

# Elite Training Seminar Hong Kong Sports Institute

## Hydration and Exercise Performance

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# Observations of Sweat Rates, Voluntary Fluid Intake & Levels of Dehydration in Various Sports

Sport	Condition	Sweat rate (L · h <sup>-1</sup> )		Voluntary fluid intake (L·h <sup>-1</sup> )		Dehydration (%BM) (=BM)	
		Mean	Range	Mean	Range	Mean	Range
Waterpolo	Training (Male)	0.29	(0.23–0.35)	0.14	(0.09–0.20)	0.26	(0.19–0.34)
	Competition (Male)	0.79	(0.69–0.88)	0.38	(0.30–0.47)	0.35	(0.23–0.46)
Netball	Summer training (Female)	0.72	(0.45–0.99)	0.44	(0.25–0.63)	0.7	(+0.3–1.7)
	Summer competition (Female)	0.98	(0.45–1.49)	0.52	(0.33–0.71)	0.9	(0.1–1.9)
Swimming	Training (Male and Female)	0.37		0.38		0	(+1.0–1.4 kg)
Rowing	Summer training (Male)	1.98	(0.99–2.92)	0.96	(0.41–1.49)	1.7	(0.5–3.2)
	Summer training (Female)	1.39	(0.74–2.34)	0.78	(0.29–1.39)	1.2	(0–1.8)
Basketball	Summer competition (Male)	1.37	(0.9–1.84)	0.80	(0.35–1.25)	1.0	(0–2.0)
	Summer competition (Male)	1.6	(1.23–1.97)	1.08	(0.46–1.70)	0.9	(0.2–1.6)
Soccer	Summer training (Male)	1.46	(0.99–1.93)	0.65	(0.16–1.15)	1.59	(0.4–2.8)
	Winter training (Male)	1.13	(0.71–1.77)	0.28	(0.03–0.63)	1.62	(0.87–2.55)
American Football	Summer training (Male)	2.14	(1.1–3.18)	1.42	(0.57–2.54)	1.7 kg (1.5%)	(0.1–3.5 kg)

# Observations of Sweat Rates, Voluntary Fluid Intake & Levels of Dehydration in Various Sports

Sport	Condition	Sweat rate (L·h <sup>-1</sup> )		Voluntary fluid intake (L·h <sup>-1</sup> )		Dehydration (%BM) (=BM)	
		Mean	Range	Mean	Range	Mean	Range
Tennis	Summer competition (Male)	1.60	(0.62–2.58)	~1.1		1.3	(+0.3–2.9)
	Summer competition (Female)		(0.56–1.34)	~0.9		0.7	(+0.9–2.3)
Tennis	Summer training (Cramp-prone Male)	2.60	(1.79–3.41)	1.6	(0.80–2.40)		
Squash	Competition (Male)	2.37	(1.49–3.25)	0.98		1.28 kg	(0.1–2.4 kg)
21-km running	Winter competition (Male)	1.49	(0.75–2.23)	0.15	(0.03–0.27)	2.42	(1.30–3.6)
Cross-country running	Summer training (Male)	1.77	(0.99–2.55)	0.57	(0–1.3)	~1.8	
Ironman Triathlon	Temperate competition (Male and Female)						
	Swim leg					1 kg	(+0.5–2.0 kg)
	Cycling leg	0.81	(0.47–1.08)	0.89	(0.60–1.31)	+0.5 kg	(+3.0–1.0 kg)
	Run leg	1.02	(0.4–1.8)	0.63	(0.24–1.13)	2 kg	(+1.5–3.5 kg)
	Total race			0.71	(0.42–0.97)	3.5%	(+2.5–6.1 %)

**Generally, athletes don't do a good job replacing what they lose in sweat**



# Dehydration and Exercise Performance

“Dehydration, if sufficiently severe, can impair performance in most events, particularly in warm and high-altitude environments. Athletes should be well hydrated before exercise and drink sufficient fluid during exercise to limit dehydration to less than about 2% of body mass. Chilled fluids may benefit performance in hot conditions”

(IOC Consensus Statement on Sports Nutrition, Lausanne, 2010)

# Dangers of Dehydration

## ■ Cardiovascular system

- Plasma volume ↓
- Blood pressure ↓
- Blood flow to muscles and skin ↓
- Heart rate ↑

## ■ Thermoregulatory system

- Sweat rate during exercise ↓
- Rectal temperature ↑
- Serum osmolality & electrolyte concentration ↑

## ■ Strongly associated with fatigue during exercise







# Nutrition for Athletes

A practical guide to eating for health and performance

Prepared by the Nutrition Working Group of the  
International Olympic Committee

Based on an International Consensus Conference held  
at the IOC in Lausanne in October 2010

Revised and Updated in April 2012



# Guidelines

**International Olympic Committee  
“Nutrition for Athletes” (April 2012)  
based on the International  
Consensus Conference, Oct 2010**

Susan M. Shirreffs & Michael N. Sawka (2011) Fluid and electrolyte needs for training, competition, and recovery, *Journal of Sports Sciences*, 29:sup1, S39-S46.

# Fluid Intake Before Competition

- Athletes should drink sufficient fluid with meals on the day before competition to ensure adequate hydration on the morning of competition
- Athletes should not refrain from drinking water or carbohydrate-containing fluids during the hours leading up to warm-up before competition

# Fluid Intake Before Competition

- It is recommended that athletes have a final drink during the 60-90 minute period before the start of the event
- During competitions lasting longer than 1 hour and which cause heavy sweating without sufficient opportunity for fluid intake, athletes often benefit by having an extra drink during the 15 minute period immediately before the start of the event

# How Much to Drink ?

- Athletes should drink at a rate that is close to sweat rate and thus limits loss of body weight
- The amount of dehydration should be limited to no more than about a 2% loss of body weight, i.e.;
  - 1.0 kg for 50 kg person;
  - 1.5 kg for a 75 kg person; &
  - 2 kg for a 100 kg person

# How Much to Drink?

- In warm environments, try to minimise dehydration, as dehydration and exercise intensity interact to increase the risk of heat illness
- Don't drink so much that you actually gain weight during exercise, unless you began exercise already dehydrated
- When it is not possible to drink during 'heavy sweating' type exercise lasting longer than 30 min, practise drinking during the 15 minutes before exercise and find how much is initially filling but comfortable once exercise begins (e.g., 300-800 ml)

# During Exercise

- When exercise is lasting longer than 1 h and which elicits fatigue, athletes are advised to ingest 20-60 grams per hour of carbohydrate in the fluid that is rapidly converted to blood glucose
- This helps to maintain pace, skills and concentration instead of succumbing to fatigue

# During Exercise

- The use of commercial sports drinks with a carbohydrate content of about 4-6% (4-6 g/100 ml) allows carbohydrate and fluid needs to be met simultaneously in most events
- It is best for athletes to stick to well-known sport drinks that they are familiar with to avoid gastrointestinal distress or other consequences
- Sodium should be included in fluids consumed during exercise lasting longer than 1-2 hours

# Rehydration after Exercise

- This process is part of the preparation for the next exercise session
- All athletes, including strength and power athletes, will perform below their best if they are not well hydrated when they begin exercise



# Rehydration after Exercise

- Replacement of water and salts lost in sweat is an essential part of the recovery process
- Aim to drink about 1.2 - 1.5 litres of fluid for each kg of weight loss in training or competition
- Drinks should contain sodium (the main salt lost in sweat) if no food is eaten at this time
- A little extra salt may usefully be added to meals when sweat losses are high, but salt tablets should be used with caution

# Monthly Air Temperature 2000-2010 in Hong Kong

	<b>Mean Daily Max. Temp</b>	<b>Mean Daily Min. Temp</b>	<b>Mean RH(%)</b>	<b>Mean at 2pm RH (%)</b>
May:	28.7 °C	23.9 °C	83%	76%
June:	30.3 °C	25.9 °C	82%	76%
July:	31.5 °C	26.6 °C	80%	73%
Aug:	31.3 °C	26.3 °C	81%	74%
Sept:	30.3 °C	25.5 °C	78%	71%
Oct:	27.9 °C	23.1 °C	73%	66%
Mean:	30.0 °C	25.2 °C	79.5%	72.6%

(Hong Kong Observatory, 2012)

# Factors Affecting Voluntary Dehydration

- Palatability: color, odor, temperature and taste  
(Szlyk et al., 1989a & 1989b; Zellner et al., 1991)
- Composition of the beverage can play a role in increasing stimulation for drinking in athletes who exercise in the heat (Wilk & Bar-Or , JAP, 1996)

# How to Monitor Hydration Status

## ■ Urine sample

- The aim should NOT be for your urine to be as pale as possible. Develop a drinking plan for training and competition that is right for you, based on sweat losses
- Urine specific gravity & urine osmolality are useful laboratory forms of hydration analysis. Quick results and simple to conduct

# How to Monitor Hydration Status

- If you are passing urine less often than normal, you may be dehydrated
- If urine colour becomes darker than what is normal for you, then you may not be drinking enough. Check your urine colour against the chart



# How to Monitor Hydration Status

- How did you feel?
- How did you perform?
- What was your weight loss over the session?
  - This should generally not exceed about 1-2% of body mass. If you lost more than this, you probably did not drink enough. Drink more next time. If you lost less, you might have drunk too much
- Did it make you feel uncomfortable?
- Did you take time out to drink that was unnecessary?

# How to Monitor Hydration Status

- If you are a “salty sweater”, you may need drinks with more salt and may need more salt in food when sweat losses are high
- To check whether you are a salty sweater, wear a black T-shirt in training and look for salt stains (white powder) under the arms and on the chest
- High salt losses are a contributing factor in some cases of muscle cramp. Sports drinks with higher salt (sodium) levels (e.g. 300-500 mg sodium per 500 ml liquid) may help reduce the risk of cramps

# How to Estimate Sweat Losses

- Measure body weight both before and after at least one hour of exercise under conditions similar to competition or a hard practice
- Take these body weight measurements wearing minimal clothing and while bare footed
- Towel dry after exercise and obtain body weight as soon as is practical after exercise (e.g. less than 10 min, and before eating, drinking or going to the toilet)



# How to Estimate Sweat Losses

- Estimate the weight of any fluid or foods you have consumed during the workout (e.g. 500 ml of fluid = 500 g or 0.5 kg)
- Sweat loss (Litres) = Body weight before exercise (in kg) - Body weight after exercise (kg), + weight of fluids/foods consumed (kg)

**Example:**

**74.5 kg – 72.8 kg + 0.80 kg (800 ml fluid) = 2.5 kg**

# Sweat Concentration

- Level of electrolyte loss depends on sweat rate, sweat composition and fluid intake during exercise
- Whole body washdown (WBW) is most accurate measurement technique
  - Requires controlled lab setting (Baker et al., 2009)
- Sweat patch is more practical for measurement in a field setting (Shirreffs et al. 2005; Maughan et al. 2004)
- Many studies have reported sweat collection under different conditions, periods of time and methods



# Hydration Status & Electrolyte Loss HKFA Soccer Players



# Participants

- 16 healthy, male professional soccer players from the Hong Kong football league:
  - Age:  $24.1 \pm 3.5$  years
  - Height:  $1.78 \pm 0.07$  m
  - Body mass (BM):  $72.6 \pm 12.1$  kg
- Two soccer-specific, in-season training sessions of similar intensity on consecutive days (T1 & T2)

# Procedures

- Environmental conditions were similar on both occasions. (Temp: 27 °C, RH: 85%, Wind speed: 1.03 - 1.20 m/sec)
- Pre- and post-training hydration status was assessed by urine sample
- Fluid consumption and sweat rate was measured for each training session
- Sweat patches were applied to the chest and thigh of each participant

# Hydration Analysis

**Environmental Conditions:** 27°C, RH: 85%, Wind speed: 1.03 - 1.20 m/sec

	T1	T2
Body mass pre (Kg)	72.62 ± 12.05 [55.00 – 97.70]	72.70 ± 12.04 [55.00 – 98.00]
Body mass post (Kg)	71.61 ± 11.88 [54.30 – 96.00]	71.81 ± 11.71 [54.30 – 96.90]
Body mass change (Kg)	-1.01 ± 0.57 [+0.30 – -1.70]	-0.89 ± 0.82 [+1.10 – -2.30]
Fluid consumed (ml)	1,270 ± 300 [820 – 2,020]	1,520 ± 340 [1,120 – 2,260]
Sweat loss (ml)	2,195 ± 674 [1,079 – 3,619]	2130 ± 690 [1,090 – 3,350]
Sweat rate (L·hr <sup>-1</sup> )	1.46 ± 0.45 [0.72 – 2.41]	1.54 ± 0.46 [0.73 – 2.23]
% Dehydration change	-1.38 ± 0.77 [+0.44 – -2.51]	-1.18 ± 1.03 [+1.52 – -2.78]

Data presented as mean ± SD

Minimum and maximum values in square parentheses

RH: Relative humidity

# Hydration Status

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	T1	T2
USG pre-exercise	1.0173 $\pm$ 0.0087	1.0179 $\pm$ 0.0068
USG post-exercise	1.0229 $\pm$ 0.0082	1.0196 $\pm$ 0.0075
Pre-ex USG > 1.020	5 (36%)	7 (50%)

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USG: Urine Specific gravity

Data presented as mean  $\pm$  SD

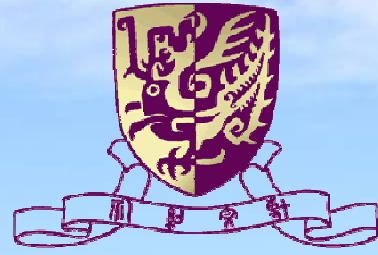
# Take Home Messages (1)

- Maintaining hydration is important for performance
- Remember that humans do not adapt to dehydration, but may learn to complain less about it
- Fluid intake before, during (where appropriate) and after exercise is especially important in hot climates
- Salt replacement is important when sweat losses are high
- Important not to try out new plans for fluid and fuel intake during important competition. Do it in practice and find what fits the athlete best



## Take Home Messages (2)

- Severe dehydration impairs performance and increases the risk of heat illness, but drinking too much can also be harmful or uncomfortable
- Every athlete is different because they have different sweat losses and different opportunities to drink fluid during their workouts and events. You need a personal hydration plan and COACHES have to play a role in developing this
- Temperature of drink is recommended to keep at 10°C-15°C



*Thank you!*

