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Influence of exercise intensity on the tendon mechanical properties of older individuals

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Background: Approximately one-third of people aged over 65 fall at least once a year and about half of these do so recurrently. The ability to maintain balance or stability has previously been associated with lower limb tendon structural and mechanical properties, with stiffer tendon structures associated with increased balance ability (Onambele et al., 2006: Journal of Applied Physiology, 100, 2048–2056). Increased tendon compliance is not an irreversible ageing effect. It has been shown that following 14 weeks high intensity resistance training (~80% one repetition maximum (1RM)), tendon stiffness was increased in an elderly population (Reeves et al., 2003: Journal of Physiology, 548, 971–981). However, the majority of resistance exercise prescribed for an elderly population is of lower intensity than 80% 1RM. It is possible that this lower intensity resistance exercise does not produce the required stimulus for tendon adaptation.

Purpose: To determine and compare the effects of low and high intensity exercise training programmes on tendon mechanical properties in an elderly population.

Methods: Following ethical approval from the local research ethics committee and informed consent, 17 older adults were randomly assigned to either low (LowR, ie. ~40%1RM) or high (High R, ie ~80%1RM) intensity resistance training programmes for 12 weeks (LowR, n = 9, age 74 ± 5 years, height 1.64 ± 0.08m, mass 71.3 ± 10.9kg; HighR, n = 8 age 68 ± 6 years, height 1.64 ± 0.07m, mass 73.5 ± 12.1kg). Participants completed a whole-body training regimen three times per week. The mechanical and structural properties of the patellar tendon (stiffness (K), Young's Modulus (σ), cross sectional area (CSA) and tendon length (L)) were measured prior to and post training using a combination of Magnetic Resonance Imaging (MRI), B-mode ultrasonography, dynamometry, electromyography and ramped isometric knee extensions. Wilcoxon tests were performed to determine the effects of the interventions and a Mann-Whitney test was used to compare the interventions effects, significance was set to $P \leq 0.05$.

Results: Following the 12 weeks training K at 100% maximal voluntary contraction increased by 6.6% (P = 0.374, effect size 0.161) in the LowR group and 57.7% (P = 0.025, effect size 1.295) in the HighR group (see figure 1 for values). When comparing these effects between the groups the HighR group demonstrated a 51.1% greater increase in tendon K than the LowR group (P = 0.021, effect size 1.041). These differences were still apparent when the data was normalized for CSA and L with the calculation of σ (Pre-post differences of 2.0% (P ¼ 0.953, effect size 0.050) and 57.9% (P ¼ 0.036, effect size 1.253) for the LowR and highR groups respectively, and 55.9%(P = 0.021, effect size 1.270) greater increases in HighR compared to LowR).

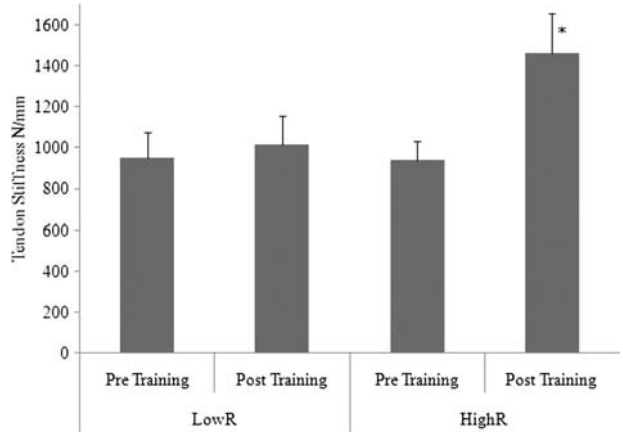

Figure 1. Tendon stiffness at 100% MVC, pre and post training for LowR and HighR training groups. Data are mean + s, * indicates significantly greater than pre values.

Discussion: In agreement with previous research high intensity resistance training brought about increases in tendon K in the elderly population; however, such adaptations were not apparent following lower intensity resistance training. This observation is novel and is in line with the theory that there is a threshold intensity level for the exercise induced changes in the mechanical properties of tendon tissue.

Conclusion: The results suggest that when prescribing exercise for an elderly population, in order to induce changes in the mechanical properties of tendon an intensity of 40%1RM or less is not sufficient. However, higher intensity exercise can bring about beneficial adaptations and should therefore be recommended.