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Effects of hypoventilation sprint training on physical performance in professional ice hockey players

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Registration date 04/09/2026	**Overall study status** Completed	[_] Statistical analysis plan [_] Results
Last Edited 04/09/2026	**Condition category** Other	[_] Individual participant data [X] Record updated in last year

Plain English summary of protocol

Background and study aims

Ice hockey players often perform many short, very intense skating sprints during a match and need to recover quickly between efforts. Training methods that target repeatedsprint ability may therefore help players to improve sportspecific fitness. Voluntary hypoventilation at low lung volume (holding the breath after exhalation during exercise) can temporarily reduce oxygen levels and increase carbon dioxide in the body, which may stimulate different physiological adaptations compared with normal breathing. This study aimed to compare the effects of a 5week onice repeatedsprint training programme performed with voluntary hypoventilation at low lung volume versus the same training with normal breathing on hockeyspecific performance and selected physiological responses in professional ice hockey players.

Who can participate?

Male professional ice hockey players from the secondhighest professional league in Slovakia were invited to take part. Participants had to be in good general health, without chronic respiratory disease or hypertension, and had to be able to attend at least 80% of the regular team training sessions and the experimental training sessions during the study period. Players who developed illnesses requiring antibiotics or who sustained injuries that significantly interrupted training during the study period were not able to complete the full protocol.

What does the study involve?

The study was carried out during the preseason period. All participating players followed the same team training programme, consisting of about five sessions per week (approximately 11 hours of training: 4 hours onice and 7 hours office). In addition, players completed ten supervised repeatedsprint training sessions on ice over 5 weeks. In these sessions, they performed short maximal skating sprints over distances of 36–44 metres with passive recovery between sprints. Experimental group performed sprints with breath-holding after exhalation. Control group did the same training with normal breathing. The sprint distance, number of sprints and recovery time were progressively adjusted over the 5 weeks.

Before and after the 5week intervention, all participants completed a series of tests: an onice repeatedsprint ability test, a YoYo Intermittent Recovery Test Level 2, a short highintensity cycling test, a maximal incremental cycling test to assess cardiorespiratory fitness, static and walking breathholding tests, and resting blood sampling for haematological measurements. All tests were carried out under standardized conditions, and participants received detailed instructions before each test.

What are the possible benefits and risks of participating?
By taking part, players could benefit from additional, structured onice conditioning aimed at improving repeatedsprint performance and intermittent endurance. The study was also designed to help coaches and sports scientists to better understand how breathholding strategies during sprint training influence performance and physiological responses in ice hockey. However, direct performance benefits for each individual player could not be guaranteed.

The risks were similar to those associated with demanding highintensity training, such as temporary fatigue, muscle soreness, and discomfort during maximal exercise tests. Breathholding during sprints could cause shortlasting feelings of breathlessness or dizziness in some players, but the protocol was carefully supervised, and players could stop at any time if they felt unwell. All procedures were reviewed and approved by the institutional ethics committee, and safety precautions were followed throughout the study.

Where is the study run from?
The study was coordinated by the Faculty of Physical Education and Sports at Comenius University in Bratislava, Slovakia. Onice training sessions and the repeatedsprint test were performed on an indoor ice rink in Hamuliakovo, Slovakia. Laboratorybased tests (cycling, breathholding and blood sampling) were conducted at the Faculty of Physical Education and Sports in Bratislava under standardized environmental conditions.

When is the study starting and how long is it expected to run for?
The study was carried out during one preseason period. For this protocol, all training sessions and measurements took place between May and June 2025. The experimental training programme lasted for 5 weeks, during which players completed ten onice repeatedsprint sessions in addition to their regular team training. Preintervention tests were completed within the week before the intervention started, and postintervention tests were completed within the week after the intervention ended.

Who is funding the study?
The study was funded by research grants from the Ministry of Education, Research, Development and Youth of the Slovak Republic (APVV220047, APVV booster 09I0303V0600062, and APVV230028). These public research funds supported the design, data collection and analysis, but did not influence how the study was conducted or reported.

Who is the main contact?
The main contact for this study is a dean of the Faculty of Physical Education and Sports, Comenius University in Bratislava - prof. Viktor Bielik and his PhD student - Frantisek Lorinczi. Contact details (Viktor Bielik, viktor.bielik@uniba.sk; Frantisek Lorinczi, frantisek.lorinczi@uniba.sk)

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Study information

Scientific Title
Effects of a 5-week on-ice repeated-sprint training with voluntary hypoventilation at low lung volume in professional ice hockey players: a randomised controlled trial

Study objectives
1. To determine whether a 5week onice repeatedsprint training programme combined with voluntary hypoventilation at low lung volume (RSHVHL) led to greater improvements in sportspecific and nonspecific conditioning abilities than matched repeatedsprint training with unrestricted breathing (RSN) in professional ice hockey players
2. To compare the effects of RSHVHL and RSN on selected physiological responses at rest and during exercise, including cardiorespiratory variables, lactate kinetics and haematological parameters

3. To explore which performance and physiological variables were associated with changes in onice repeatedsprint ability following the intervention, using regression analyses

Ethics approval required
Ethics approval required

Ethics approval(s)
Approved 12/12/2022, Etická komisia Fakulty telesnej výchovy a športu (Nábrežie arm. gen. L. Svobodu 9, Bratislava, 814 69, Slovakia; +421 940522111; eticka.komisiafsport@uniba.sk), ref: 6 /2022

Primary study design
Interventional

Allocation
Randomized controlled trial

Masking
Open (masking not used)

Control
Active

Assignment
Parallel

Purpose
Physical condition & sport performance enhancement

Study type(s)

Health condition(s) or problem(s) studied
Physical abilities - aerobic endurance, anaerobic endurance, repeated sprint ability
Breath-holding ability, Lactate clearance, Hematopoiesis

Interventions
Intervention group – repeatedsprint training with voluntary hypoventilation at low lung volume (RSHVHL)
Participants continue their usual team training (about five sessions per week, approximately 11 hours of training: 4 hours onice and 7 hours office) and, in addition, complete ten supervised onice repeatedsprint training sessions over 5 weeks. Each training session consists of allout iceskating sprints over distances of 36–44 metres, performed in sets with passive recovery between sprints. Across the 5week period, sprint distance and the number of repetitions are progressively increased, while the time between sprint departures is progressively reduced, with a constant number of sets. All sprints are performed while holding a hockey stick.

In the intervention group, participants perform the repeatedsprint training with voluntary hypoventilation at low lung volume. Before each sprint, they exhale to approximately functional residual capacity and then skate at maximal velocity while holding their breath until the end of

the sprint. During the recovery periods between sprints, they breathe normally. Participants receive two familiarisation sessions with the hypoventilation technique (one office running and one onice) before starting the intervention.

Control group – repeatedsprint training with unrestricted breathing (RSN)
Participants in the control group follow the same overall team training programme and complete the same ten onice repeatedsprint training sessions over 5 weeks, with identical sprint distances, number of repetitions, recovery intervals and progression of training load. All sprints are performed while holding a hockey stick.

In the control group, participants perform the repeatedsprint training with unrestricted breathing. They are instructed to breathe normally throughout each sprint and during the recovery periods between sprints.

Allocation to groups
Participants are randomly allocated in a 1:1 ratio to the intervention group (RSHVHL) or the control group (RSN) using a parallelgroup design. All training sessions take place on the same indoor ice rink under stable environmental conditions, and the intervention is delivered by qualified coaches and researchers.

Intervention Type
Behavioural

Primary outcome(s)
1. Number of sprints in repeated sprint ability (RSA) test measured using modified on ice RSA test - n x 36 m with maximal effort; start every 30 seconds at preintervention (baseline, within 1 week before the 5week training programme), postintervention (within 1 week after completion of the 5week training programme)

2. Decrement score in RSA test measured using on ice RSA test - 12 x 36 m with maximal effort; start every 30 seconds at preintervention (baseline, within 1 week before the 5week training programme), postintervention (within 1 week after completion of the 5week training programme)

3. Total distance in YoYo intermittent recovery test level 2 measured using YoYo intermittent recovery test level 2 at preintervention (baseline, within 1 week before the 5week training programme), postintervention (within 1 week after completion of the 5week training programme)

4. Lactate clearance measured using enzymatical analysis of capilary blood after modified wingate test (after 6th and 12th minute) at preintervention (baseline, within 1 week before the 5week training programme), postintervention (within 1 week after completion of the 5week training programme)

5. maximal oxygen uptake measured using maximal incremental cycling test at preintervention (baseline, within 1 week before the 5week training programme), postintervention (within 1 week after completion of the 5week training programme)

6. Breath-holding duration measured using static breath-holding test at preintervention (baseline, within 1 week before the 5week training programme), postintervention (within 1 week after completion of the 5week training programme)

7. Breath-holding duration measured using dynamic breath-holding test at preintervention (baseline, within 1 week before the 5week training programme), postintervention (within 1 week after completion of the 5week training programme)

Key secondary outcome(s)
1. red blood cell count measured using blood sampling & analysis at preintervention (baseline, within 1 week before the 5week training programme), postintervention (within 1 week after completion of the 5week training programme)

2. haemoglobin concentration measured using blood sampling & analysis at preintervention (baseline, within 1 week before the 5week training programme), postintervention (within 1 week after completion of the 5week training programme)

3. haematocrit measured using blood sampling & analysis at preintervention (baseline, within 1 week before the 5week training programme), postintervention (within 1 week after completion of the 5week training programme)

4. reticulocyte count measured using blood sampling & analysis at preintervention (baseline, within 1 week before the 5week training programme), postintervention (within 1 week after completion of the 5week training programme)

Completion date
30/06/2025

Eligibility

Key inclusion criteria
1. Adulthood (18+ years)
2. Absence of chronic respiratory disease or hypertension
3. Competing level in ice-hockey

Healthy volunteers allowed
Yes

Age group
Adult

Lower age limit
18 Years

Upper age limit
35 Years

Sex
Male

Total final enrolment
25

Key exclusion criteria

Illness requiring antibiotic treatment or injury

Date of first enrolment
19/05/2025

Date of final enrolment
19/05/2025

Locations

Countries of recruitment
Slovakia

Sponsor information

Organisation
Comenius University Bratislava

ROR
https://ror.org/0587ef340

Funder(s)

Funder type

Funder Name
Agentúra na Podporu Výskumu a Vývoja

Alternative Name(s)
Slovak Research and Development Agency, Agentúra na podporu výskumu a vývoja, Bratislava, Agentúra na podporu výskumu a vývoja, Slovak Research and Development Agency (SRDA), Slovak Research and Development Agency (Slovakia), APVV, SRDA

Funding Body Type
Government organisation

Funding Body Subtype
National government

Location
Slovakia

Results and Publications

Individual participant data (IPD) sharing plan

IPD sharing plan summary
Not expected to be made available