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Short Report

Relationship between Oxygen Uptake and Work Performance of Female Fischer 344 Rats in Response to Treadmill Exercise

Hiromi YANO, Sachifumi KINOSHITA and Lisa YANO

Department of Health and Sports Sciences
Kawasaki University of Medical Welfare
Kurashiki, 701-01, Japan
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Abstract

This study was undertaken to determine the oxygen uptake ($\dot{V}O_2$) and work performance of female Fischer 344 rats in response to treadmill exercise. A linear relationship between $\dot{V}O_2$ and running speed was investigated. Although it was difficult to set running speed as equal to $\%\dot{V}O_2$max at less than 50 $\%\dot{V}O_2$max, several $\%\dot{V}O_2$max intensities (>50 $\%\dot{V}O_2$max) could be estimated as equal to the running speed in female Fischer 344 rats.

Introduction

Rats have been widely used as a model in the study of physiological changes in response to exercise. Oxygen uptake ($\dot{V}O_2$) directly correlates with exercise intensities, but the relationship between $\dot{V}O_2$ and exercise intensity in small animals is strongly affected by body mass, the strain of rat, age, sex and the state of training.

Female Fischer 344 rats were used in a study of training, because there were no differences in body mass between trained and untrained rats, as well as the Long-Evans rats used by Lambert and Noakes[1]. In addition, the rate of increase in body mass was very little compared with that of another strain[2,3] or of male rats[4]. Accordingly, the use of female Fischer 344 rats in exercise experiments may be helpful in omitting the body-mass-factor[5,6]. However, the relationship between oxygen uptake and running speed was not clear.

The purpose of the present study was to determine the $\dot{V}O_2$ and work performance of female Fischer 344 rats in response to treadmill exercise.

Materials and Methods

Seven female Fischer 344 strain rats (130-150 g) were.used in this study. The experimental procedures followed the guidelines set forth in the Care and Use of Animals in the Field of Physiological Sciences approved by the Council of the Physiological Society of Japan.

All animals were fed rat chow and water ad libitum. Before the experiments, the animals were exercised during a three day acclimation period.

The steady-state $\dot{V}O_2$ of rats during 0, 10, 15, 21 and 30 m/min of treadmill running for 10 min was measured using the rapid flow open-circuit system. The $\dot{V}O_2$ max of the rats was also measured with this system on the next morning. This method has been described previously by Yano and Nagao[7].

Results and Discussion

The steady-state values for $\dot{V}O_2$ are shown in Fig. 1. We found a linear relationship between $\dot{V}O_2$ and running speed. This relationship could be expressed as $y=21.7+1.03x$ ($r=0.947$, $p<0.01$, $y=\dot{V}O_2$ in ml/min/kg, $x=$ running speed in m/min). Brooks and White[2] and Sonne[3] carried out similar experiments using Wistar rats. Although the tendencies in the linear relationships they found agree with our results, the y-intercept and the slope of the regression line in their results were a little high. We think that this might be due to differences in body mass and strain.

Several percentages of $\dot{V}O_2$ max intensities would be estimated for the running speeds of female Fischer 344 rats (Fig. 2). Running speeds for 60 %, 80 %, 100 % and 120 % $\dot{V}O_2$ max were 16, 26, 36 and 46 m/min, respectively, for treadmill running on a 15 % grade. Sonne[3] used 10 and 21 m/min running as low and moderate intensities in a study using Wistar rats (50 % and 75 % $\dot{V}O_2$ max, respectively). In our results, those intensities correspond to about 50 % and 70 % $\dot{V}O_2$ max in female Fischer 344 rats.

In this study, 32 % $\dot{V}O_2$ max at 0 m/min might be higher than the human resting level,

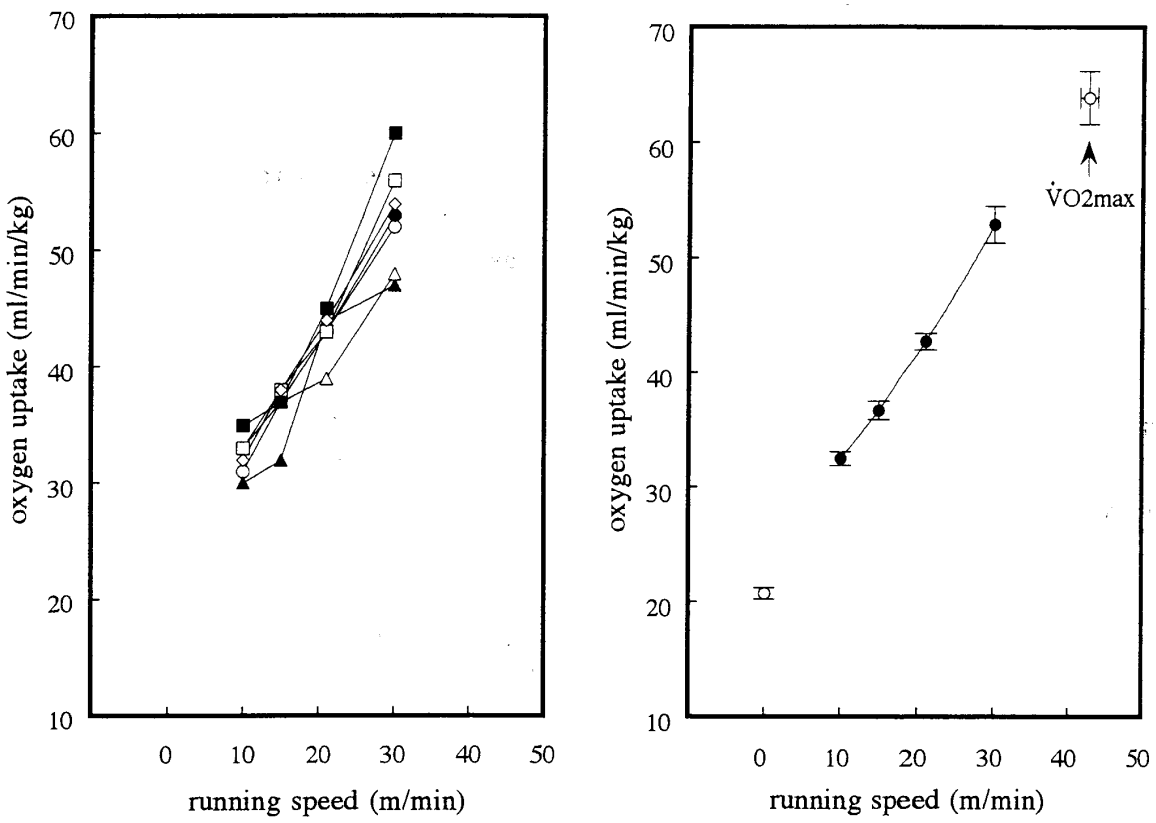
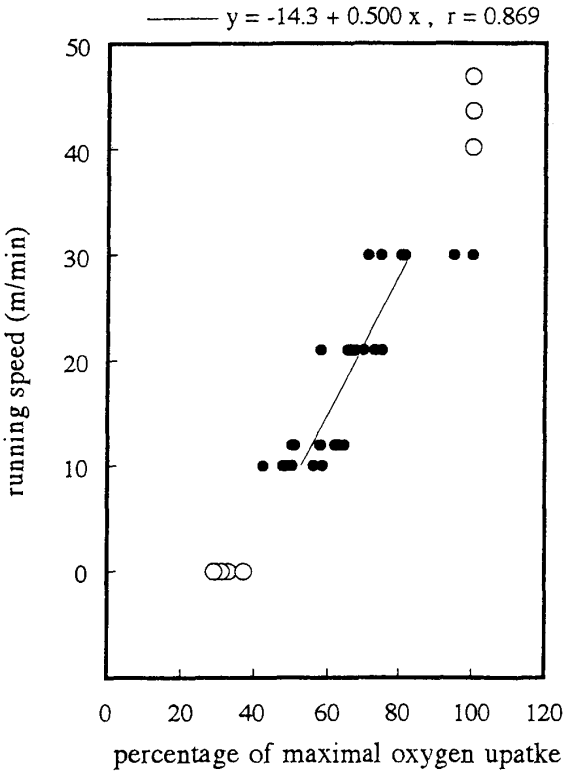


Fig. 1 Relationship between oxygen uptake and running speed on a 15 % grade in each rat (left) and the means ± SEM (right).



but this value agrees with a previous study in rats[3]. These small animals cannot be made sedentary voluntarily in a chamber on a treadmill. Additionally, lower workloads (<10 m/min) might not be adequate enough to maintain pacing and economy of motion for small animals[2]. Accordingly, it might be difficult to set a running speed which corresponds to a particular % $\dot{V}O_2$ max at less than 50 % $\dot{V}O_2$ max.

Fig. 2 Running speed on a 15 % grade in female Fischer 344 rats expressed as a function of % $\dot{V}O_2$ max.

References

1) Lambert MI and Noakes TD (1990) Spontaneous running increases $\dot{V}O_2$ max and running performance in rats. *Journal of Applied Physiology*, **68** (1), 400—403.

2) Brooks GA and White TP (1978) Determination of metabolic and heart rate responses of rats to treadmill exercise. *Journal of Applied Physiology*, **45** (6), 1009—1015.

3) Sonne B (1989) A model used to study exercise responses in the rat. With special reference to the regulation of carbohydrate metabolism. *Acta Physiologica Scandinavica*, **136** (Suppl 580), 1—77.

4) Chesky JA, LaFollette S, Travis M and Fortado C (1983) Effect of physical training on myocardial enzyme activities in aging rats. *Journal of Applied Physiology*, **55** (4), 1349—1353.

5) Mazzeo RS, Brooks GA and Horvath SM (1984) Effects of age on metabolic responses to endurance training in rats. *Journal of Applied Physiology*, **57** (5), 1369—1374.

6) Schmidt KN, Gosselin LE and Stanley WC (1992) Endurance exercise training causes adrenal medullary hypertrophy in young and old Fischer 344 rats. *Hormone and Metabolism Research*, **24**, 511—515.

7) Yano H and Nagao N (1995) Decline in maximal oxygen uptake on work performance in rats during the developmental phase. *Japanese Journal of Physiology*, **45** (5), 889—893.