



U.S. PARALYMPICS



# **BEAT THE HEAT SYMPOSIUM**

## **HEAT RISK AND COUNTER- MEASURES IN PARA ATHLETES**

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## OUTLINE



- Para athletes 'at risk' of heat related performance decrements
- Sweat rate and fluid intake
- Core temperature during exercise in Para athletes
- Heat acclimation studies in Para athletes
- Cooling strategies in Para athletes
- Practical and pragmatic strategies to avoid and manage heat stress in Para athletes



## Para Athletes 'At Risk' of Heat Related Performance Decrements



PARA SPORT
Archery
Shooting
Triathlon
Cycling
Athletics – marathon & throws / jumps
Tennis
Equestrian

IMPAIRMENT	
Spinal cord injury	Impaired sudomotor and vasomotor control
Multiple Sclerosis	Impaired thermoregulation
Neurological impairment	
Amputee	Reduced surface area, interface with prosthesis



## Sweat Rates and Fluid Intakes in Para Athletes



SPORT	IMPAIRMENT	ATHLETES	EVENT	SWEAT LOSS	FLUID INTAKE
WC basketball (National)	SCI (T4-L1) Non-SCI	7 (F) 4 (F)	Match	1.0 L	0.7 L
WC rugby	SCI C4/5-C6/7	8 (7M, 1F)	Intermittent sprint protocol (55.5 mins)	140 mL	540 mL
WC basketball (National)	SCI T4-S1	8 (7M, 1F)		369 mL	469 mL

- Sweat rates may be influenced by use of anti-cholinergic medications which has not been fully assessed



## Core Temperature During Exercise in Para Athletes



SPORT	IMPAIRMENT	ATHLETES (M/F)	EVENT	CONDITION	DURATION (min)	CHANGE IN T <sub>CORE</sub> (°C)
WC racing (Elite)	SCI T6 to L3	5 (2M,3F)	25km Time trial	22.4°C, 39% RH	49.0 (3.4)	37.3-38.6
WC basketball (National)	SCI (T4-L1) Non-SCI	6 (F) 4 (F)	Match	22.1°C, 55% RH	21 (4) 14 (6)	37.5-38.6 37.5-38.5
Triathlon (International)	PTWC Neuro Amputee VI	9 (7M,2F) 6 (3M,3F) 7 (4M,3F) 6 (3M,3F)	Race (750m swim, 21km bike, 4.8km run)	33°C, 34- 35% RH, water temp 25-27°C	75.5 (13.1) 82.20 (12.4) 71.20 (5.4) 68.30 (6.6)	37.9-39.2 37.8-39.3 37.8-39.8 37.9-39.7
Hand cycling (National)	SCI T4	1 (M)	Marathon	20-22°C	109	36.8-40.4
WC Tennis (International)	SCI (<T6) Non-SCI	2 4	Tennis match	18-20°C WBGT	45	↑0.6 ↑0.3
WC rugby (National)	SCI (C5-7) Non-SCI	10 (9M,1F) 7 (M)	Match simulation	18.4-20.9°C 31-45% RH		37.6-39.3 38.1-38.8



## Core Temperature During Exercise in Para Athletes



SPORT	IMPAIRMENT	ATHLETES (M/F)	EVENT	CONDITION	DURATION (min)	CHANGE IN $T_{\text{CORE}}$ (°C)
WC rugby	SCI C4/5-C6/7	8 (7M, 1F)	Intermittent sprint protocol	20.6°C, 39.6% RH	55.5	37 – 38.2
WC basketball (National)	SCI T4-S1	8 (7M, 1F)				37.1 - 37.6
WC rugby	SCI	8 M	Intermittent sprint protocol	20.2°C 33% RH	60	↑ 1.9°C

### Key Points:

- Total of 83 subjects
- Mostly SCI
- Only one study reports  $T_{\text{core}}$  at conditions to be expected in Tokyo



## Heat Acclimation Studies in Para Athletes



SPORT	IMPAIRMENT	DURATION	CONDITIONS	PROTOCOL	OUTCOME
Shooting	SCI (n=5, 2F, 3M) C5/6 to T9/10	7 consecutive days	33.4°C, 64.8% RH	20 min arm crank @ 50% $VO_{2peak}$ followed by 40 min rest or sim shooting	↑ Plasma volume 1.5% ↓ $T_{aur}$ 0.5°C, RPE & HR at 50-60 min No sweat response
Recreation ally active	SCI – 5 tetraplegia, 5 paraplegia (T7-L3)	7 consecutive days	35°C, 40% RH	30 min arm crank @ 50% $W_{2peak}$ followed by 15 min rest	No sig changes in any response – no heat acclimation



## Heat Acclimation in Para Athletes



- Requires more research in wider Para population
- Advise some modification from traditional heat acclimation protocols in those with limited sweat response
  - Staged increase in conditions of exercise
  - Monitor athletes carefully
  - Modify training as heat exposure is an additional 'load'



## Cooling Strategies in Para Athletes



- Cooling BEFORE and/or DURING exercise
- Methods that can be used:
  - Cold water immersion (whole body or body parts)
  - Cold air exposure
  - Ice slurry or cold water ingestion
  - Ice towels
  - Cooling vests / jackets
  - Water sprays with fans
  - Water 'dumps'
  - Ice down jerseys
- Most studies so far have been done on athletes with an SCI / wheelchair sports played indoors where environmental conditions can be controlled



## Cooling Strategies in Para Athletes – Cooling Extremities



- 8 wheelchair tennis players (2 T, 3 P, 3 other), at 30.8°C, 61% RH. 10 min hand cooling (10°C) between 60 min intermittent exercise and a 1km TT
  - 20.5 second reduction in TT with cooling, greater reduction in  $T_{\text{aural}}$
- 7 untrained SCI, 31.8°C, 26% RH. 45min hand crank while foot cooling throughout.
  - $T_{\text{ty}}$  lower from 15 min of exercise when negative pressure applied

### Limitations:

- Many athletes rely heavily on their hands for fine motor control, dexterity and speed which can be interrupted by cooling
- Only effective if  $T_{\text{core}}$  already elevated
- Most sports won't allow for application of a method throughout competition



## Cooling Strategies in Para Athletes – Ice Slurries



- 16 WC b'ball players with SCI undertook 4 conditions at rest at 22.7°C (no exercise intervention)
  - 10 min whole body cold water (15°C) immersion
  - Ice slurry ingestion (6.8 mL/kg)
  - Ice slurry ingestion (6.8 mL/kg) plus cold towels on legs, torso & back
  - Room temperature fluid ingestion, no cooling
- CWI elicited greatest reduction  $T_{core}$  (1.6°C), but ice slurry + towels also reduced  $T_{core}$  significantly 20-30 min post cooling
- Exercise – 12 male WC rugby, SCI (tetraplegia), training match, 6.8 mL/kg ice slurry ingestion (v's room temp fluid) during 20 min before warm up start
- Lower  $T_{core}$  at midpoint of exercise with IS but no difference at end exercise, no difference HR, RPE or GI comfort.



## Cooling Strategies in Para Athletes - Cooling Jackets / Vests

SPORT	EXERCISE	CONDITIONS	PROTOCOL	OUTCOME
WC rugby, n=6	30 min WC erg	32.9°C, 75% RH	Head piece or ice vest throughout exercise	No diff in $T_{re}$ , RPE, TS. Head piece less effective
WC rugby & tennis, n=8, Tetraplegia	28 min arm crank, intermittent	32°C, 50% RH	20 min ice vest pre v's throughout exercise (v's control)	Lower $T_{core}$ & RPE with both Greater reduction in TS with during
WC tennis, n=1 female, Paraplegia	60 min WC erg int. sprint	30.4°C, 54% RH	30 min ice vest pre v's 30 min ice vest pre + head and neck ice during	Higher average peak speed, lower rise in $T_{aural}$ and TS through exercise with combined
WC Tennis, n=8, mixed gender	60 min WC erg int. sprint	30.4°C, 54% RH	Head & neck cooling throughout exercise v's control	TS & RPE tended to be lower with cooling, drank 42% less water
WC rugby & tennis, n=8, Tetraplegia	60 min arm crank, intermittent	32°C, 50% RH	20 min ice vest pre v's throughout exercise (v's control)	Lower $T_{core}$ & RPE with both Maintained power and more sprints done with during although initial sprints lower PO



## Cooling Strategies in Para Athletes - Cooling Jackets / Vests



SPORT	EXERCISE	CONDITIONS	PROTOCOL	OUTCOME
Shooting, n=6, mixed impairment & gender	90 min shooting simulation	32°C, 50- 60% RH	No cooling v's cooling with head / neck and cooling jacket (replaced every 15min)	Cooling delayed rise in $T_{ty}$ , reduced thermal sensation, no effect on performance
Males, 19 AB, 17 SCI (6 T, 5 HP, 6 LP)	60 min intermittent sprint	21.1-23.9°C	No cooling (NV); Cooling vest worn throughout exercise (V)	No difference of $T_{core}$ between NV and V in any group. DID NOT CHANGE OUT THE VEST
WC rugby SCI n = 8 M	60 min intermittent sprint (match sim)	20.2°C, 33% RH	No cooling (NC); 15 min rest + 20 min warm up with CJ (P); same with water spray & fan at each break (x4, PW)	No effect on HR, RPE, thermal sensation or performance. PW sig lower change in $T_{core}$ and larger fall in $T_{skin}$ over ISP = less thermal strain



## Cooling Strategies in Para Athletes - Cooling Jackets / Vests



- Seem to be useful to pre cool before exercise, particularly during warm up
  - May not be beneficial for everyone
  - Be aware of limitations of the particular product in terms of extended use (developing microenvironment)
  - Can be heavy weight
- Combination of pre cooling with ice vest and cooling subsequent exercise with head / neck pieces seems to be more effective than pre-cooling alone



## Cooling Strategies in Para Athletes – Water Sprays



- Partially mimic sweat response in those with limited sweat capacity
- 7 WC B'ball, SCI, 22°C, 45% RH. Incremental arm crank exercise, 7 min stages, 20W increase per stage
- 1 min rest between stages, 17°C water spray to back of head, forearm, neck & face
- No significant differences in  $T_{es}$ ,  $T_{re}$ ,  $T_{skin}$ , RPE, HR, work performed or thermal sensation



## Practical Strategies



- Heat acclimation protocols are more than likely going to be useful but may need modifying.
- Maintain appropriate hydration levels and fluid intakes.
- Cool athletes whatever way makes sense for their impairment, the ecological conditions, rules of their sport, facilities & staffing available.
- Multiple cooling methods should be employed, ideally including during warm up and during exercise.
- Take caution if the cooling method reduces thermal sensation only if  $T_{\text{core}}$  could rise to dangerous levels.



