraska at Kearney Research Services Council. $3,750. Funded

Lynott, F., **Brown, G.A**., and K. Heelan. Health and Fitness of HPERLS Students. University of Nebraska at Kearney Research Services Council. $4,000. Funded

Brown G.A., K. Heelan and D.S. King. Pharmacokinetics & Efficacy of Sublingual Androstenediol for Treating Andropause. NIH NCCAM Exploratory/Developmental Grant for Clinical Studies (R21), PAR-03-153. $477,000. Not Funded.

Maughan S.L., D.P.Snider, and **G.A. Brown,** Physical Health and Social Factors Influencing Educational Success Among Hispanic Immigrant Children, University of Nebraska at Kearney Research Services Council. $4,214.60. Funded

McFarland S.P. and **G.A. Brown,** Effects of Exercise Duration on Glucose Tolerance In Mildly Overweight Men, University of Nebraska at Kearney Research Services Council. $750. Funded

Brown, G.A. Effects of Exercise Duration on Insulin Sensitivity In Mildly Overweight Men, University of Nebraska at Kearney Research Services Council. $2,000. Funded

McFarland S.P. and **G.A.Brown,** Effects of Exercise Duration on Glucose Tolerance In Mildly Overweight Men, Gatorade Sports Sciences Institute. $1,500. Not Funded

Brown, G.A. Effects of Exercise Duration on Glucose Tolerance and Insulin Sensitivity in Mildly Overweight Men. Life fitness Academy. $5,000. not funded

Brown, G.A. American College of Sports Medicine Foundation Grant. Endocrinology of weight lifting & androgen supplementation, $10,000. Not Funded.

Brown, G.A. and J.L. McMillan. Experimental and Applied Sciences. Effects of Green Tea Extract on Insulin Sensitivity and Adaptations to Exercise. $71,075. Not Funded.

Brown, G.A. American College of Sports Medicine Foundation Grant. Endocrinology of weight training & androgen supplementation, $10,000. Not Funded.

Brown, G.A. and J. Drouin. Georgia Southern University Faculty Research Grant. Effects of Resistance Training on the Hormonal response to Sublingual Androstenediol Intake. $5,000. Funded

King D.S. and **G.A. Brown.** *World Anti Doping Agency.* Effects of Testosterone Precursors on the Muscular and Hormonal Response to Resistance Training in Men. $464,634. Not Funded.

Brown, G.A. *American College of Sports Medicin*e Foundation Grant. Effect of Raisin Ingestion on Substrate Use During Exercise. $5,000. Not Funded.

King D.S. and **G.A. Brown.** *California Raisin Marketing Board.* The Glycemic Index Of Raisins Fed To Normal People And Non-Insulin Dependent Diabetics. $110,869. Not Funded.

King D.S. and **G.A. Brown.** *California Raisin Marketing Board.* The Effects Of Raisin Ingestion On Substrate Utilization and Endurance Exercise Performance In Trained Cyclists. $ 84,258. Not Funded.

Brown, G.A., E.R. Martini, and B.S. Roberts. Effect of Androstenediol on Serum Sex Hormone Concentrations. Iowa State University Professional Advancement Grant. Graduate Student Senate and Iowa State University Dept. of Health and Human Performance. $700. Funded

Instructional Development Funding

Brown G.A. and K.A. Heelan. University of Nebraska at Kearney. Proposal for the purchase of upgraded resistance exercise equipment in the Human Performance Laboratory. $21,100. Funded.

Brown G.A. and K.A. Heelan. University of Nebraska at Kearney. Proposal for the purchase of a new metabolic cart for the Human Performance Laboratory. $24,560. Funded

Brown, G.A. Georgia Southern University, Center for Excellence in Teaching Instructional Development Grant. Proposal for purchase of heart rate monitors, manual sphygmomanometers, and automated sphygmomanometers. $2,820. Funded.

Brown, G.A. Georgia Southern University, Center for Excellence in Teaching Innovative Teaching Strategies Retreat. Provides $2,000 in instructional technology funds to the participant. Funded.

Brown, G.A. Georgia Southern University, Center for Excellence in Teaching Travel Grant. $750. Funded.

Brown, G.A. Georgia Southern University student technology fee proposal. Proposal for purchase of Molecular Devices SpectraMax 250 plate reader. $17,000. Funded

Brown, G.A. Georgia Southern University student technology fee proposal. Proposal for purchase of Lode Excalibur Sport Bicycle Ergometer and Physiodyne Max 2 Metabolic Cart. $29,577. Funded

Brown, G.A. Georgia Southern University student technology fee proposal. Proposal for purchase of Packard Cobra 2 Automated Gamma Counter. $14,000. Not funded

References

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bicemr@unk.edu
Assistant Professor, Dept of Kinesiology & Sports Sciences
University of Nebraska Kearney

EXHIBIT B

WILENCHIK & BARTNESS
A PROFESSIONAL CORPORATION

frontiers in Endocrinology

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PMID: 30093882

Up-To-Date Review About Minipuberty and Overview on Hypothalamic-Pituitary-Gonadal Axis Activation in Fetal and Neonatal Life

Lucia Lanciotti, Marta Cofini, Alberto Leonardi, Laura Penta, and Susanna Esposito*

Abstract

Minipuberty consists of activation of the hypothalamic-pituitary-gonadal (HPG) axis during the neonatal period, resulting in high gonadotropin and sex steroid levels, and occurs mainly in the first 3–6 months of life in both sexes. The rise in the levels of these hormones allows for the maturation of the sexual organs. In boys, the peak testosterone level is associated with penile and testicular growth and the proliferation of gonadic cells. In girls, the oestradiol levels stimulate breast tissue, but exhibit considerable fluctuations that probably reflect the cycles of maturation and atrophy of the ovarian follicles. Minipuberty allows for the development of the genital organs and creates the basis for future fertility, but further studies are necessary to understand its exact role, especially in girls. Nevertheless, no scientific study has yet elucidated how the HPG axis turns itself off and remains dormant until puberty. Additional future studies may identify clinical implications of minipuberty in selected cohorts of patients, such as premature and small for gestational age infants. Finally, minipuberty provides a fundamental 6-month window of the possibility of making early diagnoses in patients with suspected sexual reproductive disorders to enable the prompt initiation of treatment rather than delaying treatment until pubertal failure.

Keywords: gonadotropin, hypothalamic-pituitary-gonadal, minipuberty, oestradiol, testosterone

Feedback

Introduction

Puberty is the period of life in which a child develops secondary sexual characteristics and reproductive function. Puberty requires activation of the hypothalamic-pituitary-gonadal (HPG) axis, resulting in secretion of hypothalamic gonadotropin-releasing hormone (GnRH), which in turn stimulates secretion of luteinizing hormone (LH) and follicle stimulating hormone (FSH) by the pituitary gland and the consequent maturation of gametogenesis as well as secretion of gonadal hormones. Before the onset of puberty, the HPG axis is temporary activated in two other periods of life, i.e., in the midgestational fetus and in the newborn. In recent years, many studies in the literature have referred to this latter period as minipuberty.

Minipuberty was first described in the 1970s (1, 2), but its role is still not well understood. The aim of this review is to analyse the impact and the clinical role of minipuberty. PubMed was used to search for all relevant studies published over the last 25 years using the key words "minipuberty," "mini-puberty," "HPG axis," "gonadotropins," and "sexual hormones," combined with "fetal life," "newborn," "preterm," "small for gestational age," "growth," "congenital hypogonadotropic hypogonadism," "Turner syndrome," "Klinefelter syndrome" and "CAIS". Additional sources were found from the references of the publications that were obtained from the search. The data obtained from studies published between 1973 and 2017 are included in this review, and the most recent research is dated March 2017.

Hypothalamic-pituitary-gonadal (HPG) axis activation in fetal life

During embryogenesis, neurons that produce GnRH develop from the epithelium of the medial olfactory pit and move to the fetal hypothalamus by migrating along nerve fibers (3). This process occurs at ~40 days of gestation (4). Simultaneously, the pituitary gland develops and begins synthesizing both LH and FSH at 9 weeks of gestation (WG) (5), although the hormones appear in the fetal blood by 12–14 WG (6). Kisspeptin and KISS1R are factors that are involved in the regulation of fetal GnRH neuron activity. However, serum LH and FSH levels are independent of GnRH and kisspeptin at midgestation, but they become GnRH-induced after 30–31 WG (7).

The gonadotropin levels peak at midgestation in both the pituitary gland and the serum and subsequently decrease toward birth and are suppressed at term (8, 9). This pattern is probably caused by the gradual increase in the production of placental estrogens toward the end of gestation (10) that suppresses the activity of the fetal HPG axis.

Additionally, female fetuses produce higher LH and FSH levels than male fetuses (6, 11). Indeed, Debieve et al. (12) measured LH and FSH at midpregnancy (the group had median ages of 23.8 WG for the females and 22.6 WG for the males) and at term (median ages: 39.2 WG for the females and 38.9 WG for the males). Both gonadotropins were present in the first group and exhibited a clear difference between the females and males; the girls exhibited much higher levels (33.0 ± 23.2 vs. 4.4 ± 3.3 mIU/mL for LH and 54.4 ± 27.7 vs. 0.77 ± 0.49 mIU/mL for FSH). In contrast, in the term female fetuses, both LH and FSH were undetectable, and only very low FSH levels were observed in the term male fetuses. The midpregnancy gonadotropin peak coincides with the first ovarian follicle or seminiferous tubule maturation. The difference between genders is probably caused by the negative feedback that results from the higher concentrations of fetal testicular hormones (6, 13, 14). Another marked difference between the sexes is that the LH levels overcome the FSH levels in male fetuses (15), whereas the opposite situation occurs in females.

During fetal life, the masculinization of genitalia depends on the production of testosterone (T) by the Leydig cells of the fetal testicles and on its action on target organs. During the first trimester of gestation, placental human chorio-gonadotropin (hCG) induces the differentiation of testicular mesenchymal cells into Leydig cells and stimulates T production through the activation of the LH/CG receptors expressed on their surfaces (16). Indeed, mutations of the LH/CG receptor can cause the absence of virilization and feminization of the external genitalia (17). Thus, the fetal testicular T is secreted first under the control of placental hCG, and only after the 9th WG, T secretion comes under the control of pituitary LH. A clear increase in T concentration occurs between 8 and 11 WG and reaches a maximum between 11 and 14 WG. The peak level (40–580 ng/dL) is similar to the adult value (14), whereas T levels in the fetal testes can reach ~1.9–2.1 ng/mg of tissue (16). After the 20th WG, T decreases toward term (8, 14). The fetal testicles also express FSH receptors that probably control Sertoli cell proliferation, although only few studies exist regarding the effects of FSH (18–20). Anti-mullerian hormone (AMH) that is produced by the Sertoli cells in the fetal testes causes the regression of the mullerian ducts, which prevents the formation of internal feminine genitalia. T favors the development of male urogenital structures from the wolffian duct, such as the vas deferens, epididymis, and seminal vesicles, while the formation of the prostate, penis and scrotum is due to the active metabolite of T (dihydrotestosterone).

In female fetuses, the lack of AMH allows the mullerian ducts to develop into the fallopian tubes, uterus and upper part of the vagina (21). The development of the primordial follicle in the fetal ovaries begins before 13 WG, but the follicles are more rapidly created after 14–15 WG. The pool of primordial follicles is ~100,000 at 15 WG and then rapidly increases to reach a higher number at 34 WG (680,000). Subsequently, the pool remains stable, at least until 8 months after birth (22). This pool, which represents the foundation of female fertility, is formed when estrogen levels are high in the fetal circulation. However, the majority of estrogen production during fetal life is due to the placenta, and ovarian production can be considered irrelevant. Additionally, the roles of FSH and LH in ovarian development during pregnancy are not completely understood. It seems that normal development occurs until the 34th WG even in anencephalic fetuses. In contrast, during the last part of gestation, a marked difference can be found; in anencephalic fetuses small and growing antral follicles cannot be observed as they can in normal fetuses (23), which suggests that hypothalamic stimulation is necessary to ensure physiological ovarian development after the 7th month of gestation.

Minipuberty and its implications in healthy infants

At delivery, in healthy infants the LH and FSH levels are low in the cord blood in both sexes (24) due to the inhibitory effect of the high levels of placental estrogens. In boys, the LH level increases by ~10-fold in the few minutes after delivery, and this increase is followed by a concomitant rise in the T levels that lasts for ~12 h (25, 26). In girls, this increase does not occur.

In the first few days after birth, the fall in circulating placentally produced steroids causes a progressive lack of negative feedback on the neonatal GnRH pulse generator. In this manner, the activity of the HPG axis is reinitiated, and gonadotropin levels begin rising between days 6 and 10 after birth (27, 28). In infant boys, the serum LH level reaches the pubertal range by 1 week of age, the peak is detected between the 2nd and 10th weeks of life, and the level then decreases to the prepubertal range by 4–6 months (27–30) (Figure 1). Female infants have lower peak LH values, but the pattern is similar (Figure 2) (27–29). In contrast, the FSH levels are higher in females than in males and peaking between 1 week and 3 months. Subsequently, in males, the FSH values gradually decrease to the prepubertal range within 4 months of age, whereas in females, these values remain elevated until to 3–4 years of age (27, 29, 31).

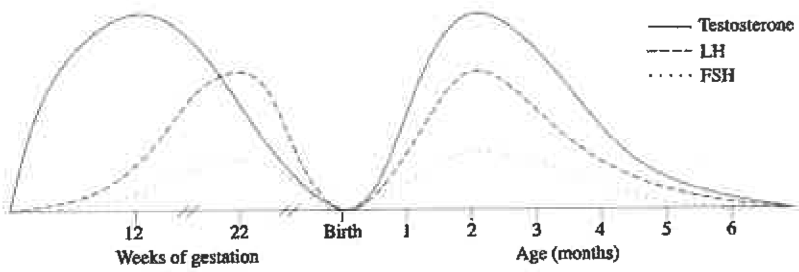

Figure 1

Patterns of fetal and postnatal luteinizing hormone (LH), follicle stimulating hormone (FSH) and testosterone (T) secretion in males.

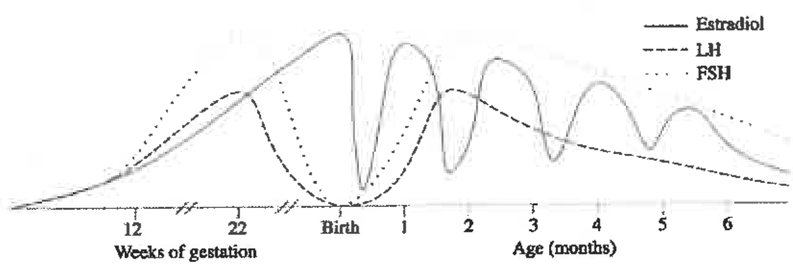

Figure 2

Patterns of fetal and postnatal luteinizing hormone (LH), follicle stimulating hormone (FSH) and oestradiol secretion in females.

Table 1 summarizes sex differences and the patterns of basal LH/FSH in the first month of life. In male neonates, the pattern of T secretion is similar to that of LH secretion: T is low in the cord blood, gradually increases to peak at 1–3 months and then declines to prepubertal values by 6–9 months of age (2, 27, 28, 30, 32). Similarly, the number of Leydig cells in the testicular tissue increases considerably until the third month and then gradually decreases due to apoptosis of the fetal Leydig cells (33–36). Sertoli cells also develop in the first months after birth under the stimulation of FSH (37), but they do not express androgen receptors during infancy, and therefore spermatogenesis does not occur (38). These cells secrete AMH in male neonates: the highest levels are observed at 3 months, and the levels subsequently decline and remain at relatively stable levels throughout childhood until puberty at which point AMH progressively decline to the adult level of 3–4% of the infant level (39). The absence of androgen receptors explains why AMH levels remain elevated in the presence of the high T levels during early infancy (38, 40). Additionally, in prepubertal boys, Sertoli cells secrete inhibin B, which represents a marker of Sertoli cell function. This hormone, which is already present in the cord blood, increases soon after birth, peaks at 3–6 months of age, reaches greater values then those observed in adults (mean +/– SD: 378 +/– 23 pg/mL), and remains elevated until at least the age of 15 months (28, 32, 41).

Table 1

Luteinizing hormone (LH) and follicle stimulating hormone (FSH) values (means ± SD) in neonates.

Age (days)	LH in males	LH in females	FSH in males	FSH in females
1–5	0.39 ± 0.48	0.48 ± 0.66	0.96 ± 0.60	2.00 ± 1.37
6–10	2.31 ± 2.29	0.45 ± 0.33	2.91 ± 4.38	2.44 ± 2.52
11–15	3.55 ± 2.84	1.58 ± 1.28	3.71 ± 2.69	8.16 ± 4.27
16–20	4.13 ± 2.76	1.03 ± 1.39	2.63 ± 1.45	1.62 ± 1.05
21–25	2.86 ± 1.51	0.46 ± 0.25	2.50 ± 1.51	7.07 ± 5.92
26–28	2.22 ± 2.37	2.75 ± 2.39	2.25 ± 0.81	9.74 ± 9.89

Values of LH and FSH are in mIU/mL.

Adapted from Schmidt and Schwarz HP (27).

Minipuberty has been associated with physiological gonadal development processes, such as penile and testicular growth and the proliferation of gonadic cells. Cortes et al. (42) found that penile length is positively correlated with serum T and increases from birth (mean +/– SD, 3.49 +/– 0.4 cm) to 3 years of age with the highest growth velocity occurring from birth to 3 months (1 mm/month). In contrast, testicular volume increases significantly in the first 5–6 months of life, from 0.27 to 0.44 cm^3, and the volume subsequently decreases to 0.31 cm^3 at ~9 months (43). This pattern is positively correlated with FSH levels (30), which is probably due to the proliferation of Sertoli cells in the seminiferous tubules (37). Additionally, Hadziselimovic et al. proposed that germ cells can differentiate into adult (Ad) spermatogonia due to the transient activation of the HPG axis during the first months of life (44).

Thus, the first months of life are fundamental for the development of the male reproductive organs. In contrast, it is not completely clear whether these months are also important for the reproductive functions of girls. At birth, oestradiol levels are high in the cord blood of both sexes. Umbilical cord estrogen concentrations depend on gestational age, the mode of delivery, pregnancy complications, and twinning, but not on infant sex (45). In a study conducted by Troisi et al. (46), the mean oestradiol values measured in cord blood were found to be 11,941 pg/ml in females and 12,782 pg/ml in males, and the difference between gender was not significant. During the first postnatal days, oestradiol levels gradually decrease, but after 1 week of age, they increase in girls only and remain high in the subsequent period (47–49) until at least the 6th month of life. Similar observations were made by Bidlingmaier et al. (50), who found the higher oestradiol concentration in the ovaries of 1- to 6-month-old girls compared with those at the end of the first year in postmortem samples. At 3 months of age, the median serum oestradiol level in girls is 30.0 pmol/L (range < 18–100) (47). However, individual oestradiol levels in girls exhibit considerable fluctuation in the first months of life, which may reflect the cycles of maturation and atrophy of the ovarian follicles. Indeed Kuiri-Hanninen et al. (31) reported increased numbers of antral follicles on ovarian ultrasonography in infant girls, and this fact corresponds to parallel elevations of oestradiol (48, 49) and AMH levels (31, 51). Indeed, in infant girls, there is a marked rise of AMH levels at 3 months of age (15 pmol/L; 4.5–29.5 pmol/L) compared with the levels found in cord blood (2 pmol/L; 2–15.5 pmol/L) and at 1 year of age (51). This fact may demonstrate the postnatal proliferation of granulosa cells, which produce AMH, and the contemporary development of the ovarian follicles, which probably occurs in response to the parallel FSH surge (31, 51).

The mammary glands and the uterus are also certainly estrogen target tissues in the fetus and in newborn. At birth, most full term babies of both sexes have palpable breast tissue (52) that probably results from in-uterus stimulation from placental estrogens. However, in the following months, the breast tissue in females remains larger and persists longer (52). In boys, the mammary gland diameter gradually decreases until the 6th month, whereas in full-term girls, it remains large, reflecting the activity of endogenous estrogens (48). In contrast, the uterine length increases primarily during pregnancy due to the hormones that cross the placental barrier, and after birth, it is longest at day 7 in full-term babies and then steadily decreases toward the third month and remains fairly unchanged until the second year (48). Therefore, the role of minipuberty in girls is still controversial and partially unknown.

Minipuberty in premature infants and in those small for gestational age (SGA)

Postnatal HPG axis activation also occurs in premature infants and is even stronger and more prolonged in time than in full-term infants (53, 54). Kuiri-Hanninen et al. (30) recently compared full-term (FT) and preterm (PT) males by measuring urinary gonadotropins and T in serial urine samples and comparing the results with testicular and penile growth. The trends of LH and T secretion are similar among the groups, but the levels are significantly higher in PT than in FT males when measured at 7 and 30 days of age. These levels then decline in both groups, but a significant difference can still be observed at month 6. Additionally, a positive association between the level of HPG axis activation and the grade of prematurity has been found, and PT males have been associated with faster penile and testicular growth after birth, which suggests that HPG axis activation plays a role in completing genital development.

In PT females, the FSH and LH values are higher than those in FT girls (55) and exhibit a more elevated and more prolonged peak; these patterns might reflect the expression of the immaturity of a negative feedback system in the HPG axis of PT girls. The greater levels of FSH in PT females are probably due to a delay in ovarian folliculogenesis; the ovaries are still immature and do not seem to be able to produce sufficient estrogens that may inhibit gonadotropin secretion. Additionally, the FSH peak is followed by transient ovarian stimulation (which reaches a maximum at ~4 weeks of age) that results in the presence of antral follicles on ultrasonography and increases in the levels of granulosa cell–derived AMH and oestradiol (31), which are higher in the serum of PT than FT girls (49). Estrogen receptor alpha is expressed in the fetal mammary glands from ~30 weeks of gestation (56), which might explain the absence of breast development in PT infants. However, in these girls, there is a stronger association between the postnatal oestradiol surge and the growth of the mammary gland diameter and uterine length (48).

A possible clinical consequence of this intensive stimulation on the genital organs that occurs in premature infants is ovarian hyperstimulation syndrome. First described in 1985 by Sedin et al. (57) in 4 very preterm neonates, ovarian hyperstimulation syndrome is characterized by oedema of the vulva, solitary or multiple cysts in the ovaries on ultrasonography, breast growth, occasional vaginal bleeding and high serum gonadotropin and oestradiol levels. This syndrome is probably the extreme consequence of the immaturity of the negative feedback mechanisms that act on the HPG axis, and this absence of feedback results in hyperstimulation of the target organs. Several cases have been reported in the literature (58–62), and all cases indicate that it is a self-limiting disease that does not require treatment if there are no complications, but follow-up until clinical resolution is necessary.

Infants born small for gestational age (SGA) are at risk of developing metabolic and endocrinological disorders (63). It is well known that SGA children are at greater risk of type 2 diabetes and cardiovascular diseases, expecially those with high catch up growth. In fact, the fetus in nutritional deficiency constantly replans his metabolism to slow growth with relative resistance to insulin, IGF-1 and GH, that persists in childhood and adult life too (64). Besides, lower insulin sensitivity has been also associated to an increased incidence of adrenal and ovarian hyperandrogenism, clinically evident as precocious pubarche and reduced ovulation rate (65).

In females, being SGA has been associated with reduced uterine and ovary size (66), whereas, in males, SGA has been linked to infertility and reduced testicular volume and T concentrations in adult life (67). Minipuberty in SGA infants is still not well defined, and the data reported in the literature are controversial. Recently, Nagai et al. (68) conducted a longitudinal study and reported lower FSH and T, as well as higher LH concentrations, in SGA infants compared with appropriate for gestational age (AGA) infants. In contrast, in previous studies, elevated serum FSH concentrations have been detected in SGA infant girls and boys (69); similarly, higher T levels have been found in SGA than in AGA boys (70). Further studies are necessary to definitely clarify the patterns of minipuberty in SGA infants and their clinical implications.

Minipuberty and growth

Growth is influenced by different hormones depending on the period of life. In fact, in the first years, thyroid hormones play the main role, together with insulin and glucocorticoids. By contrast, GH becomes predominant during infancy until the period of puberty, when the rise of levels of sexual hormones results in the growth spurt, which is essential for final growth and bone maturation.

Recently, new studies have described an association between minipuberty and growth, particularly in males. Indeed, sex steroids and gonadotropic hormones in the first 5 months of life seem to influence somatic development in boys during the following 6 years. Becker et al. (71) conducted a prospective study of 35 healthy infants (17 males) and reported that the surge in T during the first months of life has an influence on human somatic and adipose tissue development in childhood. Indeed, boys exhibit faster increases in weight and BMI at the age of 8 weeks than do girls. At this age, the median T level has been found to be 7.37 nmol/L, which corresponds to pubertal male values. Subsequently, other trials have been conducted with greater numbers of participants. Kiviranta et al. (72) studied 84 healthy neonates (45 of which were males). The linear growth velocity was significantly faster from birth to 6 months of age in boys than in girls, and the greatest growth velocity difference, i.e., 4.1 cm per year, was observed at 1 month of age, which is simultaneous with the peak of the postnatal gonadal activation, especially in terms of T level.

Minipuberty and hypogonadism

In the last 20 years, studies have been conducted to establish an association between minipuberty and hypogonadotropic hypogonadism (HH), especially in males, and have found that the disease is characterized by the absence of the postnatal FSH, LH, and T surge. For this reason, minipuberty provides a short-time window of opportunity to make an early diagnosis (41). At birth, HH can be revealed by a micropenis with or without associated cryptorchidism, and male neonates exhibiting these "red flags" should undergo a single serum sample examination to identify congenital gonadotropin deficiency (73, 74). A novel study conduced in a large cohort of HH patients, in fact, confirmed the importance of identifying male genital tract anomalies in prepubertal age, in particular showing that micropenis or cryptorchidism are significantly more represented in HH resulting from Kallman syndrome (75). The best period for the measurement of the serum concentrations of reproductive hormone is between 4 and 8 weeks of life, but it can be practically performed until 6 months of age (73). Besides, a recent study suggested that testicular position increases from birth to 3 months of age and decreases thereafter, overlapping with the period of minipuberty. Therefore, testicular distance to pubic bone may be a useful biomarker of postnatal testicular function, both for Leyding and Sertoli cell activity (76).

Hadziselimovic et al. identified impaired minipuberty as the main reason for cryptorchidism-induced infertility (77). Indeed, the lack of secretion of LH and T in the perinatal period prevents the differentiation of germ cells, which results in infertility after puberty (78).

Furthermore, the importance of minipuberty has been highlighted by evidence that orchiopexy alone does not necessary improve fertility in cryptorchid males, whereas in 6-month-olds, long targeted therapy with LH-Rh analogs following successful surgery results in the normalization of the sperm parameters in adult life (79). Table 2 presents case reports and descriptions of small trials of patients with HH who were treated during the first year of life with recombinant human LH and FSH or with T in attempts to imitate physiological minipuberty. In all cases, the effects were beneficial. The substitutive therapy with T resulted in a marked increase in T level and penile length, whereas recombinant gonadotropin administration caused increase not only in T level, but also in LH, FSH, as well as inhibin B and AMH. This hormonal pattern results both in the increase of penile length and testicular volume and in fertility potential later in life. The administration of gonadotropins is safe, well tolerated and effective. Finally, new evidences suggest also the possibility of treatment with a gonadotropin-releasing hormone agonist, which induces gonocytes to differentiate into Ad spermatogonia and rescues fertility (84). As regards hypergonadotropic hypogonadism, one of the most frequent causes is Turner syndrome (TS). In these patients, perinatal FSH secretion is similar to that in healthy girls (85), however, during infancy, the pattern of FSH secretion is strictly related to karyotype. Young girls with monosomy TS exhibit a persistent elevation of FSH up to 6 years, whereas those with 45,X/46,XX mosaicism have only minimally elevated FSH values, which suggests the presence of feedback effects on the HPG axis due to retained ovarian function (86, 87).

Table 2

Replacement therapy for hypogonadotropic hypogonadism in the first year of life.

References	Year	N. cases	Hormonal therapy	Clinical and hormonal outcome
Main et al. (80)	2000	3	T	↑ T levels and penis length
Main et al. (81)	2002	1	rLH and rFSH	↑ inhibin B levels; ↑ testicular volume and penis length
Bougnères et al. (82)	2008	2	rLH and rFSH	↑ T, inhibin B and AMH levels; ↑ testicular volume and penis length
Stoupa et al. (83)	2017	6	rLH and rFSH	↑ T, inhibin B and AMH levels; ↑ penis length

AMH, anti-mullerian hormone; rFSH, recombinant stimulating hormone; rLH, recombinant luteinizing hormone; T, testosterone.

Contrasting data can be found in the literature about males with Klinefelter syndrome (KS). Lahlou et al. (88) found that, in their cohort of KS patients 0–3 years old, the FSH, LH, and inhibin B levels were similar to those in healthy controls with the exception of T, which exhibited a physiological increase during the first trimester, but always remained at a lower level thereafter when compared with controls. Similarly, Ross et al. underlined that the neonatal surge in T is attenuated in the KS population (89). In contrast, Aksglaede et al. (90) found elevated LH levels and high-normal serum T levels in KS infants, as well as evidence of subtle Sertoli cell dysfunction with low-normal inhibin B levels. This situation may predict the postpubertal resistance of Sertoli cells to FSH action in subjects with KS in adult life (91). Table 3 summarizes studies on minipuberty in KS.

Table 3

Minipuberty in Klinefelter syndrome (KS).

References	Year	N. cases	N. controls	Age of population	Hormonal findings
Lahlou et al. (88)	2004	18	215	0–3 years	FSH, LH, inhibin B, and AMH not different between groups; T ↓ in KS
Ross et al. (89)	2005	22	–	1–23 months	T ↓ in KS
Aksglaede et al. (90)	2007	10	613	3 months	↑ T, LH and FSH; inhibin B not different between groups
Cabrol et al. (91)	2011	68	215	2–750 days	T, LH, inhibin B and AMH not different between groups; normal or ↑ FSH levels in KS

AMH, anti-mullerian hormone; LH, uteinizing hormone; rFSH, recombinant stimulating hormone; T, testosterone.

Finally, androgen receptors also play an important role in HPG axis activity. Indeed, infants with complete androgen insensitivity who present with a mutation in the androgen receptor do not exhibit the physiological peaks in LH and consequently T during minipuberty, whereas neonates with partial androgen insensitivity exhibit high-normal levels of postnatal T and LH (92).

Conclusions

The HPG axis is physiologically activated in the fetus during midgestation and gradually turns off toward term due to the negative feedback of placental hormones on the fetal hypothalamus. At birth, when the restriction is removed, the HPG axis reactivates, which results in a T peak in males between months 1 and 3; by contrast, the oestradiol levels in females fluctuate until 6 months of age. Minipuberty allows for the development of the genital organs and creates the basis for future fertility, but further studies are necessary to understand its exact role, especially in girls. Nevertheless, no scientific study has yet elucidated how the HPG axis turns itself off and remains dormant until puberty. Additional future studies may identify clinical implications of minipuberty in selected cohorts of patients, such as premature and small for gestational age infants. Finally, minipuberty provides a fundamental 6-month window of the possibility of making early diagnoses in patients with suspected sexual reproductive disorders to enable the prompt initiation of treatment rather than delaying treatment until pubertal failure.

Author contributions

LL drafted the manuscript. MC and AL performed the literature review. LP supervised the project. SE revised the manuscript and made substantial scientific contributions.

Conflict of interest statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Footnotes

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References

1. Forest MG, Cathiard AM. Pattern of plasma testosterone and A4 androstenedione in normal newborns: evidence for testicular activity at birth. *J Clin Endocrinol Metab.* (1975) 1:977–80. 10.1210/jcem-41-5-977 [PubMed] [CrossRef] [Google Scholar]

2. Forest MG, Cathiard AM, Bertrand JA. Evidence of testicular activity in early infncy. *J Clin Endocrinol Metab.* (1973) 1:148–51. 10.1210/jcem-37-1-148 [PubMed] [CrossRef] [Google Scholar]

3. Schwanzel-Fukada M, Pfaff D. Origin of luteinizing hormone-releasing hormone neurons. *Nature* (1989) 338:161–4. 10.1038/338161a0 [PubMed] [CrossRef] [Google Scholar]

4. Crossin KL, Pfaff DW, Bouloux PMG, Pasteur I, France JH. Migration of luteinizing hormone-releasing hormone (LHRH) neurons in early human embryos. *J Clin Invest.* (1996) 1996:547657. [Google Scholar]

5. Hagen C, McNeilly AS. The gonadotrophins and their subunits in foetal pituitary glands and circulation. *J Steroid Biochem.* (1977) 8:537–44. 10.1016/0022-4731(77)90259-X [PubMed] [CrossRef] [Google Scholar]

6. Clements JA, Reyes FI, Winter JSD, Faiman C. Studies on human sexual development. III. Fetal pituitary and serum, and amniotic fluid concentrations of LH, CG, and FSH. *J Clin Endocrinol Metab.* (1976) 42:9. 10.1210/jcem-42-1-9 [PubMed] [CrossRef] [Google Scholar]

7. Guimiot F, Chevrier L, Dreux S, Chevenne D, Caraty A, Delezoide AL, et al.. Negative fetal FSH/LH regulation in late pregnancy is associated with declined Kisspeptin/KISS1R expression in the tuberal hypothalamus. *J Clin Endocrinol Metab.* (2012) 97:2221–9. 10.1210/jc.2012-2078 [PubMed] [CrossRef] [Google Scholar]

8. Takagi S, Yoshida T, Tsubata K, Ozaki H, Fujii TK, Nomura Y, et al.. Sex differences in fetal gonadotropins and androgens. *J Steroid Biochem.* (1977) 8:609–20. 10.1016/0022-4731(77)90270-9 [PubMed] [CrossRef] [Google Scholar]

9. Massa G, de Zegher F, Vanderschueren-Lodeweyckx M. Serum levels of immunoreactive inhibin, FSH, and LH in human infants at preterm and term birth. *Biol Neonate.* (1992) 61:150–5. 10.1159/000243737 [PubMed] [CrossRef] [Google Scholar]

10. Troisi R, Potischman N, Roberts JM, Harger G, Markovic N, Cole B, et al. Hoover RN. Correlation of serum hormone concentrations in maternal and umbilical cord samples. *Cancer Epidemiol Biomarkers Prev.* (2003) 12:452–6. [PubMed] [Google Scholar]

11. Kaplan SL, Grumbach MM. The ontogenesis of human foetal hormones. II. Luteinizing hormone (LH) and follicle stimulating hormone (FSH). *Acta Endocrinol.* (1976) 81:808–29. 10.1530/acta.0.0810808 [PubMed] [CrossRef] [Google Scholar]

12. Debieve F, Beerlandt S, Hubinont C, Thomas K. Gonadotropins, prolactin, inhibin A, inhibin B, and activin A in human fetal serum from midpregnancy and term pregnancy. *J Clin Endocrinol Metab.* (2000) 85:270–4. 10.1210/jcem.85.1.6249 [PubMed] [CrossRef] [Google Scholar]

13. Winter JS. Hypothalamic-pituitary function in the fetus and infant. *Clin Endocrinol Metab.* (1982) 11:41–55. 10.1016/S0300-595X(82)80037-6 [PubMed] [CrossRef] [Google Scholar]

14. Reyes FI, Borodits RS, Winter JSD, Faiman C. Studies on human sexual development.2. Fetal and maternal serum gonadotropin and sex steroid concentrations. *J Clin Endocrinol Metab.* (1974) 38:612–7. 10.1210/jcem-38-4-612 [PubMed] [CrossRef] [Google Scholar]

15. Beck-Peccoz P, Padmanabhan V, Baggiani AM, Cortelazzi D, Buscaglia M, Medri G, et a. Maturation of hypothalamic-pituitary-gonadal function in normal human fetuses: circulating levels of gonadotropins, their common a-subunit and free testosterone, and discrepancy between immunological and biological activities of circulating follicle-stimu. *J Clin Endocrinol Metab.* (1991) 73:525–32. 10.1210/jcem-73-3-525 [PubMed] [CrossRef] [Google Scholar]

16. Tapanainen J, Kellokumpu-lehtinen P, Pelliniemi L. Age-related changes in endogenous steroids of human. *J Clin Endocrinol Metab.* (1981) 52:98–102. 10.1210/jcem-52-1-98 [PubMed] [CrossRef] [Google Scholar]

17. Latronico AC, Anasti J, Arnhold IJ, Rapaport R, Mendonca BB, Bloise W, et al.. Testicular and ovarian resistance to luteinizing hormone caused by inactivating mutations of the luteinizing hormone. *N Engl J Med.* (1996) 334:507–12. 10.1056/NEJM199602223340805 [PubMed] [CrossRef] [Google Scholar]

18. Zhang S, Li W, Zhu C, Wang X, Li Z, Zhang J, et al.. Sertoli cell-specific expression of metastasis-associated protein 2 (MTA2) is required for transcriptional regulation of the follicle-stimulating hormone receptor (FSHR) gene during spermatogenesis. *J Biol Chem.* (2012) 287:40471–83. 10.1074/jbc.M112.383802 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

19. Plant TM, Marshall GR. The functional significance of FSH in spermatogenesis and the control of its secretion in male primates. *Endocr Rev.* (2001) 22:764–86. 10.1210/edrv.22.6.0446 [PubMed] [CrossRef] [Google Scholar]

20. O'Shaughnessy PJ, Baker PJ, Monteiro A, Cassie S, Bhattacharya S, Fowler PA. Developmental changes in human fetal testicular cell numbers and messenger ribonucleic acid levels during the second trimester. *J Clin Endocrinol Metab.* (2007) 92:4792–801. 10.1210/jc.2007-1690 [PubMed] [CrossRef] [Google Scholar]

21. Bowles J, Koopman P. Sex determination in mammalian germ cells: extrinsic versus intrinsic factors. *Reproduction* (2010) 139:943–58. 10.1530/REP-10-0075 [PubMed] [CrossRef] [Google Scholar]

22. Forabosco A, Sforza C. Establishment of ovarian reserve: a quantitative morphometric study of the developing human ovary. *Fertil Steril.* (2007) 88:675–83. 10.1016/j.fertnstert.2006.11.191 [PubMed] [CrossRef] [Google Scholar]

23. Baker TG, Scrimgeour JB. Development of the gonad in normal and anencephalic human fetuses. *J Reprod Fertil.* (1980) 60:193–9. 10.1530/jrf.0.0600193 [PubMed] [CrossRef] [Google Scholar]

24. Varvarigou AA, Liatsis SG, Vassilakos P, Decavalas G, Beratis NG. Effect of maternal smoking on cord blood estriol, placental lactogen, chorionic gonadotropin, FSH, LH, and cortisol. *J Perinat Med.* (2009) 37:364–9. 10.1515/JPM.2009.028 [PubMed] [CrossRef] [Google Scholar]

25. Corbier P, Dehennin L, Castanier M, Mebazaa A, Edwards DA, Roffi J. Sex differences in serum luteinizing hormone and testosterone in the human neonate during the first few hours after birth. *J Clin Endocrinol Metab.* (1990) 71:1344–8. 10.1210/jcem-71-5-1344 [PubMed] [CrossRef] [Google Scholar]

26. de Zegher F, Devlieger H, Veldhuis JD. Pulsatile and sexually dimorphic secretion of luteinizing hormone in the human infant on the day of birth. *Pediatr Res.* (1992) 32:605–7. 10.1203/00006450-199211000-00025 [PubMed] [CrossRef] [Google Scholar]

27. Schmidt H, Schwarz HP. Serum concentrations of LH and FSH in the healthy newborn. *Eur J Endocrinol.* (2000) 143:213–5. 10.1530/eje.0.1430213 [PubMed] [CrossRef] [Google Scholar]

28. Bergadá I, Milani C, Bedecarrás P, Andreone L, Ropelato MG, Gottlieb S, et al.. Time course of the serum gonadotropin surge, inhibins, and anti-Müllerian hormone in normal newborn males during the first month of life. *J Clin Endocrinol Metab.* (2006) 91:4092–8. 10.1210/jc.2006-1079 [PubMed] [CrossRef] [Google Scholar]

29. Winter JSD, Faiman C, Hobson WC, Prasad AV, Reyes FI. Pituitary-gonadal relations in infancy. I. patterns of serum gonadotropin concentrations from birth to four years of age in man and chimpanzee. *J Clin Endocrinol Metab.* (1975) 40:545–51. 10.1210/jcem-40-4-545 [PubMed] [CrossRef] [Google Scholar]

30. Kuiri-Hänninen T, Seuri R, Tyrväinen E, Turpeinen U, Hämäläinen E, Stenman UH, et al.. Increased activity of the hypothalamic-pituitary-testicular axis in infancy results in increased androgen action in premature boys. *J Clin Endocrinol Metab.* (2011) 96:98–105. 10.1210/jc.2010-1359 [PubMed] [CrossRef] [Google Scholar]

31. Kuiri-Hänninen T, Kallio S, Seuri R, Tyrväinen E, Liakka A, Tapanainen J, Sankilampi U, Dunkel L. Postnatal developmental changes in the pituitary-ovarian axis in preterm and term infant girls. *J Clin Endocrinol Metab.* (2011) 96:3432–9. 10.1210/jc.2011-1502 [PubMed] [CrossRef] [Google Scholar]

32. Andersson AM, Toppari J, Haavisto AM, Petersen JH, Simell T, Simell O, et al.. Longitudinal reproductive hormone profiles in infants: Peak of inhibin B levels in infant boys exceeds levels in adult men. *J Clin Endocrinol Metab.* (1998) 83:675–81. 10.1210/jc.83.2.675 [PubMed] [CrossRef] [Google Scholar]

33. Chemes HE. Infancy is not a quiescent period of testicular development. *Int J Androl.* (2001) 24:2–7. 10.1046/j.1365-2605.2001.00260.x [PubMed] [CrossRef] [Google Scholar]

34. Codesal J, Regadera J, Nistal M, Regadera-Sejas J, Paniagua R. Involution of human fetal Leydig cells. An immunohistochemical, ultrastructural and quantitative study. *J Anat.* (1990) 172:103–14. [PMC free article] [PubMed] [Google Scholar]

35. Lejeune H, Habert R, Saez JM. Origin, proliferation and differentiation of Leydig cells. *J Mol Endocrinol.* (1998) 20:1–25. 10.1677/jme.0.0200001 [PubMed] [CrossRef] [Google Scholar]

36. Nistal M, Paniagua R, Regadera J, Santamaria L, Amat P. A quantitative morphological study of human Leydig cells from birth to adulthood. *Cell Tissue Res.* (1986) 246:229–36. 10.1007/BF00215884 [PubMed] [CrossRef] [Google Scholar]

37. Cortes D, Muller J, Skakkebaek NE. Proliferation of Sertoli cells during development of the human testis assessed by stereological methods. *Int J Androl.* (1987) 10:589–96. 10.1111/j.1365-2605.1987.tb00358.x [PubMed] [CrossRef] [Google Scholar]

38. Chemes HE, Rey RA, Nistal M, Regadera J, Musse M, González-Peramato P, et al.. Physiological androgen insensitivity of the fetal, neonatal, and early infantile testis is explained by the ontogeny of the androgen receptor expression in sertoli cells. *J Clin Endocrinol Metab.* (2008) 93:4408–12. 10.1210/jc.2008-0915 [PubMed] [CrossRef] [Google Scholar]

39. Aksglaede L, Sørensen K, Boas M, Mouritsen A, Hagen CP, Jensen RB, et al.. Changes in anti-mullerian hormone (AMH) throughout the life span: a population-based study of 1027 healthy males from birth (cord blood) to the age of 69 years. *J Clin Endocrinol Metab*. (2010) 95:5357–64. 10.1210/jc.2010-1207 [PubMed] [CrossRef] [Google Scholar]

40. Boukari K, Meduri G, Brailly-Tabard S, Guibourdenche J, Ciampi ML, Massin N, et al.. Lack of androgen receptor expression in sertoli cells accounts for the absence of anti-Mullerian hormone repression during early human testis development. *J Clin Endocrinol Metab*. (2009) 94:1818–25. 10.1210/jc.2008-1909 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

41. Grumbach MM. A window of opportunity: the diagnosis of gonadotropin deficiency in the male infant. *J Clin Endocrinol Metab*. (2005) 90:3122–7. 10.1210/jc.2004-2465 [PubMed] [CrossRef] [Google Scholar]

42. Boas M, Boisen KA, Virtanen HE, Kaleva M, Suomi AM, Schmidt IM, et al.. Postnatal penile length and growth rate correlate to serum testosterone levels: a longitudinal study of 1962 normal boys. *Eur J Endocrinol*. (2006) 154:125–9. 10.1530/eje.1.02066 [PubMed] [CrossRef] [Google Scholar]

43. Kuijper EA, van Kooten J, Verbeke JI, van Rooijen M, Lambalk CB. Ultrasonographically measured testicular volumes in 0- to 6-year-old boys. *Hum Reprod*. (2008) 23:792–6. 10.1093/humrep/den021 [PubMed] [CrossRef] [Google Scholar]

44. Hadziselimovic F, Hadziselimovic NO, Demougin P, Krey G, Oakeley E. Piwi-pathway alteration induces LINE-1 transposon derepression and infertility development in cryptorchidism. *Sex Dev*. (2015) 9:98–104. 10.1159/000375351 [PubMed] [CrossRef] [Google Scholar]

45. Hickey M, Hart R, Keelan JA. The relationship between umbilical cord estrogens and perinatal characteristics. *Cancer Epidemiol Biomarkers Prev*. (2014) 23:946–52. 10.1158/1055-9965.EPI-13-1321 [PubMed] [CrossRef] [Google Scholar]

46. Troisi R, Potischman N, Roberts J, Siiteri P, Daftary A, Sims C, et al.. Associations of maternal and umbilical cord hormone concentrations with maternal, gestational and neonatal factors (United States). *Cancer Causes Control* (2003) 14:347–55. [PubMed] [Google Scholar]

47. Schmidt IM, Chellakooty M, Haavisto AM, Boisen KA, Damgaard IN, Steendahl U, et al.. Gender difference in breast tissue size in infancy: correlation with serum estradiol. *Pediatr Res*. (2002) 52:682–6. 10.1203/00006450-200211000-00012 [PubMed] [CrossRef] [Google Scholar]

48. Kuiri-Hänninen T, Haanpää M, Turpeinen U. Postnatal ovarian activation has effects in estrogen target tissues in infant girls. *J Clin Endocrinol Metab*. (2013) 98:4709–16. 10.1210/jc.2013-1677 [PubMed] [CrossRef] [Google Scholar]

49. Chellakooty M, Schmidt IM, Haavisto AM, Boisen KA, Damgaard IN, Mau C, et al.. Inhibin A, inhibin B, follicle-stimulating hormone, luteinizing hormone, estradiol, and sex hormone-binding globulin levels in 473 healthy infant girls. *J Clin Endocrinol Metab*. (2003) 88:3515–20. 10.1210/jc.2002-021468 [PubMed] [CrossRef] [Google Scholar]

50. Bidlingmaier F, Strom TM, Dorr HG, Eisenmenger W, Knorr D. Estrone and estradiol concentrations in human ovaries, testes, and adrenals during the first two years of life. *J Clin Endocrinol Metab*. (1987) 65:862–7. 10.1210/jcem-65-5-862 [PubMed] [CrossRef] [Google Scholar]

51. Hagen CP, Aksglaede L, Sørensen K, Main KM, Boas M, Cleemann L, et al.., Juul A. Serum levels of anti-müllerian hormone as a marker of ovarian function in 926 healthy females from birth to adulthood and in 172 turner syndrome patients. *J Clin Endocrinol Metab*. (2010) 95:5003–10. 10.1210/jc.2010-0930 [PubMed] [CrossRef] [Google Scholar]

52. Jayasinghe Y, Cha R, Horn-Ommen J, O'Brien P, Simmons PS. Establishment of normative data for the amount of breast tissue present in healthy children up to two years of age. *J Pediatr Adolesc Gynecol*. (2010) 23:305–11. 10.1016/j.jpag.2010.03.002 [PubMed] [CrossRef] [Google Scholar]

53. Tapanainen J, Koivisto M, Vihko R, Huhtaniemi I. Enhanced activity of the pituitary-gonadal axis in premature human infants. *J Clin Endocrinol Metab.* (1981) 52:235–8. 10.1210/jcem-52-2-235 [PubMed] [CrossRef] [Google Scholar]

54. Shinkawa O, Furuhashi N, Fukaya T, Suzuki M, Kono H, Tachibana Y. Changes of Serum Gonadotropin Levels and Sex Differences in Premature and Mature Infant during Neonatal Life. *J Clin Endocrinol Metab.* (1983) 56:1327–31. 10.1210/jcem-56-6-1327 [PubMed] [CrossRef] [Google Scholar]

55. De Jong M, Rotteveel J, Heijboer AC, Cranendonk A, Twisk JWR, Van Weissenbruch MM. Urine gonadotropin and estradiol levels in female very-low-birth-weight infants. *Early Hum Dev.* (2013) 89:131–5. 10.1016/j.earlhumdev.2012.09.007 [PubMed] [CrossRef] [Google Scholar]

56. Keeling JW, Ozer E, King G, Walker F. Oestrogen receptor alpha in female fetal, infant, and child mammary tissue. *J Pathol.* (2000) 191:449–51. 10.1002/1096-9896(2000)9999:9999<::AID-PATH661>3.0.CO;2-# [PubMed] [CrossRef] [Google Scholar]

57. Sedin G, Bergquist C, Lindgren PG. Ovarian hyperstimulation syndrome in preterm infants. *Pediatr Res.* (1985) 19:548–52. 10.1203/00006450-198506000-00009 [PubMed] [CrossRef] [Google Scholar]

58. Marinkovic M, Rasmussen M, Jones K. Feminizing changes in a prematurely born infant. *Clin Pediatr (Phila).* (2010) 49:188–9. 10.1177/0009922809337624 [PubMed] [CrossRef] [Google Scholar]

59. Starzyk J, Wojcik M, Wojtys J, Tomasik P, Mitkowska Z, Pietrzyk JJ. Ovarian hyperstimulation syndrome in newborns–a case presentation and literature review. *Horm Res.* (2009) 71:60–4. 10.1159/000173743 [PubMed] [CrossRef] [Google Scholar]

60. Altuntas N, Turkyilmaz C, Yuce O, Kulali F, Hirfanoglu IM, Onal E, et al.. Preterm ovarian hyperstimulation syndrome presented with vaginal bleeding: a case report. *J Pediatr Endocrinol Metab.* (2014) 27:355–8. 10.1515/jpem-2013-0166 [PubMed] [CrossRef] [Google Scholar]

61. Durst MA, Wicklow B, Narvey M. Atypical case of preterm ovarian hyperstimulation syndrome. *BMJ Case Rep.* (2017) 1:2017 10.1136/bcr-2016-217517 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

62. Vochem M. [Ovarian hyperstimulation syndrome in preterm infants]. *Z Geburtshilfe Neonatol.* (2002) 206:156–60. 10.1055/s-2002-33669 [PubMed] [CrossRef] [Google Scholar]

63. Gluckman PD, Hanson MA. Living with the past: evolution, development, and patterns of disease. *Science.* (2004) 305:1733–6. 10.1126/science.1095292 [PubMed] [CrossRef] [Google Scholar]

64. Mericq V, Ong KK, Bazaes R, Peña V, Avila A, Salazar T, et al.. Longitudinal changes in insulin sensitivity and secretion from birth to age three years in small- and appropriate-for-gestational-age children. *Diabetologia* (2005) 48:2609–14. 10.1007/s00125-005-0036-z [PubMed] [CrossRef] [Google Scholar]

65. Ibáñez L, de Zegher F. Puberty after prenatal growth restraint. *Horm Res.* (2006) 65(Suppl. 3):112–115. [PubMed] [Google Scholar]

66. Ibanez L, Potau N, Enriquez G, Marcos MV, de Zegher F. Hypergonadotrophinaemia with reduced uterine and ovarian size in women born small-for-gestational-age. *Hum Reprod.* (2003) 18:1565–9. 10.1093/humrep/deg351 [PubMed] [CrossRef] [Google Scholar]

67. Cicognani A, Alessandroni R, Pasini A, Pirazzoli P, Cassio A, Barbieri E, Cacciari E. Low birth weight for gestational age and subsequent male gonadal function. *J Pediatr.* (2002) 141:376. 10.1067/mpd.2002.126300 [PubMed] [CrossRef] [Google Scholar]

68. Nagai S, Kawai M, Myowa-Yamakoshi M, Morimoto T, Matsukura T, Heike T. Gonadotropin levels in urine during early postnatal period in small for gestational age preterm male infants with fetal growth restriction. *J Perinatol.* (2017) 37:843–7. 10.1038/jp.2017.55 [PubMed] [CrossRef] [Google Scholar]

69. Ibáñez L, Valls C, Cols M, Ferrer A, Marcos MV, De Zegher F. Hypersecretion of FSH in infant boys and girls born small for gestational age. *J Clin Endocrinol Metab.* (2002) 87:1986–8. 10.1210/jcem.87.5.8459 [PubMed] [CrossRef] [Google Scholar]

70. Forest MG, de Peretti E, Bertrand J. Testicular and adrenal androgens and their binding to plasma proteins in the perinatal period: developmental patterns of plasma testosterone, 4-androstenedione, dehydroepiandrosterone and its sulfate in premature and small for date infants as compared wit. *J Steroid Biochem.* (1980) 12:25–36. 10.1016/0022-4731(80)90247-2 [PubMed] [CrossRef] [Google Scholar]

71. Becker M, Oehler K, Partsch CJ, Ulmen U, Schmutzler R, Cammann H, et al. Hormonal "minipuberty" influences the somatic development of boys but not of girls up to the age of 6 years. *Clin Endocrinol.* (2015) 83:694–701. 10.1111/cen.12827 [PubMed] [CrossRef] [Google Scholar]

72. Kiviranta P, Kuiri-Hänninen T, Saari A, Lamidi M-L, Dunkel L, Sankilampi U. Transient postnatal gonadal activation and growth velocity in infancy. *Pediatrics* (2016) 138:e20153561. 10.1542/peds.2015-3561 [PubMed] [CrossRef] [Google Scholar]

73. Quinton R, Mamoojee Y, Jayasena CN, Young J, Howard S, Dunkel L, et al.. Society for Endocrinology UK guidance on the evaluation of suspected disorders of sexual development: emphasizing the opportunity to predict adolescent pubertal failure through a neonatal diagnosis of absent minipuberty. *Clin Endocrinol.* (2017) 86:305–6. 10.1111/cen.13257 [PubMed] [CrossRef] [Google Scholar]

74. Dwyer AA, Jayasena CN, Quinton R. Congenital hypogonadotropic hypogonadism: implications of absent mini-puberty. *Minerva Endocrinol.* (2016) 41:188–95. [PubMed] [Google Scholar]

75. Bonomi M, Vezzoli V, Krausz C, Guizzardi F, Vezzani S, Simoni M, et al. Italian Network on Central Hypogonadism. Characteristics of a nationwide cohort of patients presenting with isolated hypogonadotropic hypogonadism (IHH). *Eur J Endocrinol.* (2018) 178:23–32. 10.1530/EJE-17-0065 [PubMed] [CrossRef] [Google Scholar]

76. Koskenniemi JJ, Virtanen HE, Wohlfahrt-Veje C, Löyttyniemi E, Skakkebaek NE, Juul A, et al.. Postnatal changes in testicular position are associated with IGF-I and function of Sertoli and Leydig cells. *J Clin Endocrinol Metab.* (2018) 103:1429–37. 10.1210/jc.2017-01889 [PubMed] [CrossRef] [Google Scholar]

77. Hadziselimovic F, Zitvkovic D, Bica DTG, Emmons LR. The importance of mini-puberty for fertility in Cryptorchidism. *J Urol.* (2005) 174:1536–9. 10.1097/01.ju.0000181506.97839.b0 [PubMed] [CrossRef] [Google Scholar]

78. Hadziselimovic F, Emmons LR, Buser MW. A diminished postnatal surge of Ad spermatogonia in cryptorchid infants is additional evidence for hypogonadotropic hypogonadism. *Swiss Med Wkly.* (2004) 134:381–4. [PubMed] [Google Scholar]

79. Hadziselimovic F, Gegenschatz-Schmid K, Verkauskas G, Demougin P, Bilius V, Dasevicius D, et al.. Gene expression changes underlying idiopathic central hypogonadism in cryptorchidism with defective mini-puberty. *Sex Dev.* (2016) 10:136–46. 10.1159/000447762 [PubMed] [CrossRef] [Google Scholar]

80. Main KM, Schmidt IM, Skakkebæk NE. A possible role for reproductive hormones in newborn boys: Progressive hypogonadism without the postnatal testosterone peak. *J Clin Endocrinol Metab.* (2000) 85:4905–7. 10.1210/jcem.85.12.7058 [PubMed] [CrossRef] [Google Scholar]

81. Main KM, Schmidt IM, Toppari J, Skakkebæk NE. Early postnatal treatment of hypogonadotropic hypogonadism with recombinant human FSH and LH. *Eur J Endocrinol.* (2002) 146:75–9. 10.1530/eje.0.1460075 [PubMed] [CrossRef] [Google Scholar]

82. Bougnères P, François M, Pantalone L, Rodrigue D, Bouvattier C, Demesteere E, et al.. Effects of an Early Postnatal Treatment of Hypogonadotropic Hypogonadism with a Continuous Subcutaneous Infusion of Recombinant Follicle-Stimulating Hormone and Luteinizing Hormone. *J Clin Endocrinol Metab.* (2008) 93:2202–5. 10.1210/jc.2008-0121 [PubMed] [CrossRef] [Google Scholar]

83. Stoupa A, Samara-Boustani D, Flechtner I, Pinto G, Jourdon I, González-Briceño L, et al.. Efficacy and safety of continuous subcutaneous infusion of recombinant human gonadotropins for congenital micropenis during early infancy. *Horm Res Paediatr.* (2017) 87:103–10. 10.1159/000454861 [PubMed] [CrossRef] [Google Scholar]

84. Gegenschatz-Schmid K, Verkauskas G, Demougin P, Bilius V, Dasevicius D, Stadler MB, et al.. Curative GnRHa treatment has an unexpected repressive effect on Sertoli cell specific genes. *Basic Clin Androl.* (2018) 28:2. 10.1186/s12610-018-0067-1 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

85. Heinrichs C, Bourdoux P, Saussez C, Vis HL, Bourguignon JP. Blood spot follicle-stimulating hormone during early postnatal life in normal girls and Turner's syndrome. *J Clin Endocrinol Metab.* (1994) 78:978–81. [PubMed] [Google Scholar]

86. Fechner PY, Davenport ML, Qualy RL, Ross JL, Gunther DF, et al. Toddler Turner Study Group. Differences in follicle-stimulating hormone secretion between 45,X monosomy Turner syndrome and 45,X/46,XX mosaicism are evident at an early age. *J Clin Endocrinol Metab.* (2006) 91:4896–902. 10.1210/jc.2006-1157 [PubMed] [CrossRef] [Google Scholar]

87. Chrysis D, Spiliotis BE, Stene M, Cacciari E, Davenport ML. Gonadotropin secretion in girls with Turner syndrome measured by an ultrasensitive immunochemiluminometric assay. *Horm Res.* (2006) 65:261–6. 10.1159/000092516 [PubMed] [CrossRef] [Google Scholar]

88. Lahlou N, Fennoy I, Carel J-C, Roger M. Inhibin B and anti-müllerian hormone, but not testosterone levels, are normal in infants with nonmosaic Klinefelter syndrome. *J Clin Endocrinol Metab.* (2004) 89:1864–8. 10.1210/jc.2003-031624 [PubMed] [CrossRef] [Google Scholar]

89. Ross JL, Samango-Sprouse C, Lahlou N, Kowal K, Elder FF, Zinn A. Early androgen deficiency in infants and young boys with 47,XXY Klinefelter syndrome. *Horm Res.* (2005) 64:39–45. 10.1159/000087313 [PubMed] [CrossRef] [Google Scholar]

90. Aksglaede L, Petersen JH, Main KM, Skakkebæk NE, Juul A. High normal testosterone levels in infants with non-mosaic Klinefelter's syndrome. *Eur J Endocrinol.* (2007) 157:345–50. 10.1530/EJE-07-0310 [PubMed] [CrossRef] [Google Scholar]

91. Cabrol S, Ross JL, Fennoy I, Bouvattier C, Roger M, Lahlou N. Assessment of leydig and sertoli cell functions in infants with nonmosaic klinefelter syndrome: Insulin-like peptide 3 levels are normal and positively correlated with lh levels. *J Clin Endocrinol Metab.* (2011) 96:746–53. 10.1210/jc.2010-2103 [PMC free article] [PubMed] [CrossRef] [Google Scholar]

92. Bouvattier C, Carel J-C, Lecointre C, David A, Sultan C, Bertrand AM, et al.. Postnatal changes of T, LH, and FSH in 46,XY infants with mutations in the AR gene. *J Clin Endocrinol Metab.* (2002) 87:29–32. 10.1210/jcem.87.1.7923 [PubMed] [CrossRef] [Google Scholar]

EXHIBIT

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Normative health-related fitness values for children: Analysis of 85347 test results on 9-17-year-old Australians since 1985

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ABSTRACT

Objectives To provide sex- and age-specific normative values for health-related fitness of 9–17-year-old Australians.

Methods A systematic literature search was undertaken to identify peer-reviewed studies reporting health-related fitness data on Australian children since 1985—the year of the last national fitness survey. Only data on reasonably representative s amples of apparently healthy (free from known disease or injury) 9–17-year-old Australians, who were tested using field tests of health-related fitness, were included. Both raw and pseudo data (generated using Monte Carlo simulation) were combined with sex- and age-specific normative centile values generated using the Lambda Mu and Sigma (LMS) method. Sex- and age-related differences were expressed as standardised effect sizes.

Results Normative values were displayed as tabulated percentiles and as smoothed centile curves for nine health-related fitness tests based on a dataset comprising 85347 test performances. Boys typically scored higher than girls on cardiovascular endurance, muscular strength, muscular endurance, speed and power tests, but lower on the flexibility test. The magnitude of the age-related changes was generally larger for boys than for girls, especially during the teenage years.

Conclusion This study provides the most up-to-date sex- and age-specific normative centile values for the health-related fitness of Australian children that can be used as benchmark values for health and fitness screening and surveillance systems.

BACKGROUND

Physical fitness is considered to be an important marker of current and future health in children and adults.[1] In children, cardiovascular fitness is a weak-to-strong predictor of total and abdominal adiposity, cardiovascular disease risk factors, cancer and mental health.[1 2] Certain muscular fitness components (eg, strength and endurance) are moderate predictors of cardiovascular disease risk factors, skeletal health and mental health.[1] Meaningful relationships have also been reported between running speed (another muscular fitness component) and skeletal health.[3] In adults, cardiovascular fitness is a strong and independent predictor of all-cause mortality and cardiovascular disease mortality and morbidity,[4] stroke,[5] cancer, mental health,[6] health-related quality of life[7] and many other cardiometabolic risk factors and comorbidities.[8 9] Moreover, physical fitness tracks moderately well from childhood through to adulthood.[10–13] This evidence highlights the need to include health-related fitness testing (ie, the testing of fitness components such as cardiovascular and muscular fitness that have the strongest links with health outcomes) as part of existing health and fitness screening and surveillance systems.

Although the most valid assessments of fitness require sophisticated laboratory equipment and a high level of tester expertise, they unfortunately are not suitable for mass testing. On the other hand, properly conducted field tests offer simple, feasible, and practical alternatives, which typically demonstrate good reliability and validity.[2 14–17] In Australia, unlike in Europe and North America where standardised test batteries such as the Eurofit[18] or FITNESSGRAM[19] are widely administered, a number of different field-based fitness tests and testing protocols have been used over time. For example, the most popular field test of cardiovascular fitness in Australia in the 1960s and 1970s was the 549-m (600 yd) run; in the 1980s and 1990s, it was the 1600-m run; and over the past decade or so, it has been the 20-m shuttle run.[20] Many physical educators and sports coaches in Australia continue to administer tests that are no longer in favour, largely because normative data (which are now several decades old) are available. This makes it difficult to assess the current status of health-related fitness in Australian children. Further compounding the problem is that the last national fitness survey of Australian children was conducted in 1985,[21] and with convincing evidence of recent temporal changes in several components of fitness,[22–24] the usefulness of such data seems to be limited.

Because there has never been a follow-up to the 1985 national survey, this study aimed to locate large and reasonably representative datasets of Australian children to generate normative centile values for health-related fitness. This study also aimed to quantify sex- and age-related differences in health-related fitness. These normative data will facilitate the identification of children with (a) low fitness in order to set appropriate goals and to promote positive health behaviours, and (b) specific fitness characteristics that may be considered important for sporting success.

METHODS

Data sources

A systematic review of the peer-reviewed scientific literature was undertaken to locate studies reporting descriptive summary data on Australian children tested for health-related fitness using field tests. Candidate studies were searched for in

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Table 1 Summary of the included studies that have been used to assess the health-related fitness of 9–17-year-old Australians since 1985

Study	Year	Age (years)	*N*	Raw data	Sampling method	Sample base	Protocol	Tests reported in included studies: Push-ups	Sit-ups	Standing broad jump	Basketball throw	50 m sprint	Sit-and-reach	Hand-grip	1.6 km run	20 m shuttle run
ACHPER[50]	1994	9–18	39–104	yes	School-based; stratified, proportional	State (VIC)	ACHPER[50]		•		•		•		•	•
Barnett *et al*[51]	2007	15–17	21–69	no	School-based; stratified, random	State (NSW)	ACHPER[50]									•
Birchall[52]	1990	5–12	6–184	yes	School-based; convenience	State (VIC)	Pyke[21]	•	•	•		•	•		•	
Booth *et al*[53]	1997	9, 11, 13,15	399–634	no	School-based; stratified, proportional	State (NSW)	ACHPER[50]		•		•					•
Booth *et al*[54]	2004	9–15	357–466	no	School-based; stratified, proportional	State (NSW)	ACHPER[50]									•
Burke *et al*[55]	2004	10–13	38–117	yes	School-based; stratified, proportional	Capital city (WA)	ACHPER[50]									•
Cooley and McNaughton[56]	1998	11–16	339–636	no	School-based; stratified, proportional	State (TAS)	ACHPER[50]									•
Dollman *et al*[57]	1997	10–12	118–450	yes	School-based; stratified, proportional	State (SA)	Pyke[21]			•		•			•	
Dollman pers. comm.	2002	11–12	19–154	yes	School-based; stratified, random	State (SA)	Pyke[21]						•	•		
Dollman, pers. comm.	2002	8–12	8–389	yes	School-based; stratified, proportional	State (SA)	ACHPER[50] Pyke[21]			•						•
Hands[58]	2000	6–12	14–37	yes	School-based; stratified, random	Capital city (WA)	ACHPER[50] Pyke[21]		•	•	•	•	•	•		•
McIntyre, pers. comm.	2009	10–11	23–44	yes	School-based; stratified, random	Capital city (WA)	ACHPER[50]									•
McNaughton *et al*[59]	1995	7–10	30–83	no	School-based; stratified, random	State (TAS)	Pyke[21]					•			•	
Pyke[21]	1985	7–15	405–497	yes	School-based; stratified, proportional	National	Pyke[21]	•	•	•		•	•	•	•	
Vandongen *et al*[60]	1990	11	485–486	no	School-based; stratified, random	Capital city (WA)	ACHPER[50]								•	•

identifies test data that are available.
ACHPER, Australian Council for Health, Physical Education and Recreation; year, year of testing; *n*, sample size range per sex by age by test group; VIC, TAS, SA, WA, NSW

November 2009 using a computer search of online bibliographic databases (Ausport, CINAHL, Medline, PubMed, Scopus and SPORTDiscus). The search string used for the computer search was: ((((((((((((((fitness) OR aerobic) OR anaerobic) OR cardio*) OR endurance) OR agility) OR flexibility) OR speed) OR power) OR strength) OR sprint*) OR jump*) OR push-up*) OR sit-up*) OR grip strength) OR sit and reach) AND (((((((child*) OR paediatric*) OR adolesc*) OR boy*) OR girl*) OR youth*) OR teen*) AND (Australia*). All titles and abstracts (when available) were assessed to identify eligible articles, with full-text articles retrieved if there was doubt in an article's eligibility. A number of Australian researchers were contacted through email to ask whether they knew of any appropriate studies or unpublished datasets.

Inclusion/exclusion criteria

Studies were included if they explicitly reported descriptive health-related fitness test data for apparently healthy (free from known disease or injury) 9–17-year-old Australians who were tested from 1985 onwards and if they reported data at the sex by age by test level, on children directly measured using field-based fitness tests for which explicit testing protocols were available. Studies were excluded if they reported descriptive data that were published in another identified study. The reference

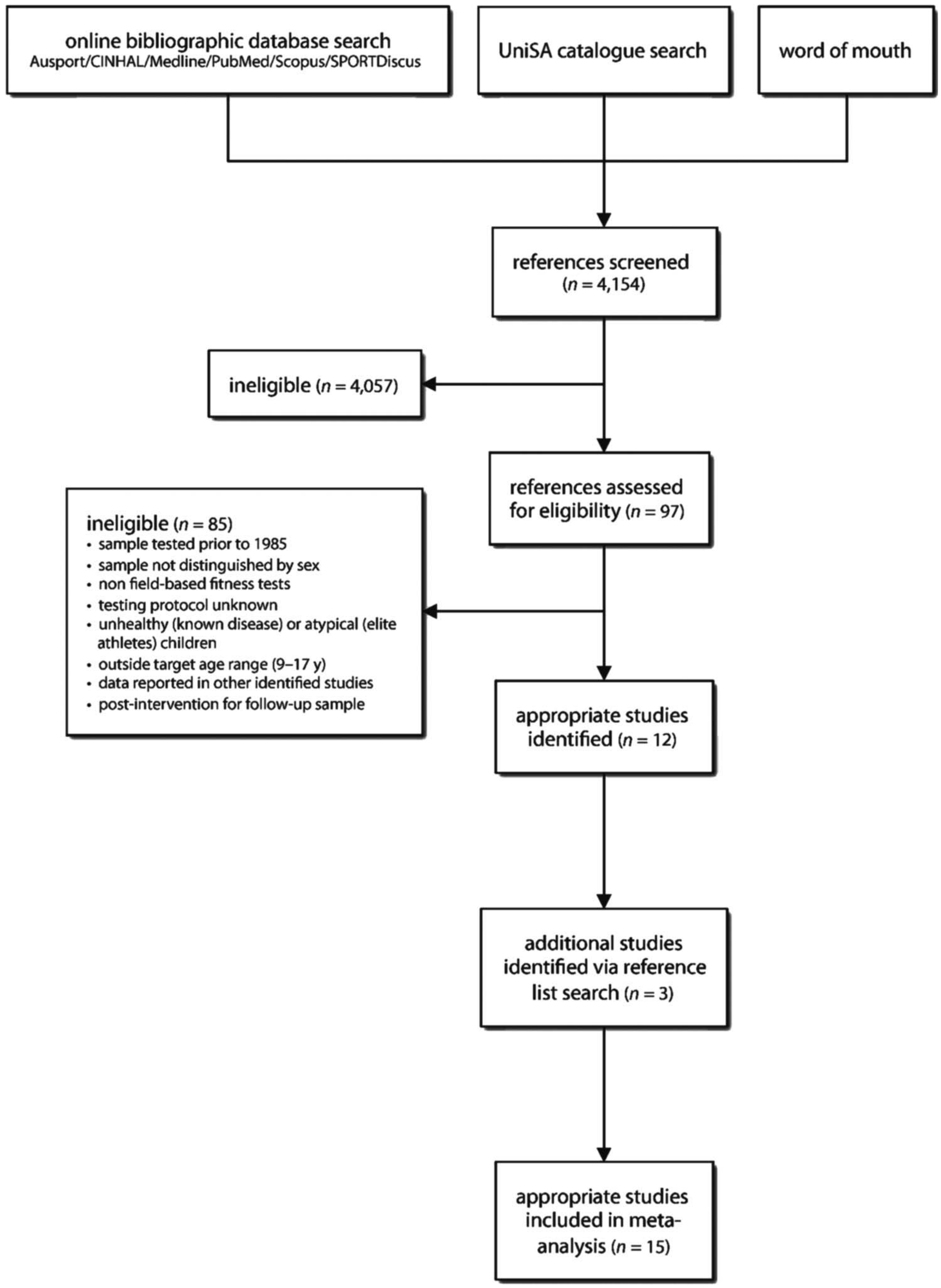

Figure 1 Flowchart outlining the identification of the included studies.

lists of all included studies were examined and cross-referenced to identify additional studies. Attempts were made to contact the corresponding author of each study to request raw data and/or to clarify study details.

Initial data analysis

The following descriptive data were extracted from each included study: sex, age, year of testing, sample size, mean, SD, fitness test type and test protocol. Only data for commonly used fitness tests that were collected using protocols that were originally described in national or state-based fitness surveys of Australian children were retained for further analysis. Tests were considered to be 'common' if they were used to measure fitness in children across a broad range of ages and in at least two separate studies. Data for each fitness test were expressed in a common metric, and protocol differences were corrected where possible (eg, 20 m shuttle run data were expressed as the number of completed stages using the correction procedures described by Tomkinson *et al*).[25] However, if protocol correction was not possible, then only fitness data collected using the most common test protocol were retained. All available raw data were checked for anomalies by running range checks with data ±3 SDs away from the respective study by sex by age by test mean excluded. Age was expressed in whole years as the age at last birthday.

Statistical analysis

Sex- and age-specific normative centile values were calculated using a dataset comprising raw data and pseudo data that were generated using the method described by Tomkinson.[24] Normative centile values were generated using LMSChartmaker Light (v2.3, The Institute of Child Health, London) software,

Table 2 1.6 km run (s) centile values and LMS summary statistics by sex and age in 9- to 17-year-old Australians

Age (year)	P_5	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{95}	L	M	S
Boys														
9	750	684	618	578	547	522	499	476	452	423	401	−1.042	521.963	0.183
10	732	666	602	564	535	511	489	469	447	420	400	−1.284	511.053	0.175
11	710	646	585	549	523	500	480	461	441	416	397	−1.466	500.394	0.166
12	682	621	563	530	505	485	467	449	430	408	392	−1.721	484.819	0.157
13	643	587	535	505	483	465	448	432	415	395	380	−1.895	464.529	0.148
14	605	556	509	482	462	446	431	416	401	382	369	−1.987	445.569	0.140
15	575	531	490	465	447	432	418	404	390	373	360	−1.979	431.504	0.133
16	552	514	477	454	437	423	410	397	383	366	354	−1.865	422.693	0.128
17	534	500	467	446	430	417	404	392	379	362	350	−1.707	416.545	0.123
Girls														
9	829	769	706	666	635	609	584	559	533	499	475	−0.779	608.674	0.167
10	820	759	697	657	626	600	576	552	526	494	470	−0.878	600.149	0.166
11	801	741	680	641	611	586	562	539	514	483	460	−0.929	585.820	0.165
12	784	726	666	629	600	575	552	529	505	474	452	−0.921	574.682	0.164
13	771	716	658	621	593	569	546	524	500	469	447	−0.852	568.706	0.163
14	763	711	655	620	592	567	545	523	498	468	445	−0.737	567.486	0.162
15	760	710	656	621	594	570	547	525	500	469	446	−0.591	569.809	0.161
16	757	710	658	624	597	573	550	527	502	471	446	−0.428	572.723	0.160
17	753	708	658	625	598	575	552	529	504	471	446	−0.263	574.536	0.159

Note, percentile data were calculated from 11 423 1.6 km run performances collected between 1985 and 1997.
L, skew; M, median; P, percentile; S, coefficient of variation.

which analyses data using the LMS method.[26] The LMS method fits smooth centile curves to reference data by summarising the changing distribution of three sex- and age-specific curves representing the skewness (L: expressed as a Box-Cox power), the median (M) and the coefficient of variation (S). Using penalised likelihood, the curves can be fitted as cubic splines using non-linear regression, and the extent of smoothing required can be expressed in terms of smoothing parameters or equivalent degrees of freedom.[27]

For each fitness test, differences in means between: (a) age-matched Australian boys and girls (eg, 10-year-old boys vs 10-year-old girls); (b) sex-matched Australian children of different ages (eg, 10-year-old boys vs 11-year-old boys); and (c) sex- and age-matched Australian and international children[18 28–30]

Table 3 20 m shuttle run (completed stages) centile values and LMS summary statistics by sex and age in 9- to 17-year-old Australians

Age (year)	P_5	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{95}	L	M	S
Boys														
9	1	1	2	2	2	3	3	3	4	5	6	0.213	2.573	0.568
10	1	2	2	3	3	4	4	5	5	7	8	0.373	3.537	0.543
11	1	2	3	3	4	4	5	5	6	7	8	0.520	4.131	0.517
12	1	2	3	3	4	4	5	6	6	8	9	0.643	4.460	0.486
13	2	2	3	4	4	5	5	6	7	8	9	0.744	4.888	0.453
14	2	3	4	4	5	6	6	7	8	9	10	0.835	5.664	0.418
15	3	3	4	5	6	7	7	8	9	10	11	0.926	6.527	0.380
16	3	4	5	6	7	7	8	8	9	10	11	1.031	7.159	0.343
17	4	5	6	6	7	8	8	9	10	11	11	1.143	7.690	0.306
Girls														
9	1	1	1	1	2	2	2	2	3	4	5	−0.065	1.842	0.535
10	1	1	2	2	2	2	3	3	4	5	6	0.086	2.468	0.557
11	1	1	2	2	2	3	3	4	4	6	7	0.220	2.844	0.573
12	1	1	2	2	3	3	3	4	5	6	7	0.324	3.016	0.577
13	1	1	2	2	3	3	4	4	5	6	7	0.400	3.138	0.569
14	1	1	2	2	3	3	4	4	5	6	7	0.457	3.225	0.554
15	1	1	2	3	3	3	4	4	5	6	7	0.505	3.412	0.536
16	1	2	2	3	3	4	4	5	5	6	7	0.554	3.672	0.518
17	1	2	2	3	4	4	5	5	6	7	8	0.603	4.032	0.499

Percentile data were calculated from 18 075 20 m shuttle run performances collected between 1990 and 2009.
The 20 m shuttle run can be scored in different metrics other than as the number of completed stages, such as the number of completed laps, the speed at the last completed stage and as mass-specific peak oxygen uptake estimates (see Tomkinson *et al*[25] for details on how to correct 20 m shuttle run performances to different metrics).
L, skew; M, median; P, percentile; S, coefficient of variation.

Table 4 50 m sprint (s) centile values and LMS summary statistics by sex and age in 9- to 15-year-old Australians

Age (year)	P_5	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{95}	L	M	S
Boys														
9	10.6	10.2	9.8	9.5	9.3	9.1	9.0	8.8	8.6	8.3	8.1	−1.837	9.136	0.078
10	10.5	10.1	9.7	9.4	9.2	9.0	8.8	8.7	8.5	8.2	8.0	−2.185	9.009	0.080
11	10.4	10.0	9.6	9.3	9.1	8.9	8.7	8.5	8.3	8.1	7.9	−2.405	8.877	0.081
12	10.2	9.8	9.3	9.1	8.9	8.7	8.5	8.3	8.1	7.9	7.7	−2.446	8.673	0.081
13	9.8	9.4	9.0	8.8	8.6	8.4	8.2	8.1	7.9	7.7	7.5	−2.489	8.377	0.079
14	9.4	9.0	8.7	8.4	8.2	8.1	7.9	7.8	7.6	7.4	7.2	−2.701	8.063	0.076
15	9.0	8.6	8.3	8.1	7.9	7.7	7.6	7.5	7.3	7.1	7.0	−3.021	7.738	0.073
Girls														
9	11.7	11.3	10.8	10.5	10.3	10.0	9.8	9.6	9.3	9.0	8.8	−0.981	10.033	0.088
10	11.1	10.7	10.3	10.0	9.8	9.5	9.3	9.1	8.9	8.6	8.4	−1.453	9.542	0.084
11	10.7	10.3	9.9	9.6	9.4	9.2	9.0	8.8	8.6	8.3	8.1	−1.803	9.161	0.082
12	10.4	10.0	9.6	9.3	9.1	8.9	8.7	8.6	8.4	8.1	7.9	−1.977	8.919	0.080
13	10.2	9.8	9.4	9.2	9.0	8.8	8.6	8.4	8.3	8.0	7.8	−1.991	8.787	0.078
14	10.0	9.7	9.3	9.1	8.9	8.7	8.5	8.4	8.2	7.9	7.8	−1.884	8.686	0.076
15	9.9	9.6	9.2	9.0	8.8	8.6	8.5	8.3	8.1	7.9	7.7	−1.724	8.638	0.075

Note, percentile data were calculated from 10 104 50 m sprint performances collected between 1985 and 1999.
L, skew; M, median; P, percentile; S, coefficient of variation.

were expressed as standardised effect sizes.[31] Positive effect sizes indicated that mean fitness test performances for boys (age-matched analysis), older children (sex-matched analysis) or Australian children (sex- and age-matched analysis) were higher than those for girls, younger children or international children, respectively. Effect sizes of 0.2, 0.5 and 0.8 were used as thresholds for small, moderate and large.[31]

RESULTS

Table 1 summarises the 15 included studies. Of these, 12 were identified through bibliographic database searching and word of mouth, and three were identified through reference list searching. Corresponding authors of all the studies were contacted through email to clarify study details and/or to request raw data. All authors satisfactorily clarified study details, and seven of them supplied raw data (figure 1).

The final dataset comprised 85347 individual test results and 142 sex by age by test groups with a median sample size of 537 (range: 54–2612). Data were available for six fitness components and nine fitness tests: cardiovascular endurance (20 m shuttle run, 1.6 km run), muscular strength (hand-grip), muscular endurance (push-ups and sit-ups), muscular power (standing broad jump and basketball throw), muscular speed (50 m sprint) and flexibility (sit-and-reach). Raw data were available for 74% of all data points.

Normative fitness data for 9–17-year-old Australians are presented as tabulated percentiles from 5 to 95 (P_5, P_{10}, P_{20}, P_{30}, P_{40}, P_{50}, P_{60}, P_{70}, P_{80}, P_{90}, P_{95}) in tables 2–10. The sex- and age-

Table 5 Basketball throw (m) centile values and LMS summary statistics by sex and age in 9- to 17-year-old Australians

Age (year)	P_5	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{95}	L	M	S
Boys														
9	2.3	2.5	2.7	2.9	3.1	3.3	3.4	3.6	3.8	4.1	4.4	0.623	3.260	0.198
10	2.5	2.8	3.0	3.3	3.4	3.6	3.8	4.0	4.2	4.5	4.8	0.675	3.608	0.192
11	2.8	3.1	3.4	3.6	3.8	4.0	4.2	4.4	4.7	5.0	5.3	0.733	4.026	0.188
12	3.1	3.4	3.8	4.0	4.3	4.5	4.7	4.9	5.2	5.6	5.9	0.792	4.471	0.188
13	3.5	3.8	4.2	4.5	4.8	5.0	5.3	5.5	5.8	6.2	6.6	0.843	5.012	0.187
14	3.9	4.2	4.7	5.0	5.3	5.5	5.8	6.1	6.4	6.9	7.2	0.898	5.522	0.186
15	4.2	4.6	5.0	5.4	5.7	6.0	6.3	6.6	6.9	7.4	7.8	0.943	5.975	0.185
16	4.4	4.8	5.3	5.6	6.0	6.3	6.5	6.9	7.2	7.7	8.2	0.964	6.254	0.185
17	4.5	4.9	5.5	5.8	6.2	6.5	6.8	7.1	7.5	8.0	8.5	0.966	6.467	0.187
Girls														
9	2.1	2.3	2.5	2.7	2.9	3.0	3.2	3.3	3.5	3.7	3.9	1.116	3.015	0.182
10	2.3	2.6	2.8	3.0	3.2	3.3	3.5	3.7	3.8	4.1	4.3	1.024	3.336	0.181
11	2.6	2.8	3.1	3.3	3.5	3.6	3.8	4.0	4.2	4.5	4.7	0.942	3.646	0.180
12	2.8	3.1	3.4	3.6	3.8	4.0	4.2	4.3	4.6	4.9	5.2	0.873	3.970	0.180
13	3.0	3.3	3.6	3.9	4.1	4.3	4.5	4.7	4.9	5.3	5.6	0.816	4.265	0.179
14	3.2	3.4	3.8	4.0	4.2	4.4	4.6	4.8	5.1	5.4	5.7	0.739	4.410	0.175
15	3.3	3.6	3.9	4.1	4.3	4.5	4.7	4.9	5.1	5.5	5.8	0.606	4.486	0.169
16	3.4	3.7	4.0	4.2	4.4	4.6	4.7	5.0	5.2	5.6	5.9	0.394	4.557	0.162
17	3.6	3.8	4.1	4.3	4.5	4.6	4.8	5.0	5.3	5.6	5.9	0.140	4.634	0.154

Note, percentile data were calculated from 5,541 basketball throw performances collected between 1994 and 1999; L, skew; M, median; P, percentile; S, coefficient of variation.

Table 6 Standing broad jump (cm) centile values and LMS summary statistics by sex and age in 9- to 15-year-old Australians

Age (year)	P_5	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{95}	L	M	S
Boys														
9	105	113	121	127	133	138	142	147	153	161	168	1.244	137.506	0.138
10	109	117	126	133	138	143	148	154	160	168	174	1.490	143.430	0.138
11	112	121	131	138	144	149	154	160	166	174	181	1.654	149.322	0.138
12	117	126	137	144	150	156	161	167	173	182	189	1.704	155.838	0.137
13	126	136	147	154	161	166	172	178	185	194	201	1.629	166.340	0.135
14	137	146	157	165	172	178	184	190	197	206	214	1.526	177.688	0.131
15	148	157	169	177	183	189	196	202	209	219	228	1.446	189.485	0.127
Girls														
9	95	102	110	116	122	126	131	136	142	150	157	1.098	126.379	0.149
10	100	108	117	123	128	133	138	143	149	158	165	1.152	133.177	0.147
11	106	114	123	129	135	140	145	151	157	166	173	1.197	140.142	0.145
12	111	118	128	135	140	145	151	156	163	171	179	1.211	145.432	0.142
13	115	123	132	139	145	150	155	161	167	176	183	1.183	150.080	0.138
14	119	127	136	143	148	154	159	164	171	180	187	1.158	153.551	0.134
15	122	129	139	145	151	156	161	166	173	181	188	1.148	155.661	0.130

Percentile data were calculated from 11 194 standing broad jump performances collected between 1985 and 2002.
L, skew; M, median; P, percentile; S, coefficient of variation.

specific LMS values for all fitness tests are also shown. The LMS values depict the nature of the age-related distributions for boys and girls and can be used to calculate z-scores and hence percentile values by looking up a z-table, using the following formula:

$$z = \frac{\left(\frac{x}{M}\right)^L - 1}{L \times S}$$

where z is z score, x is performance, L is sex- and age-specific L-value, M is the sex- and age-specific M-value and S is the sex- and age-specific S-value.

Figures 2 and 3 show the smoothed centile curves (P_{10}, P_{50}, P_{90}).

Figure 4 shows the sex-related differences in mean fitness. Boys consistently scored higher than girls on health-related fitness tests, except on the sit-and-reach test, with the magnitude of the differences typically increasing with age and often accelerating from about 12 years of age. Overall, the magnitude of differences between boys and girls was large for the 1.6 km run, 20 m shuttle run, basketball throw and push-ups; moderate for the 50-m sprint, standing broad jump and sit-and-reach; and small for sit-ups and hand-grip strength. Figure 5 shows the age-related changes in mean fitness. The age-related changes were typically larger for boys than for girls, especially during the teenage years, and for muscular fitness tests than for cardiovascular fitness tests. Fitness also tended to peak from about the age of 15 years. Figure 6 shows that the differences in health-related fitness between Australian and international children were generally small, with Australian children scoring slightly higher on hand-grip strength (mean ±95% CI: 0.20±0.03 SDs) and 50 m sprint tests (0.24±0.02 SDs), and slightly lower on sit-and-reach (−0.36±0.02 SDs), standing broad jump (−0.25±0.02 SDs) and 20 m shuttle run tests (−0.49±0.01 SDs).

Table 7 Push-ups (no. in 30 s) centile values and LMS summary statistics by sex and age in 9- to 15-year-old Australians

Age (year)	P_5	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{95}	L	M	S
Boys														
9	4	6	8	9	11	12	14	15	17	20	22	0.846	12.310	0.452
10	4	6	8	10	11	13	14	16	18	21	23	0.894	12.943	0.447
11	4	6	8	10	12	13	14	16	18	20	22	0.940	12.942	0.438
12	4	6	9	10	12	13	15	16	18	20	22	0.980	13.200	0.422
13	5	7	9	11	13	14	16	17	19	22	24	1.020	14.255	0.399
14	6	8	11	13	14	16	17	19	21	23	25	1.070	15.954	0.370
15	7	10	13	15	16	18	19	21	23	25	27	1.126	17.697	0.337
Girls														
9	2	3	5	7	8	9	10	12	13	16	18	0.719	8.989	0.550
10	2	3	5	6	7	9	10	11	13	16	18	0.652	8.655	0.583
11	2	3	4	6	7	8	9	11	13	16	18	0.584	8.142	0.624
12	1	2	4	5	6	7	9	10	12	15	18	0.518	7.395	0.672
13	1	2	3	4	6	7	8	10	12	15	18	0.453	6.792	0.720
14	1	2	3	4	5	6	8	9	11	15	18	0.390	6.384	0.765
15	1	2	3	4	5	6	7	9	11	14	18	0.329	5.818	0.812

Percentile data were calculated from 7,342 push-up test performances collected between 1985 and 1991.
L, skew; M, median; P, percentile; S, coefficient of variation.

Table 8 Sit-ups (no. in 180 s) centile values and LMS summary statistics by sex and age in 9- to 17-year-old Australians

Age (year)	P_5	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{95}	L	M	S
Boys														
9	3	5	8	11	14	17	21	25	30	40	48	0.321	17.046	0.755
10	5	8	13	17	20	24	29	34	40	50	59	0.466	24.459	0.669
11	6	10	16	21	25	29	34	39	45	55	60	0.629	29.422	0.594
12	8	14	21	26	31	36	40	45	51	60	60	0.841	35.561	0.514
13	10	17	25	31	36	40	45	50	55	60	60	1.056	40.288	0.443
14	12	20	29	34	39	43	48	52	57	60	60	1.232	43.454	0.389
15	14	22	31	36	41	45	49	53	58	60	60	1.335	44.942	0.359
16	16	24	32	38	42	46	50	54	58	60	60	1.426	46.209	0.332
17	18	26	34	40	44	47	51	55	59	60	60	1.517	47.466	0.306
Girls														
9	5	8	12	15	18	21	25	29	35	43	51	0.394	21.258	0.642
10	7	10	14	18	22	26	30	34	40	50	58	0.485	25.666	0.605
11	8	11	17	21	25	29	34	39	45	54	60	0.571	29.444	0.569
12	9	13	19	24	28	32	37	42	48	57	60	0.646	32.123	0.534
13	10	15	21	26	30	34	39	44	50	59	60	0.705	34.408	0.504
14	11	15	22	27	31	35	40	45	50	59	60	0.741	35.334	0.482
15	11	16	22	27	31	35	40	44	50	58	60	0.757	35.327	0.464
16	12	17	23	28	32	36	40	44	50	57	60	0.761	35.690	0.447
17	13	18	24	28	32	36	40	45	50	58	60	0.761	36.333	0.431

Percentile data were calculated from 8 837 sit-up test performances collected between 1985 and 1999.
L, skew; M, median; P, percentile; S, coefficient of variation.

DISCUSSION

This study provides the most up-to-date sex- and age-specific normative centile values for 9–17-year-old Australians across a range of health-related fitness tests, which can be used as benchmark values for health and fitness screening and surveillance of children. These data complement a growing literature reporting growth percentiles across a range of different health measures, such as body mass index,[32] waist girth[33] and blood pressure,[28] and a range of other health-related fitness measures.[29 30] It also quantifies the magnitude and direction of sex- and age-related differences in children's health-related fitness and shows that boys consistently scored higher than girls on fitness tests (except on the sit-and-reach test of flexibility) and that boys experience larger age-related changes in fitness. The developmental patterns of children's fitness have been well studied and extensively reviewed (eg, for cardiovascular fitness, refer to Armstrong *et al*,[34] Krahenbuhl *et al*[35] and Rowland[36]; for muscular fitness, refer to Blimkie and Sale,[37] Froberg and Lammert[38] and De Ste Croix[39]). Although the underlying causes of sex- and age-related differences are clear for some fitness test performances, such as those for muscular strength, power and speed, which are largely explained by physical differences (eg, differences in muscle mass

Table 9 Hand-grip strength (kg) centile values and LMS summary statistics by sex and age in 9- to 15-year-old Australians (taken as the mean of both hands)

Age (year)	P_5	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{95}	L	M	S
Boys														
9	11.5	12.5	13.8	14.8	15.6	16.4	17.2	18.1	19.2	20.8	22.1	0.600	16.415	0.197
10	13.1	14.3	15.9	17.0	18.0	19.0	19.9	21.0	22.2	23.9	25.4	0.728	18.967	0.198
11	14.5	15.9	17.7	19.0	20.1	21.2	22.3	23.5	24.9	26.8	28.5	0.764	21.217	0.200
12	15.4	17.0	18.9	20.3	21.5	22.7	23.8	25.1	26.6	28.7	30.5	0.747	22.655	0.203
13	17.5	19.3	21.5	23.1	24.5	25.8	27.2	28.6	30.4	32.8	34.9	0.738	25.819	0.205
14	20.8	22.9	25.5	27.4	29.1	30.7	32.4	34.1	36.2	39.1	41.6	0.742	30.731	0.207
15	24.6	27.1	30.3	32.6	34.6	36.5	38.4	40.5	43.0	46.5	49.5	0.752	36.517	0.207
Girls														
9	9.8	10.8	12.0	12.9	13.7	14.4	15.1	16.0	17.0	18.4	19.5	0.639	14.396	0.205
10	11.4	12.6	14.1	15.2	16.2	17.1	18.0	19.0	20.1	21.8	23.1	0.842	17.072	0.210
11	12.5	13.9	15.5	16.8	17.8	18.8	19.8	20.9	22.1	23.9	25.3	0.932	18.816	0.208
12	14.4	16.0	17.8	19.1	20.3	21.4	22.5	23.6	25.0	26.9	28.5	0.922	21.374	0.200
13	16.4	18.0	19.9	21.3	22.5	23.6	24.8	26.0	27.4	29.5	31.1	0.880	23.641	0.190
14	18.2	19.7	21.6	23.0	24.3	25.4	26.5	27.8	29.2	31.3	33.0	0.828	25.390	0.178
15	19.8	21.3	23.2	24.6	25.8	26.9	28.0	29.2	30.7	32.7	34.4	0.770	26.881	0.165

Percentile data were calculated from the 3 707 hand-grip strength performances collected between 1985 and 1999.
L, skew; M, median; P, percentile; S, coefficient of variation.

Table 10 Sit-and-reach (cm) centile values and LMS summary statistics by sex and age in 9- to 17-year-old Australians.

Age (y)	P_5	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}	P_{95}	L	M	S
boys														
9	10.4	12.9	15.7	17.7	19.4	20.9	22.4	23.9	25.8	28.2	30.3	1.211	20.877	0.285
10	10.0	12.5	15.3	17.3	19.0	20.5	22.1	23.7	25.5	28.0	30.1	1.190	20.537	0.294
11	9.6	12.1	15.0	17.0	18.7	20.3	21.9	23.5	25.4	28.0	30.1	1.167	20.313	0.305
12	9.3	11.8	14.8	16.9	18.7	20.3	21.9	23.6	25.6	28.3	30.5	1.133	20.292	0.315
13	9.4	12.0	15.1	17.2	19.1	20.8	22.5	24.3	26.4	29.2	31.6	1.091	20.785	0.322
14	9.8	12.5	15.7	18.0	20.0	21.8	23.6	25.5	27.8	30.9	33.4	1.054	21.804	0.328
15	10.4	13.2	16.6	19.1	21.2	23.1	25.1	27.1	29.5	32.9	35.7	1.017	23.112	0.332
16	11.1	14.0	17.6	20.1	22.3	24.4	26.5	28.7	31.3	34.9	37.8	0.984	24.392	0.334
17	11.7	14.8	18.5	21.2	23.5	25.7	27.9	30.2	33.0	36.8	40.0	0.953	25.686	0.335
girls														
9	13.0	15.8	18.9	21.1	22.9	24.6	26.2	28.0	29.9	32.6	34.8	1.285	24.614	0.264
10	13.0	15.7	18.8	20.9	22.7	24.4	26.0	27.7	29.7	32.4	34.6	1.259	24.402	0.265
11	13.2	15.9	19.0	21.2	23.0	24.7	26.4	28.1	30.1	32.8	35.0	1.235	24.705	0.265
12	14.0	16.7	19.9	22.2	24.1	25.8	27.5	29.3	31.3	34.2	36.4	1.230	25.790	0.262
13	15.3	18.2	21.6	24.0	25.9	27.7	29.5	31.4	33.6	36.5	38.9	1.250	27.740	0.256
14	16.5	19.5	23.1	25.5	27.6	29.4	31.3	33.2	35.4	38.4	40.9	1.293	29.440	0.248
15	17.0	20.1	23.7	26.1	28.1	30.0	31.8	33.7	35.9	38.8	41.2	1.350	29.997	0.241
16	17.0	20.0	23.5	25.9	27.9	29.6	31.4	33.2	35.3	38.1	40.3	1.412	29.647	0.235
17	16.8	19.8	23.2	25.5	27.4	29.1	30.7	32.5	34.4	37.1	39.2	1.472	29.074	0.229

Note, percentile data were calculated from 9,124 sit-and-reach performances collected between 1985 and 2000; L = skew; M = median; S = coefficient of variation. Note, a score of "20 cm" corresponds to the participant reaching their toes.

or height), they are less clear for others, such as for cardiovascular endurance, which may be explained by physiological differences (eg, differences in mechanical efficiency and/or fractional utilisation).[15 36] It is, nonetheless, beyond the scope of this article to discuss the causes that underscore the sex- and age-related changes in fitness test performance.

International comparisons

Although several studies have previously compared the health-related fitness of Australian children with their sex- and age-matched international peers,[20 40] comparisons have only been made for cardiovascular fitness. Figure 6 compares the 20-m shuttle run, 50 m sprint, standing broad jump, hand-grip strength and sit-and-reach performance of 9–17-year-old Australians with 1 894 971 test results from sex-, age- and test-matched international children from 48 countries who have been measured using the same test protocols as those referenced in table 1 and described in Appendix 1. Figure 6 also shows typically small differences in health-related fitness between Australian and international children. Furthermore, the sex- and age-related differences in fitness of Australian children are strikingly similar to those observed in international children. Given that the differences are generally small, the normative centile data presented in this study could be used as approximate benchmark values for health-related fitness of international children.

Fitness thresholds for cardiometabolic risk

Fitness is widely recognised as a powerful marker of current and future cardiovascular, skeletal and mental health. Unfortunately, there are no universally accepted recommendations for health-related levels of fitness. In recent years however, sex- and age-specific threshold values for cardiovascular fitness (operationalised as mass-specific peak oxygen uptake in ml/kg/min) have been established for European and US children using linked cardiometabolic risk-based values from receiver operator characteristic curve analyses.[41–44] To estimate the prevalence of Australian children with 'healthy' cardiovascular fitness (ie, those above the thresholds), 'international' sex- and age-specific thresholds for 9–17-year-old children were estimated by determining best-fitting polynomial regression model (quadratic or cubic) relating age (predictor variable) to previously reported threshold values (response variable) in Adegboye *et al*,[41] Lobelo *et al*,[42] Ruiz *et al*[43] and Welk *et al*.[44] Separate models were generated for boys and girls. Peak oxygen uptake values in Australian children were estimated using 1.6 km run and 20 m shuttle run data and the Cureton *et al*[45] and Léger *et al*[46] regression equations, respectively.

Using these thresholds, about 71% of Australian boys (median ±95% CI: 71%±8%) and 77% of Australian girls (median ±95% CI: 77%±10%) apparently have 'healthy' cardiovascular fitness. Although in light of recent secular declines in cardiovascular fitness,[20 22 23 25] and with a median testing year of 1993 in this study's cardiovascular fitness dataset, it is likely that these prevalence rates somewhat overestimate those of today. These prevalence rates are better than (for girls), or similar to (for boys), those observed in European (61% of boys and 57% of girls)[29] and US (71% of boys and 69% of girls)[42] children. Geographical differences in prevalence rates may reflect differences in (a) threshold levels, (b) the year(s) of testing, (c) sampling methodology, (d) test methodology and (e) the way in which peak oxygen uptake was measured or estimated.[47]

Ultimately, it is important to remember that the normative data presented in this study show how well Australian children perform on health-related fitness tests relative to their sex- and age-matched peers. For example, using a percentile classification, children with fitness in the bottom 20% can be classified as having 'very low' fitness; those between the 20th and 40th percentiles as having 'low' fitness; those between the 40th and 60th percentiles as having 'average' fitness; those between the 60th and 80th percentiles as having 'high' fitness; and those

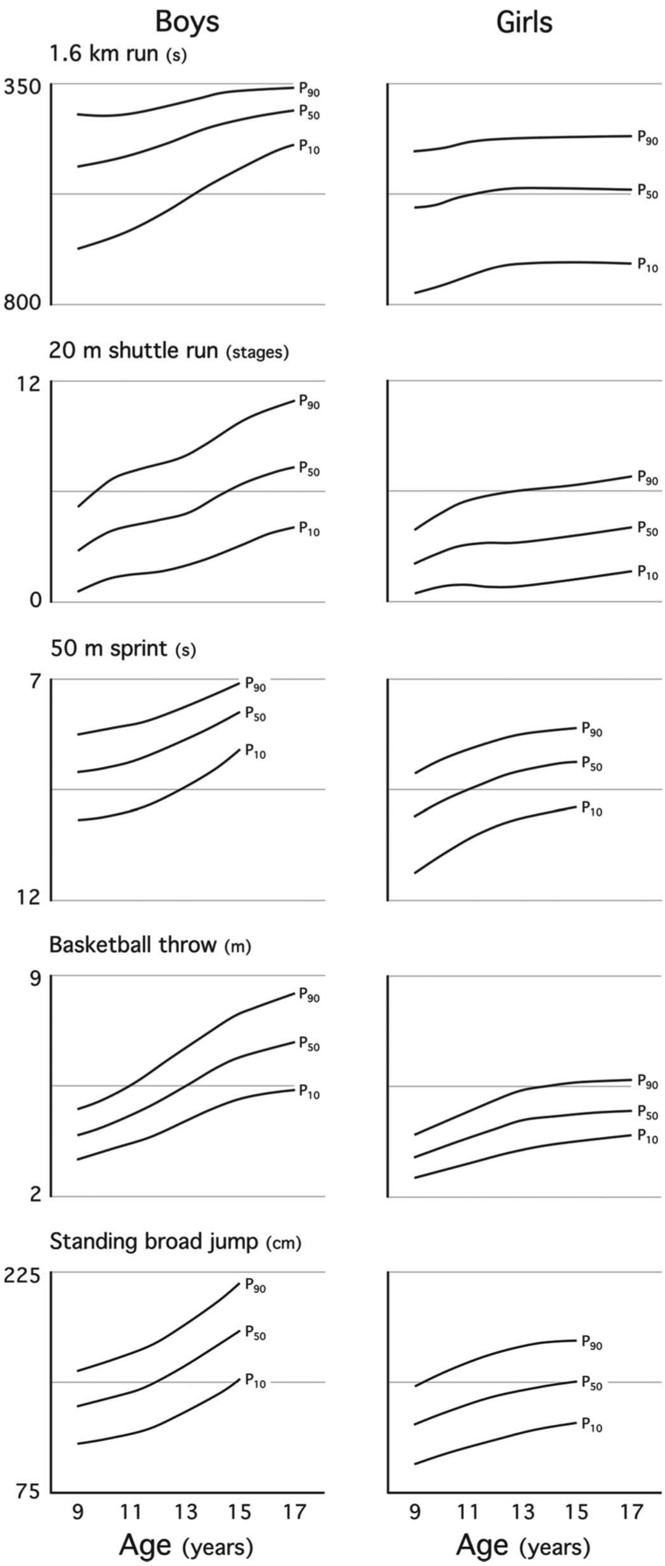

Figure 2 Smoothed centile curves (P_{10}, P_{50} and P_{90}) for (A) 1.6 km run (s), (B) 20 m shuttle run (number of completed stages), (C) 50 m sprint (s), (D) basketball throw (m) and (E) standing broad jump (cm).

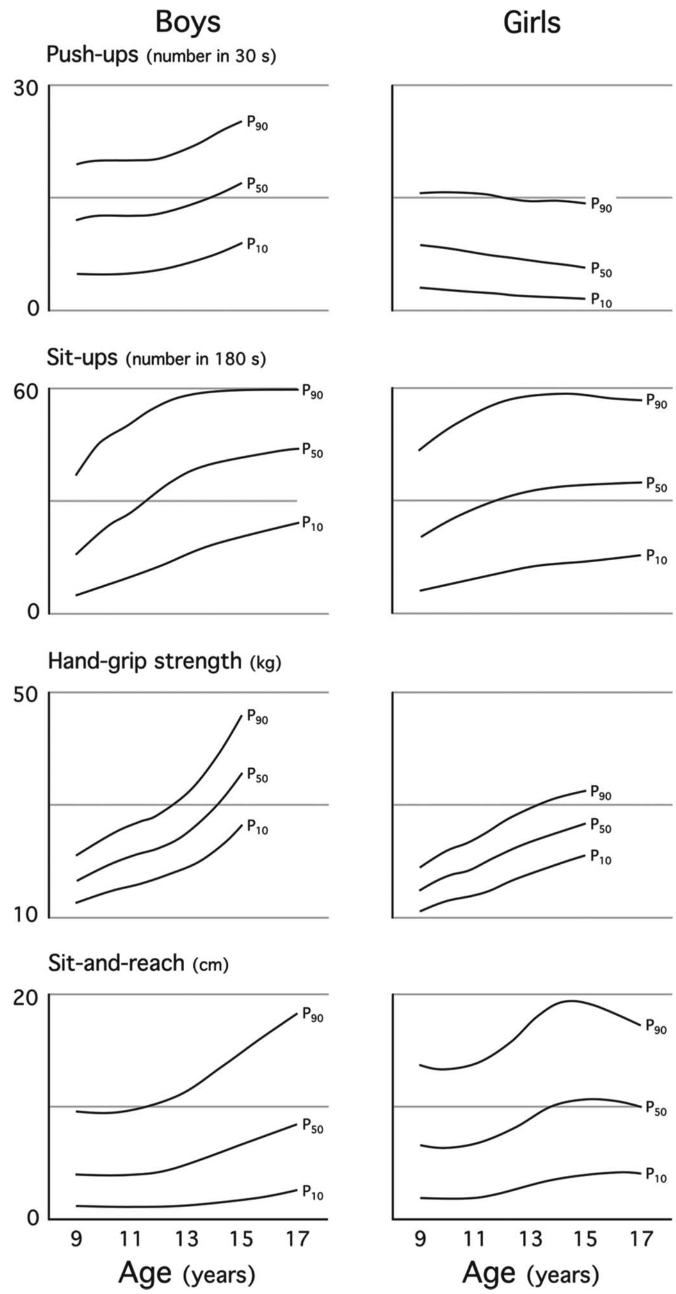

Figure 3 Smoothed centile curves (P_{10}, P_{50} and P_{90}) for (A) push-ups (number in 30 s), (B) sit-ups (number in 180 s), (C) hand-grip strength (kg) and (D) sit-and-reach (cm) tests.

above the 80th percentile as having 'very high' fitness. These data are not criterion-referenced in that they do not indicate whether children with 'very low' or 'low' (or any other classification for that matter) have 'unhealthy' cardiovascular fitness or increased cardiometabolic risk. Despite the fact that previous Australian evidence has linked low childhood cardiovascular fitness with increased cardiometabolic risk in adulthood,[48] future Australian studies are required to examine whether childhood thresholds for cardiovascular fitness (or other health-related fitness components) are significantly associated with clustered cardiometabolic risk (or other health outcomes, such as mental or skeletal health outcomes).

Strengths and limitations

Despite the fact that the last national fitness survey of Australian children was in 1985, this study provides the most up-to-date normative dataset for nine widely administered health-related fitness tests, using cumulated data from 85347 Australian children aged 9–17 years collected between 1985 and 2009. This

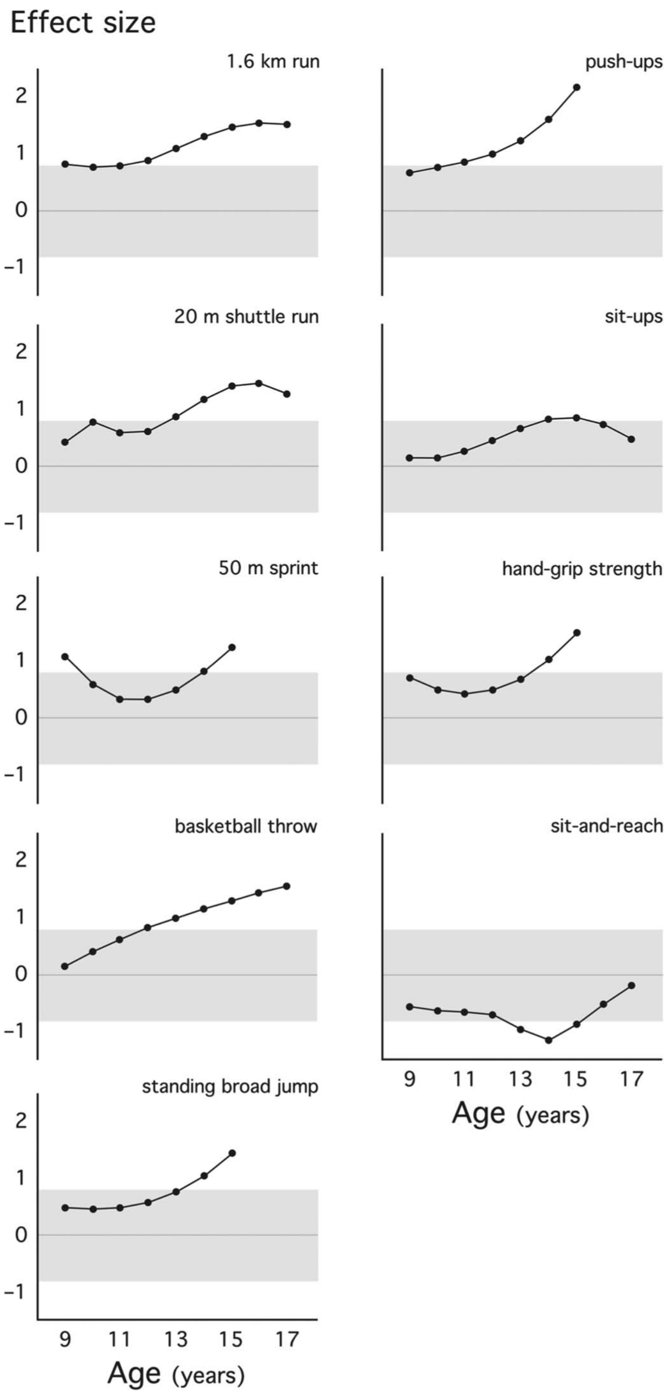

Figure 4 Sex-related differences in mean fitness expressed as effect sizes. Data are shown for 9–17-year-old children tested on the (A) 1.6 km run, (B) 20 m shuttle run, (c) 50 m sprint, (D) basketball throw, (E) standing broad jump, (F) push-ups, (G) sit-ups, (H) hand-grip strength and (I) sit-and-reach tests. The limits of the grey zone represent effects sizes of 0.8 and −0.8, beyond which large differences are observed.

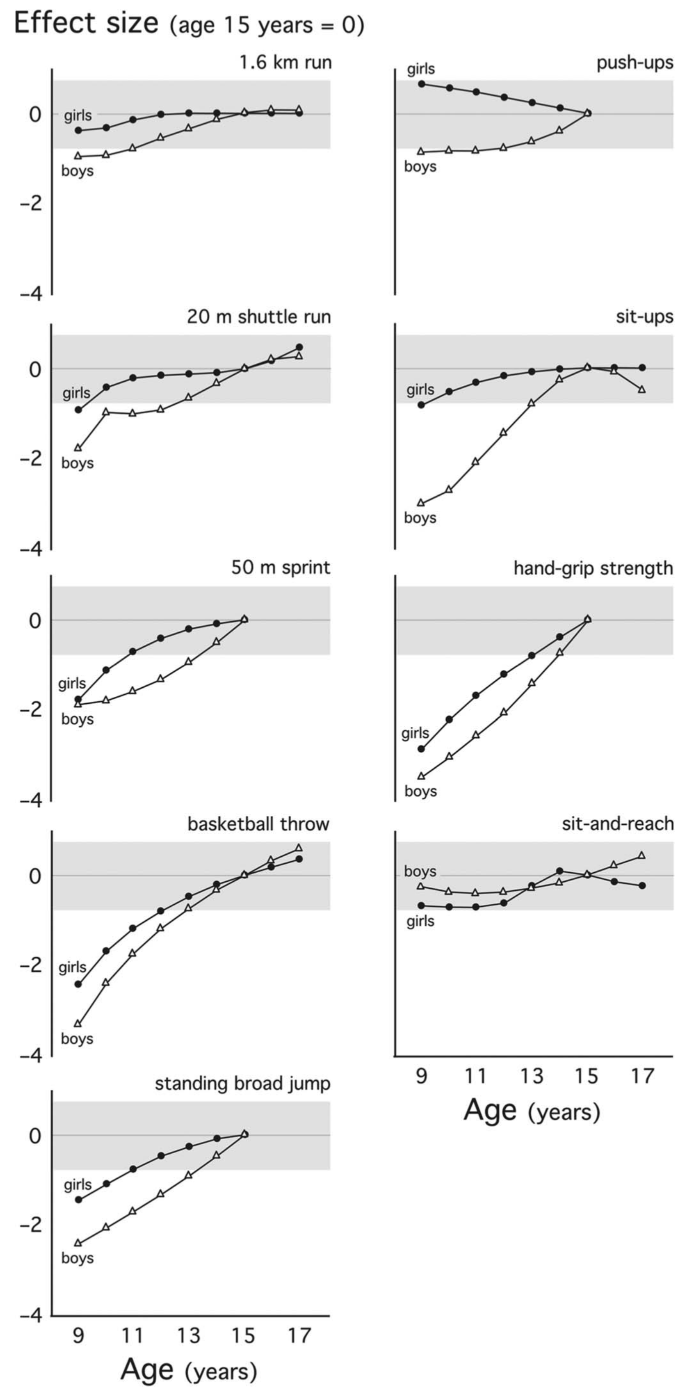

Figure 5 Age-related changes in mean fitness expressed as effect sizes standardised to an effect size of age 15 years=0. Data are shown for 9–17-year-old boys (triangles) and girls (circles) separately tested on the (A) 1.6 km run, (B) 20 m shuttle run, (C) 50 m sprint, (D) basketball throw, (E) standing broad jump, (F) push-ups, (G) sit-ups, (H) hand-grip strength and (I) sit-and-reach tests. The limits of the grey zone represent effects sizes of 0.8 and −0.8, beyond which large differences are observed.

study used a strict set of inclusion and exclusion criteria and rigorous initial data analysis procedures to systematically control for any factors (eg, differences in test methodology) that might have biased the normative values or the estimates of the sex- and age-related differences. It used a novel pseudo-data method to allow both descriptive and raw data to be merged before using the LMS method to create sex- and age-specific smoothed percentiles. It also quantified sex- and age-related differences as standardised effects sizes, allowing for comparison between sexes, among different ages, and with sex, age and test-matched international children.

However, this study is not without limitations. Only one of the 15 included studies was based on a nationally representative sample, which obviously raises the issue of representativeness. Most of the included studies used similar sampling frames

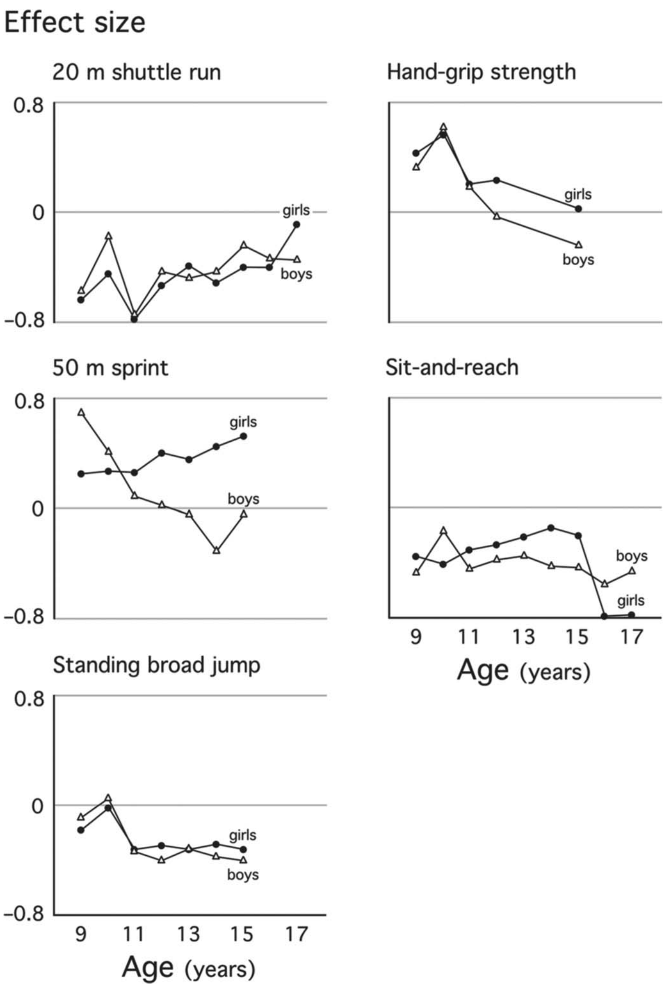

Figure 6 Sex- and age-specific effect sizes for (A) 20 m shuttle run, (B) 50 m sprint, (C) hand-grip strength, (D) sit-and-reach and (E) standing broad jump for 9–17-year-old Australian boys (triangles) and girls (circles) relative to their international peers. Positive effects indicate higher fitness scores for Australian children and negative effects indicate lower fitness scores. Comparative data represent n=284 508 20 m shuttle run performances,[28–30] n=1 216 452 50 m sprint performances,[18] n=126 361 hand-grip strength performances,[29] n=102 664 sit-and-reach performances,[29] and n=164 986 standing broad jump performances[29] of 9–17-year-old children from 48 international countries.

(table 1). Schools with a greater interest in sport and fitness may have been more willing to participate, and because participation at the individual level was voluntary, it is possible that children with low fitness levels chose not to participate. This might have resulted in fitness test performances unrepresentative of the population, but it should not have affected the sex- and age-related differences. Fitness data were also collected at different times during the 1985–2009 period, and given convincing evidence of recent temporal declines in some (but not all) components of Australian children's fitness,[23 49] it is possible that the normative data presented in this study represent a better 'health-related picture' than what would be observed today. A temporal analysis of the data accumulated in this study suggests that these normative data would probably overestimate the fitness of Australian children in 2009 by an average of 0.3 SDs or 13 percentile points, assuming of course that the observed temporal changes remained consistent across the entire 1985–2009 period. Nonetheless, these data represent the best available and most up-to-date health-related fitness data on Australian children. It must also be remembered that despite being simple, cheap, easy, reliable, reasonably valid and widely used alternatives of laboratory-based criterion measures, field tests are affected by factors other than underlying construct fitness. For example, validity data for field tests of cardiovascular fitness suggest that (at best) only 50–60% of the variance in field test performance is explained by the variance in underlying peak oxygen uptake, indicating that other physiological, physical, biomechanical, psychosocial and environmental factors also play a part.[15] In addition, although criterion-related validity has not been established for all of the included tests, face validity is generally accepted.[17] Most of the included tests are also considered to demonstrate good reliability, although tests requiring a reasonable degree of subjective judgement (eg, the subjective scoring of a properly performed sit-up or push-up) typically demonstrate poorer reliability.[14]

Conclusion

Physical fitness is considered to be an excellent marker of current and future health. In anticipation of a follow-up national fitness survey, this study provides the most up-to-date and most comprehensive set of sex- and age-specific normative centile values of health-related fitness of Australian children, which can be used as benchmark values for health and fitness screening and surveillance systems. These normative centile values will facilitate the identification of children with low fitness to set appropriate fitness goals, monitor individual changes in fitness and promote positive health behaviours. They will also facilitate the identification of children who possess specific fitness characteristics that may be considered important for sporting success, in the hope of recruiting the high achievers into elite sporting development programs.

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Correction notice This article has been corrected since it was published Online First. The authors have noticed that the normative data in Table 10 are incorrect. The correct table has been inserted.

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REFERENCES

1 Ortega FB, Ruiz JR, Castillo MJ, *et al*. Physical fitness in childhood and adolescence: a powerful marker of health. *Int J Obes (Lond)* 2008;32:1–11.
2 Ruiz JR, Castro-Piñero J, Artero EG, *et al*. Predictive validity of health-related fitness in youth: a systematic review. *Br J Sports Med* 2009;43:909–23.
3 Vicente-Rodriguez G, Ara I, Perez-Gomez J, *et al*. High femoral bone mineral density accretion in prepubertal soccer players. *Med Sci Sports Exerc* 2004;36:1789–95.
4 Kodama S, Saito K, Tanaka S, *et al*. Cardiorespiratory fitness as a quantitative predictor of all-cause mortality and cardiovascular events in healthy men and women: a meta-analysis. *JAMA* 2009;301:2024–35.
5 Lee CD, Blair SN. Cardiorespiratory fitness and stroke mortality in men. *Med Sci Sports Exerc* 2002;34:592–5.
6 Dishman RK, Washburn RA, Heath GW. *Physical Activity Epidemiology*. Champaign, IL: Human Kinetics 2004:358–9.
7 Gillespie LD, Robertson MC, Gillespie WJ, *et al*. Interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev* 2009;2:CD007146.
8 Katzmarzyk PT, Church TS, Janssen I, *et al*. Metabolic syndrome, obesity, and mortality: impact of cardiorespiratory fitness. *Diabetes Care* 2005;28:391–7.
9 Katzmarzyk PT, Church TS, Blair SN. Cardiorespiratory fitness attenuates the effects of the metabolic syndrome on all-cause and cardiovascular disease mortality in men. *Arch Intern Med* 2004;164:1092–7.
10 Andersen LB, Hasselstrøm H, Grønfeldt V, *et al*. The relationship between physical fitness and clustered risk, and tracking of clustered risk from adolescence to young

adulthood: eight years follow-up in the Danish Youth and Sport Study. *Int J Behav Nutr Phys Act* 2004;1:6.
11 Cleland VJ, Ball K, Magnussen C, *et al*. Socioeconomic position and the tracking of physical activity and cardiorespiratory fitness from childhood to adulthood. *Am J Epidemiol* 2009;170:1069–77.
12 Twisk JW, Kemper HC, van Mechelen W. Tracking of activity and fitness and the relationship with cardiovascular disease risk factors. *Med Sci Sports Exerc* 2000;32:1455–61.
13 Kristensen PL, Wedderkopp N, Møller NC, *et al*. Tracking and prevalence of cardiovascular disease risk factors across socio-economic classes: a longitudinal substudy of the European Youth Heart Study. *BMC Public Health* 2006;6:20.
14 Artero EG, España-Romero V, Castro-Piñero J, *et al*. Reliability of field-based fitness tests in youth. *Int J Sports Med* 2011;32:159–69.
15 Tomkinson GR, Olds TS. Field tests of fitness. In: Armstrong N, Van Mechelen W, eds. *Pediatric Exercise Science and Medicine*. Oxford: Oxford University Press 2008:109–28.
16 Castro-Piñero J, Artero EG, España-Romero V, *et al*. Criterion-related validity of field-based fitness tests in youth: a systematic review. *Br J Sports Med* 2010;44:934–43.
17 Ruiz JR, Castro-Piñero J, España-Romero V, *et al*. Field-based fitness assessment in young people: the ALPHA health-related fitness test battery for children and adolescents. *Br J Sports Med* 2011;45:518–24.
18 Council of Europe. *Eurofit: Handbook for the Eurofit Tests Of Physical Fitness*. Rome: Council of Europe 1988.
19 The Cooper Institute. *FITNESSGRAM/ACTIVITYGRAM Test Administration Manual*. Fourth edition. Champaign, IL: Human Kinetics 2007.
20 Olds TS, Tomkinson GR. The aerobic fitness of 9–15 year old South Australian children: norms, trends and international comparisons. *ACHPER Healthy Lifestyles Journal* 2003;50:25–30.
21 Pyke JE. *Australian Health And Fitness Survey 1985: The Fitness, Health And Physical Performance Of Australian School Students Aged 7–15 Years*. Parkside, SA: The Australian Council for Health, Physical Education and Recreation 1987.
22 Tomkinson GR, Olds TS. Secular changes in pediatric aerobic fitness test performance: the global picture. *Med Sport Sci* 2007;50:46–66.
23 Tomkinson GR, Olds TS. Secular changes in aerobic fitness test performance of Australasian children and adolescents. *Med Sport Sci* 2007;50:168–82.
24 Tomkinson GR. Global changes in anaerobic fitness test performance of children and adolescents (1958-2003). *Scand J Med Sci Sports* 2007;17:497–507.
25 Tomkinson GR, Léger LA, Olds TS, *et al*. Secular trends in the performance of children and adolescents (1980-2000): an analysis of 55 studies of the 20m shuttle run test in 11 countries. *Sports Med* 2003;33:285–300.
26 Cole TJ, Green PJ. Smoothing reference centile curves: the LMS method and penalized likelihood. *Stat Med* 1992;11:1305–19.
27 Pan H, Cole T. *User's Guide to Lms Chart Maker*. Council MR, ed. 1997–2005 Medical Research Council. UK: Medical Research Council 2005.
28 Jackson LV, Thalange NK, Cole TJ. Blood pressure centiles for Great Britain. *Arch Dis Child* 2007;92:298–303.
29 Ortega FB, Artero EG, Ruiz JR, *et al*. Physical fitness levels among European adolescents: the HELENA study. *Br J Sports Med* 2011;45:20–9.
30 Castro-Piñero J, González-Montesinos JL, Keating XD, *et al*. Percentile values for running sprint field tests in children ages 6-17 years: influence of weight status. *Res Q Exerc Sport* 2010;81:143–51.
31 Cohen J. *Statistical Power Analysis For The Behavioral Sciences*. Second edition. New Jersey: Lawrence Erlbaum 1988.
32 Cole TJ, Freeman JV, Preece MA. Body mass index reference curves for the UK, 1990. *Arch Dis Child* 1995;73:25–9.
33 Eisenmann JC. Waist circumference percentiles for 7- to 15-year-old Australian children. *Acta Paediatr* 2005;94:1182–5.
34 Armstrong N, McManus AM, Welsman JR. Aerobic fitness. In: Armstrong N, Van Mechelen W, eds. *Paediatric Exercise Science and Medicine*. Oxford: Oxford University Press 2008:269–82.
35 Krahenbuhl GS, Skinner JS, Kohrt WM. Developmental aspects of maximal aerobic power in children. *Exerc Sport Sci Rev* 1985;13:503–38.
36 Rowland TW. Evolution of maximal oxygen uptake in children. *Med Sport Sci* 2007;50:200–9.
37 Blimkie CJR, Sale DG. Strength development and trainability during childhood. In: Van Praagh E, eds. *Pediatric Anaerobic Performance*. Champaign, IL: Human Kinetics 1998:193–224.
38 Froberg K, Lammert O. Development of muscle strength during childhood. In: Bar-Or O, ed. *The Child and Adolescent Athlete*. Oxford: Blackwell Science 1996:42–53.
39 De Ste Croix MDA. Muscle strength. In: Armstrong N, Van Mechelen W, eds. *Paediatric Exercise Science and Medicine*. Second edition. Oxford: Oxford University Press 2008:199–212.
40 Olds T, Tomkinson G, Léger L, *et al*. Worldwide variation in the performance of children and adolescents: an analysis of 109 studies of the 20-m shuttle run test in 37 countries. *J Sports Sci* 2006;24:1025–38.
41 Adegboye AR, Anderssen SA, Froberg K, *et al*. Recommended aerobic fitness level for metabolic health in children and adolescents: a study of diagnostic accuracy. *Br J Sports Med* 2011;45:722–8.
42 Lobelo F, Pate RR, Dowda M, *et al*. Validity of cardiorespiratory fitness criterion-referenced standards for adolescents. *Med Sci Sports Exerc* 2009;41:1222–9.
43 Ruiz JR, Ortega FB, Rizzo NS, *et al*. High cardiovascular fitness is associated with low metabolic risk score in children: the European Youth Heart Study. *Pediatr Res* 2007;61:350–5.
44 Welk GJ, Laurson KR, Eisenmann JC, *et al*. Development of youth aerobic capacity standards using receiver operator characteristic curves. *Am J Prev Med* 2011;41: S111–6.
45 Cureton KJ, Sloniger MA, O'Bannon JP, *et al*. A generalized equation for prediction of VO2peak from 1-mile run/walk performance. *Med Sci Sports Exerc* 1995;27:445–51.
46 Léger L, Lambert J, Goulet A, *et al*. [Aerobic capacity of 6 to 17-year-old Quebecois–20 meter shuttle run test with 1 minute stages]. *Can J Appl Sport Sci* 1984;9:64–9.
47 Tomkinson G. Aerobic fitness thresholds for cardio metabolic health in children and adolescents. *Br J Sports Med* 2011;45:686–7.
48 Dwyer T, Magnussen CG, Schmidt MD, *et al*. Decline in physical fitness from childhood to adulthood associated with increased obesity and insulin resistance in adults. *Diabetes Care* 2009;32:683–7.
49 Tomkinson GR, Hamlin MJ, Olds TS. Secular changes in anaerobic test performance in Australasian children and adolescents. *Pediatr Exerc Sci* 2006;18:314–28.
50 Australian Council for Health, Physical Education and Recreation. *Australian Fitness Education Award: User's Manual And Curriculum Ideas.* Adelaide, SA: Australian Council for Health, Physical Education and Recreation 1996.
51 Barnett LM, Van Beurden E, Morgan PJ, *et al*. Does childhood motor skill proficiency predict adolescent fitness? *Med Sci Sports Exerc* 2008;40:2137–44.
52 Birchall J. Health related fitness testing. In: Went S, ed. *A Healthy Start: Holistic Approaches to Health Promotion in School Communities*. Second edition. Melbourne: Monash University 1992:251–65.
53 Booth M, Macaskill P, McLellan L, *et al*. *NSW Schools Fitness and Physical Activity Survey 1997*. Sydney: NSW Department of Education and Training, 1997.
54 Booth M, Okely AD, Denney-Wilson E, *et al*. *NSW Schools Physical Activity and Nutrition Survey (SPANS) 2004: Full Report*. Sydney: NSW Department of Health, 2006.
55 Burke V, Beilin LJ, Durkin K, *et al*. Television, computer use, physical activity, diet and fatness in Australian adolescents. *Int J Pediatr Obes* 2006;1:248–55.
56 Cooley D, McNaughton L. Aerobic fitness of Tasmanian secondary school children using the 20-m shuttle run test. *Percept Mot Skills* 1999;88:188–98.
57 Dollman J, Olds T, Norton K, *et al*. The evolution of fitness and fatness in 10–11-year-old Australian schoolchildren: changes in distributional characteristics between 1985 and 1997. *Pediatr Exerc Sci* 1999;11:106–21.
58 Hands B. *Fitness and motor skill levels of Western Australian Primary School Children*. Perth, WA: University of Western Australia 2000.
59 McNaughton L, Morgan R, Smith P, *et al*. An investigation into the fitness levels of Tasmanian primary schoolchildren. *ACHPER Healthy Lifestyles Journal* 1996;43:4–10.
60 Vandongen R, Jenner DA, Thompson C, *et al*. A controlled evaluation of a fitness and nutrition intervention program on cardiovascular health in 10- to 12-year-old children. *Prev Med* 1995;24:9–22.

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ORIGINAL ARTICLE

Physical fitness normative values for 6–18-year-old Greek boys and girls, using the empirical distribution and the lambda, mu, and sigma statistical method

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Abstract
The aim of the this study was to establish age- and gender-specific physical fitness normative values and to compare percentiles and *Z* scores values in a large, nationwide sample of Greek children aged 6–18 years. From March 2014 to May 2014, a total of 424,328 boys and girls aged 6–18 years who attended school in Greece were enrolled. The studied sample was representative, in terms of age–sex distribution and geographical region. Physical fitness tests (i.e. 20 m shuttle run test (SRT), standing long jump, sit and reach, sit-ups, and 10×5 m SRT) were performed and used to calculate normative values, using the percentiles of the empirical distributions and the lambda, mu, and sigma statistical method. Normative values were presented as tabulated percentiles for five health-related fitness tests based on a large data set comprising 424,328 test performances. Boys typically scored higher than girls on cardiovascular endurance, muscular strength, muscular endurance, and speed/agility, but lower on flexibility (all p values <0.001). Older boys and girls had better performances than younger ones ($p < 0.001$). Physical fitness tests' performances tended to peak at around the age of 15 years in both sexes. The presented population-based data are the most up-to-date sex- and age-values for the health-related fitness of children and adolescents in Greece and can be used as standard values for fitness screening and surveillance systems and for comparisons among the same health-related fitness scores of children from other countries similar to Greece. Schools need to make efforts to improve the fitness level of the schoolchildren through the physical education curriculum to prevent cardiovascular risk.

Keywords: *Physical fitness, normative values, performance, children*

Introduction

Physical fitness refers to "the ability to carry out daily tasks with vigor and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies" (Caspersen, Powell, & Christenson, 1985, p. 128). Fitness status has long been associated with age, from youth to the middle years of lifespan and even older. However, there is a lack of data in teenagers and younger children. It is crucial to know the fitness level of children as it has been suggested that fitness level in childhood is essential to carry forward favourable behavioural and biological effects into later life (Ortega, Ruiz, Castillo, & Sjöström, 2008). Accumulating epidemiologic evidence reveals that improvement in physical fitness, mainly aerobic fitness, is related to better health in children (Andersen, Wedderkopp, Hansen, Cooper, & Froberg, 2003; Ekelund et al., 2007; Hurtig-Wennlof, Ruiz, Harro, & Sjöström, 2007; Tambalis,

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Panagiotakos, Psarra, & Sidossis, 2011), in a dose response manner (Anderssen et al., 2007). Moreover, subjects with high physical fitness during adolescence may have lower levels of body fatness as adults (Eisenmann, Wickel, Welk, & Blair, 2005). In contrast, low levels of physical fitness in children have been associated with a number of cardiometabolic risk factors, such as hypertension, hyperlipidaemia, and obesity (Anderssen et al., 2007). To prevent early development of cardiovascular disease risk factors, among other significant interventions (e.g. increased physical activity levels, decreased obesity levels), preventive strategies must incorporate age- and sex-specific physical fitness assessment, even from childhood.

To make useful recommendations as regards to physical fitness, percentiles and *Z* scores have been used to assess children's and adolescent's growth and fitness status (Eisenmann, Laurson, & Welk, 2011). Percentiles are easier to understand and utilize in practice. In contrast, *Z* scores are more complicated and may be of limited use in clinical settings, but are more useful in research. However, it has been suggested that the lambda, mu, and sigma (LMS) method, a technique that uses *Z* scores and is based on smoothed percentile distribution curves over ages, better fits the data than the empirical percentile method (Wang, Moreno, Caballero, & Cole, 2006). These different methodologies may affect the cut-off points for the evaluation of fitness status and may lead to different results.

Numerous data sets on physical fitness levels among children are available worldwide; moreover age-, gender-, as well as region-specific values are essential for a variety of health-risk measurements (i.e. not only for fitness), in order to develop effective public health strategies (Tambalis et al., 2011; Tambalis, Panagiotakos, Arnaoutis, & Sidossis, 2013; Tokmakidis, Kasambalis, & Christodoulos, 2006). In addition, a comparison of both methodologies may prove useful for future researchers who would also like to calculate country-specific normative curves for fitness levels, as it would allow them to select the most appropriate procedure.

Therefore, the aim of the present work was to present the Greek region-specific distribution of age and sex physical fitness test measurements for 6–18-year-old children and adolescents and to evaluate sex- and age-related differences, using both percentiles and *Z* scores values in a nationwide sample of schoolchildren. These distributions (percentiles and Z scores) may also be valid for other similar populations around the world for comparisons among the same health-related fitness scores of children similar to Greece (i.e. Caucasians), and guide preventive strategies to better prevent cardiometabolic disorders in the future.

Methods

Study design and participants

Population-based, representative data were derived from a nationwide school-based survey under the auspices of the Ministry of Education. Specifically, anthropometric, physical activity, nutrition, and physical fitness data along with information on age and sex were collected from March 2014 to May 2014. In total, 424,328 (51% boys and 49% girls) children aged 6–18 years from Greek public and private schools agreed to participate in the study (participation rate was 40% of the total population). The working sample was representative of the entire Greek population (chi-square p value as compared with the current sample with the age–sex distribution of all Greek areas = 0.93).

Study approval

Ethical approval for the survey was granted by the Review Board of the Ministry of Education and the Ethical Committee of Harokopio University.

Assessment of fitness status

The Euro-fit physical fitness test battery was used to evaluate children's physical fitness levels; it is a set of nine physical tests covering flexibility, speed, endurance, and strength. The standardized test battery was proposed by the Council of Europe for children of school age and has been used in many European countries schools since the 1980s. Five fitness tests of the Euro-fit Battery, representative of flexibility, explosive strength, speed/agility, and aerobic performance, were administered by trained physical education professionals during the physical education classes. Specifically, measurements were performed by one teacher of physical education in each class. All physical education professionals were instructed through a detailed and extended manual of operations and followed a standardized procedure of measurements in order to minimize the potential inter-rate variability among schools. The physical education teachers were first trained by a school advisor of physical education for accurate anatomical landmarks, subject positioning, and measurement techniques. Verbal informed consent for the child to participate in the measurements was taken from physical education teachers. As the measurements were included in an obligatory school programme, verbal informed consent was considered sufficient.

Briefly, the test assessed: (a) standing long jump (SLJ; jump as far as possible from a standing position at the start) to evaluate lower body explosive power; (b) sit and reach (SR; this test involves sitting on the floor with legs stretched out straight ahead without shoes. The soles of the feet are placed flat against the box. With the palms facing downwards, and the hands on top of each other or side by side, the participant reaches forward along the measuring line as far as possible. The score is recorded to the nearest centimetre as the distance reached by the hand, using 15 cm at the level of the feet) to measure flexibility; (c) sit-ups in 30 s (SUs; lie on the mat with the knees bent at right angles, with the feet flat on the floor and held down by a partner), to measure the endurance of the abdominal and hip-flexor muscles; (d) 10 × 5 m shuttle run test (10 × 5 m SRT; from a standing start), to evaluate speed and agility; and (e) multi-stage 20 m SRT, to estimate aerobic performance. The 20 m SRT test consists of measuring the number of laps completed by participants running up and down between two lines in groups, set 20 m apart, at an initial speed of 8.5 km/h which increases by 0.5 km/h every minute, using a pre-recorded audio tape (Leger, Lambert, Goulet, Rowan, & Dinelle, 1984; Leger, Mercier, Gadoury, & Lambert, 1988). Repeat tests (two trials) were allowed for the SLJ, SR, SU, and 10 × 5 m SRT, with the best performance of each recorded.

Statistical analysis

Descriptive statistics (mean ± standard deviation) for boys and girls were calculated. Comparisons of the physical fitness tests' performances data between boys and girls were performed using the independent samples *t* test, after testing for equality of variances using the Levene test. Comparisons between percentile values of the physical fitness tests' performance data of both calculation methods were performed using the paired samples *t* test.

Age- and sex-specific distributions and percentiles were calculated using two methods: through the empirical distribution of the data, the 3th, 10th, 25th, 50th, 75th, 90th, and 97th percentiles were calculated; also, the LMS method was used (Cole & Green, 1992). The LMS method was used in order to smooth the age-dependent skewness usually observed in fitness values. Based on this method, the data were normalized using the Box–Cox power transformation. The Box–Cox λ-power transformation of the variable y_i has the following form:

$$y_i^{(\lambda)} = \frac{y_i^{\lambda} - 1}{\lambda(\mathrm{gm}(y))^{\lambda-1}} \quad \text{if } \lambda \neq 0$$

or

$$y_i^{(\lambda)} = \mathrm{gm}(y_i) \log y_i \quad \text{if } \lambda \neq 0$$

where gm is the geometric mean of y_i. The power transformation was calculated from the raw data and skewness in the distribution where y was removed. The principle idea of the LMS method is to power transform the measurement, i.e. SLJ here, and to use the coefficient of variation (CV = standard deviation/mean) of the raw data. The optimal Box–Cox power λ is the one that gives the lowest CV (Cole & Green, 1992). Thus, the LMS method calculates the best power (L), the best mean (M), and CV (S) in each series of measurements at a specific age. The degrees of freedom used to determine the L, M, and S were chosen on the basis of that which achieved the smallest difference in the penalized deviance (−2 × log{penalised likelihood}) statistic, as well as the Schwarz Bayesian Criterion (both goodness-of-fit measures) between the estimated models. Then, centiles of physical fitness tests were calculated as follows:

$$\mathrm{Centile}(\alpha) = M_{\mathrm{age}} \times (1 + L_{\mathrm{age}} \times S_{\mathrm{age}} \times Z_{\alpha})^{1/L_{\mathrm{age}}}, \quad (1)$$

where Z_{α} is the Z score (i.e. (variable − mean)/standard deviation) corresponding to the required centile (e.g. $Z = -0.67$ gives the 25th centile, $Z = 0$ gives the median M, $Z = 0.67$ gives the 75th centile). The gender-specific cut-offs of fitness tests for each age group were calculated for various centiles by solving the previous equation. Particularly, from Equation (1) we have:

$$\left(\frac{\mathrm{Centile}(\alpha)}{M_{\mathrm{age}}}\right)^{L_{\mathrm{age}}} = 1 + L_{\mathrm{age}} \times S_{\mathrm{age}} \times Z_{\alpha},$$

$$\left(\frac{\mathrm{Centile}(\alpha)}{M_{\mathrm{age}}}\right)^{L_{\mathrm{age}}} - 1 = L_{\mathrm{age}} \times S_{\mathrm{age}} \times Z_{\alpha}.$$

Thus,

$$Z_{\alpha} = \left(\left(\frac{\mathrm{Centile}(\alpha)}{M_{\mathrm{age}}}\right)^{L_{\mathrm{age}}} - 1\right) \times \left(L_{\mathrm{age}} \times S_{\mathrm{age}}\right)^{-1}. \quad (2)$$

The LMS values can be used to calculate Z scores and therefore percentile values by looking up a Z

table, using the following formula:

$$z = \frac{(x/M) - 1}{L \times S},$$

where x is performance, L is the gender- and age-specific L value, M is the gender- and age-specific M value, and S is the gender- and age-specific S value. All statistical analyses were performed using the SPSS program (Release 18; SPSS Inc., Chicago, IL, USA). The LMSchartmaker (Pan & Cole, 2010) and the LMSgrowth (Pan & Cole, 2011) freeware packages were used to calculate L, M, and S values at ages 6–18 based on Greek reference values.

Results

In Tables I and II, normative physical fitness data for 6–18-year-old children in Greece, by gender and age as tabulated critical percentiles and LMS values from 3 to 97 (P_3, P_{10}, P_{25}, P_{50}, P_{75}, P_{90}, P_{97}), are presented. Also presented are the gender- and age-specific LMS values for all fitness tests.

For each of the fitness tests, performance was better in boys compared with girls ($p < 0.001$), except for the SR test ($p < 0.001$). Moreover, older boys and girls had better performances than younger ones ($p < 0.001$). Physical fitness tests' performances also tended to peak at about the age of 15–16 years in both sexes.

In order to investigate potential differences between percentile values from the two methods, comparisons by physical fitness test and gender were performed. Data analysis revealed no significant differences between critical percentiles and LMS percentiles in SR, SLJ, SUs, 20 m SRT, and 10×5 m SRT values in either sex (all p values >0.05).

Discussion

The aim of the present work was to develop up-to-date age- and sex-specific physical fitness normative values for Greek children aged 6–18 years and to compare specific percentile values from two widely applied estimation methods: the frequency percentiles and the LMS smoothed percentiles. This study provides information relating to normative values across a range of health-related fitness tests. These values could be used as approximate indicative values for comparisons among the same health-related fitness scores of children (according to National Statistical Services the vast majority of children population in Greece are Caucasians) from other countries similar to Greece: i.e. a developed country with population predominately Caucasian. Moreover, these data can be used as benchmark values for health-related fitness screening and surveillance of children 6–18 years in Greece.

The presented data could be useful in a crude classification of how well children in Greece perform on the specific health-related fitness tests relative to their age- and sex-matched peers and to identify those children with specific physical fitness characteristics that could be considered essential for sporting success. Moreover, our findings facilitate the recognition of children and adolescents with low physical fitness aiming to set appropriate goals in the future and to promote encouraging health behaviours. Previous studies in children from Greece have linked low cardiorespiratory fitness with increased metabolic score risk and inflammation (Christodoulos, Douda, & Tokmakidis, 2012; Flouris, Bouziotas, Christodoulos, & Koutedakis, 2008). According to the presented percentile classification from both methods, and for a practical use of these data, children could be classified as having a performance score: very poor ($<P_{10}$), in the poor quartile (1st), in the good quartiles (2nd–3rd), in the very good quartile (4th), and excellent ($X > P_{90}$) of the distribution. Although this classification is not criterion-referenced, Looney and Plowman (1990) suggested that test scores above the 25th percentile (the poor quartile) in fitness tests should be considered acceptable from a health perspective. On the contrary, low levels of physical fitness have been associated with many serious health problems in childhood, while sufficient levels of physical fitness may have an important cardio-protective role in children. According to Anderssen et al. (2007), there was a strong association between aerobic fitness and the clustering of cardiovascular disease risk factors. Specifically, the odds ratios for clustering in each quartile of fitness, using the quartile with the highest fitness as reference, were 13.0 [95% confidence interval (CI) 8.8–19.1] 4.8 [95% CI 3.2–7.1], and 2.5 [95% CI 1.6–3.8], respectively, after adjusting for several confounding factors (Andersen et al., 2003; Anderssen et al., 2007; Ekelund et al., 2007; Hurtig-Wennlof et al., 2007). Future studies need to examine which specific childhood and/or adolescence thresholds for aerobic fitness are significantly associated with clustered cardiovascular disease risk factors.

The presented results revealed that boys consistently scored higher than girls in almost all fitness tests (with the exception of the SR test of flexibility). Moreover, older boys and girls performed better than younger ones ($p < 0.001$). Our findings are in accordance with recent studies from Latvia (Sauka et al.,

Table I. Boys physical fitness tests percentiles and LMS values and LMS summary statistics by age in 6–18-year-old Greek children and adolescents

		Percentiles							LMS method									
Age	N	P_3	P_{10}	P_{25}	P_{50}	P_{75}	P_{90}	P_{97}	P_3	P_{10}	P_{25}	P_{50}	P_{75}	P_{90}	P_{97}	L	M	S
20 m SRT (completed laps)																		
6	1706	1.0	4.0	9.0	14.0	22.0	31.0	44.2	2.2	4.9	9.0	14.6	22.1	31.6	43.2	0.38	14.64	0.67
7	15,196	5.0	8.0	12.0	18.0	28.0	38.0	50.0	3.2	6.7	11.8	18.9	28.0	39.4	53.2	0.39	18.86	0.64
8	20,774	6.0	9.0	14.0	23.0	34.0	47.0	59.0	4.2	8.6	14.8	23.1	33.6	46.6	62.1	0.41	23.06	0.61
9	20,149	7.0	11.0	17.0	28.0	41.0	53.0	64.0	5.2	10.4	17.6	27.1	38.9	53.0	69.7	0.44	27.09	0.59
10	19,279	8.0	12.0	20.0	31.0	45.0	58.0	70.0	6.0	12.1	20.5	31.1	44.1	59.3	76.8	0.49	31.13	0.57
11	18,793	9.0	15.0	23.0	36.0	51.0	64.0	78.0	6.6	13.8	23.4	35.4	49.5	65.8	84.1	0.54	35.36	0.55
12	11,456	8.0	15.0	24.0	39.0	54.0	69.0	82.0	6.8	15.4	26.4	39.7	55.1	72.4	91.6	0.60	39.71	0.54
13	15,555	7.0	16.0	28.0	44.0	61.0	76.0	91.0	6.8	16.7	29.3	44.0	60.7	79.0	98.9	0.66	44.04	0.54
14	13,681	7.0	19.0	32.0	50.0	69.0	85.0	100	6.4	17.8	31.8	47.8	65.4	84.5	105	0.73	47.79	0.53
15	10,135	9.0	20.0	34.0	53.0	72.0	90.0	103	5.5	18.3	33.5	50.4	68.6	87.9	108	0.79	50.37	0.52
16	1862	7.0	20.0	36.0	54.0	75.0	90.0	103	4.4	18.4	34.5	51.9	70.2	89.3	109	0.85	51.87	0.52
17	670	7.0	18.0	33.0	50.0	68.0	86.0	100	3.9	18.3	35.1	52.8	71.0	89.7	109	0.91	52.76	0.51
18	305	7.4	13.0	28.0	48.0	66.0	87.0	115	3.2	18.0	35.6	53.5	71.6	89.9	108	0.97	53.48	0.51
SLJ (cm)																		
6	17,494	64.0	76.0	90.0	102	115	128	140	59.0	75.0	89.7	103	116	129	141	1.42	103.4	0.19
7	23,994	71.0	85.0	100	113	127	140	151	66.0	83.1	98.7	113	127	141	153	1.42	113.4	0.19
8	23,836	80.0	94.0	108	123	138	150	162	72.8	90.7	107	123	137	151	165	1.43	122.7	0.18
9	22,667	85.0	100	116	131	147	160	172	79.0	97.7	115	131	146	161	175	1.44	131.2	0.18
10	21,886	90.0	108	123	140	155	169	181	84.8	104	122	139	155	171	185	1.44	139.2	0.18
11	21,241	97.0	113	130	147	163	177	190	90.3	111	130	147	164	180	196	1.45	147.3	0.18
12	12,961	100.0	119	135	154	171	187	201	95.9	117	137	156	174	191	207	1.45	156.0	0.17
13	8683	105.0	125	144	164	183	200	217	101	124	145	165	184	202	219	1.46	165.0	0.17
14	7231	112.0	133	153	175	195	212	228	106	130	152	173	193	212	230	1.48	173.3	0.17
15	2633	118	140	160	183	204	220	240	110	135	159	180	201	220	239	1.51	180.3	0.17
16	7729	122	145	167	188	209	225	240	112	139	163	186	207	226	245	1.55	185.6	0.17
17	2737	120	146	167	188	210	228	245	113	142	167	190	211	231	250	1.60	189.7	0.17
18	375	110	137	160	187	222	244	250	114	144	169	193	215	235	254	1.66	193.0	0.17
SR (cm)																		
6	21,448	2.0	5.0	10.0	15.0	18.0	22.0	25.0	2.1	5.7	9.6	13.7	18.0	22.4	27.0	0.87	13.70	0.46
7	27,509	2.0	5.0	9.0	15.0	18.0	22.0	25.0	1.8	5.3	9.2	13.4	17.9	22.5	27.3	0.84	13.44	0.48
8	27,220	2.0	4.0	9.0	14.0	18.0	22.0	26.0	1.6	5.0	8.9	13.1	17.7	22.5	27.5	0.81	13.14	0.51
9	26,692	2.0	4.0	8.0	14.0	18.0	22.0	25.5	1.4	4.6	8.5	12.8	17.4	22.4	27.6	0.78	12.78	0.53
10	25,017	2.0	4.0	8.0	13.0	17.0	21.5	26.0	1.3	4.3	8.1	12.4	17.1	22.2	27.5	0.76	12.44	0.54
11	24,418	1.0	3.0	7.0	13.0	17.0	21.0	26.0	1.2	4.2	8.0	12.3	17.1	22.2	27.7	0.74	12.29	0.56
12	15,636	1.0	3.0	7.0	13.0	17.0	22.0	27.0	1.2	4.2	8.0	12.5	17.4	22.8	28.5	0.72	12.47	0.57
13	14,613	1.0	3.0	8.0	14.0	18.0	23.0	28.0	1.3	4.4	8.4	13.0	18.2	23.8	29.9	0.71	12.99	0.57
14	12,871	2.0	4.0	9.0	15.0	20.0	25.0	30.0	1.4	4.7	8.9	13.8	19.3	25.3	31.7	0.71	13.80	0.57
15	9537	2.0	5.0	10.0	16.0	21.0	27.0	31.0	1.6	5.1	9.5	14.8	20.6	27.0	33.8	0.71	14.77	0.56
16	7291	2.0	5.0	11.0	16.5	22.0	28.0	32.0	1.8	5.5	10.2	15.8	21.9	28.7	35.9	0.70	15.76	0.56
17	2573	2.0	5.0	11.0	17.0	22.0	28.0	33.0	2.0	5.9	10.9	16.7	23.2	30.3	37.8	0.70	16.72	0.55
18	352	1.0	5.0	10.0	16.0	22.0	29.0	33.0	2.2	6.4	11.6	17.7	24.4	31.8	39.7	0.70	17.68	0.55

SUs (no. in 30 sec)																		
6	17,381	2.0	6.0	10.0	13.0	16.0	19.0	23.0	1.0	5.7	9.8	13.5	16.8	19.9	22.8	1.34	13.46	0.38
7	23,866	4.0	8.0	12.0	15.0	18.0	21.0	25.0	2.0	7.3	11.5	15.3	18.8	22.1	25.3	1.29	15.27	0.36
8	23,782	6.0	10.0	14.0	17.0	20.0	23.0	27.0	4.0	8.9	13.1	16.9	20.6	24.1	27.5	1.25	16.94	0.33
9	22,608	7.0	12.0	15.0	18.0	22.0	25.0	29.0	5.8	10.3	14.5	18.4	22.1	25.8	29.3	1.21	18.40	0.31
10	21,770	8.0	13.0	16.0	20.0	23.0	26.0	30.0	7.3	11.7	15.7	19.6	23.4	27.0	30.6	1.17	19.62	0.29
11	21,159	10.0	14.0	17.0	21.0	24.0	27.0	31.0	8.6	12.8	16.8	20.6	24.4	28.1	31.7	1.14	20.62	0.28
12	12,941	10.0	15.0	18.0	21.0	25.0	28.0	32.0	9.7	13.7	17.6	21.5	25.2	29.0	32.7	1.09	21.47	0.27
13	15,555	12.0	15.0	19.0	22.0	26.0	29.0	33.0	10.6	14.5	18.4	22.2	26.0	29.8	33.6	1.03	22.20	0.26
14	13,681	12.0	16.0	19.0	23.0	27.0	30.0	34.0	11.3	15.1	18.9	22.8	26.6	30.5	34.4	0.97	22.76	0.25
15	10,135	13.0	17.0	20.0	23.0	27.0	30.0	35.0	11.8	15.5	19.3	23.1	27.0	31.0	35.0	0.91	23.11	0.25
16	7688	13.0	16.0	19.0	23.0	27.0	30.0	34.0	12.1	15.7	19.4	23.3	27.3	31.3	35.5	0.84	23.31	0.25
17	2753	12.0	16.0	19.0	23.0	27.0	30.0	35.0	12.3	15.8	19.5	23.4	27.4	31.6	35.9	0.77	23.40	0.25
18	367	10.0	15.0	18.0	22.0	26.0	30.0	36.0	12.4	15.8	19.5	23.4	27.5	31.7	36.2	0.70	23.40	0.26
10 × 5 m SRT (sec)																		
6	21,133	32.3	28.4	26.1	24.4	22.3	21.0	19.5	31.6	29.0	26.5	24.0	21.4	18.9	16.3	1.0	24.04	0.15
7	27,340	30.0	27.0	25.0	23.0	21.3	20.0	18.6	30.6	28.2	25.7	23.3	20.8	18.3	15.9	1.0	23.32	0.15
8	23,231	29.0	26.0	23.9	22.1	20.5	19.2	18.0	29.7	27.4	25.0	22.6	20.2	17.8	15.4	1.0	22.62	0.15
9	22,143	27.9	25.0	23.1	21.5	20.0	18.7	17.4	28.9	26.6	24.2	22.0	19.6	17.3	15.0	1.0	21.96	0.16
10	25,561	27.0	24.3	22.6	21.0	19.4	18.1	17.0	28.1	25.9	23.6	21.4	19.1	16.8	14.6	1.0	21.37	0.16
11	29,745	26.1	23.8	22.00	20.4	19.0	17.7	16.4	27.5	25.3	23.1	20.9	18.6	16.4	14.2	1.0	20.86	0.16
12	12,695	26.0	23.4	21.8	20.1	18.7	17.3	16.1	27.0	24.8	22.6	20.4	18.3	16.1	14.0	1.0	20.45	0.16
13	15,168	26.3	23.2	21.3	19.8	18.3	16.9	15.7	26.6	24.4	22.3	20.1	18.0	15.9	13.7	1.0	20.13	0.16
14	13,244	26.0	23.0	21.0	19.3	17.8	16.5	15.3	26.3	24.2	22.1	19.9	17.8	15.7	13.6	1.0	19.91	0.16
15	9528	26.5	23.0	21.0	19.2	17.8	16.4	15.0	26.1	24.0	21.9	19.8	17.7	15.6	13.5	1.0	19.77	0.17
16	7146	27.8	23.5	21.1	19.3	17.9	16.4	15.0	26.1	24.0	21.9	19.7	17.7	15.6	13.5	1.0	19.68	0.17
17	2487	29.4	23.9	21.2	19.4	17.8	16.4	5.0	26.0	23.9	21.8	19.6	17.6	15.6	13.5	1.0	19.64	0.17
18	345	31.0	25.8	22.1	19.9	18.2	16.7	15.0	26.0	23.9	21.8	19.6	17.6	15.6	13.5	1.0	19.61	0.17

Note: *P*, percentile; *L*, skew; *M*, median; *S*, coefficient of variation; age: completed age, e.g. 6 years = 6.00–6.99 years.

Table II. Girls physical fitness tests percentiles and LMS values and LMS summary statistics by age in 6–18-year-old Greek children and adolescents

		Percentiles							LMS method									
Age	N	P_3	P_{10}	P_{25}	P_{50}	P_{75}	P_{90}	P_{97}	P_3	P_{10}	P_{25}	P_{50}	P_{75}	P_{90}	P_{97}	L	M	S
20 m SRT (completed laps)																		
6	1640	2.0	4.0	8.0	12.0	18.0	26.0	38.0	3.5	5.7	8.8	13.0	18.6	25.9	35.1	0.25	13.02	0.56
7	14,777	5.0	8.0	11.0	15.0	21.0	29.0	39.0	4.1	6.8	10.5	15.4	21.9	30.2	40.6	0.28	15.45	0.55
8	20,084	7.0	9.0	12.0	18.0	25.0	34.0	45.0	4.9	8.0	12.4	18.1	25.6	35.0	46.5	0.30	18.14	0.54
9	19,806	7.0	10.0	14.0	20.0	29.0	40.0	51.0	5.6	9.2	14.3	20.9	29.3	39.8	52.6	0.32	20.87	0.54
10	19,143	8.0	11.0	16.0	23.0	33.0	43.0	55.0	6.1	10.3	16.0	23.4	32.8	44.3	58.2	0.35	23.42	0.54
11	18,290	9.0	12.0	18.0	26.0	36.0	48.0	61.0	6.4	11.1	17.3	25.4	35.6	48.0	62.8	0.37	25.44	0.54
12	10,693	7.0	12.0	18.0	26.0	37.0	49.0	62.0	6.4	11.3	17.9	26.5	37.2	50.1	65.4	0.40	26.49	0.54
13	6767	6.0	12.0	18.0	26.0	37.0	50.0	62.0	6.0	11.0	17.9	26.7	37.6	50.7	66.2	0.42	26.71	0.55
14	5563	5.0	12.0	18.0	26.0	37.0	50.0	63.0	5.5	10.6	17.5	26.4	37.4	50.5	65.9	0.45	26.40	0.56
15	2576	7.0	12.0	17.0	25.0	35.0	47.0	62.0	4.9	9.9	16.9	25.8	36.8	49.9	65.1	0.47	25.82	0.58
16	1462	7.0	11.0	16.0	24.0	33.0	45.0	60.0	4.2	9.2	16.2	25.2	36.2	49.2	64.3	0.49	25.21	0.60
17	490	5.0	10.0	16.0	23.0	36.0	50.0	67.0	3.5	8.5	15.6	24.6	35.7	48.7	63.6	0.52	24.63	0.61
18	240	3.0	8.0	14.0	23.0	28.0	39.5	63.7	2.8	7.8	14.8	23.9	34.9	47.8	62.5	0.54	23.92	0.63
SLJ (cm)																		
6	17,152	59.7	70.0	80.0	93.0	105	116	128	55.3	68.4	81.0	93.2	105	117	128	1.22	93.2	0.19
7	23,303	65.0	78.0	90.0	101	115	126	140	61.5	75.6	89.1	102	115	128	140	1.19	102.3	0.19
8	23,099	73.0	85.0	97.0	110	125	138	150	67.7	82.6	97.1	111	125	139	152	1.16	111.3	0.19
9	22,427	80.0	92.5	105	120	134	148	160	73.6	89.3	105	120	135	149	164	1.13	119.8	0.19
10	21,589	85.0	99.0	111	127	142	156	170	78.5	95.0	111	127	143	158	174	1.10	127.1	0.19
11	20,678	90.0	103	118	134	150	165	180	82.1	99.1	116	133	149	165	182	1.08	132.6	0.19
12	12,171	90.0	105	120	136	153	170	185	83.8	101	119	136	153	170	187	1.07	135.8	0.19
13	7795	90.0	104	120	137	154	170	187	84.0	102	119	137	154	172	189	1.06	137.0	0.19
14	6454	89.0	103	120	135	154	170	188	83.1	101	119	137	155	172	190	1.05	136.9	0.19
15	2058	86.0	100	116	134	151	170	186	81.6	100	118	136	154	172	190	1.05	136.3	0.20
16	7677	86.0	100	115	132	150	170	187	79.9	98.7	117	136	154	172	190	1.06	135.7	0.20
17	2637	83.0	100	116	133	152	170	190	78.1	97.3	116	135	154	172	190	1.07	135.0	0.21
18	240	81.0	99.0	112	130	150	169	197	76.2	95.8	115	134	153	172	190	1.08	134.3	0.21
SR (cm)																		
6	20,463	3.0	7.0	12.0	16.0	20.0	24.0	28.0	3.3	7.4	11.7	16.0	20.5	25.0	29.6	0.93	16.04	0.41
7	26,851	3.0	7.0	12.0	16.0	21.0	25.0	29.0	3.1	7.3	11.6	16.1	20.7	25.4	30.1	0.92	16.10	0.42
8	25,849	3.0	7.0	12.0	16.0	21.0	25.0	30.0	2.9	7.1	11.6	16.2	20.9	25.7	30.7	0.91	16.17	0.43
9	25,623	2.0	6.0	12.0	16.0	21.0	26.0	30.0	2.8	7.0	11.6	16.3	21.1	26.1	31.2	0.90	16.27	0.44
10	24,913	2.0	6.0	11.0	17.0	22.0	26.0	30.0	2.8	7.0	11.7	16.5	21.6	26.7	32.0	0.89	16.54	0.45
11	24,156	2.0	7.0	12.0	17.0	23.0	28.0	32.0	2.8	7.3	12.1	17.1	22.4	27.8	33.3	0.88	17.11	0.45
12	15,228	3.0	7.0	13.0	18.0	24.0	29.0	34.0	3.0	7.6	12.6	17.9	23.4	29.0	34.8	0.87	17.88	0.45
13	14,014	3.0	8.0	14.0	19.0	25.0	30.0	35.0	3.2	8.0	13.2	18.6	24.3	30.2	36.2	0.87	18.63	0.45
14	12,543	3.0	9.0	15.0	20.0	26.0	30.0	36.0	3.4	8.3	13.6	19.3	25.1	31.1	37.3	0.87	19.25	0.45
15	9135	3.0	9.0	15.0	20.0	26.0	31.0	36.0	3.6	8.6	14.0	19.7	25.6	31.6	37.8	0.88	19.68	0.44
16	7539	4.0	9.0	15.0	20.0	26.0	31.0	36.0	3.9	8.9	14.3	19.9	25.8	31.8	38.0	0.88	19.93	0.43
17	2597	4.0	10.0	15.0	20.0	26.0	30.0	35.0	4.0	9.1	14.5	20.1	25.9	31.9	38.0	0.89	20.09	0.43
18	240	3.0	8.0	12.0	18.0	25.0	29.0	31.0	4.2	9.3	14.6	20.2	26.0	31.9	37.9	0.89	20.23	0.42

SUs (no. in 30 sec)																		
6	17,044	2.0	5.0	9.0	12.0	15.0	18.0	22.0	2.0	5.0	9.5	13.2	16.7	19.9	22.9	1.36	13.24	0.41
7	23,158	4.0	8.0	11.0	14.0	18.0	21.0	24.0	2.1	6.5	10.9	14.9	18.5	21.9	25.1	1.33	14.86	0.38
8	23,030	5.0	9.0	13.0	16.0	19.0	22.0	26.0	2.5	7.9	12.4	16.4	20.1	23.6	27.0	1.29	16.35	0.35
9	22,368	6.0	10.0	14.0	17.0	21.0	24.0	28.0	4.4	9.3	13.6	17.6	21.4	25.0	28.4	1.26	17.61	0.33
10	21,511	8.0	12.0	15.0	18.0	22.0	25.0	28.0	5.9	10.5	14.7	18.6	22.3	25.9	29.4	1.22	18.58	0.31
11	20,612	9.0	13.0	16.0	19.0	22.0	25.0	30.0	7.2	11.4	15.4	19.2	22.9	26.5	30.0	1.17	19.21	0.29
12	15,324	10.0	13.0	16.0	19.0	22.0	26.0	30.0	8.0	12.0	15.8	19.5	23.1	26.7	30.2	1.12	19.52	0.28
13	14,181	10.0	13.0	16.0	19.0	22.0	26.0	30.0	8.5	12.3	16.0	19.6	23.1	26.7	30.2	1.07	19.57	0.28
14	12,637	10.0	13.0	16.0	19.0	23.0	26.0	30.0	8.8	12.3	15.9	19.4	23.0	26.5	30.0	1.01	19.42	0.27
15	9264	10.0	13.0	16.0	19.0	22.0	26.0	30.0	8.8	12.2	15.6	19.1	22.6	26.1	29.6	0.96	19.09	0.27
16	7686	9.0	12.0	15.0	18.0	21.0	25.0	29.0	8.6	11.9	15.3	18.7	22.1	25.6	29.2	0.91	18.66	0.28
17	2634	9.0	12.0	15.0	18.0	21.0	25.0	28.0	8.4	11.6	14.8	18.2	21.6	25.1	28.7	0.87	18.18	0.28
18	242	7.0	10.0	14.0	17.0	20.0	24.0	28.0	8.2	11.2	14.4	17.7	21.0	24.5	28.1	0.82	17.65	0.28
10 × 5 m SRT (sec)																		
6	20,030	32.0	29.0	26.9	24.9	23.2	21.8	20.2	32.6	29.9	27.4	25.0	22.7	20.6	18.5	0.42	24.99	0.14
7	26,271	30.3	27.8	25.8	24.0	22.2	20.9	19.2	31.4	28.9	26.4	24.1	21.9	19.8	17.9	0.42	24.10	0.14
8	25,450	29.7	26.7	24.8	23.0	21.4	20.0	18.5	30.3	27.9	25.5	23.3	21.2	19.2	17.3	0.42	23.27	0.14
9	25,394	28.3	25.8	24.0	22.3	20.7	19.4	18.0	29.4	27.0	24.7	22.6	20.5	18.6	16.7	0.42	22.56	0.14
10	24,749	27.8	25.2	23.4	21.8	20.2	18.9	17.5	28.7	26.3	24.1	22.0	20.0	18.1	16.3	0.42	22.01	0.14
11	23,862	27.1	24.6	22.9	21.2	19.7	18.4	17.0	28.2	25.9	23.7	21.6	19.7	17.8	16.1	0.42	21.64	0.14
12	14,920	27.0	24.6	22.9	21.2	19.6	18.3	17.0	27.9	25.7	23.5	21.4	19.5	17.7	15.9	0.42	21.44	0.14
13	13,569	27.8	24.9	23.0	21.3	19.7	18.2	16.9	27.9	25.6	23.4	21.4	19.4	17.6	15.9	0.42	21.39	0.14
14	12,088	28.0	25.0	23.0	21.2	19.6	18.2	17.0	28.0	25.7	23.5	21.4	19.5	17.7	15.9	0.42	21.45	0.14
15	8575	28.3	25.4	23.4	21.5	19.9	18.3	16.8	28.1	25.8	23.6	21.5	19.6	17.7	16.0	0.42	21.56	0.14
16	7004	30.0	26.1	24.0	22.0	20.0	18.4	16.8	28.3	26.0	23.8	21.7	19.7	17.9	16.1	0.42	21.70	0.14
17	2392	30.1	26.1	24.0	22.0	20.0	18.5	16.8	28.5	26.2	23.9	21.8	19.9	18.0	16.2	0.42	21.85	0.14
18	204	32.0	27.7	24.7	22.4	20.2	18.7	16.5	28.7	26.3	24.1	22.0	20.0	18.1	16.3	0.42	22.02	0.14

Note: *P*, percentile; *L*, skew; *M*, median; *S*, coefficient of variation; age: completed age, e.g. 6 years = 6.00–6.99 years.

2011), Portugal (Santos et al., 2014), and Australia (Catley & Tomkinson, 2013) that have examined similar physical fitness tests in children aged 6–18 years. In all the aforementioned studies, boys performed better than girls in cardiorespiratory endurance, speed/agility, muscular strength, and muscular endurance tests, while older ages, in both sexes, have incorporated higher percentile values in comparison with younger ones (Catley & Tomkinson, 2013; Santos et al., 2014; Sauka et al., 2011). Moreover, it seems that physical fitness test performance tends to peak from about the age of 15 years, especially in girls. This finding is in accordance with results from a previous large European epidemiological study (the HELENA study) which found stability in girls' performance in aerobic fitness, speed/agility, and flexibility tests after about the age of 15 years (Ortega et al., 2011).

A finding that deserves attention is the lack of significant differences between the two methods used to create the percentiles in 20 m SRT, SLJ, SR, SUs, and 10×5 m SRT, in both sexes. The LMS method uses smoothed curves to estimate the critical centiles and has been extensively been used to provide a way of obtaining normalised growth centiles standards (Cole, 1990). To the best of our knowledge, this is one of the few times that the LMS method has been used to calculate fitness centiles in children and adolescents (Bustamante, Beunen, & Maia, 2012; Catley & Tomkinson, 2013; Eisenmann et al., 2011; Gulías-González, Sánchez-López, Olivas-Bravo, Solera-Martínez, & Martínez-Vizcaíno, 2014; Santos et al., 2014; Silva, Aires, Mota, Oliveira, & Ribeiro, 2012). None of the above-mentioned studies have made comparisons between two methods. In our study, for at first time we have made comparison between the LMS method and the empirical method which showed that the results can be trusted, at least in large data analysis.

School in Greece, as in most developed countries, is the first institution providing opportunities for physical activity through the pursuit of the physical education curriculum (Cavill, Kahlmeier, & Racioppi, 2006). Given that our study was based on a yearly nationwide school-based survey programme under the auspices of the Ministry of Education, our findings may be of assistance to physical fitness educators and policy-makers when assessing schools' physical education programmes. In fact, it is an opportunity for a significant intervention focusing on elementary and secondary school children physical fitness through the relatively easy access of schools, where changes in physical fitness can be easier implemented and monitored, and affect almost all schoolchildren.

Strengths and limitations

The present study has several strengths. The sample is representative of the national gender and geographical representation, as we studied almost 40% of the total population of 6–18-year-old children in Greece. The study was performed in children aged 6–18 years. This age range is an advantageous period in the life of children and adolescents at which to apply effective prevention strategies to improve physical fitness levels. Finally, the presented data were derived using the same standardized procedures in all schools.

There are also limitations in our study design. Although a common, validated protocol was used to evaluate fitness tests in all schools, a large number of experienced, professional physical educators participated as evaluators in the study. In order to minimize the variability among the different experimenters, all educators were instructed through a detailed and extended manual of operations and followed a standardized procedure of measurements. Even so, some variability in measurement will still exist. Moreover, the 20 m SRT is an objective test of aerobic fitness which indirectly infers peak VO_2 and does not directly measure aerobic fitness. In order to fully understand the development of VO_{2max} during adolescence, longitudinal studies are required to take into consideration the tempo and timing of growth and maturation, particularly in girls (Eisenmann, Laurson, & Welk, 2011). Finally, the cross-sectional design of our study cannot provide causal relationships, but only provides hypotheses for further research.

Conclusions

In conclusion, we established sex- and age-specific normative physical fitness values for children aged 6–18 years living in Greece. Boys performed better in all measurements except flexibility than girls of the same age and older children performed better than younger ones. These findings may help policy-makers to design appropriate health-related educational and physical fitness programmes for the young, to facilitate future more detailed epidemiology research on this topic and for comparisons among the same health-related fitness scores of children from other countries similar to Greece.

Acknowledgements

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Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Andersen, L. B., Wedderkopp, N., Hansen, H. S., Cooper, A. R., & Froberg, K. (2003). Biological cardiovascular risk factors cluster in Danish children and adolescents: The European youth heart study. *Preventive Medicine, 37*, 363–367. doi:10.1016/S0091-7435(03)00145-2

Anderssen, S. A., Cooper, A. R., Riddoch, C., Sardinha, L. B., Harro, M., Brage, S., & Andersen, L. B. (2007). Low cardiorespiratory fitness is a strong predictor for clustering of cardiovascular disease risk factors in children independent of country, age and sex. *European Journal of Cardiovascular Prevention & Rehabilitation, 14*, 526–531. doi:10.1097/HJR.0b013e328011efc1

Bustamante, A., Beunen, G., & Maia, J. (2012). Evaluation of physical fitness levels in children and adolescents: Establishing percentile charts for the central region of Peru. *Revista Peruana de Medicina Experimental y Salud Publica, 29*, 188–97.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Representative, 100*, 126–131.

Catley, M. J., & Tomkinson, G. R. (2013). Normative health-related fitness values for children: Analysis of 85347 test results on 9–17-year-old Australians since 1985. *British Journal of Sports Medicine, 47*, 98–108. doi:10.1136/bjsports-2011-090218

Cavill, N., Kahlmeier, S., & Racioppi, F. (2006). What can the health sector and others do to increase physical activity? In N. Cavill, S. Kahlmeier, & F. Racioppi (Eds.), *Physical activity and health in Europe: Evidence for action* (pp. 15–23). Copenhagen: World Health Organization Regional Office for Europe.

Christodoulos, A. D., Douda, H. T., & Tokmakidis, S. P. (2012). Cardiorespiratory fitness, metabolic risk, and inflammation in children. *International Journal of Pediatrics, 12*, Article no. 270515. doi:10.1155/2012/270515

Cole, T. J. (1990) The LMS method for constructing normalized growth standards. *European Journal of Clinical Nutrition, 44*, 45–60. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/2354692

Cole, T. J., & Green, P. J. (1992). Smoothing reference centile curves: The LMS method and penalized likelihood. *Statistics in Medicine, 11*, 1305–1319. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/1518992

Eisenmann, J. C., Laurson, K. R., & Welk, G. J. (2011). Aerobic fitness percentiles for U.S. adolescents. *American Journal of Preventive Medicine, 41*, S106–S110. doi:10.1016/j.amepre.2011.07.005

Eisenmann, J. C., Wickel, E. E., Welk, G. J., & Blair, S. N. (2005). Relationship between adolescent fitness and fatness and cardiovascular disease risk factors in adulthood: The aerobics center longitudinal study (ACLS). *American Heart Journal, 149*, 46–53. doi:10.1016/j.ahj.2004.07.016

Ekelund, U., Anderssen, S. A., Froberg, K., Sardinha, L. B., Andersen, L. B., Brage, S., & European Youth Heart Study Group. (2007). Independent associations of physical activity and cardiorespiratory fitness with metabolic risk factors in children: The European youth heart study. Diabetologia, *50*, 1832–1840. doi:10.1016/S0140-6736(06)69075-2

Flouris, A. D., Bouziotas, C., Christodoulos, A. D., & Koutedakis, Y. (2008). Longitudinal preventive-screening cutoffs for metabolic syndrome in adolescents. *International Journal of Obesity, 32*, 1506–1512. doi:10.1038/ijo.2008.142

Gulías-González, R., Sánchez-López, M., Olivas-Bravo, Á., Solera-Martínez, M., & Martínez-Vizcaíno, V. (2014). Physical fitness in Spanish schoolchildren aged 6–12 years: Reference values of the battery EUROFIT and associated cardiovascular risk. *Journal of School Health, 84*, 625–635. doi:10.1111/josh.12192

Hurtig-Wennlof, A., Ruiz, J. R., Harro, M., & Sjöström, M. (2007). Cardiorespiratory fitness relates more strongly than physical activity to cardiovascular disease risk factors in healthy children and adolescents: The European youth heart study. *European Journal of Cardiovascular Prevention & Rehabilitation, 14*, 575–581. doi:10.1097/HJR.0b013e32808c67e3

Leger, L. A., Lambert, J., Goulet, A., Rowan, C., & Dinelle, Y. (1984). Aerobic capacity of 6 to 17-year-old Quebecois–20 meter shuttle run test with 1 minute stages. *Canadian Journal of Applied Sport Sciences, 9*, 64–9. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/6733834.

Leger, L. A., Mercier, D., Gadoury, C., & Lambert, J. (1988). The multistage 20 metre shuttle run test for aerobic fitness. *Journal of Sports Sciences, 6*, 93–101. doi:10.1080/02640418808729800

Looney, M. A., & Plowman, S. A. (1990). Passing rates of American children and youth on the FITNESSGRAM criterion-referenced physical fitness standards. *Research Quarterly for Exercise and Sport, 61*, 215–223. doi:10.1080/02701367.1990.10608682

Ortega, F. B., Artero, E. G., Ruiz, J. R., España-Romero, V., Vicente-Rodríguez, G., Molnar, D., ... Gutiérrez, A., HELENA Study Group. (2011). Physical fitness levels among European adolescents: The HELENA study. *British Journal of Sports Medicine, 45*, 20–29. doi:10.1136/bjsm.2009.062679

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: A powerful marker of health. *International Journal of Obesity, 32*(1), 1–11. doi:10.1038/sj.ijo.0803774

Pan, H., & Cole, T. J. (2010). LMS Chartmaker, a program to construct growth references using the LMS method. Version 2.43. Retrieved from http://www.healthforallchildren.co.uk/

Pan, H., & Cole, T. J. (2011). LMS growth, a Microsoft Excel add-in to access growth references based on the LMS method. Version 2.71. Retrieved from http://www.healthforallchildren.co.uk/

Santos, R., Mota, J., Santos, D. A., Silva, A. M., Baptista, F., & Sardinha, L. B. (2014). Physical fitness percentiles for Portuguese children and adolescents aged 10–18 years. *Journal of Sports Sciences, 13*, 1–3. doi:10.1080/02640414.2014.906046

Sauka, M., Priedite, I. S., Artjuhova, L., Larins, V., Selga, G., Dahlström, O., & Timpka, T. (2011). Physical fitness in northern European youth: Reference values from the Latvian physical health in youth study. *Scandinavian Journal of Public Health, 39*, 35–43. doi:10.1177/1403494810380298

Silva, G., Aires, L., Mota, J., Oliveira, J., & Ribeiro, J. C. (2012). Normative and criterion-related standards for shuttle run performance in youth. Pediatric *Exercise Science, 24*, 157–69.

Tambalis, K. D., Panagiotakos, D. B., Arnaoutis, G., & Sidossis, L. A. (2013). Endurance, explosive power, and muscle strength in relation to body mass index and physical fitness in Greek children aged 7–10 years. Pediatric *Exercise Science, 25*, 394–406. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/23877385

Tambalis, K. D., Panagiotakos, D. B., Psarra, G., & Sidossis, L. A. (2011). Inverse but independent trends in obesity and fitness levels among Greek children: A time-series analysis from 1997 to 2007. *Obesity Facts, 4*, 165–174. doi:10.1159/000327994

Tokmakidis, S. P., Kasambalis, A., & Christodoulos, A. D. (2006). Fitness levels of Greek primary schoolchildren in relationship to overweight and obesity. *European Journal of Pediatrics, 165*, 867–874. doi:10.1007/s00431-006-0176-2

Wang, Y., Moreno, L. A., Caballero, B., & Cole, T. J. (2006). Limitations of the current world health organization growth references for children and adolescents. *Food and Nutrition Bulletin, 27*, S175–S188. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/17361655

EXHIBIT E

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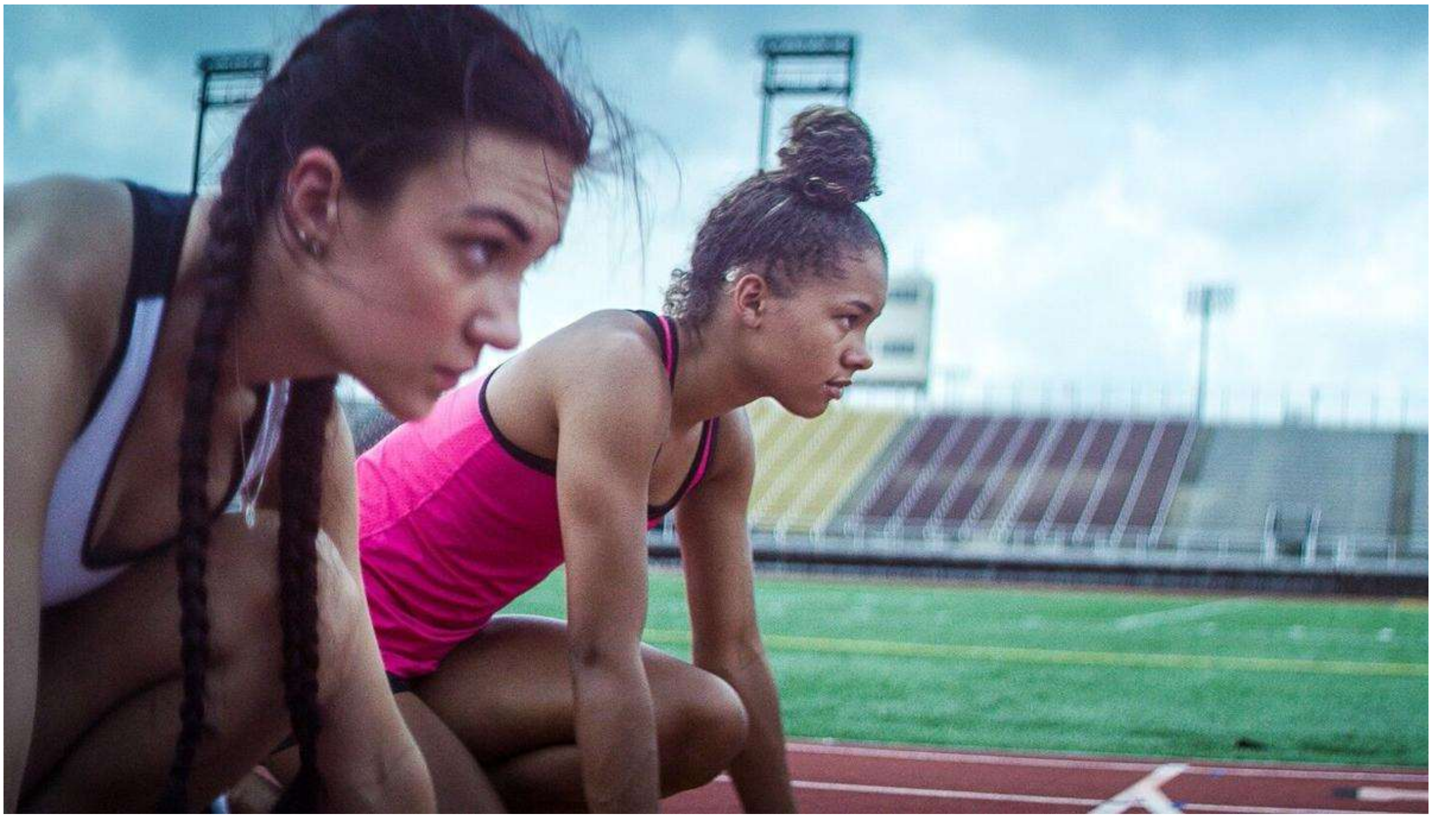
TOP STORY

'No Chance of Winning': Four female athletes challenge high school transgender policy

By Casey Harper | The Center Square
Sep 30, 2022

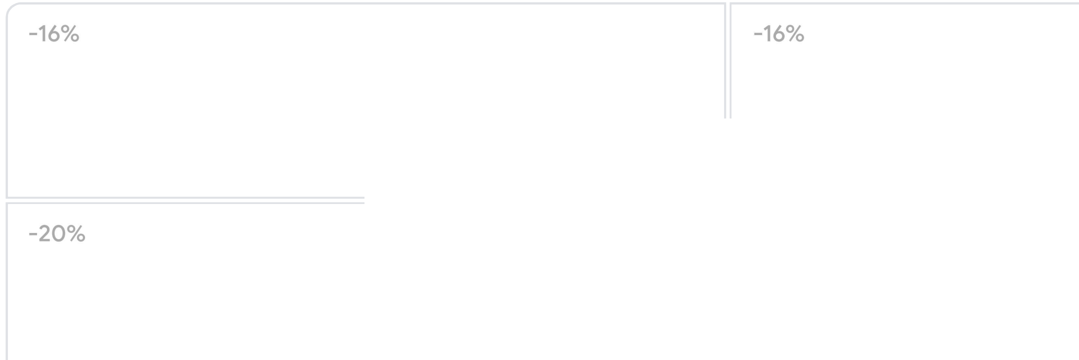


High-school athletes Selina Soule (left) and Alanna Smith (right), who compete within the Connecticut Interscholastic Athletic Conference.

Credit: Alliance Defending Freedom

(The Center Square) – Four female athletes are locked in a legal battle over transgender athletes that could set major precedent for the same fight playing out in schools around the country.

The four female athletes appealed to a federal court over a Connecticut policy allowing high school males identifying as females to compete against girls. The U.S. Court of Appeals for the 2nd Circuit heard Soule v. Connecticut Association of Schools this week, where the girls' legal team argued the policy is unfair to girls and hands female sports victories over to transgender athletes.



Selina Soule, Alanna Smith, Chelsea Mitchell and Ashley Nicoletti are the four young women who saw their high school athletic goals thwarted by transgender athletes. They argue the policy violates federal Title IX law, whose "whole purpose was to ensure that girls had equal athletic opportunities to compete – and win – in girls' sports events."

"Mitchell, for example, would have won the 2019 state championship in the women's 55-meter indoor track competition, but because two males took first and second place, she was denied the gold medal," said Alliance Defending Freedom, the legal group representing the female athletes. "Soule, Smith, and Nicoletti likewise were or have been denied medals and/or advancement opportunities."

The debate has sparked controversy at the local, state and national level as athletes born biologically male but who identify as female have joined women's sports and often dominated the competition.

Notably this year, trans athlete Lia Thomas, who was born a biological male, easily beat Olympic silver medalists Emma Weyant and Erica Sullivan in the NCAA 500-yard freestyle championship in March, as The Center Square previously **reported**.

That same dynamic has played out in Connecticut after the policy in question.

"As a result of the CIAC's policy, two males were permitted to compete in girls' athletic competitions beginning in the 2017 track season," ADF said. "Between them, they took 15 women's state championship titles (titles held in 2016 by nine different Connecticut girls) and more than 85 opportunities to participate in higher level competitions from female track athletes in the 2017, 2018, and 2019 seasons alone."

Supporters of the transgender policy argue those in opposition to the new policies are discriminating against transgender athletes.

“Connecticut’s laws preventing discrimination against trans youth in school and sports are consistent with federal law,” said Elana Bildner, ACLU Foundation of Connecticut senior staff attorney. “For years now, Andraya and Terry have carried more on their shoulders, as two Black trans youth, than most adults face in a lifetime. We hope the court will uphold the lower court’s decision so our clients may move forward with their lives, and so all transgender students in Connecticut can rest assured that their rights, humanity, and ability to be fully part of their school communities is not up for debate,”

The girls also say the transgender athlete’s successes take away college scholarship opportunities.

“Girls deserve the same opportunity as boys to excel in athletics. Allowing boys to compete in girls’ sports, as we see happening in Connecticut and elsewhere, deprives girls of the opportunity to be champions, showcase their talents, and potentially earn college scholarships,” said ADF Senior Counsel Christiana Kiefer. “All female athletes deserve to compete on a fair playing field, and we are urging the court to ensure respect for their right to equal treatment and opportunity in sports.”

The four female athletes also testified before the Senate Judiciary Committee in Washington, D.C. in March of last year.

“When I was a freshman in high school everything changed,” Smith said in her testimony. “I knew I’d be racing against a male who identified as a female at the State Open. I knew I had no chance of winning despite the hours of training and knowing my personal bests in each event. I was defeated before stepping onto the track. I knew it wasn’t fair to me or to any of the other girls competing at the State Open. I knew I had biologically-advantaged competition running against me.”

That question of fairness has been front and center in the debate over school policies on the issue. The girl's legal team argues that allowing the transgender athletes to compete against girls creates an uneven playing field and threatens the existence of girls sports.

"Males will always have inherent physical advantages over comparably talented and trained girls; Title IX's whole purpose was to ensure that girls had equal athletic opportunities to compete – and win – in girls' sports events," said ADF Senior Counsel Roger Brooks. "And when our laws and policies fail to recognize the real physical differences between males and females, women and girls bear the brunt of the harm. It's our hope that the 2nd Circuit will give the young women we represent the right to pursue their case and put women's sports back on a level playing field."

Casey Harper

D.C. Bureau Reporter

Casey Harper is a Senior Reporter for the Washington, D.C. Bureau. He previously worked for The Daily Caller, The Hill, and Sinclair Broadcast Group. A graduate of Hillsdale College, Casey's work has also appeared in Fox News, Fox Business, and USA Today.

EXHIBIT

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What Rank Did Lia Thomas Stand at While Competing in the Men's Swimming Division?

Published 03/22/2022, 1:09 PM EDT
By SAMARVEER SINGH

via Imago

Lia Thomas, the first transgender woman to win at the NCAA Swimming Finals, is at the center of controversy. In fact, it is her very victory that has given rise to controversy the world over.

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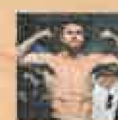
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Up until last year, Thomas was competing in the men's division, before undergoing a yearlong transitioning process. Thus, she competed in the female category this year and has won resoundingly.

Consequently, many athletes in her division took offense to it. Moreover, popular stars and athletes from across the globe are on the fence about the situation as well.

What rank did Lia Thomas finish at in the men's division?

Lia Thomas, the transgender swimmer from the University of Pennsylvania became one of the top athletes in the NCAA female division. Last weekend, she reached the finals of three events in the NCAA championships.

Moreover, she didn't compete in the 1650-yard freestyle but had one of the USA's top times in the event. In fact, in the 500-yard freestyle event, Thomas secured the fastest swim time in the nation.

Lia Thomas makes history as first out trans woman tc
championship

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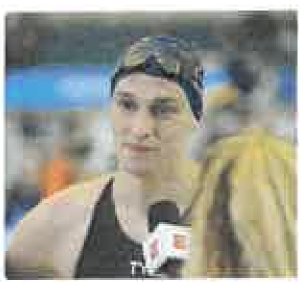
thepinknews.com
Lia Thomas makes history as first out trans woman swimming title

2:12 AM · Mar 18, 2022

During the **last season** in the NCAA, Lia Thomas competed in the men's division, in 2018-19. There, she ranked 554th in the 200-yd freestyle, and she is now fifth in the event this year.

Furthermore, in the 500-yd freestyle, Thomas was 65th in the country. Now, she ranked first place in the event. Finally, in the 1650 freestyle, she is now eighth in the nation, as opposed to 32nd in the men's division.

DIVE DEEPER



American Rapper Boosie Badazz Attacks Champion Transgender Swimmer Lia Thomas

Interestingly, in the 100 freestyle event, Thomas' best time in the men's division was 47.15. Now, at the NCAA Championships, she posted a time of 47.37, which reflects little to no change.

Virginia Tech athlete released a statement condemning Thomas' participation in the NCAA Championships

Reka Gyorgy, who finished seventeenth in the NCAA championships, scathingly critiqued the NCAA for allowing Thomas' participation.

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Gyorgy called Lia Thomas' case "*a problem in our sport right now*". In fact, she feels that Lia's participation is "*hurting athletes, especially female swimmers*".

Virginia Tech swimmer Reka Gyorgy has released a fu
NCAA allowing Lia Thomas to compete in the 500 fre
the event

EDITORS' PICK

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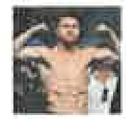

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12:51 PM · Mar 20, 2022 from Austin, TX

21K Reply Share

Despite supporting Lia in her right to transition as well as swim, Gyorgy called out the NCAA for letting Thomas ... She critiqued "*the NCAA rules that allow her (Lia) to compete against us, who are biologically women,*" Gyorgy's stateme

Thus, she asked the NCAA to change the rules that allow for transgender athletes to compete, for the overall betterment of the sport. How much do you agree with Gyorgy's statement?

WATCH THIS STORY: Lia Thomas Becomes First Transgender Woman to Win NCAA Gold- Rivals Stage Protest on Podium

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EXHIBIT

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[PRINT] **ESPN.com:** NCAA [Print without images]

Thursday, March 17, 2022

Amid protests, Penn swimmer Lia Thomas becomes first known transgender athlete to win Division I national championship

By Katie Barnes

ATLANTA -- Lia Thomas is a national champion.

Thomas, who is a transgender woman, touched the wall in 4 minutes, 33.24 seconds in the 500-yard freestyle on Thursday night to become the first known transgender athlete to win a Division I national championship in any sport.

Thomas finished 1.75 seconds ahead of second-place Emma Weyant, who attends Virginia. Thomas' time was a season best and a little more than 9 seconds off of Katie Ledecky's 4:24.06 record.

The race began with the crowd cheering for each of the swimmers, but fans were noticeably quiet for Thomas' introduction. Save Women's Sports founder Beth Stelzer draped a vinyl banner with the organization's phrase over the railing.

During the race, Thomas was alternately tested by Olympians Brooke Forde (Stanford), Erica Sullivan (Texas) and Weyant. Thomas led early, but was passed by Sullivan and trailed for most of the first half of the race. Thomas and Weyant went stroke-for-stroke in the back half of the race, but Thomas pulled away over the final 150 yards to win her first national championship.

"It means the world to be here," Thomas said in an interview with Elizabeth Beisel after the race.

Thomas, who declined to attend the NCAA-required postrace news conference, told Beisel she has been trying to tune out the distractions. "I try to ignore it as much as I can," Thomas said. "I try to focus on my swimming, what I need to do to get ready for my races. And just try to block out everything else."

As she stood on the podium with her trophy, she flashed a peace sign, just as she did for her four Ivy League championships. And once again, the crowd was noticeably quiet as she was announced as the champion.

Thomas returns to the pool Friday morning for the 200-yard freestyle prelims. She also is scheduled to compete in the 100 on Saturday.

"It's a symbol of Lia's resilience," Schuyler Bailar, who at Harvard became the first known transgender man to compete on a Division I men's team, told ESPN. "The fact that she's able to show up here, despite protesters outside, people shouting and booing her, I think it's a testament to her resiliency. And it's also a symbol that we can both be who we are and do what we love."

"Any hate is unnecessary," Virginia junior Lexi Cuomo said after the Cavaliers won the 200 freestyle relay. "We need to look at it as we're all competitors right now. We're focused on ourselves and our team. Our first and foremost goal is to win a national title."

After posting the nation's top times in the 200 and 500 freestyle events in December at the Zippy Invitational in Akron, Ohio, Thomas garnered national attention. Her success in the pool drew both praise and criticism. Some of that criticism was on full display in Atlanta.

Outside of the McAuley Center, dueling protests dominated the morning. More than 20 protesters from Save Women's Sports and Young Women for America (the college branch of Concerned Women for America) chanted outside, protesting Thomas' inclusion in the women's category.

The group also included Idaho state Rep. Barbara Ehardt, the author of HB 500. HB 500 was the first law restricting transgender athletes' ability to play sports in accordance with their gender identity. It has since been blocked in federal court.

"We're not going to stand by and let women be displaced," said Annabelle Rutledge, the national director for Young Women for America. "We must fight for their rights."

Concerned Women for America announced Thursday that the organization filed a Title IX complaint against the University of Pennsylvania. CWA contends that Penn is violating Title IX by allowing Thomas to compete on the women's team.

"The future of women's sports is at risk and the equal rights of female athletes are being infringed," CWA president and CEO Penny Nance said in a statement. "We filed a formal civil rights complaint against UPenn in response to this injustice."

This is not the first Title IX complaint CWA has filed in response to a prominent transgender athlete. After Franklin Pierce University (FPU) track athlete CeCe Telfer won a Division II national championship in the 400m hurdles in 2019, CWA filed a Title IX complaint with the Office for Civil Rights (OCR) at the Department of Education. The OCR found that FPU's transgender inclusion policy violated Title IX and the school was forced to rescind its policy. The Department of Education has not yet responded to CWA's latest complaint.

On the other side of the street from Save Women's Sports and CWA were a dozen counterprotesters, who were Georgia Tech graduate and undergraduate students.

"They are bringing off-campus hate onto our campus," Georgia Tech Grad Pride president Naiki Kaffezakis told ESPN.

Another counterprotester, who wished to be acknowledged by only her first name, had words of support for Thomas.

"I'm rooting for her. I'm very happy for her," Em said. "Good luck out there, girl. Get 'em."

EXHIBIT H

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ALLIANCE DEFENDING FREEDOM

MORE

Why Male Athletes Who Identify as Transgender Should Not Compete in Women's Sports

Should transgender athletes compete in women's sports? Here's why males will always have an advantage over females in athletics.

Written by ***Maureen Collins***
Published **September 23, 2022**
Revised **March 10, 2023**

Should male athletes who identify as transgender compete in women's sports?

If you've listened to any major news outlets recently, you'd hear a resounding "yes." Athletes who identify as—then compete against—the opposite sex are often celebrated in the media.

Collegiate athlete Lia Thomas, a male swimmer from the University of Pennsylvania, was applauded after winning the NCAA women's championship in the 500-yard freestyle in March 2022. CeCe Telfer, a male runner, was similarly commended after winning the NCAA Division II national championship in the women's 400-meter hurdles in 2019. And the media cheered as Laurel Hubbard, a 43-year-old male weightlifter from New Zealand, became the first athlete to compete against the opposite sex in the Olympics during the 2021 Tokyo Games.

You'll notice that all these athletes have one thing in common: they are all males competing in women's sports. It's not often that you hear of a controversy involving female athletes competing in men's sports. And the reason for that is simple and obvious: males have a physical advantage over females in athletics.

But those who simply state this truth are often met with vile attacks online and in the media. That's because the fact that men and women are different and have different strengths and weaknesses has become taboo in our culture today. But this difference isn't a bad thing—and it's necessary that we recognize it to preserve the integrity of women's sports.

Below, we'll unpack why male athletes have immense physical advantages over female athletes and how women are harmed when they are forced to compete against men.

Is it fair for males to compete in women's sports? Here's the science.

Is it fair for male athletes to compete against female athletes? No. And that answer isn't just based on common sense—the science is conclusive.

Some activists claim that males who receive cross-sex hormones and artificially lower their testosterone levels should be allowed to compete against females. But recent studies have proven that these methods do not negate the performance gap between the sexes. Forcing females to compete against males strips them of their right to a fair playing field.

An expert report by Dr. Gregory A. Brown, an exercise science professor at the University of Nebraska, sheds some light on how policies that allow men to compete against women harm female athletes.

Dr. Brown cites research showing that allowing males to compete against female athletes in track and field could allow "many who would not be considered top tier male performers" to replace the world's most skilled female athletes on the podium. For example, in 2017 alone, well over 5,000 males, including some under 18 years old, ran 400-meter times that were faster than the personal bests of U.S. Olympic gold medalists Sanya Richards-Ross and Allyson Felix.

Dr. Brown's report shows that policies allowing males to compete in women's sports would do even greater harm to female athletes in a variety of other sports.

Similarly gifted and trained males have physical advantages over females—from greater height and weight and larger, longer, and stronger bones to larger muscles and higher rates of metabolizing and releasing energy. These innate physiological traits result in greater muscle strength; stronger throwing, hitting, and kicking; higher jumping; and faster running speeds for males, all of which create an athletic edge over females.

For example, despite greater body weight, males have a roughly 15-20 percent jumping advantage over women. When examining the vertical jump needed in volleyball, one study found that on average male players jumped 50 percent higher during an "attack" at the net than female players.

Even if male athletes are receiving androgen inhibitors and cross-sex hormones, it will not reverse the distinct advantage males have over females.

In another report, Dr. Brown elaborates: "[I]t is obvious that some effects of male puberty that confer advantages for athletic performance—in particular bone size and configuration—cannot be reversed once they have occurred." He goes on to demonstrate how puberty creates height and mass differences that provide a significant athletic advantage for males. And no amount of testosterone blockers can compensate for that advantage.

Dr. Brown also cites five separate studies to further prove this point. One study was even conducted by researchers who were sympathetic to transgender ideology. But despite the researchers' personal opinions, the scientific facts required them to recognize that the irreversible physical differences between males and females "provide a strong argument that [males] have an intolerable advantage over [females]."

For the past several decades, female athletes have seen their opportunities grow steadily. The average number of collegiate women's sports teams has more than tripled since Congress passed Title IX of the Education Amendments of 1972.

And in that same time span, women have also been given the opportunity to compete in more events at the Olympics. In fact, many of America's most famous Olympic athletes are women, such as Serena Williams, Simone Biles, and Katie Ledecky.

But Dr. Brown's research shows that if female athletes are forced to compete against males, even these Olympians would not have a fair chance to compete. And young girls would never get the opportunity to fulfill their dreams, no matter how hard they work.

Title IX and the history of women's sports

In today's world, it's difficult to imagine that there was a time when women and girls didn't have many opportunities to play sports.

But before the 1970s, the concept of women's sports was not widespread at all. In fact, sporting events for girls were almost nonexistent. During the 1971-1972 school year, only 7 percent of high school athletes were girls. In the 2010-2011 school year, by comparison, girls made up over 41 percent of all high school athletes.

So, what changed after 1972?

Congress passed Title IX—a piece of legislation intended to give women and girls equal opportunities in education. Since its passage into law, women have been given exponentially more opportunities to play organized sports.

Title IX changed the game and opened many new opportunities for women and girls.

Males have taken titles from female athletes

Scientific studies are a great resource in showing that males have a biological advantage over females in athletics, but we don't need a study to tell us just how discouraging it is for female athletes to compete and lose to males.

Since 2017, the Connecticut Interscholastic Athletic Conference (CIAC) has allowed males who identify as girls to compete in high school women's sports, putting female athletes at an automatic disadvantage in their own sports.

Selina Soule is one such athlete. Selina is a dedicated sprinter. When she competed in high school, she devoted countless days, nights, and weekends to train in order to shave mere fractions of a second off her race times. She trains to win. But when she stepped up to the starting blocks at the beginning of a race, she knew that the odds were against her.

Since the CIAC's policy change, male athletes who identity as female won race after race, collecting state titles along the way. In fact, since the CIAC changed its policy, two male athletes have taken 15 state titles that were previously held by nine different girls in 2016.

Here are just a few of these championship titles:

- At the 2018 CIAC State Open Championship, two males took first and second place in the women's varsity 100-meter dash.
- At the 2019 Indoor Track Championship, a male athlete won both the women's 55-meter dash and the women's 300-meter dash.
- At the 2019 CIAC Combined State Open Championship, a male athlete won the women's 200-meter dash.

Beyond the state level, one of these male athletes went on to win the women's 200-meter dash at the 2019 New England Interscholastic Track and Field Championships.

It shouldn't be surprising that male athletes can outrun female athletes.

What *is* surprising is that officials from the CIAC are allowing males to deprive so many girls of the championship titles they've trained so hard to achieve. They're stripping girls of opportunities—not just on race day but for their future college scholarships, athletic careers, and more.

After months of training for the 55-meter dash, Selina placed just one spot away from qualifying for the final and a chance to compete for a spot in the New England regional championships, where many college scouts attend.

Two male athletes had taken first and second in that race. Had they not been permitted to do so, Selina likely would have competed at the regional championships in front of college scouts.

States are passing bills addressing transgender athletes in women's sports

Selina is far from the only female athlete who has been forced to compete against males. And Connecticut is far from the only state where this is happening.

Thankfully, many states are taking a stand for fairness in women's sports. States including Mississippi, Montana, Arkansas, and Florida passed legislation that keep males from competing against women.

For example, in 2020, Idaho passed the Fairness in Women's Sports Act. This law ensures that only females are competing in sports designated for girls and women.

Shortly after Idaho passed the Fairness in Women's Sports Act, the American Civil Liberties Union filed a lawsuit. It is attempting to strike down the law and subject female athletes to unfair competitive conditions that prioritize gender ideology over biological realities.

Similarly, in 2021, West Virginia passed a law to protect athletes like Lainey Armistead. Like Selina, Lainey has been fiercely dedicated to her sport since childhood—in her case, soccer. "I have made many sacrifices over the course of my athletic career to play the sport that I love," she explains.

But soon after West Virginia passed this commonsense law to ensure a level playing field for athletes like Lainey, the ACLU sued yet again. Alliance Defending Freedom filed a motion to intervene on behalf of Lainey.

Thankfully, in January of 2023, a federal district court granted summary judgment in favor of Lainey and dissolved the preliminary injunction that was initially put in place, allowing the Save Women's Sports Act to go fully into effect.

But the ACLU appealed to the U.S. Court of Appeals for the 4th Circuit, which granted a temporary injunction to allow a young male athlete in West Virginia to compete against women while the case is on appeal.

ADF is now asking the Supreme Court to reverse the 4th Circuit's injunction and make it clear that West Virginia is free to allow only female athletes to compete in women's sports.

Athletic events that allow males to compete against women

Men and women are not interchangeable. It's a fact of both science and common sense that they differ in many ways. And when males who identify as female are permitted to compete in women's sports, it is women and girls who suffer.

Female athletes in contact sports face safety risks when they are forced to compete against males. And women and girls across the board will see their athletic and academic opportunities limited. They will be stepping up to compete knowing that they do not have a fair chance to win. And for many women, athletics are their best bet for a college scholarship.

Below is a list of 25 different sports leagues and conferences that have allowed males to compete in women's sports.

And this list is likely not even exhaustive.

1. **Women's basketball** – A 50-year-old, 6-foot-6-inch man, who played on a college men's team 30 years prior, has played on a women's junior college basketball team.
2. **Women's beach handball** – A male athlete, who formerly played on an NCAA Division III women's soccer team, has also played for Team USA Women's Beach Handball.
3. **Women's bodybuilding** – A male who had competed in men's bodybuilding in the past started competing as a woman.
4. **Women's cricket** – Two male athletes have competed on women's cricket teams, one in Australia and one in England.
5. **Women's cross country** – A male runner has competed on an NCAA Division I women's cross country team and was once named the conference's "Women's Athlete of the Week."
6. **Women's cycling** – Several male athletes have participated in women's cycling events (examples here and here).
7. **Women's dance** – A male dancer is training to dance professionally as a female ballerina.
8. **Women's dodgeball** – A male athlete who once competed on the Canadian men's dodgeball team later competed on Canada's women's team.
9. **Women's football** – Several male athletes who had previously competed on men's football teams have also competed in women's football (examples here and here).
10. **Women's golf** – A male athlete was approved to compete in the Ladies European Tour in 2004. And another male athlete was permitted to compete in the 2020 Women's World Long Drive Competition.
11. **Women's hockey** – A male hockey player participates in the Canadian Women's Hockey League.
12. **Women's MMA (Mixed Martial Arts)** – A male MMA fighter who competes as a woman broke a female opponent's eye socket and gave her a concussion.
13. **Women's powerlifting** – A male powerlifter competed as a female and broke several records before being disqualified.
14. **Women's roller derby** – A male athlete has been part of a women's roller derby team that won the world championships three times. And another male athlete is poised to be the next women's roller derby star.
15. **Women's rowing** – Two male athletes were part of a rowing team that competed in a women's boat race in Canada.
16. **Women's rugby** – Several male athletes compete on women's rugby teams. One has even been celebrated for injuring female opponents.
17. **Women's running** – Three male runners were permitted to qualify and race as women at the 2018 Boston Marathon.
18. **Women's soccer** – A male athlete earned a spot on an NCAA Division III women's soccer team.

19. **Women's softball** – A male high school student earned one of 15 spots on the girls' varsity softball team.
20. **Women's swimming** – A male swimmer competed on the men's team for three years before competing on the women's team.
21. **Women's tennis** – This male tennis player competed in the 1977 U.S. Open as a woman.
22. **Women's track and field** – Two male athletes dominated the girls' high school competitions in Connecticut. A male athlete in Alaska competed and placed at the girls' state championships. And another male college athlete won the 400-meter hurdles at the NCAA Division II women's national championships.
23. **Women's volleyball** – A male athlete has competed on an NCAA Division III women's volleyball team. Male athletes have also competed on women's professional teams in the U.S. and Brazil.
24. **Women's weightlifting** – This Australian weightlifter set masters world records in the women's category despite being a male.
25. **Women's wrestling** – A male has competed in women's professional wrestling.

We cannot pretend this isn't happening.

The end of women's sports?

While some female athletes have taken a brave stand for fairness in women's sports, many others have been hesitant to speak out. And it's no wonder why.

Those who dare to question whether males should be allowed to compete against females are ridiculed and bullied. Activists lashed out against tennis legend Martina Navratilova when she wrote that it's "cheating" for a man to compete as a woman.

Likewise, when Selina and other female competitors have voiced their criticism, they have been portrayed as sore losers.

Since when does speaking the truth make you a sore loser?

It is a physiological fact that men and women are built differently. Men have more muscle mass and a higher bone density, making them physically stronger than women.

And as Navratilova pointed out, "Simply reducing hormone levels — the prescription most sports have adopted — does not solve the problem. A man builds up muscle and bone density, as well as a greater number of oxygen-carrying red blood cells, from childhood. Training increases the discrepancy."

No amount of training can change the fact that males have a physiological advantage over females in most sports.

That's why we have separate men's and women's sports. But somehow, the line between the two is becoming increasingly blurry. And women and girls are suffering the consequences.

Maureen Collins

Contributing Writer

Maureen Collins served as Web Editor and SEO Manager at Alliance Defending Freedom.

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NCAA

High School volleyball player Payton McNabb urges ban on transgender athletes after serious injury

A female player was injured by a transgender woman.

Payton McNabb, a senior at Hiwassee Dam High School in Murphy, N.C. **LAPRESSE**

LW

21/04/2023 - 23:09 CDT

A high school volleyball player in North Carolina, **Payton McNabb**, has urged state lawmakers to pass a bill banning transgender athletes born male from playing on female sports teams after she was seriously injured during a game. McNabb told state representatives that a transgender girl spiked a ball at her face during a game in September, causing her to suffer a concussion and neck injury.

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"Due to the **North Carolina High School Athletic Association** policy allowing biological males to compete against biological females, my life has forever been changed," McNabb said. She added that she still struggles with the effects of her injuries, including impaired vision, partial paralysis on the right side of her body, unremitting headaches, anxiety, and depression.

Independent Women's ...
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🚨MUST WATCH: Speaking about her experience for the first time, Payton McNabb, a North Carolina high school athlete at Hiwassee Dam High School, shared her experience competing against a biological male in volleyball on the opposing team & the injuries she suffered as a result.

Ver en Twitter

5:38 p. m. · 19 abr. 2023

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"I'm here for every biological female athlete behind me. My little sister, my cousins, my teammates. Allowing biological males to compete against biological females is dangerous. I may be the first to come before you with an injury, but if this doesn't pass, I won't be the last," she added.

Former All-American Kentucky swimmer, **Riley Gaines**, also supported the legislation. "Watch the clip of Payton McNabb getting spiked in the face by a male competing with the women. Then watch her testimony she gave today for the first time publicly. I was honored to stand alongside her in NC to continue the fight to protect women's sports," she tweeted.

Riley Gaines
@Riley_Gaines_ · **Seguir**

Watch the clip of Payton McNabb getting spiked in the face by a male competing with the women. Then watch her testimony she gave today for the first time publicly. I was honored to stand alongside her in NC to continue the fight to protect women's sports.

8:33 p. m. · 19 abr. 2023

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65,4 mil Responder C...

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NC prohibit transgender girls from joining female sports teams

On Wednesday, the Republican-controlled **North Carolina House** passed the **Fairness in Women's Sports Act**, which would prohibit transgender girls from joining female sports teams in middle school, high school, and college. The veto-proof vote was 73-39-with three Democrats voting in favor.

The bill now heads to the Senate, where a competing proposal could reach the floor as soon as Thursday. The Senate bill would only create restrictions for middle and high school athletes.

"This bill is a bill to be inclusive, not to be exclusive," said GOP Rep. **Kristin Baker**, the bill's primary sponsor. "This bill is to allow fair and particularly safe, physically safe, competition."

ICONS Women @icons_women · **Seguir**

Women in NC testifying with Payton McNabb this week did it so no other female athlete has to experience the life altering injury that she did.
Thank you to the McNabb family, @Riley_Gaines_ , & Evie Edwards (@DexterSaxapahaw) for standing up for this generation & the next.

OutKick @Outkick

Payton McNabb, a high school volleyball player in North Carolina, was struck in the face by a volleyball spiked by a biological male claiming to be a girl last fall.

The senior recently told lawmakers that she is still suffering physical and mental trauma from the situation.

Última edición
12:18 p. m. · 21 abr. 2023

961 Responder Comp...

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However, Democratic Rep. **Vernetta Alston** criticized the GOP for amplifying a few isolated incidents to blow the problem out of proportion, saying injuries happen all the time in sports regardless of who's participating.

"It is a pretext for bigotry and part of a larger effort to ban transgender people from living their lives," Alston said during floor debate, warning that the bill would further exclude a small and already vulnerable population. But Baker argued an injury like

McNabb's is one too many.

Independent Women's Voice
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"I might be the first to come before you with an injury, but if this doesn't pass, I won't be the last." ⚠️

High school volleyball player, Payton McNabb, who was injured competing against a biological male speaks up alongside @Riley_Gaines_.

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6:14 p. m. · 19 abr. 2023

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Home › Free Style › Transgender MMA Fighter Destroys Female Opponent

Transgender MMA Fighter Destroys Female Opponent

by Guest Post

SHARE 3

By: Laura Meyers

Critics are scrutinizing mixed martial arts (MMA) competitor Fallon Fox, after the transgender fighter gave her opponent a concussion and broke her eye socket.

resulted in a damaged orbital bone that required seven staples.

In a post-fight interview this week, Brents told Whoa TV, “I’ve never felt so overpowered ever in my life.”

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

Fox’s “grip was different,” Brents added. “I could usually move around in the clinch against…females but couldn’t move at all in Fox’s clinch.”

A video (below) of the fight shows Fox throwing several powerful knees to the face and torso of Brents at the start of the match, who pulled guard to protect herself. Then, Brents turns to avoid damage, where she then took about 45 seconds of elbow and fist strikes before the fight was stopped by the referee.

In 2013, after a 39-second knockout victory, Fox's fifth straight first-round victory, it was revealed that Fox had not told the mixed martial arts community about her sex-change operation, which took place in 2006.

Equality or nah?

Generally speaking, lopsided matches and fights like the one in question are not exactly the best choice for sports bettors. Betting websites tend to offer very low odds on the favorites, while the underdogs' chances to win are virtually non-existent. If you would like to know which bookmakers offer the best sports betting odds, you can find a comprehensive list of new betting sites on this page. Or even try https://fitnessvolt.com/ for better health and fitness.

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Professor Maintains that Trans Athletes Causing Serious Injuries to Girls

Holt Hackney gender equity Transgender December 12, 2022 | 0

SPORTS LAW
EXPERT

up being propelled head first into the boards with enough force to deliver a concussion" which left her unconscious.

Not surprisingly, the resulting article which reported it in detail was entitled IGNORING BIOLOGICAL REALITY PUTS FEMALE HOCKEY PLAYERS AT RISK.

The article concluded that "a frightening injury at an NHL-sponsored transgender tournament in Wisconsin reminds us why women's leagues should remain sex-protected spaces."

This plea stands in seeming contrast to recent statements by the tournament sponsor National Hockey League [NHL] that "Trans women are women. Trans men are men. Nonbinary identity is real."

As the article noted regarding that claim said: "Should naturally bigger, stronger, faster biological males who self-identify as girls or women be permitted to compete in leagues and tournaments with (on average) smaller, weaker, slower biological females? The reason why the gender slogans tweeted by the NHL attracted so much controversy is that the league now seems to be answering that last question in the affirmative."

In an earlier situation involving play between two high school girl's volleyball teams, a M2F player was able to spike the ball so forcefully that it caused "severe" and possibly permanent injuries to his biological female opponent, who was knocked to the ground and suffered a concussion.

As a result of this hard-hit spike, the injured girl is experiencing long-term concussion symptoms, such as vision problems, Indeed, her injuries are so severe that she has not yet been medically cleared to return to play, and her school has been forced to forfeit all its games against the school with the biological male volleyball player in order to protect its own girls against similar serious injuries.

So, the same undeniable fact that biological males tend to be bigger and stronger – and have other major athletic advantages – than biological females creates two strong arguments against the former competing against the latter:

■ In most sports, biological males have a very significant size and strength advantage which can rob girls and women of opportunities to compete fairly and possibly win, obtain scholarships, and enjoy other advantages

■ In contact sports such as football, boxing, wrestling, and hockey, and even basketball and volleyball, there is a very real danger of serious and possibly permanent physical injuries to biological girls and women

Many who oppose M2F students competing in most girl's and women's events stress fairness and equality, not just fear of injuries, in noting that, in many sports, the competition between biological males and biological females is not just unfair but inherently very unequal. They pose the following analogies to prove the point.

Would a 20-year-old be permitted to compete in the Senior Olympics (> 50) simply because he feels like – and/or believes himself to be – 55 years of age, and even if he claims that many senior citizens can outperform some 20-year olds?

Similarly, would a boxer or wrestler who weighs 240 pounds ever be allowed to even step into the ring or onto the mat in matches in lightweight divisions simply because he believes himself to much lighter, and even if he can show that a few heavyweights might lose to a much lighter but more highly skilled opponent?

The reason that the answer to both questions is obviously a resounding "NO" is demonstrated by the Army's standards for applicants being considered for acceptance.

These very different standards provide a dramatic example of the typical difference in strength (e.g., as measured by pushups) between males and even physically fit females.

Based upon extensive testing and experience with thousands of applicants, the Army has determined that the standards must be very different based upon both age and gender to be fair, and not create unfair comparisons and false equivalences.

Here are the minimum number of pushups applicants in each category [M v F AND young v middle aged] must be able to perform to be considered even minimally physically fit:

MALES: 17-21 years of age = 31 pushups and MALES: 37-41 years of age = 19 pushups. Then, in stark and dramatic contrast,

FEMALES: 17-21 years of age = 11 pushups and FEMALES: 37-41 years of age = 3 pushups

In other words, the difference in this one standard criteria for comparing upper-body strength – which, unlike lifting barbells and other weights, provides an advantage for those who weigh less – is far greater between men and women of the same age than between men who are young and those who are less athletic because they are middle aged.

Although most would agree that having 40-year-old men competing against men who are 20 would generally be quite unfair (31 – 19 = 12 pushup difference; a 65% advantage), the difference in pushup requirements between males and females is much greater:

AMONG 20-YEAR OLDS: Male vs Female 31-11 = 20 pushup difference or an 180% advantage

SPORTS LAW
EXPERT

"I also was knocked on my ass by a hard hit spike in volleyball, but it took a 6 foot 4 inch Olympic contender to accomplish it, and we were playing with a volleyball net set at men's height," says Banzhaf, who notes that the official height of the net in female volleyball competition is a full 7 and 1/2 inches lower (and therefore much easier to hit over) than it is for males [7 feet, 11+ 5/8 inches for boys and 7 feet, 4+ 1/8 inches for girls].

That's why in coed volleyball, the net must be set at the higher men's height – to protect women against the harder hitting spikes taller and more muscular males players can deliver, especially on a very low net.

At age 16, boys are also typically more than 4 inches taller than girls; in addition to their additional upper-body strength, longer arms, and stronger leg muscles which enable them to leap higher when spiking the ball.

If I could play with a 7-inch lower net as the women do, even I could hit a hard spike, quipped Banzhaf, who reminds us that volleyball is generally not considered to be a contact sport.

The risk of a concussion or similar serious injury to a female athlete forced to compete with a biological male is obviously much greater in contact sports where muscular strength is even more important, such as football, boxing, hockey, and wrestling, argues Banzhaf.

So how unfair is it to prevent M2F students from playing on the women's team, rather than on the men's team?

At his George Washington University, like many other colleges and universities, there is a women's varsity volleyball team but no corresponding men's varsity volleyball team.

Male students who may have played and even excelled in high school volleyball, and spent countless hours in conditioning and practice, cannot continue their athletic careers in volleyball, simply because of their gender.

Thus there is a strong incentive for males who want to play varsity volleyball – as well as to be eligible for substantial monetary scholarships – to be able to play as a M2F female if it's permitted, suggests the law professor.

Moreover, he suggests, keeping M2F players off the varsity women's team will adversely affect only a very few players at most, since only about 1% of all students are transgender, whereas the policy limiting varsity volleyball play to those without a penis disadvantages many young males who played volleyball in high school or with leagues before coming to college.

In short, requiring biological males to play volleyball on the men's team if they wish to play varsity volleyball will affect a much small number of students than those who are male and cannot play varsity volleyball at all because of their gender, argues Banzhaf.

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AZ Senate Advances Bill to Ban Transgender Kids from School Sports

KAWC | By **Howard Fischer**

Published January 21, 2022 at 5:16 PM MST

1 of 3

By Howard Fischer
Capitol Media Services

PHOENIX -- Rejecting pleas from parents of transgender children, a Senate panel voted Thursday to limit their participation in public or private school sports to the biological sex of their birth.

The 4-3 party line vote by the Republican dominated Judiciary Committee came after Matt Sharp, an attorney with Alliance Defending Freedom, cited instances in Connecticut where transgender females defeated cis-gender girls and women in sports. He said those born male have a biological advantage over girls.

Sharp, however, could not cite a single instance of problems in Arizona. But he said that's irrelevant.

"We're trying to prevent what happened in other states from happening here," Sharp said.

The Arizona Interscholastic Association which governs high school sports already has a policy that says all students should be able to participate "in a manner that is consistent

AIA lobbyist Barry Aarons said there have been only a dozen requests in the past seven to 10 years to allow students to participate in a sport in the gender with which they identify when it does not match that of their birth. And he said the AIA's Medical Sports Advisory Council which reviews these has granted just seven.

The measure requires each interscholastic or intramural athletic team sponsored by a public or private school whose students or teams compete against a public school to be expressly designated as for males, females or coed "based on the biological sex of the students who participate on the team or in the sports." And it specifically prohibits teams designed for females from being open to males.

It also says any student or school who suffers any harm from violation of what's being called the Save Women's Sports Act can file suit to both halt the practice and collect damages.

SB 1165 picked up support from several speakers who said that allowing those born male to compete against girls and women isn't fair. That includes Jadis Argiope who identified herself as a transgender woman who said all the measure does is deal with "biological reality."

"The reality is we're stronger," she said.

"We have bigger bones, we can take in more oxygen," Argiope continued. "We have a better fat distribution that gives us an advantage taking hits. We have stronger ligaments."

Christine Pierce cited her own experience in sports.

"Allowing males to compete against females takes away the fairness of competition in female athletics," she said. But Vanessa Anspach said she sees it from the perspective of the parent of two children, including a 10-year-old transgender girl.

"When I became a parent I never imagined I'd be standing here today begging you for my child's right to be a child," she testified. "As a parent, my job is to support her, defend her and be her advocate."

Anspach said she knows her daughter will face multiple challenges.

"Playing sports with her peers shouldn't be one of them," she said.

Albert Levensohn had his own story.

"I am the proud parent of a transgender girl in middle school who deserves all the rights and opportunities to play sports just like all other girls growing up in Arizona," he told lawmakers. And Levensohn said that those who are backing the measure are wrongly focused on who wins.

"Participating in sports is an important part of students' physical, social and emotional well being," he said. "Playing sports provides student athletes with important lessons about leadership, self-discipline, success and failure as well as the joy and shared excitement of being part of a team."

But Sen. Warren Petersen, R-Gilbert, said the measure does not discriminate but simply recognizes biological differences.

"It is absolute lunacy to think that it's OK to allow a male to dominate in a female sport," he said. And Petersen said nothing in the legislation precludes transgender students from doing that.

"They can play," he said. "They just can't play on the team they want to play on."

He suggested that one option would be for schools to create "transgender leagues."

That suggestion, however, drew questions from Sen. Martin Quezada, D-Glendale, who questioned whether Petersen was advocating a form of "separate but equal," a concept the U.S. Supreme Court rejected in the 1950s when it disallowed schools from being segregated because of race.

Sen. Wendy Rogers, R-Flagstaff, cited her own experience playing high school volleyball and participating in track and field competition in college, all of which came about because of federal Title IX which prohibits any institution from discriminating against individuals on the basis of sex in education or programs.

Stahl Hamilton, D-Tucson, said all that is based on what she believes is a mistaken premise that men, by definition, are stronger than women. In fact the senator said she would like the men on the committee to stand up with her.

"There is not a man on this dais whose physical appearance I find intimidating," said Stahl Hamilton who said she stands 5-foot-10 in her bare feet -- and 6 feet with heels. "I would take any one of them on on the basketball court any given day, and would have done it as a 14-year-old girl," she continued. "And, in fact, I did."

The measure now goes to the full Senate after constitutional review by the Rules Committee.

On Twitter: @azcapmedia

Howard Fischer

See stories by Howard Fischer

EXHIBIT M

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Top Arizona Republicans ask to defend trans athlete ban in court

GOP leaders are hoping to defend Arizona's trans athlete ban, which they helped pass, after the attorney general refused to do so.

Last month, two trans athletes and their families filed a lawsuit seeking to nullify a 2022 law that bars them from joining school sports teams consistent with their gender identity. In the lawsuit, the 11- and 15-year-old girls argued that the ban infringes on multiple federal protections, including the Fourteenth Amendment, the Title IX Education Amendments of 1972 and the Americans with Disabilities Act, all of which guarantee freedom from discrimination.

On Monday, legislative leaders moved to back that law in Attorney General Kris Mayes' absence. Mayes has informed state Superintendent of Public Instruction Tom Horne, who is also a defendant in the lawsuit, that she is "disqualified" from defending the law in court, according to the brief filed by Senate President Warren Petersen and House Speaker Ben Toma.

A spokesperson for the attorney general's office did not respond to a request for comment on what that might mean, only confirming that she won't be involved in the challenge.

In a statement, Petersen touted the law as a necessary protection for Arizona women, calling it "unjust" for people to support trans student athletes.

"Senate and House Republicans stand in solidarity to protect women and girls from the injustices being attempted against them by the extreme left," he said. "Female athletes deserve equal opportunities in sporting events, which will not happen so long as males are allowed to compete against them."

Trans people, and women in particular, have been repeatedly singled out by Republican politicians in recent years, as the party has weaponized biological essentialism to push discriminatory legislation and appeal to the fringe. Sports has become a flashpoint in the debate despite the fact that trans athletes are in the extreme minority: The Arizona Interscholastic Association's Sports Advisory Committee, which governs high school sports across the state, has fielded only 16 appeals from transgender students since 2017 out of the 280 member schools and roughly 170,000 students it oversees.

Petersen said trans girls have male biology, which gives them greater height, muscle and bone structure formation and leaves them with clear advantages over girl athletes. That argument, however, is likely to face a rebuttal in court, with the two plaintiffs in the lawsuit having previously noted that they have yet to undergo male puberty and are thus physically on par with other girls. One of the two, in fact, stated that she has been taking puberty blockers and hormone therapy for years to ensure she doesn't enter male puberty.

Attorneys for Petersen and Toma wrote that their intervention is imperative, because they are best situated to defend the 2022 law. Horne, they point out, has yet to file a response despite a rapidly approaching deadline and, if he fails to do so, the law will be left without support. Even if Horne succeeds, they add, Petersen and Toma still contribute a unique legislative perspective. Both lawmakers voted for the underlying bill last year, and Petersen also co-sponsored the measure.

EXHIBIT

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Arizona House passes bill banning transgender student athletes from participating in girls sports

The Arizona House of Representatives passed a controversial bill Tuesday that aims to ban transgender female athletes from participating in girls' school sports. If signed into law, the ban would apply to all students in the state through college.

The bill, HB 2706, would require female athletes to prove their biological sex with a signed doctor's note following genetic testing if another student athlete disputed it. All public and private schools that sponsor interscholastic and intramural sports would be forced to comply, including K-12 schools, community colleges and universities.

"Women are being displaced in their own sport. The playing field is no longer level," said Republican Representative Nancy Barto, who introduced the bill. "All that needs to be determined is what sex a person is and that determines which team they can play on."

If the bill becomes law, any student would be able to dispute another athlete's gender if they feel it has negatively affected them. According to Democratic lawmakers, students would be allowed to target other students with no burden of proof.

> *I haven't figured out why we're even hearing #HB2706. This isn't a problem in Arizona, the @AZHouseDems have covered every angle of why this bill is not only unnecessary, but harmful. (Part 1 of my closing statement on why I voted no.) pic.twitter.com/crzHKyIO7f*
> *— Rep. Kirsten Engel (@EngelForArizona) March 4, 2020*

Barto said the bill "frankly doesn't discriminate or ban anybody from playing sports," adding that transgender girls could play on coed teams or boy's teams if they wanted.

Democrats called the bill "unnecessary and transphobic" and said it threatens the privacy of Arizonans, but a Republican majority passed it 31 to 29 along party lines.

"Transgender children are being attacked at the will of members of the @AZGOP all because they don't fit in their siloed and antiquated thought process," State Representative César Chávez tweeted Tuesday.

Opponents argue to bill leaves LGBTQ youth vulnerable to harmful bullying and privacy invasions.

"The vote tonight was shameful," State Representative Kirsten Engel tweeted. "Political points for Republicans at the cost of our most vulnerable kids, our transgender youth. I'm not proud of my State today."

> *🗣Trans girls are girls🗣#HB2706 is a harmful bill that sends the message to trans girls that they are not worthy of a full and social life and it denies them the opportunities and experience that their peers have. pic.twitter.com/7Rv6tSBx3v*

— ACLU of Arizona (@ACLUaz) February 18, 2020

"Whether someone is a sports fans or not, most view this as a matter of basic fairness," Representative Barto said in defense of the bill. "Female student athletes should not be forced to compete in a sport against biological males, who possess inherent physiological advantages. When this is allowed, it discourages female participation in athletics and, worse, it can result in women and girls being denied crucial educational and financial opportunities."

The bill will now head to the Senate. According to the House, similar legislation is being considered in Idaho, New Hampshire, Washington, Tennessee, Georgia, and Missouri.

The ACLU of Arizona called the bill invasive, discriminatory and harmful. "#HB2706 will police young girls' bodies and shame trans girls in the process," it tweeted.

"Transgender girls are girls, and transgender boys are boys. Transgender students participate in sports for the same reasons that other students do. They want enjoy the activities, challenge themselves and be a part of a team," Amanda Parris, policy counsel for the ACLU of Arizona, said in a statement. "Participation in sports has been shown to lead to better grades, better academic performance and improved self-esteem. We should not allow politicians to deny students opportunities to follow their passion and to compete. Transgender students deserve our support, not baseless attacks because of who they are as people."

Currently, the Arizona Interscholastic Association (AIA) allows all students to participate in sports in a way that is "consistent with their gender identity" regardless of their gender assigned at birth. The AIA also guarantees confidentiality in the process of determining eligibility for transgender student athletes.

“If the Speaker and President are not allowed to intervene, they will not be able to exercise their statutory right to mount a defense, and the duly enacted laws challenged here may receive no adequate defense, or even no defense at all,” reads the brief.

This isn’t the first time the legislative leaders have asked the court to let them take sides in a lawsuit. The two won permission to intervene in a lawsuit against 2021 abortion laws earlier this year, as well as in a challenge to President Biden’s COVID-19 vaccine mandate for federal contractors — both cases in which Mayes refused to take up the mantle of her predecessor, Republican Mark Brnovich.

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ORIGINAL PAPER

Individuals Treated for Gender Dysphoria with Medical and/or Surgical Transition Who Subsequently Detransitioned: A Survey of 100 Detransitioners

Lisa Littman[1]

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Abstract

The study's purpose was to describe a population of individuals who experienced gender dysphoria, chose to undergo medical and/or surgical transition and then detransitioned by discontinuing medications, having surgery to reverse the effects of transition, or both. Recruitment information with a link to an anonymous survey was shared on social media, professional listservs, and via snowball sampling. Sixty-nine percent of the 100 participants were natal female and 31.0% were natal male. Reasons for detransitioning were varied and included: experiencing discrimination (23.0%); becoming more comfortable identifying as their natal sex (60.0%); having concerns about potential medical complications from transitioning (49.0%); and coming to the view that their gender dysphoria was caused by something specific such as trauma, abuse, or a mental health condition (38.0%). Homophobia or difficulty accepting themselves as lesbian, gay, or bisexual was expressed by 23.0% as a reason for transition and subsequent detransition. The majority (55.0%) felt that they did not receive an adequate evaluation from a doctor or mental health professional before starting transition and only 24.0% of respondents informed their clinicians that they had detransitioned. There are many different reasons and experiences leading to detransition. More research is needed to understand this population, determine the prevalence of detransition as an outcome of transition, meet the medical and psychological needs of this population, and better inform the process of evaluation and counseling prior to transition.

Keywords Gender dysphoria · Detransition · Transgender

Introduction

Detransition is the act of stopping or reversing a gender transition. The visibility of individuals who have detransitioned is new and may be rapidly growing. As recently as 2014, it was challenging for an individual who detransitioned to find another person who similarly detransitioned (Callahan, 2018). Between 2015 and 2017, a handful of blogs written by individual detransitioners started to appear online, private support groups for detransitioners formed, and interviews with detransitioners began to appear in news articles, magazines, and blogs (Anonymous, 2017; 4thwavenow, 2016; Herzog, 2017; McCann, 2017). Although few YouTube videos about detransition existed prior to 2016, multiple detransitioners started to post videos documenting their experiences in 2016 and the numbers of these videos continues to increase.[1] In late 2017, the subreddit r/detrans (r/detrans, 2020) was revitalized and in four years has grown from 100 members to more than 21,000 members. A member poll of r/detrans conducted in 2019 estimated that approximately one-third of the members responding to the survey were desisters or detransitioners (r/detrans, 2019). The Pique Resilience Project, a group of four detransitioned or desisted young women, was founded in 2018 as a way to share the experiences of detransitioners with the public (Pique Resilience Project, 2019). In late 2019, the Detransition Advocacy Network, a nonprofit organization to "improve the well-being of detransitioned people everywhere" was launched (The

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[1] A search of the word "detransition" in YouTube can be filtered by date of upload. https://www.youtube.com/results?search_query=%22detransition%22&sp=CAI%253D22

Detransition Advocacy Network, 2020) and the first formal, in-person conference for detransitioned people was held (Bridge, 2020). In the face of this massive change, clinicians have called for more research into the experiences of detransitioners (Butler & Hutchinson, 2020; Entwistle, 2021; Marchiano, 2020).

Although there were rare published reports about detransitioners prior to 2016, most of the published literature about detransition is recent (Callahan, 2018; D'Angelo, 2018; Djordjevic et al., 2016; Kuiper & Cohen-Kettenis, 1998; Levine, 2018; Marchiano, 2017; Pazos Guerra et al., 2020; Stella, 2016; Turban & Keuroghlian, 2018; Turban et al., 2021; Vandenbussche, 2021). The prevailing cultural narratives about detransition are that most individuals who detransition will retransition and that the reasons for detransition are discrimination, pressures from others, and nonbinary identification (Turban et al., 2021). However, case reports are shedding light on a broader and more complex range of experiences that include trauma, worsened mental health with transition, re-identification with natal sex, and difficulty separating sexual orientation from gender identity (D'Angelo, 2018; Levine, 2018; Pazos Guerra et al., 2020).[2] Detransitioners and desisters, in their own words, have provided additional depth to the discussion, describing that:

(1) Trauma (including sexual trauma) and mental health conditions contributed to their transgender identification and transition (Callahan, 2018; Herzog, 2017; twitter.com/ftmdetransed & twitter.com/radfemjourney, 2019)
(2) Their dysphoria and transition were due to homophobia and difficulty accepting themselves as homosexual (Bridge, 2020; Callahan, 2018; upperhandMARS, 2020)
(3) Peers, social media, and online communities were influential in the development of transgender identification and desire to transition (Pique Resilience Project, 2019; Tracey, 2020; upperhandMARS, 2020)
(4) Their dysphoria was rooted in misogyny (Herzog, 2017)

Two recently published convenience sample reports provide additional context about the topic of detransition. First, Turban et al. (2021) analyzed data from the United States Trans Survey (USTS) (James et al., 2016). The USTS contains data from 27,715 transgender and gender diverse adults from the U.S. who were recruited through lesbian, gay, bisexual, transgender, queer (LGBTQ), and allied organization outreach. The USTS included the question, "Have you ever detransitioned? In other words, have you ever gone back to living as your sex assigned at birth, at least for a while?" with the multiple choice options of "yes," "no," and "I have never transitioned." For the 2,242 participants who answered "yes," Turban et al. analyzed the responses to the multiple choice question, "Why did you detransition? In other words, why did you go back to living as your sex assigned at birth? (Mark all that apply)." Although most of the offered answer options were about external pressures to detransition (pressure from spouse or partner, pressure from family, pressure from friends, pressure from employer, discrimination, etc.), participants could write in additional reasons that were not listed. Turban et al.'s sample included more natal males (55.1%) than natal females (44.9%). Roughly half (50.2%) had taken cross-sex hormones and 16.5% had obtained surgery. The findings revealed that most (82.5%) of the sample expressed at least one external factor for detransitioning and 15.9% expressed at least one internal factor (factors originating from self).

The second study by Vandenbussche (2021) recruited detransitioners from online communities of detransitioners and analyzed data for the participants who answered affirmatively to the question, "Did you transition medically and/or socially and then stopped?" The sample of 237 participants was predominantly natal female (92%), and from the U.S. (51%) and Europe (32%). Most (65%) had transitioned both medically and socially. Participants selected from multiple choice options to indicate why they detransitioned with options covering a range of experiences. Respondents also had the option to write in additional reasons. Frequently endorsed reasons for detransition included realizing that their gender dysphoria was related to other issues (70%); health concerns (62%); observing that transition did not help their dysphoria (50%); and that they found alternatives to deal with their dysphoria (45%). In contrast to Turban et al. (2021), external factors such as lack of support, financial concerns, and discrimination were less common (13%, 12%, and 10%, respectively). Many in the sample described that when they detransitioned they lost support or were ostracized from lesbian, gay, bisexual, and transgender (LGBT) communities, suggesting that many of the participants in Vandenbussche (2021) would not have been reached by the recruitment efforts of the USTS (James et al., 2016).

The objective of the current study was to describe a population of individuals who experienced gender dysphoria, chose to undergo medical and/or surgical transition and then detransitioned by discontinuing medications, having surgery to reverse the effects of transition, or both. In contrast to Turban et al. (2021) and Vandenbussche (2021), this study focused only on

[2] The debate about the terminologies used to describe an individual's sex (including "assigned sex at birth," "biological sex," "natal sex," "birth sex," "sex," etc.) is far from settled. Although some professionals have argued for the use of "assigned sex at birth," others argue that this terminology is misleading and not consistent with the events that occur at birth and prior to birth (Bouman et al., 2017; Byng et al., 2018; Dahlen, 2020; Griffin et al., 2020). Supporting the unsettled nature of the discussion, I received conflicting comments from the reviewers of this manuscript about my selection of natal sex terms–one reviewer asked that I justify my preference for natal sex over the other terminologies; another reviewer expressed support for my use of natal sex. I prefer to use "natal sex" and "birth sex" because they are accurate and objective. Further, I propose that "natal sex" and "birth sex" might be seen as reasonable, polite compromise terms between "biological sex" and "assigned sex at birth."

individuals who transitioned and detransitioned medically, surgically, or both. For the purpose of this study, medical transition refers to the use of puberty blockers, cross-sex hormones, or anti-androgens and surgical transition refers to any of a variety of surgical procedures (common surgical procedures include mastectomy, genital surgery, and breast augmentation). This study does not describe the population of individuals who undergo medical or surgical transition without issue nor is it designed to assess the prevalence of detransition as an outcome of transition. Instead, the goal was to identify detransition reasons and narratives in order to inform clinical care and future research.

Method

Participants and Procedure

During the recruitment period, 101 individuals who met the study criteria completed online surveys. Inclusion criteria were (1) completion of a survey via Survey Monkey; (2) answering that they had taken or had one or more of the following for the purpose of gender transition: cross-sex hormones, anti-androgens, puberty blockers, breast surgery, genital surgery, other surgery; and (3) answering that they had done any of the following for the purpose of detransitioning: stopped taking cross-sex hormones, stopped taking anti-androgens, stopped taking puberty blockers, had any surgery to reverse transition. One survey was excluded for nonsense answers leaving 100 surveys for analysis. The sample included more natal females (69.0%) than natal males (31.0%) with respondents who were predominantly White (90.0%), non-Hispanic (98.0%), resided in the U.S. (66.0%); had no religious affiliation (63.0%), and support the rights of gay and lesbian couples to marry legally (92.9%) (see Table 1). At the time of survey completion, the mean age of respondents was 29.2 years (SD = 9.1) though natal females were significantly younger ($M = 25.8$; SD = 5.0) than natal males ($M = 36.7$; SD = 11.4), $t(98) = -6.56$, $p < .001$. Prior to transitioning, natal females were more likely to report an exclusively homosexual sexual orientation and natal males were more likely to report an exclusively heterosexual sexual orientation.

A 115-question survey instrument with multiple choice, Likert-type, and open-ended questions was created by the author and two individuals who had personally detransitioned. The author had met both detransitioners by way of introductions from colleagues. The author and both individuals who had detransitioned created questions for the survey, provided feedback, and revised the survey questions collaboratively with a focus on content, clarity, and relevance to a variety of transition and detransition experiences. The survey instrument included two questions that were adapted from an online survey of female detransitioners (Stella, 2016). Once completed, the survey was uploaded onto Survey Monkey (SurveyMonkey, Palo Alto, CA) via an account that was HIPAA-enabled.

Recruitment information with a link to the survey was posted on blogs that covered detransition topics and shared in a private online detransition forum, in a closed detransition Facebook group, and on Tumblr, Twitter, and Reddit. Recruitment information was also shared on the professional listservs for the World Professional Association for Transgender Health, the American Psychological Association Section 44, and the SEXNET listserv (which is a listserv of sex researchers and clinicians) and the professionals on the listservs were asked to share recruitment information with anyone they knew who might be eligible. Efforts were made to reach out to communities with varied views about the use of medical and surgical transition and recruitment information stated that participation was sought from individuals regardless of whether their transition experiences were positive, negative or neutral. Potential participants were invited to share recruitment information with any potentially eligible person or community with potentially eligible people. The survey was active from December 15, 2016 to April 30, 2017 (4.5 months). The median time to complete a survey was 49 min; 50% of the surveys were completed between 32 and 71 min. There were no incentives offered for participating. Data were collected anonymously, without IP addresses, and stored securely with Survey Monkey.

Participation in this study was voluntary. Electronic consent was obtained from all participants in the following manner. The first page of the online survey informed respondents about the research purpose, potential risks and benefits, that participation was voluntary, and provided contact information for the researcher. Survey questions were only displayed if the participant clicked "agree" which indicated that they read the information, voluntarily agreed to participate and were at least 18 years of age.

Measures

Demographic and Baseline Characteristics

Information was collected about participant age, natal sex, race/ethnicity, country of residence, educational attainment, socioeconomic status, religion, attitudes about legal marriage for gay and lesbian couples, and where they first heard about the study. The term sexual orientation in this article is intended to refer to the natal sex of the participant and the natal sex of the individuals with whom they are sexually attracted. Participants were asked to select one or more labels for how they identified their sexual orientation prior to transition with options inclusive of participant sex (e.g., asexual female, bisexual female, heterosexual female, etc.). These responses were coded to be consistent with participant natal sex and were categorized into homosexual, heterosexual, bisexual, pansexual, asexual, and multiple. The multiple category included respondents who

Table 1 Demographic and baseline characteristics

	Natal female *N* (%) *N* = 69	Natal male *N* (%) *N* = 31
*Race/ethnicity**		
White	62 (89.9%)	28 (90.3%)
Multiracial	6 (8.7%)	3 (9.7%)
Other	4 (5.8%)	0 (0%)
Asian	1 (1.4%)	1 (3.2%)
Hispanic	1 (1.4%)	1 (3.2%)
Black	0 (0%)	0 (0%)
Country of residence		
USA	46 (66.7%)	20 (64.5%)
UK	8 (11.6%)	1 (3.2%)
Canada	5 (7.2%)	4 (12.9%)
Australia	2 (2.9%)	2 (6.5%)
Other	8 (11.6%)	4 (12.9%)
Education		
Bachelor's or graduate degree	29 (42.0%)	18 (58.1%)
Associates degree	3 (4.3%)	1 (3.2%)
Some college but no degree	28 (40.6%)	9 (29.0%)
High school graduate or GED	8 (11.6%)	2 (6.5%)
<High school	1 (1.4%)	0 (0%)
Other	0 (0%)	1 (3.2%)
Socioeconomic status compared to others in country of residence		
Above average (somewhat or very much)	19 (27.5%)	12 (38.7%)
About average	20 (29.0%)	7 (22.6%)
Below average (somewhat or very much)	27 (39.1%)	12 (38.7%)
Prefer not to say	3 (4.3%)	0 (0%)
Categorized sexual orientation (by natal sex) prior to transition[a]		
Homosexual	18 (26.1%)	2 (6.5%)
Heterosexual	6 (8.7%)	12 (38.7%)
Bisexual	15 (21.7%)	8 (25.8%)
Pansexual	4 (5.8%)	1 (3.2%)
Multiple	20 (29.0%)	5 (16.1%)
Asexual	6 (8.7%)	3 (9.7%)
Religious affiliation		
No religious affiliation	41 (59.4%)	22 (73.3%)
Liberal Christian	5 (7.2%)	3 (10.0%)
Liberal Jewish	5 (7.2%)	0 (0%)
Conservative Christian	1 (1.4%)	2 (6.7%)
Liberal Muslim	1 (1.4%)	0 (0%)
Conservative Jewish	0 (0%)	0 (0%)
Conservative Muslim	0 (0%)	0 (0%)
Other	16 (23.2%)	3 (10.0%)
Legal marriage for gay and lesbian couples		
Favor	65 (97.0%)	26 (83.9%)
Oppose	1 (1.5%)	5 (16.1%)
Don't know	1 (1.5%)	0 (0%)
Source where participant first heard about study		
Detransition blogs	26 (37.7%)	15 (48.4%)
Other social media	37 (53.6%)	11 (35.5%)
A person they know	3 (4.3%)	3 (9.7%)
Other	3 (4.3%)	2 (6.5%)

*May select more than one answer

[a]Natal females were more likely to express an exclusively homosexual sexual orientation prior to transition ($\chi^2 = 5.15$. The *p*-value is .023). Natal males were more likely to express an exclusively heterosexual sexual

Table 1 (continued)

orientation prior to transition ($\chi^2 = 13.05$. The p value is $< .001$). Natal sex differences were not significant for individuals expressing pre-transition sexual orientations of bisexual, pansexual, multiple, and asexual. For bisexual sexual orientation, $\chi^2 = 0.20$. For pansexual sexual orientation, $\chi^2 = 0.29$. For multiple sexual orientations reported, $\chi^2 = 1.88$. For asexual sexual orientation, $\chi^2 = 0.02$

selected more than one response where responses indicated more than one pattern of sexual attraction (e.g., lesbian female and heterosexual female). Other questions about baseline characteristics included questions about diagnosed psychiatric disorders and neurodevelopmental disabilities, trauma, and non-suicidal self-injury (NSSI) before the onset of gender dysphoria.

Gender Dysphoria Onset and Typologies

Participants were asked how old they were when they first experienced gender dysphoria and whether this was during childhood, at the onset of puberty, during puberty, or later. Respondents were categorized as having early-onset gender dysphoria if they indicated that their gender dysphoria began "during childhood" and late-onset gender dysphoria if their gender dysphoria began "at the onset of puberty" or later. To evaluate typologies, participants were characterized by Blanchard's (1985, 1989) typology as homosexual (if the sexual orientations listed prior to transition were exclusively homosexual) or non-homosexual which includes heterosexual, asexual, bisexual, pansexual, and multiple responses.

Transition

Participants were asked for their age and the year that they first sought care to transition, sources that encouraged them to believe that transition would be helpful to them, and whether they felt pressured to transition. The friendship group dynamics that were identified in previous work were assessed by asking respondents whether their friendship group mocked people who were not transgender, whether people in their pre-existing friend group transitioned before the participant decided to transition, and how participant popularity changed after announcing that they would transition (Littman, 2018). Questions were asked about participant experiences with clinicians, the social, medical, and surgical steps they took to transition, and the duration of time spent taking each medication.

Detransition

Participants were asked for their age and the year that they decided to detransition, how long they were transitioned before deciding to detransition, their reasons for wanting to detransition, what sources encouraged them to believe that detransition would be helpful to them, and whether they felt pressured to detransition. Participants were also asked which social, medical, and surgical steps they took to detransition and whether they contacted the doctor or clinic that they used for their transition to tell them that they detransitioned.

Transition and Detransition Narratives

In this article, "narratives" denote participant interpretations of their experiences and rationales surrounding their decisions to transition and detransition. To associate each participant survey with a set of relevant narratives, the data were reviewed with horizontal (beginning to end) passes and vertical passes for selected questions (these questions are listed in the supplemental materials). Surveys were coded as belonging to zero or more of the following narrative categories: discrimination, nonbinary, retransition, trauma and mental health, internalized homophobia, social influence, and misogyny. Each narrative and the responses that were associated with them are detailed below. Example quotes were selected with care taken to avoid quoting a participant more than once per narrative. Narratives are ordered and reported with the more commonly accepted narratives first and the newer narratives next.

The *discrimination* narrative was defined as when someone detransitioned due to experiencing discrimination or external social pressures. The *nonbinary* narrative consisted of answering that their current identification was "nonbinary/genderqueer" or providing open-text responses that described aspects of discovering or maintaining a nonbinary identification. Although there were no questions in the survey specifically asking about retransition, the *retransition* narrative was identified if participants expressed that they had retransitioned or resumed transition in any of the open-text responses in the survey. The *gender dysphoria was caused by trauma or a mental health condition* narrative was identified by selection for the answers, "what I thought were feelings of being transgender were actually the result of trauma," "what I thought were feelings of being transgender were actually the result of a mental health condition," "I discovered that my gender dysphoria was caused by something specific (ex. trauma, abuse, mental health condition)" or open-text responses consistent with these reasons. The *internalized homophobia/difficulty accepting oneself as a lesbian female, gay male, or bisexual person* narrative consisted of descriptions that the respondents' discomfort and distress about being lesbian, gay, or bisexual was related to their gender dysphoria, transition, or detransition, or that they assumed they were transgender because they did not yet understand themselves to be lesbian, gay or bisexual. The *social pressure to transition* narrative was identified with an affirmative answer to whether they felt pressured to transition with an open-text response indicating that the pressure came from a person or group of people. The *misogyny* narrative was identified for natal female respondents with open-text responses using the word "misogyny" or expressing a hatred of femaleness.

Gender Identification at Start of Transition and at Survey Completion

Participants were asked how they identified their gender when they started their transition and at the time of survey completion. They were given options of female, male, nonbinary/genderqueer, trans man/FTM, trans woman/MTF, none of the above, and other. Responses were coded by natal sex and categorized as transgender, birth sex, nonbinary, and other. Answers that were combinations of the above categories were reported as combinations such as "birth sex and nonbinary."

Self-Appraisal of Transition and Detransition

One question asked if participants believe they were helped and another if they were harmed by their transition with options of "very much," "a little," or "not at all." These results were categorized into exclusively helped, exclusively harmed, and both helped and harmed. Participants were asked which of the following reflected their feelings about their transition: "I am glad that I transitioned," "I wish I had never transitioned," "Transitioning distracted me from what I should have been doing," "Transition was a necessary part of my journey." Participants were asked to rate their regret about their transition ("no regrets," "mild regrets," "strong regrets," and "very strong regrets") and were asked to indicate their satisfaction with their decisions to transition and detransition ("extremely satisfied," "very satisfied," "somewhat satisfied," "somewhat dissatisfied," "very dissatisfied," and "extremely dissatisfied"). Satisfaction options were collapsed into "satisfied" and "dissatisfied." In addition, participants were asked if they knew then what they know now, would they have chosen to transition.

Data Analysis

After data were cleaned, statistical analyses were performed using google sheets. Results are presented as frequencies, percentages, medians, means and standard deviations. t tests and chi-square tests were performed for selected variables and were considered significant for $p < .05$. Qualitative data were obtained from the open-text answers to questions that allowed participants to provide additional information. Selected open-text responses were categorized, tallied, and reported numerically. Salient respondent quotes and summaries from the qualitative data were selected to illustrate the quantitative results and to provide relevant examples.

Results

Before Transition

Mental health diagnoses and traumatic experiences before the onset of gender dysphoria. Table 2 shows data about psychiatric disorders, neurodevelopmental disabilities, NSSI, and trauma that were reported as occurring prior to the onset of gender dysphoria. Because these conditions and events occurred before participants began to feel gender dysphoric, they cannot be considered to be secondary to gender incongruence or transphobia.

Gender dysphoria onset and typology. Most participants (82.0%) were living with one or both parents when they first experienced gender dysphoria at a mean age of 11.2 years (SD = 5.6). The mean age of gender dysphoria onset was not statistically different between natal females ($M = 11.3$; SD = 5.4) and natal males ($M = 11.0$; SD = 5.9), $t(96) = 0.25$. By Blanchard typologies, 26.1% of natal females were exclusively homosexual and 73.9% non-homosexual while 6.5% of natal males were exclusively homosexual and 93.5% non-homosexual (Blanchard, 1985, 1989). Slightly more than half of the respondents (56.0%) experienced early-onset gender dysphoria and slightly less than half (44.0%) experienced late-onset gender dysphoria. Although late-onset gender dysphoria in natal females was largely absent from the scientific literature prior to 2012 (Steensma et al., 2013; Zucker & Bradley, 1995; Zucker et al., 2012a), 55.1% of the natal female participants reported that their gender dysphoria began with puberty or later. Because the information about the timing of gender dysphoria onset was obtained from participants reporting on their own experiences, it can be assumed that these cases were indeed late-onset rather than early-onset gender dysphoria that was concealed from parents and other people.

Transition reasons. Table 3 shows data about the reasons that individuals wanted to transition and the most frequently endorsed were: wanting to be perceived as the target gender (77.0%); believing that transitioning was their only option to feel better (71.0%); the sensation that their body felt wrong the way it was (71.0%), and not wanting to be associated with their natal sex (70.0%). Most participants believed that transitioning would eliminate (65.0%) or decrease (63.0%) their gender dysphoria and that with transitioning they would become their true selves (64.0%).

Sources of transition encouragement and friend group dynamics. Participants identified sources that encouraged them to believe transitioning would help them. Social media and online communities were the most frequently reported, including YouTube transition videos (48.0%), blogs (46.0%), Tumblr (45.0%), and online communities (43.0%) (see supplemental materials). Also common were people who the respondents knew offline such as therapists (37.0%); someone (28.0%) or a group of friends (27.0%) that they knew in-person. A subset of

Table 2 Mental health diagnoses and traumatic experiences prior to the onset of gender dysphoria

	Natal female N (%) N=69	Natal male N (%) N=31
*Diagnosed with a mental illness or neurodevelopmental disability**[a]		
Depression	27 (39.1%)	5 (16.1%)
Anxiety	22 (31.9%)	5 (16.1%)
Attention deficit hyperactivity disorder (ADHD)	10 (14.5%)	2 (6.5%)
Post-traumatic stress disorder (PTSD)	10 (14.5%)	1 (3.2%)
Eating disorders	10 (14.5%)	0 (0%)
Autism spectrum disorders	9 (13.0%)	1 (3.2%)
Bipolar disorder	9 (13.0%)	0 (0%)
Obsessive compulsive disorder	6 (8.7%)	3 (9.7%)
Borderline personality disorder	5 (7.2%)	0 (0%)
Schizophrenia or other psychotic disorders	1 (1.4%)	0 (0%)
None of the above	28 (40.6%)	17 (54.8%)
Other	7 (10.1%)	2 (6.5%)
Non-suicidal self-injury (NSSI)[b]		
Engaged in NSSI before the onset of gender dysphoria	19 (27.5%)	5 (16.1%)
Trauma[c]		
Experienced a trauma less than one year before the start of gender dysphoria	33 (47.8%)	4 (12.9%)

*May select more than one answer

[a]Natal sex difference for one or more pre-existing diagnoses (100-none of the above) was not significant [$\chi^2(1, 100) = 1.76$]

[b]Natal sex differences for NSSI before the onset of gender dysphoria was not significant ($\chi^2 = 1.52$)

[c]Experiencing a trauma less than one year before the start of gender dysphoria was statistically different [$\chi^2(1, 100) = 11.19, p < .001$] with natal females > natal males

Table 3 Transition reasons

	Natal female N (%) N=69	Natal male N (%) N=31
*Reasons for transition**		
I wanted others to perceive me as the target gender	53 (76.8%)	24 (77.4%)
I thought transitioning was my only option to feel better	50 (72.5%)	21 (67.7%)
My body felt wrong to me the way it was	50 (72.5%)	21 (67.7%)
I didn't want to be associated with my natal sex/natal gender	51 (73.9%)	19 (61.3%)
It made me uncomfortable to be perceived romantically/sexually as a member of my natal sex/natal gender	49 (71.0%)	18 (58.1%)
I thought transitioning would eliminate my gender dysphoria	43 (62.3%)	22 (71.0%)
I felt I would become my true self	42 (60.9%)	22 (71.0%)
I identified with the target gender	40 (58.0%)	24 (77.4%)
I thought transitioning would lessen my gender dysphoria	45 (65.2%)	18 (58.1%)
I felt I would fit in better with the target gender	36 (56.5%)	20 (64.5%)
I felt I would be more socially acceptable as a member of the target gender	38 (55.1%)	11 (35.5%)
I felt I would be treated better if I was perceived as the target gender	35 (50.7%)	14 (45.2%)
I saw myself as a member of the target gender	31 (44.9%)	18 (58.1%)
I thought transitioning would reduce gender-related harassment or trauma I was experiencing	35 (50.7%)	5 (16.1%)
I had erotic reasons for wanting to transition	9 (13.0)	12 (38.7%)
Other	9 (13.0%)	3 (9.7%)

*May select more than one answer

participants experienced the friendship group dynamics identified in previous work, including belonging to a friendship group that mocked people who were not transgender (22.2%), having one or more friend from the pre-existing friend group transition before the participant decided to transition (36.4%), and experiencing an increase in popularity after announcing plans to transition (19.6%) (Littman, 2018). Most did not have this experience (68.7%, 61.6%, and 62.9%, respectively).

Pressure to transition. More than a third of the participants (37.4%) felt pressured to transition. Natal sex differences in feeling pressured to transition were significant by chi-square test with natal females > natal males $\chi^2(1, 99) = 4.22$, $p = .04$. Twenty-eight participants provided open-text responses of which 24 described sources of pressure (17 described social pressures and 7 described sources that were not associated with other people). Clinicians, partners, friends, and society were named as sources that applied pressure to transition, as seen in the following quotes: "My gender therapist acted like it [transition] was a panacea for everything;" "[My] [d]octor pushed drugs and surgery at every visit;" "I was dating a trans woman and she framed our relationship in a way that was contingent on my being trans;" "A couple of later trans friends kept insisting that I needed to stop delaying things;" "[My] best friend told me repeatedly that it [transition] was best for me;" "The forums and communities and internet friends;" "By the whole of society telling me I was wrong as a lesbian;" and "Everyone says that if you feel like a different gender…then you just are that gender and you should transition." Participants also felt pressure to transition that did not involve other people as illustrated by the following: "I felt pressured by my inability to function with dysphoria" and "Not by people. By my life circumstances."

Experiences with clinicians. When participants first sought care for their gender dysphoria or desire to transition, more than half of the participants (53.0%) saw a psychiatrist or psychologist; about a third saw a primary care doctor (34.0%) or a counselor (including licensed clinician social worker, licensed professional counselor, or marriage and family therapist) (32.0%); and 17.0% saw an endocrinologist. For transition, 45.0% of participants went to a gender clinic (44.4% of those attending a gender clinic specified that the gender clinic used the informed consent model of care); 28.0% went to a private doctor's office; 26.0% went to a group practice; and 13.0% went to a mental health clinic (see supplemental materials).

The majority (56.7%) of participants felt that the evaluation they received by a doctor or mental health professional prior to transition was not adequate and 65.3% reported that their clinicians did not evaluate whether their desire to transition was secondary to trauma or a mental health condition. Although 27.0% believed that the counseling and information they received prior to transition was accurate about benefits and risks, nearly half reported that the counseling was overly positive about the benefits of transition (46.0%) and not negative enough about the risks (26.0%). In contrast, only a small minority found the counseling not positive enough about benefits (5.0%) or too negative about risks (6.0%) suggesting a bias toward encouraging transition.

Transition

Participants were on average 21.9 years old (SD = 6.1) when they sought medical care to transition with natal females seeking care at younger ages ($M = 20.0$; SD = 4.2) than natal males ($M = 26.0$; SD = 7.5), $t(97) = -5.07$, $p < .001$. Given that the majority of natal males were categorized as Blanchard typology non-homosexual, the finding that natal males sought medical care to transition at older ages than natal females is concordant with previous research (Blanchard et al., 1987). The average year for seeking care was more recent for natal females ($M = 2011$; SD = 3.8) than natal males ($M = 2007$; SD = 6.9), $t(96) = 2.78$, $p = .007$, and thus, there may have been differences in the care they received due to differences in the culture surrounding transition and the prevailing medical approaches to gender dysphoria for the time.

At the start of transitioning, nearly all (98.0%) of the participants identified as either transgender (80.0%), nonbinary (15.0%), or both transgender and nonbinary (3.0%). Participants identified which social, medical, and surgical steps they had taken to transition. Table 4 shows these steps, separated by natal sex where appropriate. Most respondents adopted new pronouns (91.0%) and names (88.0%), and the vast majority (97.1%) of natal females wore a binder. Most participants took cross-sex hormones (96.0%) and most natal males took anti-androgens (87.1%). The most frequent transition surgery was breast or chest surgery for natal females (33.3%). Genital surgery was less common (1.4% of natal females and 16.1% of natal males). Natal females took testosterone for a mean duration of 2.0 years (SD = 1.6). Natal males took estrogen for a mean duration of 5.1 years (SD = 5.9) and anti-androgens for 2.8 years (SD = 2.6). The minority of patients who took puberty blockers took them for a mean duration of less than a year ($M = 0.9$ years; SD = 0.6).

Detransition

Before deciding to detransition, participants remained transitioned for a mean duration of 3.9 years (SD = 4.1) with natal females remaining transitioned for a shorter period of time ($M = 3.2$ years; SD = 2.7) than natal males ($M = 5.4$ years; SD = 6.1), $t(96) = -2.40$, $p = .018$. When participants decided to detransition they were a mean age of 26.4 years old (SD = 7.4) though natal females were significantly younger ($M = 23.6$; SD = 4.5) than natal males ($M = 32.7$; SD = 8.8), $t(97) = -6.75$, $p < .001$. The mean calendar year when participants decided to detransition was 2014 ($M = 2014$; SD = 3.3), but the difference

Table 4 Steps taken for social, medical, and surgical transition

	N (%)
*Social transition**	
Pronouns	91 (91.0%)
Different name	88 (88.0%)
Clothes/hair/makeup	90 (90.0%)
Legal name change	49 (49.0%)
Gender/sex changed on government documents	36 (36.0%)
Voice training	20 (20.0%)
Natal female	
Wore a binder	67 (97.1%)
*Medical transition**	
Cross-sex hormones	96 (96.0%)
Puberty blockers	7 (7.0%)
Natal male	
Anti-androgens	27 (87.1%)
*Surgical transition**	
Face/neck surgery	5 (5.0%)
Natal female	
Breast/chest surgery	23 (33.3%)
Genital surgery (to create a penis)	1 (1.4%)
Natal male	
Breast implants	5 (16.1%)
Genital surgery (to create a vagina)	5 (16.1%)

*May select more than one answer

between natal females and natal males was not significant ($M=2014$, $SD=3.3$; $M=2014$, $SD=3.5$), $t(95)=0.52$.

Respondents detransitioned for a variety of reasons and most (87.0%) selected more than one reason. The most frequently endorsed reason for detransitioning was that the respondent's personal definition of male and female changed and they became comfortable identifying with their natal sex (60.0%) (see Table 5). Other commonly endorsed reasons were concerns about potential medical complications (49.0%); transition did not improve their mental health (42.0%); dissatisfaction with the physical results of transition (40.0%); and discovering that something specific like trauma or a mental health condition caused their gender dysphoria (38.0%). External pressures to detransition such as experiencing discrimination (23.0%) or worrying about paying for treatments (17.0%) were less common.

Encouragement and pressure to detransition. Participants were asked to select sources that encouraged them to believe that detransitioning would help them. These included blogs (37.0%), Tumblr (35.0%), and YouTube detransition videos (23.0%) (see supplemental materials). At some point in their process, 23.2% felt pressured to detransition. There was no significant difference between natal females and natal males for feeling pressured to detransition, $\chi^2(1, 99)=1.11$. Of the 21 open-text responses provided, 14 respondents expressed social pressure to detransition; three expressed internal pressure to detransition and four provided responses that were neither

Table 5 Reasons for detransitioning

	Natal female N (%) N=69	Natal male N (%) N=31
*Reasons for detransitioning**		
My personal definition of female or male changed and I became more comfortable identifying as my natal sex	45 (65.2%)	15 (48.4%)
I was concerned about potential medical complications from transitioning	40 (58.0%)	9 (29.0%)
My mental health did not improve while transitioning	31 (44.9%)	11 (35.5%)
I was dissatisfied by the physical results of the transition/felt the change was too much	35 (50.7%)	5 (16.1%)
I discovered that my gender dysphoria was caused by something specific (ex, trauma, abuse, mental health condition)	28 (40.6%)	10 (32.3%)
My mental health was worse while transitioning	27 (39.1%)	9 (29.0%)
I was dissatisfied by the physical results of the transition/felt the change was not enough	22 (31.9%)	11 (35.5%)
I found more effective ways to help my gender dysphoria	25 (36.2%)	7 (22.6%)
My physical health was worse while transitioning	21 (30.4%)	11 (35.5%)
I felt discriminated against	12 (17.4%)	11 (35.5%)
I had medical complications from transitioning	12 (17.4%)	7 (22.6%)
Financial concerns about paying for transition care	11 (15.9%)	6 (19.4%)
My gender dysphoria resolved	10 (14.5%)	5 (16.1%)
My physical health did not improve while transitioning	9 (13.0%)	2 (6.5%)
I resolved the specific issue that was the cause of my gender dysphoria	6 (8.7%)	4 (12.9%)
I realized that my desire to transition was erotically motivated	1 (1.4%)	5(16.1%)
Other	19 (27.5%)	6 (19.4%)

*May select more than one answer

or unclear. Regarding social pressure to detransition, seven participants expressed that the pressure came from partners, parents, or other family members as shown in the following example quotes: "I was threatened that if I did not immediately detransition I would NEVER see my [...] children again," "My father very much wanted me to desist," and "Parents constantly encouraging me to detransition." Five participants expressed societal pressure to detransition as expressed in the following quotes: "I did not pass, I was mocked in public, I could not get a job. It was not ok to be trans" and "Well, I mean basically the entire world was against me transitioning, so yeah." One participant felt pressured by doctors and another one from a blog.

Detransition steps. Table 6 shows data about the social, medical, and surgical steps participants took to detransition. Nearly all participants medically detransitioned by ceasing cross-sex hormones (95.0%). Social detransition steps were also common and included returning to the use of previously used pronouns (63.0%) and birth names (33.0%) and changing one's clothes and hair presentations (48.0%). Surgical detransition steps were less common (9.0%).

Finding better ways of coping with gender dysphoria. Participants were asked to select responses that that they considered to have been better ways for them to cope with their gender dysphoria. Responses included community (44.0%), mindfulness/meditation (41.0%), exercise (39.0%), therapy (24.0%), trauma work (24.0%), medication to treat a mental health condition (18.0%), and yoga (14.0%).

Table 6 Social, medical, and surgical detransition steps

	N (%)
*Social detransition**	
Previous pronouns	63 (63.0%)
Clothes/hair/makeup	48 (48.0%)
Birth name	33 (33.0%)
New name (not birth name)	24 (24.0%)
None of the above	2 (2.0%)
*Medical detransition**	
Stopped cross-sex hormones	95 (95.0%)
Stopped puberty blockers	4 (4.0%)
Started hormones consistent with natal sex	14 (14.0%)
Natal male	
Stopped anti-androgens	17 (54.8%)
*Surgical detransition**	
Surgery to reverse changes from transition	9 (9.0%)

*May select more than one answer

Transition and Detransition Narratives

Several transition and detransition narratives emerged from the data. A sizable minority of participants (41.0%) expressed more than one narrative in their responses.

The *discrimination and external pressures to detransition* narrative was described by 29.0% of participants. Examples include: "I had to detransition in order to get a job"; "I was afraid of being homeless and unable to support myself"; "I felt much happier with myself but I couldn't go anywhere without being afraid. I passed okay but not perfectly. I was stared down and sneered at in the women's clothes section, I wouldn't dare use a public toilet because I'd find either violent men or women who wished an encounter with a violent man on me."

A *nonbinary* narrative was expressed by 16.0% of participants. Some described that they discovered their nonbinary gender identity during their transition, as in the following quotes: "I still was uncomfortable with my body and figured I should stop and make sure I really wanted to keep going. I didn't and I decided I must be nonbinary, not FTM"; "Transitioning didn't do what I thought I wanted it to. I had transitioned to the wrong gender. I still felt wrong. Then, I realized I was not male, but genderqueer. I detransitioned to suit my true identity." And others described a consistent nonbinary identification, as in the following quote, "I identified the same way that I did before. I had gotten what I wanted out of HRT and was ready to stop taking it." (Cross-sex hormones are sometimes referred to as "hormone replacement therapy" and abbreviated as HRT).

Three participants (3.0%) expressed the *retransition* narrative in open-text answers indicating that they had retransitioned, including the following quotes: "I am now transitioning for a second time"; I retransitioned after 5 years of detransitioning"; and "Anyway, I retransitioned over 10 years after detransitioning."

Most participants (58.0%) expressed the *gender dysphoria was caused by trauma or a mental health condition* narrative which included endorsing the response options indicating that their gender dysphoria was caused by something specific, such as a trauma or a mental health condition. More than half of the participants (51.2%) responded that they believe that the process of transitioning delayed or prevented them from dealing with or being treated for trauma or a mental health condition. The following are example quotes that were in response to why participants chose to detransition: "I slowly began addressing the mental health conditions and traumatic experiences that caused such a severe disconnect between myself and my body..."; "I was starting to become critical of transition because I felt that many people were doing it out of self-hatred and started to realize that applied to me as well"; "I was deeply uncomfortable with my secondary sex characteristics, which I now understand was a result of childhood trauma and associating my secondary sex characteristics with those events."

Despite the absence of any questions about this topic in the survey, nearly a quarter (23.0%) of the participants expressed the *internalized homophobia and difficulty accepting oneself as lesbian, gay, or bisexual* narrative by spontaneously describing that these experiences were instrumental to their gender dysphoria, their desire to transition, and their detransition. All of the participants in this category indicated that they were either same-sex attracted exclusively or were same-sex attracted in combination with opposite-sex attraction (such as bisexual, pansexual, etc.). The following responses were written in as "other" for the question about why participants transitioned: "Transitioning to male would mean my attraction to girls would be 'normal'"; "being a 'gay trans man' (female dating other females) felt better than being a lesbian, less shameful"; "I felt being the opposite gender would make my repressed same-sex attraction less scary"; "I didn't want to be a gay man." Some participants described that it took time for them to gain an understanding of themselves as lesbian, gay, or bisexual as seen in the following: "At the time I was trying to figure out my identity and felt very male and thought I was transgender. I later discovered that I was a lesbian…"; and "Well, after deep discovery, I realized I was a gay man and realized that a sexual trauma after puberty might [have] confused my thought. I wanted to live as a gay man again." Several natal female respondents expressed that seeing other butch lesbians would have been helpful to them as shown by the following: "What would have helped me is being able to access women's community, specifically lesbian community. I needed access to diverse female role-models and mentors, especially other butch women."

The *social influence* narrative was identified where participants added information to the question about if they had felt pressured to transition and the response described pressure from a person or people. One-fifth (20.0%) of participants expressed that they felt pressured by a person or people to transition. Example quotes for social influence were described in a previous section.

Of the natal females, 7.2% expressed the *misogyny* narrative. Example quotes include: "…I realized how much of it [dysphoria] may have been caused by internalized misogyny and homophobia"; "Finally realizing there's nothing wrong or disgusting or weak about being female"; and "My transition was a desperate attempt to distance myself from womanhood and femaleness due to internalized lesbophobia and misogyny combined with a history of sexual trauma."

After Detransition

Disposition. At the time of survey completion, most participants had returned to identifying solely as their birth sex (61.0%) with an additional 10.0% identifying as their birth sex plus another identification. Fourteen percent of the participants identified solely as nonbinary with an additional 11.0% identifying as nonbinary plus a second identification. Eight percent of the participants identified solely as transgender with an additional 5.0% identifying as transgender plus another identification. Four percent of the responses did not fit into the above categories and were coded as "other." Figure 1 illustrates the distribution of participants' current gender identification (post-detransition). Only 24.0% of participants had informed the doctor or clinic that facilitated their transitions that they had detransitioned.

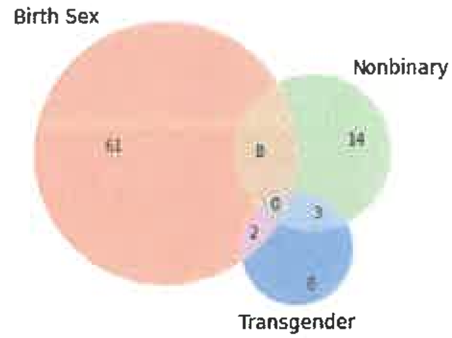

Fig. 1 Distribution of participants' current gender identification (after detransition) (n = 100). *Notes*: The sum of the numbers appearing in the "Birth Sex" circle indicates the number of participants who returned to identifying with their birth sex (71)—either as birth sex alone (61) or birth sex in addition to a second identification (10) represented in the overlap between two circles. For example, eight participants identify as their birth sex and as nonbinary. The sum of the numbers appearing in the "Nonbinary" circle indicates the number of participants who identify as nonbinary (25)—either as nonbinary alone (14) or nonbinary in addition to a second identification (11). The sum of the numbers appearing in the "Transgender" circle indicates the number of participants who identify as transgender (13)—either as transgender alone (8) or transgender in addition to a second identification (5). Four participants had responses that did not fit the categories above and were coded as "other"

Self-appraisal of past transgender identification. Table 7 presents the data for responses endorsed by participants to reflect how they feel currently about having identified as transgender in the past. The statements most frequently selected included: "I thought gender dysphoria was the best explanation for what I was feeling" (57.0%), "My gender dysphoria was similar to the gender dysphoria of those who remain transitioned" (42.0%), "What I thought were feelings of being transgender actually were the result of trauma" (36.0%), "What I thought were feelings of being transgender actually were the result of a mental health condition" (36.0%).

Self-appraisal of transition and detransition. When asked to select which statement best reflects their feelings about their transition, nearly a third (30.0%) indicated that they wish they had never transitioned while 11.0% indicated they were glad they transitioned. Some (34.0%) selected the statement that transition "was a necessary part of [their] journey" but others (21.0%) indicated that the process of transitioning distracted them from what they should have been doing. Responses about whether transition helped or harmed them were also complicated. While 50.5% selected answers consistent with being both helped and harmed, 32.3% indicated that they were only harmed and 17.2% indicated that they were only helped. The majority of respondents were dissatisfied with their decision to transition (69.7%) and satisfied with their decision to detransition (84.7%). At least some amount of transition regret was

Table 7 Self-appraisal of past transgender identification

	Natal female N (%) N=69	Natal male N (%) N=31
*Self-appraisal about identifying as transgender in the past**		
I thought gender dysphoria was the best explanation for what I was feeling	39 (56.5%)	18 (58.1%)
My gender dysphoria was similar to the gender dysphoria of those who remain transitioned	32 (46.4%)	10 (32.3%)
What I thought were feelings of being transgender actually were the result of trauma	31 (44.9%)	5 (16.1%)
What I thought were feelings of being transgender actually were the result of a mental health condition	28 (40.6%)	8 (25.8%)
Someone else told me that the feelings I was having meant that I was transgender and I believed them	25 (36.2%)	10 (32.3%)
I still identify as transgender	20 (29.0%)	10 (32.3%)
I believed I was transgender then, but I was mistaken	16 (23.2%)	6 (19.4%)
I was transgender then but I am not transgender now	15 (21.7%)	7 (22.6%)
I formerly identified as transgender and now identify as genderqueer/nonbinary	12 (17.4%)	5 (16.1)
My gender dysphoria was different from the gender dysphoria of those who remain transitioned	11 (15.9%)	4 (12.9%)
I was never transgender	8 (11.6%)	3 (9.7%)
I thought I had gender dysphoria but I was mistaken	4 (5.8%)	4 (12.9%)
I never had gender dysphoria	1 (1.4)	2 (6.5%)
N/A as I did not identify as transgender in the past	0 (0%)	1 (3.2%)
Other	18 (26.1%)	5 (16.1%)

*May select more than one answer

common (79.8%) and nearly half (49.5%) reported strong or very strong regret. Most respondents (64.6%) indicated that if they knew then what they know now, they would not have chosen to transition.

Discussion

This study was designed to explore the experiences of individuals who obtained medical and surgical treatment for gender dysphoria and then detransitioned by discontinuing the medications or having surgery to reverse the changes from transition. The findings of this study, however, should not be assumed to be representative of all individuals who detransition. Although this study further documents that detransitioners exist, the prevalence of detransition as an outcome of transition is unknown. Only a small percentage of detransitioners (24.0%) informed the clinicians and clinics that facilitated their transitions that they had detransitioned. Therefore, clinic rates of detransition are likely to be underestimated and gender transition specialists may be unaware of how many of their own patients have detransitioned, particularly for patients who are no longer under their care.

This research demonstrates that the experiences of individuals who detransition are varied and the reasons for detransition are complex. Nearly all participants identified as transgender or nonbinary at the start of their transition and most sought transition because they did not want to be associated with their natal sex, their bodies felt wrong the way they were, and they believed that transition was the only option to relieve their distress. Some were helped by transition and only detransitioned because they were pressured to do so by people in their lives, society, or because they had medical complications. Some were harmed by transition and detransitioned because they concluded that their gender dysphoria was caused by trauma, a mental health condition, internalized homophobia, or misogyny—conditions that are not likely to be resolved with transition. These findings highlight the complexity of gender dysphoria and suggest that, in some cases, failure to explore co-morbidities and the context in which the gender dysphoria emerged can lead to misdiagnosis, missed diagnoses, and inappropriate gender transition. Some individuals detransitioned because their gender dysphoria resolved, because they found better ways to address their symptoms, or because their personal definitions of male and female changed and they became comfortable identifying as their natal sex.

The study sample was predominantly young natal females, many of whom experienced late-onset gender dysphoria which mirrors the recent, striking changes in the demographics of gender dysphoric youth seeking care as well as the youth described by their parents in Littman (2018) (see also Aitken et al., 2015; de Graaf et al., 2018; Zucker, 2019). Concerns have been raised that this new cohort of gender dysphoric individuals is unlike previous cohorts. Professionals have started to call for caution before treating this cohort with interventions with permanent effects because the etiologies, desistance and persistence rates, expected duration of symptoms, and whether this new population is helped or harmed by gender transition is still unknown (D'Angelo et al., 2021; Kaltiala-Heino et al., 2018). The natal females and natal males in this sample differed on several dimensions, including that natal females were younger than natal males when they sought transition, when they decided to detransition, and at the time of survey completion. Natal females were more likely than natal males to have experienced a trauma less than one year before the onset of their gender dysphoria and were more likely to have felt pressured to transition. Compared to natal males, natal females remained transitioned for a shorter duration of time before deciding to detransition. Additionally, natal females transitioned more recently than natal males, so their experiences may vary due to changing trends in the clinical management of gender dysphoria and the cultural settings in which they became gender dysphoric.

The study findings covered a wide range of detransition experiences that are consistent with the diversity of experiences described in previously published clinical case reports and case series. Overlap of findings include: transition regret; absence of transition regret; re-identification with birth sex; continued identification as transgender; improvement or worsening of well-being with transition; retransitioning; detransitioning due to external social pressures; nonbinary identification; and recognizing and accepting oneself as homosexual or bisexual (D'Angelo, 2018; Djordjevic et al., 2016; Levine, 2018; Pazos Guerra et al., 2020; Turban & Keuroghlian, 2018; Turban et al., 2021; Vandenbussche, 2021). The population in this study is similar to the population in Vandenbussche in that both were predominantly natal females in their mid-20s. Because the current study recruited in 2016–2017 and Vandenbussche recruited in 2019, the similar mean age of participants may reflect the age of individuals who can be reached in online detransitioner communities. Several findings in this study were consistent with Vandenbussche's findings, including similar reasons for detransition (realizing that their gender dysphoria was related to other issues, finding alternatives to address gender dysphoria, gender dysphoria resolved, etc.). Although these two studies were recruited in different years, had different eligibility criteria, and included participants from several countries, it is possible that there may be some overlap of study populations.

The current study findings provide additional insight into the complex relationships between internalized homophobia, gender dysphoria, and desire to transition. Contrary to arguments against the potential role of homophobia in gender transitions (Ashley, 2020), participants reported that their own gender dysphoria and desire to transition stemmed from the discomfort they felt about being same-sex attracted, their desire to not be gay, and the difficulties that they had accepting themselves as lesbian, gay or bisexual. For these individuals, exploring their distress and discomfort around sexual orientation issues may have been more helpful to them than medical and surgical transition or at least an important part of exploration before making the decision to transition. This research adds to the existing evidence that gender dysphoria can be temporary (Ristori & Steensma, 2016; Singh et al., 2021; Zucker, 2018). It has been established that the most likely outcome for prepubertal youth with gender dysphoria is to develop into lesbian, gay, bisexual (LGB) (non-transgender) adults (Ristori & Steensma, 2016; Singh et al., 2021; Wallien & Cohen-Kettenis, 2008; Zucker, 2018). And, temporary gender dysphoria may be a common part of LGB identity development (Korte et al., 2008; Patterson, 2018). Therefore, intervening too soon to medicalize gender dysphoric youth risks iatrogenically derailing the development of youth who would otherwise grow up to be LGB non-transgender adults. Participants who detransitioned because they became comfortable identifying as their natal sex and because their gender dysphoria resolved further support that gender dysphoria is not always permanent.

The data in this study strengthen, with first-hand accounts, the rapid-onset gender dysphoria (ROGD) hypotheses which, briefly stated, are that psychosocial factors (such as trauma, mental health conditions, maladaptive coping mechanisms, internalized homophobia, and social influence) can cause or contribute to the development of gender dysphoria in some individuals (Littman, 2018). Littman also postulated that certain beliefs could be spread by peer contagion, including the belief that a wide range of symptoms should be interpreted as gender dysphoria (and proof of being transgender) and the belief that transition is the only solution to relieve distress. The current study supports the potential role of psychosocial factors in the development of gender dysphoria and further suggests, by participant responses that transitioning prevented or delayed them from addressing their underlying conditions, that maladaptive coping mechanisms may be relevant for some individuals. The potential role of social influence is demonstrated as well. First, when respondents were asked to describe how they currently feel about having identified as transgender in the past, more than a third endorsed the option, "Someone told me that the feelings I was having meant that I was transgender, and I believed them." Second, a subset of participants experienced the unique friendship group dynamics reported in Littman where peer groups mocked people who were not transgender and popularity within the friend group increased when respondents announced their plan to transition. Additionally, respondents identified several social sources that encouraged them to believe that transitioning would help them including: YouTube transition videos, blogs, Tumblr, and online communities. And finally, 20.0% of participants felt pressured to transition by social sources that included friends, partners, and society. More research is needed to further explore these hypotheses.

The current study and the Turban et al. (2021) analysis of the USTS data share some similarities and differences. Similarities include the use of convenience samples, targeted recruitment, and anonymous data collection. The findings of Turban et al. (including external pressures to detransition and transgender identification after detransition) are a subset of the array of experiences described in the current study. The current study differed from James et al. (2016) and Turban et al. in that it enrolled participants based on the criterion of detransition after medical or surgical transition regardless of how they currently identified, recruited from communities with diverse perspectives about transition and detransition, used a precise definition for detransition that specifies the use of medication or surgery, and included answer options that were relevant to many different types of detransition experiences. In contrast, the USTS only enrolled transgender-identifying individuals regardless of whether they medically or surgically transitioned, recruited from communities likely to have similar perspectives about transition and detransition, and provided multiple choice answer options that were relevant to a narrower range of detransition experiences (James et al., 2016). Further, the definition used by the USTS for "detransitioned" (having "gone back to living as [their] sex assigned as birth, at least for a while") is quite vague. Although Turban et al. provide valuable information about the subset of transgender-identifying people who may have detransitioned, the current study provides a more comprehensive view of individuals who detransition after medical or surgical transition.

Over the past 15 years, there have been substantial changes in the clinical approach to gender dysphoric patients notable for a shift from approaches that employ thorough evaluations and judicious use of medical and surgical transition (the watchful waiting or Dutch approach, the developmentally informed approach, and the medical model of care) to approaches with minimized or eliminated evaluation and liberal use of transition interventions (the affirmative approach and the informed consent model of care) (Cavanaugh et al., 2016; de Vries & Cohen-Kettenis, 2012; Meyer et al., 2002; Rafferty et al., 2018; Schulz, 2018; Zucker et al., 2012b). This trend is prominent in the U.S. where the American Academy of Pediatrics endorsed the affirmative approach in 2018 and Planned Parenthood currently uses the informed consent model to provide medical transition in more than 200 clinics in 35 states (Planned Parenthood, 2021; Rafferty et al., 2018). It is plausible that an unintended consequence of these clinical shifts may be an increase in people who detransition. Many participants in this study believe that they did not receive an adequate evaluation by a clinician before transition. The definition of "adequate evaluation" was not provided in the survey and may be open to respondent interpretation. But given the complexities of the gender dysphoria described in the current study, one might consider a low bar of "adequate" to be the exploration of factors that could be misinterpreted as non-temporary gender dysphoria as well as factors that could be underlying causes for gender dysphoria. The most recently emerging approach to gender dysphoria is called the "exploratory approach" which is a neutral psychotherapeutic approach to help individuals gain a deeper understanding of their gender distress and the factors contributing to their dysphoria (Churcher Clarke & Spiliadis, 2019; Spiliadis, 2019). The study's findings suggest that an exploratory type of approach may have been beneficial to some of the respondents. Future research is needed to determine which patients are best treated by which approaches long term.

Patients considering medical and surgical interventions deserve accurate information about the risks, benefits, and alternatives to that treatment. In this sample, nearly half of the participants reported that the counseling they received about transition was overly positive about the benefits of transition and more than a quarter reported that the counseling was not negative enough about the risks. Several participants felt pressured to transition by their doctors and therapists. If these types of clinical interactions are verified, exploration is needed to determine the extent to which this situation occurs and what measures might be taken to ensure that clinicians provide patients with their options accurately and dispassionately.

There are several obstacles to obtaining accurate rates of detransition and desistance, including stigma and the low numbers of detransitioners who inform their clinicians that they detransitioned. One approach to bypass some of these barriers would be to incorporate non-judgmental questions about detransition and desistance into nationally representative surveys that collect health data. For example, the Behavioral Risk Factor Surveillance System contains an optional module about sexual orientation and gender identity that includes two questions to explore gender issues (Downing & Przedworski, 2018). By changing one existing question, "Do you consider yourself to be transgender?" into two questions, "Have you ever, at any point in your life, considered yourself to be transgender?" and "Do you currently consider yourself to be transgender?" and by adding a follow-up question if answers indicate past but not current transgender identification, "Did you ever take puberty blockers, cross-sex hormones, anti-androgens, or have any surgery as part of your transition?", valuable information about desistance, detransition, and current transgender identification could be obtained. These types of questions may also be of use in clinical practice and electronic medical records. The information gained about rates of detransition and desistance would enhance transgender healthcare by aiding informed consent processes at the start of any medical or surgical transition.

One of the strengths of this study is that it is one of the largest samples of detransitioners to date. Other strengths include the use of a precise definition for detransition, enrollment of detransitioners regardless of their post-detransition gender identification, recruitment from communities with likely divergent views about transition and detransition, and collaboration with two individuals who had detransitioned which helped to create a survey instrument with questions relevant to a variety of detransition experiences and enhanced the recruitment efforts.

There are several limitations to this study that should be considered when interpreting the findings. Like Vandenbussche (2021), James et al. (2016), and Turban et al. (2021), this study used a cross-sectional design, anonymous surveying, and a convenience sample and therefore shares the same limitations that are inherent to these methodologies. These limitations include that conclusions about causation cannot be determined, identities of participants cannot be verified, and the findings of this study may not be generalizable to the entire population of people who detransition or to people outside of the countries where participants were from. Although this study reached out to communities with differing perspectives about transition and detransition, targeted recruitment and convenience samples always introduce the limitations associated with selection biases which should be addressed in future research. Finally, many of the participants in this study had less than ideal outcomes to their medical and surgical transitions, and it is possible that these experiences may have colored some of the responses.

Additional research is needed to determine the prevalence of detransition as an outcome of transition and to identify and meet the psychological and medical needs of the emerging detransitioned population. Because many individuals who detransition re-identify with their birth sex, are no longer connected to LGBT communities, and don't return to gender clinics, future research about detransition needs to expand recruitment efforts beyond gender clinics and transgender communities. The development and testing of non-medical interventions for gender dysphoria could provide valuable options to be used as alternatives or in conjunction with medical and surgical treatments. Because of the potential for some to experience trauma, mental health conditions, internalized homophobia, and misogyny as gender dysphoria, research needs to be conducted on the evaluation process before transition to find approaches that respectfully and collaboratively explore factors that might contribute to gender-related distress. There continues to be an absence of long-term outcomes evidence for youth treated with medical and surgical transition and a lack of information about the trajectories of youth experiencing late-onset gender dysphoria–research is needed to address these gaps. Continued work is needed to reduce rigid gender roles, increase representation of gender stereotype nonconformity, and to address discrimination and social pressures exerted against people who are transgender, lesbian, gay, bisexual, and gender stereotype non-conforming.

Conclusion

This study described individuals who, after transitioning with medications or surgery, have detransitioned. The prevalence of detransitioning after transition is unknown but is likely underestimated because most of the participants did not inform the doctors who facilitated their transitions that they had detransitioned. There is no single narrative to explain the experiences of all individuals who detransition and we should take care to avoid painting this population with a broad brush. Some detransitioners return to identifying with their birth sex, some assume (or maintain) a nonbinary identification, and some continue to identify as transgender. Some detransitioners regret transitioning and some do not. Some of the detransitioners reported experiences that support the ROGD hypotheses, including that their gender dysphoria began during or after puberty and that mental health issues, trauma, peers, social media, online communities, and difficulty accepting themselves as lesbian, gay, or bisexual were related to their gender dysphoria and desire to transition. Natal female and natal male detransitioners appear to have differences in their baseline characteristics and experiences and these differences should be further delineated. Future research about gender dysphoria and the outcomes of transition should consider the diversity of experiences and trajectories. More research is needed to determine how best to provide support and treatment for the long-term medical and psychological well-being of individuals who detransition. Findings about detransition should be used to improve our understanding of gender dysphoria and to better inform the processes of evaluation, counseling, and informed consent for individuals who are contemplating transition.

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Declarations

Conflict of interest The author has no relevant financial or non-financial conflicts of interest to disclose.

Consent to Participate Electronic consent was obtained from all participants included in the study. On the first page of the online survey, participants were informed of the research purpose and potential risks and benefits of participating, that their participation was voluntary, and were presented with a way to contact the researcher. The research survey questions were displayed only if the participant clicked "agree" which indicated that the participant read the information, voluntarily agreed to participate, and were at least 18 years of age.

Ethical Approval The research was determined to be Exempt Human Research by the Program for the Protection of Human Subjects of the Icahn School of Medicine at Mount Sinai in New York, NY. All procedures were performed in accordance with the ethical standards of the Program for the Protection of Human Subjects at the Icahn School of Medicine at Mount Sinai and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

References

Aitken, M., Steensma, T. D., Blanchard, R., VanderLaan, D. P., Wood, H., Fuentes, A., Spegg, C., Wasserman, L., Ames, M., Fitzsimmons, C. L., Leef, J. H., Lishak, V., Reim, E., Takagi, A., Vinik, J., Wreford, J., Cohen-Kettenis, P. T., de Vries, A. L. C., Kreukels, B. P. C., & Zucker, K. J. (2015). Evidence for an altered sex ratio in clinic-referred adolescents with gender dysphoria. *Journal of Sexual Medicine, 12*(3), 756–763. https://doi.org/10.1111/jsm.12817

Anonymous. (2017). Experience: I regret transitioning. *The Guardian*. https://www.theguardian.com/lifeandstyle/2017/feb/03/experience-i-regret-transitioning

Ashley, F. (2020). Homophobia, conversion therapy, and care models for trans youth: Defending the gender-affirmative approach. *Journal of LGBT Youth, 17*(4), 361–383. https://doi.org/10.1080/19361653.2019.1665610

Blanchard, R. (1985). Typology of male-to-female transsexualism. *Archives of Sexual Behavior, 14*(3), 247–261.

Blanchard, R. (1989). The classification and labeling of nonhomosexual gender dysphorias. *Archives of Sexual Behavior, 18*(4), 315–334.

Blanchard, R., Clemmensen, L. H., & Steiner, B. W. (1987). Heterosexual and homosexual gender dysphoria. *Archives of Sexual Behavior, 16*(2), 139–152. https://doi.org/10.1007/BF01542067

Bouman, W. P., Schwend, A. S., Motmans, J., Smiley, A., Safer, J. D., Deutsch, M. B., Adams, N. J., & Winter, S. (2017). Language and trans health [Editorial]. *International Journal of Transgenderism, 18*(1), 1–6. https://doi.org/10.1080/15532739.2016.1262127

Bridge, L. (2020). Detransitioners are living proof the practices surrounding "trans kids" need to be questioned. *Feminist Current*. https://www.feministcurrent.com/2020/01/09/detransitioners-are-living-proof-the-practices-surrounding-trans-kids-need-be-questioned/

Butler, C., & Hutchinson, A. (2020). Debate: The pressing need for research and services for gender desisters/detransitioners. *Child and Adolescent Mental Health, 25*(1), 45–47. https://doi.org/10.1111/camh.12361

Byng, R., Bewley, S., Clifford, D., & McCartney, M. (2018). Redesigning gender identity services: An opportunity to generate evidence. *British Medical Journal, 363*. https://doi.org/10.1136/bmj.k4490

Callahan, C. (2018). Unheard voices of detransitioners. In H. Brunskell-Evans & M. Moore (Eds.), *Transgender children and young people: Born in your own body* (pp. 166–180). Cambridge Scholars Publishing.

Cavanaugh, T., Hopwood, R., & Lambert, C. (2016). Informed consent in the medical care of transgender and gender-nonconforming patients. *AMA Journal of Ethics, 18*(11), 1147–1155. https://doi.org/10.1001/journalofethics.2016.18.11.sect1-1611

Churcher Clarke, A., & Spiliadis, A. (2019). 'Taking the lid off the box': The value of extended clinical assessment for adolescents presenting with gender identity difficulties. *Clinical Child Psychology and Psychiatry, 24*(2), 338–352. https://doi.org/10.1177/1359104518825288

Dahlen, S. (2020). De-sexing the medical record? An examination of sex versus gender identity in the General Medical Council's trans healthcare ethical advice. *The New Bioethics, 26*(1), 38–52. https://doi.org/10.1080/20502877.2020.1720429

D'Angelo, R. (2018). Psychiatry's ethical involvement in gender-affirming care. *Australasian Psychiatry, 26*(5), 460–463. https://doi.org/10.1177/1039856218775216

D'Angelo, R., Syrulnik, E., Ayad, S., Marchiano, L., Kenny, D. T., & Clarke, P. (2021). One size does not fit all: In support of psychotherapy for gender dysphoria [Letter to the Editor]. *Archives of Sexual Behavior, 50*(1), 7–16. https://doi.org/10.1007/s10508-020-01844-2

de Graaf, N. M., Giovanardi, G., Zitz, C., & Carmichael, P. (2018). Sex ratio in children and adolescents referred to the Gender Identity Development Service in the UK (2009–2016) [Letter to the Editor]. *Archives of Sexual Behavior, 47*(5), 1301–1304. https://doi.org/10.1007/s10508-018-1204-9

de Vries, A. L. C., & Cohen-Kettenis, P. T. (2012). Clinical management of gender dysphoria in children and adolescents: The Dutch approach. *Journal of Homosexuality, 59*(3), 301–320. https://doi.org/10.1080/00918369.2012.653300

Djordjevic, M. L., Bizic, M. R., Duisin, D., Bouman, M.-B., & Buncamper, M. (2016). Reversal surgery in regretful male-to-female transsexuals after sex reassignment surgery. *Journal of Sexual Medicine, 13*(6), 1000–1007. https://doi.org/10.1016/j.jsxm.2016.02.173

Downing, J. M., & Przedworski, J. M. (2018). Health of transgender adults in the U.S., 2014–2016. *American Journal of Preventive Medicine, 55*(3), 336–344. https://doi.org/10.1016/j.amepre.2018.04.045

Entwistle, K. (2021). Debate: Reality check–Detransitioner's testimonies require us to rethink gender dysphoria. *Child and Adolescent Mental Health, 26*(1), 15–16. https://doi.org/10.1111/camh.12380

4thwavenow. (2016). *In praise of gatekeepers: An interview with a former teen client of TransActive Gender Center*. https://4thwavenow.com/2016/04/21/in-praise-of-gatekeepers-an-interview-with-a-former-teen-client-of-transactive-gender-center/

Griffin, L., Clyde, K., Byng, R., & Bewley, S. (2020). Sex, gender and gender identity: A re-evaluation of the evidence. *BJPsych Bulletin*. https://doi.org/10.1192/bjb.2020.73

Herzog, K. (2017). The detransitioners: They were transgender until they weren't. *The Stranger*. https://www.thestranger.com/features/2017/06/28/25252342/the-detransitioners-they-were-transgender-until-they-werent

James, S. E., Herman, J. L., Rankin, S., Keisling, M., Mottet, L., & Anafi, M. (2016). *The Report of the 2015 U.S. Transgender Survey*. National Center for Transgender Equality.

Kaltiala-Heino, R., Bergman, H., Työläjärvi, M., & Frisen, L. (2018). Gender dysphoria in adolescence: Current perspectives. *Adolescent Health, Medicine and Therapeutics, 9*, 31–41. https://doi.org/10.2147/AHMT.S135432

Korte, A., Goecker, D., Krude, H., Lehmkuhl, U., Grüters-Kieslich, A., & Beier, K. M. (2008). Gender identity disorders in childhood and adolescence currently debated concepts and treatment strategies. *Deutsches Aerzteblatt Online, 105*(48), 834–841. https://doi.org/10.3238/arztebl.2008.0834

Kuiper, A. J., & Cohen-Kettenis, P. T. (1998). Gender role reversal among postoperative transsexuals. *International Journal of Transgenderism, 2*(3), 1–6.

Levine, S. B. (2018). Transitioning back to maleness. *Archives of Sexual Behavior, 47*(4), 1295–1300. https://doi.org/10.1007/s10508-017-1136-9

Littman, L. (2018). Parent reports of adolescents and young adults perceived to show signs of a rapid onset of gender dysphoria. *PLoS ONE, 13*(8), e0202330. https://doi.org/10.1371/journal.pone.0202330

Marchiano, L. (2017). Outbreak: On transgender teens and psychic epidemics. *Psychological Perspectives: A Quarterly Journal of Jungian Thought, 60*(3), 345–366. https://doi.org/10.1080/00332925.2017.1350804

Marchiano, L. (2020). The ranks of gender detransitioners are growing. We need to understand why. *Quillette*. https://quillette.com/2020/01/02/the-ranks-of-gender-detransitioners-are-growing-we-need-to-understand-why/

McCann, C. (2017). When girls won't be girls. *The Economist*. https://www.economist.com/1843/2017/09/28/when-girls-wont-be-girls

Meyer, W., Bockting, W. O., Cohen-Kettenis, P., Coleman, E., Diceglie, D., Devor, H., Gooren, L., Hage, J. J., Kirk, S., Kuiper, B., Laub, D., Lawrence, A., Menard, Y., Patton, J., Schaefer, L., Webb, A., & Wheeler, C. C. (2002). The Harry Benjamin International Gender Dysphoria Association's standards of care for gender identity disorders, Sixth Version. *Journal of Psychology & Human Sexuality, 13*(1), 1–30. https://doi.org/10.1300/J056v13n01_01

Patterson, T. (2018). Unconscious homophobia and the rise of the transgender movement. *Psychodynamic Practice, 24*(1), 56–59. https://doi.org/10.1080/14753634.2017.1400740

Pazos Guerra, M., Gómez Balaguer, M., Gomes Porras, M., Hurtado Murillo, F., Solá Izquierdo, E., & Morillas Ariño, C. (2020). Transexualidad: Transiciones, detransiciones y arrepentimientos en España. *Endocrinología, Diabetes y Nutrición, 67*(9), 562–567. https://doi.org/10.1016/j.endinu.2020.03.008

Pique Resilience Project. (2019). https://www.piqueresproject.com/

Planned Parenthood. (2021). *What do I need to know about trans health care?* https://www.plannedparenthood.org/learn/gender-identity/transgender/what-do-i-need-know-about-trans-health-care

Rafferty, J., Committee on Psychosocial Aspects of Child and Family Health, Committee on Adolescence, & Section on Lesbian, Gay, Bisexual, and Transgender Health and Wellness. (2018). Ensuring comprehensive care and support for transgender and gender-diverse children and adolescents. *Pediatrics, 142*(4), e20182162. https://doi.org/10.1542/peds.2018-2162

r/detrans. (2019). *R/detrans subreddit survey update!* [Reddit]. https://www.reddit.com/r/detrans/comments/azj8xd/subreddit_survey_update/

r/detrans. (2020). [Reddit]. https://www.reddit.com/r/detrans/

Ristori, J., & Steensma, T. D. (2016). Gender dysphoria in childhood. *International Review of Psychiatry, 28*(1), 13–20. https://doi.org/10.3109/09540261.2015.1115754

Schulz, S. L. (2018). The informed consent model of transgender care: An alternative to the diagnosis of gender dysphoria. *Journal of Humanistic Psychology, 58*(1), 72–92. https://doi.org/10.1177/0022167817745217

Singh, D., Bradley, S. J., & Zucker, K. J. (2021). A follow-up study of boys with gender identity disorder. *Frontiers in Psychiatry*. https://doi.org/10.3389/fpsyt.2021.632784

Spiliadis, A. (2019). Towards a gender exploratory model: Slowing things down, opening things up and exploring identity development. *Metalogos Systemic Therapy Journal, 35*, 1–9.

Steensma, T. D., Kreukels, B. P. C., de Vries, A. L. C., & Cohen-Kettenis, P. T. (2013). Gender identity development in adolescence. *Hormones and Behavior, 64*(2), 288–297. https://doi.org/10.1016/j.yhbeh.2013.02.020

Stella, C. (2016). *Female detransition and reidentification: Survey results and interpretation* [Tumblr]. http://guideonragingstars.tumblr.com/post/149877706175/female-detransition-and-reidentification-survey

The Detransition Advocacy Network. (2020). https://www.detransadv.com

Tracey, M. (2020). *Why all this trans stuff?* YouTube. https://youtu.be/r57wGbiK3U8

Turban, J. L., & Keuroghlian, A. S. (2018). Dynamic gender presentations: Understanding transition and "de-transition" among transgender youth. *Journal of the American Academy of Child and Adolescent Psychiatry, 57*(7), 451–453. https://doi.org/10.1016/j.jaac.2018.03.016

Turban, J. L., Loo, S. S., Almazan, A. N., & Keuroghlian, A. S. (2021). Factors leading to "detransition" among transgender and gender diverse people in the United States: A mixed-methods analysis. *LGBT Health, 8*, 273–280. https://doi.org/10.1089/lgbt.2020.0437

twitter.com/ftmdetransed, & twitter.com/radfemjourney. (2019). Our voices our selves—Amplifying the voices of detransitioned women. In M. Moore & H. Brunskell-Evans (Eds.), *Inventing transgender children and young people* (pp. 167–174). Cambridge Scholars Publishing.

upperhandMARS. (2020). *Desist to exist as Chiara*. YouTube. https://www.youtube.com/watch?v=rLfTrTRnIRk

Vandenbussche, E. (2021). Detransition-related needs and support: A cross-sectional online survey. *Journal of Homosexuality*. https://doi.org/10.1080/00918369.2021.1919479

Wallien, M. S. C., & Cohen-Kettenis, P. T. (2008). Psychosexual outcome of gender-dysphoric children. *Journal of the American Academy of Child and Adolescent Psychiatry, 47*(12), 1413–1423. https://doi.org/10.1097/CHI.0b013e31818956b9

Zucker, K. J. (2018). The myth of persistence: Response to "A critical commentary on follow-up studies and 'desistance' theories about transgender and gender non-conforming children" by Temple Newhook et al. (2018). *International Journal of Transgenderism, 19*(2), 231–245. https://doi.org/10.1080/15532739.2018.1468293

Zucker, K. J. (2019). Adolescents with gender dysphoria: Reflections on some contemporary clinical and research issues. *Archives of Sexual Behavior, 48*(7), 1983–1992. https://doi.org/10.1007/s10508-019-01518-8

Zucker, K. J., & Bradley, S. J. (1995). *Gender identity disorder and psychosexual problems in children and adolescents*. Guilford Press.

Zucker, K. J., Bradley, S. J., Owen-Anderson, A., Kibblewhite, S. J., Wood, H., Singh, D., & Choi, K. (2012a). Demographics, behavior problems, and psychosexual characteristics of adolescents with gender identity disorder or transvestic fetishism. *Journal of Sex & Marital Therapy, 38*(2), 151–189. https://doi.org/10.1080/0092623X.2011.611219

Zucker, K. J., Wood, H., Singh, D., & Bradley, S. J. (2012b). A developmental, biopsychosocial model for the treatment of children with gender identity disorder. *Journal of Homosexuality, 59*(3), 369–397. https://doi.org/10.1080/00918369.2012.653309

Sweden puts brakes on treatments for trans minors

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Stockholm (AFP) – **Sweden, the first country to introduce legal gender reassignment, has begun restricting gender reassignment hormone treatments for minors, as it, like many Western countries, grapples with the highly-sensitive issue.**

With the number of diagnoses soaring, the medical community faces the dilemma of weighing precaution against the risks associated with not offering treatment to those suffering from "gender dysphoria".

Sweden decided in February 2022 to halt hormone therapy for minors except in very rare cases, and in December, the National Board of Health and Welfare said mastectomies for teenage girls wanting to transition should be limited to a research setting.

"The uncertain state of knowledge calls for caution," Board department head Thomas Linden said in a statement in December.

So-called puberty blockers have been used in young teens contemplating gender transition to delay the onset of unwanted physical changes.

Like many other countries, Sweden has seen a sharp rise in cases of gender dysphoria, a condition where a person may experience distress as a result of a mismatch between their biological sex and the gender they identify as.

According to the Board of Health and Welfare, approximately 8,900 people were diagnosed with gender dysphoria in Sweden between 1998 and 2021, in a country of around 10 million.

In 2021 alone, about 820 new cases were registered.

The rising trend in gender dysphoria cases is particularly visible among 13- to 17-year-olds born female © Jonathan NACKSTRAND / AFP

The trend is particularly visible among 13- to 17-year-olds born female, with an increase of 1,500 percent since 2008.

"It used to be a male phenomenon and now there is a strong female over-representation," psychiatrist Mikael Landen, chief physician at Sahlgrenska University Hospital in Gothenburg, told AFP.

Landen, who contributed to the scientific study on which the Board of Health based its decision, said the reasons for this increase remain largely a "mystery".

"Tolerance has been high in Sweden for at least the last 25 years, so you can't say it has changed," he said when asked if it was simply a result of a more accepting society.

Western debate

The profile of those diagnosed is often complex, according to Linden, as gender dysphoria often occurs in those also suffering from other diagnoses, such as attention deficit and eating disorders or autism.

In May 2021 – before the Swedish authorities' decision to restrict gender reassignment hormone treatments – the prestigious Karolinska Hospital in Stockholm chose to restrict such hormone treatments to research projects only.

The prestigious Karolinska University Hospital near Stockholm began restricting gender reassignment hormone treatments before the government chose to do so © Jonathan NACKSTRAND / AFP

Other countries are weighing the same questions.

Neighbouring Finland took a similar decision in 2020, while France has called for "the utmost reserve" on hormone treatments for young people.

The UK meanwhile saw a high-profile court case in 2020.

Keira Bell, who regretted her transition from female to male, filed a complaint against the public body responsible for gender dysphoria treatments, claiming she had been too young at age 16 to consent to the treatments.

She ultimately lost her case.

Sweden's recent rollback is all the more notable as it was first in the world to authorise legal gender transition in 1972, paving the way for sex reassignment surgery to be covered by its universal healthcare system.

Rights groups have expressed concern.

Elias Fjellander, president of the youth branch of RFSL, the country's main organisation championing LGBTQ rights, says Sweden's decision risks leading to increased suffering.

"These people might need more care and invasive procedures in the future, because the decision could not be made earlier, even though the medical need was there," he said.

Twenty-year-old Antonia Lindholm, a trans woman who began her transition as a teenager, agreed.

"I think hormones save a lot of people," she told AFP.

"If I were 13 today, I wouldn't have a chance" of getting this treatment, Lindholm added.

Regret

But others who have had hormone treatment support the Swedish position.

Mikael Kruse, 36, changed his gender in his late 20s but had a change of heart and finally "detransitioned".

"I think it's good to take a break to understand what's going on," he told AFP.

For seven years, the Swede lived as a woman, but that never resolved his discomfort.

A new diagnosis revealed he had Asperger's Syndrome as well as Attention Deficit Disorder, and the suffering he thought was related to his gender was due to different factors.

"All the pieces of the puzzle fell into place," Kruse said.

For Carolina Jemsby, co-director of the Swedish documentary The Trans Train which brought the care of adolescents into the limelight in 2019, the current debate shows it is "more complex than the healthcare system and society had hoped".

"One aspect of this dilemma is that it has become a political issue," she told AFP.

"It does a disservice to this group who need scientifically proven medical care to help them and give them a better life, and a better ability to live who they are."

In 1972 Sweden introduced an act to allow people to legally change their gender thus becoming, according to the government, "the first country in the world to introduce a formal option in law to be assigned with a new legal gender".