The Effects of Upper Body Arm Movement on Metabolic Rate in Lower Body Positive Pressure Treadmill Running

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Abstract

Lower body positive pressure (LBPP) treadmill running is being used more frequently in clinical and athletic settings. A previous study in the Exercise Physiology Lab determined metabolic rate (VO₂) on a LBPP and normal treadmill (NTM). Average ±(SD) VO₂ at 5 and 6 mph on NTM was 2285.1±376.6 and 2659.7±427.4 ml O₂·min⁻¹. Average LBPP at 60% body weight resulted in a VO₂ of 1714.1±374.6 and 1913.2±478.8 ml O₂·min⁻¹ at the two treadmill speeds. Interestingly, the percent difference in metabolic rate was not proportional to the decrease in weight (~30% vs. 40%). We predict the ~10% difference in VO₂ is attributed to upper body arm movement on the LBPP treadmill.

Methods

Thirteen active, non-obese, college age participants completed two exercise tests of walking and running at 60% body weight on an Alter G treadmill and 100% body weight on a normal treadmill. The tests were: (a) walking for 2 min at 0.894 m·s⁻¹ (2 mph), (b) running for 3 min at 2.24 m·s⁻¹ (5 mph) and (c) running for 3 min at 2.68 m·s⁻¹ (6 mph). The volunteers were tested once with normal arm swing and once with arms stationary. Oxygen consumption was measured using open flow indirect calorimetry and last thirty-second averages were defined as steady state. RESULTS: Volunteers’ average ±(SD) absolute VO₂ with arm use at 6 mph on the ATG with and without arms were 1866.0±550.5 and 1856.7±556.5 ml O₂·min⁻¹ respectively. Volunteers’ average ±(SD) absolute VO₂ at 6 mph on the NTM with and without arms were 2447.2±485.5 and 2517.3±675.5 ml O₂·min⁻¹ respectively. CONCLUSION: As predicted, absolute VO₂ was significantly less running on ATG yet there was no difference in VO₂ on the ATG with and without arms. Running on the ATG is less efficient as shown by no change in VO₂ with or without arm movement. This could account for the ~10% less metabolic rate of our previous study comparing LBPP and NTM.

Introduction

Exercising with a lower body weight can be a benefit for overweight or obese individuals and for rehabilitation of lower leg injuries (Eastlack et al. 2005). The Alter G treadmill uses lower body positive pressure (LBPP) to reduce the individuals’ body weight. Recent results in our lab (Hupman et al., 2015) have shown that the decrease in oxygen consumption (VO₂) is not proportional to the decrease in body weight between LBPP treadmill and normal treadmill. Several factors may contribute to the greater VO₂ than expected at a reduced body weight such as running biomechanics and change in economy. Running with arm swing on a normal treadmill or track has been shown to reduce energetic cost as it provides biomechanical benefits (Umberger, 2008). Conversely, in the absence of arm swing, metabolic power demand and pelvic rotation increased (Arellano & Kram, 2014). Due to the use of arm position during running on the Alter G, we hypothesized that an exaggerated arm swing could be a cause of the greater metabolic cost of running on Alter G treadmill.

Purpose

The aim of this study was to determine the metabolic cost with and without arm swing running on a NTM and LBPP treadmill at 60% body weight. It was hypothesized that the less than proportional VO₂ between NTM and LBPP is due to unique arm swing used in LBPP running.

Results

Results of 3X ANOVA reported no statistically significant three-way interaction between treadmill, speed, and arm movement. F(1,12) = 0.125, p = 0.730. There was a statistically significant two-way treadmill*speed interaction, F(1,12) = 15.793, p < .05. Simple paired t-test comparing absolute VO₂ on normal treadmill at 5 mph with and without arms elicited a statistically significant increase in VO₂, t(12) = 3.907, p < .05. At 6 mph no significant differences in mean VO₂, t(12) = 1.775, p = 0.10. There were no significant differences in VO₂ and arm movement on ATG.

Conclusion

Metabolic rate was greater with NAM while running on a normal treadmill yet not on the ATG. This indicates that arm movement is necessary to be biomechanically efficient while running. The findings on the ATG were contrary to our predictions as there were no significant changes in VO₂ with and without arm movement. Arm movement is required for normal running, suggesting that the ATG changes running biomechanics and decreases efficiency.

References