# ACCLIMATIZATION, DECAY AND RE-ACCLIMATIZATION

Candi D. Ashley cashley@usf.edu





- NIOSH
- Sunshine ERC
- Students, faculty and staff at USF
- Research collaborators:
  - Dr. Thomas E. Bernard
  - Dr. Eric Coris
  - Dr. Rebecca Lopez





- Introduction to acclimatization
- Physiological adaptations of acclimatization
- How long to acclimatize?
- What about decay of acclimatization?
- How long to re-acclimatize after absence?
- Acclimatization/Re-acclimatization Guidelines



• Exertional heat illness is a risk for workers in hot environments.

	Fatal illnesses (n=14)	Nonfatal illnesses (n=11)	Total sample (n=25)
Unacclimatized n (%)	11 (78.6)	1 (9.1)	12 (48.0)

Tustin AW, Lamson GE, Jacklitsch BL, et al. Evaluation of Occupational Exposure Limits for Heat Stress in Outdoor Workers — United States, 2011–2016. MMWR Morb Mortal Wkly Rep 2018;67:733–737.

#### UNIVERSITY OF SOUTH FLORIDA. PHYSIOLOGY OF ACCLIMATIZATION: HEART RATE

- Decreased heart rate for a given intensity
- Increased plasma volume
- Increased stroke volume
- Increased skin blood flow



#### UNIVERSITY OF SOUTH FLORIDA. PHYSIOLOGY OF ACCLIMATIZATION: CORE TEMPERATURE

- Decreased core temperature for a given workload
- Decreased threshold for the onset of sweating



#### UNIVERSITY OF SOUTH FLORIDA. PHYSIOLOGY OF ACCLIMATIZATION: SWEAT RATE

- Greater sweat rate
- More dilute sweat
- Sweat at a lower core temperature



#### Sweat Rate with Acclimtization



- Decreased perceived exertion
- Reduced oxygen demand at a given intensity
- Fitness confers an advantage to acclimatization



#### UNIVERSITY OF SOUTH FLORIDA. CURRENT ACCLIMATIZATION GUIDELINES

- Occupational Safety and Health Administration:
  - 5 days beginning with 50%; increase to 100% by day 5
- National Institute for Occupational Safety and Health:
  - 5 days beginning with 20%; increase 20% each day
- Mining Safety and Health Administration
  - 6 days beginning with 50%; increase 20%
- Military guidelines
  - 2 weeks





- n =18
- Evidence of acclimatization = plateau in core temperature over last 30 minutes for 3 days
- $\rightarrow$  6 days for acclimatization





Sports Med (2018) 48:409–430 https://doi.org/10.1007/s40279-017-0808-x

SYSTEMATIC REVIEW



# Heat Acclimation Decay and Re-Induction: A Systematic Review and Meta-Analysis

Hein A. M. Daanen<sup>1</sup><sup>[b]</sup> · Sebastien Racinais<sup>2</sup> · Julien D. Périard<sup>2,3</sup>

- Adaptations in heart rate and core temperature occur in 5 days with daily heat exposure.
  - Increased duration of daily heat exposure improves core temperature adaptations.
  - Increased WBGT improves sweat rate adaptations.

#### UNIVERSITY OF SOUTH FLORIDA. ACCLIMATIZATION, DECAY AND REACCLIMATIZATION: HEART RATE



#### UNIVERSITY OF SOUTH FLORIDA. ACCLIMATIZATION, DECAY AND REACCLIMATIZATION: CORE

TEMPERATURE

#### Core Temperature





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SYSTEMATIC REVIEW



## Heat Acclimation Decay and Re-Induction: A Systematic Review and Meta-Analysis

Hein A. M. Daanen<sup>1</sup> · Sebastien Racinais<sup>2</sup> · Julien D. Périard<sup>2,3</sup>

- For every decay day, ≈ 2.5% of adaptations in heart rate and core temperature are lost.
- Rate of decay in core temperature can be reduced with **increased duration** and **decreased exposure**.



- OSHA:
  - 5 days after 2 weeks away
- MSHA:
  - 4 days after 8 days away;Beginning with 50%
- NIOSH
  - 4 days begin with 50%





- Research:
  - 4 days after 2 weeks away
  - 5 days after 4 weeks away





- Heat stress is based on:
  - Environmental conditions
  - -Metabolic rate
  - Clothing

### UNIVERSITY OF SOUTH FLORIDA. ACCORDING TO TEMPERATURE AND WORK RATE

Recommendations for Heat Acclimatization for Warm Conditions	
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	Light Work (125 - 275 W)		Moderate Work (275 - 375 W)		Hard Work $(375 - 475 W)$	
WBGT ፑ	Time Spent working in hot environment	Heat Acclimatization Days	Time Spent working in hot environment	Heat Acclimatization Days	Time Spent working in hot environment	Heat Acclimatization Days
78-81.9	90_100%	2 – 3	70_100%	3 <sub>–</sub> 5	50_100%	6
82_84.9	80_100%	2 _ 4	70_100%	3 <u>–</u> 5	50_100%	6
85_87.9	70_100%	3 _ 5	60_100%	4 <u>–</u> 6	50_100%	6
88_89.9	60_100%	4 <u>–</u> 6	50_100%	6	50_100%	6
90+	50_100%	6	50_100%	6	50_100%	6

#### USF SOUTH FLORIDA. RE-ACCLIMATIZATION GUIDELINES ACCORDING TO TEMPERATURE AND WORK RATE

<b>Recommendations for Re-Acclimatization for Warm Conditions</b>						
Routine				GREEN		
Absence	Absence Due					
	to Illness	Day 1	Day 2	Day 3	Day 4	Day 5
< <b>4</b>		100		_		
4_5	1_3	90	100			
6_12	4_5	80	90	100		
12_20	6_8	60	80	90	100	
>20	>8	50	60	80	90	100

Routine Absence	Absence Due			YELLOW		
	to Illness	Day 1	Day 2	Day 3	Day 4	Day 5
< 4		90	100			
4_5	1_3	80	90	100		
6_12	4_5	70	80	90	100	
12_20	6_8	60	70	80	90	100
>20	>8	50	60	70	80	90

Routine Absence	Absence Du	e		RED		
	to Illness	Day 1	Day 2	Day 3	Day 4	Day 5
< <b>4</b>		80	90	100		
4_5	1_3	60	80	90	100	
6_12	4_5	50	60	80	90	100
12_20	6_8	50	60	70	80	90
>20	>8	50	60	70	80	90



- Establishing heat acclimatization policies is crucial in ensuring worker safety.
- Adaptations of acclimatization can be accrued in 5 to 6 days with greater benefits with longer exposures.
- Acclimatization is lost when workers are away from the heat, and a re-acclimatization schedule is warranted.
- Prudent acclimatization and reacclimatization guidelines should take into account environmental conditions and work rate.

# THANK YOU FOR YOUR TIME!



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