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FEEDING THE TRAIL RUNNER: FROM THE LAB TO THE PLATE

Monash University,

Faculty of Medicine, Nursing & Life Sciences

Department of Nutrition & Dietetics

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'I acknowledge the Traditional Owners and Custodians of the lands on which I live and work, and pay respects to Elders past, present and future'.

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Content:

- Daily intake to meet training needs and adaptations.
- Before running.
- During running.
- After running.
- Gut symptoms: prevention & management.

A short historical summary:

- Boston Marathon 1920's.

- Blood glucose levels related to fatigue and collapse.

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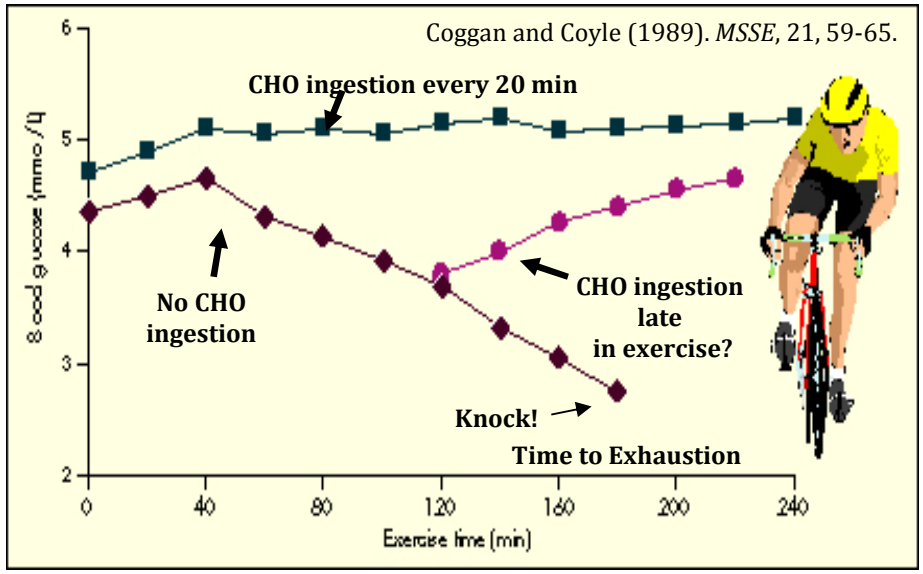
- 1940's to 1990's Maintaining blood glucose during exercise attenuated fatigue and improved performance.



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- 1990's ACSM Nutrition & Performance position statement- refined in 2009, updated 2016.

- Obsession with dehydration!!!

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- 2005 start of the low carb high fat and ketogenic trend.

- 10 years of metabolic adaptation research by Australian researchers and AIS.

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- 2016 Exponential growth in recreational athletes vs.

research outcomes vs. mega-media access.

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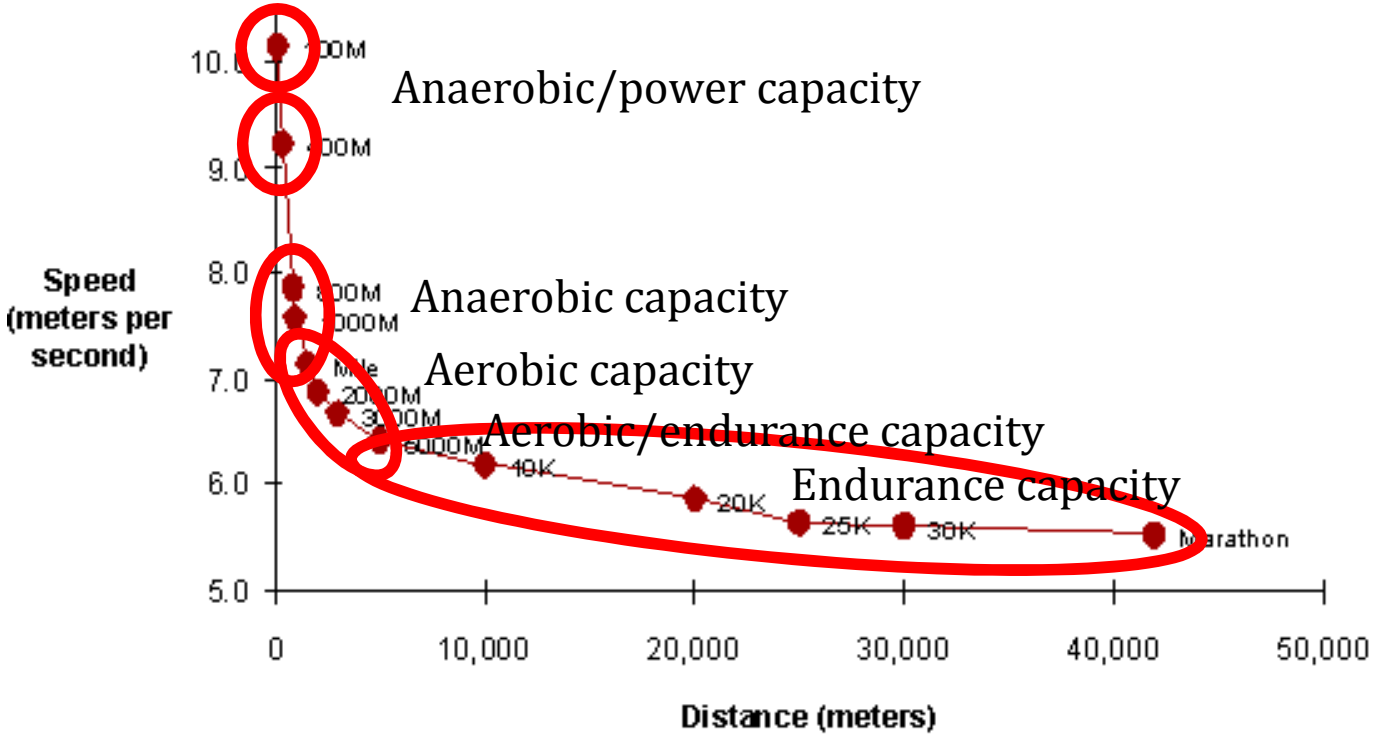
WHAT NOW???

2016 Exponential growth in recreational athletes vs. research outcomes vs. mega-media access.

Daily intake to meet training needs.



World running records over various distances

FUEL AVAILABILITY?
FATIGUE FACTORS?
MUSCLE FIBRE TYPE?

- **"Metabolic Fatigue"**
- **"Peripheral Fatigue"**
- **"Central Fatigue"**

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Daily intake to meet training needs.

- High carbohydrate,
- Low carbohydrate high fat,
- Training fasted,
- Train low compete high,
- Train ½ for longer,
- Double daily sessions,
- Sleep low.

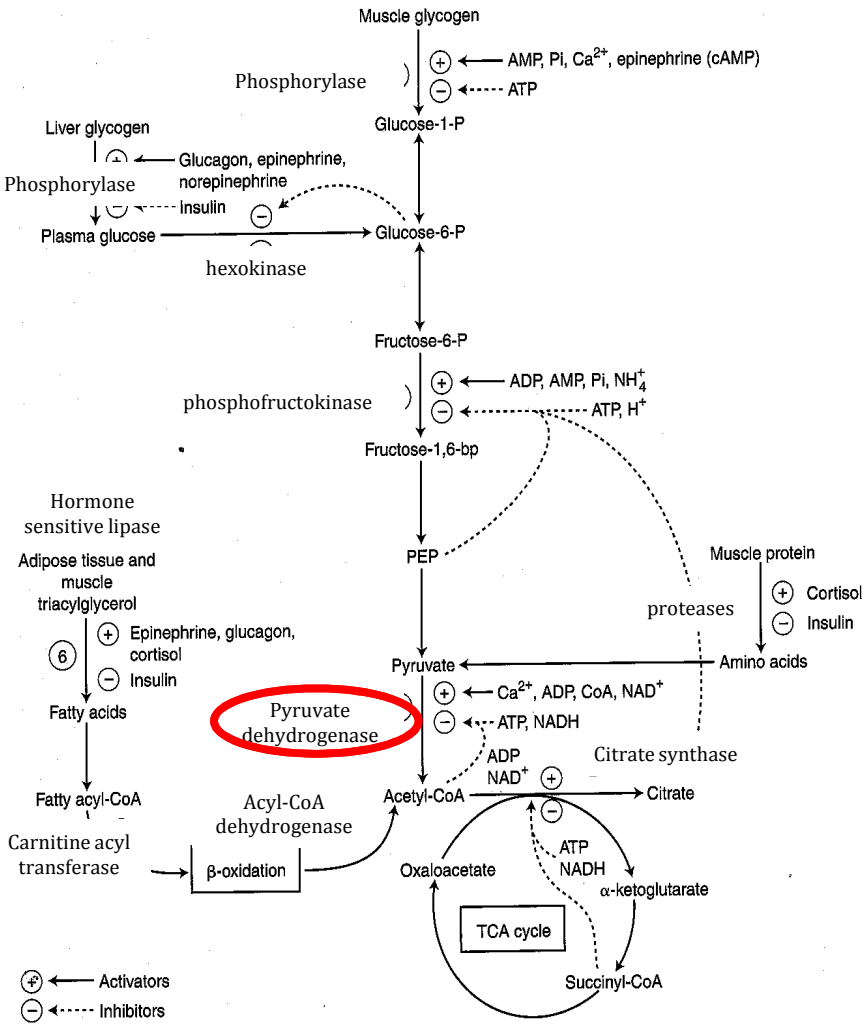
Increases in total fat oxidation are observed.

Some evidence for improved time to exhaustion at low exercise intensity.

No evidence for improved exercise performance (distance test or time trial).

(Hawley J and Burke L, AIS).

Daily intake to meet training needs.



Published Data –Short to Moderate Term Fat Adaptation or Ketogenic Dietary Impact on Exercise Performance (each individual perf. test per study shown)

Performance Decrease (12)

Bergstrom, J., et al., Acta Physiologica Scandinavica, 1967. 71(2): p. 140-50.

CHRISTENSEN, E. H.,et al. . *Scand. Arch. Physiol.* 81:160–171, 1939.

GALBO, H. et al. *Acta Physiol. Scand.* 107:19–32, 1979.

Pitsiladis, Y.P. Et al. The Journal of physiology, 1999. 517 (Pt 3): p. 919-30.

Starling, R.D., et al., Journal of Applied Physiology, 1997. 82(4): p. 1185-9.

Maughan, R.J. and D.C. Poole, Eur J Appl Physiol Occup Physiol, 1981. 46(3): p. 211-9.

Greenhaff, P.L., et al. European journal of applied physiology and occupational physiology, 1987. 56(3): p. 331-7.

Greenhaff, P.L., et al., European journal of applied physiology and occupational physiology, 1987. 56(4): p. 444-50.

Greenhaff, P.L., et al. European journal of applied physiology and occupational physiology, 1988. 57(5): p. 583-90.

Havemann, L., et al., 1k sprint performance. J Appl Physiol (1985), 2006. 100(1): p. 194-202.

Havemann, L., et al., 4k sprint performance. J Appl Physiol (1985), 2006. 100(1): p. 194-202.

O'KEEFFE, et al. *Nutr. Res.* 9:819–830, 1989.

No Effect (7)

Phinney, S.D., et al., Metabolism, 1983. 32(8): p. 769-76.

Havemann, L., et al., 100km performance. J Appl Physiol (1985), 2006. 100(1): p. 194-202.

Burke LM, et al. *J Appl Physiol* 89: 2413–2421, 2000.

Burke LM, et al.. *Med Sci Sports Exerc* 34: 83–91, 2002.

Carey AL,et al. . *J Appl Physiol* 91: 115–122, 2001.

Lambert, E.V., et al., No Change High Intensity Test. Eur J Appl Physiol Occup Physiol, 1994. 69(4): p. 287-93.

Goedecke, J.H., et al., Metabolism, 1999. 48(12): p. 1509-17.

Improved Performance (2)

Lambert, E.V., et al.,. International journal of sport nutrition and exercise metabolism, 2001. 11(2): p. 209-25.

Lambert, E.V., et al., Inc. Perf. Prolonged Test. Eur J Appl Physiol Occup Physiol, 1994. 69(4): p. 287-93.

Metabolism
Clinical and Experimental

Volek et al. 2016
Metabolic characteristics of keto-adapted ultra-endurance runners

Fatpeak: LC 70%, HC 55%
Oxidation rates:
LC 1.21g/min, HC 0.76g/min

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Fatmax @ 68% VO2max

Khoo, A, Miall, A., Rauch, C., Snipe, R., Costa, R.J.S., (2015). *G*ut training exhibits no change in total carbohydrate or fat oxidation rates during endurance running. *Sports Dietitians Australian Conference*.

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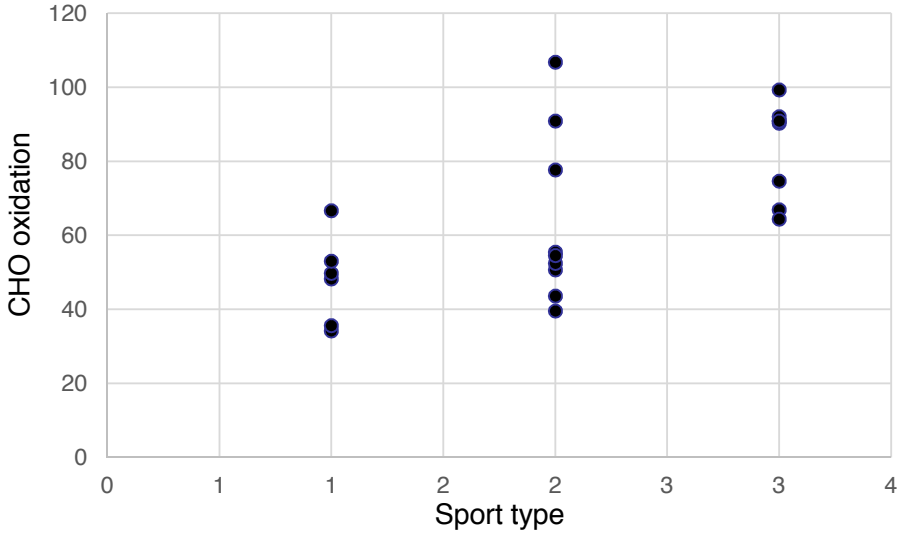
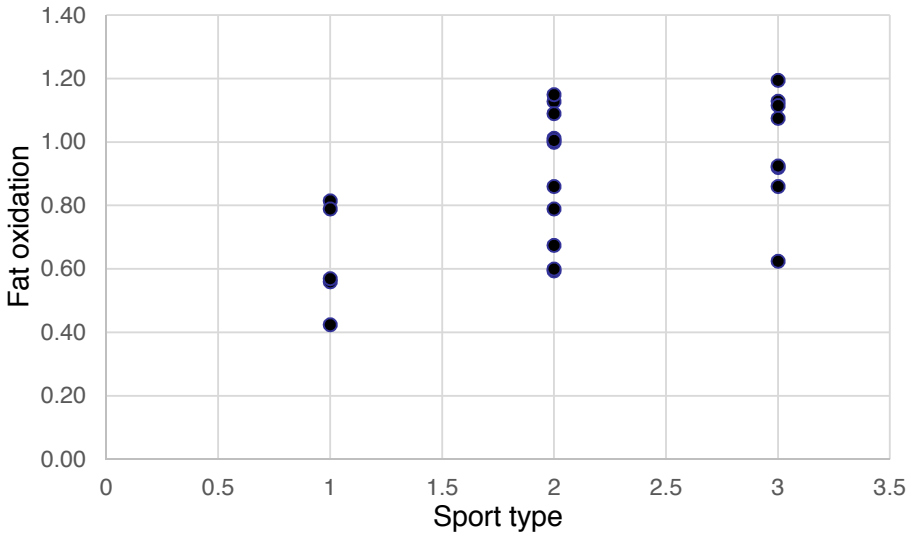


p= 0.004, 1 vs 3.



p= 0.013, 1 vs 2 and 1 vs 3.

Khoo, A, Miall, A., Rauch, C., Snipe, R., Costa, R.J.S., (2015). *G*ut training exhibits no change in total carbohydrate or fat oxidation rates during endurance running. *Sports Dietitians Australian Conference*.

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Dietary periodisation and tailoring intake:

- Preparation nutrition
- Recovery nutrition
- Metabolic nutrition
- Days off
- Race nutrition training (long)

OI	Sun	Mon	Tue	Wed	Thur	Fri	Sat
AM	Long cycle 120km	Inter swim 5.0km	Inter swim 5.0km	Long cycle 120km	Inter swim 5.0km	Aero swim 5.0km	Rec
PM	Aero swim 4.5km	Bricks 60km/ 15k	Interval run 16km	Recovery	Aero run 20km	Bricks 60km/ 15k	Rec

Weekly distances: Swim- 24.5km; cycle- 360km; run- 66km
Weekly training time: ~20-30hr/week

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Dietary periodisation and tailoring intake:

ACSM et al. 2016- position statement. MSSE

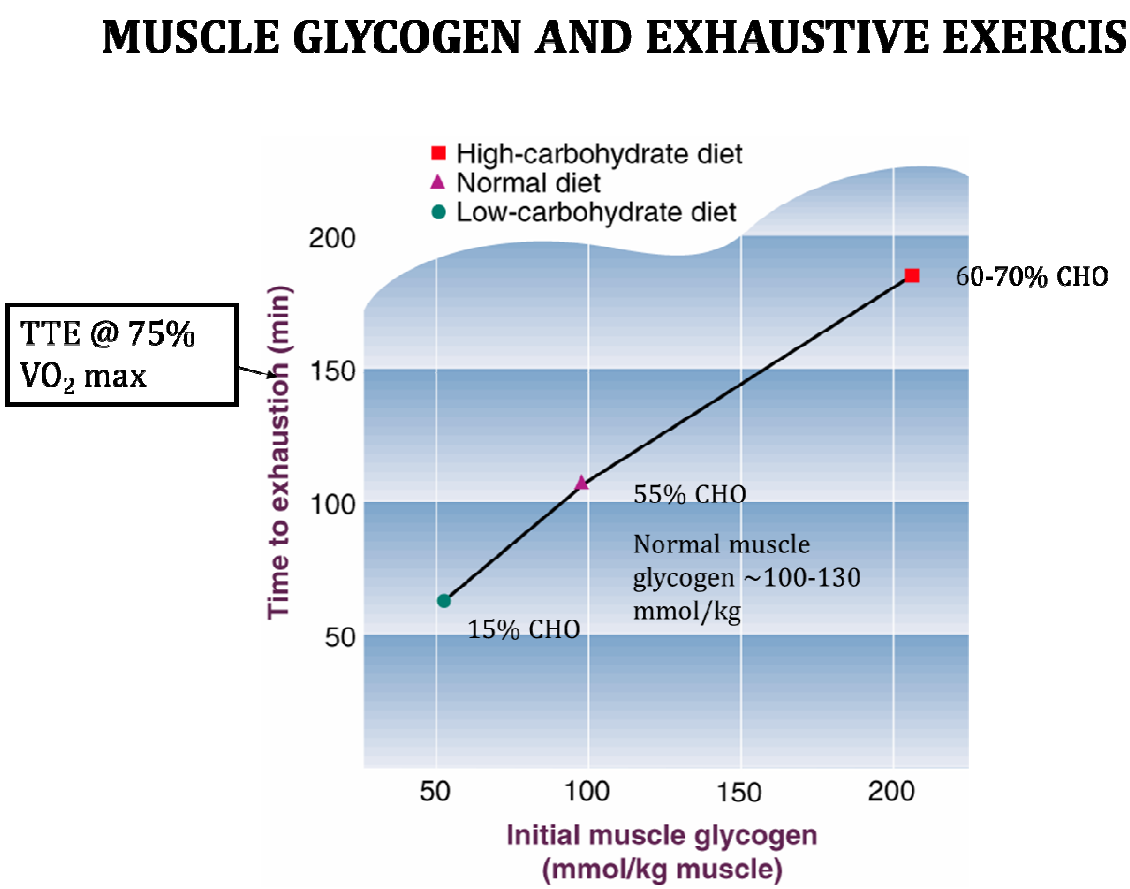
Light	• Low intensity or skill-based activities	3–5 g/kg of athlete's body weight/d
Moderate	• Moderate exercise program (eg, ~1 h per day)	5–7 g/kg/d
High	• Endurance program (eg, 1–3 h/d mod-high-intensity exercise)	6–10 g/kg/d
Very High	• Extreme commitment (eg, >4–5 h/d mod-high intensity exercise	8–12 g/kg/d

ACUTE FUELLING STRATEGIES – these guidelines promote high carbohydrate availability to promote optimal performance in competition or key training sessions

General fuelling up	• Preparation for events < 90 min exercise	7–12 g/kg per 24 h as for daily fuel needs	• Athletes may choose carbohydrate-rich sources that are low in fiber/residue and easily consumed to ensure that fuel targets are met, and to meet goals for gut comfort or lighter 'racing weight".
Carbohydrate loading	• Preparation for events > 90 min of sustained/intermittent exercise	36–48 h of 10–12 g/kg body weight per 24 h	
Speedy refuelling	• <8 h recovery between 2 fuel demanding sessions	1–1.2 g/kg/h for first 4 h then resume daily fuel needs	• There may be benefits in consuming small regular snacks • Carbohydrate rich foods and drink may help to ensure that fuel targets are met.
Pre-event fuelling	• Before exercise > 60 min	1–4 g/kg consumed 1–4 h before exercise	• Timing, amount and type of carbohydrate foods and drinks should be chosen to suit the practical needs of the event and individual preferences/experiences. • Choices high in fat/protein/fiber may need to be avoided to reduce risk of gastrointestinal issues during the event. • Low glycemic index choices may provide a more sustained source of fuel for situations where carbohydrate cannot be consumed during exercise.

Maintaining Euhydration.

Before running.



The Pearl Barley Risotto

"A carbohydrate and protein rich dish, packed with Mediterranean flavours and a pearl barley chew"

Dr. Ricardo J S Costa

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Sports Smoothies

"Ideal for helping to replenish muscle carbohydrate stores"

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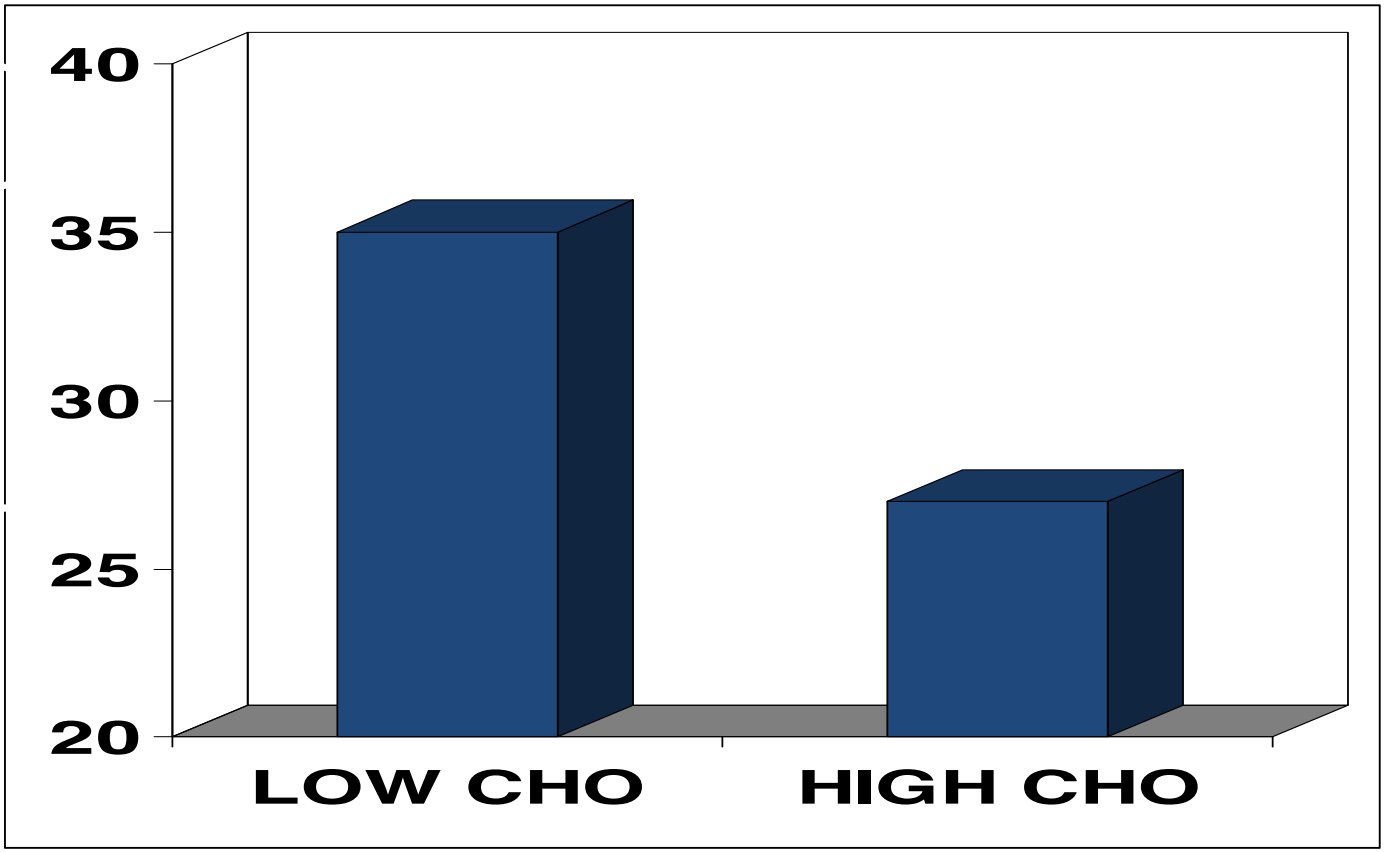
Cycle time trial performance after a 3-d high (>70% CHO) and low (<10% CHO) diet in 12 trained cyclists



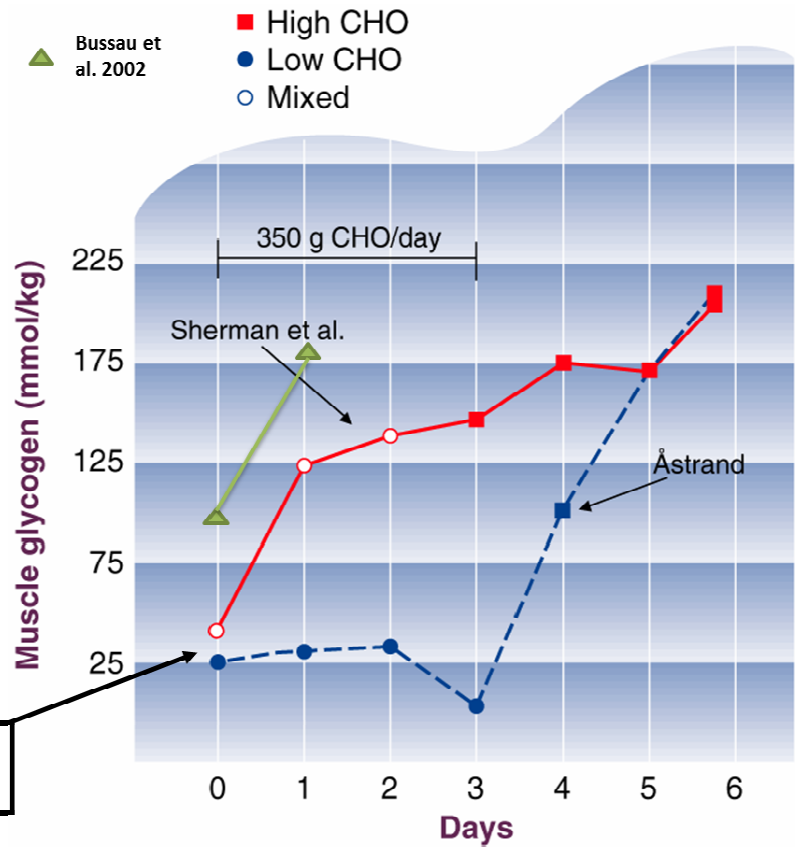
Bishop *et al*. (2001). *Int J Sports Nutr*. 11, 490-502

Before running.

Normal muscle glycogen ~100-130 mmol/kg

Low muscle glycogen after exercise bout

MUSCLE GLYCOGEN LOADING



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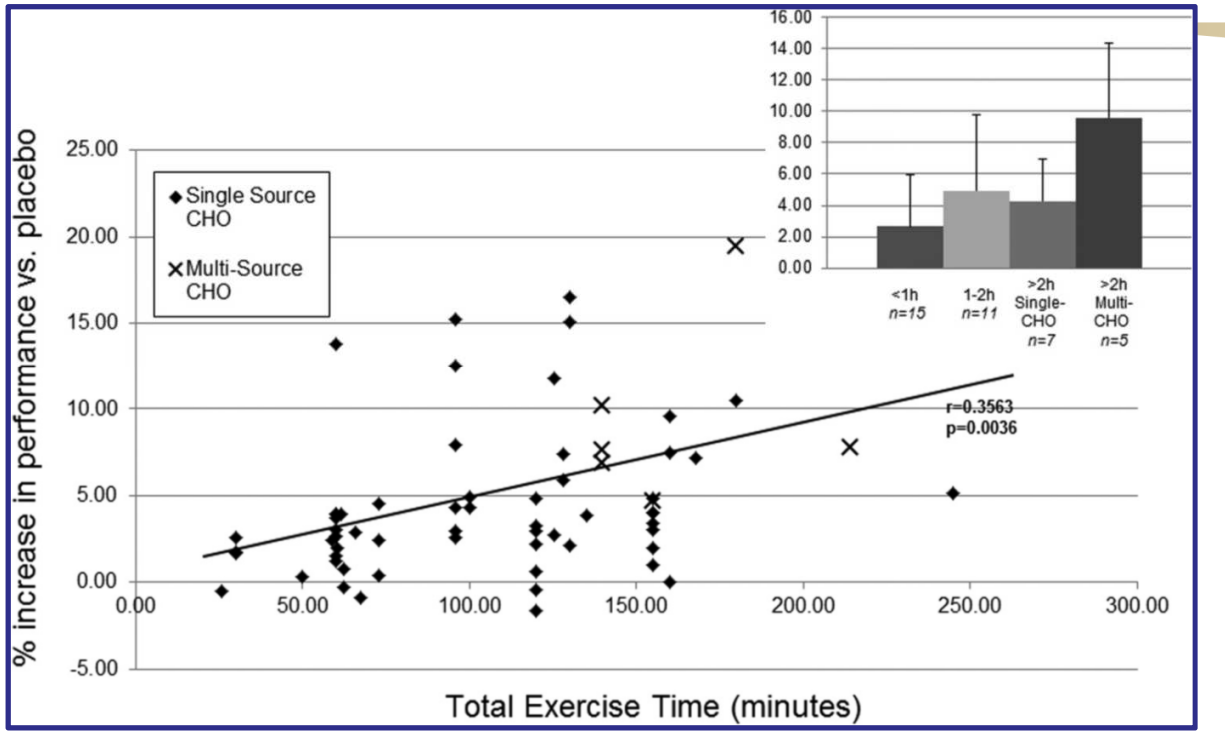
During running.

CHO Intake & performance Vs. Placebo: Systematic Review



(2h cycle + 20k TT)

CHO intake	9g/h	13g/h	31g/h	48g/h	78g/h
↑TT perf	1%	2%	3%	4%	4.7%

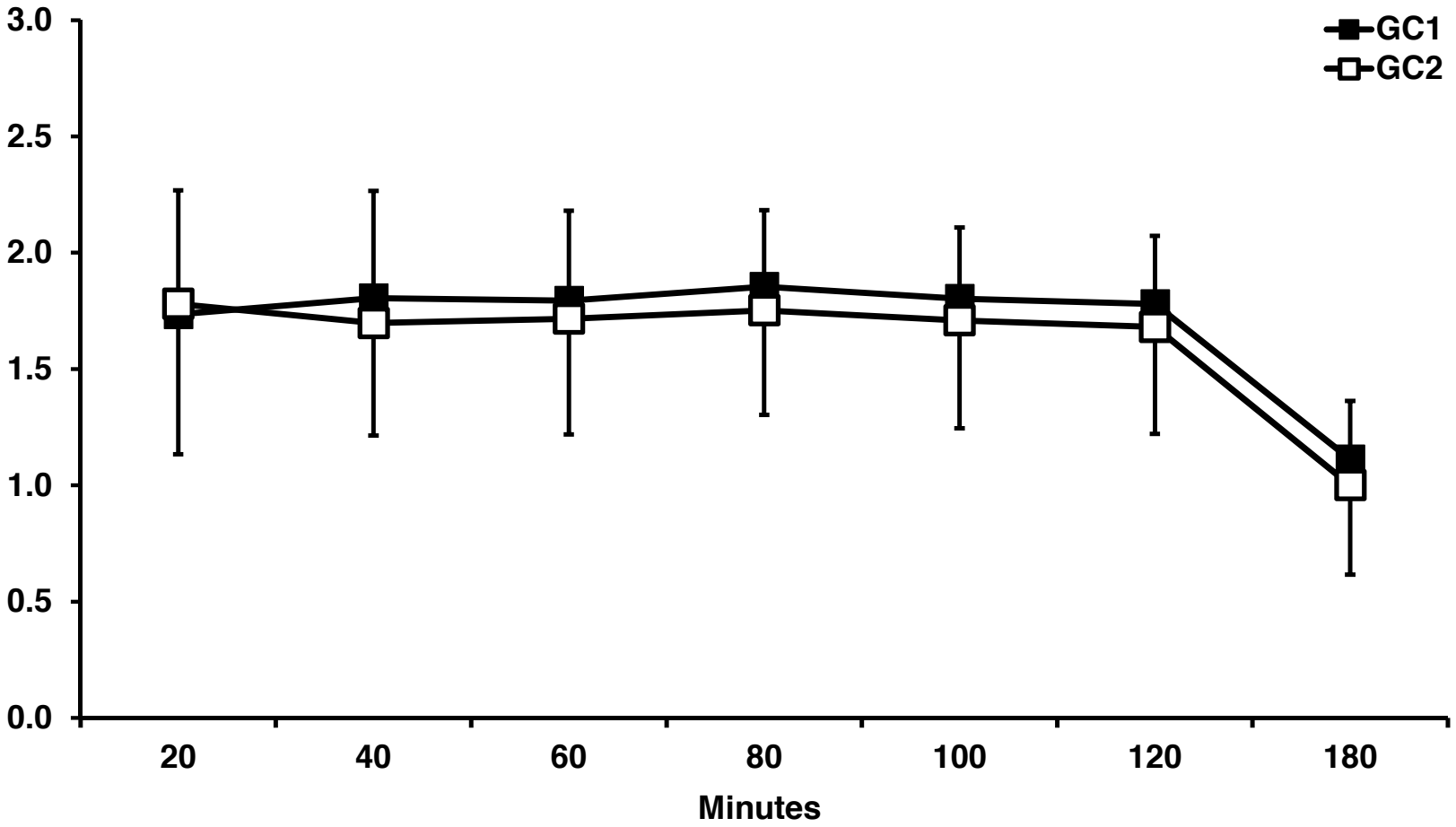
Stellingwerf & Cox 2014. Appl. Physiol. Nutr. Metab. 39:998-1011; Brooks GA and Mercier 1994

Guidelines & Recommendations: CHO During Exercise

Duration	CHO amount	CHO type	Glucose	Glucose + Fructose
<45mins	Not required	----	----	----
45-75mins	Very small (mouth rinse)	Most forms	✓	✓
1 to 2h	Up to 30g/h	Most forms	✓	✓
2-3h	Up to 60g/h	Glucose, maltodextrin	✓	✓
>3h	Up to 90g/h	Multi-transport CHO		✓

Adapted from: Jeukendrup (2010), Curr.Opin.Clin.Nutri.Metab.Care., 13:452-457.

2h steady state running at 60% VO_{2max} in 20ºC whilst consuming 90gCHO/h (30g/20mins, 10% w/v 2:1 glucose to fructose) + 1h TT (water ad libitum).



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Carbohydrate intake during exercise increases gastrointestinal symptoms

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Multi-transportable carbohydrate intake during exercise results in malabsorption.

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Gut-Training reduces symptoms and malabsorption

Gut-Training improves running performance

Do active individuals have increased fluid requirements?

ENVIRONMENT
↑ Temperature & ↑ humidity=
↑ water body losses

OTHER FACTORS:
Clothing/equipment, genetic predisposition, heat acclimation, training status, individual sweating rates, opportunities to drink, players position, GI factors, respiration, urinary, etc...

EXERCISE
↑ Intensity & ↑ duration=
↑ water body losses

TOTAL BODY WATER LOSSES

Gains:
Heat acclimatisation
Metabolic water
Glycogen storage

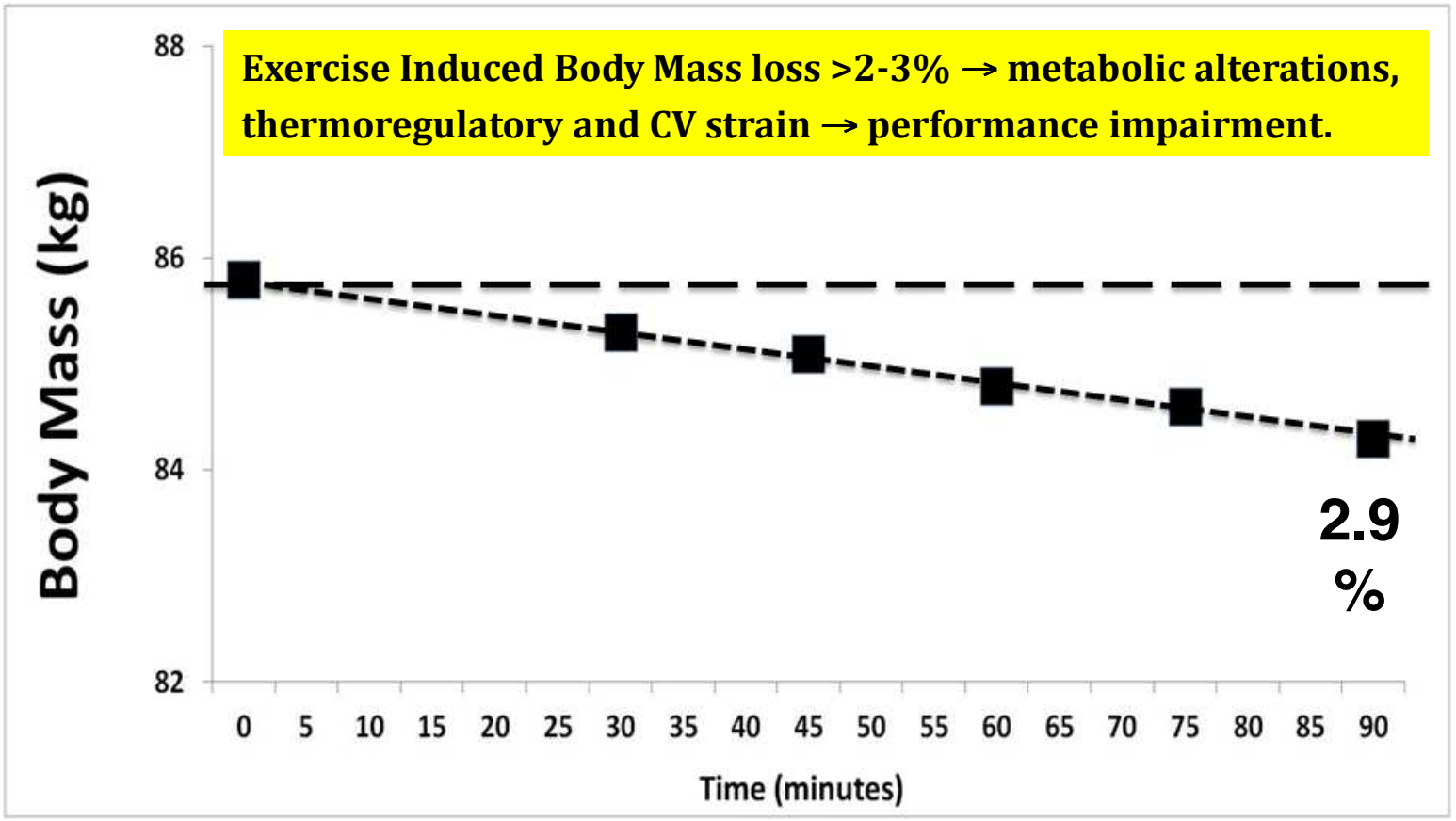
Individually programme fluid provisions

Total body water losses **FAR GREATER THAN** Total fluid intake	Total body water losses **SIMILAR** Total fluid intake
HYPOHYDRATION, FATIGUE, DECREASES IN SPORTS PERFORMANCE	**EUHYDRATION**

Increase in overall strain: CV, thermal, metabolic, and neurological

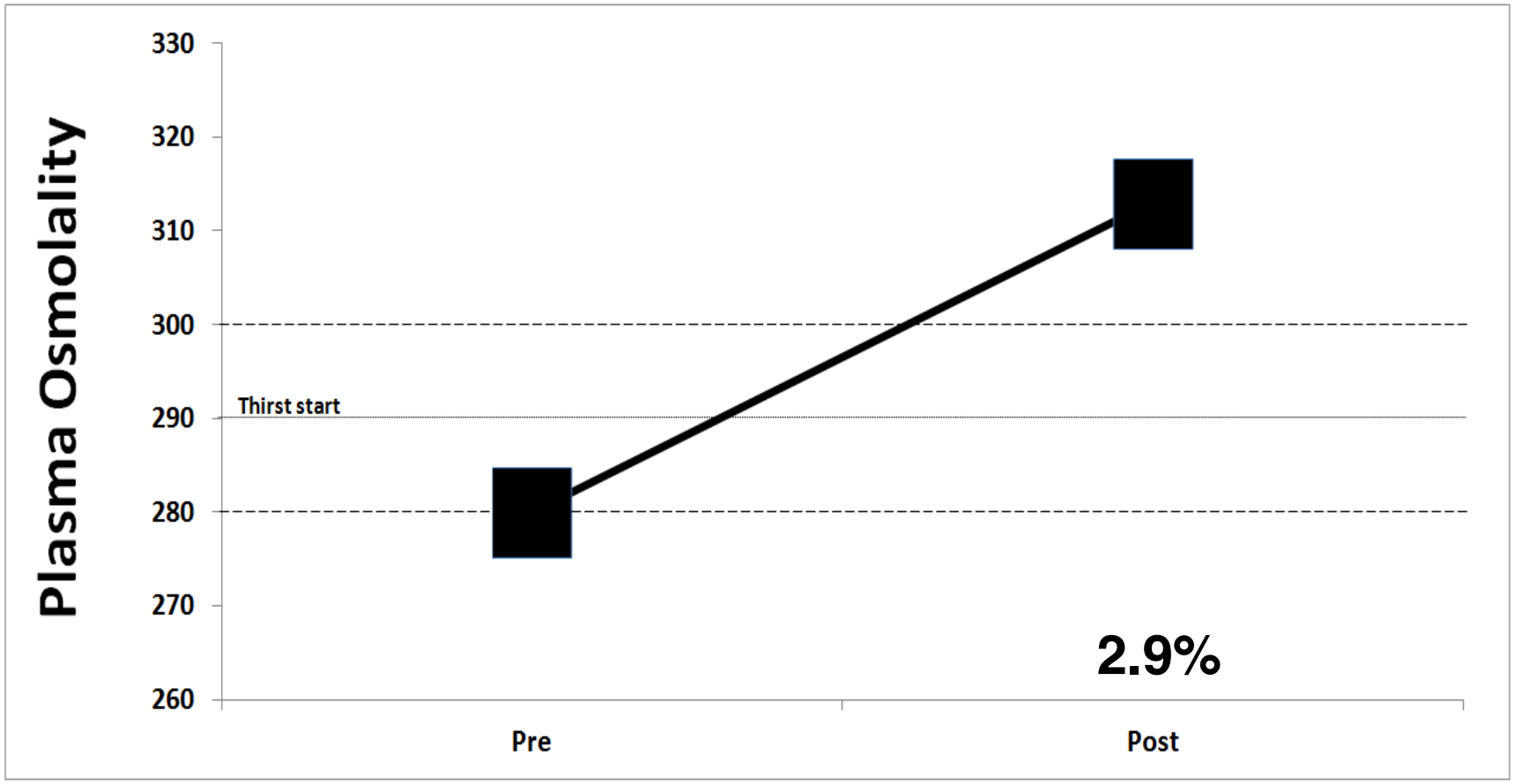
Hypohydration

90min running exercise at 60% of maximal effort in 30^{0}C ambient temperature
0ml fluid intake.

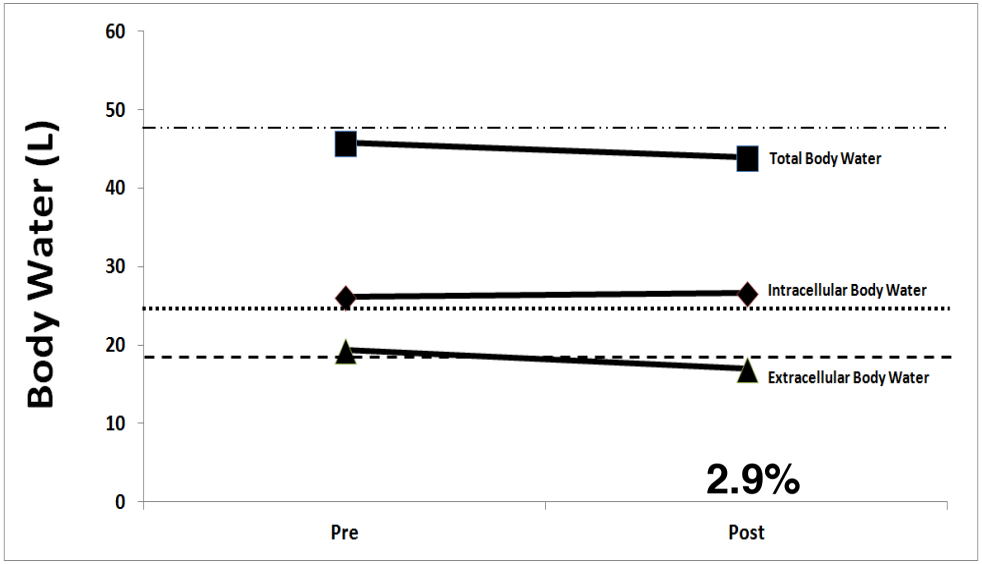


ACSM et al. (2007), MSSE, 39:377-390; Goulet (2012), Br.J.Sports.Med, Epub; Noakes (2007), J.Sport.Sci., 25:781-796; Noakes & Sawka (2007), MSSE, 38(8):1209-1217.

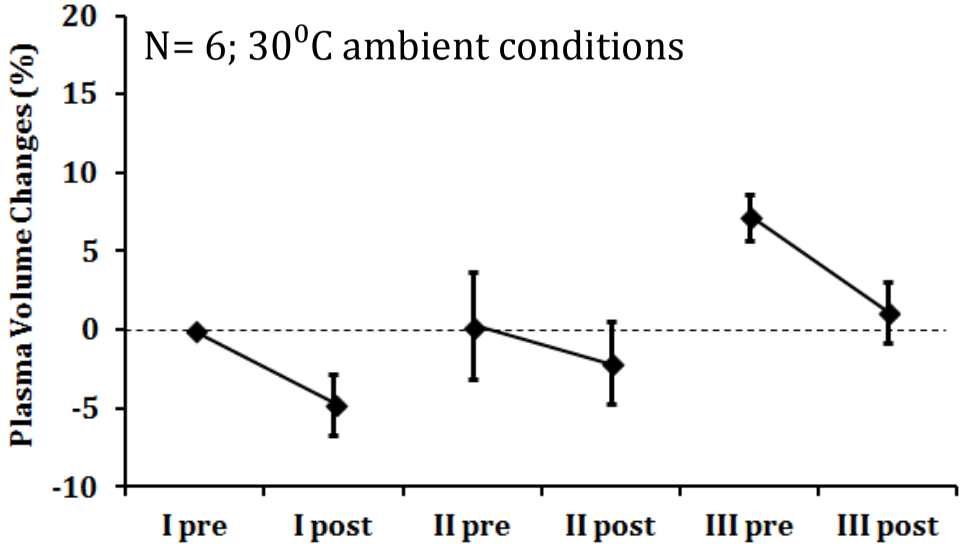
Plasma osmolality normal physiological range: 280-300mOsmol/kg
AVP release: 280-285mOsmol/kg
Increased thirst sensation 290-295mOsmol/kg

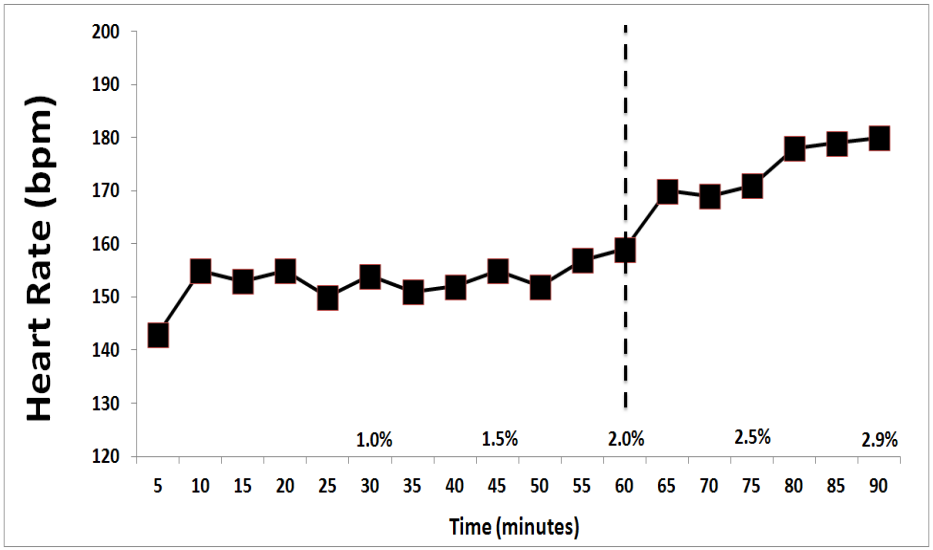


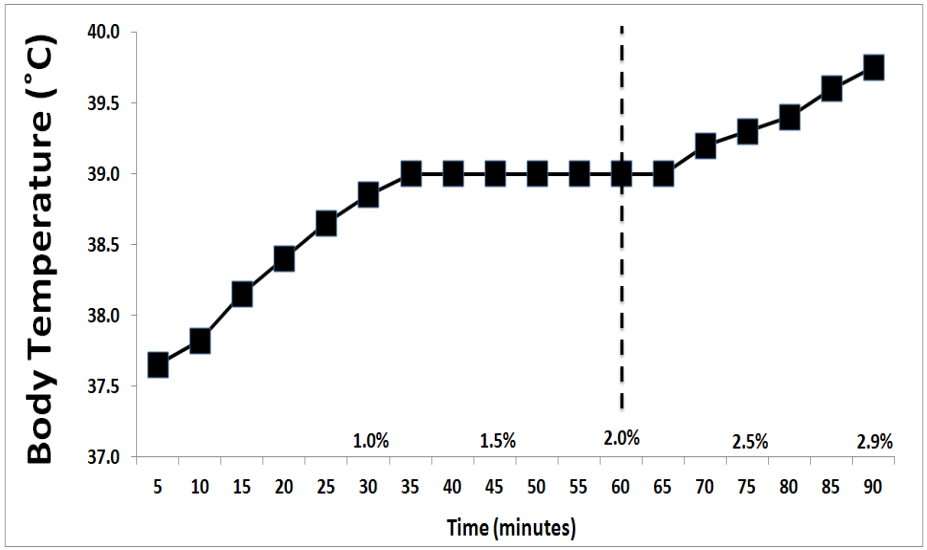
Hew-Butler et al. (2006), Clin.J.Sport.Med, 16:283-292; Thomas et al. (2008), J. Am. Med.Dir. Assoc. 9: 292-301.

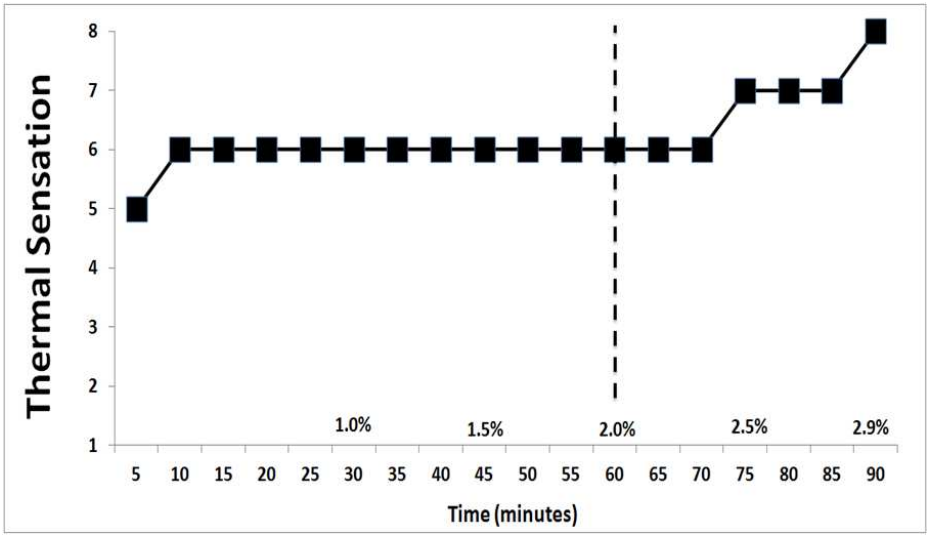


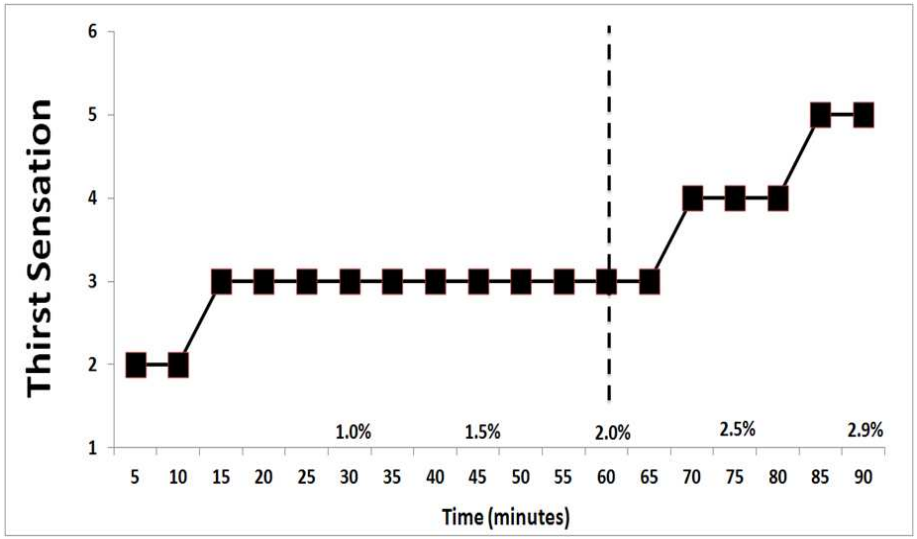
Costa et al. (2014). Heat acclimation responses of an ultra-endurance running group preparing for hot desert-based competition. Euro.J.Sport.Sci., 14(S1): S131-S141.











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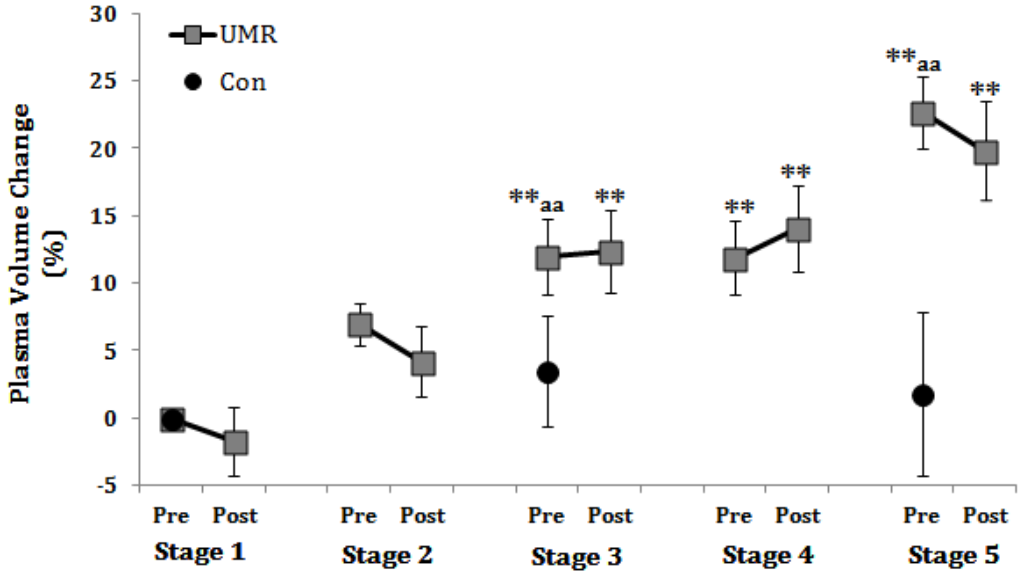


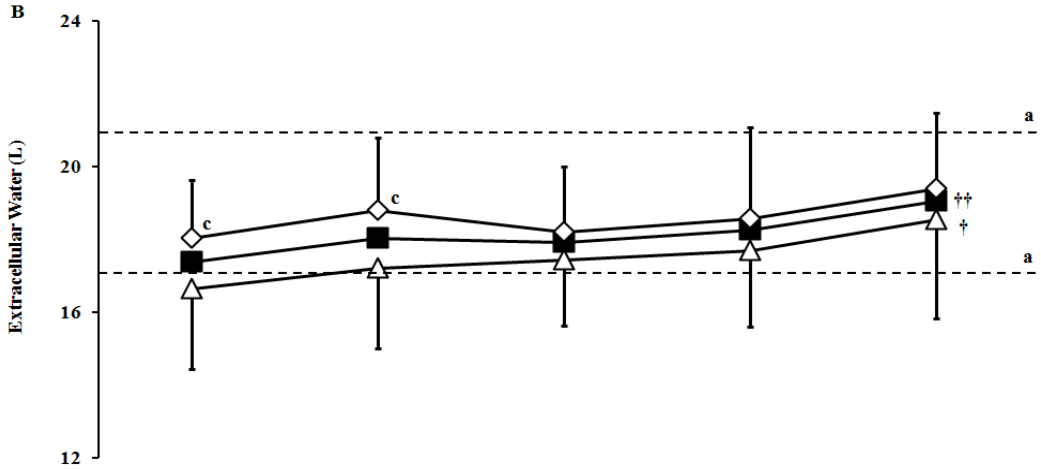
Mean ± SEM (n=19); $F_{(9,180)}$= 14.0; P< 0.001
** P< 0.01 *vs.* Pre-Stage 1, aa P< 0.01 *vs.* Con.

(Dill & Costill 1974, Maughan et al. 2001)

Heat Acclimatisation- extracellular hypervolaemia:

-↑ Circulatory osmotic pressure,
- ↑ Plasma proteins (e.g. albumin),
- ↑ Aldosterone and ADH.

Patterson et al. (2004), J.Appl.Physiol., 559(Pt 1), 327-334; Wendt et al. (2007), Sports.Med., 37(8), 669-682.



Changes in pre-stage resting body water of UER along MSUM competition. (**B**) Extra-cellular water. Mean (SD): UER (■, n = 43); slow runners (SR Δ; MSUM mean speed <8 km/h, n = 23); fast runners (FR ♢; MSUM mean speed ≥8 km/h, n = 20). [a] Normal physiological range (Quadscan 4000, Bodystat, Douglas, Isle of Man, UK). †† p < 0.01 and † p < 0.05 *vs.* Stage 1; [c] p < 0.05 *vs.* SR.

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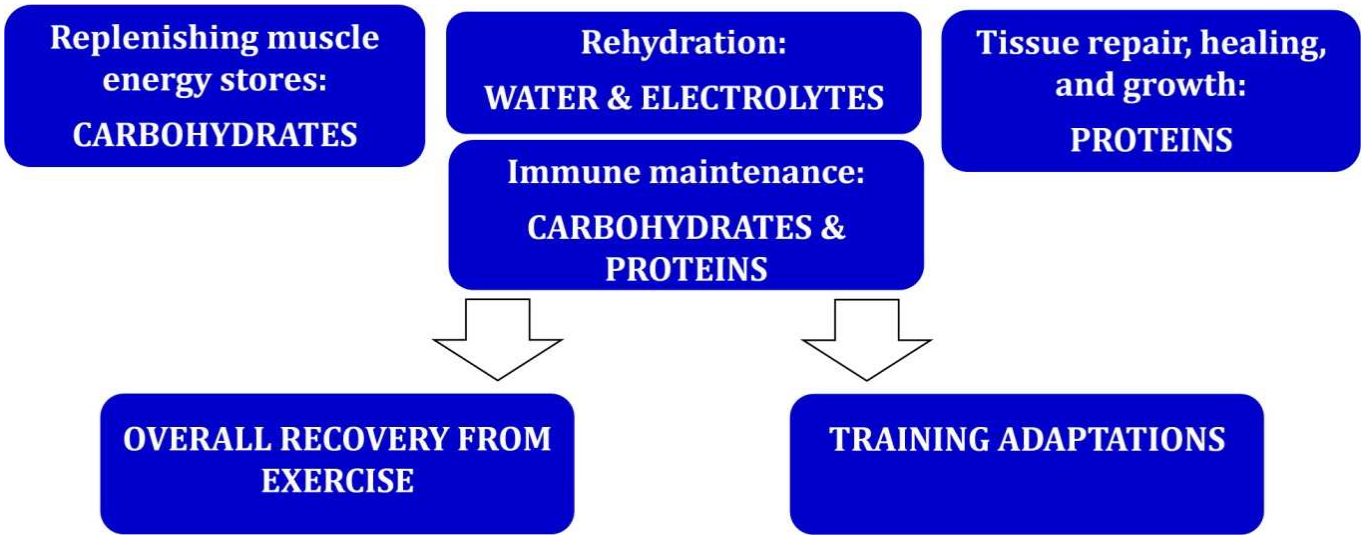
After running.



Making Recovery Even Easier:

- **Fluid replacement to x1.5 losses (e.g. 1kg body mass loss= 1.5L fluid replacement)**
- **For carbohydrate have fruit juice or fruit smoothies.**
- **For protein have milk*.**
- **For carbohydrate & protein have a flavoured milkshake*.**

* Or dairy milk alternatives

ACSM et al. (2009), Med.Sci.Sports Exerc. **41**(3): 709-731; Beelen et al. (2010), Int.J.Sport Nutr.Exerc.Metab. **20**(6): 515-532; Costa et al. (2009), Int.J.Sport Nutr.Exerc.Metab. **19**(4): 366-384; Costa et al. (2011), Int.J.Sport Nutr.Exerc.Metab. **21**(3): 205-213; Costa et al. (2012), Int.J.Sport Nutr.Exerc.Metab., **22**(3), 184 – 191; Kerksick et al. (2008), J.Int.Soc.Sports Nutr. **5:** 17-29.

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Pumped-Up Spanish Omelette

"Carbohydrate and protein rich savoury snack for between session recovery."

Dr. Ricardo J S Costa

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TAKE HOME MESSAGES

- Individually tailored dietary regime, periodised to match training.
- Nutritional balance by consuming a variety of foods to meet energy requirements.
- Ensure sufficient glycogen stores to meet training/competition demands.
- Carbohydrate intake during exercise, as needed.
- Practice race nutrition in training.
- Optimise recovery and adaptation nutrition.

- Start euhydrated and maintain euhydration throughout, as needed.
- Rehydrate in accordance with losses.