

**The Effects of Cryostimulation
on Inflammatory Cytokines
and Hematological Parameters**

Introduction

Cryostimulation

- 2-4 minutes of (-110°C to -200°C) cold exposure
- Performed in a cryosauna
- Reduce inflammation



Figure 1: Cryomed Pro Cryosauna

Introduction

- Cost: \$60-100
- Cryosauna
- CWI 6-8 minutes
- Treatment time: 2-4 minutes



Figure 2: CryoUSA Cryosauna

Background

- Used in sports medicine
- Prevents inflammation and helps with injury recovery
- 2 minutes reduced inflammation without any negative effects
- 3 minutes of cryostimulation had positive effects

(Banfi, 2009; Banfi, 2010) (Costello, 2012)



Background

- Used in Northern Europe
- Inflammatory status differs before and after
- The pro-inflammatory cytokines:
 - IL-6, IL-1 β , and TNF- α
- Anti-inflammatory cytokine:
 - IL-10
- IL-6 can act as both a pro-and anti-inflammatory cytokine

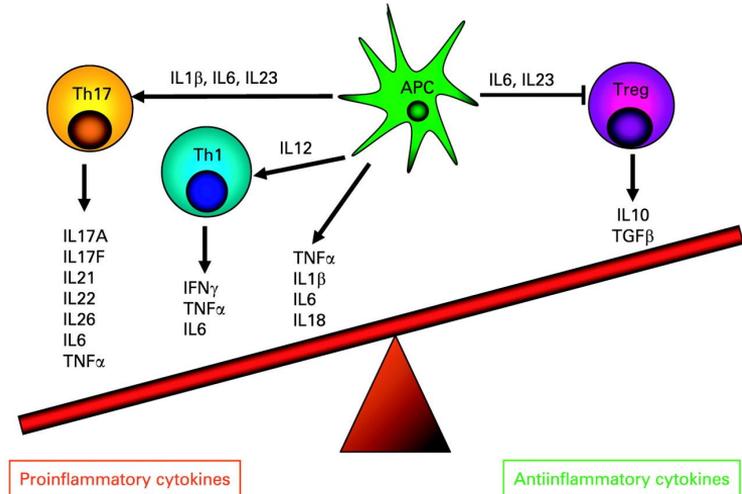
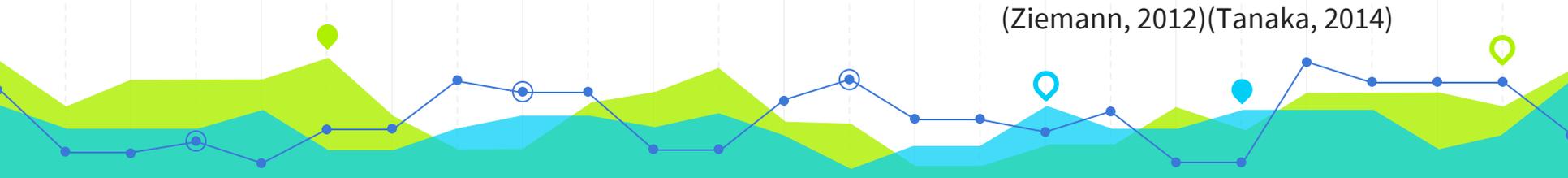


Figure 3: Anti-Inflammatory and proinflammatory cytokine diagram

Background

- Il-6 is a pro-inflammatory cytokine with a pleiotropic effect
- Extremely low temperature can trigger muscle shivering
- Result in an the decrease in IL-6
- IL-10 or synthesis inhibitory factor (CSIF)
- Encoded by the IL10 gene

(Ziemann, 2012)(Tanaka, 2014)



Background

- Positive effects on creatine kinase (CK)
- Indicates muscular involvement during exercise
- Hematological parameters
 - Hemoglobin (Hb) and red blood cells (RBC)
- IL-1 β is a prototypic proinflammatory cytokine that has pleiotropic effects
- Cryostimulation effectively reduces TNF- α concentrations

(Ziemann, 2013)



Purpose

- To evaluate the cryostimulation treatment and find the optimum duration for effective treatment
- Compare the different numbers of minutes (2-3)
- Based on inflammatory cytokines or hematological parameters



Research Question

What is the optimum duration of cryostimulation treatment to reduce inflammation?



Alternative Hypothesis

- The optimum treatment time for cryostimulation to significantly reduce inflammation is 3 minutes per day

Null Hypothesis

- 3 minutes of cryostimulation treatment does not affect the inflammation



Methods

- Systematic literature review
- Analyzed peer-reviewed papers
- Papers on inflammatory cytokines and hematological parameters
- Selected research design is most accurate



Explanation of Data Analysis

- Date range-Peer reviewed papers: 2006 to 2018
- Used online databases
 - Such as Elsevier, ScienceDirect, and Plos One
- Search terms
 - Inflammation, cryostimulation, cold therapy, cytokines, hematological parameters
- Study only includes 2 and 3 minutes
- 4 minutes is not used as frequently



Results

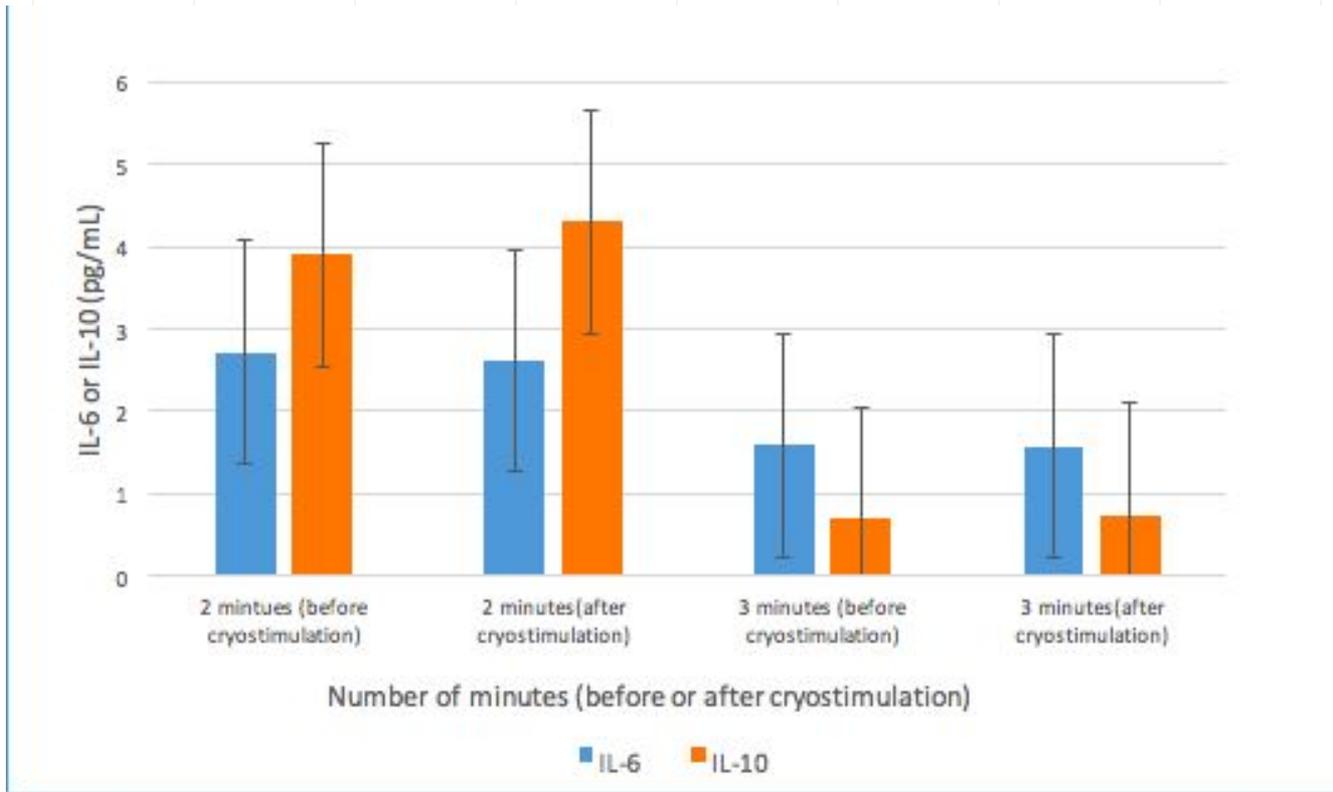


Figure 4: Interleukin 6 and 10 (pg/mL) at 2 and 3 minutes before and after cryostimulation $p=0.0221$

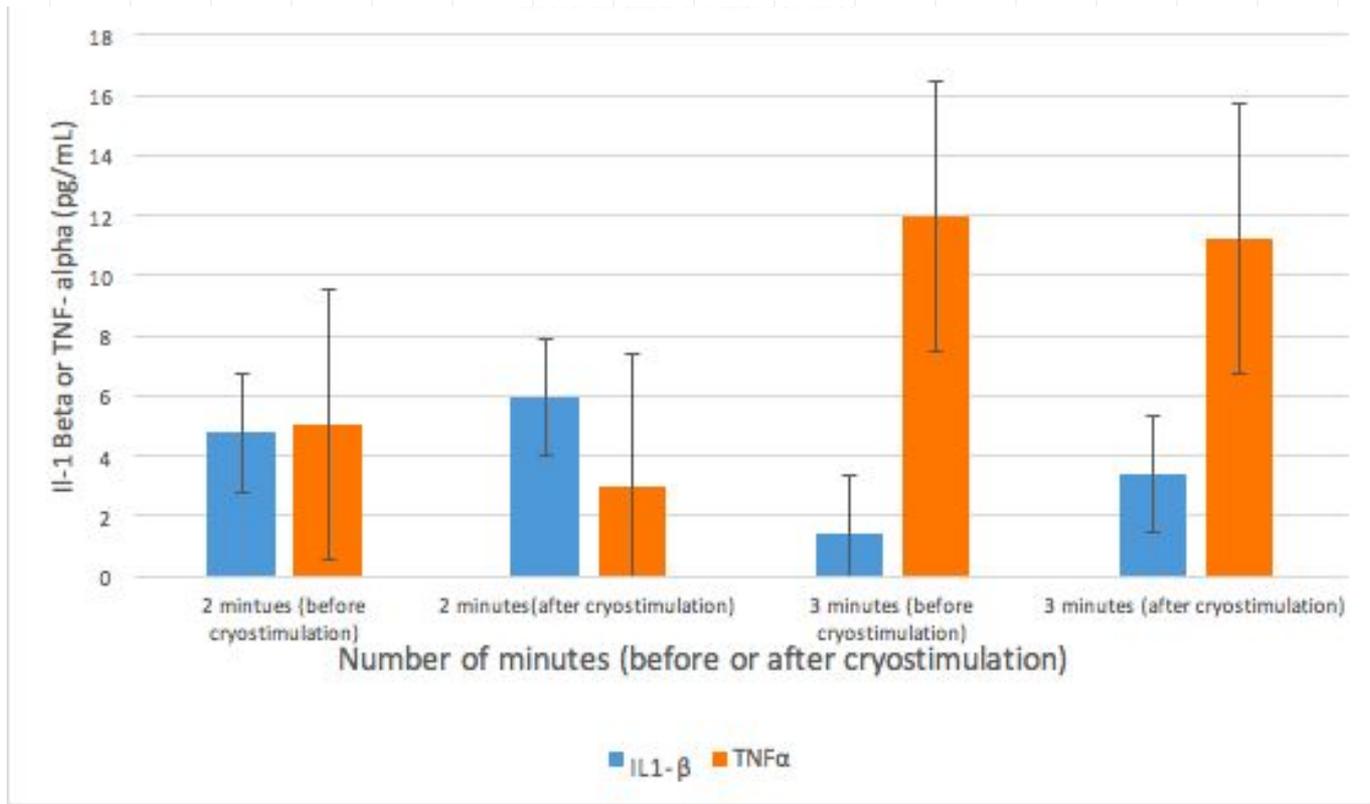


Figure 5: Interleukin 1-Beta and Tumor necrosis factor alpha (pg/mL) at 2 and 3 minutes before and after cryostimulation. P=0.253

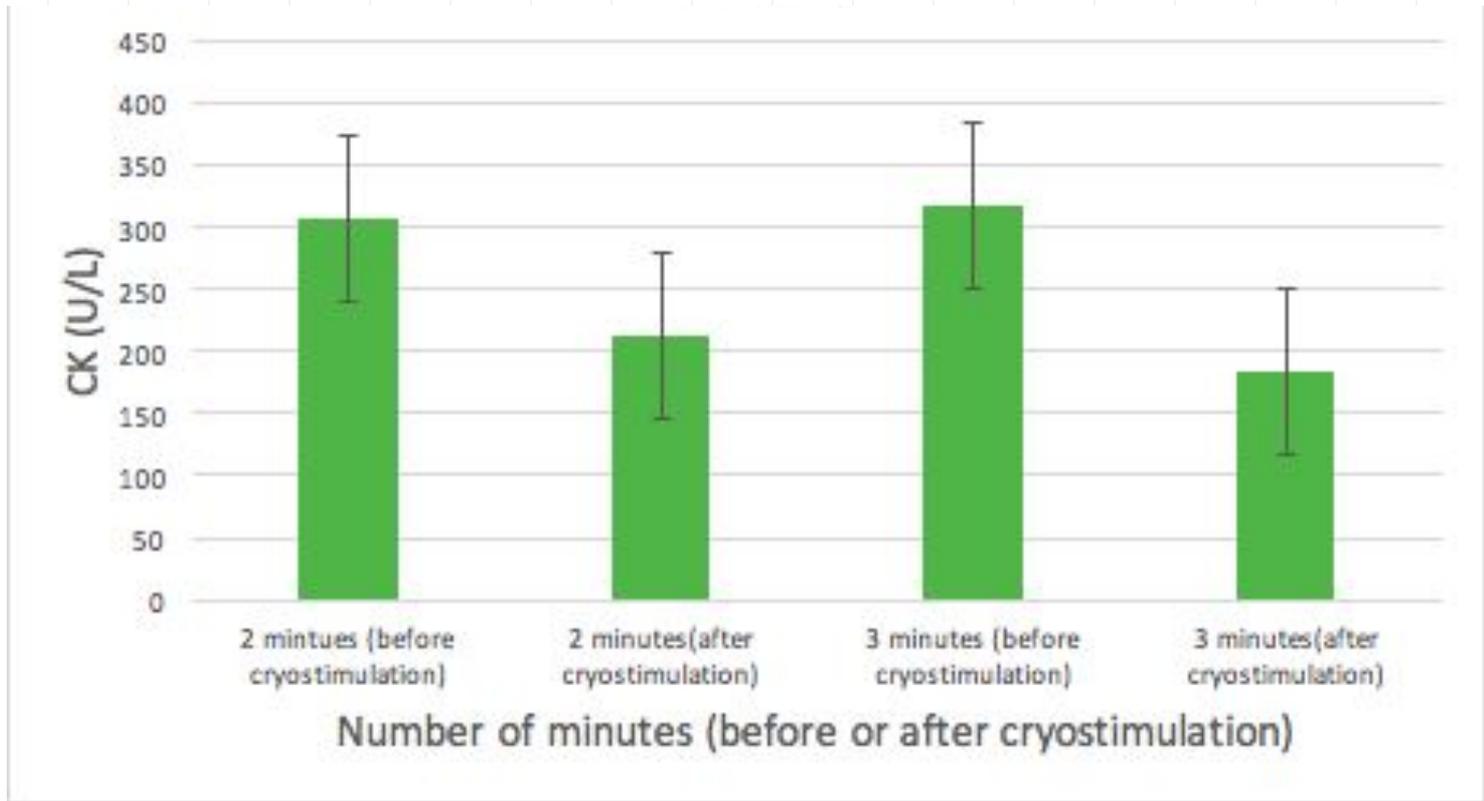


Figure 6: Creatine kinase (U/L) at 2 and 3 minutes before and after cryostimulation
 $p=0.359$

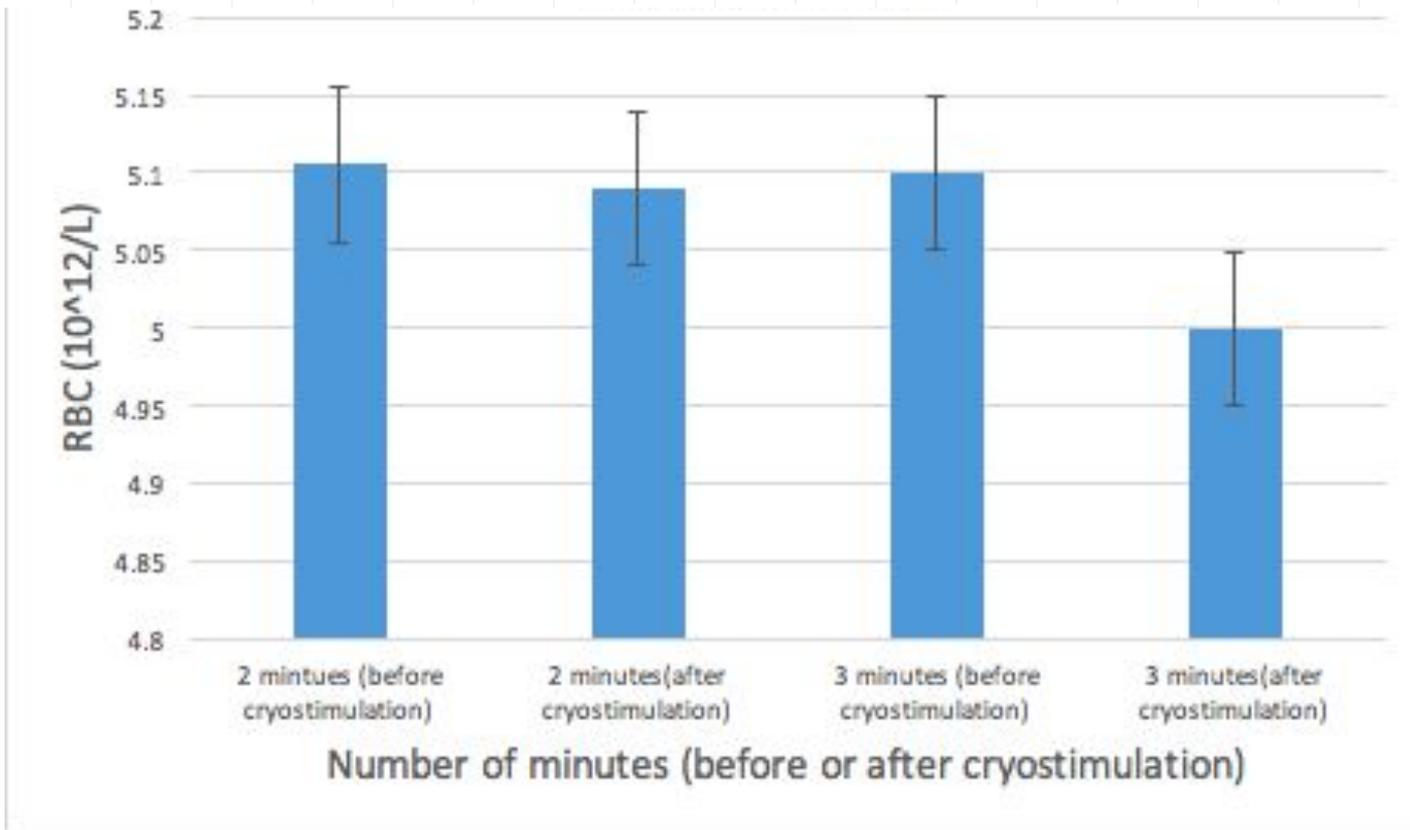


Figure 7: Red blood cells ($10^{12}/L$) at 2 and 3 minutes before and after cryostimulation $p=0.232$

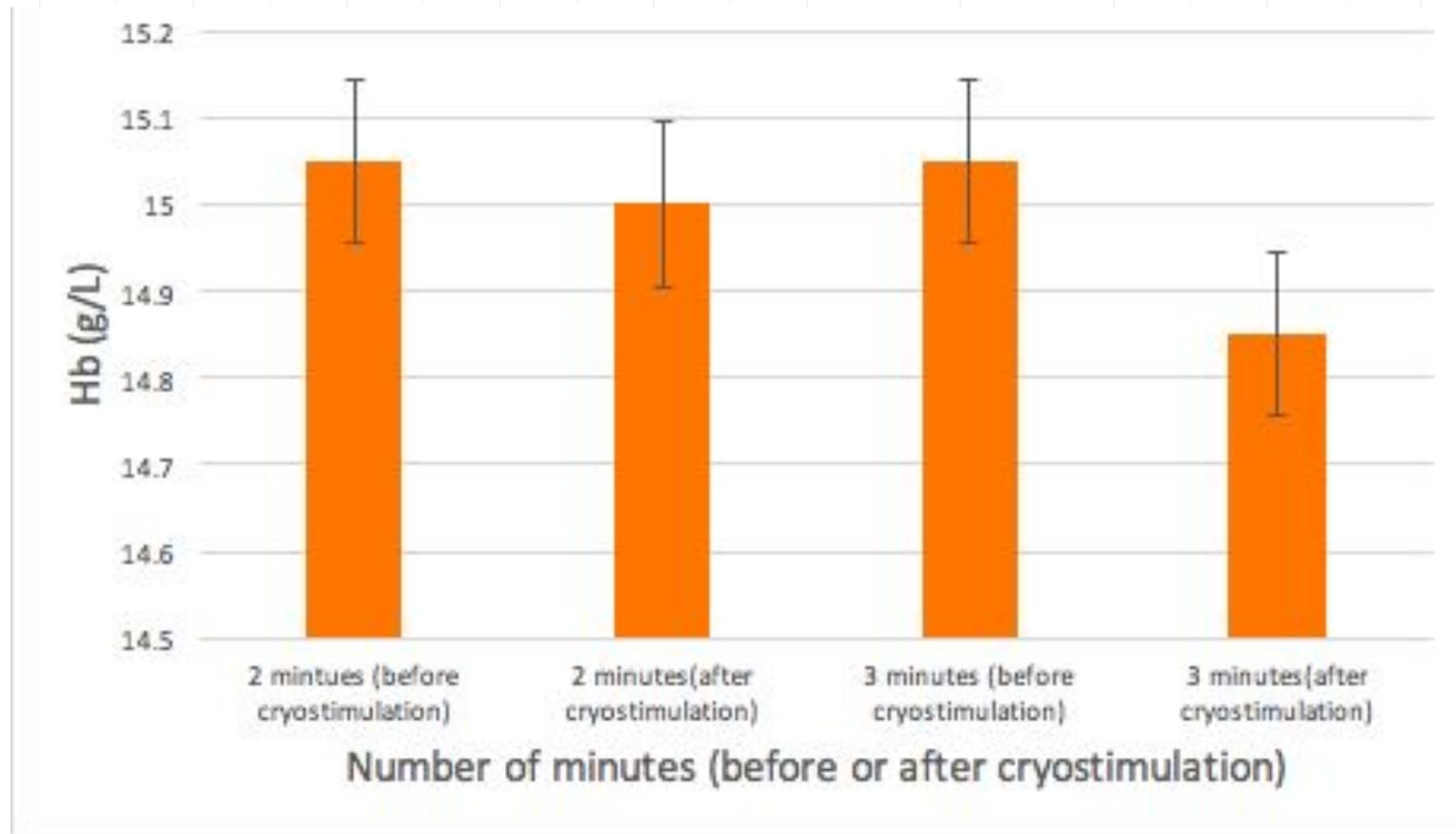


Figure 8: Hemoglobin (g/L) at 2 and 3 minutes before and after cryostimulation $p=0.25$

Results

- Increase in IL-10
- Decrease in IL-6
 - 2 minutes 10% greater than 3 minutes in both
- Decrease in TNF- α
 - 2 minutes 3% more significant decrease than 3 minutes
- Increase in IL-1 β
 - 2 minutes 2% less than at 3 minutes



Results

- Decrease in CK
 - 3 minutes 1.4% more effective than 2 minutes
- Decrease in RBC
 - 2 minutes 15% greater decrease than 3 minutes
- Decreases in Hb
 - 3 minutes 25% greater decrease than 2 minutes



Discussion

- Muscle shivering: the source of IL-6 production
- Slight hypothermia induced the expression of IL-10
- IL-10 has decreased in a wide spectrum of pro-inflammatory cytokine genes brought on by IL-10
- Increase in IL-1 β might have been caused by the increased level of IL-10

(Ziemann, 2012) (Ziemann, 2013)



Discussion

- Increase in IL-1 β means inflammation was increased
- High variability because of large standard deviation bars
- Plasma IL-1 β had a short-lived increased
- Previous published studies have seen TNF- α effectively reduced

(Ziemann, 2013) (Ziemann, 2013)



Discussion

- ① Decrease in serum CK suggested rapid recovery from muscle damage
- ② No detrimental effect on hematological parameters
- ③ Muscle contraction caused RBC decrease



Conclusions

- Inflammation is more significantly affected by 3 minutes
- Athletes and non-athletes can recover faster with cryostimulation
- Spend less time and money on physical therapy or other recovery methods
- Better understanding of the positive effects of cryotherapy and the optimum number of minutes



Limitations

- The variability of the data
- Only focused on 2 and 3 minutes
- No primary data collection could have been performed



Further Work

- Baseline for the number of minutes that cryostimulation is performed
- Further studies on other inflammatory cytokines
 - IL-3, IL-2 and IL-8
- More hematological parameters
 - Hematocrit, mean corpuscular value and hemoglobin, and platelets
- More research on IL-1 β



Acknowledgements

- Dr. Lombardi at University of Milan, Italy
- Mr. Giuseppe Banfi (IRCCS)
- Mr. Saul Cuttell at the University of Northampton
- Dr. Malhotra
- Ms. Michelle Magnusson

References

Banfi, G., Lombardi, G., Colombini, A., & Melegati, G. (2010). Whole-Body Cryotherapy in Athletes. *Sports Medicine*, 40(6), 509-517. doi:10.2165/11531940-000000000-00000

Banfi, G., Melegati, G., Barassi, A., & Deril, G. M. (2009). Beneficial effects of the whole-body cryotherapy on sport haemolysis. *Journal of Human Sport and Exercise*, 4(2), 189-193. doi:10.4100/jhse.2009.42.11

Banfi, G., Melegati, G., Barassi, A., Dogliotti, G., D'Eril, G. M., Dugué, B., & Corsi, M. M. (2009). Effects of whole-body cryotherapy on serum mediators of inflammation and serum muscle enzymes in athletes. *Journal of Thermal Biology*, 34(2), 55-59. doi:10.1016/j.jtherbio.2008.10.003

Costello, J. T., Culligan, K., Selfe, J., & Donnelly, A. E. (2012). Muscle, Skin and Core Temperature after -110°C Cold Air and 8°C Water Treatment. *PLoS ONE*, 7(11). doi:10.1371/journal.pone.0048190

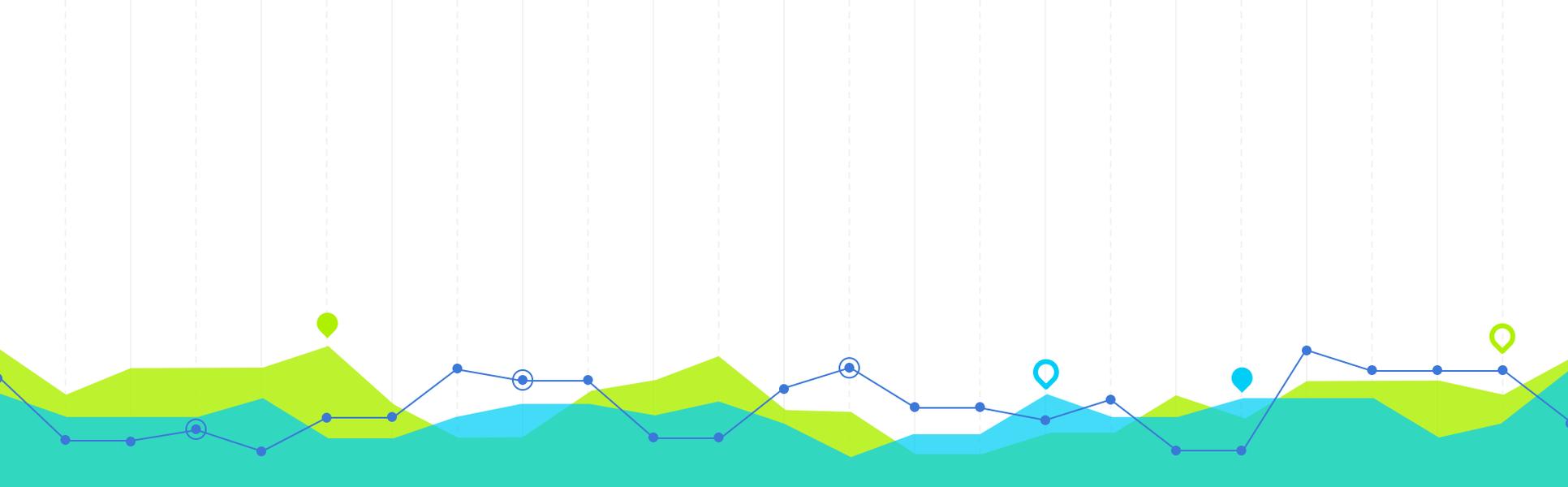
Lombardi, G., Lanteri, P., Porcelli, S., Mauri, C., Colombini, A., Grasso, D., . . . Banfi, G. (2013). Hematological Profile and Martial Status in Rugby Players during Whole Body Cryostimulation. *PLoS ONE*, 8(2). doi:10.1371/journal.pone.0055803

Tanaka, T., Narazaki, M., & Kishimoto, T. (2014). IL-6 in Inflammation, Immunity, and Disease. *Cold Spring Harbor Perspectives in Biology*, 6(10), a016295. <http://doi.org/10.1101/cshperspect.a016295>

Ziemann, E., Olek, R. A., Grzywacz, T., Antosiewicz, J., Kujach, S., Łuszczuk, M., Laskowski, R. (2013). Whole-body cryostimulation as an effective method of reducing low-grade inflammation in obese men. *The Journal of Physiological Sciences*, 63(5), 333-343. doi:10.1007/s12576-013-0269-4

Ziemann, E., Olek, R. A., Kujach, S., Grzywacz, T., Antosiewicz, J., Garsztko, T., & Laskowski, R. (2012). Five-Day Whole-Body Cryostimulation, Blood Inflammatory Markers, and Performance in High-Ranking Professional Tennis Players. *Journal of Athletic Training*, 47(6), 664-672. doi:10.4085/1062-6050-47.6.13





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