EFFECTS OF ENDURANCE TRAINING ON THE MECHANICS OF BREATHING

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for the degree of Master of Science

by

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I certify that the substance of this thesis has not already been submitted for any degree and is not being currently submitted for any other degree.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

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SUMMARY

This thesis reports a study which examined the relationship between endurance training and the elastic and dynamic mechanical properties of the respiratory system. The study was conducted to elucidate the role of this relationship in the training-related increases in dynamic lung volumes such as the maximum breathing capacity, and the mechanical efficiency of exercise and exercise endurance.

The total mechanical work of breathing ($W_{m(r)}$), and its elastic and dynamic components, were considered to be the ideal respiratory mechanics parameters for this purpose, but ethical and practical considerations excluded measuring these parameters in human subjects during dynamic lung volume manoeuvres and exercise. Measurements were therefore made on an animal model during conditions of physical inactivity and moderately raised levels of ventilation, and the data extrapolated to the conditions found during dynamic lung volume manoeuvres and strenuous exercise in humans.

The sheep was selected as the most suitable animal model. A method was developed for measuring the compliance of the total respiratory system (C_r), the total elastic work of breathing (W_{el}), the total dynamic work of inhalation ($W_{dyn(i)}$), and $W_{m(r)}$ in anaesthetized and artificially ventilated sheep.

The effects of an eight week programme of treadmill endurance training on the C_r, W_{el}, $W_{dyn(i)}$, and $W_{m(r)}$ of five anaesthetized (30 $mg.kg^{-1}$ pentobarbitone sodium, IV), Merino crossbreed wethers were examined. These parameters were measured during artificial ventilation with a stroke volume of 400 ml (BTPS), a pump frequency of 24.5 min^{-1}, and an inspiratory time to expiratory time ratio of 1:1. The training programme consisted of ten minutes treadmill walking per day, five days per week, for a period of eight weeks. The treadmill gradient was 9^0 elevation at the commencement of the programme, and was increased to 13^0 after three weeks of training, while treadmill speed was kept at 3.7 $km.hr^{-1}$ throughout the programme.

The training programme significantly reduced the heart rate response to exercise at set workloads, and increased the exercise endurance. The

$W_{dyn(i)}$ was not altered, but a significant post-training decrease occurred in C_r (9.8%) which produced significant increases in W_{el} (10.7%) and $W_{m(r)}$ (9.0%). The nature of the decrease in C_r was not resolved, but several possible mechanisms were discussed.

The respiratory mechanics parameters in this study were measured during anaesthesia and moderately elevated levels of artificial ventilation. Extrapolation of these data to the conditions found during dynamic lung volume manoeuvres and strenuous exercise in humans suggest that the changes in C_r and W_{el} may be enhanced, but that the dynamic work of breathing and $W_{m(r)}$ (per litre of ventilation) were not altered by endurance training. The data therefore indicate that changes in the mechanical properties of the respiratory system do not contribute to endurance training-related increases in dynamic lung volumes, mechanical efficiency of exercise, or exercise endurance.

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