

# Winter Olympics: Altitude affects skill sports, not just endurance events

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For winter sports athletes, including Olympians competing in Vancouver this week, the altitude of the sports venue can have a significant impact on performance, requiring athletes in skill sports, such as figure skating, ski jumping and snowboarding, to retool highly technical moves to accommodate more or less air resistance.

When considering the challenges and benefits of training and performing at sea level verses altitude, people often think of the effect altitude can have on [oxygen delivery](#) to muscles -- at higher altitudes, the body initially delivers less oxygen to muscles, which can result in fatigue occurring sooner during exercise. Higher altitudes also have less air density -- about 3 percent reduction for every 1,000 feet -- which can result in faster speeds in ski and skating races due to less aerodynamic drag, but can also affect timing and other technical components in skill sports.

"Many athletes perform thousands upon thousands of moves so they get a certain motor pattern ingrained," said Robert Chapman, an expert in altitude training at Indiana University. "A different altitude will change the feedback they get from balance and proprioception. In an endurance sport such as cross country skiing or biathlon, for competition at altitude it takes about 10-14 days to adjust. For a skill sport, it's harder to judge how long it will take to acclimate to the reduced air density at altitude. Hopefully, these athletes have incorporated this into their training, maybe in the last year or for a period of time, not just the two weeks leading up to competition."

Chapman, an exercise physiologist in the Department of [Kinesiology](#) in IU's School of Health, Physical Education and Recreation, wrote about the topic in a special Winter Olympics issue of the journal [Experimental Physiology](#). The article, "Altitude training considerations for the winter sport athlete," was published online last week. Co-authors include lead author Benjamin D. Levine, University of Texas Southwestern Medical Center, and Jonathon L. Stickford, IU's School of HPER.

The Winter Olympics are being held in Vancouver, British Columbia, which is practically at sea level. The ice events also are nearly at sea level, with other venues ranging from altitudes of around 2,600 feet for the sled events to around 5,000 feet for women's and men's downhill skiing.

Chapman said fans should expect few record times in speed skating events because of the low altitude and greater air resistance facing athletes. He and his co-authors note in their paper that current world records for men and women in every long-track speed skating event from the 500-meter to 10,000-meter races were set in Olympics held in either Calgary, at an altitude of 3,400 feet, or Salt Lake City, with an altitude of 4,300 feet. They note that every Olympic record for all individual event distances was set at the 2002 Olympic Games in Salt Lake City, with none topped in the 2006 [Winter Olympics](#) held in Turin, which lies at an altitude of 784 feet.

"The general thought is that altitude slows you down because you have less oxygen going to your muscles," Chapman said. "But at altitude, just as it is easier to hit a home run in the thin air of Denver, speed skaters in Calgary and Salt Lake City could skate faster, move through the air faster, because there was less drag. Eight years after Salt Lake City, we have natural improvements that you'd expect to see involving training, coaching and technology, but we won't see many records in Vancouver. It doesn't mean the athletes are worse, if anything they're probably

better. It's the effects of altitude on athletes' times."

Air density can have a dramatic effect on ski jumping, he said, requiring athletes to change the angle of their lean depending on the altitude.

Chapman said the women's and men's Olympic downhill skiing, freestyle skiing and snowboarding events take place at higher altitudes this month and could require technical adjustments by the athletes.

Chapman and his co-authors make the following recommendations concerning training and performing at altitude:

- Allow extra time and practice for athletes to adjust to changes in projectile motion. Athletes in sports such as hockey, shooting, figure skating and ski jumping may be particularly affected.
- Allow time for acclimatization for endurance sports: Three to five days if possible, especially for low altitude (1,640-6,562 feet); one to two weeks for moderate altitude (6,562-9,843 feet); and at least two weeks if possible for high altitude (more than 9,843 feet). Chapman said altitude affects breathing, too, with breathing initially being harder at higher altitudes.
- Increase exercise-recovery ratios as much as possible, with a 1:3 ratio probably optimal, and consider more frequent substitutions for sports where this is allowed, such as ice hockey. Recovery refers to the amount of time an athlete eases up during practice between harder bouts. If an athlete runs hard for one minute, following this with three minutes of slower running would be optimal before the next sprint. The recovery period gives athletes more time to clear lactic acid build up from their muscles.
- Consider the use of supplemental oxygen on the sidelines in ice

hockey or in between heats in skating and Alpine skiing to help with recovery. Chapman said this helps calm breathing, which can be more difficult at altitude.

- Living at high altitudes while training at low altitudes can help [athletes](#) in endurance sports improve performance at lower altitudes.

**More information:** For a copy of the article, visit [www3.interscience.wiley.com/journal/123195950/abstract](http://www3.interscience.wiley.com/journal/123195950/abstract).

Provided by Indiana University

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