

# The Effect of Cold Ambient Temperatures on Climbing-Specific Finger Flexor Performance

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## Rock climbing

- A sport that is performed and studied in indoor and outdoor settings
- Performed in a wide range of ambient temperatures



Daniel Woods completes "The Game" V16 in cold conditions



- Environmental conditions may have a significant effect on climbing performance

Exposure occurs:

- During the approach to the climbing destination
- While climbing
- Between climbs



- Finger flexor performance is one of the most important aspects of rock climbing

Aim

- Examine the effects of cold ambient temperatures on climbing-specific finger flexor performance



## Methods

- 12 college aged rock climbers
  - 8 Males
  - 4 Females
- All climbers had at least 1 year of climbing experience
- Average climbing grade of 5.10c redpoint (YDS)

	<b>Males (n = 8)</b>	<b>Females (n = 4)</b>
<b>Age (y)</b>	<b>21.3 ± 3.0</b>	<b>20.8 ± 2.8</b>
<b>Height (cm)</b>	<b>177.5 ± 6.0</b>	<b>166.5 ± 2.5</b>
<b>Weight (kg)</b>	<b>75.9 ± 11.2</b>	<b>60.8 ± 2.9</b>
<b>Body fat (%)</b>	<b>10.6 ± 5.0</b>	<b>20.0 ± 4.2</b>

## Methods

- All participants attended a familiarization session
  - Informed consent
  - Climbing experience
  - Anthropometry
  - Practice study protocol

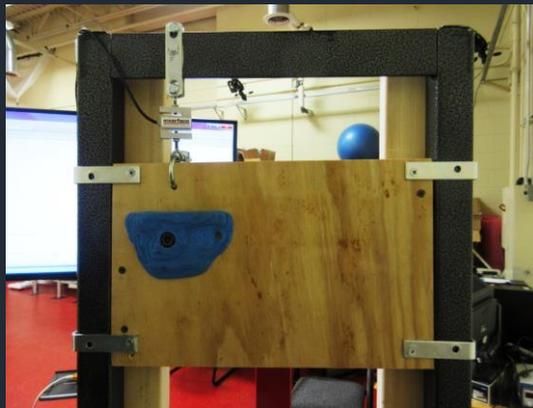
## Methods

### Laboratory Temperature Conditions

- **Thermoneutral**      **24 ± .38° C**
- **Cold**                      **10 ± .64° C**
- Counterbalanced repeated measures design
  - Each session was separated by 1 week

## Testing Device

- Existing metal frame was used
- Crimp grip
- SMA-600N Load cell  
(Interface, Scottsdale, AZ)



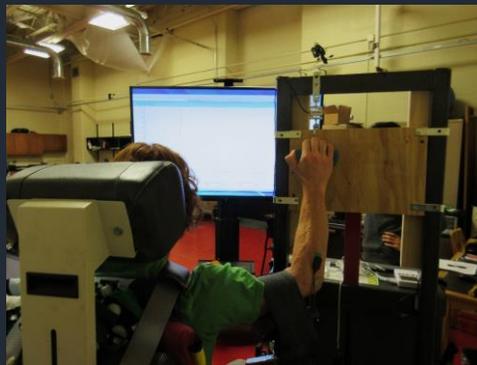
## Set Up

- Participants were set up and secured into an existing Biodex chair
- Dressed in shorts, a T-shirt, and shoes for both sessions
  - Sat motionless for 30 minutes before beginning the protocol
- Room temperature
- Skin temperature
- Thermal rating
- monitored throughout testing



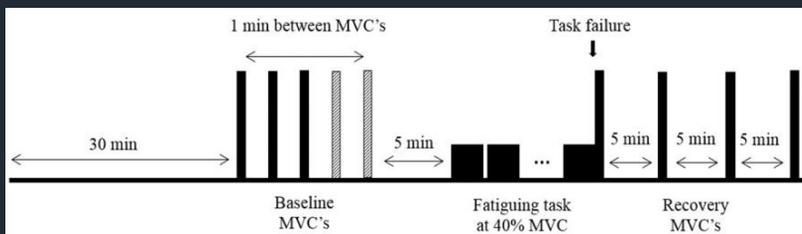
## Set Up

- Elbow supported on a cushioned surface
- A Velcro strap was placed around the biceps muscle to prevent the arm from lifting of the surface
- Force data was recorded at 2000 Hz with Spike 2 and displayed on a 1.77 m monitor located 2 m in front of the participant



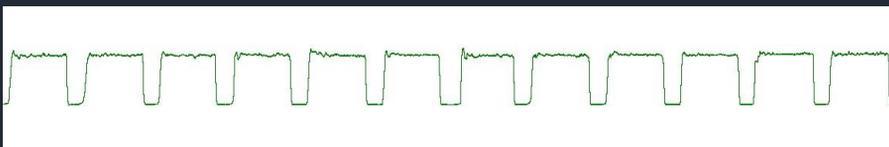
## Baseline MVC's

- After 30 min of rest....
- 3 MVC's of the finger flexors
  - Separated by 1 min
- 2 MVC's of the wrist extensors



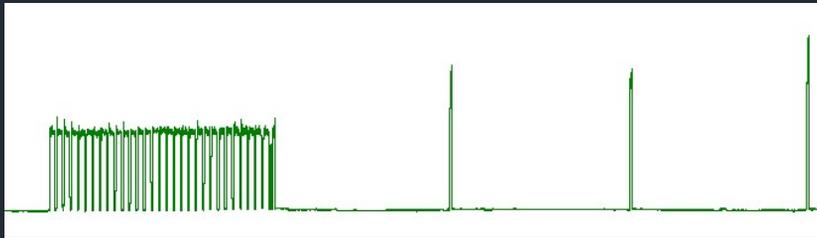
## Fatiguing Task

- Intermittent fatiguing protocol
  - 10 sec at 40% of MVC
  - 3 sec of rest
- Failure was defined as not being able to maintain -5% of the 40% MVC for 2 consecutive seconds



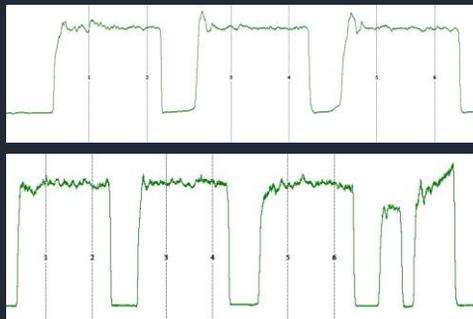
## Recovery Measurements

- Passive MVC recovery was assessed:
  - Immediately after
  - 5
  - 10
  - 15 minutes post task failure

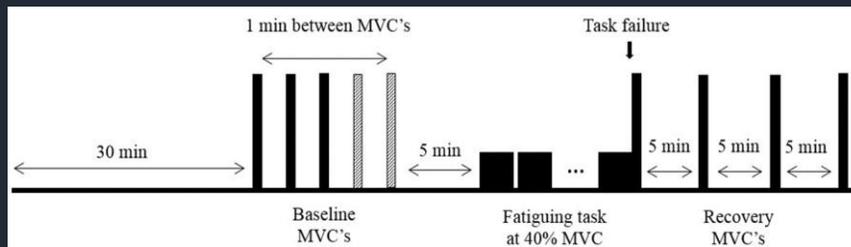


## Force Variability

- Participants were instructed to maintain force at the required level and to minimize variation in force production
- Coefficient of variation ( $CV = \text{SD of force} / \text{mean of force} \times 100$ )
- Analyzed and averaged during the middle 5 seconds of the first 3 contractions and last 3 contractions, before the failure set



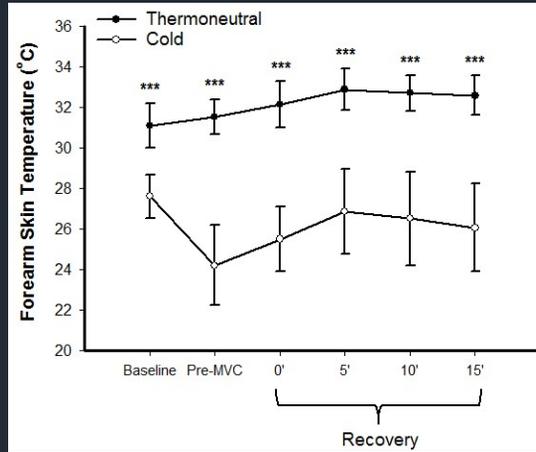
## Protocol



## Statistical Analysis

- A paired samples t-test was used to compare time to task failure during the fatiguing task.
- Repeated measures analysis of variance (ANOVA) were used to detect differences in MVC changes from baseline to post fatiguing task, MVC changes throughout recovery, force variability, skin temperature, and thermal rating.
- For each ANOVA the sphericity of data was verified with Mauchly's test and technical corrections were performed whenever necessary.
- Statistical significance was considered as  $P < 0.05$

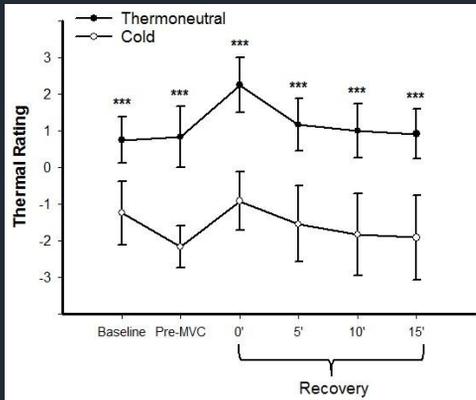
## Skin Temperature



\*\*\* P < 0.001

Skin Temp	Baseline	Pre-MVC	0'	5'	10'	15'
TN	31.1 ± 1.11	31.5 ± 0.8	32.1 ± 1.1	32.8 ± 1.0	32.6 ± 0.8	32.5 ± 0.9
Cold	27.6 ± 1.1	24.2 ± 2.0	25.5 ± 1.6	26.8 ± 2.1	26.5 ± 2.3	26.0 ± 2.1

## Thermal Rating

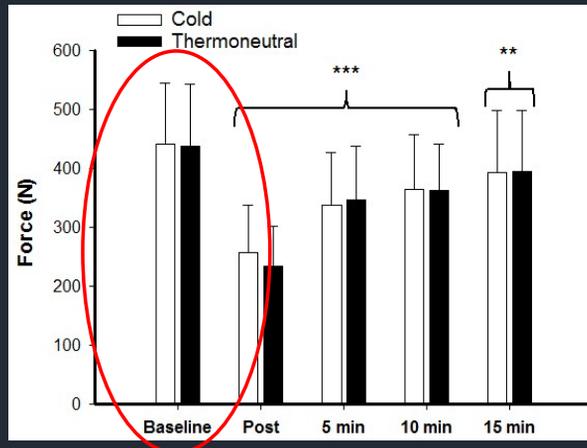


\*\*\* P < 0.001

Value	Thermal Scale
+3	Hot
+2	Warm
+1	Slightly Warm
0	Neutral
-1	Slightly Cool
-2	Cool
-3	Cold

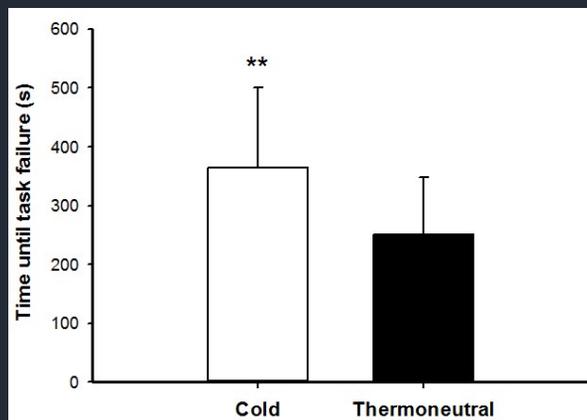
Skin Temp	baseline	Pre-MVC	0'	5'	10'	15'
TN	0.75 ± 0.62	0.83 ± 0.83	2.25 ± 0.75	1.17 ± 0.72	1 ± 0.74	0.92 ± 0.67
Cold	-1.25 ± 0.87	-2.17 ± 0.58	-0.92 ± 0.79	-1.54 ± 1.03	-1.83 ± 1.11	-1.92 ± 1.16

## MVC results



Skin Temp	Baseline	0'	5'	10'	15'
TN	437.8 ± 105.3	234.2 ± 68.2	347.0 ± 90.7	362.8 ± 78.4	395.3 ± 102.4
Cold	441.9 ± 102.8	257.9 ± 79.2	336.8 ± 90.3	364.4 ± 93.1	392.3 ± 106

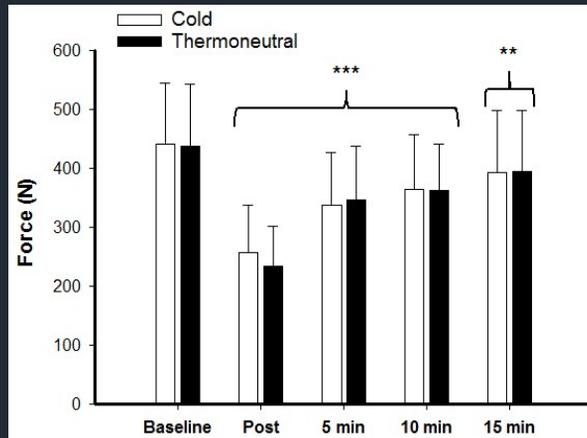
## Fatiguing task results



Time until task failure (s)

Cold	Thermoneutral
364.6 ± 135.5	251.0 ± 97.6

## MVC results

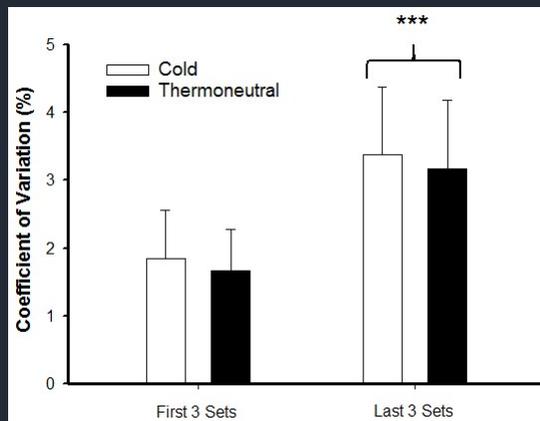


\*\*\* P < 0.001

\*\* P < 0.01

Skin Temp	Baseline	0'	5'	10'	15'
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Cold	441.9 ± 102.8	257.9 ± 79.2	336.8 ± 90.3	364.4 ± 93.1	392.3 ± 106

## Force Steadiness



\*\*\* P < 0.001

	First 3 sets	Last 3 sets
TN	1.67 ± 0.61	3.17 ± 1.02
Cold	1.85 ± 0.71	3.37 ± 1.0

## Discussion

- First study to examine the effects of exposure to different ambient temperatures on climbing specific measures of finger flexor performance
- Despite no significant difference between conditions in finger flexor MVC strength...
- Time to failure during the fatiguing task was significantly longer in the cold condition

- These findings are important for both researchers and climbers when considering testing conditions and optimizing climbing performance, respectively



Keep cool and climb on!

Questions?

