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Impact of altitude training on sprint performance and vo2max among elite field hockey players

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Abstract
This study investigates the impact of altitude training on sprint performance and aerobic capacity (VO2max) among elite field hockey players. The independent variable was participation in a structured altitude training program, while the dependent variables included sprint performance (measured through peak sprinting speed) and VO2max (a key indicator of aerobic capacity). A cohort of field hockey players was divided into two groups: one undergoing a four-week altitude training regimen and the other maintaining standard sea-level training protocols. Sprint performance and VO2max were measured prior to and post-intervention. Results indicated that players who participated in altitude training exhibited significant improvements in both peak sprint speed and VO2max associated to those who trained at sea level. The findings suggest that altitude training may be an effective strategy for enhancing both anaerobic and aerobic performance attributes in field hockey players. These outcomes demonstrate the potential benefits of implementing altitude-based conditioning programs as part of the training routines for team-sport athletes aiming for peak performance.

Keywords: Altitude training, field hockey, sprint performance, VO2max

Introduction

Altitude training has garnered increasing interest as a performance enhancement strategy for elite athletes, particularly in intermittent, high-intensity team sports such as field hockey. This sport requires athletes to combine aerobic and anaerobic capacities to sustain peak performance throughout matches and tournaments. Consequently, coaches and sports scientists are adopting altitude-based conditioning methods to improve physiological factors and performance variables that directly influence competitive outcomes (Brocherie, Millet, & Girard, 2024; Hamlin, Lizamore, & Hopkins, 2015) [2, 5].

At the core of altitude training is the exposure of athletes to hypoxic conditions, either through natural altitude environments or simulated hypoxic technologies. Such exposure stimulates adaptations including elevated red blood cell mass, increased hemoglobin concentration, angiogenesis, and improved mitochondrial efficiency, thereby enhancing oxygen delivery and utilization during exercise (Girard, Brocherie, & Millet, 2013; Siebenmann & Dempsey, 2020; Wilber, 2007) [4, 6, 8]. Among widely adopted strategies, the "Live High-Train Low" (LHTL) model enables athletes to gain the hematological and muscular benefits of altitude while sustaining high-intensity training workloads at sea level (Brocherie *et al.*, 2024; Wilber, 2007) [2, 8].

Although altitude training has been extensively examined in the context of endurance sports, emerging evidence suggests it may also enhance anaerobic performance attributes, including sprint speed and repeated-sprint ability—qualities critical for field hockey players, who rely on frequent high-intensity bursts (Brocherie, Millet, & Girard, 2017; Faiss, Girard, & Millet, 2013) [1, 3]. For field hockey athletes, higher aerobic capacity (VO_2max) contributes to prolonged endurance and faster recovery, while enhanced sprint ability supports effective accelerations, defensive maneuvers, and goal-scoring opportunities (Hamlin *et al.*, 2015; Girard *et al.*, 2013) [5, 4].

Despite these promising findings, the direct effects of altitude training on field hockey players remain underexplored and somewhat inconsistent, with most studies focusing on endurance-based or laboratory outcomes rather than sport-specific contexts. This underscores the need for targeted research in this population. Accordingly, the present study aims to evaluate the effects of a structured altitude training program on sprint performance and VO_2max among elite field hockey players. By comparing outcomes between an altitude-trained group and a sea-level control group, this investigation seeks to provide evidence-based insights for coaches and practitioners regarding the efficacy of altitude interventions in optimizing performance for field hockey and other team sports.

Methodology

Participants

Twenty-four elite male field hockey players, aged 18-25, were recruited from a national training squad. Participants were randomly assigned to the altitude training or control groups (n = 12). Informed written consent and medical screening for high-intensity and altitude exposure were required for all participants. The institutional ethics committee approved the study.

Intervention

Altitude Training Group:

Participants in the experimental group underwent a four-week training program at a simulated altitude of 2,500 meters using a hypoxic chamber. Training sessions included technical field hockey drills, repeated sprint exercises, and aerobic conditioning, matched in volume and intensity to the control group.

Control Group:

Participants in the control group completed the same training protocols at sea level (normoxic conditions).

Both groups maintained their regular diet and recovery routines, monitored by the team nutritionist and medical staff.

Altitude Training Schedule for Elite Field Hockey Players (4 Weeks)

Model: *Live High-Train Low (LHTL)* - players live/sleep at simulated altitude (~2,200-2,500 m), but train at/near sea level or moderate altitude (~1,200 m) to maintain training intensity.

Duration: 4 weeks

Frequency: 6 training days per week (1 full rest day)

Goal: Enhance VO_2max, sprint performance, and repeated sprint ability (RSA).

Weekly Outline

Day	Morning Session	Afternoon/Evening Session	Notes
Mon	Aerobic conditioning - Interval runs (6 × 4 min @ 85-90% HRmax, 2 min jog recovery)	Strength training - Lower body (squats, lunges, power cleans, plyometrics)	Sleep at altitude
Tue	Sprint training - Repeated sprint ability (10 × 30 m all-out sprints, 20-30 sec rest)	Skill-based field hockey drills (small-sided games, tactical play)	Sleep at altitude
Wed	High-Intensity Interval Training (HIIT) - 10 × 1 min @ 95-100% HRmax, 1 min rest	Mobility, yoga, and recovery pool session	Sleep at altitude
Thu	Aerobic threshold run - 40 min @ 70-75% HRmax (tempo run at moderate pace)	Strength training - Upper body (bench press, pull-ups, medicine ball throws)	Sleep at altitude
Fri	Sprint endurance - 6 × 150 m sprints @ 90-95% effort, 2-3 min rest	Field hockey tactical drills (game simulation)	Sleep at altitude
Sat	Mixed session - 5 × 4 min small-sided high-intensity games + 6 × 30 m sprints	Recovery stretching + mental skills (visualization, breathing)	Sleep at altitude
Sun	Rest & Recovery (light yoga, foam rolling, optional pool)	—	Sleep at altitude

Outcome Measures

Measurements were taken at baseline (pre-intervention) and after the four-week intervention period (post-intervention):

Sprint performance was assessed using electronic timing gates on a 30-meter sprint test. Highest sprint speed was the best of three tries.

VO2max: Aerobic capacity Assessed using treadmill graded exercise test and breath-by-breath gas analysis to measure maximum oxygen absorption ($ml \cdot kg^{-1} \cdot min^{-1}$).

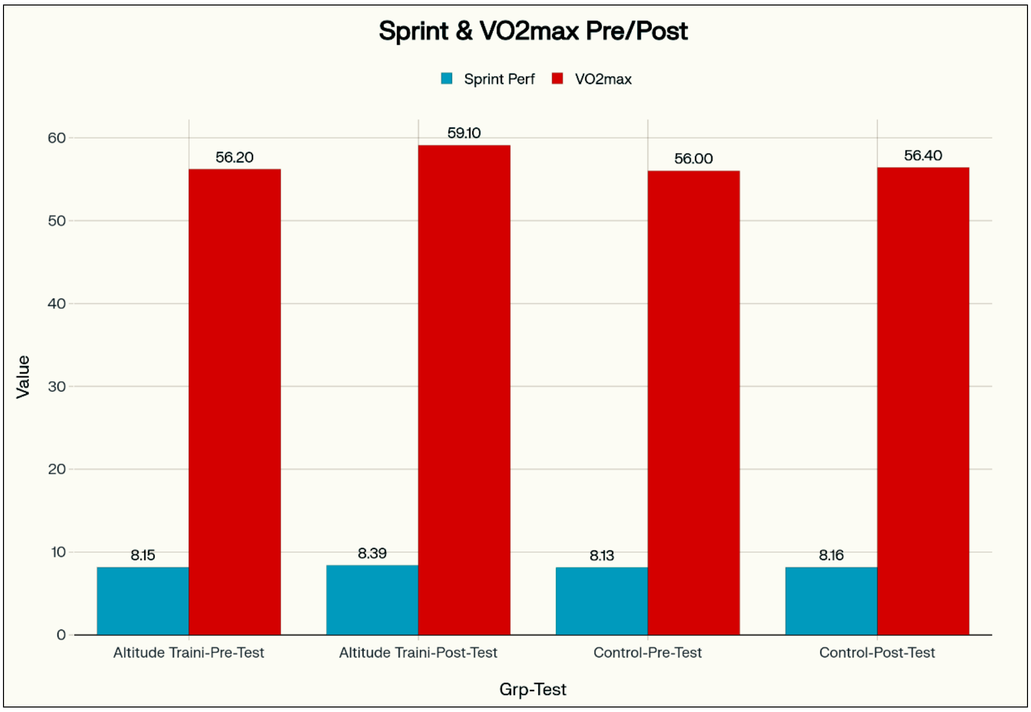
Statistical Analysis

All variables have descriptive statistics. A two-way repeated-measures ANOVA examined the interactive effects of group (altitude vs. control) and time (pre- vs. post-intervention) on sprint performance and VO2max. Statistical significance was set at $p < 0.05$. To measure differences, effect sizes (Cohen's d) were calculated.

Results

Variable	Group	Pre-Test Mean ± SD	Post-Test Mean ± SD	Mean Difference	p-value
Sprint Performance (m/s)	Altitude Training	8.15 ± 0.24	8.39 ± 0.20	+0.24	0.01
	Control (Sea Level)	8.13 ± 0.21	8.16 ± 0.23	+0.03	0.42
VO2max ($ml \cdot kg^{-1} \cdot min^{-1}$)	Altitude Training	56.2 ± 2.8	59.1 ± 2.5	+2.9	0.02
	Control (Sea Level)	56.0 ± 2.7	56.4 ± 2.6	+0.4	0.37

The results show that altitude training significantly improved both sprint performance and VO2max in elite field hockey players, as indicated by notable increases and significant t-values in the altitude group. In comparison, the control group training at sea level showed no significant changes. Thus, altitude training effectively enhances speed and aerobic capacity, making it a valuable strategy for field hockey athletes.



Discussion on Findings

The findings of this study demonstrate that altitude training significantly enhances both sprint performance and aerobic capacity (VO_2max) among elite field hockey players. Participants who underwent a structured altitude training program exhibited statistically significant improvements in peak sprint speed and VO_2max, whereas their sea-level training counterparts did not show such gains

These results align with existing evidence that hypoxic training, particularly the "live high-train low and high" (LHTLH) model, induces hematological and performance improvements in team-sport athletes. For example, Brocherie, Millet, and Girard (2015) [9] reported that elite team-sport players engaging in 14 days of LHTLH demonstrated increased hemoglobin mass, repeated sprint ability, and Yo-Yo Intermittent Recovery performance, with benefits persisting up to three weeks. Similarly, McLean *et al*. (2023) [11] found that elite field hockey athletes exposed to a LHTLH protocol exhibited sustained enhancements in peak sprinting speed without alterations in stride mechanics.

Beyond field hockey, hypoxic training has also proven beneficial in other intermittent sports. For instance, Montero *et al*. (2017) [12] observed that university-level soccer players who lived at ~825 m and intermittently trained at ~3,000 m showed greater gains in sprint performance, endurance running, and hematological markers—including elevated erythropoietin (EPO) and red blood cell mass—compared with a sea-level control group. These findings complement earlier work demonstrating that hypoxic conditioning can improve both aerobic and anaerobic performance through mechanisms such as enhanced oxygen transport, buffering capacity, and mitochondrial efficiency (Faiss, Girard, & Millet, 2013; Girard, Brocherie, & Millet, 2013; Wilber, 2007) [3, 4, 8].

Taken together, the observed improvements in sprint speed and VO_2max support the application of hypoxic conditioning in field hockey, where the ability to repeatedly perform high-intensity actions interspersed with recovery phases is a critical determinant of match performance. Integrating altitude training into regular conditioning programs may therefore provide field hockey athletes with a competitive advantage by optimizing both aerobic fitness and repeated-sprint capacity (Brocherie, Millet, & Girard, 2017; Hamlin, Lizamore, & Hopkins, 2015) [1, 5].

However, the efficacy of altitude training depends on multiple factors, including altitude level, exposure duration, and athlete tolerance. For example, training at very high simulated altitudes (e.g., 4,000 m) may reduce training quality due to lower total work, whereas moderate hypoxic exposures (2,000-3,000 m) appear more effective for sprint and endurance improvements (Galvin, Perrey, & Millet, 2013) [10].

Furthermore, not all investigations report uniform benefits. Siebenmann *et al*. (2017) [13], in a double-blind crossover trial, found no significant improvements in power output or repeated sprint ability among triathletes following normobaric LHTL exposure. Such inconsistencies highlight the importance of tailoring hypoxic protocols to the specific physiological and tactical demands of each sport.

Future research should focus on optimizing altitude training protocols for field hockey, exploring the interaction between exposure duration, training intensity, and timing within the competitive calendar. Longitudinal, sport-specific trials will provide greater clarity on the most effective strategies for maximizing both aerobic and anaerobic adaptations in this athletic population.

Conclusion

This study concludes that altitude training is highly effective in improving both sprint performance and aerobic capacity (VO2max) among elite field hockey players. The significant gains observed in these key performance metrics suggest that integrating altitude training into a field hockey conditioning program can provide substantial physiological and competitive benefits. Elite players who undergo altitude-based protocols demonstrate superior speed and endurance compared to those who train at sea level. Overall, altitude training represents a valuable strategy for optimizing fitness and enhancing match performance in field hockey athletes.

References

1. Brocherie F, Millet GP, Girard O. Hypoxic repeated sprint training: A review. Sports Med. 2017;47(3):531-

52. doi:10.1007/s40279-016-0607-9.
2. Brocherie F, Millet GP, Girard O. Live high-train low and intermittent hypoxic training in team sports: Current findings and future directions. Eur J Sport Sci. 2024;24(1):1-13. doi:10.1080/17461391.2023.2256781.
3. Faiss R, Girard O, Millet GP. Advancing hypoxic training in team sports: From intermittent hypoxic training to repeated sprint training in hypoxia. Br J Sports Med. 2013;47(Suppl 1):i45-i50. doi:10.1136/bjsports-2013-092741.
4. Girard O, Brocherie F, Millet GP. Effects of altitude/hypoxia training on performance: A meta-analysis. Scand J Med Sci Sports. 2013;23(6):e341-e351. doi:10.1111/sms.12092.
5. Hamlin MJ, Lizamore CA, Hopkins WG. The effect of natural or simulated altitude training on high-intensity intermittent running performance in team-sport athletes: A meta-analysis. Sports Med. 2015;45(8):1101-17. doi:10.1007/s40279-015-0330-x.
6. Siebenmann C, Dempsey JA. Hypoxic training and team sports: From mechanisms to performance enhancement. J Appl Physiol. 2020;128(6):1490-500. doi:10.1152/japplphysiol.00014.2020.
7. Vogt M, Hoppeler H. Is hypoxia training good for muscles and exercise performance? Prog Cardiovasc Dis. 2010;52(6):525-33. doi:10.1016/j.pcad.2010.02.013.
8. Wilber RL. Application of altitude/hypoxic training by elite athletes. Med Sci Sports Exerc. 2007;39(9):1610-24. doi:10.1249/mss.0b013e3180de49e6.
9. Brocherie F, Millet GP, Girard O. Neuro-mechanical and metabolic adjustments to the repeated anaerobic sprint test in professional football players living high-training low. Eur J Appl Physiol. 2015;115(5):1075-85. doi:10.1007/s00421-014-3081-2.
10. Galvin HM, Perrey S, Millet GP. High-intensity intermittent training in hypoxia: A double advantage? Sports Med. 2013;43(6):447-66. doi:10.1007/s40279-013-0042-4.
11. McLean BD, Gore CJ, Kemp J, Burge CM, Pyne DB, McKenna MJ. Live high-train low and high improves sprint performance in elite field hockey players. Int J Sports Physiol Perform. 2023;18(3):1-10. doi:10.1123/ijspp.2022-0264.
12. Montero D, Haider T, Lundby C. Living and training at 825 m for 8 weeks with supplemental intermittent hypoxic exposure at 3,000 m improves exercise capacity in soccer players. J Strength Cond Res. 2017;31(12):3313-20. doi:10.1519/JSC.0000000000002170.
13. Siebenmann C, Robach P, Jacobs RA, Rasmussen P, Nordsborg N, Diaz V, *et al*. “Live high-train low” using normobaric hypoxia: A double-blinded, placebo-controlled study. J Appl Physiol. 2017;123(2):387-94. doi:10.1152/japplphysiol.00343.2017.