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Changes in fitness during prolonged training in Standardbred horses

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Summary

The aim of this study was to investigate the effect of 31 weeks prolonged, intense training on the aerobic fitness of horses by measuring maximum oxygen uptake (VO_{2max}). Thirteen Standardbred horses were trained on a treadmill for 31 weeks. The first 7 weeks consisted of endurance training and the other 24 weeks consisted of high intensity training in an increasing exercise program. In the last 15 weeks horses were divided into 2 groups, HIT (7 horses) and C (6 horses), with the HIT group receiving greater frequency, intensity, and duration of training than group C. VO_{2max} continued to increase with training and peak VO_{2max}, at 31 weeks of training, was 29% higher than pre-training values. There was no difference between C and HIT groups. We concluded that VO_{2max} continued to increase during prolonged, intense training in Standardbred horses and that training at greater exercise frequencies and intensities does not increase VO_{2max}.

Keywords: maximum oxygen uptake, training, fitness, horses

Veränderungen der Leistungsfähigkeit während langandauerndem Training bei Trabern

Das Ziel dieser Studie war, den Effekt von 31 Wochen fortgeführtem, intensiven Training auf die aerobe Leistungsfahigkeit zu untersuchen. Gemessen wurde hierbei die maximale Sauerstoffaufnahme.
13 Traber wurden für 31 Wochen auf dem Laufband trainiert. Die ersten sieben Wochen bestanden aus einem Ausdauertraining. Die restlichen 24 Wochen bestanden aus hochintensivem Training mit steigender Belastungsintensität. In den letzten 15 Wochen wurden die Pferde in 2 Gruppen unterteilt, der HIT-Gruppe (Hochintensivtraining, 7 Pferde) und der C-Gruppe (Kontrolle, 6 Pferde). Die HIT-Gruppe wurde mit größerer Häufigkeit, höherer Intensität und längerer Dauer trainiert als die C-Gruppe. VO_{2max} stieg kontinuierlich mit dem Training an und der Peak von VO_{2max} nach 31 Wochen Training war um 29% höher als die Werte vor dem Training. Es gab jedoch keinen Unterschied zwischen der Kontrollgruppe und der HIT-Gruppe. Wir schlußfolgern, daß VO_{2max} bei langandauerndem, intensiven Training bei Trabern kontinuierlich ansteigt, und daß bei Training mit höherer Häufigkeit und Intensität VO_{2max} nicht ansteigt.

Schlüsselwörter: maximale Sauerstoffaufnahme, Training, Leistungsfähigkeit, Pferde

Introduction

Maximum oxygen uptake (VO_{2max}) is a measure of the body's total aerobic metabolic rate or maximal aerobic capacity and has long been used as an objective indicator of overall fitness in human athletes (*Shephard,* 1984; *Howley* et al., 1995) and more recently in horses (*Evans* and *Rose,* 1987). While VO_{2max} is not the only factor involved in athletic performance, it is generally considered the single best predictor of athletic potential in humans (*Åstrand* and *Rodahl,* 1986). Measurement of VO_{2max} is critical in the assessment of athletic performance in horses and a number of reports now exist demonstrating that the best performed equine athletes have the highest values for VO_{2max} (*Hodgson* and *Rose,* 1994).
Horses have a very high VO_{2max}, and when compared with humans on a mass specific basis, the average Thoroughbred or Standardbred racehorse has about twice the VO_{2max} of a human athlete (*Evans* and *Rose,* 1988, *Rose* et al., 1990). VO_{2max} in horses has been shown to increase by up to 25% in response to training with increases occurring rapidly, within 6 to 9 weeks. (*Evans* and *Rose,* 1987; *Evans* and *Rose,* 1988; *Knight* et al., 1991; *Art* and *Lekeux,* 1993; *Evans* et al., 1995). However, the greatest increases in VO_{2max} have occurred where the exercise protocol involves an increase in training intensity (*Art* and *Lekeux,* 1993; *Evans* and *Rose,* 1988).
There is little information on the changes in VO_{2max} over a more prolonged training period, with the exercise stimulus increasing throughout training, because the maximum training period studied in horses has been only 12 weeks. A more prolonged training period more accurately reflects the type of training practised by horse trainers in the field.
It has been shown that the relative intensity of training (between 40% and 80% VO_{2max}) does not affect the increase in VO_{2max} over a 6 or 9 week training period (*Knight* et al., 1991; *Evans* et al., 1995). However, there is little known about the effects of high intensity training (at or greater than 100% VO_{2max}) on VO_{2max} in horses. A high proportion of energy is supplied via aerobic sources during exercise in horses, even in the shorter, "sprinting" races. Over 70% of the energy required for 1 min gallop to fatigue at 115% VO_{2max} (equivalent to about a 1000 m gallop) is supplied via aerobic sources (*Tyler* et al., 1996). Therefore, VO_{2max} is an important determinant of fitness and performance in the racehorse, even during high intensity exercise.
Our aims were to determine whether horses continue to improve fitness, measured by increases in VO_{2max}, over 31 weeks of intense training with an increasing training load.

Materials and methods

Thirteen Standardbred geldings, 3 to 5 years old, were trained for 31 weeks. Prior to the commencement of the study, all horses were rested on pasture (detrained) for a period of at least 4 months. All training and exercise tests took place on a high speed treadmill (Mustang, Kagra AG,

Switzerland) at a 10% slope. All horses completed a warm-up of 1000 m at 4 m.s^{-1} before exercise training started. The first 7 weeks consisted of endurance training 5 days a week. Horses were trained at intensities ~60% VO_{2max} over distances from 2000 to 4000 m per day. The following 8 weeks consisted of high intensity training. Horses were trained 3 days a week at moderate intensities (~80% VO_{2max}) for a distance of 3000 m per day, and 2 days a week at high intensities (100% VO_{2max}) in 2 min intervals. The intervals increased from 2 (~2400 m) up to a total of 3 intervals (~3600 m) per day. In the final 15 weeks, the horses were divided into 2 groups: high intensity training (HIT), 7 horses and control (C), 6 horses.

The HIT group exercised at higher intensities, more frequently and for longer durations than group C. The HIT group were trained 3 days a week at moderate intensities (~ 85% VO_{2max}) and 3 days a week at high intensities (100%–110% VO_{2max}) High intensity exercise consisted of rapidly increasing intervals at 100% VO_{2max} up to approximately 16 min per day (9600 m) for 12 weeks, followed by intervals at 110% VO_{2max} to fatigue for up to 7500 m per day for the final 3 weeks. Moderate intensity training increased from 4000 m to 6000 m per day. The C group continued training 3 days a week at moderate intensities (~80% VO_{2max}) for distances of 3000 m to 4500 m per day, and 2 days a week at high intensities (100% VO_{2max}) in 2 min intervals. The intervals increased from 3 (~3600 m) up to a total of 4 intervals (~5000 m) per day.

VO_{2max} was measured every 2–3 weeks during the 31 weeks of training, using a standardised incremental exercise test. The test consisted of 2 min warm-up at 4 m.s^{-1}, followed by 1 min increments at increasing speeds until fatigue (the point at which the horse was unable to keep pace with the treadmill) and total run time for the test was recorded. An open flow gas collection system was used for collection of expired gas samples over the last 15 seconds of each speed increment. Measurements of VO_2 during the exercise test were performed and VO_{2max} was confirmed in all horses by demonstrating no increase in VO_2 between the last two steps of the exercise test (*Eaton* et al., 1995).

Mean VO_{2max} values were compared using a one-way repeated measures analysis of variance. HIT and C values during the last 15 weeks of training were compared using a two-way analysis of variance to determine the effects of time and group on VO_{2max}. Post hoc tests of least significant difference were performed where F values were significant ($p<0.05$). Results are presented as the mean ± sem.

Results

From pre-training values of 117 ± 2 ml/kg/min (± sem), VO_{2max} increased by 15% ($p<0.01$) in the first 7 weeks to 135 ± 1 ml/kg/min. After 8 weeks high intensity training, the VO_{2max} (140 ± 2 ml/kg/min) was 20% ($p<0.01$) higher than pre-training values. At 31 weeks of training, VO_{2max} (151 ± 2 ml/kg/min) was 29% ($p<0.01$) higher than pre-training values in both the C and HIT groups and VO_{2max} was not significantly different between C and HIT groups during training.

Discussion

This is the first long term study in horses of changes in VO_{2max} with training and it was surprising to find that VO_{2max} continued to increase throughout training. The total increase was 29% above pretraining values with about half of the increase and the most rapid increase occurring in the first seven weeks of endurance training. The increase in VO_{2max} was greater than has been previously described in training studies involving horses. Reported increases in VO_{2max} have ranged from 10% (*Knight* et al., 1991) to 25% (*Art* and *Lekeux,* 1993). However, the current study involved 31 weeks of training, compared to 6 to 12 weeks in the previous reports. As well as training for a far greater period of time, the current study also involved training at higher intensities with the exercise stimulus continually increasing throughout the study in both groups of horses. Horses trained at a constant exercise load for 6 weeks, at intensities of either 40% or 80% VO_{2max} showed a 10% increase in VO_{2max} at either intensity after 2 weeks of training but thereafter there were no further increases (*Knight* et al., 1991). This contrasts with studies where horses were trained with an increasing exercise load for 7 and 9 weeks, and had a 23% and 25% increase in VO_{2max}, respectively, at the end of training (*Evans* and *Rose,* 1988; *Art* and *Lekeux,* 1993).

The greater frequency, intensity and duration of exercise performed by the HIT group, had no effect on increasing VO_{2max} above values for the C group. This may be because the increase in VO_{2max} was close to the possible limit of increase in VO_{2max}. However, the greater volume of exercise performed by the HIT group consisted almost entirely of high intensity exercise and it has been reported in human athletes that high intensity training may not improve VO_{2max} (*Nakao* et al., 1995). Training at intensities of ~80% VO_{2max} have been suggested as ideal for maximising the increase in VO_{2max} in humans (*Åstrand* and *Rodahl,* 1986) and in the current study, both groups of horses performed moderate intensity exercise 3 days per week over relatively similar distances. The implications for training in practice are that increased frequency (days per week) and intensity of training are unlikely to confer an advantage in aerobic fitness for horses and may lead to increased risk of injury.

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