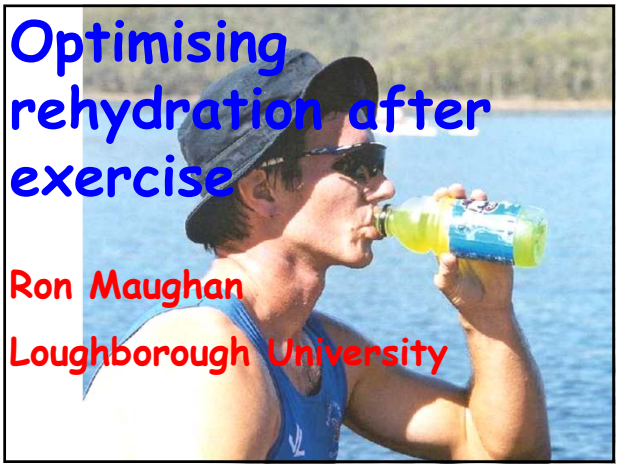


Recovery aims after exercise

Hydration/fluid balance restoration

Muscle glycogen restoration

Muscle protein synthesis

Restore homeostasis
eg Reduce temperature

Restore exercise capacity

Outline

Why rehydration after exercise ?

Post-exercise rehydration

Milk as a rehydration drink

Why is hydration important?

Dehydration, if sufficiently severe can cause:

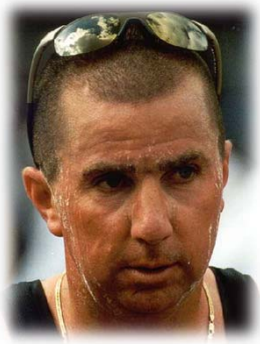
Reduced exercise performance
Reduced blood volume
Increased heart rate
Reduced skin & muscle blood flow
Impaired thermoregulation
Increased perception of effort
Headache, nausea, insomnia
Impaired mental function
Increased risk of heat illness

Water and Salt Losses in Exercise

Sweat loss normally exceeds fluid intake: some dehydration is normal

Electrolyte composition of sweat is highly variable: main electrolyte lost is sodium

Athletes finish exercise with both fluid and electrolyte deficits

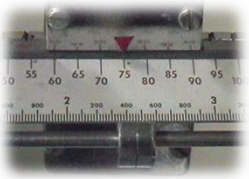


Post-exercise hydration

"After exercise, the goal is to fully replace any fluid and electrolyte deficit. If recovery time and opportunities permit, consumption of normal meals and snacks with a sufficient volume of plain water will restore euhydration, provided the food contains sufficient sodium to replace sweat losses. If dehydration is substantial with a relatively short recovery period (<12 h) then aggressive rehydration programs may be merited."

SPECIAL COMMUNICATIONS
Exercise and Fluid Replacement

Sweat volume and electrolyte losses in athletes



Fluid balance in football

Players (n = 26) weighed pre/post training

All drinks bottles also weighed

Mean mass loss = 1.23 (0.50-2.55) kg

Mean drink intake = 972 (239-1724) ml

Mean sweat loss = 2.19 (1.67-3.14) l

Dehydration = 1.6 (0.7-3.2) %

Individual variations

Data from football training

124 1st team players – top European clubs

Sweat loss	880-3140 ml
Fluid intake	44-2278 ml
Dehydration	-0.2%-3.2%
Salt loss	1.7-9.9 g

Outline

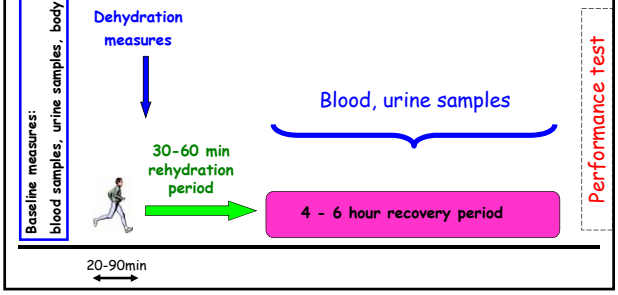
Why rehydration after exercise ?

Post-exercise rehydration
- How much to drink
- What to drink

Milk as a rehydration drink

Recovery of fluid and electrolyte balance after exercise

Post-exercise rehydration protocol



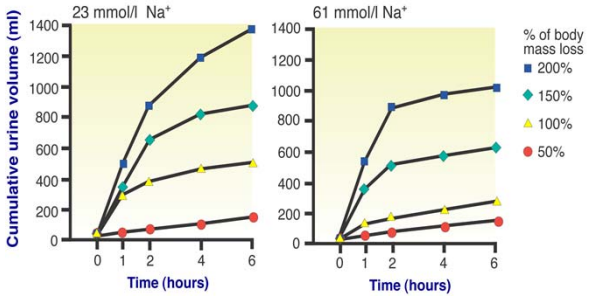
Volume and Composition (1)

Interaction of volume of fluid consumed and sodium concentration on the efficacy of rehydration after sweat loss of 2% of body mass.

Two subject groups:
- Low (23 mmol/l) sodium
- High (61 mmol/l) sodium

Four Volume trials:
- 50% of weight loss
- 100% of weight loss
- 150% of weight loss
- 200% of weight loss

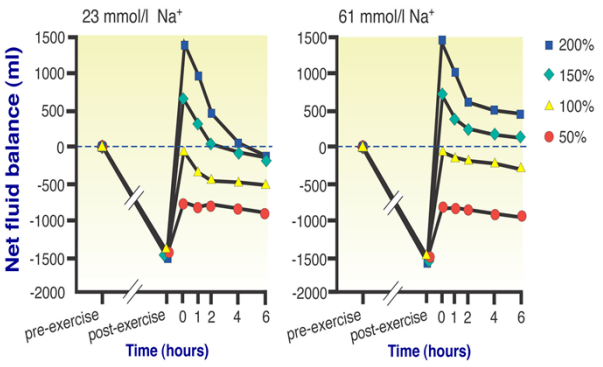
Urine excretion during recovery



Urine collected over 6h after rehydration
Excretion related to volume consumed

Shirreffs et al, 1996

Whole body fluid balance status



CONCLUSION

Unless sufficient volume is consumed after dehydration, the body remains in net negative fluid balance

If the electrolyte (sodium) content of drinks is low, positive fluid balance is not maintained, even when the volume consumed is large

Positive fluid balance is achieved when both volume and sodium content of drinks are high. It is probably necessary to drink about 1.5 litres for each litre of sweat loss

Others ways of altering rate of replacement: Carbohydrate

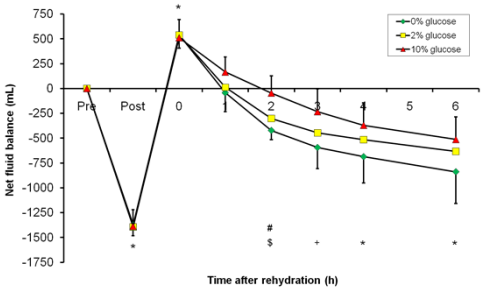
Hypohydration = 1.9% body mass

Drink volume = 150% of body mass loss

Drinks: 25mmol/l Na^+ + 0% CHO ◆
25mmol/l Na^+ + 2% CHO ■
25mmol/l Na^+ + 10% CHO ▲

Evans et al, Nutrition, 2009

Whole body fluid balance



Evans et al, Nutrition, 2009

Others ways of altering rate of replacement: Carbohydrate

Hypertonic glucose-sodium drinks may be more effective at restoring and maintaining hydration status after sweat loss than more dilute solutions when the sodium concentration is comparable

This is presumably due to the effect of energy content in slowing absorption

Evans et al, 2009

Recovery of fluid and electrolyte balance after exercise

1. Adequate volume must be consumed Shirreffs et al, (1996) MSSE, 28: 1260-1271
2. Sodium concentration must be moderately high in relation to sweat losses Shirreffs & Maughan (1998) AJP, 274: F868-F875
3. The sodium can be obtained from the rehydration drink or from food Maughan et al, (1996) EJAP, 73: 317-325; Ray et al, (1998)
4. Increasing energy content of drinks can improve retention Evans et al (2009) Br J Nutr

Sports drinks

Sports drinks

Milk composition compared to other drinks

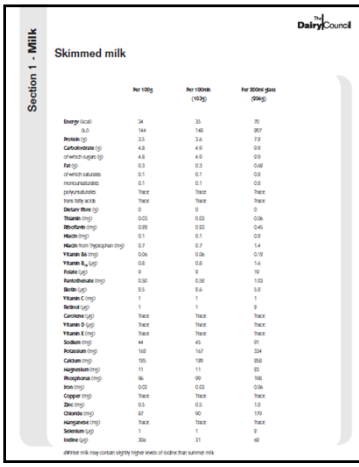
	Typical Sports Drink	Very Low Fat Milk	Fruit Juice	Cola	Water
Water (g/l) ☆	930	900	860	900	1000
Energy (kcal/l) ☆	240	340	540	380	0
CHO (g/l) ☆	60	50	130	110	0
Fat (g/l)	0	1	0	0	0
Protein (g/l)	0	33	2	0	0
Na (mmol/l) ☆	23	30	1	0	0.2
K (mmol/l)	2	40	12	0	0.1
Osmolality (mosmol/kg) ☆	280	280	660	700	0

Outline

Why rehydration after exercise ?

Post-exercise rehydration
- The role of sodium
- Drink delivery rate
- Potassium

Milk as a rehydration drink



Composition of skimmed milk (UK)

Water
Sodium
(Potassium)
Protein
Carbohydrate

Milk as a post-exercise rehydration drink

Shirreffs et al, Br J Nutr, 2007

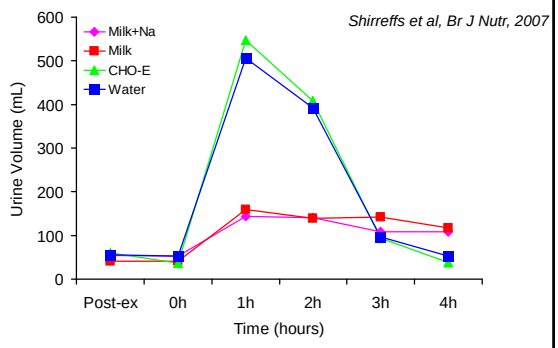
11 subjects (5 male, 6 females)

Intermittent exercise in the heat to lose 1.2±0.3kg (1.8±0.2%) of body mass

Rehydrated after exercise by drinking 150% of sweat volume lost ie 1.79±0.42 litres

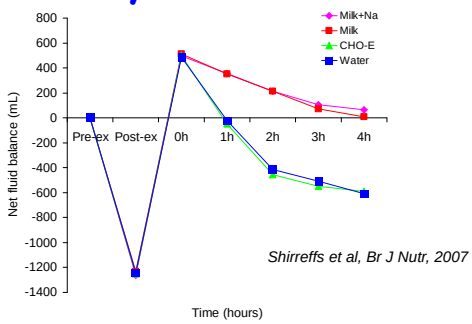
- Plain water
- Sports drink (carbohydrate-electrolyte solution)
- 0.1% fat milk
- 0.1% fat milk with added NaCl

Urine production during recovery



Shirreffs et al, Br J Nutr, 2007

Whole body net fluid balance



Shirreffs et al, Br J Nutr, 2007

Subjects remained in positive fluid balance or euhydrated throughout recovery after drinking the milk drinks but returned to net negative fluid balance 1 h after drinking the other drinks

"Milk can be an effective post-exercise rehydration drink for use after exercise"

Shirreffs et al, Br J Nutr, 2007

Can milk ingestion help subsequent performance?

Watson et al, Eur J Appl Physiol, 2008

7 males

Intermittent exercise in the heat to lose 1.52±0.17kg (2.0±0.1%) body mass.

Rehydration with a volume equivalent to 150% body mass loss ie 2270±245mL

Sports drink (carbohydrate-electrolyte solution)

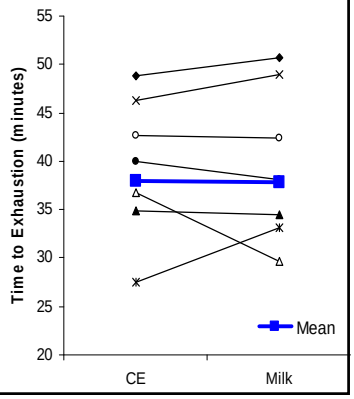
0.1% fat milk

At the end of the 3 h recovery period, an exercise capacity test was completed at 61% VO2peak in warm (35.3±0.5°C), humid (63±2%) conditions

Exercise performance

No difference in exercise time to exhaustion between trials (39.6±7.3 min vs. 39.7±8.1 min on trials CE and M, respectively)

Watson et al, Eur J Appl Physiol, 2008



Study conclusions

Despite the effect on fluid retention, exercise capacity was not different between skimmed milk and a commercially available carbohydrate-electrolyte drink 4 h following exercise/heat-induced body mass loss

Watson et al, Eur J Appl Physiol, 2008

Recovery aims after exercise

Hydration/fluid balance restoration

Muscle glycogen restoration

Muscle protein synthesis

Restore homeostasis
eg Reduce temperature

Restore exercise capacity

Recovery of glycogen stores

Recommendation:

Immediate post-exercise intake of CHO

140 g (2 g/kg) in first 2 h after exercise

Moderate-high GI carbohydrate

Immediate intake better than delayed intake

Milk can contribute – smoothies with added CHO may be better still

IOC Consensus October 2010

1. Muscle protein synthesis is maximized at a dose of about 20g of high quality protein
2. Dairy proteins, especially whey, are very effective
3. The effectiveness of these proteins is likely due to their leucine content
4. The timing of protein ingestion appears to be important: intake during and post-exercise seem optimal

SM Phillips

Protein (with CHO) after training will promote net muscle protein synthesis and MAY enhance performance

A commercial protein/carbohydrate supplement?

Milk-based drinks might be best

Conclusions

Milk can restore and maintain hydration status as well as, or better than, commercially-available sports drinks

Subsequent performance may be similar to that with a commercially-available sports drink

Milk offers other recovery benefits