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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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"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:

Rebecca Grigg

Dr. James Faulkner

Dr. Danielle Lambrick

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List of Abbreviations

ANOVA - Analysis of variance

AT - Aerobic training group

BDNF - Brain-derived neurotrophic factor

BF % - Body fat percentage

BG - Blood glucose

BMI - Body mass index

BOLD - Blood-oxygen-level dependent

CI - Confidence intervals

DBP - Diastolic blood pressure

DPF - Differential pathlength factor

DSBT - Digital span backwards test

DV - Dependent variable

ECG - Electrocardiogram

EEG - Electroencephalography

FIM - Functional independence measure

fMRI - Functional magnetic resonance imaging

GET - Gaseous exchange threshold

GXT - Graded exercise test

HC - Healthy controls

HDL - High-density lipoprotein

HHb - Deoxy-haemoglobin

HR – Heart rate

HRR - Heart rate reserve

HR_{Max} - Maximum heart rate

HSD - Honest significant difference

IV - Independent variable

LDL - Low-density lipoprotein

MoCA - Montreal cognitive assessment

NIHSS - National Institutes of Health Stroke Scale

NIRS - Near infrared spectroscopy

O_2Hb - Oxy-haemoglobin

PASAT - Paced auditory serial addition test

PET - Positron-emission tomography

PO - Power output

RAVLT - Rey auditory verbal learning test

RER - Respiratory exchange ratio

RHR - Resting heart rate

RM - Repetition maximum

RPE - Ratings of perceived exertion

RPM - Revolutions per minute

RT - Resistance training group

SBP - Systolic blood pressure

SDST - Symbol digit substitution test

SIS - Stroke impact scale

SNR - Signal-to-noise ratio

SPECT - Single-photon-emission computed tomography

SRTT - Serial reaction timed task

TC - Total cholesterol

THb - Total haemoglobin

TIA - Transient ischemic attack

TSI - Tissue saturation index

$\dot{V}CO_2$ - Carbon dioxide

$\dot{V}_E$ - Minute ventilation

$\dot{V}O_2$ - Oxygen consumption

$\dot{V}O_{2Max}$ - Maximal oxygen consumption

$\dot{V}O_{2peak}$ - Peak oxygen consumption

WCST - Wisconsin card sorting task

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.