The effect of continuous *vs* intermittent exercise on substrate utilization during exercise and recovery in healthy adults

M.L. Borg, C.G. Stathis and A. Hayes, Exercise Metabolism Unit, School of Biomedical and Health Sciences, Victoria University, Footscray, Victoria 3011, Australia.

Introduction. The incidence of obesity and type II diabetes is reaching epidemic proportions in today's society and are associated with long-term ill health and reduced quality of life. As such, it has been recommended that effective weight loss strategies be developed. Carbohydrate and lipids are the primary substrates utilized for energy during exercise. Lipids provide the majority of fuel supply to the exercising skeletal muscle during steady state, moderate intensity exercise (SSMIE), with an increasing supply from carbohydrate sources with increasing intensities (Romijn *et al.*, 2000). However, recent studies have demonstrated an increased capacity for high intensity intermittent exercise (HIIE) to evoke decreases in adiposity compared with SSMIE, without providing metabolic mechanisms (Trapp *et al.*, 2008; Tremblay *et al.*, 1994). Therefore the purpose of this study was to examine plasma and respiratory indicators of lipid and carbohydrate metabolism during and after a single bout of HIIE compared with SSMIE in order to explain decreased adiposity witnessed during HIIE.

Methods. This study obtained approval from Victoria University, Human Research Ethics Committee (HRETH 07/281) and all experiments conformed to the National Statement on Ethical Conduct in Human Research. Participants (8 males and 8 females) performed two exercise bouts, SSMIE (50% VO_2 peak), and HIIE (20s sprint: 40s rest) for 30 minutes on two separate occasions in randomised order. The HIIE bout was designed to be three times the workload of SSMIE, performed for a third of the time, such that the two exercise bouts required the same amount of mechanical work. Blood was taken during exercise and one hour of recovery, and was analysed for glucose, lactate, glycerol and free fatty acids (FFA). Respiratory gas exchange data was also obtained.

Results. There was no significant difference in oxygen consumption between the bouts, indicating similar aerobic requirements of SSMIE and HIIE. Both exercise bouts increased lipid oxidation as measured by increased plasma glycerol concentrations during exercise and in recovery. However, RER values were significantly lower ($p < 0.05$) during recovery after HIIE than SSMIE, indicating an increased reliance on lipid oxidation. HIIE also showed a significant decrease in plasma FFA at the end of exercise ($p < 0.05$), suggesting increased uptake by the muscle to support lipid oxidation. Lactate concentrations rose over the 30 minutes, and were significantly higher in HIIE ($p < 0.05$), mostly due to the anaerobic breakdown of glycogen, as plasma glucose concentrations remained the same.

Discussion. It is feasible that HIIE creates a 'substrate shuttle' whereby there are repeated shifts from anaerobic to aerobic energy sources. ATP and PCr are partly depleted during the high intensity work phases, with their resynthesis during the rest periods occurring via oxidative pathways (Essen *et al.*, 1977), leading to increased energy expenditure during rest periods of HIIE. Glycogen, although depleted, does not appear to be resynthesised during the rest periods, with ongoing diminution over the HIIE session (Bangsbo *et al.*, 1991). As such, restoration of glycogen stores is of high metabolic priority during recovery, contributing to increased energy expenditure and a negative energy balance after HIIE. Differences in metabolism during rest and recovery from HIIE may explain decreases in adiposity observed, and further investigation of exercise specifically designed for fat loss is required.

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