Plasma K^+ dynamics during incremental exercise and recovery in older adults before and after 12 weeks of high-intensity interval training

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Potassium (K^+) has an important role in regulating membrane excitability and may contribute to development of muscle fatigue during intense exercise. Surprisingly, however, little is known about the regulation of K^+ during intense exercise, or the effects of training, in older adults. This study investigates the magnitude of increase in plasma [K^+] during incremental exercise and the subsequent post-exercise decline in plasma [K^+] in adults aged over 65 years, before and after High-Intensity Interval Training (HIT).

Eight older adults (6 male, 2 female, age 69.8 ± 3.8 years, mean ± SD) volunteered for the study. Participants were free from known cardiovascular or metabolic diseases. Participants attended the laboratory after an overnight fast . The graded exercise test was performed on a cycle ergometer with workrate commencing at 20 W; then increased by 20 W. each min for males, 10 W each min for females. The test was completed when a participant reached Rating of Perceived Exertion of 17 (Borg 6-20), or prior to RPE=17 if signs and/or symptoms associated with abnormal cardiac function were observed. Venous blood (antecubital vein) was taken at rest, every min during exercise, immediately at the end of exercise and at 1, 2, 3, 5, 10, 30 and 60 minutes post-exercise and was analysed for fluid shifts, plasma electrolytes and acid-base status. Participants then trained under supervision three times per week for 12 weeks on a mechanically braked cycle ergometer (Monark 868, Vansbro, Sweden). The training protocol comprised four, 4-minute intervals performed at an intensity corresponding to 90-95% of the HR peak attained during the incremental exercise test, with each interval interspersed by four minutes of active recovery where participants cycled at 50-60 % of peak HR.

Results: The peak workrate achieved in the eight participants was 141 ± 56 W and the VO2 peak was 25.3 ± 6.2 $ml.kg^{-1}.min^{-1}$. The venous plasma [K^+] was 3.96 ±0.15 $mmol.l^{-1}$ at rest and reached only 4.74 ± 0.41 $mmol.l^{-1}$ at the end of exercise (RPE=17). Immediately post-exercise, plasma [K^+] did not decline rapidly; rather there was a gradual reduction in plasma [K^+] throughout recovery, such that plasma [K^+] did not return to baseline until 30 minutes after exercise. Post-training the peak workrate increased from pre-training by 25% (181.3±56.6 W, $P<0.05$). Post-training the plasma [K^+] tended to be higher than Pre 5.23±0.57 $mmol.l^{-1}$ at the end of exercise ($P=0.07$) and returned to baseline within 5 minutes of exercise ending (4.36±0.46 mmol.l-1).

Key findings in these older participants performing intense incremental exercise were the slow rise in plasma [K^+] to only very modest values during exercise and the slow return in plasma [K^+] towards baseline values during recovery, which became more rapid post HIT. Ceasing exercise at RPE=17 (very hard) rather than at “maximal” workrate (exhaustion) will likely have slightly reduced the peak power and total work performed and therefore reduced K^+ release from contracting muscles into plasma during exercise. Further the low venous [K^+] during exercise may also be attributed to an inability to achieve high workrates due to poor leg muscle strength, lowered muscle mass, and/or early fatigue onset in these older adults. The slow and incomplete recovery of [K^+] post-exercise may suggest a reduction in Na^+,K^+-ATPase activation in aged skeletal muscle.