

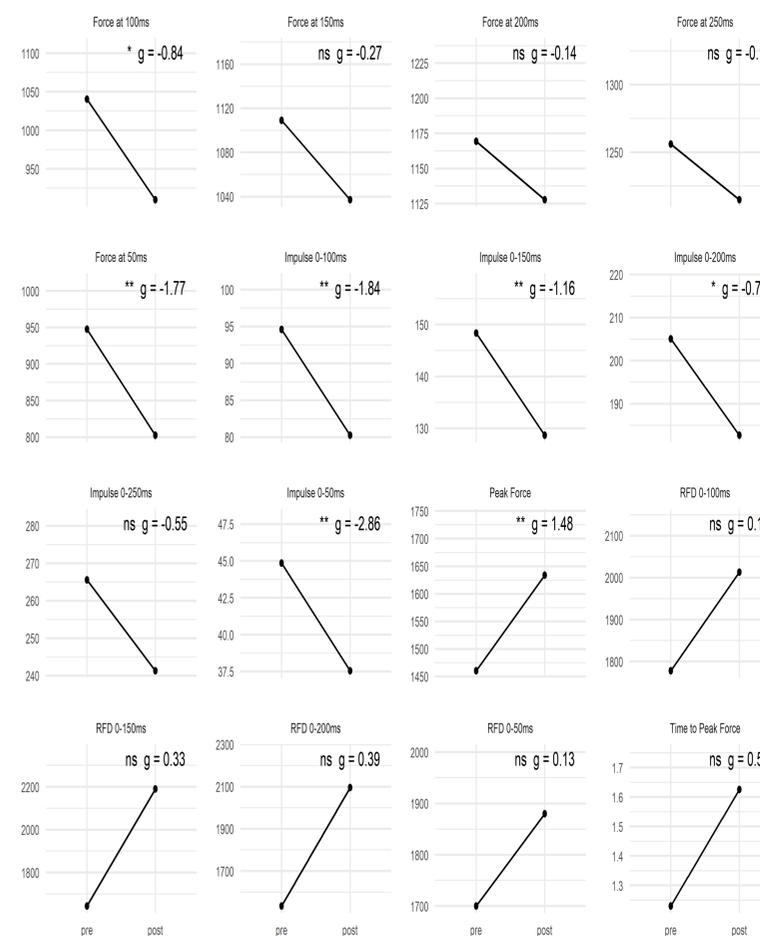
INTRODUCTION & PURPOSE

The demand for a golf swing often includes optimal strength and power development. While resistance training specifically designed for golf athletes exists, the effect of such programs on key golf metrics, such as clubhead speed, remains largely unknown. One method for assessing lower-body muscular strength and power is the isometric mid-thigh pull (IMTP) test, which has demonstrated a significant correlation with general muscular strength and power in athletic populations (1). Previous research has investigated IMTP force-time characteristics in professional and high-level amateur female golf athletes, but not in the collegiate female population (2, 3). Thus, **the purpose of the present study is to assess changes in the isometric muscular strength characteristics of female collegiate golf athletes following an off-season resistance training program.**

METHODS & MATERIALS

- Ten National Collegiate Athletic Association (NCAA) Division-II female golf athletes ($\bar{x} \pm SD$; height=164.85±7.33cm; body mass=65.27±8.91kg) participated in the present investigation.
- Athletes performed 2-4 IMTP on a dual force plate system (Hawkin Dynamics, Westbrook, ME).
- The vertical ground reaction force of the best trial IMTP was analyzed.
- All athletes performed the IMTP test at two time points (before and after the resistance training program).
- A series of Wilcoxon Signed-Rank Tests were performed on selected variables to detect changes. Effect sizes were calculated using Hedge's *g* (Figure 1).

An offseason resistance training program improved IMTP force-time metrics. Metrics such as **peak force** and **RFD** captured from **IMTPs** using **force plates** are metrics of interest for practitioners to track progress in training programs.



* $p < .05$, ** $p < .01$, *** $p < .001$, ns = not significant

Figure 1. Line plots depicting changes in IMTP force-time metrics before and after an off-season resistance training program in collegiate golf athletes.



Figure 2. A female collegiate golf athlete swinging the golf club during competition.

Table 1. Mean±SD for IMTP force-time Metrics before and after resistance training programs; * significant increases ($p < 0.05$); # significant decreases ($p < 0.05$).

Metric	Pre	Post	<i>p</i>
Peak Force	1460.6 ± 216.6	1634.0 ± 251.1*	0.002
Force at 50ms	947.6 ± 110.5	802.6 ± 122.0#	0.004
Force at 100ms	1040.4 ± 128.8	909.9 ± 183.1#	0.037
Force at 150ms	1109.0 ± 149.8	1037.1 ± 275.3	0.275
Force at 200ms	1169.4 ± 165.1	1127.7 ± 265.7	0.557
Force at 250ms	1256.1 ± 184.8	1214.8 ± 215.2	0.557
Impulse 0-50ms	44.9 ± 4.7	37.6 ± 5.0#	0.002
Impulse 0-100ms	94.6 ± 10.3	80.3 ± 12.3#	0.002
Impulse 0-150ms	148.4 ± 17.2	128.7 ± 22.8#	0.010
Impulse 0-200ms	205.1 ± 24.6	182.7 ± 35.7#	0.037
Impulse 0-250ms	265.6 ± 32.7	241.3 ± 47.6	0.084
RFD 0-50ms	1700.0 ± 1020.4	1880.0 ± 1115.1	0.557
RFD 0-100ms	1778.0 ± 784.7	2013.0 ± 1212.2	0.695
RFD 0-150ms	1642.7 ± 654.3	2190.0 ± 1503.5	0.492
RFD 0-200ms	1534.0 ± 642.9	2095.5 ± 1122.1	0.375
Time to Peak Force	1.2 ± 0.6	1.6 ± 0.6	0.160

RESULTS

- Significant improvement: Peak force ($p = 0.005$)
- Significant decrease: Force at 50ms and 100ms ($p = 0.007 - 0.037$), and all impulse from 0ms to 200ms ($p = 0.005 - 0.037$)
- No significant changes: Rate of force development (RFD) ($p > 0.14$), force at 150ms to 250ms ($p > 0.24$), impulse between 0 - 250ms ($p = 0.074$), and time to peak force ($p = 0.14$)

CONCLUSIONS

- Off-season resistance training programs can significantly improve muscular strength within golf populations.
- Although no significant improvement was detected in RFD metrics in this cohort of golf athletes, this quality can be developed during the pre-season phase with a focus on explosive, ballistic, and plyometric exercises once adequate levels of muscular strength have been achieved.

PRACTICAL APPLICATIONS

The findings of the present investigation demonstrated the benefits of an off-season resistance training program for golf athletes. Future research should utilize the findings of the current investigation to examine the relationship between resistance training program characteristics, improvements in measures of athleticism, and golf-specific key performance indicators such as club head speed.

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References

- Stone, M. H., O'Bryant, H. S., Hornsby, G., Cunanan, A., Mizuguchi, S., Suarez, D. G., South, M., Marsh, D. J., Haff, G. G., Ramsey, M. W., Beckham, G. K., Santana, H. A. P., Wagle, J. P., Stone, M. E., & Pierce, K. C. (2019). Using the isometric mid-thigh pull in the monitoring of weightlifters: 25+ years of experience. *Professional Strength & Conditioning*, 15(4), 19-26
- Brennan, A., Murray, A., Coughlan, D., Wells, J., Xu, J., Turner, A., Brearley, S., & Bishop, C. (2024). Associations and Within-Group Differences in Physical Characteristics and Golf Performance Data in High-Level Amateur Players. *Applied Sciences*, 14(5).
- obinson, L., Murray, A., Glover, D., Coughlan, D., Mountjoy, M., Scott, F., Turner, A., & Bishop, C. (2025). Associations Between Physical Performance and Golf Shot Data: A Pilot Study of Touring Professional Female Players. *Journal of strength and conditioning research*, 39(6), 687-694.