



Normative Force Production Values for Men's and Women's Power Five Division I Sports

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Introduction

- The isometric mid-thigh pull (IMTP) has become increasingly popular as an assessment tool to quantify maximal and explosive strength (Stone et al., 2019) in both a research and practitioner setting.
- While IMTP normative data exists for certain collegiate sports and other populations, normative data has not yet been established for a range of collegiate sports.
- To our knowledge, no published data on collegiate gymnasts, swimmers, or divers exists, while published data on collegiate volleyball players, wrestlers, track & field athletes, weightlifters, and baseball players are scarce (Kavanaugh et al., 2018; Suchomel et al., 2020; Hornsby et al., 2013; Haff et al., 2005; McGuigan et al., 2006; Painter et al., 2012).
- Established normative force characteristic data, such as maximal strength, relative strength, and explosive strength, can assist practitioners in assessing the developmental level of the athlete to subsequently provide appropriate training for the betterment of the athlete.
- There is a need for larger IMTP datasets to establish stabilized normative data (Piovesana & Senior, 2018; Bridges & Holler, 2007), which is what these data will provide.

Methodology

Subjects: Eighty-two female (67.6 ± 9.3 kg) and ninety-two male (84.6 ± 13.3 kg) collegiate athletes participated in this study. Sport breakdown is shown in *Figure 1*.

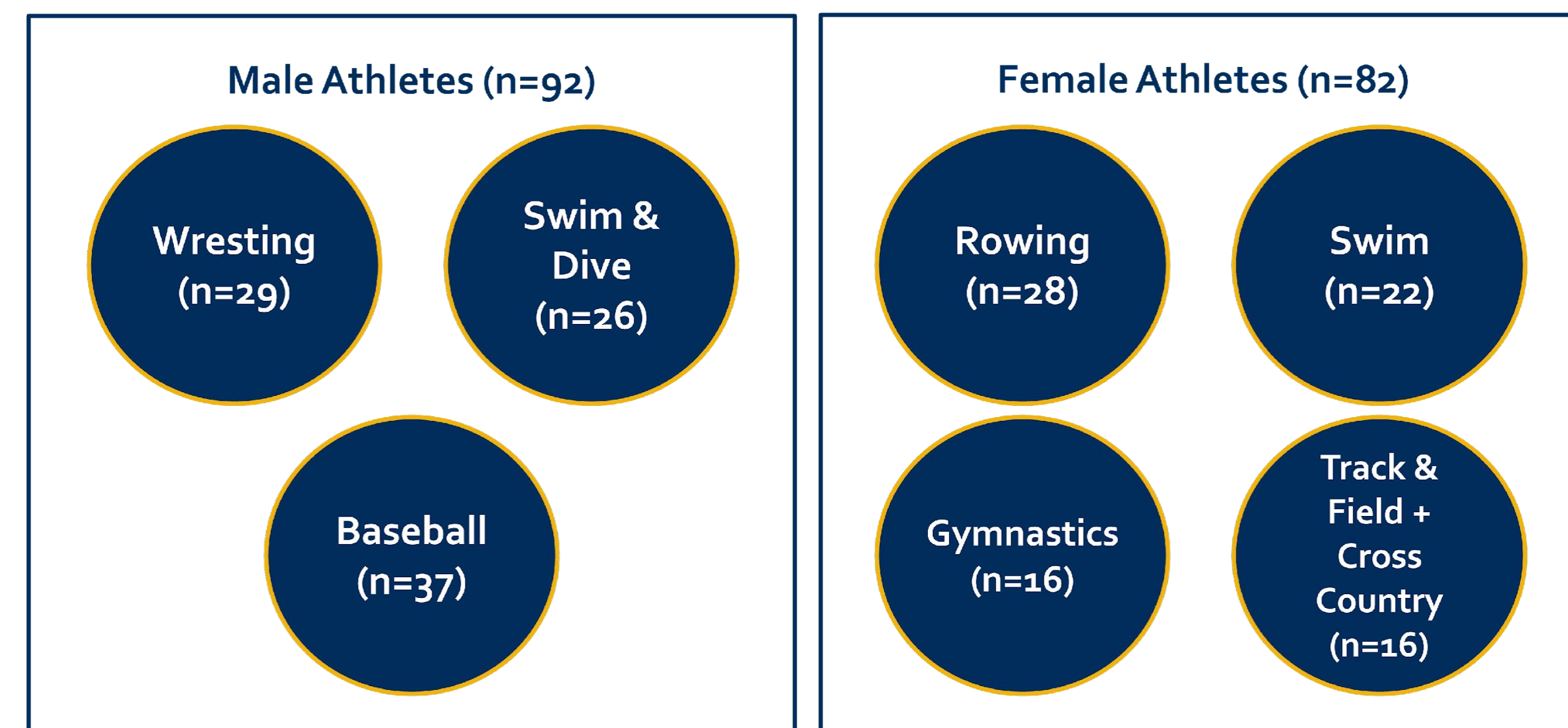


Figure 1. Breakdown of participants across sex and sport team.

Testing Procedure & Statistics

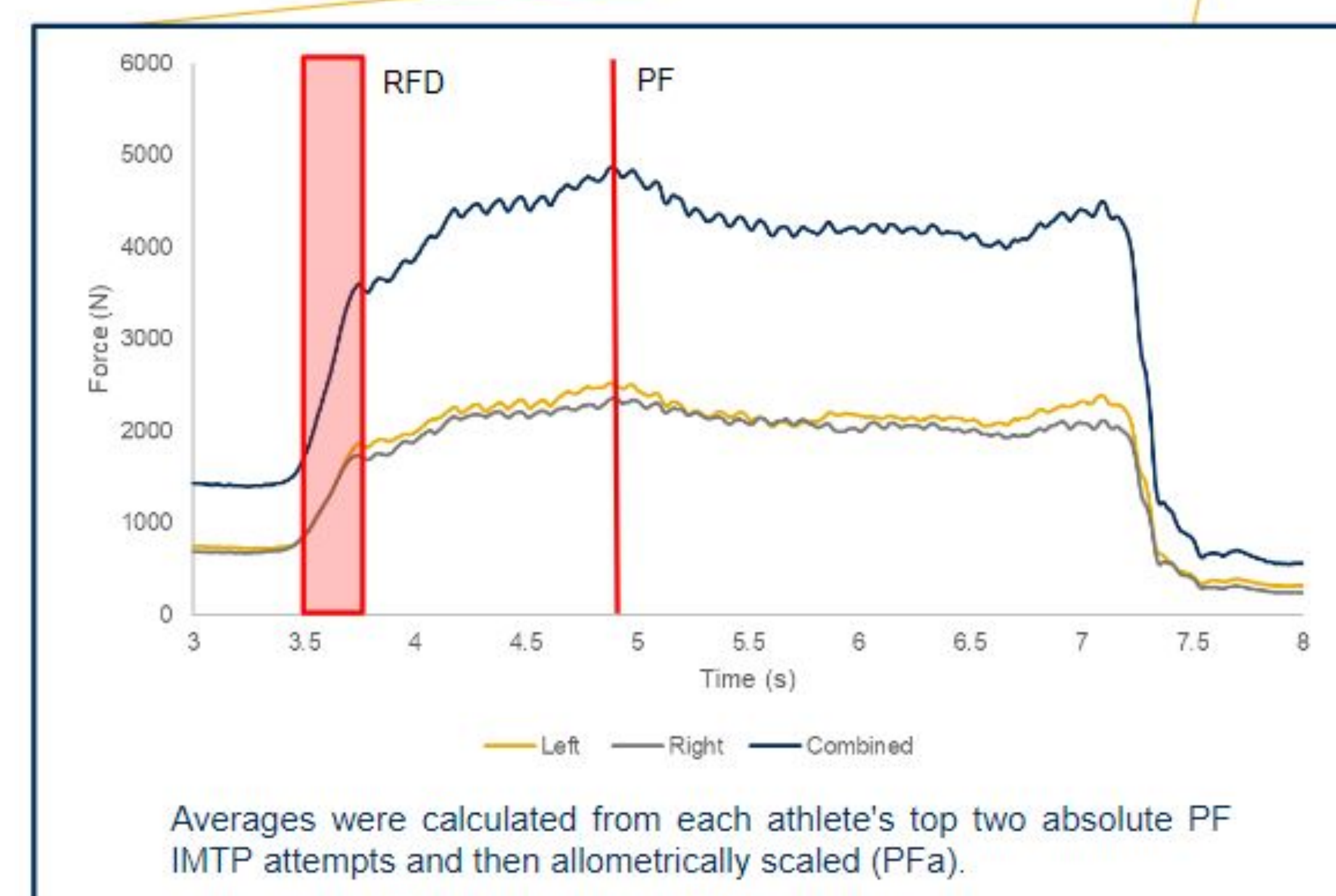
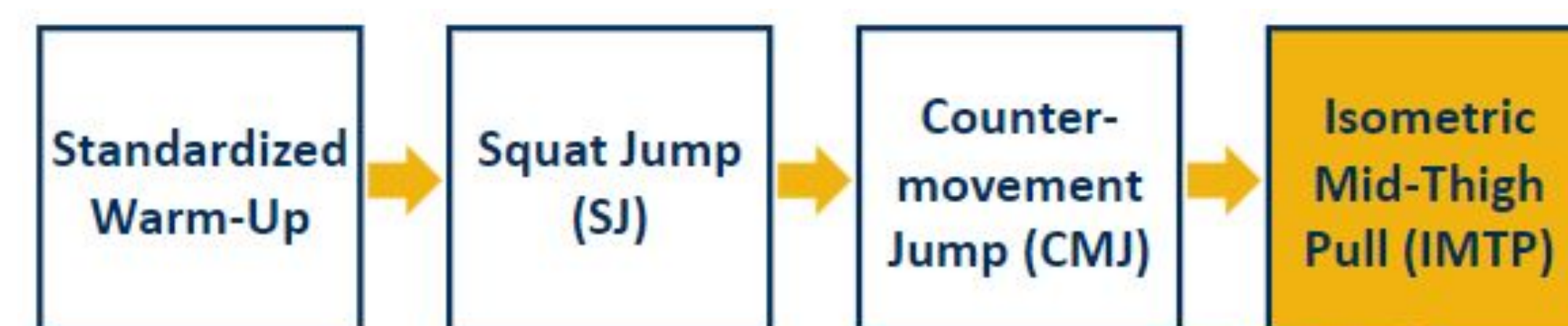


Figure 2. Sequence of testing battery and force-time plot. The yellow box indicates the data used here (IMTP). The graph depicts a force-time plot and the metrics computed. PF = peak force; PFa = peak force, allometrically scaled; RFD = rate of force development, 0-250 ms.

Results

- Mean values of PFa and RFD are reported by distribution (*Figure 3*) and mean (*Figure 4*).
- The sample meets all sample size recommendations per the skewness coefficient following guidelines in Piovesana and Senior (2018), reported in *Table 1*.
- There is a significant difference between male athletes and female athletes in PFa (220.0 ± 32.2 N/(kg^{2/3}) vs. 158.3 ± 26.8 N/(kg^{2/3}), respectively; p<0.05) and RFD (6980.1 ± 1953.6 N/s vs. 4380.8 ± 1327.7 N/s, respectively; p<0.05).
- Pairwise comparisons between sports of the same sex resulted in six significant differences between groups out of 18 comparisons: W-SWIM / W-ROW (PFa, p=0.049), W-SWIM / W-GYM (RFD, p=0.041), M-SD / M-WREST (PFa, p=0.031; RFD, p<0.01), and M-SD / M-BASE (PFa, p<0.01; RFD, p<0.01).

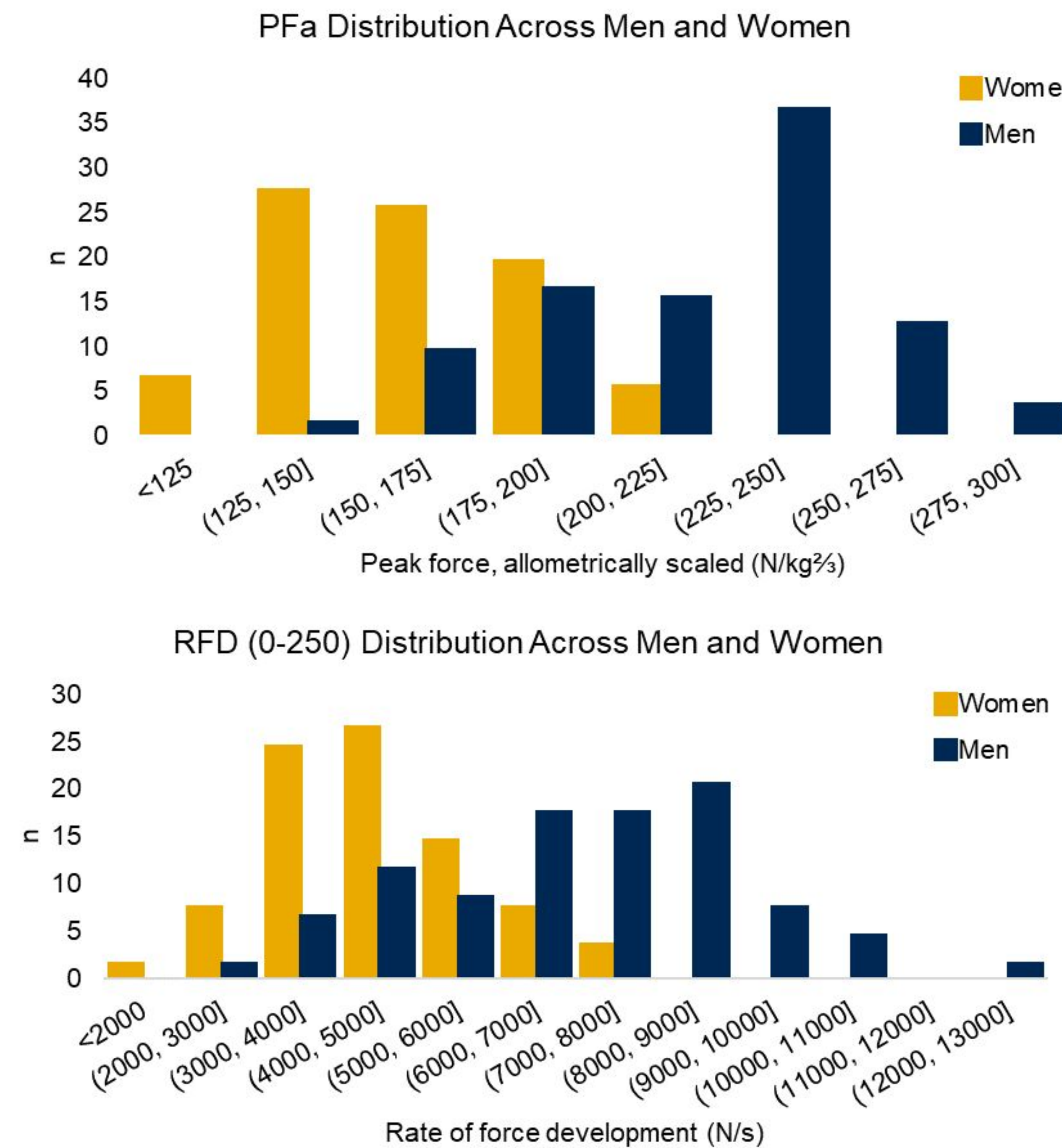


Figure 3. Distribution of PFa (top) and RFD (bottom) across sex.

	Male		Female	
	Skewness Statistic	Recommended Sample Size	Skewness Statistic	Recommended Sample Size
Mean PF	-0.24	66.9	0.56	79.3
Mean PFa	-0.43	64.7	0.06	71.0
Mean RFD	-0.11	68.6	0.37	76.2

Table 1. Sample size recommendations for each metric, by sex, per the guidelines and equations outlined in Piovesana and Senior (2018).

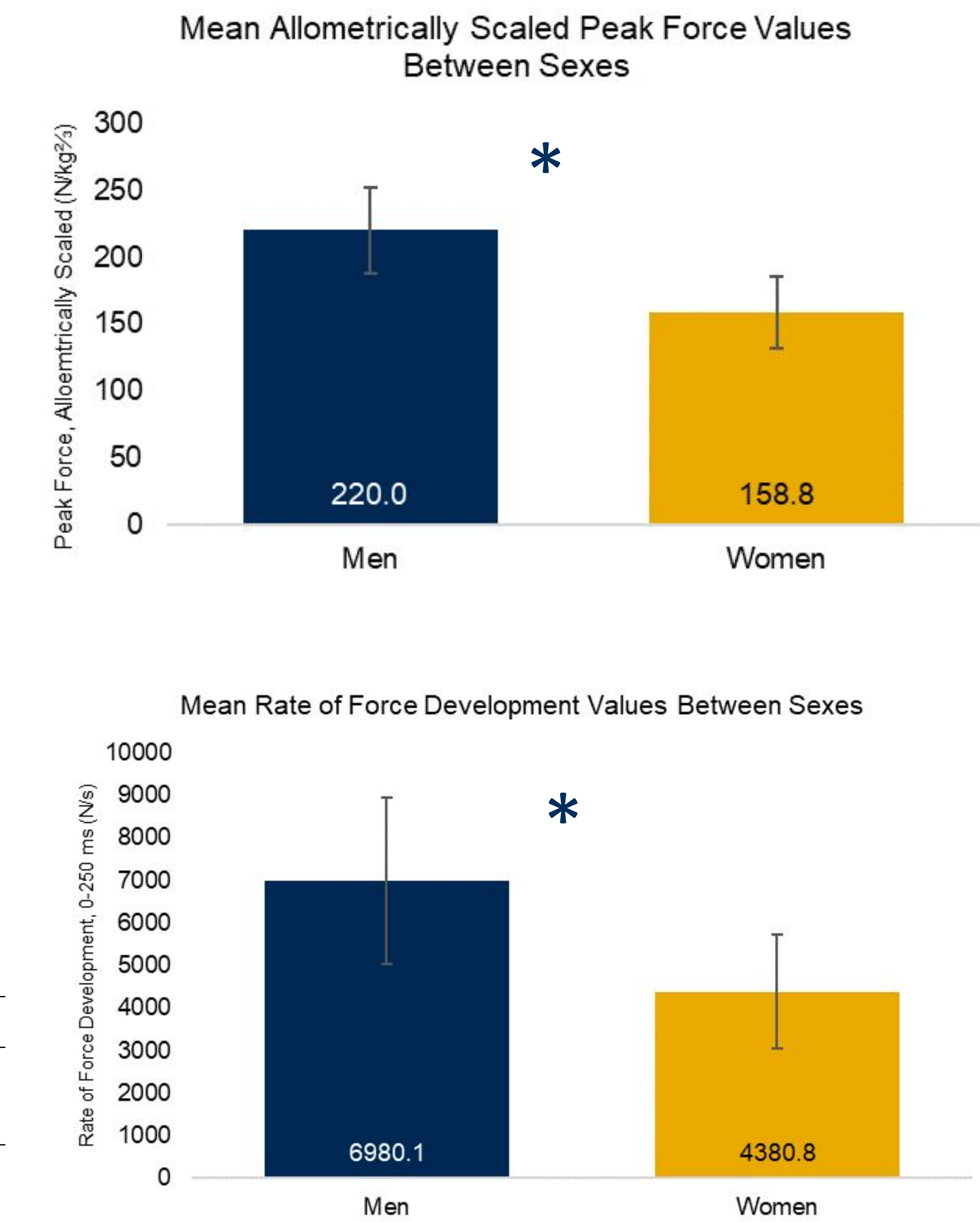


Figure 4. Mean PFa (top) and RFD (bottom) values across sex. The asterisk indicates significance.

Discussion

To our knowledge, this is the largest dataset of Division I Power 5 NCAA level athletes (n=174), as well the greatest number of sports obtained in a single study (n=7). Perhaps unsurprisingly, a wide range of average PFa and RFD values were observed across sex and sport. Primary findings include:

- 1) Males were significantly stronger and more powerful than females across all sports.
- 2) Few differences were significant when comparing average force production metrics across sports within the same sex – six comparisons between sports of the same sex were significantly different out of 18 total pairwise comparisons of PFa and RFD.
- 3) These data meet the standard outlined in Piovesana & Senior (2018) in which the data can be used with confidence as normative data in its respective population (Power Five Division 1 collegiate athletes).

Differences in maximal strength and explosive strength exist between men and women, however within sex (male or female) substantial overlap exists between various sports. Within the same population, values were similar to other studies that have reported IMTP values, such as Suchomel et al. (2020) and Merrigan et al. (2021).



Figure 5. Isometric mid-thigh pull with Kairos rack.

Practical Applications

This study provides a normative data set of mean- and standard-deviation-stabilized force production characteristics in NCAA Power Five Division I student-athletes. A better understanding of force generating capabilities in specific sport population groups can aid sport coaches and strength coaches in assessing and developing their athletes during their collegiate athletic careers. Based on these data, beyond separating for sex, coaches may look to set strength goals and expectations more broadly instead of having different goals for individual sports.

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