THE EFFECT OF A 12-WEEK HIIT PROTOCOL ON ISOKINETIC STRENGTH AND MUSCLE ACTIVATION IN OLDER MEN AND WOMEN

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Introduction

- By 2050, there will be an estimated 84 million adults aged 65 or above.[1]
- Increased atrophy of skeletal muscle associated with aging leads to a decline in the ability to complete activities of daily living (ADL's), increased risk of falling, and loss of independence.[2]
- Resistance training can be beneficial in combating the ill effects of aging.
- High intensity, higher velocity resistance training has shown improvements in muscle power, which has a higher correlation to fall prevention than muscle strength alone.[3]
- High-intensity interval training (HIIT) is a form of exercise that requires less time and has greater health benefits compared to low- and moderate-intensity exercise.[3,4]
- Additionally, incorporation of explosive movements into HIIT training protocols may lead to greater improvements in gait speed and overall mobility in older adults.

Therefore, the purpose of this study was to evaluate the impact of high intensity interval training (HIIT) on lower body isokinetic muscle strength and muscle activation in older men and women.

Methods

HIIT Protocol: 15 older adult volunteers (Female: n=7, age=74.14 ± 8.03 yrs, height=1.64 ±0.04 m, weight=74.82 ± 13.38 kg; Male: n=8, Age=76.75 ± 6.04, Height=1.77 ± 0.07 m, Weight=84.94 ± 14.55 kg) completed 12-weeks of total body (TB) HIIT program (resistance exercise, agility, circuit, and bike training) consisting of three sessions per week (35-40 min; nonconsecutive days). Work-to-rest ratios were increased from weeks 1-4 (20-sec:40-sec exercise to rest) to weeks 5-8 (30 -sec:30-sec exercise to rest), and to weeks 9-12 (40 -sec:20 -sec exercise to rest). Each participant was instructed to maintain 85%-95% maximum heart rate throughout the study monitored by heart rate monitors.

Training Component	Specific Exercises and Resistance	Time
Warm-up	Stationary bike/dynamic mobility	5-7 Minutes
Circuit HIIT: 1-minute training blocks 1 set of each exercise	• Squats (30% of e1RM) • Medicine ball forward chest throw (5% of BW) • Medicine ball overhead throw (5% of BW) • Farmers walk (walking with dumbbell in each hand) (20% of BW) • Seated shoulder press (30% of e1RM) • Seated row sitting on fitness ball (30% of BW) • Aerobic riser step ups • Foot ladder drills* • Twisting medicine ball pass**	Weeks 1-4 (20:40, exercise:rest, seconds) Weeks 5-8 (30:30, exercise:rest, seconds) Weeks 9-12 (40:20, exercise:rest, seconds) Total Time: 7-9 Minutes
2-minute rest break		
Repeat of Circuit HIIT: 1-minute training blocks 1 set of each exercise	Same as above	Same as above
Bike HIIT	Total body (push, pull, and pedal) all-out intervals on the Assault Airbike	Same as circuit HIIT
Cool Down	Stretching and relaxation exercises	4-5 Minutes

BW = Body weight, e1RM – estimated 1RM
*Exercises introduced at 5 weeks
**Exercises introduced at 9 weeks

Table 1. HIIT Outline

Isokinetic Testing: Isokinetic torque and muscle activation variables were assessed at Pre-, Mid- (week 6), and Post TB-HIIT protocol. During the testing sessions, participants performed 3 maximal isokinetic knee extensions at 180°/s using a 90° range of motion. Surface electromyography (sEMG) of the vastus lateralis (VL) and rectus femoris (RF) were recorded and the peak sEMG (pEMG; mV) was obtained for each contraction. The sEMG signal was normalized to pEMG and the rate of muscle activation (RER; % pEMG·s^{-1}) was calculated as the highest 10 ms peak from the rectified, derivative signal after muscle activation onset for both RF (RFRER50) and VL (VLRER50). Participants were instructed to kick out "as hard and as fast as possible throughout the entire range of motion". Peak isokinetic torque (pTQ) for each contraction was analyzed as the highest mean torque value for any 25ms epoch during the load range and averaged between contractions.

Results

Paired sample t-tests were conducted to examine pre- to post-intervention changes in peak torque and electromyographic (EMG) activity across multiple muscle-related variables: pTQ, VLRER50, VLpEMG, RFRER50, and RFpEMG. The analysis revealed a non-significant increase in pTQ ($t(9) = -1.76$, $p = 0.101$; Pre=103.46 ± 27.70 Nm/s vs. Post=116.72 ± 10.37Nm/s), with a mean increase of 13.25 Nm (95% CI: -29.44, 2.93). VLpEMG activity showed no significant change ($t(9) = -1.34$, $p = 0.202$; Pre=1.79 ± 0.48 mV vs. Post=2.22 ± 1.12 mV), with a mean increase of 0.43 mV (95% CI: -1.12, 0.26). However, significant increases were observed in RFRER50 ($t(9) = -2.38$, $p = 0.034$; Pre=0.063 ± 0.025 % pEMG·s^{-1} vs. Post=0.096 ± 0.047 % pEMG·s^{-1}) and RFpEMG ($t(9) = -2.87$, $p = 0.012$; Pre=0.23 ± 0.063 mV vs. Post=0.30 ± 0.082 mV), with mean increases of 0.036 and 0.069, respectively. VLRER50 was not statistically significant ($t(9) = -1.77$, $p = 0.098$, 95% CI: -0.041, 0.004; Pre=0.068 ± 0.038 % pEMG·s^{-1} vs. Post=0.087 ± 0.046 % pEMG·s^{-1}).

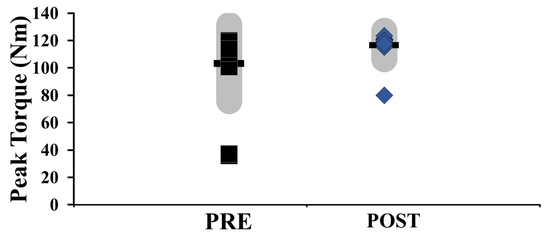

Figure 2. Differences between PRE and POST in pTQ.

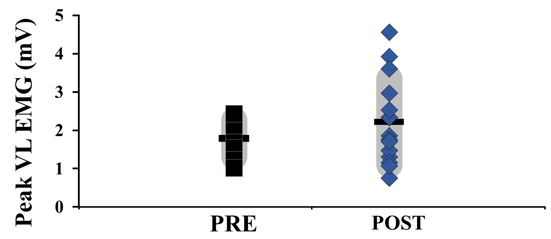

Figure 3. Differences between PRE and POST in VL pEMG.

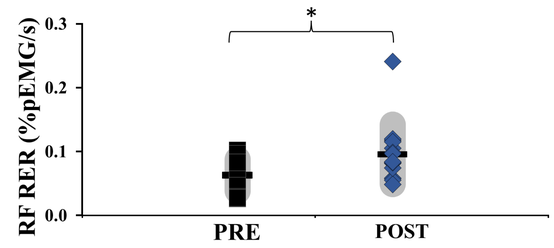

Figure 4. Differences between PRE and POST in RFRER50 (%pEMG/s). * = Significant increase (p≤0.05)

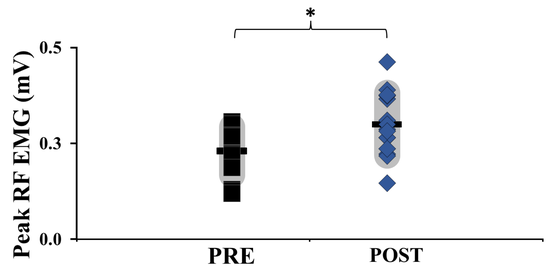

Figure 5. Differences between PRE and POST in RF pEMG. * = Significant increase (p≤0.05)

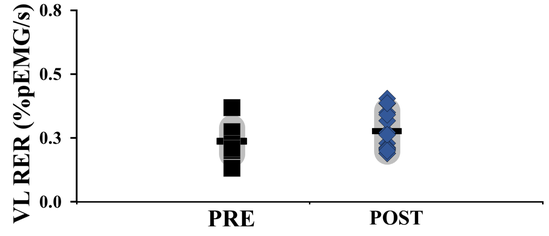

Figure 6. Differences between PRE and POST in VLRER50 (%pEMG/s).

Conclusions

The data indicates increased neuromuscular activation following the intervention with confidence intervals suggesting a statistically reliable effect on rectus femoris EMG activity and activation (RFRER50). Although the VLRER50 was not significantly improved, the confidence interval suggests that the observed increase in neuromuscular recruitment may be meaningful but requires further investigation. Collectively, the study indicates potential improvements in neuromuscular function and muscle activation post-HIIT intervention.

Practical Applications

Muscular atrophy and reduced muscular function due to aging is linked to reduced mobility, slower movement speeds, and lower maximum strength. Improved muscle activation patterns observed following the HIIT intervention may provide the adaptations for quicker and more powerful muscular responses necessary to prevent falls.[2] HIIT interventions may also lead to an improved ability to complete activities of daily living and increase independence for individuals in the elderly population.

References

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[2] Weston KS, Wisløff U, Coombes JS. High-intensity interval training in patients with lifestyle-induced cardiometabolic disease: a systematic review and meta-analysis. *Br J Sports Med*. 2014;48(16):1227-1234. doi: 10.1136/bjsports-2013-092576 [doi].
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