

Additional file 2. Study Protocol

Study Protocol

Study Title

Effects of Different Doses of Pre-Race Sport-Specific Activation on Competitive State Anxiety, Executive Function, and Skiing Performance in Alpine Skiers

1. Research Background and Objectives

Alpine skiing is characterized by high speed, high risk, and considerable uncertainty. Athletes often experience varying degrees of tension, anxiety, and attentional fluctuation before competition, and these changes may further affect executive function and skiing performance. Pre-race sport-specific activation is a common component of training and competition preparation. However, systematic evidence remains limited regarding the effects of different activation doses on athletes' pre-race psychological state, cognitive function, and skiing performance.

This study aims to compare the acute effects of different doses of pre-race sport-specific activation on competitive state anxiety, executive function, and skiing performance in alpine skiers. The findings are expected to provide evidence for optimizing pre-race preparation procedures and developing individualized activation strategies.

2. Study Design

This study uses a randomized crossover design. Participants will complete three pre-race sport-specific activation conditions on separate experimental days. The order of the conditions will be determined using a randomization method. A washout interval of 48–72 hours will be arranged between conditions to reduce the residual effects of the previous test session.

3. Participants

A total of 53 alpine skiers will be recruited.

Inclusion Criteria

Participants must meet the following criteria:

Have a sport-specific training background in alpine skiing;

Be aged 18–35 years;

Be able to participate in normal training and testing during the study period;
Voluntarily agree to participate in the study and sign the written informed consent form.

Exclusion Criteria

Participants will be excluded if they meet any of the following criteria:

Have a recent acute injury or illness that may affect testing;
Have cardiovascular, neurological, psychiatric, or psychological disorders;
Are currently using medications that may affect mood, cognition, or motor responses;
Are unable to complete the full testing procedures.

4. Interventions

Participants will complete the following three pre-race sport-specific activation conditions:

5-minute low-intensity sport-specific activation;
10-minute moderate-intensity sport-specific activation;
15-minute moderate-to-high-intensity sport-specific activation.

All sport-specific activation routines will be performed on land. The routines will include dynamic mobility exercises, lower-limb and core activation, and movement-preparation exercises similar to the movement characteristics of alpine skiing. During the experiment, relative heart rate and rating of perceived exertion will be recorded as manipulation-check indicators.

5. Study Procedures

The testing procedures will be generally consistent across all experimental days. Each testing session will include the following steps:

Recording sleep duration, sleep quality, caffeine intake, subjective fatigue, and environmental information;
Completing pre-race psychological measurements;
Performing the assigned dose of pre-race sport-specific activation;
Completing psychological measurements again after activation;
Completing executive-function tests, including the Stroop task and Flanker task;
Completing a skiing test under standardized conditions, with first-section skiing time,

total skiing time, and errors recorded.

6. Outcome Measures

Primary Outcome Measures

The primary outcome measures are:

Competitive state anxiety;

Executive function, including Stroop interference and Flanker interference;

Skiing performance, including first-section skiing time.

Secondary Outcome Measures

The secondary outcome measures are:

Emotion regulation difficulties;

Task self-efficacy;

Total skiing time;

Number of skiing errors.

7. Risks and Safety

This study is a non-drug, low-risk sport intervention study. Possible risks mainly include transient increases in heart rate, mild fatigue, muscle soreness, attentional fatigue, and minor risks of imbalance or falls during the skiing test.

To reduce these risks, health screening will be conducted before the study. Researchers and coaches will monitor participants during testing. All participants will wear protective equipment according to training requirements. If a participant experiences obvious discomfort, pain, dizziness, or any other abnormal condition, the test will be stopped immediately and the predetermined emergency procedures will be followed. Participants have the right to withdraw from the study at any stage.

8. Data Management and Statistical Analysis

Study data will be collected using standardized recording forms and entered into an electronic database. All data will be used only for scientific research purposes, and personal identity information will be anonymized.

Descriptive statistics and linear mixed-effects models will be used for statistical analysis. The effects of different activation conditions and pre-to-post changes on each outcome measure will be compared. Post-hoc comparisons and sensitivity

analyses will be conducted as needed. The level of statistical significance will be set at $P < 0.05$.

9. Ethics Statement

This study has been reviewed and approved by the Academic Ethics Committee of Harbin Sport University. All participants will voluntarily sign a written informed consent form after fully understanding the study objectives, procedures, potential risks, and their rights. Participant privacy and data security will be strictly protected throughout the study.

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