

Recovery strategies: Nutrition for optimal recovery

Nutrition is a key component in enhancing adaptations to training and optimising performance.

Recovery Strategies are sport and athlete specific.

- It depends on the intensity, duration and type of training undertaken as well as individual nutritional and performance goals.
- For individual advice, see a Performance/Sports Nutritionist.

Recovery begins after your last hard repetition or effort. It includes a range of nutrition-related processes:

1. Refuelling energy stores
2. Repair and synthesis of muscle cells
3. Rehydration/Refuelling

Refuelling

Your recovery snack/meal should vary in size depending on the length, intensity and type of training, your overall nutritional aims and how many sessions you are undertaking in a day.

Small, frequent meals and snacks allow you to meet your energy needs without the discomfort of over eating, particularly if you are training more than once a day.

Aim to have a carbohydrate (CHO) containing recovery snack/meal as soon as you can after your activity has finished (ideally within 30 mins) as the body uses nutrients more efficiently during this time. This is particularly important if you undertake prolonged/ high intensity training more than once a day.

When CHO needs are high due to the volume and intensity of training (e.g. endurance training), or you find it difficult to eat after exercise, go for compact forms of CHO e.g. low fibre choices of CHO-rich foods, sports drinks, milk shakes, fruit smoothies and liquid meal replacements.

For those with a restricted energy budget, manipulating snack/meal size, composition and timing can help you meet your nutritional goal.

Repair

Consume some protein within a post exercise recovery snack and/or meal to help repair muscle and improve muscle adaptations to training. (See Table 1 on next page)

Hydration

Try to drink regularly throughout the day.

After prolonged endurance and/or high intensity exercise, rehydration should be a priority as dehydration can have a negative effect on subsequent exercise sessions if not corrected before the next work out.

Alcohol can increase undesirable swelling to damaged tissues hindering repair processes. The advice is to avoid alcohol for at least 24 hours.

Other Tips

Be organised - have suitable foods and fluids available at your exercise venue.

Consuming suitable foods and fluid is more than adequate for optimal recovery from exercise (see suggestions in Table 1 on next page). Foods and fluids are preferable as they have a number of advantages compared to relying on commercial supplements.

TABLE 1:

Examples of recovery snacks/ meals which contain both carbohydrate and protein to aid your recovery

Low fat milkshake	Jacket potato with tuna sweet corn
Bowl of cereal with milk	Liquid meal replacement
Meat or fish filled roll	Scrambled/poached eggs and /or beans on toast
Low fat yoghurt and a banana	Crumpet with peanut butter
Chicken, veg and pasta salad	

Key Points

- The amount you will need to eat and drink for a recovery snack/meal will depend on the type, intensity, duration of exercise as well as your overall nutritional goals.
- Recovery snacks should contain some CHO, protein as well as some fluid.
- Aim to have a recovery snack/meal ASAP after training, especially if you are training later the same day.

Recovery from key training or competition sessions based on endurance or 'quality' work.

Please note, the information provided here is aimed at athletes who are undertaking endurance and/or high intensity training for over 90 minutes per day, where total energy requirements are elevated.

Guidelines for athletes that are training once per day

If an athlete has 24 hours or more recovery between sessions, then as long as total carbohydrate required to replete glycogen is achieved within the recovery period, the timing is less important.

Guidelines for athletes that are training twice per day

When there is less than eight hours between workouts or events that deplete glycogen stores (stores may be depleted when exercising for 60-90 minutes or more of high intensity work), the athlete should maximise effective recovery time by consuming a high carbohydrate (CHO) meal or snack as soon as possible (ideally within 30 minutes of completing each session). (See Table 1)

Effective refuelling should begin after the last hard effort in training.

CHO is the priority after prolonged aerobic exercise. Foods with a high glycaemic index in the immediate recovery stage are advised when recovery periods are short (Table 2). Recovery can then be continued with foods which release their energy more slowly in subsequent meals and snacks.

Aim for ~ 1.0 g of CHO per kg BM as soon as possible after endurance or high intensity exercise lasting over 60 minutes exercise (Table 2). The athlete should use this guide when they have 8 hours or less between training sessions or during competition or training when glycogen stores have been challenged. This will help to ensure speedy recovery of glycogen stores (post-exercise recovery) or to “top up” fuel stores prior to a workout (pre-exercise snack).

This post exercise recovery strategy should be repeated every 2 hours until normal meal patterns are resumed. If total body weight is an issue then a sports nutritionist should be consulted to ensure most appropriate snacks are chosen. Please see the Energy Budget section.

TABLE 2:

High Glycaemic Index Carbohydrate snacks that contain approximately 50g

Snacks for use when athletes have 8 hours or less between training sessions or during competition or training when glycogen stores have been challenged. These foods should be followed up with a meal or further snack within 2 hrs.

**700-800ml Sports Drink	1 large or 2 small fruit bun or scone with jam
**800ml High Juice	2 English Muffins with syrup, ham or honey
**500ml Fruit Juice, Soft Drink	Medium bowl of Cornflakes/ Weetabix/ Branflakes/ RiceCrispies
**60-70g jelly beans or jelly babies (approx. 10 sweets)	Ripe banana & a large tablespoon of raisins (30g)
**Jaffa cakes (x 5)	Large cup of thick veg soup & large bread roll
**2 Sports Gels (check label for total carbohydrate content)	**75g Turkish Delight (no chocolate cover)
2 slices toast/bread or a bagel with jam, honey or a banana	2 ½ slices of pre sliced malt loaf
250g (large) baked potato or mashed potato	3 oatcakes with jam
	2 cereal bars
	100g (1-2 large) pancakes with syrup, ham or honey

**Please remember if using very sugary foods for recovery on a regular basis then ensure extra care with dental hygiene.

Recovery snacks and meals should contribute towards a daily CHO intake of 7-10 g per kg BM if you are undertaking 3-4 hours of moderate to high intensity training a day. Total CHO requirements need to be individualised to each athlete's exercise program (intensity and duration) and energy budget so should vary on a daily basis. Athletes should be encouraged to seek advice from a sports nutritionist to assess the quantity and quality of carbohydrate required.

When CHO needs are high, and appetite is suppressed or gastric comfort is an issue, the athlete should focus on compact forms of CHO, including low-fibre choices of CHO-rich foods, sugar-rich foods, sports drinks, milk shakes, fruit smoothies and liquid meal replacements (Table 2). Small, frequent meals may assist the athlete to achieve high CHO intakes without the discomfort of overeating.

Large CHO intakes immediately post exercise can practically be difficult to achieve. Research has shown that the consumption of protein alongside a smaller amount of CHO (0.8g /Kg/BM) immediately in the post exercise meal or snack can result in similar muscle glycogen repletion rates compared to higher intake (1.0g/Kg/BM) of CHO alone (Beelen et al 2010, Van Loon et al, 2000 & Ivy et al, 2002).

So, as long as protein intakes are not so great as to displace CHO intake resulting in a reduction muscle glycogen resynthesis, a recovery snack or meal combining CHO and protein is suggested (Tables 1 and 3). The consumption of protein (10-20 g) within recovery snacks and meals helps to enhance the synthesis of new proteins underpinning adaptations to the workout, and contributes to any increase in protein requirements related to exercise.

Nutritious CHO foods and drinks contain other nutrients including vitamins and minerals that may be important in other post-exercise recovery processes. These nutrients are also important in the overall diet. Research has suggested that intake early of CHO after exercise could enhance other activities of repair and rebuilding, as well as the immune system.

For endurance athletes it may also be important that they have sufficient fat in their overall diets to replace intramuscular stores of fat.

Special comments for the athletes with a restricted energy budget

Since the athlete may have increased requirements for protein and micronutrients as a result of their exercise program, it is important that foods consumed as recovery snacks contribute to overall nutrient intake goals as well as immediate recovery needs.

Pre- or post-exercise recovery snacks should not contribute additional energy to a restricted energy budget.

When rapid recovery is required (i.e. when training twice or more in a day), the energy-restricted athlete should change the timing of their existing meal structure to allow for immediate intake after exercise sessions.

Where this is not practical, the athlete may be able to take a small snack from within their usual meal plan to consume immediately after training or as a pre-resistance training snack (for example, fruit and flavoured yoghurt usually consumed as a dessert with dinner), then consume the remainder of their meal at the usual time.

Nutrient-rich CHO foods and drinks (e.g. fruit, flavoured milk drinks and dairy foods, sandwiches with meat and salad fillings) are more valuable than lower nutrient choices (e.g. sweets, soft drink, bread with jam or honey).

To maximise the satiety value of meals and snacks, the energy-restricted athlete should also make use of foods which have:

- A high fibre content (e.g. fresh fruit rather than juice)
- A high volume/low energy density (e.g. salad fillings added to sandwiches)
- A low GI (e.g. rolled oat cereals rather than cornflakes)
- Protein in addition to carbohydrate (e.g. yoghurt with fruit, meat or cheese in sandwich)

Guidelines for low-fat eating are also important.

The energy-restricted athlete is unlikely to have a sufficient energy budget to cover the guidelines for optimal intakes of some macronutrients (e.g. CHO for optimal daily glycogen synthesis).

Specialised dietary advice from a sports nutritionist is valuable in ensuring that the athlete has reasonable goals related to their energy requirements and physique goals, and is able to organise meal plans to optimise their nutrient intake within this energy budget. It may be valuable to cycle between nutritional goals – i.e. restrict energy during periods suitable for loss of body fat, while liberalising energy and CHO intake to promote better fuelling and recovery for key sessions or competition.

Recovery from key resistance training workouts - Repair

Guidelines for pre-exercise recovery strategies (for endurance athletes)

The athlete should consume a source of carbohydrate and protein before a resistance work out as this has been shown to promote recovery after the workout.

For athletes who are not on an energy budget, aim to consume at least 40g CHO & 10-20g of protein (6 - 9 g of essential amino acids) prior to the session. This has been shown to promote enhanced protein recovery after the workout (Tipon et al, 2000).

Guidelines for post-exercise recovery strategies

The athlete should repeat the pre exercise recovery strategy above & consume CHO and protein within 30-60mins after the session (CHO consumed at the same time may enhance the protein response and promote rapid recovery of muscle glycogen stores).

Suggestions of protein/CHO snacks and light meals that can be consumed to promote recovery until normal meal patterns are resumed are shown in Tables 1 and 3.

Table 3 (on next page) provides suggestions of snacks/light meals containing between 40-70g of carbohydrate to ensure speedy recovery of glycogen stores (post-exercise recovery) or to "top up" fuel stores prior to a workout (pre-exercise snack). They also provide protein (10-20g) which when taken in conjunction with CHO (aim for 0.8-1g kg BM) in the post exercise recovery period will help meet goals for enhanced net protein synthesis.

The athlete's daily diet should provide adequate total energy and protein intake to meet their goals for gain of muscle mass. In terms of daily protein requirements, the maximum intake for athletes undertaking endurance exercise and/or high intensity resistance training, is likely to be ~ 1.5-2.0 g per kg BM spread throughout the day.

Research to date does not support intakes above this level, and intakes greater than this are not likely to confer any additional benefits for muscle gain but are likely to displace other food groups and nutrients from the diet.

For the majority of athletes, consuming greater than 20g protein at the one time is not required as there is a limit to how much protein can be processed and utilised efficiently by the body at one time. It is better to spread out protein intake throughout the day (Phillips et al 2012).

Protein intake in the recovery period must fit in with the athletes overall energy and protein requirement.

For example, a 50kg athlete with a protein requirement of 75g per day (1.5g/kg BM) having 20 g of protein as part of their recovery snack contributes a much greater proportion of overall intake than that of a 75kg athlete (total protein at 1.5g/kg BM = 112g protein). As such, lighter athletes may have less protein in their recovery snack so protein intake can still be spread out more evenly during the day.

Those who are on an energy budget please refer to the section on energy budget.

Table 3.

Foods suitable before & after strength training when an athlete is looking to enhance net protein synthesis.

These are also suitable examples for athletes who have undertaken prolonged and high intensity exercise which causes protein breakdown.

Food	Portion	Carbohydrate (g)	Protein (g)
Liquid Meal Replacement & fresh or dried fruit	250ml & portion of fruit	50g	14
Liquid Meal Replacement & a banana	250ml & medium banana	58g	15
Friji Fresh Thick Flavoured Milk Shake	500ml	57	17.5
Yop Drinking Yoghurt	400ml	57	18
Large Bowl of cereal with Semi skim milk	80g cereal 250ml milk	66	16
Tuna (or meat/cheese) Sandwich & Low fat milk	2 slices of bread and 300ml milk	68	35
Lucozade Recovery Drink	2 sachets in 500ml water	54	18
SIS Rego Drink	100g in 1000ml water	55	27
Nesquik	30g(6 tsps.) with 400ml semi skim milk	50	14
Nesquik made up and a Banana	400ml & medium banana	73	15

Full/semi/skimmed milk & a banana	500ml & medium banana	45	17
Egg (scrambled/poached or boiled) on toast	2 eggs & 2 x toast	40	18
Creamed rice pudding	250g pot	40	10
Baked beans on toast	220g baked beans & 2 x toast	55	15
Baked potato and cottage cheese and glass of milk	Large potato & 1 tbsp. cottage cheese, 300ml milk	70	17
Crumpets with peanut butter and glass of milk	Crumpets x 2 thick spread of peanut butter, 300ml milk	60	17
Fruit salad/tinned fruit and low fat fruit yoghurt	200g fruit and 200g yoghurt	50	10

It should be noted that when muscle hypertrophy (growth) is main goal then it is critical that an adequate overall energy intake is consumed (rather than a sole focus on increasing protein intake) for an anabolic response on a day to day basis.

When strength-training sessions are prolonged, or undertaken in conjunction with an aerobic exercise session, the athlete should undertake strategies to promote rapid recovery of depleted muscle glycogen stores. Athletes should aim to consume 0.8-1.0 g CHO per kg BM (40-100g CHO) and 10 - 20 grams of high quality protein. These issues are discussed in more detail in Section: Recovery from key training or competition sessions based on endurance or 'quality' work. For those on an energy budget please refer to this section.

The athlete should avoid alcohol during the 24 hours following a strength workout, since there is evidence that alcohol impairs protein synthesis. For more information see the section below on alcohol.

Hydration

Please note that this advice is aimed at athletes undertaking prolonged and/or high intensity exercise.

- Fluid losses can be worked out by weighing yourself in and out of key training sessions.
- After prolonged and/or high intensity exercise aim to consume a volume equal to 1.5 x fluid lost over the subsequent 2-4 hours after exercise to fully restore fluid balance.

FLUID LOSS (g/ml) =	Weight Pre Exercise (g)	MINUS	Weight Post Exercise (g) + (Any Fluid Consumed During Exercise (ml) - Urine Losses (g)
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It is important to note that athletes that are dehydrated will be compromised in their ability to refuel. This should be taken into consideration when planning a recovery strategy to ensure rehydration requirements are also addressed.

Whilst hydration is important in the recovery process consuming fluids in excess of the recommendations (particularly if that fluid is water) can be detrimental to your health.

When undertaking prolonged and/or high intensity exercise, dehydration can have a negative effect on subsequent exercise sessions if not corrected before the next workout. Moderate to severe fluid deficits can also have an effect on recovery, since they are associated with an increased risk of gastro-intestinal upset and discomfort, potentially limiting the athlete's ability to ingest substantial amounts of nutrients.

Therefore, when undertaking prolonged exercise, rehydration should be considered a priority, especially where gastrointestinal function is compromised.

Early recovery strategies may need to focus on rehydration goals (e.g. consuming dilute fluids) before the athlete is able to consume significant amounts of the macronutrients needed for refuelling and protein recovery.

The athlete who has undertaken an endurance training session should not rely on thirst or opportunity to dictate fluid intake to reverse a situation of dehydration. A random approach may be acceptable when fluid deficits are 1 L or less, but when fluid losses are greater, an organised schedule is required.

It is important to ensure that an adequate supply of palatable drinks is available. This may be challenging and forward planning is the key to success.

In situations where fluid intake needs to be encouraged if fluid losses have been high/hard exercise in the heat, the provision of flavoured drinks is a useful strategy. Since most people prefer sweet tasting drinks, they are likely to increase their voluntary intake of such fluids.

Keeping drinks at a refreshing temperature is also known to encourage greater intake. Cool drinks (10-15 °C) are preferred in most situations. Very cold fluids (0-5 °C) may seem ideal when the environment or the athlete is hot; however it is often challenging to drink them quickly or in large volumes.

Carbohydrate-containing drinks are also useful in assisting with refuelling goals and allow the athlete to tackle a number of recovery goals simultaneously.

In the situation of moderate-large fluid deficits (e.g. > 2 L), sodium replacement will assist the retention of ingested fluids, by minimising urine losses. Options include sports drinks, commercial Oral Rehydration Solutions, salty foods or salt added to post-exercise meals. A high sodium beverage such as an Oral Hydration Solution (50-90 mmol/L or 2-5 g of salt per L), or salt added to post-exercise meals along with substantial fluid intake should guarantee that sufficient fluid and sodium have been replaced.

Electrolyte-containing drinks (e.g. Sports drinks containing electrolytes) are the preferred option for recovery when undertaking prolonged and/or high intensity exercise in hot or humid environments or for heavy sweaters as they replace the electrolytes lost in sweat – water cannot do this.

Dietary strategies that minimise urine losses during the rehydration period not only enhance the speed of regaining fluid balance, but help the athlete to achieve better quality rest or sleep without frequent disturbances related to having to get up to urinate.

Athletes are often educated that the production of “copious amounts of clear urine” is a desirable state and a sign of good hydration status. Measurements of urinary specific gravity or osmolality are sometimes undertaken to provide an indicator of euhydration and good hydration practices. Although this may be true in the long-term situation, the athlete is reminded that during the acute period of fluid replacement immediately following dehydration, mismatch of fluid and electrolyte replacement can lead to production of large amounts of dilute urine despite the continuing existence of substantial fluid deficits. Thus, in the case of significant fluid loss, the athlete should be aware of the need for electrolyte replacement, and should know that “urine checks” over the first hours of fluid intake often provide false readings.

As mentioned previously, whilst hydration is important in the recovery process consuming fluids in excess of the recommendations (particularly if that fluid is water) can be detrimental to your health.

Caffeine-containing fluids (e.g. cola drinks, tea, coffee and energy drinks) are generally not considered to be ideal rehydration beverages in the early post-exercise phase since caffeine may increase urine losses. However, a review of the literature concluded the diuretic effect of caffeine is overstated in habitual caffeine drinkers. Furthermore, greater voluntary consumption of favourite beverages such as Cola drinks may lead to better hydration status even if they are associated with a slightly greater urine production. Although in practise “fizzy drink” are not usually advised due to reasons such as energy budgets, gastric discomfort &/or dental hygiene.

Where possible, the athlete should avoid post-exercise activities that exacerbate sweat losses – for example, long exposure to hot-spas, saunas or sun.

Alcohol

An athlete should avoid excessive intake of alcohol during recovery from exercise for at least 24 hours. Although there is potential for direct effects on refuelling and recovery processes, alcohol exerts its main effect on recovery through indirect means: the intoxicated athlete is unlikely to follow sound nutritional practices and is more likely to undertake high-risk behaviour and suffer an increased risk of accidents.

Alcohol is a powerful vasodilator of cutaneous blood vessels, therefore if any muscle damage/soft tissue injuries have occurred it has been suggested that alcohol could increase undesirable swelling to damaged sites and therefore might hinder repair processes.

Alcohol also causes an increase in urine losses, and drinks containing significant amounts of alcohol (4% or more of volume) are not considered ideal rehydration beverages.

If alcohol is consumed at any point, this should be done in moderation rather than binge drinking.

Supplements

Consuming suitable foods and fluid is more than adequate for optimal recovery from exercise (see suggestions in Tables 1-3). Foods and fluids are preferable as they have a number of advantages compared to relying on commercial supplements.

Supplementary nutritional products, even those which are batch tested (<http://www.informed-sport.com/>) are taken at the athletes own risk with regard to a positive doping test in sport.

As such a Supplement Disclaimer is required to be filled in (LINK), regularly updated and signed by any athlete taking supplements. The 100% me website from UK Anti-doping provides lots of useful information <http://www.ukad.org.uk/athletes/>.