Inspiratory muscle training and its effect on indices of physiological and perceived stress during incremental walking exercise in normobaric hypoxia

Amanda L. Seims, John P. O'Hara, Roderick, F.G.J. King and Carlton B. Cooke.

LEEDS METROPOLITAN UNIVERSITY
Centre for Sports Performance

AIM: To evaluate the effects of inspiratory muscle training (IMT) on inspiratory muscle fatigue (IMF), blood lactate concentration (BLa), rating of perceived exertion (RPE) and rating of breathlessness (RB) during trekking specific exercise completed in moderate hypoxia (3000 m)

Introduction

The elevated ventilation and reduced O_2 supply in hypoxia increases RB, RPE and BLa during exercise and exacerbates IMF, shown as a reduction in force output of the inspiratory muscles (1). IMF triggers the inspiratory metaboreflex which reduces limb blood flow (2) and may further increase BLa and intensify RPE (1). Reducing IMF can prolong exercise time to exhaustion in hypoxia and reduce RB and RPE (1). Increased inspiratory muscle strength (MIP) following IMT has been shown to attenuate IMF and the metaboreflex (3). Four weeks of IMT significantly increased MIP by ~25% and reduced IMF by 10% and RPE and RB by 13% during high-intensity running to fatigue in normobaric hypoxia [FIO_2 = 14%, 3200 m (4)]. IMT may benefit trekking expeditions at moderate altitude, but this has not been evaluated in controlled conditions of hypoxia using trekking specific exercise

Methods

Participants: 21 males (age 32.4 ± 9.61 years, $\dot{V}O_{2peak}$ 58.8 ± 6.75 ml·kg^{-1}·min^{-1})

Exercise Protocol: 39-min incremental walking exercise (3-min stages), starting at 3 km·hr^{-1} (1% gradient), increasing to finish on 5 km·hr^{-1} (16% gradient). Performed in normoxia (NORM) and hypoxia [HYP, (FIO_2 ~14.5%, 3000 m altitude)]. BLa, RPE and RB measured every 3 min.

IMF = pre to post exercise decrease in MIP

Matched on baseline MIP, randomised to IMT (n=11) or placebo (P, n=9)

Eight weeks, twice daily

IMT: 30 efforts @ 50% MIP

P: 60 efforts @ 15% MIP

Repeat exercise protocol

Findings

MIP

P 6.20 ± 15.6%

IMT 17.6 ± 30.1%

Not different between groups (P=0.319)

95% CI

P: -3.98 to 24.7 cmH_2O

IMT: +5.21 to 43.3 cmH_2O

No IMT effects in NORM exercise

IMF

PRE: ~5% ↓ in MIP (P=0.000), for both groups in HYP

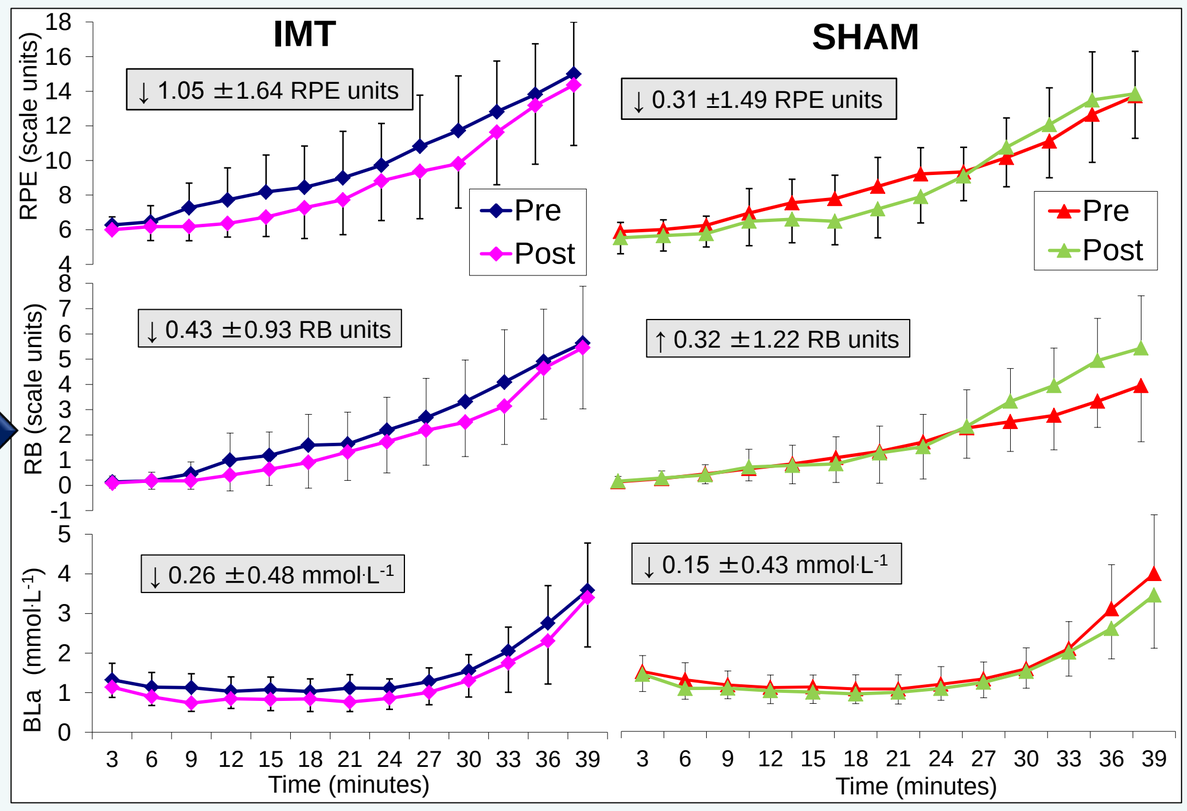
POST: No significant change (P=0.23)

Exercise in HYP (mean change)

RPE: sig. interaction (P=0.03). Sig. ↓ post IMT (P=0.013)

RB: sig. group interaction post training (P=0.01)

BLa: no group interaction post training (P=0.338)



Conclusions

IMT may attenuate increased RPE during walking exercise in moderate hypoxia. This may benefit expeditions completed at moderate altitude (~3000 m). The effect of IMT on BLa and RB may be enhanced with severe hypoxia and/or sustained moderate intensity walking exercise where inspiratory fatigue is likely greater.

References

(1) Amman *et al*. (2007) Inspiratory muscle work in acute hypoxia influences locomotor muscle fatigue and exercise performance of healthy humans. *Am. J. Physiol. Regul.Integr.Comp. Physiol*., **293**, R2036-R2045

(2) Harms *et al*. (1997) Respiratory muscle work compromises leg blood flow during maximal exercise. Respiratory muscle work compromises leg blood flow during maximal exercise. *J. Appl. Physiol*., **82**, 1573 – 1583

(3) McConnell and Lomax (2006) The influence of inspiratory muscle work history and specific inspiratory muscle training upon human limb muscle fatigue. *J. of Physiol.*, **577.1**, 445-457.

(4) Downey *et al*. (2007) Effects of inspiratory muscle training on exercise responses in normoxia and hypoxia. *Respir. Physiol .Neurobiol.*, **2**, 137-146.