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# NUTRITION FOR ENDURANCE SPORTS

endurance events >60 min.



# Key Differences from Average Persons' Balanced Diet -

Increased:

↪ ENERGY (esp Carbohydrates)

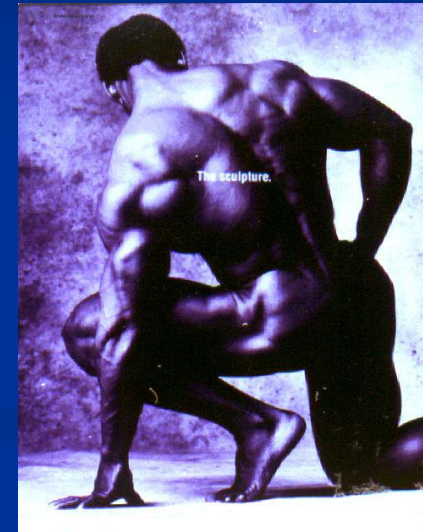
↪ FLUIDS



# Excess Body Fat in Athletes

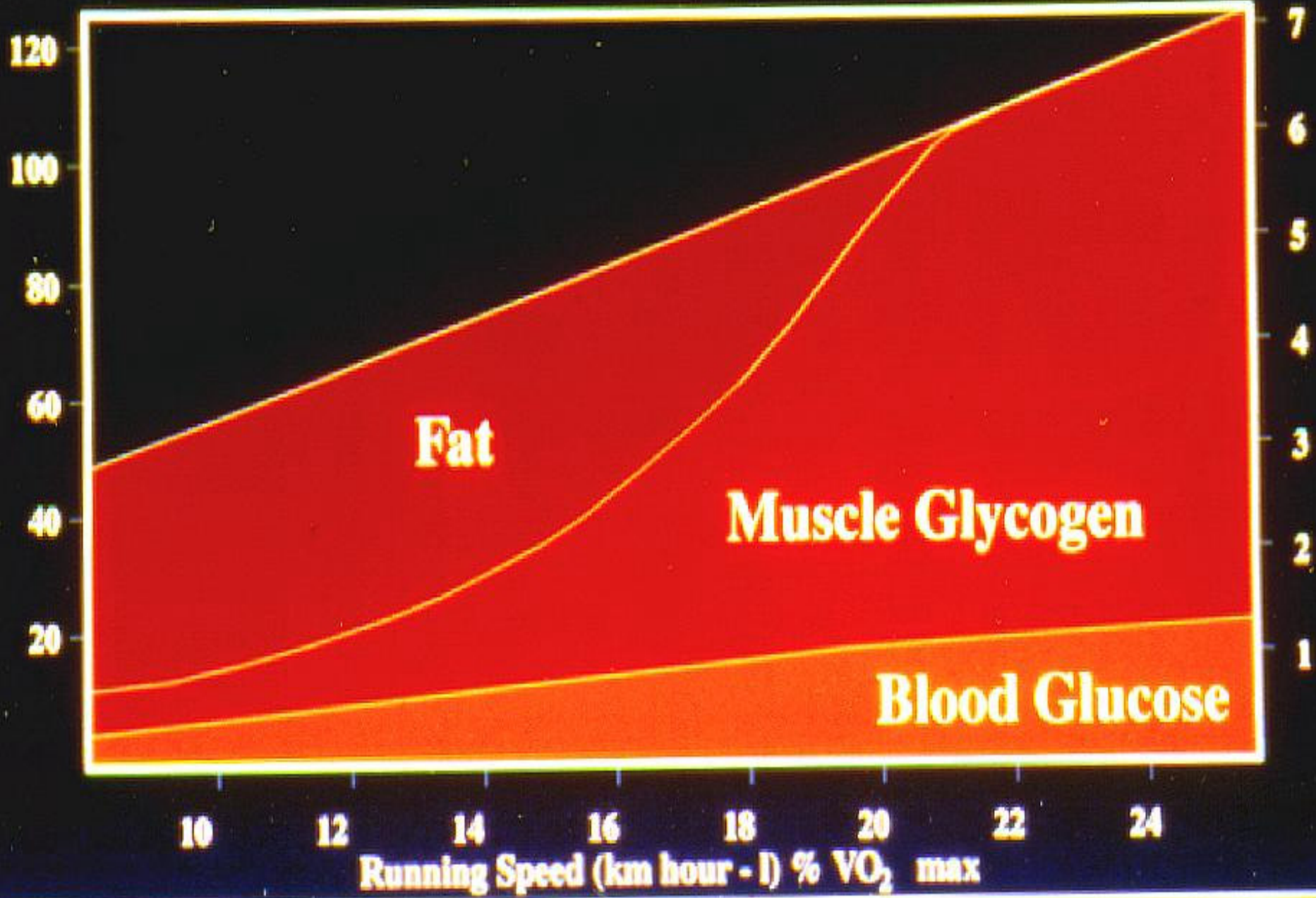
negatively correlated with motions:

- ↓ physical work capacity
- ↑ energy cost of movement
- ↑ rolling resistance
- ↓ 30% running performance
- ↑ oxygen demand  $0.2 \text{ L O}_2/\text{kg} / \text{km}$



**Energy Cost  
(KJ minute<sup>-1</sup>)**

**Rate of  
Carbohydrate utilisation  
(g minute<sup>-1</sup>)**



# MAJOR CAUSES OF FATIGUE



dehydration



substrate depletion:

- **muscle glycogen**
- low blood glucose



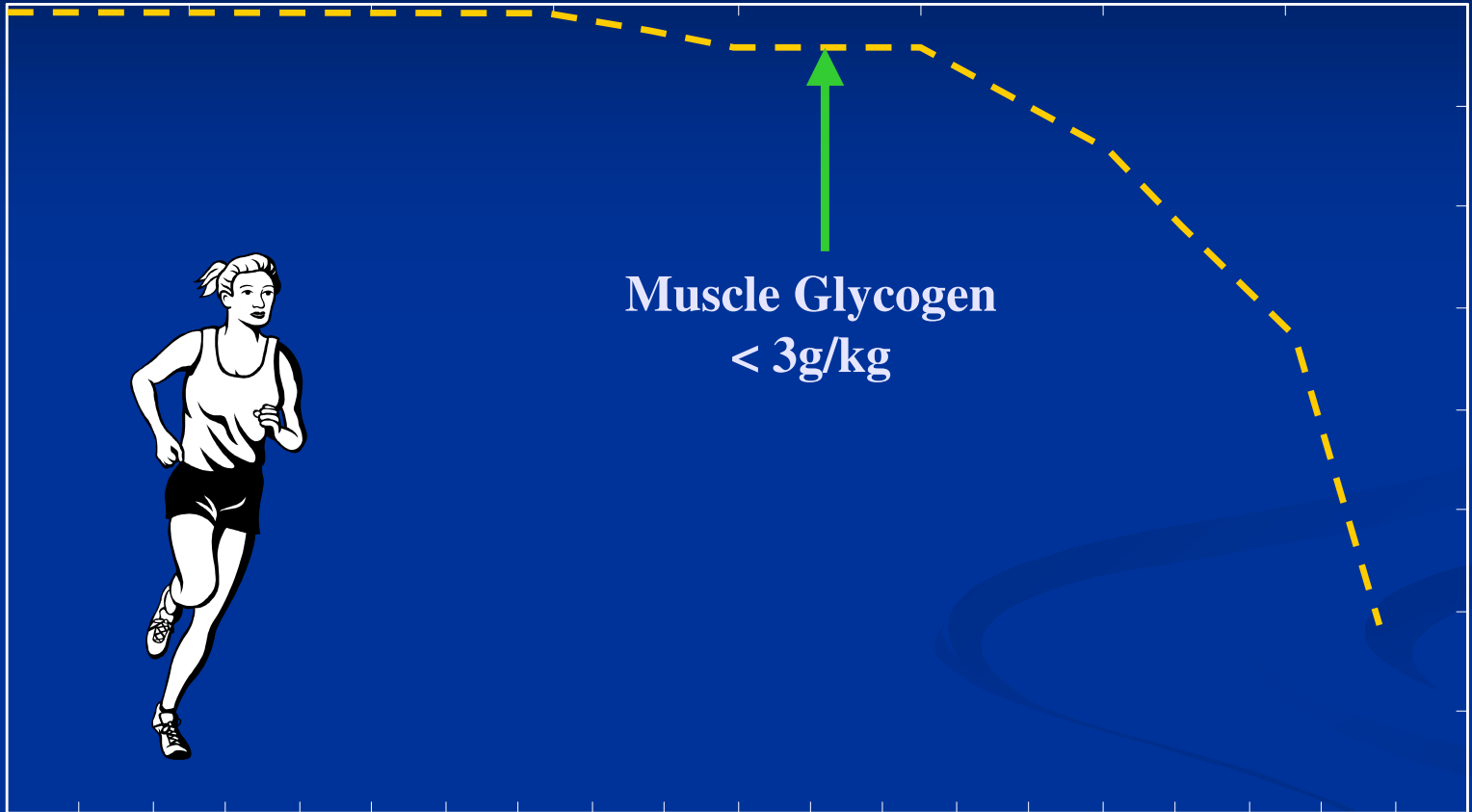
Start



Finish



4 8 12 16 20 24 28 Kilometers



Muscle Glycogen  
<math>< 3\text{g/kg}</math>

0  
5  
10  
15  
20  
Time Loss, Minutes

0 2 4 6 8 10 12 14 16 18 Miles



Race Distance

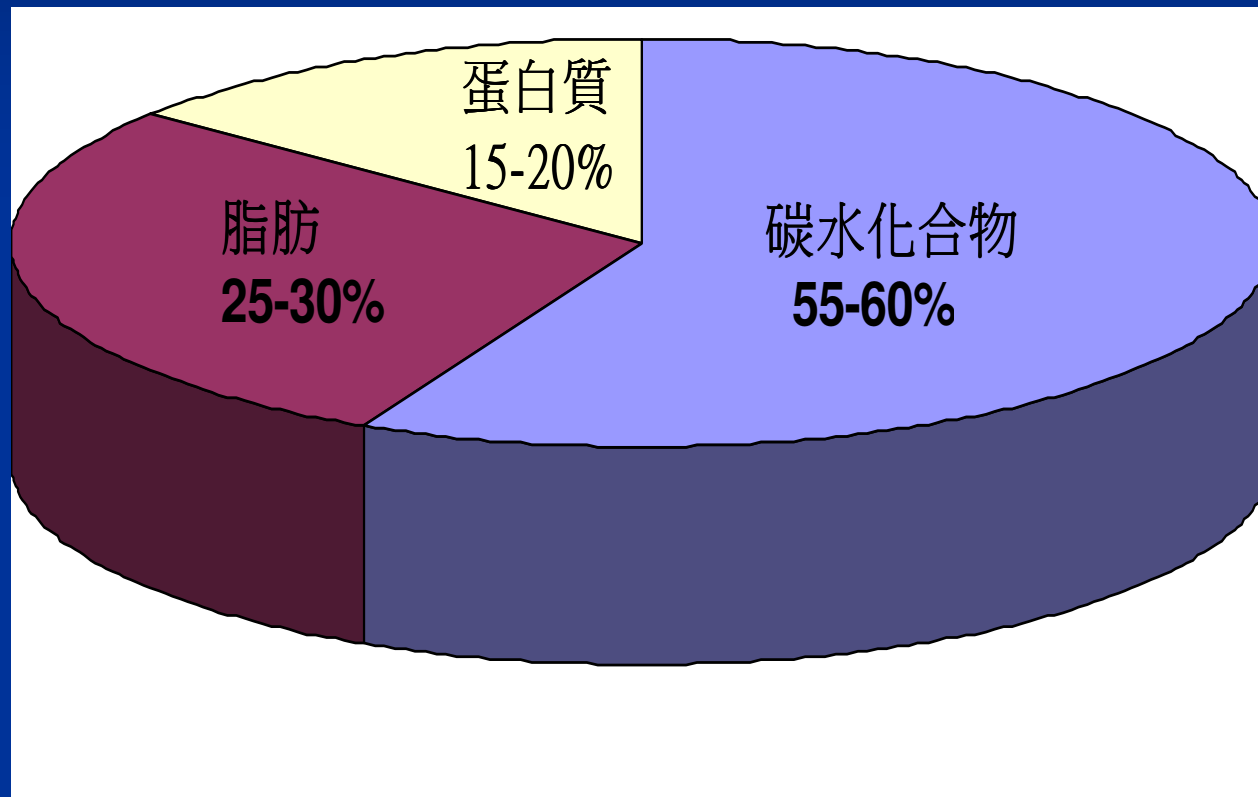


# Carbohydrates are core

- what the body relies on most for fuel during exercise
- carbohydrates in body directly impacts stamina & endurance



# 運動員飲食熱能來源比例



# CHO INTAKE GUIDELINES: TRAINING

	(g) CHO / kg	70 kg man (g) CHO requirement
Moderate exercise <1 h	5 - 7	35 - 490
Endurance (1-3 hr, moderate-to high intensity)	7 - 10	490 - 700
Extreme exercise (>4-5 hrs, moderate- to high intensity)	10 - 12	700 - 840

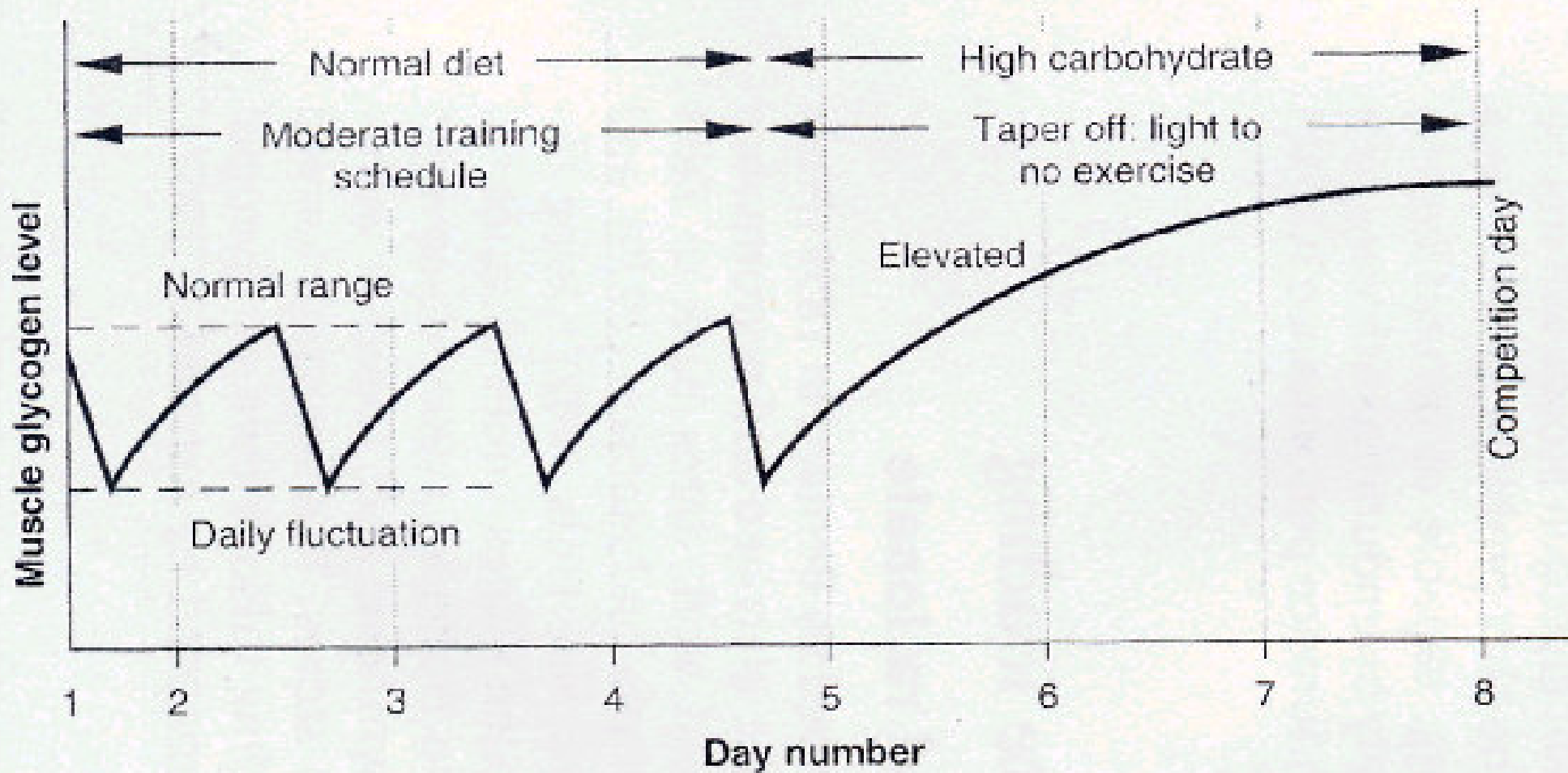
🔑 higher CHO requirement for strenuous daily competition &/or damaged muscles, up to 12-13g CHO/kg



# Ergogenic Effects of CHO Loading

- **Improve 20% endurance**
- **prevent decline in speed/work**
- **↑ output 2-3%, esp. cycling, running**
- **no sig. benefits for events <45-90 min.**





## Modified CHO Loading

Heavy training hold down muscle glycogen on a normal diet.

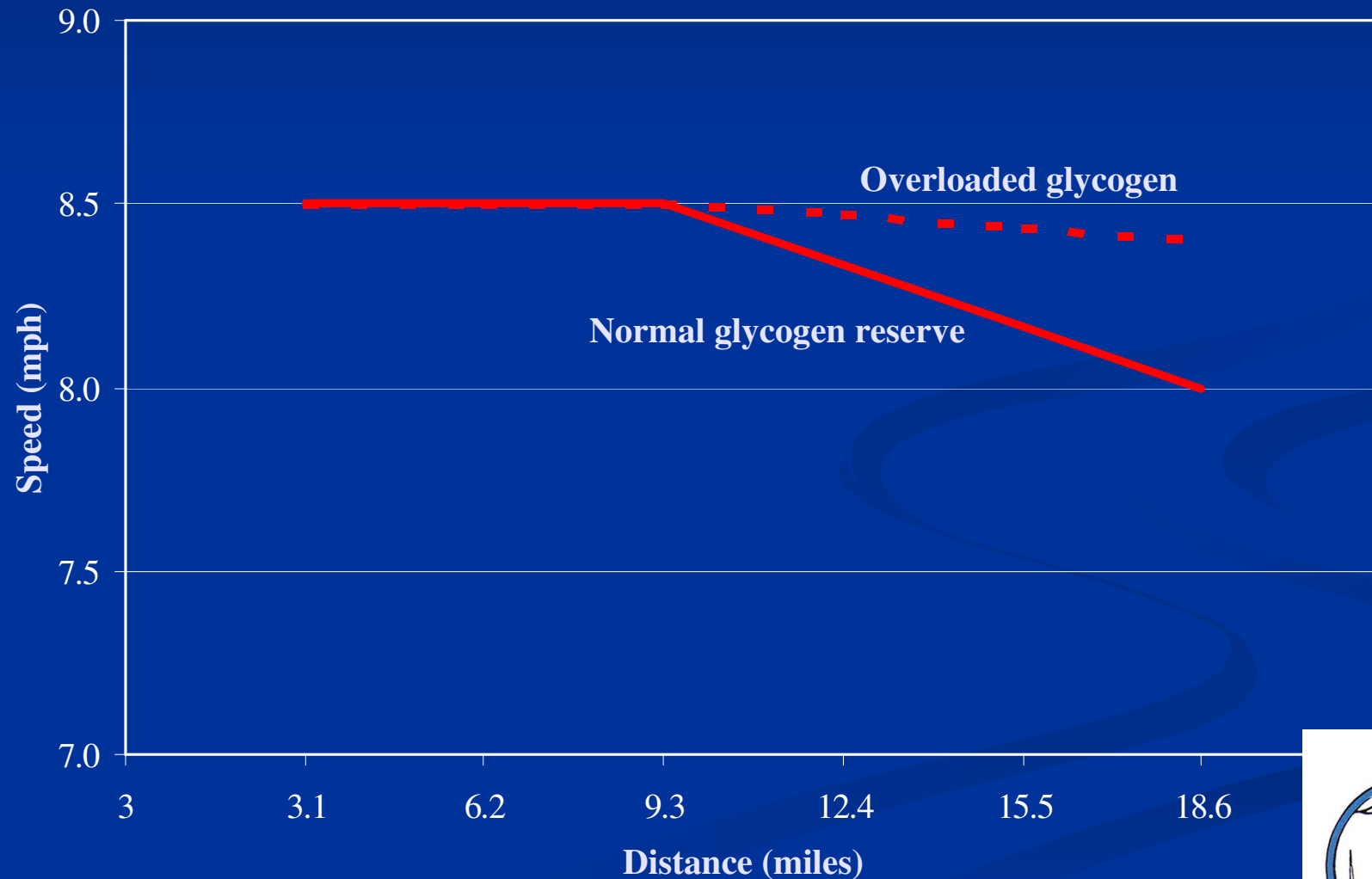
high CHO diet + tapering training leads to ↑ muscle glycogen

Burke & Read 87; Shrman 81



overloaded runners maintain speed for a longer time, thereby shortening race times by roughly 11 min.

Karlsson & Saltin71



# Pre-exercise feeding in competition

- Generally eat about 3 hrs before competition
- Contributes to energy & fluid requirements
- Readily digestible meal
- High in CHO & relatively low in lipids & proteins



# CHO-FEEDING DURING EXERCISE

- ⚡ prevent onset of hypoglycaemic
- ⚡ maintain or ↑ blood glucose

## Beneficial effects of CHO feeding:

↑ endurance (moderate-intensity)

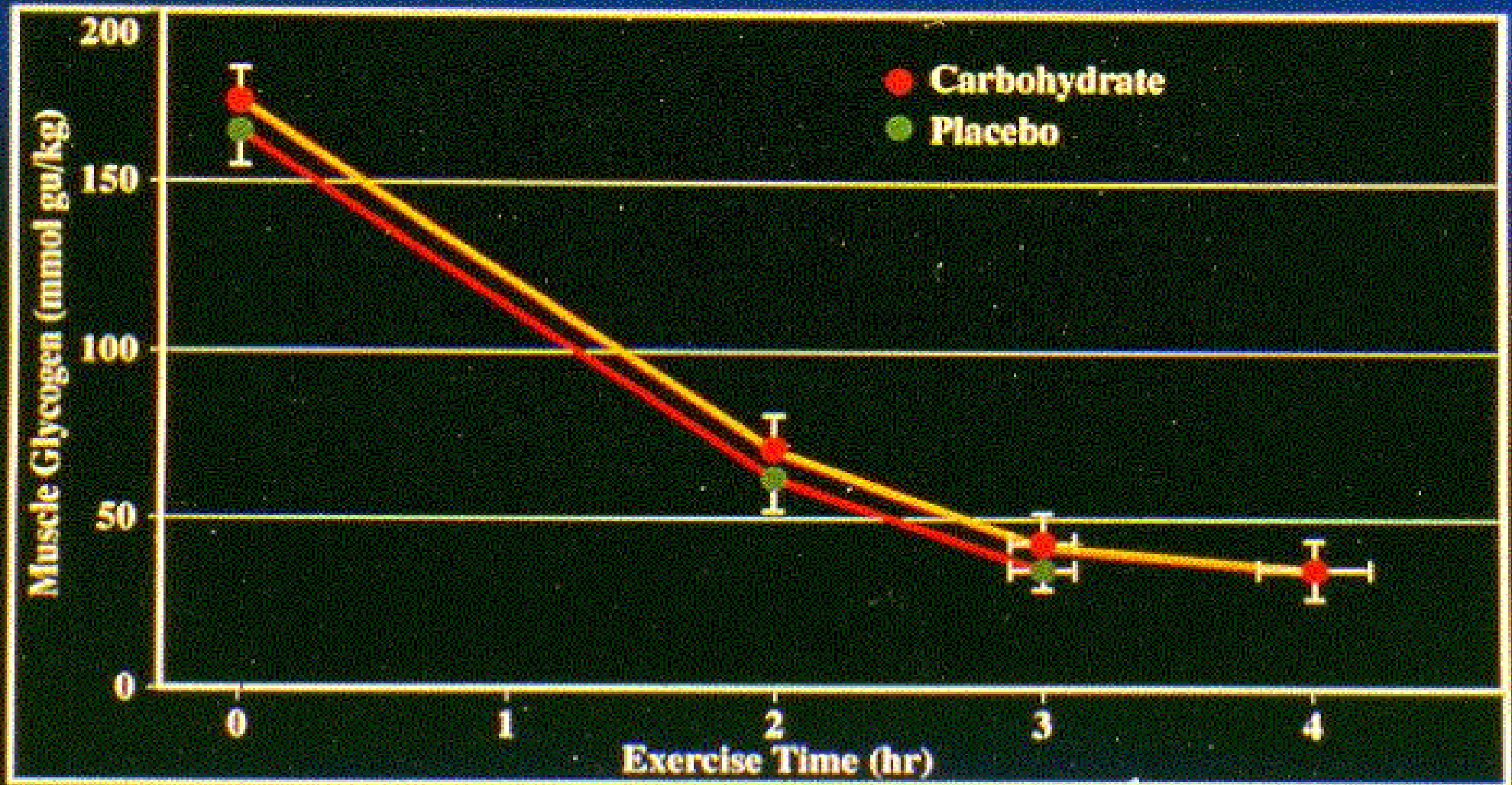
↑ speed performance (intermittent high-intensity exercise)

↑ mental & physical skill (team, racquet games), esp. at last 10 min of high-intensity one- hr exercise



# Cyclists

placebo or CHO solution ingested every 20 min.



(Coyle et al, 1986)



# NUTRITION STRATEGY DURING EXERCISE

- **Suggested CHO feeding :**
  - ✦ 30-60g / hour
  - ✦ 0.5 to 1 L. of 6% CHO sports drink per hour



# CALCULATING CHOCONTENT

$$\frac{\text{Grams of CHO}}{\text{Serving size}} \times 100$$

$$\frac{14\text{g}}{240 \text{ ml}} \times 100 = 6\%$$

$$8 \text{ oz. (250mL)} \ 6\text{-}7\% \\ = 15\text{-}17\text{g CHO}$$

## Nutrition Facts

Serving Size 8 fl oz (240ml)

Servings Per Container 8

Amount Per Serving

Calories 50

% Daily Value\*

Total Fat 0g 0%

Sodium 110mg 5%

Potassium 30mg 1%

Total Carbohydrate 14g 5%

Sugars 14g

Protein 0g

Not a significant source of Calories From Fat, Saturated Fat, Cholesterol, Dietary Fiber, Vitamin A, Vitamin C, Calcium, Iron.

\*Percent Daily Values are based on a 2000 calorie diet.

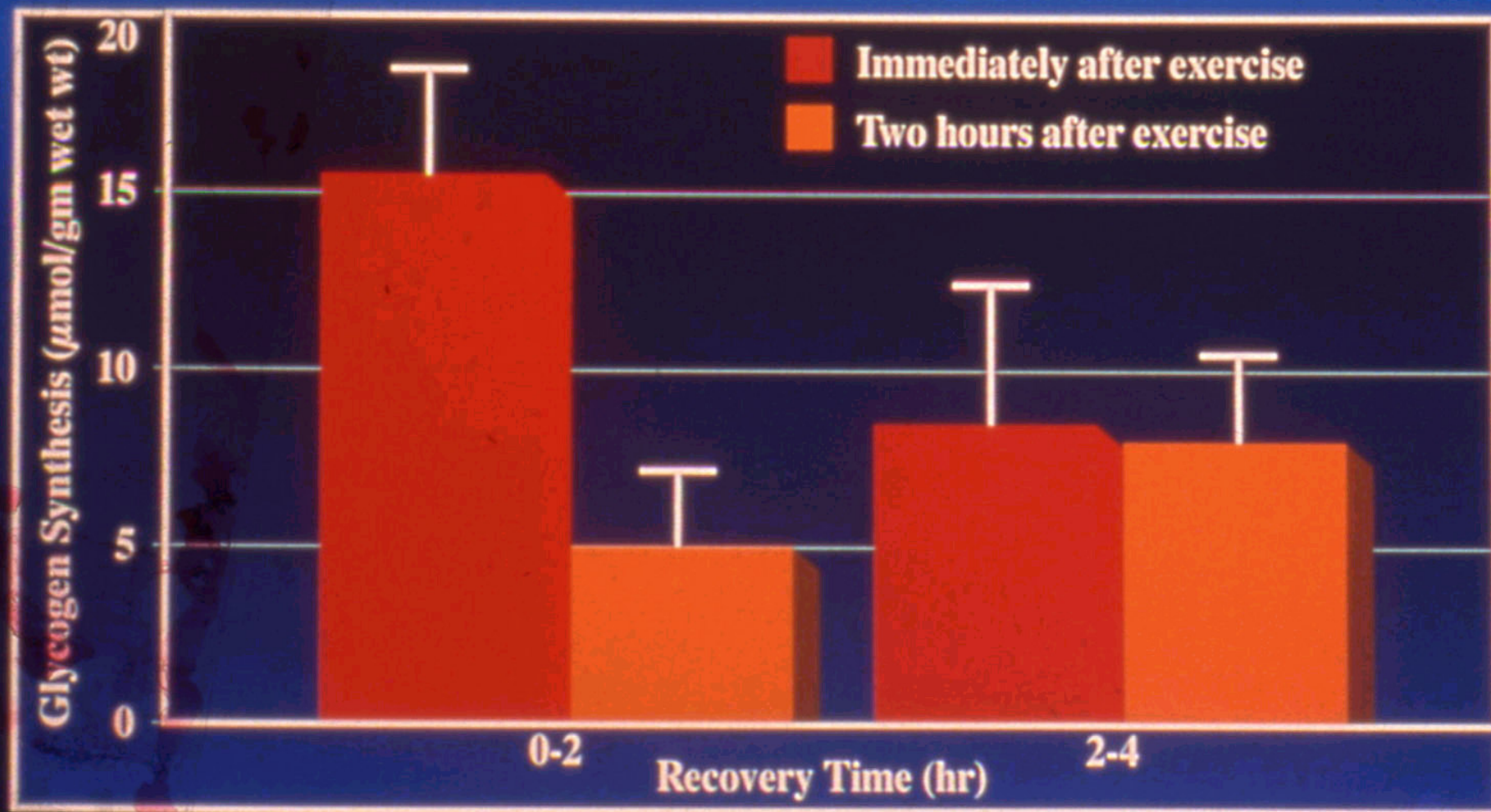


# Post-Exercise CHO intake for Muscle Glycogen Restoration

- Highest storage rates during first 2 hours
- Delay of CHO feeding after 2 hrs should be avoided if recovery time is  $< 8$  hrs.
- Small frequent meals to avoid gastric discomfort
- Total restoration at 525-648g per 24 hours (7-9g CHO/kg body wt)



Muscle glycogen storage in the vastus lateralis muscle during the first two hours and second two hours of recovery when carbohydrate was consumed immediately after exercise or two hours after exercise.



*(Ivy et al, 1988)*



# GENERAL GUIDELINES

- **begin exercise** in well-hydrated condition.
- calculate sweat loss, avoid excessive fluid intake
- replace fluid loss **between competition sessions**
- drink regularly to maintain gastric vol. & emptying



# HOW MUCH TO DRINK for DEHYDRATION ?

🍷 vol. equal to sweat losses → 50-70% rehydration

🍷 150% replacement → ↑ rates , quantity fluid emptying, & ↑ net fluid restoration (68% vs. 48%)

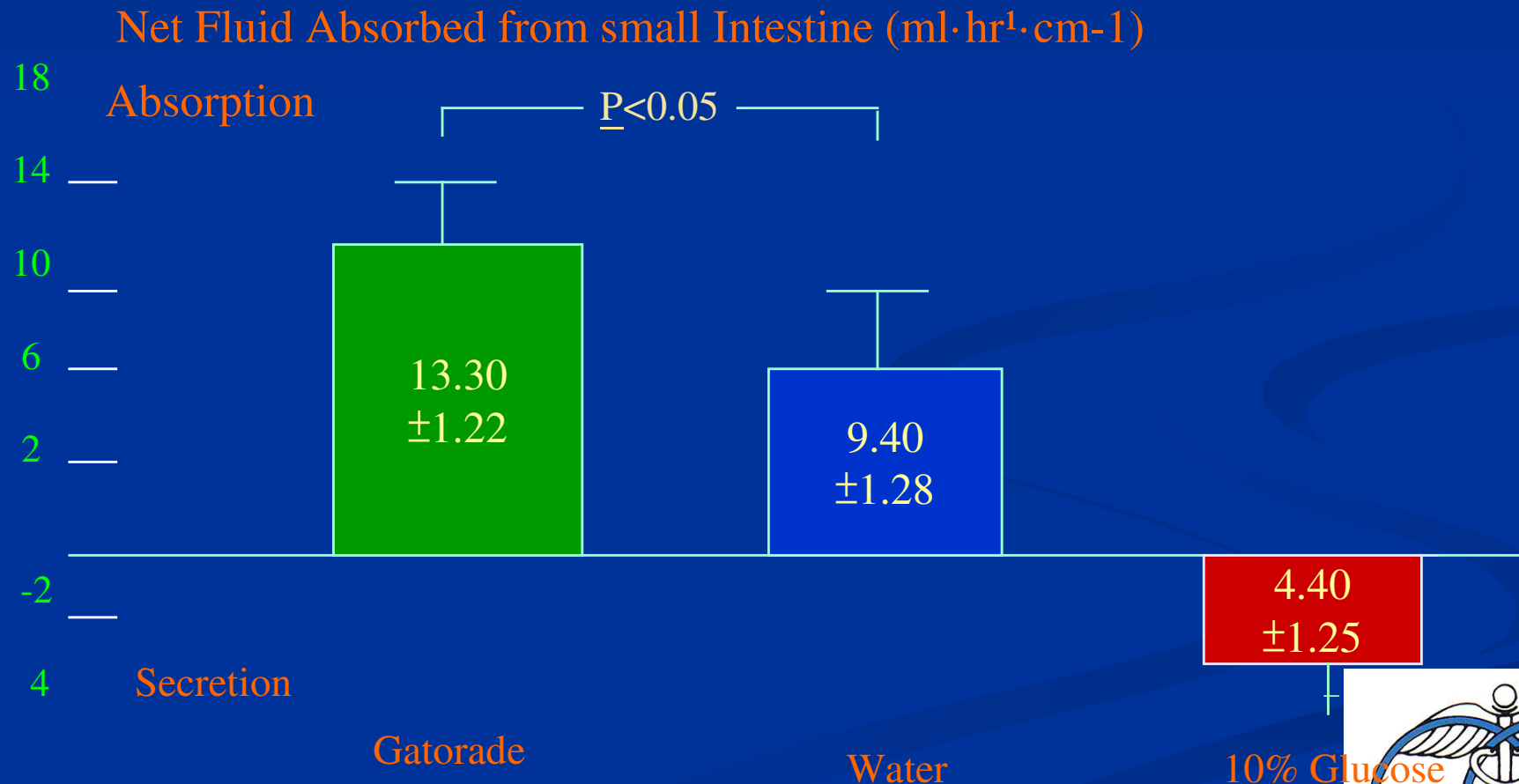


# GUIDELINES FOR SPORT DRINKS

- ↗ Mix: glucose, sucrose, fructose, malto-dextrin (glucose polymers)
- ↗ Na: promote fluid retention, maintain osmotic drive to drink, prevent hyponatremia.  
Higher sodium (61mmol/L vs. 23mmol/L)  
0.5 tsp salt = 1150mg sodium = 50 mmol/L
- ↗ cool (4.4-10°C), palatable, different flavor, readily accessible



# ***SPORTS DRINKS ABSORBED FASTER THAN WATER***



Adopted from: Gisolfi et al.<sup>3</sup>



# >1小時或間歇性比賽的飲食指引

American College of Sports Medicine: Nutrition and athletic performance. J Am Diet Assoc. 2000

	水份	碳水化合物
運動前數日	保持體內水份充足	
運動前餐飲 (2小時前+)	400-600ml	1- 4克 / kg (最少70克)
比賽前10-20分鐘	250-500ml (8-16安士)	含碳水化合物
比賽期間	每15-20分鐘150-350毫升(450-1400mL/hr)	0.5-1.0克 / kg / hour (30-60克/ hour)
比賽完畢立刻進食	液體, 糖份, 鈉質, 蛋白質飲食	1.5克/kg首30分鐘; 2小時後再重覆2-3 次
賽後24小時內	相等150-200%體重流失份量(450-675mL/0.5kg )	每公斤體重7-10克



# Case study:

- a runner ( Weight 150 lb. 68kg ) runs 3 hours daily. Before and after training, weigh-in lost 2 lbs.



**During exercise(500-1000mL per hr); 30-60g per hr**

**After exercise (repeat 2 hrs) 1-1.5g/kg- 70g**

**Daily: CARB 7-10g/kg(476g-680g) FLUID 32- 43mL/kg (2176mL)**

6:00am Breakfast:	CHO(g)	mL	Afternoon Snacks:	CHOg	mL
2 sl. bread+ 1 tbsp honey	25+17	+ fluid	2 pc. Granola bar	58	
Sweet soymilk 250mL	12	250	1 cup soymilk	12	250
7:30-10:30am Run 3 hrs (500-1000mL 6% drink)  (within 2 hrs & repeat)	60	1000	Ice cream 1/2 cup	16	
1 banana +2pkg cracker +500mL sports drink	28 + 20 +30= 78	500	Evening Snack:		
			2 canned peaches	24	
			1 cups soymilk	12	250
12:00 Lunch/Dinner- each			<b>TOTAL:</b>		
2 bowls rice (200g each) x 2	112 + 112		<b>607g CHO</b>		
1 cup green vegetables x2	10 + 10		<b>3250mL</b>		
1pc. Apple + 1 pc.banana	21 + 28				
soup/water 500mL		500+500			



食物成份表:

<http://www.health.gov/dietaryguidelines/dga2005/document/html/appendixB.htm>

香港中央健康教育組

[http://www.chcu.gov.hk/b5/info/exercise\\_04.htm](http://www.chcu.gov.hk/b5/info/exercise_04.htm)



# PROTEIN NEEDS IN EXERCISE

Increase protein needs due to :

1. repair exercise-induced damage to muscle fibers
2. as energy source
3. support gains in lean tissue mass
4. ↑ protein loss in urine & sweat



# Estimated protein requirement for athletes

Population	Protein requirement g/kg/d
Sedentary, recreational endurance	0.80 – 1.0
Elite male endurance	1.6 ( <b>1.2-1.4</b> )
Moderate-intensity endurance	1.2
Football, power sports	1.4 – 1.7
Resistance (early training)	1.5 – 1.7 ( <b>1.6-1.7</b> )
Resistance (steady state)	1.0 – 1.2
Female athletes	~15% lower than male

Tarnopolsky 1999

\* American College of Sports Medicine



# Calculation of Protein Requirement

70 kg athlete

■ 1.7g / kg

= 119 g protein / day



# Sample 1-Day Food Intake of An Athlete

		Protein (g)
<b>Breakfast</b>		
2 fried eggs		12.3
1 slice ham		7.0
2 slice bread		8.0
1 glass milk		8.0
<b>Lunch &amp; Dinner</b>		
2 bowls rice	12.4	
5 oz. Fish/meat	35.0	
1 cup vegetables	5.0	
1 fruit	2.0	
	<hr/> 54.2x2	108
<b>Snack:</b>		
tuna fish sandwich		22.0
1 glass milk		8.0
		<hr/> 173.7



# EXCESS PROTEIN INTAKE

- body protein synthesis plateau at around 1.4g/kg/d
- intake above requirement is oxidized for energy
- no sig. diff. in strength/muscle mass ↑ between 1.35g /kg and 2.6g /kg (Lemon)
- may jeopardize CHO intake
- ↑ fluid requirements



# Supplements for Endurance Events

- Caffeine
  - Stimulant
  - May conserve glycogen to a small extent in endurance events
- Side effects
  - Diuretic, increased susceptibility to heat illness
  - Nervousness, insomnia



# Caffeine & Exercise

- ♠ ergogenic :  
**prolonged** (>30 min) **moderate intensity**  
(75-80%)  $\text{VO}_2\text{max}$
- ♠ not consistently for short & strength  
exercise
- ♠ optimal dose 5-6 mg/kg (250-500mg)
- ♠ 300mg (2 cups of strong coffee) 1-2 hours  
before exercise
- ♠ trial in training to check effectiveness,  
safety & urine status



# CAFFINE CONTENT OF FODS (mg)

*7-up, Sprite, Fresca*

*0*

*Coca-cola*

*45*

*Cocoa mix powder – 15-20 mL (3-4 tsp)*

*5*

*Coffee, Instant powder – 5 mL (1 tsp)*

*57*

*Coffee, drip method, 6 fl oz*

*138*

*Cold remedies, 1 tablet*

*15-30*

*Chocolate flavour mix – 10-15 mL  
(2-3 tsp powder)*

*8*

*Chocolate ice cream – 150 mL*



# Caffeine & Doping

- 1984 IOC listed as restricted substance
- single urine sample post-event  $<12$  ug/mL
- urine caffeine is 1-5% of ingested caffeine
- ergogenic dose 5-6 mg/kg usually produce –  
ve urine test
- higher dose (e.g. 9mg/kg) may exhibit ‘illegal’  
urinary caffeine conc., no additional  
performance advantage



# Evaluation & Practice

- sort supplements into three groups:
  1. those that work,
  2. those that don't work
  3. those we are not sure about.
- Practice only **scientifically proven, evidence-based medicine** supported by solid data
- is safe, effective & efficient.



# Nutrition Web Sites

- [www.eatright.org](http://www.eatright.org)
- [www.dietitian.ca](http://www.dietitian.ca)
- [quackwatch.org](http://quackwatch.org)

## Office of Dietary Supplements

<http://ods.od.nih.gov/>

