

Carbohydrate - The Facts

The term carbohydrate is synonymous with sports nutrition. The immediate impact of carbohydrate intake (or its absence) on daily training and competition performance has been widely researched and documented. Recent media attention directed at public health issues, however, has suggested low carbohydrate diets are beneficial for weight loss and other health benefits. In addition, different approaches to fuelling sports performance become an item of discussion among scientists or the locker room from time to time. It is no wonder many recreational and elite athletes remain unsure of the amount of carbohydrate they need to support their training and competition to optimise performance while achieving a weight and body composition that is appropriate for their sport.

Why is carbohydrate important?

Carbohydrate is a key fuel source for exercise, especially during prolonged continuous or high-intensity exercise. The body stores carbohydrate as glycogen in the muscles and liver, however its storage capacity is limited. When these carbohydrate stores are inadequate to meet the fuel needs of an athlete's training program, the results include fatigue (staleness), reduced ability to train hard, impaired competition performance, and a reduction in immune system function. For these reasons, active people are encouraged to plan carbohydrate intake around key training sessions and over the whole day according to their carbohydrate requirements as an exercise fuel.

How much carbohydrate do athletes need?

Carbohydrate requirements are dependent on the fuel needs of the athlete's training and competition program, with parameters including the frequency, duration and intensity of the activity. Since activity levels change from day to day, carbohydrate intake should fluctuate to reflect this. On high activity days, carbohydrate intake should be increased to match the increase in activity. This will help to maximise the outcomes from the training sessions and promote recovery between sessions. Alternatively, on low or no training days, carbohydrate intake should be reduced to reflect the decreased training load. . A clever way to adjust carbohydrate intake from day to day is to schedule carbohydrate-rich food choices at meals or snacks around the important training sessions. As the sessions increase in their carbohydrate demands, so should the athlete increase their carbohydrate intake before, during or after exercise. Not only does this strategy help the athlete to keep track of their total carbohydrate needs, but it ensures that the timing of the carbohydrate is best suited to fuel the session.

The following table provides some general targets for daily carbohydrate intake goals across a range of activity levels. Each athlete should fine-tune their carbohydrate intake with individual consideration of total energy (kilojoule) needs, specific training demands, and feedback from training performance. Additional guidelines outline the specific ways in which carbohydrate intake can be timed to enhance carbohydrate availability for key sessions.

Daily Needs for Fuel and Recovery:

	Situation	Carbohydrate Targets
Light	Low-intensity or skill-based activities	3-5 g per kg BM
Moderate	Moderate exercise programme (~1 hr / day)	5-7g per kg BM
High	Endurance programme (i.e. moderate-to-high intensity exercise of 1-3 hr / day)	6-10g per kg BM
Very High	Extreme commitment (i.e. moderate-to-high intensity exercise of >4-5 hr / day)	8-12g per kg BM

BM = Body Mass

Acute Fuelling Strategies:

	Situation	Carbohydrate Targets
General fuelling up	Preparation for events < 90 min exercise	7-12g/kg per 24 hr as for daily fuel needs
Carbohydrate loading	Preparation for events >90 min of	36-48 hours of 10-12 g/kg BM per

	sustained/intermittent exercise	24 hour
Pre-event fuelling	Before exercise > 60 min	1-4 g/kg BM (consumed 1-4 hr pre-competition)
During brief exercise	<45min	Not required
During sustained high-intensity exercise	45-75 min	Small amounts including mouth rinse
During endurance exercise including "stop and start" sports	1-2.5 hours	30-60g/hr
During ultra-endurance exercise	>2.5-3 hours	Up to 90 g/hr using multiple transportable carbohydrates (glucose:fructose mix)
Speedy refuelling	<8 hr recovery between two fuel demanding sessions	1-1.2 g/kg BM every hour for first 4 hr then resume daily fuel needs

Which foods are good sources of carbohydrate?

Many everyday foods and fluids contain carbohydrate, but have different features. For this reason, carbohydrate-containing foods and fluids are often divided into categories for comparison. Previously, carbohydrates were classified as either simple or complex, and more recently, the terms low and high glycemic index (GI) are being used (more on GI below). From a sports nutrition point of view, it is more helpful to classify carbohydrates as nutrient-dense, energy-dense or high-fat.

Category	Description	Examples	Use for athletes
Nutrient-dense carbohydrate	Foods and fluids that are rich sources of other nutrients including protein, vitamins, minerals, fibre and antioxidants in addition to carbohydrate	Breads and cereals, grains (e.g. pasta, rice), fruit, starchy vegetables e.g. potato, corn), legumes and low-fat dairy products	Everyday food that should form the base of an athlete's diet. Helps to meet other nutrient targets.
Nutrient poor carbohydrate	Foods and fluids that contain carbohydrate but minimal or no other nutrients	Soft drink, energy drinks, lollies, carbohydrate gels, sports drink and cordial.	Shouldn't be a major part of the everyday diet but may provide a compact carbohydrate source around training.
High-fat carbohydrate	Foods that contain carbohydrate but are high in fat	Pastries, cakes, chips (hot and crisps) and chocolate	'Sometimes' foods best not consumed around training sessions

Refer to the [carbohydrate ready reckoner](#) for foods that provide 50g carbohydrate each

What about Glycaemic Index?

Glycaemic Index (GI) is a ranking of how quickly carbohydrate foods raise blood glucose levels (BGLs) in the body following ingestion. High GI foods are rapidly digested and absorbed by the body and raise BGLs quickly. Low GI foods, on the other hand, are much slower to be digested and absorbed and result in more gradual rise in blood glucose levels. Refer to the official Glycemic Index website for more information (<http://www.glycemicindex.com/>).

In sport, it is important to consider immediate requirements and what a whole food or snack can provide (such as protein, vitamins and minerals) rather than looking at only one component of any food. For example, higher GI foods can be useful immediately after exercise to promote a faster recovery of muscle glycogen stores. Daily requirements, based on physique and performance goals should also be considered when making such food choices.

When is carbohydrate important?

An individual's carbohydrate requirements before, during and after training or competition depend on a number of factors including:

- type, intensity, duration of exercise
- frequency of exercise or time available for recovery between sessions
- body composition goals
- environmental conditions
- training background
- performance goals for the session.

While the recommendations provided above considers the overall carbohydrate needs over the day, it is also important to consider the timing of carbohydrate around training and competition.

Carbohydrate ingestion before exercise should assist in topping up blood glucose levels as well as glycogen stores in the muscle and liver. This is especially important if the competition or training is undertaken first thing in the morning or if the event is high intensity or will continue beyond 90 mins in duration. Refer to [Carbohydrate Loading](#) and [Eating Before Exercise](#) fact sheets for further information.

The replacement of carbohydrate during prolonged exercise can benefit sports performance, both through effects on the muscle (reducing/delaying the decline in exercise intensity with time) and the brain/central nervous system (reducing/delaying the decline in concentration and mental skills, as well as reducing/delaying the decline in pacing strategies with time). Using specific training sessions to practice consuming specific carbohydrate foods is also important if it is intended to be consumed during a competition. Carbohydrate intake after exercise is essential for optimum recovery of glycogen stores. Often athletic performance is dependent upon the ability to recover from one session and do it all again in the next session. Incomplete or slow restoration of muscle glycogen stores between training sessions can lead to a reduced ability to train and a general feeling of fatigue. In competition, it may also reduce subsequent performances where efforts are repeated within or across days (such as in a tournament, a swim or athletics meet, or a rowing regatta). Refer to the [Recovery Nutrition](#) fact sheet for more detailed information.

In order to ensure your carbohydrate needs are met, and that you are achieving optimum performance, please see a sports dietitian who can tailor a nutrition program to help you achieve your goals.

Food Portions Providing 50 g of Carbohydrate

CEREAL	
Wheat biscuit cereal (e.g. Weet Bix)	60g (5 biscuits)
'Light' breakfast cereal (e.g. Cornflakes)	60 g (2 cups)
'Muesli' flake breakfast cereal	65 g (1-1.5 cups)
Toasted muesli	90 g (1 cup)
Porridge - made with milk	350 g (1.3 cups)
Porridge - made with water	550 g (2.5 cups)
Rolled oats	90 g (1 cup)
Bread	100 g (4 slices white or 3 thick wholegrain)
Bread rolls	110 g (1 large or 2 medium)
Pita and lebanese bread	100 g (2 pita)
Chapati	150 g (2.5)
English muffin	120 g (2 full muffins)
Crumpet	2.5
Muesli bar	2.5
Rice cakes	6 thick or 10 thin
Crispbreads and dry biscuits	6 large or 15 small

Fruit filled biscuits	5
Plain sweet biscuits	8-10
Cream filled/chocolate biscuits	6
Cakestyle muffin	115 g (1 large or 2 medium)
Pancakes	150 g (2 medium)
Scones	125 g (3 medium)
Iced fruit bun	105 g (1.5)
Croissant	149 g (1.5 large or 2 medium)
Rice, boiled	180g (1 cup)
Pasta or noodles, boiled	200 g (1.3 cups)
Canned spaghetti	440 g (large can)
FRUIT	
Fruit crumble	1 cup
Fruit packed in heavy syrup	280 g (1.3 cups)
Fruit stewed/canned in light syrup	520 g (2 cups)
Fresh fruit salad	500 g (2.5 cups)
Bananas	2 medium-large
Large fruit (mango, pear, grapefruit etc.)	2-3
Medium fruit (orange, apple etc.)	3-4
Small fruit (nectarine, apricot etc.)	12
Grapes	350 g (2 cups)
Melon	1,000 g (6 cups)
Strawberries	1,800 g (12 cups)
Sultanas and raisins	70 g (4 Tbsp)
Dried apricots	115 g (22 halves)
VEGETABLES	
Potatoes	350 g (1 very large or 3 medium)
Sweet potato	350 g (2.5 cups)
Corn	300 g (1.2 cups creamed corn or 2 cobs)
Green Beans	1,800 g (14 cups)
Baked beans	440 g (1 large can)
Lentils	400 g (2 cups)
Soy beans and kidney beans	400 g (2 cups)
Tomato puree	1 litre (4 cups)
Pumpkin and peas	700 g (5 cups)
DAIRY PRODUCTS	

Milk	1 litre
Flavoured milk	560 ml
Custard	300 g (1.3 cup or half 600 g carton)
'Diet' yoghurt and natural yoghurt	800 g (4 individual tubs)
Flavoured non-fat yoghurt	350 g (2 individual tubs)
Icecream	250 g (10 Tbsp)
Fromage frais	400 g (2 tubs)
Rice pudding/creamed rice	300 g (1.5 cups)
SUGARS and CONFECTIONERY	
Sugar	50 g
Jam	3 Tbsp
Syrups	4 Tbsp
Honey	3 Tbsp
Chocolate	80 g
Mars Bar and other 50-60 g bars	1.5 bars
Jubes and jelly babies	60 g
MIXED DISHES	
Pizza	200 g (medium - 1/4 thick or 1/3 thin)
Hamburgers	1.3 Big Macs
Lasagne	400 g serve
Fried rice	200 g (1.3 cups)
DRINKS	
Fruit juice - unsweetened	600 ml
Fruit juice - sweetened	500 ml
Cordial	800 ml
Soft drinks and flavored mineral water	500 ml
Fruit smoothie	250-300 ml
SPORTS FOODS	
Sports drink	700 ml
Carbohydrate loader supplement	250 ml
Liquid meal supplement	250-300 ml
Sports bar	1-1.5 bars
Sports gels	2 sachets
Glucose polymer powder	60 g

(Source: Peak Performance: training and nutritional strategies for sport J. Hawley and L. Burke. Sydney: Allen & Unwin, 1998).

