

THE IMPACT OF AN EIGHT WEEK APNEA TRAINING PROGRAM ON SPLEEN VOLUME AND HAEMATOLOGICAL VALUES

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Abstract

Aims. Apnea training has recently been proposed as a simple and cheap method to stimulate erythropoietin (EPO) production and increase hemoglobin (Hb) concentration and hematocrit (Hct). This study aimed to investigate both acute and chronic effects of apnea on spleen volume and hematological values through an 8-week apnea training program.

Methods. Thirteen subjects daily performed five static apneas. Before, halfway through and after the apnea training period, subjects performed five maximal breath-holds at the laboratory. Baseline values for and changes in splenic volume, [Hb], Hct, reticulocyte count (RET%) and EPO were assessed.

Results. A strong spleen contraction in response to acute apnea was observed with volume reductions of $50 \pm 10\%$ ($p < 0.001$). An acute increase in [Hb] from 156 ± 11 g L⁻¹ to 159 ± 9 g L⁻¹ (+2%, $p < 0.05$) was seen immediately after the last apnea. Apnea training did not improve acute effects for neither spleen volume ($p = 0.868$), [Hb] ($p = 0.358$) nor Hct ($p = 0.421$). Although no differences in baseline Hct, RET% and EPO were found ($p > 0.05$), the apnea training program did increase baseline spleen volume by $24 \pm 27\%$ ($p < 0.05$) and baseline [Hb] by $3.3 \pm 5\%$ ($p < 0.05$).

Conclusion. Our results show an apnea-specific training effect, as it was demonstrated that both baseline spleen volume and [Hb] had increased after eight weeks of apnea training. These increases suggest improved oxygen storage and transport capacity which might be beneficial for both elite athletes and anaemic patients. In contrast, acute spleen contraction and temporarily increases in [Hb] remained unaltered after training.

INTRODUCTION



Spleen contraction^[1]



Acute ↑ [Hb]^[1]



More pronounced in trained divers^[3]

EPO production^[2]



Chronic ↑ [Hb]



Higher [Hb] in trained divers^[3]

AIMS

- To determine the magnitude of the acute response
- To determine the impact of an 8 week apnea training program on the acute response
- To determine the impact of an 8 week apnea training program on baseline spleen volume and [Hb]

METHODS



8 WEEK TRAINING STUDY

- Daily training
- Series of 5 static apneas: 4x 80% + 1x max



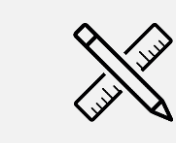
13 MALE PE STUDENT

- Age 22.3 ± 1.4y
- Height 1.79 ± 0.05m
- Weight 71.1 ± 7.4kg
- VO₂ max 55.3 ± 5.6 mL min⁻¹ kg⁻¹



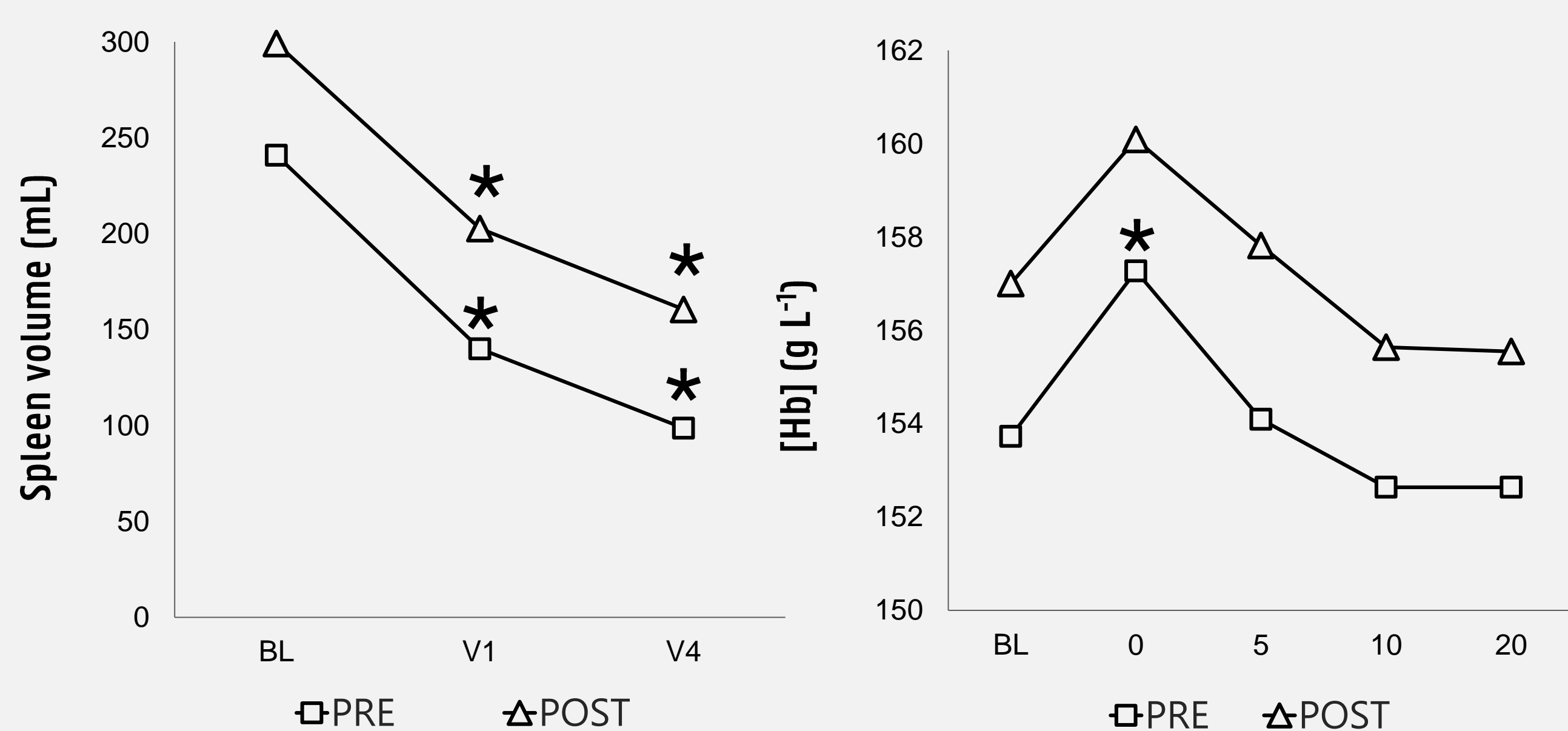
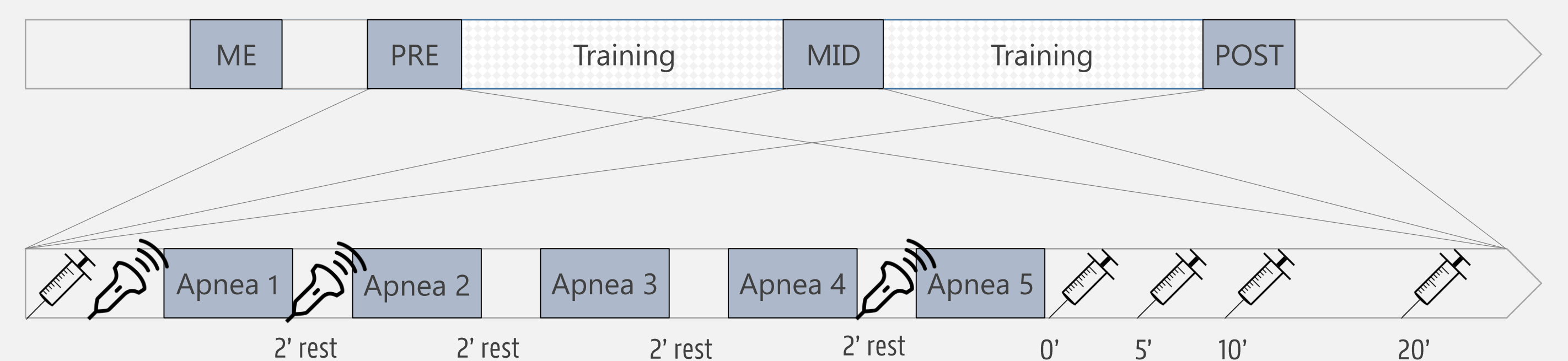
STATISTICAL ANALYSES

- RM Manova
- Acceptance at $p < 0.05^*$



MEASURES

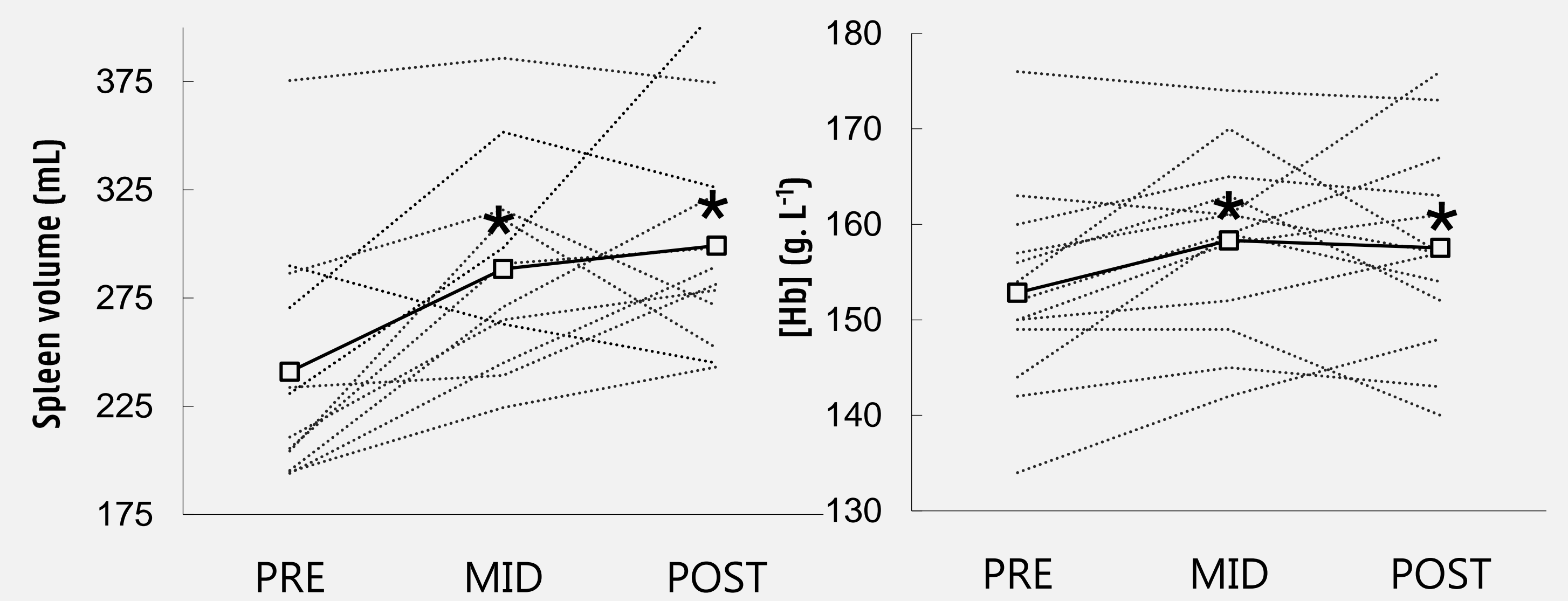
- [Hb] (Venous blood)
- Spleen volume (Ultrasonography)



Acute response and training adaptation

- Acute apnea evokes a spleen contraction of $34 \pm 12\%$ after one (V1) and $50 \pm 10\%$ (V4 on left panel) after 4 apneas, increasing circulating [Hb] from 156 ± 11 at baseline (BL) to 159 ± 9 g L⁻¹ (right panel) immediately post apnea (time point 0).
- This response was not altered by the training program.

RESULTS



Training adaptation to baseline values

- Apnea training did increase baseline spleen volume by 24% from 241 ± 55 mL PRE training to 299 ± 51 mL POST training (left panel). Baseline [Hb] was increased by 3.3% from 153 ± 10 to 159 ± 9 g L⁻¹ (right panel).

CONCLUSION

- This study confirms the acute spleen contraction and concomitant ↑ in [Hb] following a series of maximal static apneas.
- No training adaptations were observed for the acute response
↔ to the differences between trained and untrained individuals.
- This study was the first to observe ↑ in baseline spleen volume and [Hb] following an apnea training program.
This is in agreement with the larger spleen volumes and higher [Hb] found in divers vs non divers^[4].
The magnitude of the ↑ [Hb] is in line with ↑ following high altitude training^[5].

References

- Baković D, Eterović D, Sarattija-Novaković Z, Palada I, Vatic Z, Bilopavlović N, Dujic Z (2005) Effect of human splenic contraction on variation in circulating blood cell counts. *Clinical and Experimental Pharmacology and Physiology*, 32, 944-951.
- de Bruijn R, Richardson M, Schagatay E (2008) Increased erythropoietin concentration after repeated apneas in humans. *European Journal of Applied Physiology*, 102, 609-613.
- Richardson M, de Bruijn R, Holmberg HC, Björnkjund G, Haughey H, Schagatay E (2005) Haemoglobin levels in elite divers, elite skiers and untrained humans. *Canadian Journal of Applied Physiology*, 30, 276-281.
- Schagatay E, Richardson M, Lodin-Sondström (2012) Size matters: Spleen and lung volume predict performance in human apneic divers. *Frontiers in Physiology*, 3, 173.
- Park H, Hwang H, Park J, Lee S, Lim K (2016) The effects of altitude/hypoxic training on oxygen delivery capacity of the blood and aerobic exercise capacity in elite athletes - a meta-analysis. *J Exerc Nutrition Biochem* 20:015-022.

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