ActivFit Physiotherapy
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Adequate Nutrition for Athletes

KISS - Keep It SSimple! Note even what is even in a 'musette' for a Tour de France cyclist or elite triathletes' BentoBox – often easily digestable and tasty normal foods, a mix of carb and electrolyte drinks, gels, cereal and fruit bars, odd Panini, tart, rice balls, defizzed coke, sweet and salty taste to line and calm the stomach and mind!

Your Daily Diet
Carbohydrates 50% (vegetables, fruit, grains)
Fibre, Vitamins and Minerals (fruit and vegetables) 25%
Protein (meats, nuts, dairy) 20%
Fats and Sweets 5%

At rest an athlete will burn;

Sleeping	64 cal/hr
Eating	140 cal/hr
Reading	75 cal/hr
Heavy mental activity	110 cal/hr

1 calorie = 4 kilojoules, 1gram carbs=4 calorie

Carbohydrates: 1 gram = 4 calories (16kj). Fat: **1 gram** = 9 **calories**. Protein: **1 gram** = 4 **calories** Alcohol: **1 gram** = 7 **calories**

A simple equation is an athlete burns; 1gram of carb per 1kg weight per 1 hour of endurance exercise (1g/kg/hr). A well trained athlete probably has enough stored energy to sustain up to 2 hrs of moderately intense exercise

Elite athletes will burn 600-900 cal per hour during intense endurance exercise, up to 6-8000 cal per day. However, your body can only process up to 250-300 cal per hour of ingested food whilst cycling and dealing with the more immediate and important job of providing blood, oxygen and energy to your working muscles, and dispersing heat to your skin. Your GIT struggles even more under running stresses. Too much intake sends it into a spin and the demands of exercise are challenged by the stress you have put onto your GIT – enough to make you feel sick!! Thus you have to rely primarily on muscle, blood and liver supplies of glucose, fat stores and muscle proteins as a last resort to get you through your Ironman. Always in that order as sugars / glucose have a primary energy source role, whereas fats have more functional roles such as lining nerves, lining cells, protecting body parts and proteins are muscles which you can't afford to break down too much!

Sucrose (sugar) is a disaccharide combination of monosaccharide glucose and fructose
1 can of coke (340ml / 12oz) = 40g sugar = 10 teaspoons sugar = 140 calories = 1 340ml glass of fruit juice

Simple carbohydrates (starch or sugar) are broken down into monosaccharides and absorbed as glucose (80%), fructose and galatose (20%), and converted to glucose within 2 hours of consumption causing a rise in blood glucose levels (BGL). Muscle contractions lead to a cells sensitivity to insulin. Insulin stimulates cells to take up blood glucose. Simple carbohydrates generally have a high glycaemic index and should be used sparingly to avoid insulin spikes, but are particularly useful for energy supplementation during and after exercise (sports drinks).

Complex carbohydrates (polysaccharides such as maltodextrose and glucose polymers) with low glycaemic index should make up 60% of your energy needs, (outside of immediate training and competitive needs).

Protein should provide 10-20% of your calorie needs as well as help provide amino acids to build musculoskeletal system, (outside of immediate training and competitive needs)

A sedentary person needs to eat about 0.8g of protein per kg of body mass each day. Athletes, and people who want to build muscle, need about double this (1.2 – 1.7g of protein/kg of body mass). Most of us are eating 1.6-1.8g protein/kg of body mass per day.

There are two types of amino acid; essential, which our bodies cannot make and we must get in their original form from protein-rich food, and non-essential, which our bodies can make from other types of amino acid.

Both types of amino acid ultimately come from our food. When we eat protein – such as meat, fish, pulses or eggs – our digestive system breaks it down into amino acids, which our bodies can use for a range of functions, including muscle building.

The best time to send amino acids to the muscles, if you want to build them up, is after a work-out once you have rehydrated and recovered. But for optimal effect, try to consume equal amounts of protein and carbs at that time. Carbohydrates increase insulin levels and that actually helps the muscles take in the amino acids they need to build new muscle.

Such as the following snacks after a workout:

- Two glasses of low-fat milk
- A lean meat sandwich like a turkey roll
- Smoothie of low-fat milk, yoghurt and banana
- Tuna with pasta

The timing of meals is important, spread your protein over the day, so you have three main meals and two or three snacks [containing some protein]. Often men, in particular, have all their protein at one meal.

Spreading protein intake out will optimize amino acid levels in the blood and promote muscle repair and growth.

Fats are important and should provide 25% of your calorie needs and provide fat soluble vitamins, (outside of immediate training and competitive needs). Saturated fats are solid at room temperature such as in meats and dairy products. Poly-unsaturated fats are semi solid and mono-unsaturated fats are liquid at room temperature, such as olive oils – these fats are the best for your energy needs and less detrimental to your body if consumed to excess. Fat metabolism has a byproduct of ketones which are toxic in high concentrations and therefore should supplement primary carbohydrate metabolism.

Other Compounds
Intense exercise may produce increased **free radical levels** (molecules missing an electron), thus fruit and vegetables **high in antioxidants** such as fat soluble vitamin E (RDA 15UI), water soluble vitamin C (RDA 60mg) and beta-carotene should be a focus in your food intake. Glucosamine (1500mg) and chondroitin (500mg) daily may provide relief from degenerative cartilage joint pain.

Hydration

Water
We are 80% water. All our systems require a constant content of water to operate efficiently, during exercise particularly transporting nutrients in the bloodstream, regulating body temperature, maintaining proper digestion. Fluid absorption occurs in the small intestine (the top one). An inactive 75kg person in mild climates requires 2.5 litres of water per day. 15% of that water comes as a metabolic by-product. 80% of the balance will typically be from drinking, the rest from foods. However, consider the small intestine has to also deal with 6-7 litres of fluid secretions per day from the saliva, stomach, pancreas and liver, and can only hold about 150ml at any one time. Sodium (Na+) in the intestine wall cells create a passive absorption pump that draws water into the body – you can't force fluid in! You only absorb fluid when you need it!! Otherwise it will rest in the stomach sloshing around, enough to make you feel nauseous!

Dehydration of 5% can decrease work capacity by 10% up to 30%. This means for a 75kg person a negative fluid balance of 3.5 litres (equivalent weight loss 3.5kg).

The sensation of thirst is complex. Thirst is a subjective perception in the brain hypothalamus stimulated by inputs of receptors measuring blood pressure, blood volume, electrolyte osmolarity and hormonal and nervous inputs. Probably drinking when you feel thirsty is still a logical and physiologically reactive behavior, as a trained athlete probably drinks in advance

anyway and we have become so conditioned to taking in fluid. Have a look at Tim Noakes's scientific work as a reference.

Electrolytes
Electrolytes are essential for all body cell functions and to sustain exercise performance. The food pyramid provides adequate electrolyte levels for narmal activity. In exercise carbs and electrolytes are needed in varying amounts depending on the intensity, duration, and environmental stresses. Electrolytes co-transport into the GIT with glucose and amino acids, so a carb electrolyte drink is a good idea.

Note the relative amounts of electrolytes in blood, sweat, seawater and carb/electrolyte drinks in the appendix. A saline drip (Hartmanns solution) used in hospitals approximates blood electrolyte concentrations. Per litre; 3800mg Chlorides (Cl-), 3000mg Sodium (Na+) 195mg Potassium (Ka+) and 90mg Calcium (Ca+). There is an ionic balance between the positive (+) ions and negative (-) ions that keeps all the cells in the body (muscles and nerves) balanced.

Sweat is the primary water loss during exercise. Electrolytes are also lost. Amounts of electrolytes vary somewhat between individuals. Sweat rates can be as high as 2 litres/hr of exercise

Sweat per Litre

Na+	1,150mg	50mm/l range 500-2200mg/l
K+	230mg	4.8mm/l
Ca	20mg	1.3mm/l
Mg	50mg	0.5mm/l
Cl-	1,480mg	46mm/l poolwater 0.5mm/l

In intense endurance exercise in hot humid conditions fluid intake demands can be enormous – up to 16 litre over Kona Ironman (KR, 2013) which is over 1.2 l/hr, about as much as the GIT could maximally absorb. Dehydration by 2% starts to impair performance (~ 1litre). This could be measured by a 1kg loss of body weight.

Heat Stress

Heat illness can occur with higher levels of dehydration and convective (radiant) and conductive (metabolic) heat load.
Internal metabolic process at rest generate approx 100watts, and hard exercise produces up to 1000 watts of power that result in heat production. Evaporation of sweat cools the body, and rate and therefore effectiveness of evaporation is related to;

- Ambient temperature
- Air movement across sweat

Prevent with loose wicking clothing and protect from direct heat.
White clothes reflect heat, black clothes conduct heat. In hot sunny conditions a white top and peaked hat to reflect heat and black shorts to draw heat from working leg muscles is ideal.

Avoid more than 1-2 cups of coffee as the caffeine, whilst being a good stimulant has a small diuretic effect and will decrease blood volume, water losses due to caffeine is 1.17 ml/mg caffeine at higher than 200mg of caffeine (there is at least 150mg of caffeine in 150ml of brewed coffee). Sodium is also excreted at a higher rate. Water loss is estimated at 10ml/g of alcohol , 1 standard drink is 10g of alcohol.

After 1 hour, less in heat, you need electrolyte replacement as well, particularly potassium, sodium and magnesium. Carbohydrate concentration in fluid should also be about 9% for this duration, although athletes can suffer gastric discomfort if too much water and carbs are consumed. Events lasting beyond 2 hrs in heat need earlier electrolyte intake. Practice before the event during training!!

During Exercise

Thus we need to have water, energy and electrolytes at the correct rate and concentration to match our needs or suffer performance loss or nausea. You need water to work with carbs and electrolytes. By far the energy requirements have to be met by our bodies own supplies, supplementation is limited by our ability to absorb energy and fluid. A mix of fluid, simple and complex carbs and electrolytes (sports drinks, gels and bars), and some yummy food (ie bananas) is the ticket. The art and science is having the correct amounts of each of these, as conditions on the day will obviously vary a lot and you need a game plan for each event. This will need you to do your sums!!

In drinks, simple carbs need to be at a solution concentration of 6-8% to match your body's osmolality of 280-300m Osm. In drinks complex carbs can be mixed to 15-18% to match your body's osmolality but need more conversion work in your liver to be used at muscle level. Even small amounts of protein (amino acids) can be consumed to provide energy when glucose becomes scarce.

Pre-exercise
Consume **up to** but generally not exceeding 25-50g of carbs (=100-200cal = 400-800kj) 1-2 hours before exercise with 250ml of water

During hard and prolonged moderate exercise
Consume **up to** 25g of carbs (100cal/400kj) each 45 mins of exercise (1 gel pack). Drink up to 125-250ml of fluid (water of diluted sports drink) for every 15 mins of exercise, depending on intensity of exercise, environment and your thirst. This is often individual to suit your gastrointestinal system!!!

Post exercise
Consume 25-50g carbs immediately post run – food and drink. Drink 2 glasses of water for every ½ kilo of weight lost. Repeat 25-50g carbs 30 mins after exercise. 1-2 hours after exercise consume a meal of at least 100g carbs and 40g protein, and repeat again 2 hrs later.

Cramps during sports are often thought to be due to;
Dehydration
Electrolyte depletion (mineral supplements esp. magnesium (Epsom Salts)
Muscle trauma and neural sensitization

Try quinine (think Schweppes tonic / bitter lemon)

"**stitches"** in the abdominal region may be due to excessive and sudden increases in fluid volume that mechanically overloads and irritates the supporting abdominal organ smooth muscle and connective tissue, causing irritation and spasm. Stitches can usually be run out.

APPENDIX

Electrolyte	Typical daily intake (mg)	Typical absorption efficiency	Typical sweat losses per litre (mg)	Loss in litres of sweat to be deficient	Deficiency possible by sweating
*Sodium	4000	>90%	1500-1700	4	Yes
Potassium	2700	>90%	150	16	No
Calcium	500	30%	28	5	Possible
Magnesium	300	10-70%	8.3-14.2	15	No

Electrolyte Carbohydrate Rehydration Drinks

	ScInSport		Endura	Dextro	Shotz	Gatorade	Powerade
serve	40g scoop		2x20g scoop	2x20g scoop	tablet		237ml
ml	500ml		400ml	500ml	500ml	350ml	
Ca	22mg	1mm/l	70mg		31mg	0	
Mg	5mg	0.4mm/l	250mg	56mg	20mg	0	
K+	60mg	3.1mm/l	200mg	300mg		45mg	24mg
Na	200mg	20mm/l	120mg	344mg	400mg	150mg	100mg
Energy	800kj (191cal)		700kj	631kj	0kj VitC Ribof	336kj	80cal
carbs	36g			34.7g		21g	19g
%carbs/ electro	92/2						

	Staminade		San Pellegrino
serve	40g scoop		volcanic origin
ml	250ml		250ml
Ca	0	0mm/l	44mg
Mg	25mg	1mm/l	15mg
K+	160mg	6mm/l	1mg
Na	120mg	12mm/l	10mg
Energy	800kj (191cal)		0 kj Bicarbs 50mg/l
carbs	72g/l	7.2%	Chloride 15mg/ll

Element	Blood mg/l	Seawater mg/l	Sweat mg/l
Sodium	3220	10800	1700
Chlorine	3650	19400	1900
Potassium	200	392	150
Calcium	50	411	28
Magnesium	27	1290	9
Phosphorus	36	0.09	
Iron	1	0.004	
Copper	1	0.001	

Zinc	1.1	0.005	
Chromium	1.1	0.0002	
Bromine	4	67	
Fluorine	0.1	1.3	
Boron	1	5	
Selenium	0.9	0.0001	

Table 1. The element composition of blood and sea water (in mg per liter) (after Batten 1997, p. 24).