Effects of Hypobaric and Normobaric Hypoxia on Myogenic and Proteolytic Gene Expression in Humans

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ABSTRACT

Current research suggests that physiological responses to hypobaric and normobaric hypoxia may be different. It is unknown if these differences extend to skeletal muscle and the transcriptional responses regulating muscle mass. **PURPOSE:** To determine the effects of hypobaric and normobaric hypoxia on myogenenic and proteolytic gene expression. **METHODS:** Recreationally trained subjects (n= 15; age= 24 ± 4 y; VO_{2max}= 3.60 ± 0.83 L · min^{-1}) completed three trials of 60-min cycling at 70% of W_{max} followed by 4-h recovery at ambient conditions (975 m), hypobaric hypoxia (4,420 m), and normobaric hypoxia (4,420 m). A muscle biopsy was taken from the *vastus lateralis* before exercise and at the end of the 4-h recovery period in each trial for gene expression analysis (RT-qPCR). **RESULTS:** There were no differences in the myogenic gene expression of MYOD, MYF-5, or MYOG between trials (p > 0.05). MYF-6 was higher after exercise (p = 0.002) regardless of trial. MSTN decreased pre- to post-exercise in all conditions (p < 0.001) and was lower in hypobaric hypoxia compared to control (p = 0.02) and normobaric conditions (p = 0.037). There were no differences in the expression of atrogin-1 with exercise or between trials (p > 0.05). However, FOXO3 and MuRF-1 increased with exercise (p < 0.05) but were not different between conditions (p > 0.05). CONCLUSION: These data indicate that hypobaric and normobaric hypoxia during recovery from exercise does not affect myogenic and proteolytic gene expression with the exception of a modest attenuation of myostatin in hypobaric hypoxia.

INTRODUCTION

- It is well known that prolonged stays at altitude will decrease body mass.
- This decline is attributed to an increase in basal metabolic rates, reduction of food intake, impairments in protein synthesis, and potential changes in gene expression from hypoxia.
- Recent literature suggests simulating high altitude through normobaric hypoxia is physiologically different from hypobaric hypoxia.
- It is unknown, however, if these differences extend to the cellular level within skeletal muscle tissue.
- Myogenic and proteolytic responses to these different forms of hypoxia may give insight into potential physiological differences.
- The purpose of this research was to determine the differences in key myogenic and proteolytic gene expression between hypobaric and normobaric hypoxia after acute, aerobic exercise.

METHODS

- 8 recreationally trained male and 7 recreationally trained female subjects completed 3 trials in a randomized, counter-balanced order.
- Subjects cycled for 1 h on an electronically braked cycle ergometer (Velotron, RacerMate, Seattle, WA) followed by 4 hours of recovery at simulated altitudes.
- Recovery altitudes consisted of ambient conditions (975 m), hypobaric hypoxia (4,420 m), and normobaric hypoxia (4,420 m).
- Participants rested supine in an altitude tube (Engineering Innovations, LLC, Littleton, CO) capable of lowering the barometric pressure.
- The altitude tube was located inside a hypoxic chamber (Tescor, Warminster, PA) capable of lowering the percentage of oxygen in the air.
- Muscle biopsies were taken from the *vastus lateralis* before exercise and after each recovery period for analyses of myogenic and proteolytic gene expression.

RESULTS

Table 1. Participant descriptive data (n = 15)

Age (y)	Height (cm)	Weight (kg)	Body Fat (%)	VO_2 Peak (L · min^{-1})
24 ± 4	178 ± 12	72.47 ± 13.84	14 ± 7	3.6 ± 0.8

Data are mean ± SD.

RESULTS

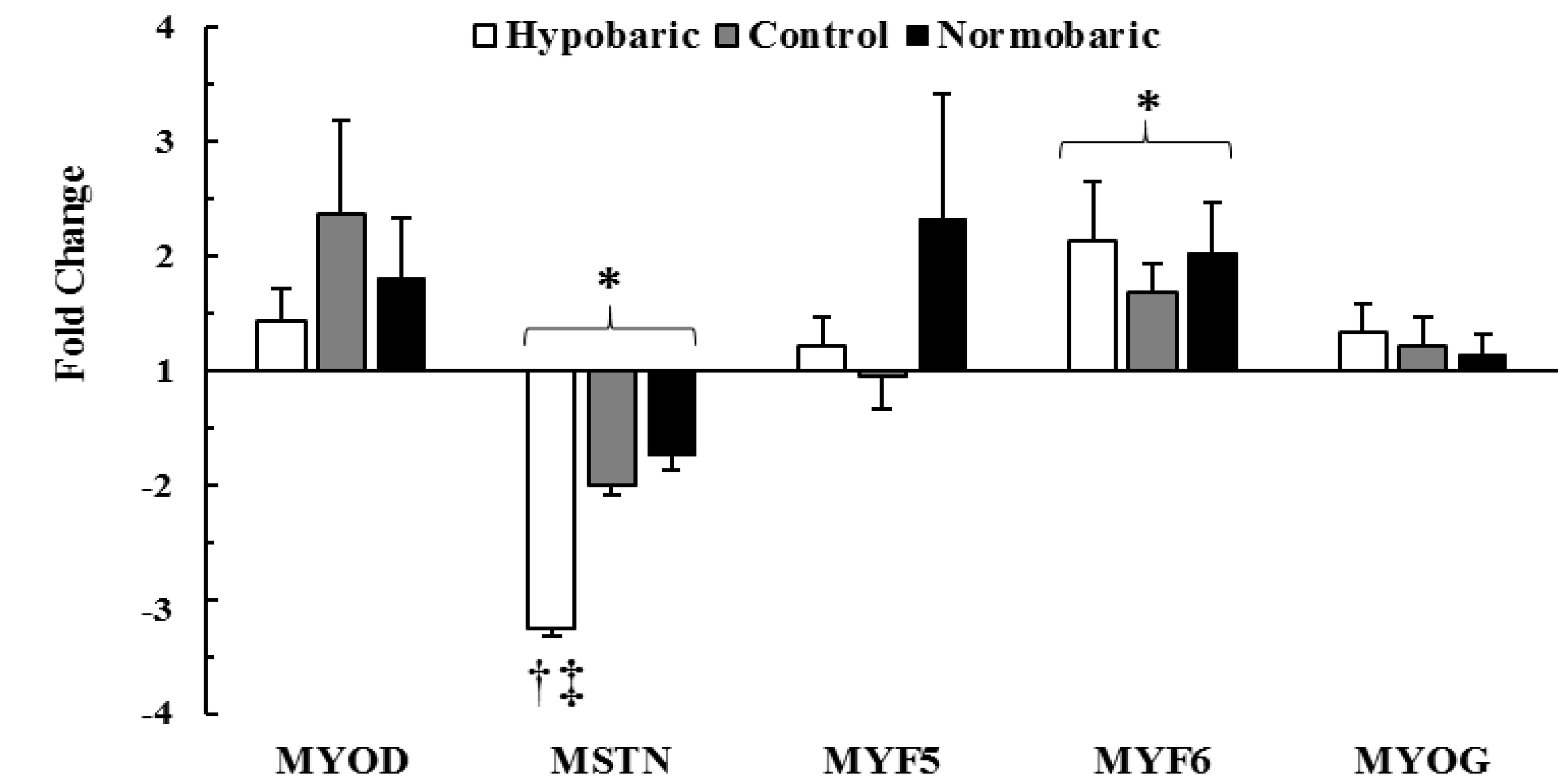

Figure 1. Myogenic gene expression. Data are mean ± SE. *$p < 0.05$ from pre-exercise. †$p < 0.05$ from control. ‡$p < 0.05$ from Normobaric.

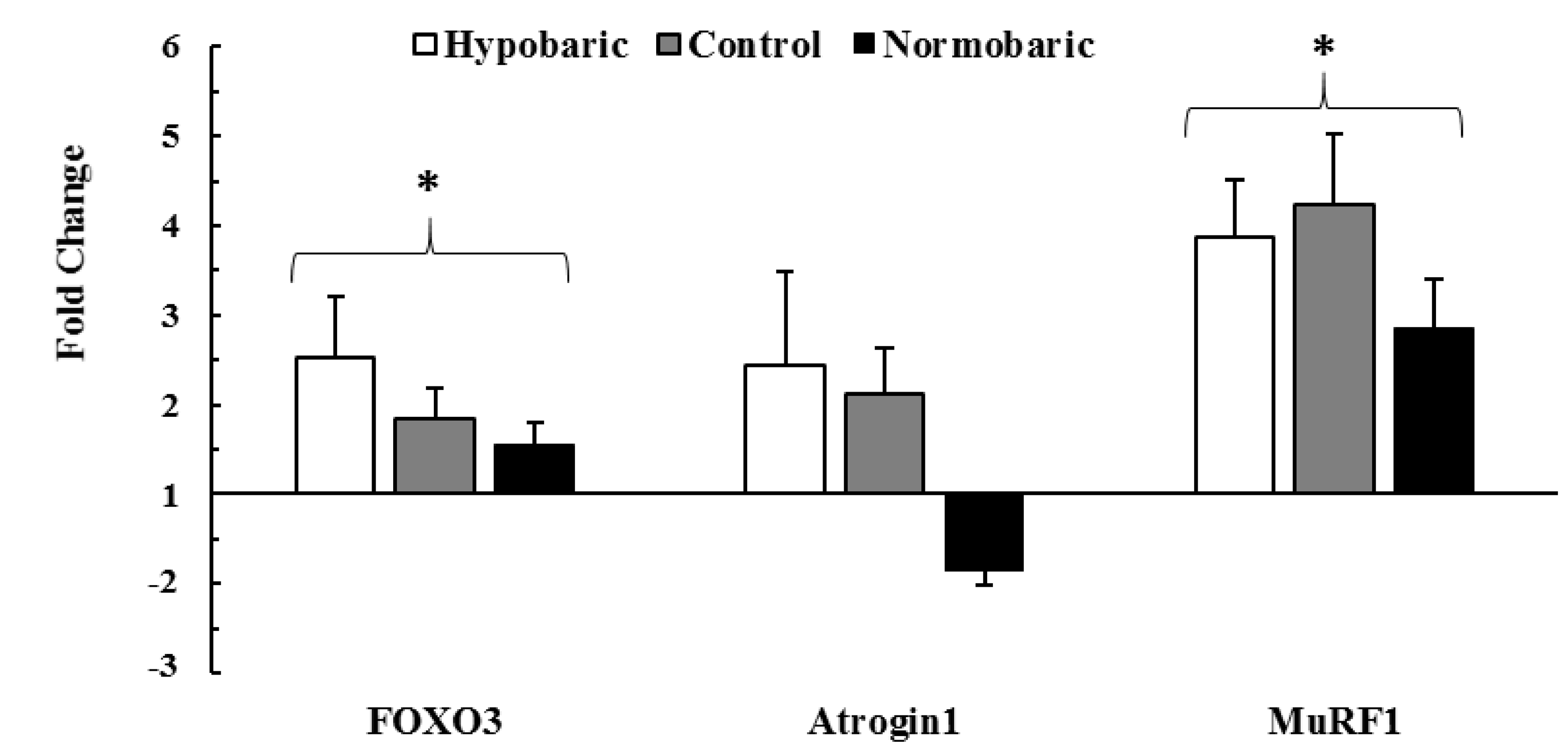

Figure 2. Proteolytic gene expression. Data are mean ± SE. *$p < 0.05$ from pre-exercise.

CONCLUSIONS

- Hypobaric and normobaric hypoxia recovery from aerobic exercise does not affect myogenic and proteolytic gene expression with the exception of a modest attenuation of myostatin in hypobaric hypoxia.
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