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Neural effects of exercise, diet and sleep

Submission date
10/11/2015

Recruitment status
No longer recruiting

Registration date
16/11/2015

Overall study status
Completed

Last Edited
30/12/2022

Condition category
Mental and Behavioural Disorders

[X] Prospectively registered
[ ] Protocol
[ ] Statistical analysis plan
[ ] Results
[ ] Individual participant data
[ ] Record updated in last year

Plain English summary of protocol

Background and study aims
The brain of a child and that of an adult are organised very differently. In adolescence the brain undergoes extensive remodelling, maturing and building connections. It is during this time that the cerebral cortex (the folded, outer part of the brain) undergoes extensive changes, marking the development of complex thinking processes, increasing a persons' capacity for learning. There are many known benefits of taking part in regular physical activity for the body, but there is a good deal of evidence that it is also valuable for healthy cerebral development. Despite this, teenagers are becoming increasingly inactive, many becoming overweight or obese. Many studies have shown that cognitive function (mental abilities such as thinking, reasoning, memory and attention) is improved after taking part in exercise in children, boosting academic performance. The aim of this study is to find out whether taking part in high-intensity exercise will help to improve cognitive function and learning in adolescents.

Who can participate?
Healthy adolescents aged between 15 and 19 who attend a participating high school or vocational school.

What does the study involve?
Participants are randomly allocated to one of two groups. Those in the first group take part in three 20 minute exercise sessions every week during school hours. In these sessions, participants complete a warm up (low intensity), and then high intensity interval running exercise such as running or circuit training, followed by a short low intensity cool down. Those in the second group continue with their usual exercise regime and have no extra training sessions. At the start of the study and then again after one months, participants in both groups have a scan to test their brain activity, as well as completing a number of tests to find out if there has been any change to their cognitive function. A subgroup of the study population also have a scan to test their brain activity before and after a single high intensity interval exercise to study the effects of acute exercise on brain functioning.

What are the possible benefits and risks of participating?
Participants will benefit from taking part in the study are they will be able to receive detailed information about their health and fitness levels, as well as feedback about any changes they could make to improve. There is a small risk of injury during the exercise training, although measures will be taken to prevent this.

Where is the study run from?
University of Jyväskylä (Finland)

When is the study starting and how long is it expected to run for?
January 2015 to December 2018

Who is funding the study?
Jenny and Antti Wihuri Foundation (Finland)

Who is the main contact?
Dr Eero Haapala

Contact information

Type(s)
Scientific

Contact name
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Additional identifiers

Protocol serial number
N/A

Study information

Scientific Title
High-intensity exercise training intervention study to improve cognitive functions and learnining in adolescents

Acronym
NEEDS

Study objectives
High-intensity and low-volume exercise intervention will improve cognitive function and learning in the study group compared to the control group during the three month intervention period.

Ethics approval required
Old ethics approval format

Ethics approval(s)
Ethics committee of University of Jyväskylä, 25/08/2015

Study design
Current study design:
Single-centre single-blind parallel controlled cross-over study

Previous study design:
Single-centre single-blind cluster-randomized controlled trial

Primary study design
Interventional

Study type(s)
Other

Health condition(s) or problem(s) studied
Cognition, learning, brain function

Interventions
Current Interventions as of 17/03/2017:
Participants are allocated to the intervention group or the control group.

Intervention group: Participants take part in high-intensity and low volume exercise training during school days. The aim of the exercise intervention is to provide three short (approximately 20 minute) exercise sessions weekly and to improve cardio-respiratory fitness, totaling in all 12 sessions over the 1-month intervention period. As a training mode high intensity running will be adopted. The protocol includes 3 minute warm-up at light to moderate intensity and eight to twelve repeated bouts of 0.5 to 1 minute at 90% to 100% of the capacity of the participants interspersed by 75–90 second recovery at light intensity, followed by 3 minute recovery period at light to moderate intensity.

In the sub-study, the participants participate in three brain scans. First scan is performed two weeks before second visit to the laboratory. During the second visit, the participants perform a brain scan before and after the acute high intensity interval exercise. The exercise is performed using mechanically braked cycle ergometer. The exercise protocol include eight 30-second maximal intensity exercise bouts interspersed by 90-second active recovery.

Control Group: Participants will continue their usual physical activity behavior without supervised exercise by the study.

There is no follow-up planned.

Previous Interventions:
Participants are randomly allocated to the intervention group or the control group.

Intervention group: Participants will take part in high-intensity and low volume exercise training during school days. The aim of the exercise intervention is to provide three short (approximately

20 minute) exercise sessions weekly and to improve cardio-respiratory fitness and motor performance, totaling in all 24 sessions over the 2-month intervention period. As a training mode high intensity running and circuit training will be adopted. The protocol includes 3 minute warm-up at light to moderate intensity and eight to twelve repeated bouts of 1 minute at 90% to 100% of the capacity of the participants interspersed by 75–90 second recovery at light intensity, followed by 3 minute recovery period at light to moderate intensity.

Control Group: Participants will continue their usual physical activity behavior without supervised exercise by the study.

After the intervention period, the participants will be followed-up until the end of vocational and high school for approximately for two years (from baseline) but no intervention is provided during follow-up.

Intervention Type
Behavioural

Primary outcome(s)
Current primary outcome measures as of 17/03/2017:
1. Attention, working memory, associative learning, processing speed and executive function is measured using the computerized CogState battery at the baseline and at the 3 months
2. Brain functions by magnetoencephalography (MEG) in a subsample of participants taking part in sub study investigating the effects of acute high intensity interval training on cognition and brain functioning.

Previous primary outcome measures:
1. Attention, working memory, associative learning, processing speed and executive function is measured using the computerized CogState battery at the baseline and at the 3 months
2. Reading and arithmetic skills are measured using pseudo word reading and KTLT tests, respectively, at the baseline and at the 3 months
3. Brain functions by magnetoencephalography (MEG) at baseline and 3 months

Key secondary outcome(s))
Current secondary outcome measures as of 17/03/2017:
1. Cardiorespiratory fitness is measured using maximal cycle ergometer test with respiratory gas analyses at baseline and 3 months
2. Physical activity is measured using PA-3D accelerometer, the Youth Physical Activity Questionnaire and the Youth Sedentary Behaviour questionnaire at baseline and 3-months
3. Sleep length and quality is measured using the Epworth sleepiness scale and Basic Nordic Sleep Questionnaire at baseline and 3 months
4. Arterial stiffness is measured using an Arteriograph at baseline and 3 months
5. Motivation is measured using a questionnaire developed by Professor Niemivirta in the 2002 study "Motivation and performance in context: The influence of goal orientations and instructional setting on situational appraisal and task performance" at baseline and 3 months
6. Self-efficacy is measured using a questionnaire developed by Professor Niemivirta in the 2002 study "Motivation and performance in context: The influence of goal orientations and instructional setting on situational appraisal and task performance" at baseline and 3 months
7. Depression is measured using the 21 item Beck Depression Scale at baseline and 3 months

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4. Arterial stiffness is measured using an Arteriograph at baseline and 3 months
5. Adiposity is measured using dual-energy x-ray absorbtiomerty at baseline and using bio-impedance device at baseline and 3 months
6. Motivation is measured using a questionnaire developed by Professor Niemivirta in the 2002 study "Motivation and performance in context: The influence of goal orientations and instructional setting on situational appraisal and task performance" at baseline and 3 months
7. Self-efficacy is measured using a questionnaire developed by Professor Niemivirta in the 2002 study "Motivation and performance in context: The influence of goal orientations and instructional setting on situational appraisal and task performance" at baseline and 3 months
8. Depression is measured using the 21 item Beck Depression Scale at baseline and 3 months

Completion date
30/12/2018

Eligibility

Key inclusion criteria
Current inclusion criteria as of 17/03/2017:
1. Aged 15-19 years of age
2. Attending high school and vocational schools

Previous inclusion criteria:
1. Aged 15-17 years of age
2. Attending high school and vocational schools

Participant type(s)
Healthy volunteer

Healthy volunteers allowed
No

Age group
Child

Lower age limit
15 years

Upper age limit
19 years

Sex
All

Key exclusion criteria

1. Heart disease
2. Untreated or poorly controlled type 1 diabetes
3. Musculoskeletal disease or trauma
4. Severe depression or anxiety

Date of first enrolment
01/12/2015

Date of final enrolment
30/03/2017

Locations

Countries of recruitment
Finland

Study participating centre
University of Jyväskylä
Department of Biology of Physical Activity
Jyväskylä
Finland
FI-40014

Sponsor information

Organisation
University of Jyväskylä

ROR
https://ror.org/05n3dz165

Funder(s)

Funder type
Charity

Funder Name
Jenny ja Antti Wihurin Rahasto

Alternative Name(s)
Jenny JA Antti Wihurin Rahasto sr, Jenny and Antti Wihuri Foundation

Funding Body Type
Private sector organisation

Funding Body Subtype
Trusts, charities, foundations (both public and private)

Location
Finland

Funder Name
Päivikki and Sakari Sohlberg Foundation

Results and Publications

Individual participant data (IPD) sharing plan
Not provided at time of registration

IPD sharing plan summary
Not provided at time of registration

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Other publications		01/09/2020	30/12/2022	Yes	No