Growth-Period Treadmill Training Yields a Higher Exercise Capacity that Persists into a Sedentary Adulthood

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Summary

We analyzed the effect of growth-period exercise on metabolic capacity and running economy in guinea fowl. After a year of training we observed improvements in both aerobic capacity and sub-maximal running economy. Surprisingly, after a six-month washout period of no exercise, we found that the exercised birds maintained a significantly higher maximal metabolic capacity. The gains in locomotor economy, however, dissipated after the washout period.

Introduction

Exercise is associated with multiple health benefits including increased bone strength, muscle development, and lower risks of diseases [1]. Childhood is an important period where exercise behaviors may be learned that persist into adulthood [2]. However, few studies systematically analyze physiological effects of exercise during the growth stage and whether these changes persist into adulthood in a way that can affect exercise capacity and effort. To analyze the effects of early exercise versus sedentism during the growth stage, we employed a guinea fowl (*Numida meleagris*) model. Our hypothesis was that one year of growth-period run training would improve both aerobic capacity and locomotor economy compared to untrained birds. We also hypothesized that gains in aerobic capacity would be lost in adulthood after ceasing to exercise, but that economy would remain greater, thus lowering relative effort long-term.

Methods

We obtained 30 two-day old guinea fowl keets from a regional breeder. At two weeks of age, animals were divided into two groups: a restricted-movement control group (CON, n=15) and an exercise group (EXE, n=15). Both groups were cage-raised with food and water *ad libitum* for one year, through skeletal maturity. EXE birds were treadmill trainined five days per week at 1.33 ms^{-1} (moderate speed running) and a 6° incline. After one year, metabolic rates were tested (rate of oxygen consumption, $\dot{V}O_2$, and carbon dioxide production, $\dot{V}CO_2$) at 1.33 m s^{-1} and walking at 0.45 m s^{-1}, and maximal metabolic rate. From 12 – 18 months, birds were singly housed in large pens without treadmill exercise. At 18 months, we performed the same metabolic tests on EXE and CON.

Results and Discussion

After training 12 months, the CON birds had an average maximum $\dot{V}O_2$ of 68.88±9.72 ml O_2 kg^{-1} min^{-1} and the EXE birds had a maximum $\dot{V}O_2$ of 80.96±14.40 ml O_2 kg^{-1} min^{-1} (p=0.010; Fig. 1A). The CON birds had a submaximal metabolic rate of 20.30±1.01 W kg^{-1} at 1.33 m s^{-1} and the EXE birds had a submaximal metabolic rate of 18.86±2.75 W kg^{-1} (p=0.049; Fig. 1B). After the 6-month washout, the CON birds had an average maximum $\dot{V}O_2$ of 71.30±12.17 ml O_2 kg^{-1} min^{-1} and the EXE birds had a maximum $\dot{V}O_2$ of 83.79±14.10 ml O_2 kg^{-1} min^{-1} (p=0.013; Fig. 1A). After the 6-month washout, the CON birds had a submaximal metabolic rate of 19.29±3.29 W kg^{-1} at 1.33 m s^{-1} and the EXE birds had a submaximal metabolic rate of 19.85±2.14 W kg^{-1} at 1.33 m s^{-1}, a difference that was not statistically significant (p=0.316; Fig. 1B). These data partially support our hypothesis: EXE birds were more economical at the training speed of 1.33 ms^{-1} after the training period, but this economy was not maintained after the 6-month washout. However, the maximum metabolic capacity was significantly different both at the end of the training period and after the 6-month washout period resulting in a lower relative effort of running that persisted into a sedentary adulthood.

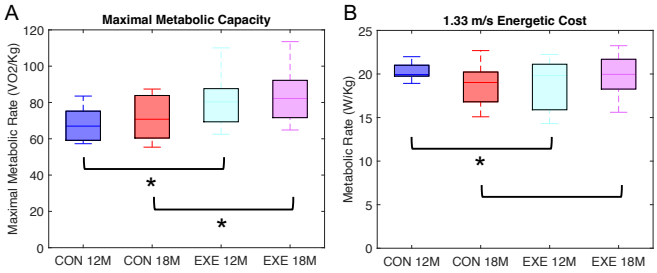

Figure 1: A. Maximal metabolic capacity for control and exercise birds. B. Submaximal metabolic data showing W/kg at 1.33 ms^{-1}. Blue-CON 12 months; red-CON 18 months; teal-EXE 12 months; pink-EXE 18 months, * denotes significance.

Conclusions

Our results show that growth period training improved maximal metabolic capacity after training and that it is maintained even after a significant non-exercise washout period. Our results also show that growth period training can improve locomotor economy at the speed trained at, but this is lost if the training is not maintained. This study highlights the importance of growth period exercise and the lasting impacts it can offer, a result with significant implications if corroborated in human studies [3].

Acknowledgments

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References

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