PERFORMANCE OPTIMISATION THROUGH THE USE OF COMPRESSION GARMENTS AND BIOSENSORS

By

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Author Declaration

I certify that the present study of the dissertation has not been submitted for a degree nor is a part of the requirements for other qualification. This excludes the full acknowledgment in this thesis.

I also certify that this thesis has been completed by myself. Any other support for my current study and in the dissertation itself has been fully acknowledged. Additionally, I certify that all literature and sources of information are cited in this thesis.

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Abbreviations

A	:	Ankle
AT	:	Anterior Thigh
ATP	:	Adenosine Triphosphate
BF	:	Biceps Femoris
Bla-	:	Blood Lactate
BRS	:	Baroreflex Sensitivity
C	:	Calf
CCGs	:	Correct Size Compression Garments
CGs	:	Compression Garments
CK	:	Creatine Kinase
CLBCGs	:	Well Fitted Lower Body Compression Garments
CMJ	:	Countermovement Jump
CMVJ	:	Countermovement Vertical Jump
C-RP	:	C-Reactive Protein
CS	:	Compression Stocking
CWBCGs	:	Corrected Size Whole Body Compression Garments
DBP	:	Diastolic Blood Pressure
DOMS	:	Delayed Onset Muscle Soreness
DVT	:	Deep Vein Thrombosis
E	:	Exercise

ECG	:	Electrocardiogram
EEG	:	Electroencephalography
EIMD	:	Exercise Induced Muscle Damage
ES	:	Effect Sizes
FAST	:	Fabric Assurance by Simple Testing
FFT	:	Fast Fourier Transform
FVC	:	Forearm Vascular Conductance
G	:	Gluteus
GM	:	Gastrocnemius Medialis
GM	:	Gluteus Maximus
H	:	Hip
HF	:	High Frequency
HR	:	Heart Rate
HRV	:	Heart Rate Variability
Hz	:	Hertz
K	:	Knee
KES-F	:	Kawabata Evaluation System for Fabrics
LBCGs	:	Lower Body Compression Garments
LF	:	Low Frequency
LFHF	:	Rate of Low Frequency and High Frequency
LSCGs	:	Long- Sleeve Compression Garments
MA	:	Medial Ankle
MAP	:	Mean Arterial Blood

MC	:	Medial Calf
Mean	:	Mean Value
Mean NN	:	The Mean Of RR Intervals
MECS	:	Medical Elastic Compressive Stockings
MM	:	Medial Malleolus
MSA	:	Mid-shank Anterior
MSP	:	Mid-shark Posterior
MTA	:	Mid-thigh Anterior
MTP	:	Mid-thigh Posterior
MVC	:	Maximal Voluntary Knee Extension
MVIC	:	Maximal Voluntary Isometric Contraction
NCGs	:	Non Compression Garments
NCS	:	Non Compression Stocking
NN50	:	Number Of Successive RR Interval Pairs More Than 50 ms
nTHI	:	Tissue Haemoglobin Index
O_2	:	Oxygen
OLBCGs	:	Loose Fitted Lower Body Compression Garments
OWBCGs	:	Over Size Whole Body Compression Garments
PC	:	Posterior Calf
PDE	:	Skeletal Muscle Intracellular Phosphodiester
PME	:	Muscle Metabolites Phosphomonoester
PMS	:	Perceived Muscle Soreness
pNN50	:	Percentage Of All Sequential RR Deviations Exceeding 50 ms

PRE	:	Rating of Perceived Exertion
PT	:	Posterior Thigh
QT	:	QT intervals
QTc	:	Corrected of QT intervals
R	:	Recovery
RER	:	Respiratory Exchange Ratio
RF	:	Rectus Femoris
RFD	:	Rate Of Force Development
RMSSD	:	The Root Mean Square Of Subsequent Deviation
RPE	:	Rate Of Perceived Exertion
RR	:	RR intervals
S	:	Shank
SBP	:	Systolic Blood Pressure
SCGs	:	Compression Shorts
SD	:	Standard Deviation
SDNN	:	A Standard Deviation Of RR Intervals
SE	:	Standard Error
SLCGs	:	Sleeveless Compression Garments
SSLCGs	:	Short-Sleeved Compression Garments
ST	:	ST intervals
STD	:	Standard Deviation
TES	:	Esophageal Temperature
TOI	:	Tissue Oxygenation Index

UCGs	:	Undersize Compression Garments
ULF	:	Under Low Frequency
VLF	:	Very Low Frequency
VO2	:	Oxygen Consumption
YRS	:	Years
WBCGs	:	Whole Body Compression Garments

Abstract

It is well known that exercise-induced muscle damage and the disruption of metabolic processes occur in individuals who are not accustomed to intensive physical activity. Disruption in the muscles' contractile elements and metabolic processes results in a reduction in sports performance and muscle power output alike. There were three main aims of the current study, and the first aim was to determine whether compression garments (CGs) affected cardiovascular function during exercise of running trainers. The second aim was to establish whether electrocardiogram (ECG) signals are affected by wearing CGs on the recovery phase. The last purpose was to investigate the relationship between brain activity and the application of CGs.

Subjects randomly performed the experiments in different garments including compression garments and non-compression garments. ECG and EEG sensor collected the electrical signals based on the electrodes attached to the body. The sensors of ECG-Flex/Pro were used for the collection of cardiovascular signal through lead II position. Besides, the raw EEG signal were collected from the surface of head via O1 position using Flexcomp Infiniti Monitor. Parameters were compared based on paired t-tests. Statistical significance was reported when the p-value was lower than 0.05.

As part of the study, participants completed the designed protocols for data collection. In Experiment 1, eight subjects (women, n=3; men, n=5; 25.1 ± 3.8 yrs; 61.4 ± 13.7 kg; 165.9 ± 8.3 cm; 19.6 ± 4.4 kg.m-2) completed a running protocol for ECG collection wearing non-compression garments (NCGs), under-size compression garments (UCGs) and correct-size compression garments (CCGs). Experiment 2 (n=14; 24.7±4.5 years, 166.0±7.6 cm; 60.9±12.0 kg) concentrated on the recovery phase. In Experiment 3, ten subjects (men, n=5; women, n=5; 24.1 ± 4.5 yrs; 58.7 ± 11.0 kg; 163.6 ± 7.7 cm; 21.77 ± 2.63 kg.m-2) completed the tests with electroencephalography (EEG) collection wearing no-compression garments (NCGs) and fitted compression garments (CCGs). Electrocardiogram (ECG) and electroencephalogram (EEG) signals were collected using wearable bio-sensors.

In Experiment 1, results obtained indicated significant alteration ($p < 0.05$) in heart rate between both correctly fitted compression garments (CCGs), undersize compression garments (UCGs), and non-compression garments (NCGs). QT intervals (QT), corrected of QT intervals (QTc) was demonstrated significant difference in UCGs compared with NCGs. The results of Experiment 2 indicated a significant difference between CGs and NCGs at the end of the running test and from 90 minutes onwards during the recovery phase ($p < 0.05$). ECG parameters showed some significant difference in heart rate (HR), ST interval and corrected QT (QTc) interval ($p < 0.05$). Moreover, there were significant differences in alpha, beta and theta power spectral density between CCGs and NCGs in Experiment 3 ($p < 0.05$). The findings of this research conclude that the utilization of CGs during exercise produces positive effects on cardiovascular function and brain activity.