When stress is good: Exercise and stress protein responses in mice and humans

Heather Sue Thompson, *University of Massachusetts Amherst*

Abstract

Eccentric contractions promote short- and long-term adaptations in skeletal muscle proteins, but little is known of molecular alterations associated with these changes. The present work investigated adaptations particular to eccentrically-biased exercise by evaluating mRNA and protein expression of three heat shock proteins (HSP25, HSC70 and HSP70) in both a murine and human model. ^ In the first model, untrained murine biceps brachii were examined following a single 15 minute bout of either uphill (+15°) or downhill (−15°) running. Uphill running elicited several mRNA changes but only one detected protein increase of HSP70 (3-fold) at 12 and 24 hours post-exercise (PX) and a significant decrease in HSP25 during exercise and at 6 hours PX. In contrast, downhill running also prompted significant mRNA changes as well as HSP70 protein accumulation (ranging from 2- to 5-fold) at 0.5, 1, 12, 48 hours and 1 week PX; HSP25 expression increased significantly at 24 hours and 1 week PX. HSC70, which is thought to be non-inducible, exhibited both short and long-term changes in abundance after downhill running, with significant increases in expression (also ranging from 2- to 5-fold) at 1, 24 and 72 hours as well as 1, 4 and 12 weeks PX. ^ In the human model for eccentric exercise, untrained subjects performed 50 high-force eccentric contractions with their non-dominant biceps brachii (BB) and ran downhill (−10°) for 30 minutes. The 48-hour PX stress response was evaluated with immunoblotting and RT-PCR of material obtained in muscle biopsies. On the protein level, HSP27 and HSP70 abundance increased significantly PX in the BB (383% and 226% respectively; $p < 0.01$, but there were no significant HSP changes in the vastus lateralis (VL). The RT-PCR data supported these findings: BB HSP27 and HSP70C mRNA levels increased (135% and 128% respectively; $p < 0.05$); HSP70B increased in the VL only (206%; $p < 0.05$). ^ In sum, a single bout of eccentrically-biased exercise elicits short- and long-term adaptations in the inducible expression of stress proteins HSP70 and HSP25 as well as constitutive proteins like HSC70. Further, these data indicate that HSP responses are exercise-specific and the consistently larger HSP response in the exercise with the most eccentric nature suggests that these molecules may be important to long-term skeletal muscle adaptations such as hypertrophy. ^

Subject Area

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