UNIT NO. 4

SPORTS NUTRITION – PRACTICAL USE OF GLYCAEMIC INDEX VALUE IN SPORT SETTING

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ABSTRACT

The Glycaemic Index (GI) ranks foods based on the speed at which the carbohydrate they contain enters the blood stream. Foods may be classified as low (GI <55), moderate (GI 55-70) or high GI (GI >70). It is calculated based on ingestion of 50 g carbohydrate value of the food and not the average serving sizes Also, the GI values commercially available are largely based on test using single foods and not a mixed meal. The glycaemic index value of a food item is affected by the presence of additional food ingredients such as protein and fat in a meal. Each athlete must judge the benefits and the practical issues associated with pre-exercise feedings in their particular situation. The glycaemic index of a meal/snack may be a consideration for some athletes. These include those who may not be able to consume carbohydrate during a prolonged event; they may find it useful to choose a menu based on low GI carbohydrate foods to promote a more sustained release of carbohydrate throughout exercise. However, there is no evidence of universal benefits from such menu choices. In the overall strategies, pre-event eating needs to balance a number of factors such as palatability, portability, cost, intestinal tolerance, ease of preparation and overall nutritional value of the meal.

SFP 2008; 34(4): 24-27

INTRODUCTION

The Glycaemic Index (GI) is a tool available to rank foods based on the speed at which the carbohydrate they contain enters the blood stream. It has replaced the simple vs. complex classification of carbohydrate rich foods; a system that assumed the blood sugar response of a food was totally dictated by its chemical structure i.e. simple carbohydrates or 'sugary foods' would be digested quickly, causing a rapid increase in blood sugar (glucose) while 'starchy foods' or complex carbohydrates would be digested slowly promoting a flatter and more sustained blood sugar response. Research has shown this to be a myth and identified that blood sugar responses to a food are influenced by a wide array of factors including the type of carbohydrate, cooking method, type and amount of fibre in food, fat content and interactions between nutrients.

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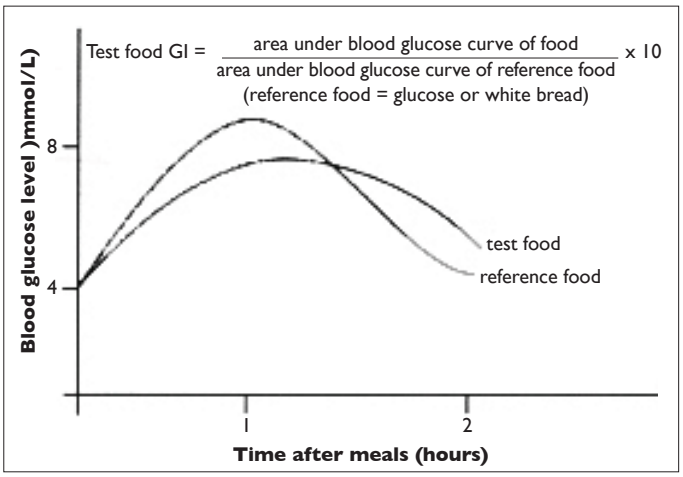
Figure 1: Determination of Glycaemic Index



Source: Peak Performance (Ed. Hawley & Burke) Allen Unwin 1998

FACTORS AFFECTING GLYCAEMIC INDEX

Because so many factors influence the blood sugar response of a food, its glycaemic index is almost impossible to predict. In fact the only way to assess the blood sugar response is to actually feed the food (amount of food providing 50 grams of carbohydrate) and monitor the blood sugar response over the ensuing hours. This is then compared to the response observed from ingesting equal amounts of a reference food (50 grams of glucose) and a percentage or index calculated (i.e. glycaemic index). Foods may be classified as low (GI <55), moderate (GI 55-70) or high GI (GI >70). Put simply; as the GI of a food increases so to does its blood sugar response. The glycaemic index of an array of some common foods is specified in Table 1.

The Glycaemic Index has been shown to provide a reliable and consistent measure of relative blood sugar response to carbohydrate rich foods and meals and its values have been used to manipulate meals and diets to produce a desired metabolic outcome, which is useful in the management of diabetes, hyperlipidemias and obesity (Wolever 1990, Brand Miller 1994). But more recently the application of GI has been used widely in sports nutrition with specific guidelines proposed for before, during and after exercise nutrition strategies.

GI AND THE PRE-EXERCISE MEAL

Early study by Thomas, 1991 found that a 1g/kg carbohydrate meal in the form of a low GI food (lentils), eaten 1 hour prior to cycling at 76% of VO2 max, was found to prolong time to exhaustion compared with the ingestion of a high GI food (potatoes). These results were attributed to lower glycaemic and insulinaemic responses to the low GI trial compared with the high GI meal, promoting more stable blood glucose levels during

Table 1: The Glycaemic Index of an Array of Foods

Low GI (<55)		Moderate GI (55-70)		High GI (>70)	
Food/Fluid	GI	Food/Fluid	GI	Food/Fluid	GI
Mixed grain bread	45	Muesli flake cereal	68	Glucose	100
Fruit bread	47	Porridge	61	Rice cakes	82
Pasta	41	Muffin/cake	62	Baked potato	85
Kidney beans	27	Rice	58	Sports Drink	78
Apples/pears	36	Table sugar	65	Cornflakes	84
Oranges	43	Soft drink	68	Honey	73
Lentils	26	White/wholemeal bread	70	Watermelon	72
Milk	27	Orange juice	57	'Sugary confectionery'	80
Flavoured yoghurt	33	Power/muesli bar	61	Pretzels	83

exercise, reduced rates of carbohydrate oxidation and increased free fatty acid concentration. The results of the study have been publicized widely and are largely responsible for the general advice that athletes should choose pre-exercise meals based on low GI, carbohydrate rich foods and drinks (Brand-Miller 1998). However other studies have failed to find performance benefits following the intake of a low GI pre-exercise meal (Sparks et al 1998, Burke et al 1998, Wee et al 1999, Febbraio et al 2000).

The significant of pre-exercise meal lies with its effect on exercise performance. Most studies fail to show performance benefits arising from the consumption of low GI meal, even when metabolism has been altered throughout the exercise. An important factor in the interpretation of these studies, as with many areas of sport nutrition research, lie in the issue of defining and measuring 'performance'. Performance in a study is typically measured with time to exhaustion at a fixed work rate. These are not readily applied to the world of competitive sport where a successful performance is determined as being able to complete a set amount of work or set distance in the shortest possible time, and where the athlete is free to choose and vary their work rate. Another factor to be taken into consideration in study involving pre-exercise feeding is that athlete is expected to take the pre-event meal before exercise and expected to perform prolonged exercise while consuming water or nothing at all. Again these are not advocated to competitive athletes in a sporting event.

Practical Tips

Use the following guidelines to plan pre-exercise meal:

- Eat 2-4 hours prior to exercise, allowing time for the meal to be digested. Larger meals are best consumed 3-4 hours prior to warm up while smaller meals and snacks can generally be tolerated 1-2 hours beforehand
- Focus on carbohydrate for maximum energy
- Fill up but don't overeat – your stomach should be the last thing on your mind once the whistle blows
- Keep the fat down as fat slows digestion
- Watch the fibre. Too much fibre may put you at risk of bloating, diarrhoea and general intestinal discomfort
- Drink your meal. If you're too nervous or it's too early for you to eat, try a sports drink or liquid meal (e.g. Sustagen Sports, Ensure, Resource).
- Experiment in training to find out what works best for you. The psychological value of taking foods that is familiar or 'tried and tested' should not be underestimated.

GI AND CARBOHYDRATE INTAKE WHILE EXERCISING

Ingesting carbohydrate during prolonged exercise is a proven performance booster, getting fuel to the muscles when they need it most. While there appears to be little performance difference between moderate and high GI foods/fluids, athletes intuitively select foods/fluids promoting a moderate to high glycaemic response. Therefore, ingesting convenient, readily accessible carbohydrate rich foods/fluids at a rate of 30-60 grams per hour of exercise may be a higher priority than the GI of options available.

Practical Tips

Table 2 shows examples of carbohydrate rich snacks and drinks to be consumed during exercise. Most are high GI options and provide 30-60 grams of energy giving carbohydrate per serve.

While water might be the best sports drink for sessions of less than an hour, commercially available sports drinks lead the way in longer duration sessions. They have being scientifically formulated to simultaneously meet both immediate carbohydrate and fluid requirements during exercise.

Table 2: Carbohydrate Rich Snacks

Food/ Drink	Amount
Sports Drink e.g. 100 Plus	500-1000ml
Carbohydrate Gel e.g. Power Gel™	1-2 gels
Sports Bar e.g. Power Bar™	2/3-1½ bars
Cereal/Granola bar	1-2 bars
Fruit	2-4 pieces
Sweets	50-100 g

GI AND RECOVERY

Recovery encompasses a complex range of nutrition-related issues including:

- Restoration of muscle and liver glycogen stores
- Replacement of fluid and electrolytes lost in sweat
- Regeneration, repair and adaptation processes following the catabolic stress and damage caused by the exercise

Since glycogen storage is influenced by both insulin and a rapid supply of glucose substrate, it appears logical that carbohydrate source with a moderate to high GI would enhance post-exercise refueling.

Burke 1993 compared high GI foods versus low GI foods on their effects on glycogen storage during the 24 hours of post exercise recovery. It was found that the magnitude of increase in glycogen storage was substantially greater than the difference in 24 hours blood glucose and insulin profiles.

Post-exercise recovery must become a priority for hard training athletes, especially those training more than once each day. As both carbohydrate availability and blood insulin levels influence recovery of carbohydrate stores, it has been proposed that high GI foods/fluids should become a priority in recovery as they naturally promote greater blood sugar and insulin responses. Research to date supports this belief, at least in the first 6-8 hours of recovery. Therefore, manipulating the GI of your post-exercise meal may be an effective strategy when recovery becomes a priority.

Stevenson et al, 2005 investigated the metabolic responses to high GI or low GI meals consumed during recovery from prolonged exercise. Meals were given at 30 mins and 2 hours following cessation of exercise. They found that the GI of the carbohydrate consumed during the immediate post-exercise period might not be as important as long as sufficient carbohydrate is consumed. The high insulin concentrations following a high GI meal later in the recovery period could facilitates further muscle glycogen re-synthesis.

Practical Tips

Use the following guidelines to help rebuild energy levels after training or competition:

- Recovery process starts when substantial amounts of carbohydrate have been ingested.
- Aim to consume a carbohydrate-rich meal/snack within 30 minutes of completing exercise.
- Aim for an intake of ~1 gram of carbohydrate per kilogram body mass immediately after exercise and repeat this every 2 hours or until normal meal patterns return.
- Maintain a daily carbohydrate intake of 7-10 grams/ kg body mass to optimize carbohydrate reserves i.e. 490-700 grams for a hard training 70kg athlete
- If your appetite is suppressed following exercise, focus on low-fibre, compact forms of carbohydrate e.g. sugar rich foods, sweet drinks or specially formulated sports supplements e.g. sports drinks, carbohydrate loader drinks, sports bars, powdered meal replacement formulas
- Make a preference for high GI options, especially if your next session is less than 8 hours away. Low GI foods may be poorly absorbed, lowering the rate at which fuel reserves can be rebuilt
- Don't discount fluid needs in recovery. Aim to replace 150% of losses in the hours following a session e.g. a 2kg decrease in body mass demands an intake of 3 litres of fluid in the recovery period if body fluid levels are to be restored.

Table 3: Guide on Different Types of Drinks and Their Suitability for Consumption During Exercise

Description	Amount providing 50g CHO*	When to use	Comments
Water		Exercise lasting less than 30 mins	• does not stimulate fluid intake to the same extent as sports drinks - drinking to a plan is therefore crucial • does not provide energy, but may be taken in addition to sports drinks or solid food to make up the total fluid requirement.
Sports drinks (5-8% CHO and electrolytes)	600-1000ml	Exercise lasting 30 - 60 minutes or more	• high GI value • best option for meeting fluid- and CHO- requirements simultaneously • palatable flavour • provide small amounts of electrolytes
Soft drinks (11% CHO)	500ml	May be used as a recovery drink	• usually high GI value • slow absorption due to CHO content • may not promote adequate fluid intake and may cause gastric discomfort during exercise, due to the gas present • negligible source of electrolytes
Fruit juices (8-12% CHO)	500ml	May be used as a recovery drink or for boosting calorie intake	• various GI values • slow absorption due to CHO content • negligible source of electrolytes • possible risk of gastrointestinal upset if juice is high in fructose
Energy-dense drinks e.g. smoothies, milk-based drink (70-80% CHO)	200-300ml	May be used as a recovery drink or for boosting calorie intake	• various GI values • good option for the athlete attempting to bulk up • may contain significant amounts of proteins

*CHO: Carbohydrate

Table 4: Carbohydrate-rich recovery snacks and meals providing 50 grams of carbohydrate per serve. High glycaemic index options are specified with an asterisk (*)

Food/ Drink	Amount
Sports drink*	800 ml
Fruit juice, soft drink*	500 ml
Carbohydrate loader powder/drink*	200 ml
Jube sweets*	60 g packet
Jam/honey (thickly spread) sandwich*	1
Cereal/granola/sports bar	2 bars (1 sports bar)
Rice/noodles with sauce, meat and vegetables	1 cup rice or noodles
Baked potato*	large
Fruit	3 medium pieces

CONCLUSIONS

Each athlete must judge the benefits and the practical issues associated with pre-exercise feedings in their particular situation. While factors such as palatability, portability, cost, intestinal tolerance, ease of preparation and overall nutritional value of a food may be of a higher priority, the glycaemic index of a meal/ snack may be a consideration for some athletes. These include those who may not be able to consume carbohydrate during a prolonged event; they may find it useful to choose a menu based on low GI carbohydrate foods to promote a more sustained release of carbohydrate throughout exercise. However, there is no evidence of universal benefits from such menu choices, particularly where the athlete is able to refuel during their session, or where their favored and familiar choices happen to have a high GI. In the overall strategies, pre-event eating needs to balance a number of factors such as palatability, portability, cost, intestinal tolerance, ease of preparation and overall nutritional value of the meal.

There are several limitations in using the GI value; i) Glycaemic index is a value calculated based on ingestion of 50 g carbohydrate value of the food and not the average serving sizes, ii) The GI values commercially available are largely based on test using single foods and not a mixed meal. With these limitations, glycaemic index may be used in sports setting to fine-tune food choices, but should not be used exclusively to provide guidelines for carbohydrate intake.

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LEARNING POINTS

- **Glycaemic index is typically measuring the rate of blood sugar response after ingesting carbohydrate food.**
- **Glycaemic index value of mixed meals is harder to determine, as additional food ingredients such as protein and fat in a meal affect it.**
- **Glycaemic index value can be used as part of nutritional strategies in the preparation for event/ competition.**
- **More research is needed to determine its effect on exercise performance and on competition settings.**
- **More research is needed to determine the GI value of Asian foods and mixed meals.**