

Grip Matters: Grip Variations Affect Chain-Based IMTP Peak Force in Youth Athletes

A Randomized Crossover Study



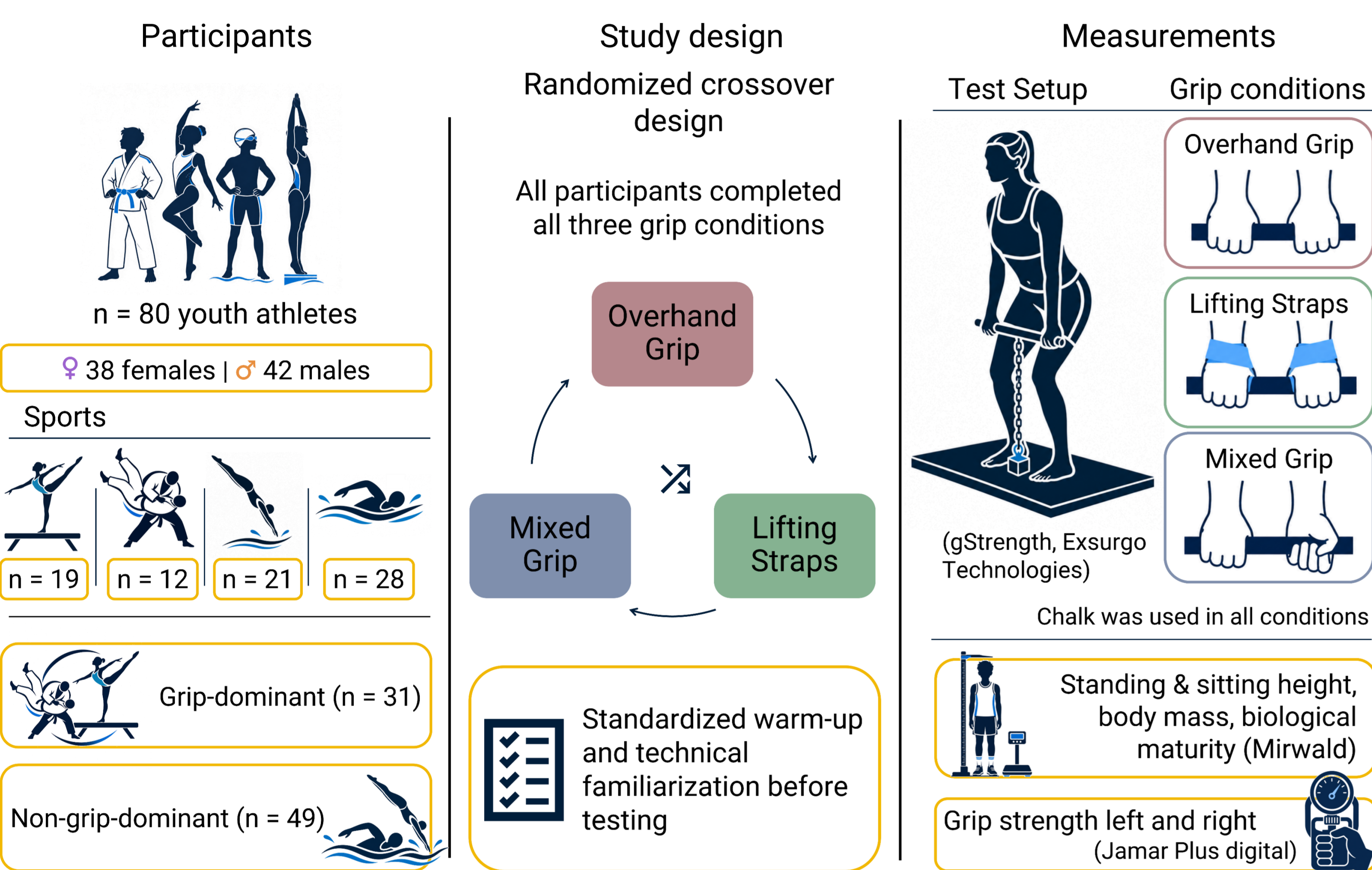
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INTRODUCTION and PURPOSE

The isometric mid-thigh pull (IMTP) is a reliable and time-efficient method for assessing maximal isometric force. However, peak force output may be constrained by grip strength or grip condition, particularly in youth athletes and athletes from sports with limited hand-grip demands. Although lifting straps and grip type can influence IMTP peak force, existing evidence is largely limited to adult or sport-specific samples [1-3]. In youth field-testing, lifting straps may be impractical, and it remains unclear whether a mixed grip offers a feasible alternative without additional equipment.

This study compares peak force during a chain-based IMTP across three grip conditions: overhand grip, mixed grip, and overhand grip with lifting straps in youth athletes.

METHODS



Statistics: Peak force was analyzed using linear mixed models with participant ID as random effect. Grip condition was the primary fixed effect; sex, age, body mass, grip dominance, and grip strength were included as covariates. Pairwise comparisons were adjusted (Holm).

RESULTS

The study included 80 youth athletes aged 12.5 ± 1.1 years. Female and male participants showed similar anthropometric characteristics (Table 1).

Table 1. Anthropometric measures

Descriptive statistics	All Athletes		Grip-dominant		Non-grip-dominant	
	Females	Males	Females	Males	Females	Males
n	38	42	10	21	28	21
Age [yrs]	12.4 ± 1.1	12.5 ± 1.1	12.4 ± 0.7	12.8 ± 1.1	12.5 ± 1.1	12.2 ± 1.0
Body Mass [kg]	44.4 ± 9.0	45.9 ± 9.3	46.6 ± 11.7	42.5 ± 9.4	43.7 ± 8.3	49.2 ± 8.0
Standing Height [cm]	153.1 ± 9.8	158.3 ± 12.0	160.5 ± 3.7	164.7 ± 12.0	150.5 ± 9.9	152.0 ± 8.2
Sitting Height [cm]	79.5 ± 5.7	81.8 ± 6.1	83.5 ± 2.7	84.9 ± 6.4	78.1 ± 5.8	78.9 ± 4.1
Grip Strength Left [kg]	26.4 ± 5.8	29.2 ± 6.8	27.6 ± 6.8	29.8 ± 7.1	26.0 ± 5.6	28.5 ± 6.4
Grip Strength Right [kg]	28.1 ± 6.0	30.1 ± 6.1	29.6 ± 7.7	29.6 ± 6.3	27.6 ± 5.5	30.4 ± 5.8
Hip-Joint-Angle [°]	132.8 ± 5.7	134.5 ± 5.3	135.3 ± 6.2	134.4 ± 5.6	131.9 ± 5.1	134.5 ± 5.0
Knee-Joint-Angle [°]	141.6 ± 6.7	145.4 ± 6.7	138.0 ± 6.0	145.8 ± 6.6	142.9 ± 6.4	145.1 ± 6.9

Grip condition significantly affected IMTP peak force. Adjusted mean peak force was lowest with overhand grip (1012 N), higher with mixed grip (1360 N), and highest with lifting straps (1428 N) (Figure 1A). Compared with overhand grip, peak force was substantially greater with lifting straps (+416.9 N, $p < 0.001$, $d = 2.49$) and mixed grip (+348.1 N, $p < 0.001$, $d = 2.08$). Lifting straps also produced slightly higher peak force than mixed grip (+68.8 N, $p = 0.01$, $d = 0.41$) (Figure 1B). **Total handgrip strength (sum of grip strength left and right) significantly predicted IMTP peak force** ($p < 0.001$), corresponding to an increase of ~14 N per 1 kg greater total handgrip strength (Figure 1C). The grip condition × grip strength interaction was not significant ($p = 0.266$). Sex showed a trend toward higher adjusted peak force in males ($p = 0.052$), whereas body mass, grip dominance, and biological age were not significant predictors.

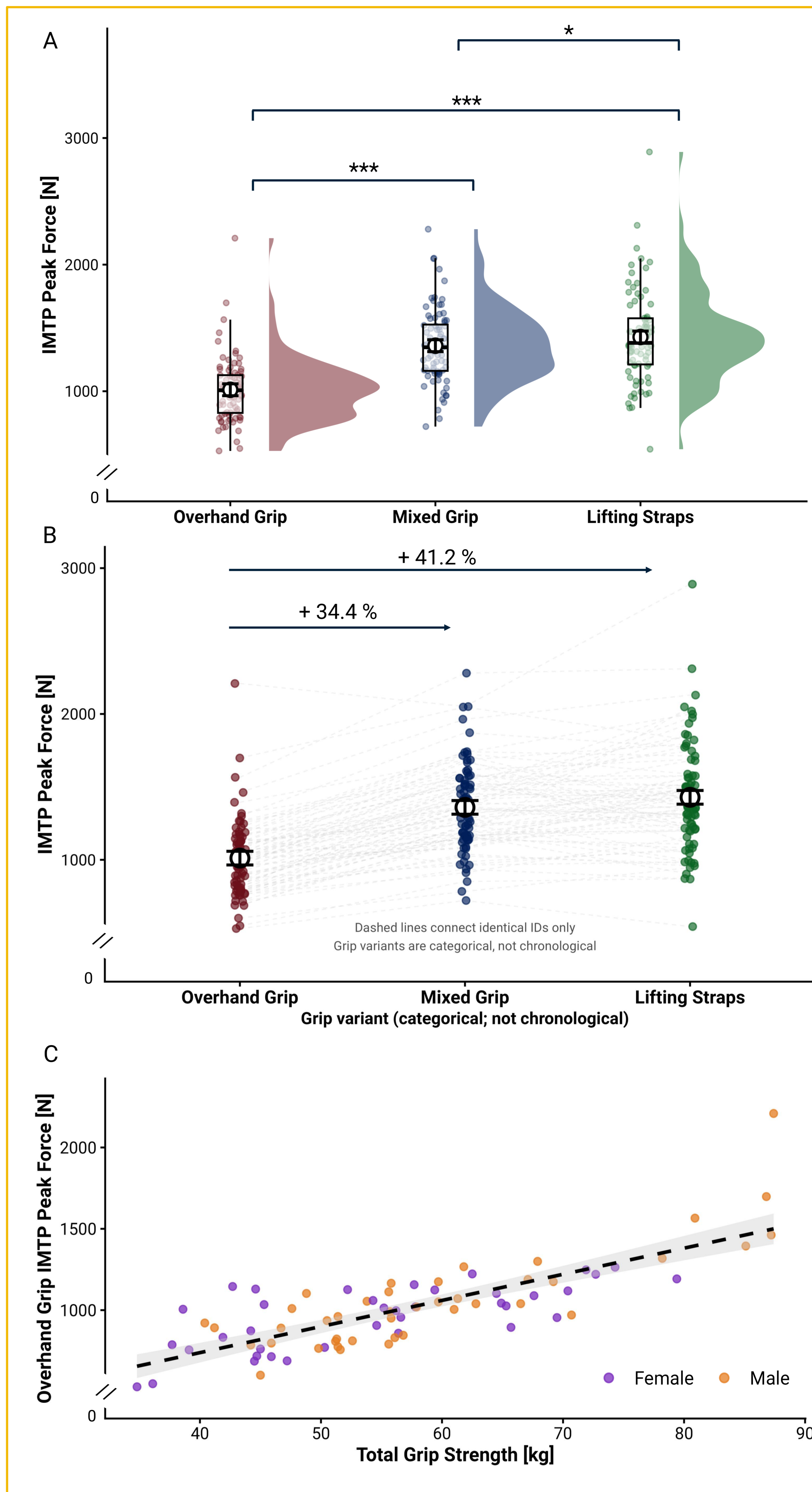
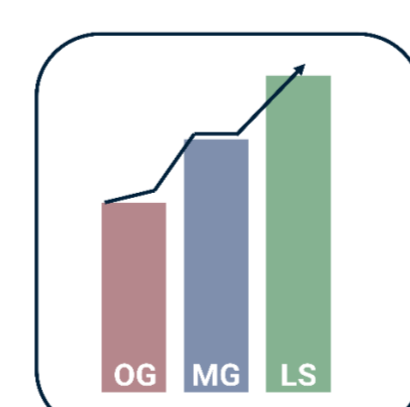


Figure 1. Grip condition and grip strength effects on IMTP peak force. A: adjusted means; B: individual responses; C: association with total grip strength.

CONCLUSION and PRACTICAL IMPLICATIONS



Interpretation

- Grip condition strongly affects achievable IMTP peak force in youth athletes



Practical application

- Use lifting straps when standardized maximal force assessment is the priority
- Mixed grip may serve as a practical alternative in field settings not requiring the handling of additional equipment
- Consider using chalk to minimize grip-strength effects across grip variations



Conclusion

- Overhand grip should not be used when the aim is to assess maximal IMTP peak force

[1] Elkins, E. A. (2020). Effect of lifting straps on peak force during an isometric mid-thigh pull.

[2] Prajongjai, V., Pramkratok, W., & Vongchaisub, T. (2023). Influence of grip type on peak force during isometric mid-thigh pull and its relationship with hand grip strength in elite badminton players. Journal of Physical Education and Sport.

[3] Rhodes, D., Jeffery, J., Carling, C., Mawéné, Y., & Alexander, J. (2022). The association between grip strength and isometric mid-thigh pull performance in elite footballers. Science & Sports.

