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Influence of antioxidant supplementation during exercise in the heat

Submission date	**Recruitment status**	[X] Prospectively registered
22/10/2014	No longer recruiting	[ ] Protocol
Registration date	**Overall study status**	[ ] Statistical analysis plan
12/12/2014	Completed	[ ] Results
Last Edited	**Condition category**	[ ] Individual participant data
18/09/2017	Other	[ ] Record updated in last year

Plain English summary of protocol

Background and study aims
Regular exercise is an important part of a healthy lifestyle. However, all forms of exercise cause some oxidative stress which can lead to cell damage. Moderate exercise produces healthy amounts of reactive chemicals (such as reactive oxygen), which is beneficial. However, prolonged vigorous exercise, particularly in hot environments (e.g. prolonged running in the sun), may produce a lot of reactive chemicals and result in damage to muscles and vital organs. Evidence suggests that a diet rich in foods that are naturally high in antioxidants is beneficial for health. Antioxidants reduce the effects of oxidative stress by mopping up (neutralizing) reactive chemicals when they develop, preventing the cell damage. The aim of this study is to investigate whether short-term antioxidant supplementation can influence the ability of enzymes to protect muscle cells when oxidative stress is caused by exercise in the heat. The supplements used are Quercetin and Vitamin C. Quercetin is one of the most abundant type of antioxidants called flavonoids, present in many plants and foods, such as red wine, onions, green tea, apples and berries. Vitamin C (also known as ascorbic acid) is a water-soluble vitamin and a powerful antioxidant. It is abundant in fruits and vegetables, especially citrus fruits. The researchers want to know whether supplementation with these antioxidants (in tablet form) could be used to improve exercise performance in hot environments.

Who can participate?
Male volunteers aged 18 to 48 years, who are active (exercise more than 20 minutes per day, at least 3 times per week), non-smokers, not taking any supplementation and who do not suffer from any disease

What does the study involve?
Participants are asked to attend a preliminary visit before the experimental trial. When there, anthropometric measurements are taken (height, body mass and percentage of body fat). They then perform two separate tests on a motorized treadmill, one for determining the relationship between running speed and their oxygen uptake and the other to measure peak oxygen uptake (their maximum ability to deliver oxygen to the muscles - VO2max). From the results of these two tests, we can work out how hard each participant should be asked to run in the actual experimental trial. Participants are then asked to run in the heat at 70% VO2max (that is, at 70% of their peak oxygen uptake) for 60 minutes where the temperature is kept at 33°C and with

40% relative humidity to familiarise themselves with the test. For the actual trials, each participant is randomly assigned to receive either a dummy tablet (CON), Quercetin (Q), or Quercetin plus vitamin C (QC). They are all asked to take a 1000 mg tablet 14 hours (that is, the night before) the study begins, then to take a further tablet of 500 mg two hours before they start the experimental trial. Before they start the exercise, their body mass is recorded. They are then asked to do a warm up on a motorized treadmill for 5 minutes (at 50% VO2max) before running at 70% VO2max (33°C, 40% relative humidity) for one hour. Expired gases and blood samples are taken during the last minute of the warm up and then every 20 minutes during the trial and then one hour after they have stopped the exercise. Heart rate, temperature and the participants' perceptions on how tired and hot they are recorded every 10 minutes. After collection of exhaled gases, the participants are given plain water and whatever tablet they have been allocated to take. Each participant is weighed after they have finished exercising. A muscle biopsy sample is collected 2 days before and 2 days after the experimental trial. Participants do have the option of saying no to this if they wish. The participants are asked to do the experimental trial on three occasions. They are assigned to a different tablet on each occasion and all participants will take all three tablets. There is a seven-day break between each trial.

What are the possible benefits and risks of participating?
At the end of the study, each participant will be given a copy of their results and personalised feedback on their fitness level, diet, blood results (including haemoglobin, total antioxidant status and plasma volume) and body composition analysis (percentage body fat and muscle mass). During the VO2max test participants will reach their maximal ability to take up oxygen and this will require maximum effort for 1-2 minutes. However, they will decide when they can no longer maintain this level of exercise and, therefore, when the test ends. They should recover fully in around 5 minutes. The blood samples taken might cause minor discomfort and bruising. The muscle biopsies may cause bleeding and a little soreness afterwards. Participants will be given a sheet that lists the possible complications, including those that are more severe (e.g. intramuscular bleeding, infection). These complications are very rare, however, and the risks are minimised by following best practice. Exercise in the heat can endanger health and impair exercise performance. However, during the 1 hour run on the treadmill, participants will be asked to drink an appropriate beverage at the start of, every 20 minutes and at the end of the exercise bout to prevent dehydration. Participants will also be asked to stop exercising and will be removed from the heat if their body core temperature exceeds 39.5°C. All participants will be asked to wear minimal clothing. Importantly, volunteers are free to withdraw from the study at any point.

Where is the study run from?
The Exercise Physiology Laboratory within the Department for Health at the University of Bath (UK)

When is the study starting and how long is it expected to run for?
January 2015 to September 2016

Who is funding the study?
1. Malaysian Higher Education Authority (Malaysia)
2. University of Bath (UK)

Who is the main contact?
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Contact information

Type(s)
Scientific

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Additional identifiers

EudraCT/CTIS number

IRAS number

ClinicalTrials.gov number

Secondary identifying numbers
N/A

Study information

Scientific Title
Influence of antioxidant supplementation on oxidative stress and thermal tolerance during exercise heat stress

Study objectives
It is hypothesised that antioxidant supplementation will significantly influence the responses of antioxidant enzymes and intramuscular heat shock proteins (HSPs) and enhance endurance capacity during exercise in the heat. The null hypothesis is that there will be no difference in the responses of antioxidant enzymes and HSPs between the antioxidant supplementation group and the control group.

Ethics approval required
Old ethics approval format

Ethics approval(s)
NRES Committee South West of England - Frenchay, 26/06/2014, ref: 14/SW/0098.

Study design

Randomised cross-over design

Primary study design
Interventional

Secondary study design
Randomised cross over trial

Study setting(s)
Other

Study type(s)
Treatment

Participant information sheet
Not available in web format, please use the contact details to request a patient information sheet

Health condition(s) or problem(s) studied
Antioxidant supplementation, oxidative stress, Heat Shock Protein (HSPs), antioxidant enzyme

Interventions
Main Experimental Trials: Participants will be randomly assigned to either consume a tablet of 1000 mg Quercetin (Q), Quercetin plus vitamin C (QC) or placebo control (CON) 14 hours (the night before the trial). 2 hours before exercise, participants will consume a tablet of 500 mg Quercetin, Quercetin plus vitamin C or placebo control.

Participants will be asked to run on a motorized treadmill at 70% VO2max (33°C, 40% relative humidity) for one hour. The motorized treadmill will be remained flat. At 10 minute intervals during the trial, heart rate, rectal temperature, rating of perceived exertion and thermal discomfort will be recorded. Expired air and blood samples will be obtained every 20 minutes during the trial and after one hour post-exercise. Following the collection of expired air, participants will be asked to consume 3 ml.kg-1 body weight of plain water with tablet of either Quercetin, Quercetin plus vitamin C or placebo. Post-exercise nude body weight will be also recorded.

Additionally, a muscle biopsy sample will be taken 2 days before and 2 days after the actual experimental trials from willing participants.

Each trial will be separated by at least 7 days. For the second and third trial, the study protocol will be identical to the first trial.

Intervention Type
Supplement

Primary outcome measure
Oxidative stress blood markers and intramuscular heat shock protein (HSPs) following each experimental trial.
Blood antioxidant measurements: quercetin, ascorbic acid, urate, oxidised/reduced glutathione (GSSG-GSH) ratio, total antioxidant capacity and oxidative stress biomarkers (lipid peroxidation (MDA) and protein carbonyl).

Measured before warm-up, immediately after warm-up, every 20 minutes during the one hour exercise bout and post one hour exercise.

Secondary outcome measures
Intramuscular heat shock proteins (HSP 70 and HSP60), measured 2 days pre-exercise and 2 days post-exercise

Overall study start date
05/01/2015

Completion date
30/09/2016

Eligibility

Key inclusion criteria
1. Males
2. Aged between 18-48 years
3. Individuals free from cardiovascular, metabolic or joint disease as determined by a standard health questionnaire
4. Non-smoker
5. Not taking any mineral or vitamin supplement (other than those provided) or any other antioxidant supplements for 2 weeks before and during the study

Participant type(s)
Healthy volunteer

Age group
Adult

Lower age limit
18 Years

Upper age limit
48 Years

Sex
Male

Target number of participants
12

Key exclusion criteria
1. Individuals taking vitamin supplements
2. Any bleeding disorder or taking medication which impacts blood coagulation
3. Known tendency towards keloid scarring
4. Known sensitivity or allergy to any local anaesthetic medicines
5. Any reported use of substance which may pose undue personal risk to participants or introduce bias into the experiment
6. Any other condition or behaviour deemed either to pose undue risk to participants or

introduce bias into the experiment
7. A known renal dysfunction

Date of first enrolment
26/01/2015

Date of final enrolment
16/09/2016

Locations

Countries of recruitment
England

United Kingdom

Study participating centre
University of Bath
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Sponsor information

Organisation
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University/education

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ROR

https://ror.org/002h8g185

Funder(s)

Funder type
University/education

Funder Name
Malaysian Higher Education Authority (Malaysia)

Funder Name
University of Bath (UK)

Alternative Name(s)
UniofBath

Funding Body Type
Private sector organisation

Funding Body Subtype
Universities (academic only)

Location
United Kingdom

Results and Publications

Publication and dissemination plan
Planned publication in a high-impact peer reviewed journal.

Intention to publish date

Individual participant data (IPD) sharing plan
The datasets generated during and/or analysed during the current study are not expected to be made available. All the participants' data were stored in a password-protected university PC.

IPD sharing plan summary
Not expected to be made available

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
HRA research summary			28/06/2023	No	No