UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Concurrent Exercise Training for Physical and Mental Health in the Academic Workplace

by Samuel Higham

Thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

Under the supervision of
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Certificate of Original Authorship

I, Sam Higham declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Sport, Exercise and Rehabilitation, Faculty of Health, at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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Preface

This thesis for the degree of Doctor of Philosophy is in the format of Thesis by compilation and abides by the 'Procedures for Presentation and Submission of Theses for Higher Degrees – University of Technology Sydney; Policies and Directions of the University'.

From the research design and data collection by the candidate, three research study chapters have been developed. An introduction chapter provides background information, research problem, as well as the purpose and significance of the three studies. A literature review chapter provides an overview of the cardiometabolic and mental health risk factors that may be present in the academic workplace, and how concurrent exercise training could be used to counter these risks. The research study chapters are then presented in a logical sequence following the development of research ideas within this thesis. Each chapter has a similar outline of introduction, methods, results, discussion, and conclusion. Findings from all studies are combined into a discussion chapter, where collective results are discussed in reference to related literature. This thesis finishes with an overall conclusion, practical applications, and directions for future research.

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Abbreviations

BMI	Body mass index
BP	Blood pressure
bpm	Beats per minute
C:HDL	Total Cholesterol to HDL-C ratio
CI	Confidence Interval
cm	Centimetre
CO_2	Carbon dioxide
CONSORT	Consolidated Standards of Reporting Trials
CRP	C-reactive protein
CT	Concurrent training
CVD	Cardiovascular disease
DASS-21	Depression, anxiety and stress scales
DBP	Diastolic blood pressure
DEXA	Dual Energy X-ray Absorptiometry
EDTA	Ethylenediaminetetraacetic acid
EMA	Ecological momentary assessment
ERI	Effort reward imbalance
GLTEQ	Godin Leisure-Time Exercise Questionnaire
GXT	Graded exercise test
h	Hour
HASS	Humanities, Arts, and Social Sciences
HDL-C	High density lipoprotein cholesterol
HOMA-IR	Homeostatic model assessment for insulin resistance
HR	Heart rate
HREC	Human research ethics committee
IL-6	Interleukin-6
IQR	Interquartile range
K10	Kessler scale
kg	Kilogram
L	Litre
LDL-C	Low density lipoprotein cholesterol
MET	Metabolic equivalent

MetS	Metabolic Syndrome
min	Minute
mL	Millilitre
mmHg	Millimetre of mercury
mmol	Millimoles
MVPA	Moderate to vigorous physical activity
n	Number
NHANES	National health and nutrition examination survey
O_2	Oxygen
OR	Odds ratio
PPO	Peak power output
REDCap	Research Electronic Data Capture
RHR	Resting heart rate
RR	Risk ratio
RR	Relative risk
SBP	Systolic blood pressure
SD	Standard deviation
SMD	Standardised mean difference
SPSS	Statistical Package for the Social Sciences
SST	Serum separator tube
STEM	Science, Technology, Engineering, and Mathematics
TNF-α	Tumor necrosis factor-alpha
VAT	Visceral adipose tissue
VO_{2max}	Maximal oxygen consumption
VO_{2peak}	Peak oxygen consumption
W	Watts
WC	Waist circumference
WMD	Weighted mean difference
y	Years
µU	Micro unit

Abstract

Competing work responsibilities and high workload experienced in the academic workplace likely contribute to the higher stress and longer work hours reported in academics compared to other employees. High stress and long work hours are associated with lower levels of physical activity, which is a risk factor for mental and cardiometabolic disorders. Low amounts of physical activity are reported in the academic workplace, though few studies report concurrent assessments of mental and cardiometabolic health in inactive academics. Limited research also exists on interventions designed to increase physical activity in academics with the aim of improving cardiometabolic and mental health outcomes. Concurrent exercise training (CT) combines endurance and resistance exercise and has been shown to improve cardiometabolic and mental health; however, minimal workplace-based CT interventions have been reported in inactive academics (150 min/week of weighted physical activity).

This thesis firstly aimed to describe the cardiometabolic and mental health of inactive full-time academics within an Australian University and compare cardiometabolic and mental health risk factors by sex and academic level (study 1). Secondly, this thesis aimed to determine the effect of a 14-week CT program on components of the metabolic syndrome (MetS), insulin resistance, body composition, aerobic capacity and markers of systemic inflammation in inactive full-time academics from an Australian University (study 2). Thirdly, this thesis aimed to evaluate the effect of 14-weeks of CT on symptoms of depression, stress and anxiety in inactive full-time academics within an Australian University (study 3). Lastly, this thesis aimed to investigate the relationships between metabolic risk factors (e.g. fat mass, insulin resistance and systemic inflammation), stress and symptoms of depression (study 1, 2 and 3).

Study 1 was a cross-sectional study to describe the cardiometabolic and mental health of inactive academics (n=59), in relation to sex and level of appointment. Results showed that 20% of inactive academics had MetS and nearly half (48%) were overweight or obese. Twenty-two percent experienced moderate to severe symptoms of anxiety, stress and/or depression. Lower ranking academics (Associate Lecturers and Lecturers) experienced significantly greater feelings of distress, depression and stress compared to their more senior colleagues. No difference in mental health measures were evident between males and females. Higher job stress was associated with higher depressive symptoms and higher anxiety was associated with lower aerobic capacity. In addition, a relationship between mental and cardiometabolic health was evident, whereby higher distress and depressive symptoms were associated with an increased likelihood of MetS.

Study 2 involved a randomised controlled trial comparing the effect of 14-weeks of CT to normal behaviour (control group) on the cardiometabolic health of inactive academics (n=59). Measures of MetS, body composition, insulin resistance, aerobic capacity and markers of systemic inflammation including interleukin-6 (IL-6) and tumor necrosis factor (TNF-α) were measured before and after training. Results showed significant decreases in fat mass (%) and central adiposity, and increases in lean mass and aerobic capacity in CT compared to control. There were no changes to IL-6, TNF-α, insulin resistance or lipid profile in CT or control groups. Of note, changes in insulin resistance were positively associated with IL-6 in the control group only.

Using the same 14-week randomised controlled trial as study 2, study 3 aimed to determine the effect of CT on mental health in inactive academics (n=59). Symptoms of depression, anxiety, and stress (job specific and general), effort-reward imbalance, and systemic inflammation (IL-

6 and TNF-α) were measured pre- and post-intervention. Further, measures of wellness (sleep duration, sleep quality, stress, fatigue, mood and workload) were self-reported daily, before and during the last 2-weeks of the intervention. Results showed a significant decrease in symptoms of depression after CT. However, there were no changes observed in effort-reward imbalance or symptoms of anxiety, stress (general or job-specific) or daily wellness measures. No relationships were evident between changes in stress and changes in systemic inflammation or symptoms of depression.

This thesis reports evidence of poor mental and cardiometabolic health in academics with low levels of physical activity. In turn, a 14-week concurrent exercise program was implemented within the academic workplace, with subsequent improvements in cardiometabolic and mental health. In particular, CT resulted in improvements to body composition, aerobic capacity, and symptoms of depression in the inactive academic workplace. The findings relay the benefits of CT for non-clinical populations at higher risk of mental and physical health disorders. The results may have important implications for both inactive academics and the broader university sector.