Core Temperature and Thermal Sensation Change after Cold Water SCUBA Diving

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Human Physiology

Introduction

- Humans homeostatically maintain a core temperature (Tc) of 37 ± 0.5ºC.[4]
- Thermal sensation (Ts) is one's perception of their thermal condition.[2]
- In cold water immersion (CWI), Tc decreases because heating mechanisms, triggered by lowered skin temperature, cannot produce enough heat to maintain Tc.[1]
- Anthropometrics, such as body surface area (BSA), body mass (BM), and body mass index (BMI) play a role in the extent to which Tc changes after CWI.[1,5]
- Previous studies have focused on mostly male and technical divers in extreme conditions, lacking data on females and recreational divers.

Aims of the study:

1. Impact of suit type (drysuit vs wetsuit) on Tc and Ts.
2. Effect of BSA/BM and BMI on Tc and Ts.

Methods

- Subjects recruited from UO SCUBA classes.
- Cold water dives (9.3±5.8°C) in Oregon (freshwater) and Washington (saltwater).
- Drysuit n=10 (5M, 5F), Wetsuit n=42 (19M, 23F).
- Tc collected via telemetric pill before and after the dive.
- Ts measured using a 0 (unbearably cold) to 8 (unbearably hot) scale before and after the dive.
- Dive info and anthropometrics collected on all subjects.
- Core wetsuit thickness the same for all wet divers (7mm farmer john and 7mm shorty long sleeve).

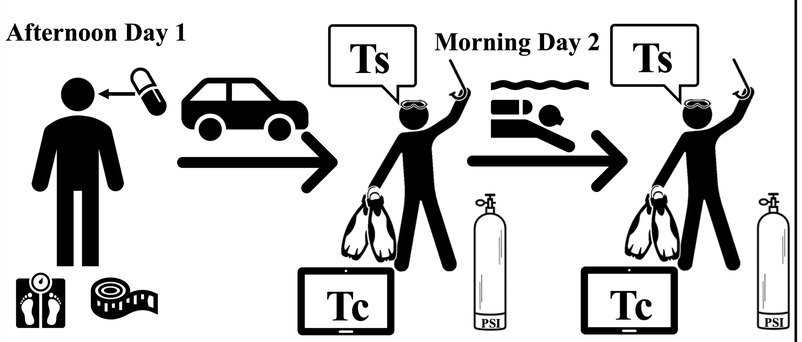

Figure 1: Protocol illustrating anthropometric data collection and telemetric pill activation the night before the dive and recording of Ts and Tc before and after the dive.

Results

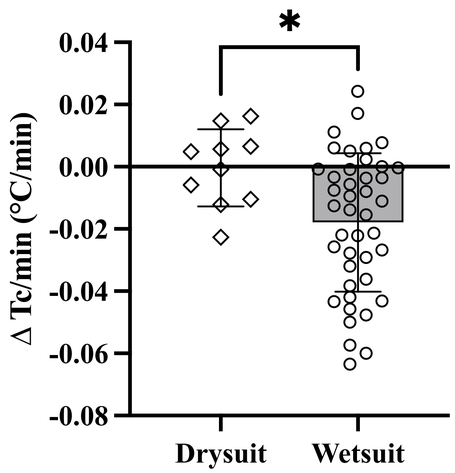

Figure 2: ΔTc/min (°C/min) in drysuit and wetsuit divers. Error bars denote one standard deviation from means. * indicates group difference in ΔTc/min ($p<0.05$).

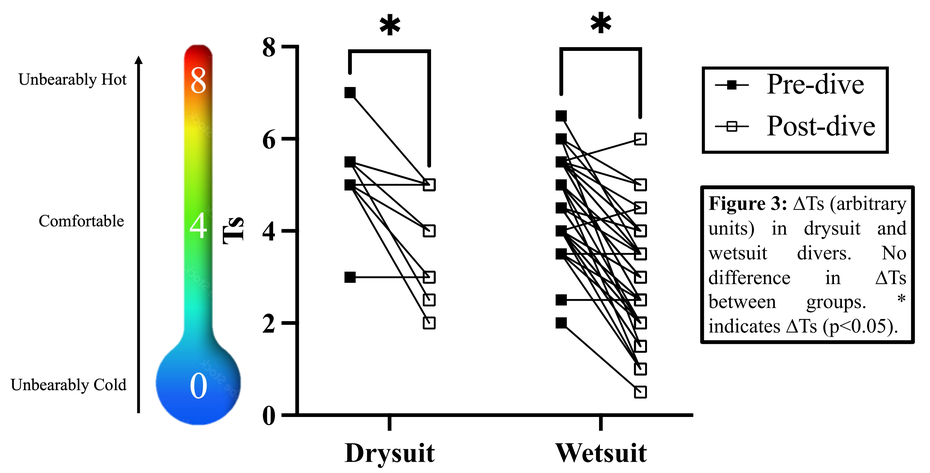

Figure 3: ΔTs (arbitrary units) in drysuit and wetsuit divers. No difference in ΔTs between groups. * indicates ΔTs ($p<0.05$).

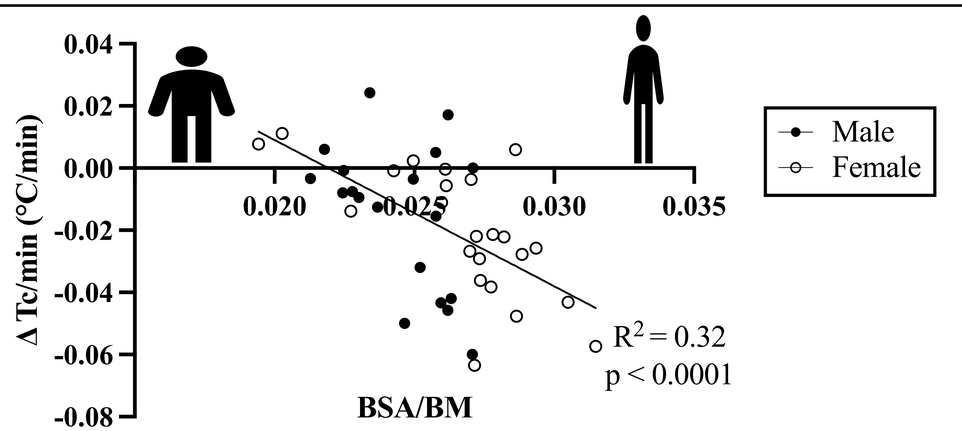

Figure 4: ΔTc/min (°C/min) vs. BSA/BM in wetsuit divers. Human icons give reference sizes for the lower and upper end of BSA/BM.

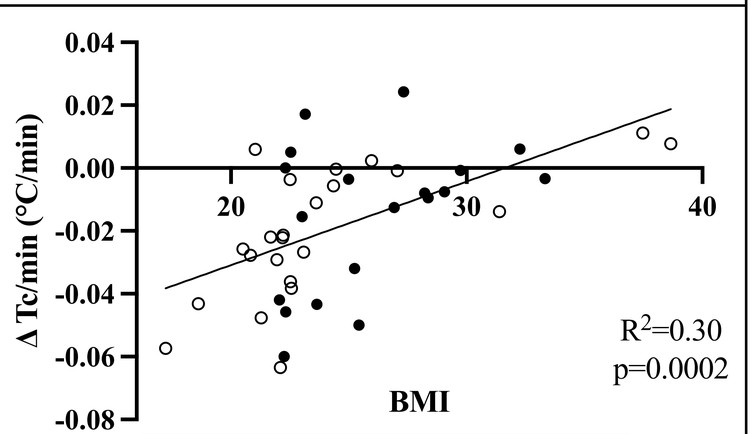

Figure 5: ΔTc/min (°C/min) vs. BMI in wetsuit divers.

Results

- Wetsuit divers had a greater decrease in Tc/min than drysuit divers ($p<0.05$, Figure 2).
- Wetsuit and drysuit divers both had significant Ts decrease ($p<0.05$) but there was no significant difference in the decrease of Ts between groups ($p>0.05$, Figure 3).
- BSA/BM was negatively correlated with ΔTc/min ($p<0.0001$, $R^2=0.32$, Figure 4).
- BMI was positively correlated with ΔTc/min ($p<0.05$, $R^2=0.30$, Figure 5).

References

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2. **Kingma et al.** *Indoor Air*, *22*(3), 253–262, 2012
3. **Lafère et al. C.** *Int Marit Health*, *72*(3), 217–222, 2021
4. **Morrison & Nakamura** *Annu Rev Physiol.*, 285-308, 2019
5. **Zhang et al.** *Building and Environment*, *234*, 110206, 2023

Conclusions

- There was a greater decrease in Tc/min in wetsuit wearers vs. drysuit wearers, presumed secondary to the increased direct water-to-skin exposure in wetsuit divers.[3]
- Ts decreased in both wetsuit and drysuit groups, likely due to both groups having sustained exposure to cold water.
- The negative correlation between BSA/BM and ΔTc/min was expected (Figure 4). Previous literature on CWI has shown that higher BSA/BM leads to greater Tc decrease under CWI conditions due to increased convection.[1]
- The positive correlation between BMI and ΔTc/min was expected (Figure 5). High BMI is associated with increased white adipose tissue and lower heat loss.[5]
- **Future Directions:** Future studies should include divers with wetsuits of differing thicknesses to assess whether increasing thickness leads to better thermal protection correlating with lower decreases in Tc.

Acknowledgments

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