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How training cycles affect fitness and recovery in competitive speed skaters

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Registration date 04/09/2025	**Overall study status** Completed	[X] Statistical analysis plan [_] Results
Last Edited 03/09/2025	**Condition category** Other	[_] Individual participant data [_] Record updated in last year

Plain English summary of protocol

Background and study aims
Training is essential for competitive athletes, but people often respond differently to the same training program. Some athletes recover quickly and improve steadily, while others may feel tired or show slower progress. Understanding these differences can help coaches adjust training to suit individual needs.

This study aims to measure how competitive speed skaters adapt to a structured 24-week training program. The researchers want to find out how aerobic fitness (measured by breathing and blood tests), muscle power (measured by jumps and cycling tests), and heart function (measured by heart rate monitoring) change during different phases of training. The study also looks at how athletes' own ratings of effort and readiness relate to their fitness changes over time.

Who can participate?
Adult volunteer competitive speed skaters aged 18 to 25 years who have at least three years of elite-level training experience and are medically cleared to participate in high-intensity sport.

What does the study involve?
Athletes will follow their regular training program designed by their coaches, which includes aerobic conditioning, strength training, and on-ice drills. The research team will observe and record how athletes adapt over the 24 weeks.
Testing will take place at the beginning, middle, and end of the program. The tests include:
• VO_2max test: a treadmill breathing test to measure maximum oxygen use.
• Lactate threshold test: a fingertip blood test during exercise to measure when the body starts to tire.
• Wingate test: a 30-second cycling test to measure power.
• Countermovement jump test (CMJ): a vertical jump to measure muscle strength.
• Heart rate recovery: measuring how quickly the heart slows after exercise.
In addition, athletes will:
• Wear a heart rate monitor for short daily readings of heart rate variability (HRV).
• Record how hard training felt 30 minutes after each session using a simple 0–10 scale.
• Record how ready they feel before training using a 1–10 readiness score.

The study will not change the athletes' training program. It only monitors how their bodies respond.

What are the possible benefits and risks of participating?
Benefits: Athletes will receive feedback on their test results, such as aerobic capacity, power, and heart rate recovery. This may help them and their coaches track progress and fine-tune training plans. The results may also help improve training methods for future athletes.

Risks: The risks are very small. Athletes may experience short-term fatigue, mild soreness, or breathlessness during the tests. These are normal responses to exercise. Medical staff will supervise all testing, and athletes may stop at any time if they feel unwell.

Where is the study run from?
The National Speed Skating Training Centre and the Tianjin University of Sport, Tianjin, China.

When is the study starting and how long is it expected to run for?
July 2025 to January 2026.

Who is funding the study?
1. The Ministry of Education Humanities and Social Sciences Research Program (project on the integration and development of the Northeast economy and ice and snow industry)
2. The Hebei Province Social Science Fund Project (project on event management and commercialization in ice and snow sports)
3. The Hebei Provincial Sports Bureau Sports Science and Technology Research Project

Who is the main contact?
Prof. Shi Donglin (Principal Investigator), Tianjin University of Sport, shidonglin1ok@163.com

Contact information

Type(s)
Public, Scientific, Principal investigator

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Additional identifiers

Protocol serial number
Hebei Provincial Sports Bureau Sports Science and Technology Research Project Number 2025CY25

Study information

Scientific Title
Research on the changes in physical reserve and training adaptability of speed skaters based on macro-micro cycle structure

Acronym
SPARTA

Study objectives
This is a prospective cohort study of collegiate speed skaters (Participants) evaluating the effects of autoregulated macro–microcycle training (Intervention) compared with standard training cycles (Comparison) on aerobic capacity, neuromuscular power, heart rate variability, and overall training adaptability (Outcomes)

The principal objective of this study is to quantify dynamic changes in physiological reserve across macrocycle phases, evaluate microcycle-specific training adaptability using heart rate variability (HRV), session rating of perceived exertion (sRPE), and performance load ratio (PLR), assess inter-individual variability in response to reloading stressors, and establish a feedback-driven framework for adaptive training design in competitive speed skating.

Ethics approval required
Ethics approval required

Ethics approval(s)
Approved 29/07/2025, Tianjin Institute of Physical Education Ethics Review Committee (No.51 Weijin Nan Road, HeXi District, Tianjin, 300381, China; +86 22 2301 2606; office@tjus.edu.cn), ref: TJUS 2025-093

Primary study design
Observational

Study design
Prospective longitudinal cohort study with repeated within-subject measures

Study type(s)
Prevention, Treatment, Efficacy

Health condition(s) or problem(s) studied
Training adaptability, physiological reserve, and fatigue recovery in competitive speed skaters.

Interventions
This is a prospective observational cohort study at a national training centre and university laboratory. All participants follow the same structured 24-week macro–microcycle program with standardized aerobic, resistance, and on-ice training. No randomisation or masking. Repeated measures are taken at baseline, mid-phase (week 12), and post-phase (week 24), with additional taper follow-up to week 32.

All athletes complete the same structured macro–microcycle program designed by team coaches: (a) aerobic–anaerobic conditioning phase (16 weeks, including Zone 2/3 running,

resistance training, and on-ice intervals); (b) taper and neuromuscular consolidation phase (8 weeks, including reduced volume, ballistic lifting, and sprint sharpening). Internal and external loads are monitored via session-RPE, GPS/on-ice timing gates, and tethered sled measurements.

Intervention Type
Behavioural

Primary outcome(s)
1. Maximal oxygen uptake (VO_2max) measured using a graded treadmill protocol with breath-by-breath gas analysis (MetaMax 3B, Cortex Biophysik GmbH, Germany) at baseline (week 0), mid-phase (week 12), and post-phase (week 24).
2. Lactate threshold (LT) measured using fingertip capillary blood sampling (Biosen C-Line, EKF Diagnostics, Germany) during incremental treadmill test at baseline, week 12, and week 24.
3. Wingate anaerobic peak power (W) measured using a 30-second Wingate test on Monark 894E cycle ergometer at baseline, week 12, and week 24.
4. Countermovement jump (CMJ) height (cm) measured using OptoJump infrared platform (Microgate, Italy) at baseline, week 12, and week 24.
5. Heart rate recovery (HRR-1, bpm) measured using a Polar H10 heart rate sensor at 1 min post-exercise during a graded treadmill test at baseline, week 12, and week 24.
6. Heart rate variability (RMSSD, ms) measured using a Polar H10 sensor with 5 min supine rest and Kubios HRV software at daily intervals throughout the 24-week study

Key secondary outcome(s)
1. Session rating of perceived exertion (sRPE, AU) measured using the Borg CR10 scale, recorded 30 minutes after each training session via mobile survey platform, across all 24 study weeks.
2. Subjective readiness (1–10 scale) measured using the McLean single-item readiness scale, recorded before each training session, across all 24 study weeks.
3. Performance Load Ratio (PLR) measured using study data calculated weekly as the ratio of external load (m) to internal load (AU from sRPE × time), tracked weekly from baseline to week 24.
4. Training compliance (%) measured using study data and calculated as percentage of planned sessions completed, and the monotony index calculated as mean daily load ÷ SD daily load, assessed weekly across 24 weeks.
5. HRV suppression rate (%), defined as >20% drop in RMSSD below baseline, and lag response coefficient (days), defined as delay between training load peak and HRV/CMJ suppression, measured using study data weekly across 24 weeks.
6. Biomechanical asymmetry index (%) measured using 3D motion capture (Vicon Nexus, UK) and inertial sensors (Xsens DOT, Netherlands) during 300 m on-ice drills at baseline, week 12, and week 24.
7. Composite Performance Reserve Index (PRI) measured using study data, calculated as integrated score of VO_2max, LT, Wingate, CMJ, HRR, and HRV, assessed at baseline, week 12, week 24, and post-taper (week 32).

Completion date
15/01/2026

Eligibility

Key inclusion criteria
1. Age between 18 and 25 years
2. Minimum of three continuous years of elite-level speed skating training

3. VO_2max ≥ 58.0 mL/kg/min (males) or ≥ 52.0 mL/kg/min (females), measured via graded treadmill test
4. Medical clearance for participation in high-load sport confirmed by team physicians

Participant type(s)
Healthy volunteer, Learner/student

Healthy volunteers allowed
No

Age group
Adult

Lower age limit
18 Years

Upper age limit
25 Years

Sex
All

Total final enrolment
18

Key exclusion criteria
1. Use of medications that modulate cardiovascular, endocrine, or metabolic responses
2. Use of substances prohibited by the World Anti-Doping Agency
3. History of diagnosed cardiovascular, pulmonary, or neuromuscular disorders
4. Acute illness (fever >38°C, respiratory infection), musculoskeletal injury (grade ≥2), or surgery within the past 3 months

Date of first enrolment
01/08/2025

Date of final enrolment
15/08/2025

Locations

Countries of recruitment
China

Study participating centre
National Speed Skating Training Centre
2 Lincui Rd, Chaoyang
Beijing
China
100107

Sponsor information

Organisation
Ministry of Education of the People's Republic of China

ROR
https://ror.org/01mv9t934

Funder(s)

Funder type
Not defined

Funder Name
Ministry of Education of the People's Republic of China

Alternative Name(s)
, Министерство образования Китайской Народной Республики, , Bildungsministerium der Volksrepublik China, Ministry of Education of China, Ministry of Education, The People's Republic of China, Ministry of Education of the Central People's Government, State Education Commission, MOE

Funding Body Type
Government organisation

Funding Body Subtype
National government

Location
China

Funder Name
Hebei Province Social Science Fund Project

Funder Name
Hebei Provincial Sports Bureau

Results and Publications

Individual participant data (IPD) sharing plan

De-identified individual participant data (IPD), including physiological test results (VO_2max, lactate threshold, Wingate, CMJ, HRV) and training load metrics, will be made available upon reasonable request to the corresponding author, Prof. Shi Donglin (Principal Investigator), Tianjin University of Sport, shidonglin1ok@163.com. Data will be shared beginning 6 months after publication and will remain available for 5 years. Requests must include a methodologically sound proposal and will require a signed data access agreement.

IPD sharing plan summary

Available on request

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Other files			03/09/2025	No	No
Participant information sheet			03/09/2025	No	Yes
Protocol file			03/09/2025	No	No
Statistical Analysis Plan			03/09/2025	No	No