Condensed version and key points from the study:

Alleviation of exercise-induced injury by hydrogen inhalation via the reduction of oxidative stress and inflammation in athletes

Study Overview
A non-randomised controlled intervention study published in the Journal of Thoracic Disease (August 2025), conducted between November 2024 and April 2025 at Shanghai Minhang District Central Hospital and Shanghai No.2 Sports School. It investigated whether hydrogen gas inhalation could alleviate exercise-induced lung injury by reducing oxidative stress and systemic inflammation, and compared its efficacy against infrared blanket therapy.

Why Exercise-Induced Lung Injury Matters

- During exercise, a surge in skeletal muscle oxygen consumption leads to excessive production of reactive oxygen species (ROS), which induce oxidative stress when they exceed the body's antioxidant clearance capacity. This activates inflammatory signalling pathways, promotes the release of pro-inflammatory factors, and recruits neutrophils and macrophages. The resulting inflammation disrupts the alveolar-capillary barrier, leading to exercise-induced bronchoconstriction, pulmonary oedema, and in chronic cases, pulmonary fibrosis.
- Repeated intense exercise may trigger a maladaptive cycle in which unresolved oxidative stress and persistent low-grade inflammation impair the resilience of the lungs, especially in untrained individuals or those with pre-existing respiratory condition.

Why Infrared Therapy Was Included as a Comparison
Infrared therapy is widely used in post-exercise recovery for its ability to improve local blood circulation, reduce muscle soreness, and accelerate recovery. However, its therapeutic effect is mainly limited to superficial tissues, and its ability to regulate oxidative stress and inflammatory responses in the deep lungs remains poorly understood.

Participants
Thirty-one healthy athletes aged 15–27 years were recruited from Shanghai No.2 Sports School, all engaged in land-based sports including athletics, cycling, and weightlifting, with a minimum of 3 years of regular professional training. They were divided into three groups: a control group (n=14), an infrared blanket group (n=9), and a hydrogen inhalation group (n=8).

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How the Intervention Was Delivered

- All participants completed a standardised repeated sprint cycling exercise test consisting of two rounds of 10-second maximum power sprints at 7.5% body weight load, followed by 110 seconds of unloaded low-speed cycling. Immediately after exercise, the H_2 group inhaled a mixture of 66.7% H_2 and 33.3% O_2 at a flow rate of 3 L/min for 20 minutes via a hydrogen gas generator. The infrared group received 20 minutes of infrared blanket therapy. The control group recovered naturally breathing room air.
- Blood samples were collected before and after winter training to evaluate oxidative stress markers (T-AOC, SOD, MDA), inflammation markers (WBC, CRP), hematological indicators (RBC, haemoglobin, haematocrit, MCV), biochemical markers (CK, BUN), and stress-related hormones (testosterone, cortisol, ferritin).

Key Results — Before Winter Training (Acute Single Session)

- **Participants in both the infrared blanket and H_2 groups showed significantly enhanced antioxidant capacity, reflected by elevated T-AOC and SOD levels, compared to the control group.** MDA, a marker of lipid peroxidation, was significantly reduced in both intervention groups. **Among the groups, the H_2 group exhibited the most pronounced improvement, suggesting a stronger capacity to alleviate exercise-induced oxidative stress.**
- WBC in both intervention groups was slightly lower than in controls, indicating reduced systemic inflammation. **Testosterone and ferritin levels in the H_2 group were significantly higher, indicating an enhanced acute endocrine stress response**. CRP levels in the H_2 group were the lowest, suggesting a possible anti-inflammatory effect, though this did not reach statistical significance.

Key Results — After Winter Training (Sustained Effects)

- After a full winter training period, T-AOC and SOD levels remained elevated in both intervention groups while MDA levels continued to decline — consistent with the pre-training findings, indicating the sustained antioxidant effect of both interventions. In terms of enhancing antioxidant defence, the H_2 group performed consistently better than the infrared blanket group.
- Both intervention groups exhibited significantly reduced WBC counts compared to controls, suggesting alleviation of exercise-induced systemic inflammation. The infrared blanket group showed notable reductions in RBC, haemoglobin, and haematocrit levels — whereas the H_2 group maintained relatively stable values in these markers, suggesting better preservation of oxygen-carrying capacity.
- Both intervention groups showed significantly lower BUN and CK levels compared to the control group, indicating reduced muscle damage and protein breakdown load from intense exercise.

An Interesting Nuance — CRP After Training

- The CRP levels in the H_2 group increased after training — which could be related to an adaptive stress response rather than persistent inflammation. Both interventions helped reduce markers of inflammation and tissue damage, but the stress hormone response was greater in the H_2 inhalation group, suggesting complex physiological adaptations to prolonged training.
- This is a noteworthy finding: not all markers moved in a uniformly "positive" direction, reminding us that hydrogen's effects on physiology are complex and context-dependent.

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The Proposed Mechanism

- As a small, non-polar molecule, H_2 can quickly penetrate biological membranes and selectively scavenge hydroxyl radicals (•OH) and peroxynitrite ($ONOO^-$) without interfering with normal redox signals. H_2 can also inhibit the activation of NF-κB and NLRP3 inflammasomes, thereby reducing the release of pro-inflammatory factors and alleviating tissue inflammation.
- H_2 may maintain red blood cell membrane integrity through antioxidant effects, preserving haemoglobin function and the efficiency of oxygen transport. Additionally, H_2 may participate in the maintenance of iron homeostasis in lung tissue by regulating ferritin expression, helping reduce the synergistic oxidative and inflammatory damage caused by excess free iron promoting harmful Fenton reactions.

Conclusions

- H_2 inhalation therapy alleviates exercise-induced lung injury by reducing oxidative stress and systemic inflammation while helping to maintain hematological stability. Compared with infrared blanket therapy, H_2 inhalation showed relatively greater potential in supporting antioxidant defences, attenuating inflammatory responses, and preserving red blood cell function and oxygen transport capacity during and after high-intensity winter training. These findings suggest that H_2 inhalation may serve as a promising and safe adjunctive strategy to support recovery and mitigate pulmonary stress during strenuous physical activity.

Limitations to Keep in Mind

- The sample size was relatively small, limiting statistical power. The experimental period was short, so long-term dynamic effects of H_2 during training adaptation were not observed. The study mainly observed systemic indicators and lacked direct evidence at the lung function or tissue level — future work should incorporate respiratory mechanics parameters or lung imaging to verify direct pulmonary protection.
- The study was non-randomised and unblinded, meaning participants knew which group they were in, introducing potential bias. Sex-specific analyses were not performed, despite evidence that oestrogen may modulate oxidative stress responses differently between male and female athletes.
- Participants were exclusively land-based athletes — swimmers were not included — so findings may not generalise to aquatic sports where distinct pulmonary demands apply.
- The H_2 group was notably smaller (n=8) than the control group (n=14), limiting direct statistical comparisons. This is also a very recently published study (August 2025) with no independent replication yet.

To Read The Full Study Please CLICK HERE