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LETTER TO THE EDITOR

Rethinking the evidence base: a critical analysis of Joyner et al. on sex differences in sports performance

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TO THE EDITOR: We thank Joyner et al. (1) for contributing to the ongoing debate on sex-based differences in sports performance, particularly in the context of transgender women athletes. Their perspective synthesizes existing data on physiology, performance, and testosterone exposure to justify separate women's and men's elite competition in most sports. Joyner et al. (1) also aim to inform related policy considerations, particularly concerning the participation of transgender women (statement 6 in Ref. 1). However, we must address several conceptual and methodological oversights in the analysis presented in support of statement 6 that may mislead readers and policy-makers if left unchallenged.

MISCLASSIFICATION OF STUDY PARTICIPANTS AND MISUSE OF BMI

In statement 6, Joyner et al. (1) cite our study (2) as evidence that transgender women retain significant physical advantages following gender-affirming hormone therapy (GAHT), while also misclassifying the participants as "overweight/obese XY athletes" based solely on body mass index (BMI) (26.2 ± 6.2 kg/m^2) (3). This characterization is factually inaccurate given that BMI is a measure with recognized limitations in athletic populations, as it often overestimates adiposity in individuals with higher lean mass (4). Research by Canda (5) indicated that as many as 72% of athletes may be inaccurately classified as obese when evaluated solely by BMI. Besides, athletic body composition is influenced by "morphological optimization" strategies specific to sport and position (6, 7), meaning BMI variation across athlete cohorts does not reliably indicate performance capacity or fat mass distribution.

OVERSIMPLIFIED CLAIMS OF PERFORMANCE RETENTION POST-GAHT

The claim that transgender women retain male-like performance advantages post-GAHT is based on the flawed assumption that transgender women begin their transitions at performance levels equivalent to cisgender men. This is not supported by existing evidence (Table 1). For example, Van Caenegem et al. (8) found that sedentary transgender women had lower areal and volumetric bone mineral density; forearm and calf muscle cross-sectional area; lean body mass and grip strength; greater fat mass, calf and forearm fat cross-sectional area compared with cisgender men even before starting GAHT. Wiik et al. (10) found that isometric torque and muscle volume levels were below cisgender men at baseline. Similarly, Chiccarelli et al. (9) reported that pre-GAHT transgender women in the US Air Force (49.9 ± 10 push-ups) performed below cisgender males (54 ± 9) and well above cisgender females (30 ± 10), indicating that performance levels are distinct across all three groups. These data undermine the argument that transgender women should be considered equivalent to cisgender men, even before hormone suppression. This nuance is critical for accurate interpretation.

RELATIVE VERSUS ABSOLUTE PERFORMANCE: A MISLEADING EMPHASIS

Joyner et al. (1) present absolute strength and physiological measures while ignoring relative values, despite relative measures having been presented in the cited papers. Concerning statement 6, Hamilton et al. (2) found that, once adjusted for muscle mass, there is no statistically significant difference in the handgrip strength and lower body power of transgender and cisgender women athletes and that transgender women perform more poorly in tests of lung function, jump height, and relative maximal oxygen uptake ($\dot{V}O_{2max}$). Similarly, Alvarez et al. (11, 12) found no difference in the relative cardiopulmonary capacity and mean strength of transgender and cisgender women nonathletes and a second study (13) from the same authors on volleyball athletes concurred with Hamilton et al.'s (2, 14) findings of lower relative to fat-free mass jump height and handgrip strength. Presenting both relative and absolute values is important since the former are often more relevant in athletic contexts. Gregory et al. (15) demonstrated

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Table 1. *Comparison between cisgender men and transgender women pre-GAHT*

	Metric	Cis Men, Means ± SD	Trans Women (Pre-GAHT), Means ± SD
Sedentary (8)	Numbers	49	49
	Bone area, cm^2	2,340 ± 150	2,258 ± 181
	BMC, g	2,823 ± 375	2,466 ± 362
	Forearm muscle CSA, mm^2	4,512 ± 579	3,999 ± 746
	Calf muscle CSA, mm^2	8,233 ± 1,498	7,742 ± 1,361
	Lean body mass, kg	61.3 ± 6.8	57.4 ± 8.7
	Fat body mass, kg	14.1 ± 5.7	14.9 ± 6.6
	Grip strength, N/kg	49 ± 6	42 ± 9
US Air Force (9)	Numbers	NA	146
	Push-ups	54 ± 9	49.9 ± 10
	Fitness score	90.9	90.1

BMC, bone mineral content; CSA, cross-sectional area; GAHT, gender-affirming hormone therapy.

that relative performance variables, such as $\dot{V}O_{2max}$ and $\dot{V}O_{2peak}$ power, correlated more strongly with race performance than absolute measures. Andersen et al. (16) found similar results in female soccer players, where relative lower-body strength better predicted agility and sprint performance than absolute strength. Importantly, we previously reported that the relative performance metrics of a transgender female athlete aligned with those of cisgender women after 6 mo of GAHT, despite the athlete maintaining higher absolute values (14).

OVERRELIANCE ON MUSCLE MEMORY THEORY

Joyner et al. (1) cite muscle memory as a mechanism for retained advantage in transgender women. However, human evidence remains inconclusive. Pataky et al. (17) showed that sex hormone levels, not chromosomes, primarily dictate muscle gene expression. Psilander et al. (18) found no change in myonuclei during periods of training, detraining, or retraining, whereas Snijders et al. (19) demonstrated that muscle hypertrophy gains in older adults are lost within 1 yr of detraining. These findings cast doubt on the permanence of male pubertal muscle adaptations after testosterone suppression. Although Joyner et al. (1) may ultimately be correct in suggesting that muscle memory contributes to retained advantages in transgender women athletes, it is important not to prejudge the field. Our research group and others remain active in this research area (20, 21), but the current evidence remains insufficient to draw definitive conclusions. Ongoing research is essential to clarify the long-term impact of prior testosterone exposure on muscle characteristics.

SELECTIVE INTERPRETATION OF EVIDENCE

Joyner et al. (1) present evidence from "case studies of real-world performances, systematic reviews, and cross-sectional studies of physical performance." However, their review appears to selectively present the literature, omitting several relevant studies that provide a more comprehensive understanding of transgender athletes' performance. For example, Alvares et al. (13) found comparable performance and biomarker profiles between transgender and cisgender women volleyball players, yet these findings are absent from Joyner et al.'s synthesis. Similarly, Cheung et al. (22) reported no significant differences in relative percentage lean mass, fat mass, hemoglobin levels, or $\dot{V}O_2$peak between transgender and cisgender women, but this evidence is not acknowledged. Furthermore, a longitudinal study by Harper (23) reported a 14.9 ± 6.0% increase in post-GAHT race time among nine transgender women runners (23), which is higher than the average differences in outdoor running performance between cisgender women and men according to Joyner et al. (1) (9.5%–12.3%). The omission of these findings reflects a pattern of selective evidence inclusion that risks reinforcing confirmation bias and promoting a singular narrative, rather than fostering a balanced and comprehensive scientific discussion.

CONCLUSIONS

Although thoughtful commentaries have value, research on transgender athlete performance is currently marked by an abundance of opinion and a lack of original research and data. Many strong claims are made without robust empirical evidence. Although Joyner et al. (1) aim to provide an important physiological perspective on the topic, their conclusions depend heavily on a selective and decontextualized representation of data, along with theoretical mechanisms that have yet to be empirically validated in the relevant populations. In a policy environment where the stakes are high, claims must be rooted in comprehensive, balanced, and methodologically rigorous science, not merely scholarly opinion. We advocate for a shift toward more collaborative, interdisciplinary research that directly addresses the physiological realities of athletic performance across diverse populations, including transgender and differences of sex development (DSDs) athletes.

DISCLOSURES

Y.P. is a member of the International Olympic Committee (IOC) Medical and Scientific Commission, which recently published articles and framework documents on the topic. All authors have recently published articles on the topic on behalf of various organizations such as the IOC and the International Federation of Sports Medicine (FIMS). None of the other authors has any conflicts of interests, financial or otherwise, to disclose.

AUTHOR CONTRIBUTIONS

K.H. and Y.P. drafted manuscript; K.H., B.R.H., M.P., and Y.P. edited and revised manuscript; K.H., B.R.H., M.P., and Y.P. approved final version of manuscript.

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