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The effect of seated and supine exercise on executive function in TIA patients and healthy controls.

A thesis presented in fulfilment of the requirements for the degree of Master of Health Science in Sport and Exercise at Massey University, Wellington.

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December, 2014

“I certify that all material in this dissertation which is not my own work has been identified and that no material is included for which a degree has previously been conferred upon me.”

Signed:

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List of Abbreviations

ANOVA - Analysis of variance	NIRS - Near infrared spectroscopy
AT - Aerobic training group	O ₂ Hb - Oxy-haemoglobin
BDNF - Brain-derived neurotrophic factor	PASAT - Paced auditory serial addition test
BF % - Body fat percentage	PET - Positron-emission tomography
BG - Blood glucose	PO - Power output
BMI - Body mass index	RAVLT - Rey auditory verbal learning test
BOLD - Blood-oxygen-level dependent	RER - Respiratory exchange ratio
CI - Confidence intervals	RHR - Resting heart rate
DBP - Diastolic blood pressure	RM - Repetition maximum
DPF - Differential pathlength factor	RPE - Ratings of perceived exertion
DSBT - Digital span backwards test	RPM - Revolutions per minute
DV - Dependent variable	RT - Resistance training group
ECG - Electrocardiogram	SBP - Systolic blood pressure
EEG - Electroencephalography	SDST - Symbol digit substitution test
FIM - Functional independence measure	SIS - Stroke impact scale
fMRI - Functional magnetic resonance imaging	SNR - Signal-to-noise ratio
GET - Gaseous exchange threshold	SPECT - Single-photon-emission computed tomography
GXT - Graded exercise test	SRTT - Serial reaction timed task
HC - Healthy controls	TC - Total cholesterol
HDL - High-density lipoprotein	THb - Total haemoglobin
HHb - Deoxy-haemoglobin	TIA - Transient ischemic attack
HR – Heart rate	TSI - Tissue saturation index
HRR - Heart rate reserve	\dot{V}_{CO_2} - Carbon dioxide
HR _{Max} - Maximum heart rate	\dot{V}_E - Minute ventilation
HSD - Honest significant difference	\dot{V}_{O_2} - Oxygen consumption
IV - Independent variable	$\dot{V}_{O_{2Max}}$ - Maximal oxygen consumption
LDL - Low-density lipoprotein	$\dot{V}_{O_{2peak}}$ - Peak oxygen consumption
MoCA - Montreal cognitive assessment	WCST - Wisconsin card sorting task
NIHSS - National Institutes of Health Stroke Scale	WWT - Walking while talking test

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Abstract

Purpose: Exercise is suggested to improve executive function in healthy adults. However, there is limited research in this area on stroke populations. The purpose of this study was to examine the effects of an acute sub-maximal bout of seated and supine exercise on executive function in transient ischemic attack (TIA; minor stroke) patients and an age-matched healthy control group (HC). **Methods:** Nine TIA patients (7 males, 2 females; 65.1 ± 10.1 y; 85.8 ± 16.9 kg) and fifteen HC participants (13 males, 2 females; 61.5 ± 7.1 y; 84.9 ± 16.3 kg) performed two familiarisation sessions and four laboratory-based exercise protocols on a cycle ergometer. During the laboratory-based exercise tests participants performed two continuous, incremental maximal graded-exercise tests (GXT) to volitional exhaustion; one test was performed on a seated cycle ergometer, the other on a cycle ergometer in a supine position. The two remaining tests were 30-minute sub-maximal exercise tests (Seated and Supine). The Stroop task assessed executive function and was performed prior-to (Baseline), immediately after (Post) and 15-minutes (15-min Post) following the sub-maximal exercise tests. Near infrared spectroscopy (NIRS) was continuously recorded throughout the entire testing protocol to assess changes in total haemoglobin (tHb), oxy-haemoglobin (O_2Hb), deoxy-haemoglobin (HHb), and tissue saturation index (TSI). **Results:** Regardless of exercise modality (Seated cf. Supine) or condition (TIA cf. HC) ($P < 0.05$), exercise elicited significant improvements in the time to complete the Stroop task (Baseline: 61.3 ± 10.0 s; Post: 58.1 ± 9.4 s; 15-min Post 54.8 ± 9.0 s). There were no changes in the number of correct Stroop answers reported for Seated exercise across each assessment time point ($P > 0.05$). However, a significant decrease in the number of correct answers was revealed immediately after (Post) Supine exercise which increased 15-minutes after exercise ($P < 0.05$). There was a significant increase in tHb (-0.6 ± 7.3 cf. 15.6 ± 8.1 %) and O_2Hb (-2.3 ± 10.9 cf. 22.2 ± 11.1 %) after exercise (Baseline to Post) which remained significantly higher 15-minutes following exercise regardless of the exercise modality (Seated cf. Supine) or condition (TIA cf. HC) (both $P < 0.001$). **Conclusion:** This study showed 30-minutes of sub-maximal exercise in a seated and supine position led to improvements in executive function in TIA and HC participants. Cognitive improvements were observed immediately and 15-minutes after exercise. Possible mediators include increases in cerebral oxygenation and neurotransmitters. These findings may be important for improving executive function, a cognitive domain greatly impaired by stroke. Future research should further investigate the underlying mechanisms by which exercise affects executive function in stroke patients.