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Aerobic exercise to achieve a higher cerebral blood flow

Submission date 30/06/2026	**Recruitment status** No longer recruiting	[_] Prospectively registered [_] Protocol
Registration date 01/07/2026	**Overall study status** Completed	[_] Statistical analysis plan [_] Results
Last Edited 01/07/2026	**Condition category** Circulatory System	[_] Individual participant data [X] Record updated in last year

Plain English summary of protocol

Background and study aims
Maintaining healthy blood flow to the brain is important for supporting cognitive function and reducing the risk of age-related cognitive decline. Reduced cerebral blood flow is associated with aging and several neurological diseases. Aerobic exercise is known to improve overall cardiovascular and brain health, but there is growing interest in identifying exercise strategies that may further enhance blood flow to the brain. One factor known to increase cerebral blood flow is a temporary rise in carbon dioxide levels in the blood, which causes blood vessels in the brain to widen. Nasal breathing during exercise may naturally increase carbon dioxide retention because it can reduce the amount of air moved in and out of the lungs compared with normal breathing through both the nose and mouth. As a result, nasal breathing may provide a simple, non-invasive way to increase blood flow to the brain during exercise. The aim of this study was to determine whether a 4-week aerobic training program performed using nasal breathing would produce different cerebrovascular responses than a similar program performed using conventional breathing. The study specifically examined blood flow in the carotid arteries during exercise and evaluated whether participants adapted to the breathing method over time. It was hypothesized that participants using nasal breathing would demonstrate greater increases in blood flow to the brain during exercise and would develop physiological adaptations that reduced the initial cardiorespiratory challenges associated with breathing only through the nose.

Who can participate?
Healthy men between 18 and 30 years of age

What does the study involve?
Participants attended an initial screening and consent session to confirm eligibility and learn about the study procedures. They then completed a baseline assessment visit before beginning the training program. At the beginning and end of the study, participants completed a graded exercise test on a semi-recumbent cycle ergometer. During these tests, researchers measured heart rate, blood pressure, breathing gases, oxygen consumption, body composition, and blood flow in the carotid arteries using ultrasound imaging. Participants performed these tests using their assigned breathing method. Participants were randomly assigned to one of two groups. One group completed all exercise sessions using nasal breathing only, while the other group

used their normal breathing pattern through both the nose and mouth. The training program lasted 4 weeks and consisted of supervised cycling exercise sessions performed four times per week at a moderate intensity. Each session lasted 30 minutes and was monitored by research staff. Throughout the intervention, researchers measured heart rate, blood pressure, blood oxygen saturation, energy expenditure, and any symptoms that might indicate discomfort or difficulty related to the breathing condition. Participants were also asked to maintain their usual diet and physical activity levels and to avoid excessive caffeine, alcohol, and other substances that could affect the study measurements. Researchers compared measurements collected before and after the 4-week program to determine how the different breathing methods influenced blood flow to the brain and cardiovascular responses during exercise.

What are the possible benefits and risks of participating?
Participation in this study involves minimal risk. Participants may be exposed to a small amount of radiation during the body composition scan, although the level of exposure is considered low and unlikely to cause harm. Ultrasound assessments may cause minor discomfort due to the application of gel on the neck. Exercise testing and training may result in temporary muscle soreness, fatigue, headaches, dizziness, or lightheadedness, particularly when exercising with nasal breathing. Blood pressure measurements may also cause brief discomfort from cuff inflation.
Participants may not receive direct medical benefits from taking part in this study; however, they will receive detailed information about their health and fitness, including measures of body composition, cardiovascular function, respiratory performance, and cognitive function before and after the training program. Participation may also provide insight into individual responses to exercise and breathing techniques. More broadly, the findings from this study may help researchers better understand how breathing patterns during exercise influence blood flow to the brain and could contribute to future strategies aimed at supporting long-term brain and cognitive health.

Where is the study run from?
Baylor University (USA)

When is the study starting and how long is it expected to run for?
March 2023 to March 2024

Who is funding the study?
Texas Chapter of the American College of Sports Medicine (USA)

Who is the main contact?
Dr Jose M. Moris, jose.moris@tamiu.edu

Contact information

Type(s)
Public, Scientific, Principal investigator

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Study information

Scientific Title
Utilizing nasal breathing during aerobic exercise is associated with a higher cerebral blood flow volume

Acronym
NBX-CBF

Study objectives
1. To investigate the effects of a 4-week aerobic training program using prescribed nasal breathing (NB) versus unrestricted combined breathing (CB) on cerebrovascular hemodynamics in healthy young males.
2. To determine if over the 4-week training period, the NB group would demonstrate physiological adaptations to overcome initial cardiorespiratory limitations imposed by the breathing protocol as a sign of rapid adaptability to their breathing condition.

Ethics approval required
Ethics approval required

Ethics approval(s)
Approved 22/03/2023, Baylor University Institutional Review Board (One Bear Place #97310, Waco, 76798, United States of America; +1 (0)254 710 3708; irb@baylor.edu), ref: 2028473

Primary study design
Interventional

Allocation
Randomized controlled trial

Masking
Open (masking not used)

Control
Active

Assignment
Parallel

Purpose

Screening

Study type(s)

Health condition(s) or problem(s) studied
Cerebrovascular hemodynamics in healthy young males

Interventions
This randomized controlled trial investigates the acute hemodynamic and cerebrovascular adaptations to nasal breathing during aerobic exercise following a 4week training intervention. Participants are block randomized to either a nasal breathing (NB) group or a combined oronasal breathing control (CB) group. Participants complete a supervised 4-week cycling program (four sessions/week, 30 minutes/session at 65–70% of predicted maximal heart rate) under their assigned breathing condition.

Primary outcomes include cerebral blood flow (CBF), assessed via Doppler ultrasound of the internal and external carotid arteries, and hemodynamic responses (heart rate, systolic and diastolic blood pressure) measured at rest and during graded maximal exercise testing (GXT). Secondary outcomes include oxygen uptake, oxygen pulse (as an estimate of stroke volume), and exercise performance metrics.

Assessments are conducted pre- (Visit 1) and post-intervention (Visit 2), with CBF and cardiovascular variables measured at standardized relative intensities (40–100% of VO_2max) during GXT. The study aims to determine whether nasal breathing training enhances cardiovascular and cerebrovascular efficiency during aerobic exercise.

Intervention Type
Behavioural

Primary outcome(s)
1. Cerebral blood flow measured using ultrasound sonography during GXT (visit 1 and visit 2), calculating volumetric CBF during peak systolic and diastolic phases in the internal and external carotid artery, at baseline (V1) and at the end of the intervention (following 4 weeks of the intervention, V2)

Key secondary outcome(s)
1. Cardiac limitation measured using oxygen pulse (O2pulse, ml/beat), calculated by dividing oxygen uptake (VO2, mL·min-1) by HR (bpm), which is an analogous estimate of stroke volume, at baseline (V1) and at the end of the intervention (following 4 weeks of the intervention, V2)

Completion date
14/03/2024

Eligibility

Key inclusion criteria
1. Male individuals between 18 and 30 years of age
2. No orthopedic limitations or any recent surgery during the past 2 years that would limit participation in the study
3. No absolute or relative contraindications for exercise testing or prescription as outlined by the American College of Sports Medicine

4. On no medications or receiving treatment for any cardiopulmonary disease
5. Not taking any medication that affects blood pressure and/or heart rate

Healthy volunteers allowed
Yes

Age group
Adult

Lower age limit
18 Years

Upper age limit
30 Years

Sex
Male

Total final enrolment
22

Key exclusion criteria
1. Females
2. Males outside of the age range
3. Pre-existing cardiometabolic conditions

Date of first enrolment
23/03/2023

Date of final enrolment
08/03/2024

Locations

Countries of recruitment
United States of America

Sponsor information

Organisation
Baylor University

ROR
https://ror.org/005781934

Funder(s)

Funder type

Funder Name
Investigator initiated and funded

Funder Name
Texas Chapter of the American College of Sports Medicine (TACSM)

Results and Publications

Individual participant data (IPD) sharing plan

IPD sharing plan summary
Not expected to be made available