Does Environmental Cold Exposure and Fatigue Effect Pistol Marksmanship and Decision Making?

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Introduction

Occupations involving the use of firearms such as modern warfighters and law enforcement often require rapid deployment in austere environments. With the likelihood of increased military force deployment in cold environments, these future conflict zones will expose warfighters to environmental stressors resulting in a necessity to understand individual tolerance to environmental exposures during military operations. Equally, there is a lack of operational understanding of tactical performance and law enforcement team interaction in cold environments. The anecdotal impact of cold exposure has been the focus of select tactical training environments, however, the research in this area is limited.

Purpose

The purpose of this study was to examine the effects of cold exposure and fatigue on pistol marksmanship and target engagement decision making in trained marksmen.

Methods

Twelve healthy participants (mean ± SD; age: 28.75 ± 4.0 yrs.) were exposed to two simulated environmental conditions consisting of:

1. Thermoneutral, Normal Condition (24°C) → **NM**
2. Cold Condition (10°C) → **CD**

30-min Acclimation Period:

- A custom built 2.4 x 3.05 m environmental room was used to control environmental temperatures
- Subject remained seated for 30-min acclimating to the corresponding environmental condition

Shoot-No-Shoot Protocol(Figure 1):

- To assess pistol marksmanship and decision making the shoot-no-shoot protocol was performed on a calibrated infrared shooting simulator (Laser Ammo, Israel) that tracked all reaction times, hits, and misses.
- Targets consisted of random sets of numbers and colors (0-9; G, Y, B, R) displayed at a simulated distance of 9.1m at random locations on screen followed by a standardized audible command indicating the number and color of target to engage.
- Participants completed 5 rounds prior to and after the fatiguing protocol in each environmental condition.

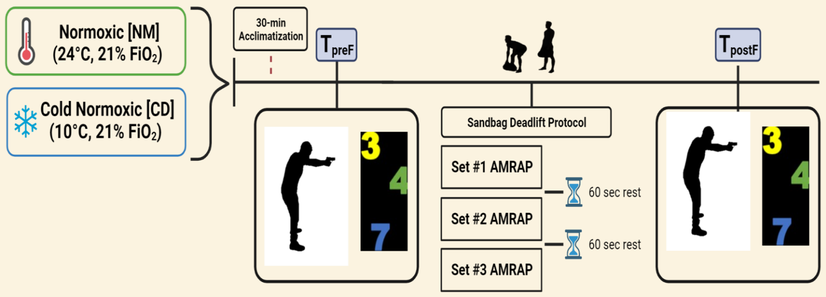

Figure 1. *Overview of study protocol.*

Sandbag Deadlift Protocol (Figure 1):

- An adjustable sandbag was set to a load corresponding to 50% of subjects body mass
- Subjects performed three sets of deadlifts, completing as many repetitions as possible until volitional exhaustion
- 60-sec of rest was allowed between the first two sets

Statistical Analysis

- Five separate, 2 (Condition: NM, CD) x 2 (Time: Pre-Deadlift and Post-Deadlift) repeated measures ANOVA were performed for Shooting accuracy (ACC), Target Hits (Hits), Target Misses (Miss), Total Shots (Tot), and Completion Time (Comp-T)
- Follow up paired sample t-tests were performed when appropriate

Results

- There were significant Condition x Time interactions for ACC, Miss, Total, and Comp-T (p=0.02 – 0.04).

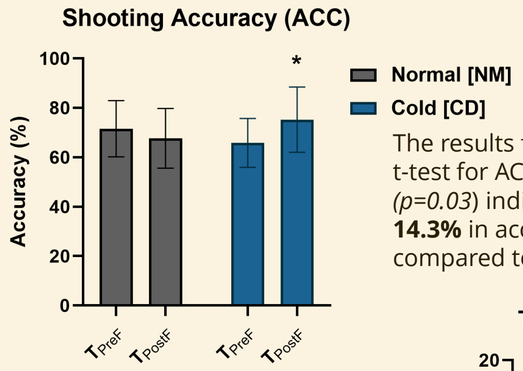

Figure 2. *Target accuracy for conditions post fatigue.(Mean ± SD). * indicates $Tpost_F$ > $Tpre_F$ in CD (p < 0.05).*

The results from the paired sample t-test for ACC in the CD condition (p=0.03) indicated an increase of **14.3%** in accuracy post-fatigue compared to pre-fatigue. (Figure 2)

The results from the paired sample t-test for Miss in the CD condition (p=0.02) indicated a decrease of **34.7%** in missed shots post-fatigue compared to pre-fatigue. (Figure 3)

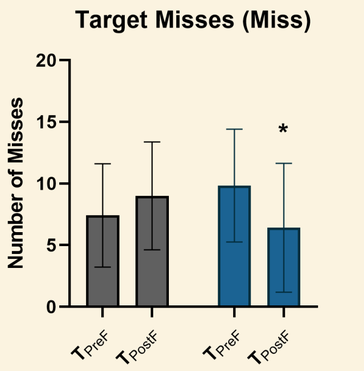

Figure 3. *Total misses for conditions post fatigue.(Mean ± SD).* indicates $Tpost_F$ > $Tpre_F$ in CD (p < 0.05).*

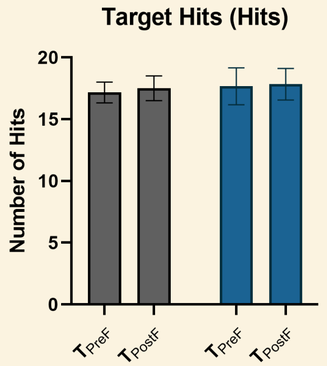

Figure 4. *Total misses for conditions post fatigue.(Mean ± SD).*

For Hits, there was no significant interaction (p=0.79) or main effects (p=0.31-0.46). (Figure 4)

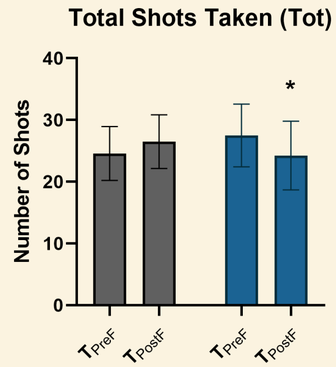

Figure 5. *Total number of shots taken for conditions post fatigue.(Mean ± SD).* Indicates $Tpre_F$ > $Tpost_F$ in CD (p < 0.05).*

The results from the paired sample t-test for Tot in the CD condition (p=0.04) indicated a decrease of **10.6%** in total shots taken post-fatigue compared to pre-fatigue. (Figure 5)

The results from the paired sample t-test for Comp-T in the CD condition (p=0.04) indicated a decrease of **9.6%** in completion time post-fatigue compared to pre-fatigue. (Figure 6)

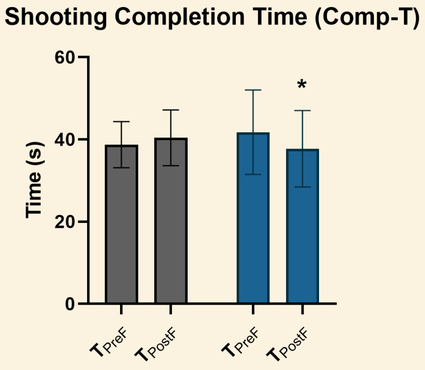

Figure 6. *Time to completion for the SNS protocol for conditions post fatigue. (Mean ± SD). Indicates $Tpre_F$ > $Tpost_F$ in CD (p < 0.05).*

There were no detectable differences observed between time points throughout the NM condition, nor when compared to CD (p>0.05)

Conclusions

- Acute cold exposure had no effect on pistol marksmanship and decision making.
- Participants showed improvements in accuracy, misses, total shots, and time to complete task following a repetitive whole body fatiguing protocol in the CD condition.
- The increase in marksmanship performance observed within the CD condition following the fatiguing protocol suggests the improvements were likely due to an increase in thermoregulation.
- The improvement in thermoregulation likely improved tactically relevant fine motor skills, with more studies needed to identify physiological causes.

Practical Applications

These findings are important to Tactical Strength and Conditioning facilitators working with populations that are frequently exposed to unique thermal environments to include cold exposure. Understanding the influence of thermoregulation on tactically relevant tasks can assist in identifying strategies that can optimize performance for personnel who are expected to perform duties in austere environments.

All figures were created with BioRneder.com or GraphPad Prism version 9.5.1