THE VELOCITY OF STRETCH-SHORTENING CYCLES DURING A CHRONIC EXPOSURE AFFECTS MUSCLE PERFORMANCE DIFFERENTIALLY WITH AGE

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INTRODUCTION

The age distribution of the workforce in the United States is predicted to shift to older workers (Bureau of Labor Statistics, 1999). Indeed, the 55-64 year old demographic is now the fastest growing sector of the labor force in the United States. Senescent-related changes in strength and skeletal muscle mass have been studied previously (Evans et al., 1993); however, changes in functional performance and muscle plasticity with resistance training in aged-populations are not fully understood. An effective and physiologically relevant means to study muscle function and adaptation to physical loading is via stretch-shortening cycles (SSCs). Natural muscle function during locomotion, daily lifting tasks, and sports are comprised of SSCs (reciprocal concentric and eccentric muscle actions). SSCs have been studied in the context of human locomotion and athletic performance (Komi, 2000) and have been shown to produce muscle injury due to the eccentric component of the cycle. However, the effect of age on the ability to adapt to a chronic exposure of SSCs, and how age affects performance during different SSC velocities has not been studied. We hypothesized age negatively affects the ability to adapt to repetitive exposures of SSCs, and performance is most affected during higher velocity SSCs.

METHODS

All testing was performed on male Fischer Brown Norway Hybrid rats (F344 x BN F1, N = 11) obtained from the National Institutes on Aging colony. Young adult (N=6, 330g ± 28 g SD, 12 weeks of age) and old (N= 5, 588g ± 32 g SD, 30 months) rats were housed in an AAALAC accredited animal quarters. All testing was performed on a custom-designed rat dynamometer (Cutlip et al., 1997). The response of the dorsiflexor muscles to isometric and stretch-shortening contractions (SSC) were quantified *in vivo*. Young and old rats underwent exposure to 8 sets of 10 SSCs, 3 times/week, for 4.5 weeks duration. Performance was assessed by pre and post isometric testing and dynamic muscle function testing via a single SSC (Table 1). The sets of SSCs were performed at an angular velocity of 60°/s from 90° to 140° ankle angle for a total of 80 SSC (see Table 1). There was a 2 minute rest period between steps in the experimental protocol to minimize fatigue.

Table 1. Experimental Protocol

Step	Young (N=6)	Old (N=5)
1	Isometric Test (90 deg)	Isometric Test (90 deg)
2	1 Stretch-Shortening Contraction **70°-140°-70° ankle angle @ 500 deg/s**	1 Stretch-Shortening Contraction **70°-140°-70° ankle angle @ 500 deg/s**
3	8 sets of 10 intermittent Stretch-Shortening Contractions at **90°-140°-90° ankle angle @ 60 deg/s**	8 sets of 10 intermittent Stretch-Shortening Contractions at **90°-140°-90° ankle angle @ 60 deg/s**
4	Isometric Test (90 deg)	Isometric Test (90 deg)
5	1 Stretch-Shortening Contraction **70°-140°-70° ankle angle @ 500 deg/s**	1 Stretch-Shortening Contraction **70°-140°-70° ankle angle @ 500 deg/s**

The performance parameters used to evaluate the force changes were: 1) peak force (i.e, the maximum force achieved in the eccentric contraction), 2) minimum force (i.e. the force value prior to the eccentric contraction), negative work (eccentric work), and positive work (concentric work). These parameters were generated from the pre-test SSC (step 2) and the first SSC of the 8 sets (step 3) at each exposure.

RESULTS AND DISCUSSION

The peak force (@ 500 °/s) of the young group improved over the 4.5 week exposure while the old group declined. The 60 °/s performance was lower for both groups (Fig 1). The isometric pre-stretch force increased for the young group and decreased for the old group during the chronic exposure (Fig 2). Negative work increased for the young group and decreased for the old group (@ 500 °/s) but was lower and did not change over the exposure period for the 60 °/s performance (Fig 3). Positive work also showed the same trends as the negative work (Fig 4).

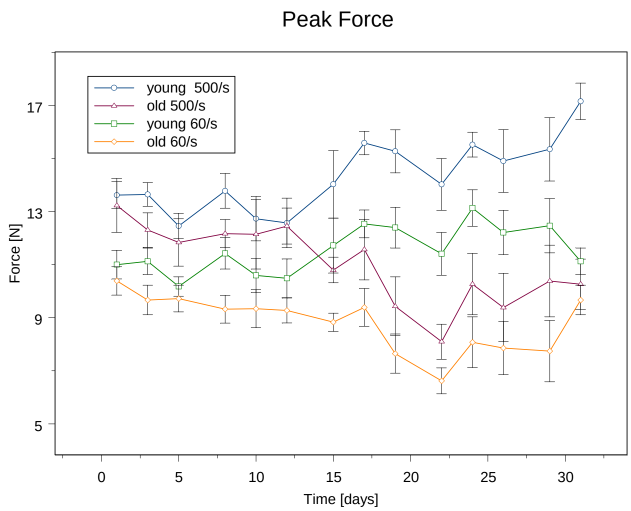

Figure 1: Peak Eccentric Force

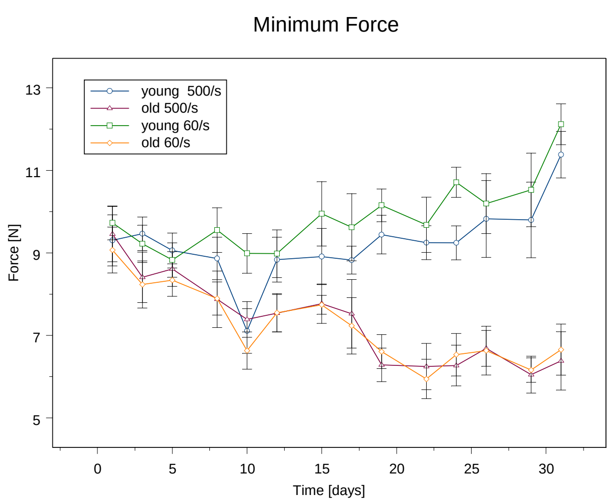

Figure 2: Isometric Pre-stretch force

SUMMARY

The performance differences between age groups and during the chronic exposure period was much more magnified during higher velocity SSCs. This indicates that high velocity performance is a more sensitive measure of changes in muscle function than low velocity performance.

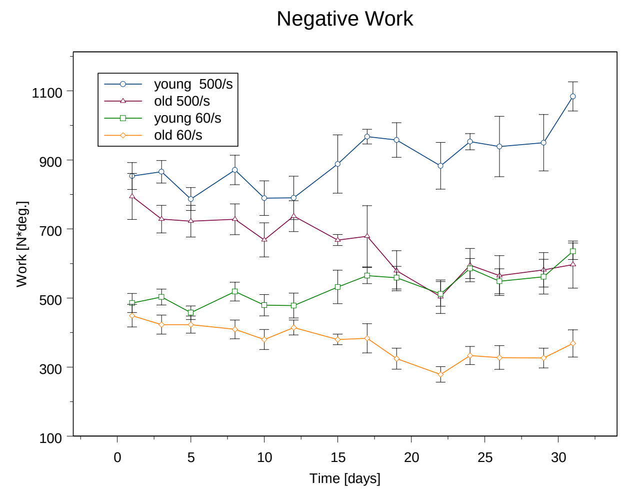

Figure 3: Negative Work

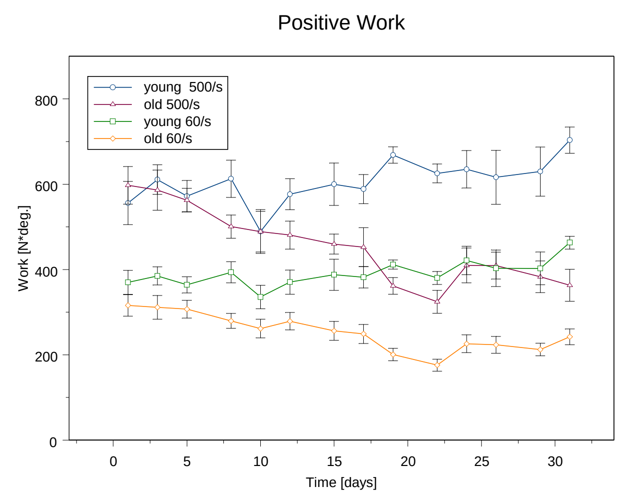

Figure 4: Positive Work

DISCLAIMER

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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