

RIO TINTO CHILDREN'S DIABETES CENTRE

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TYPE 1 DIABETES & PHYSICAL ACTIVITY

A guide containing useful information relating to diabetes management during sport and exercise

Purpose statement

This document is designed to inform, educate, and help people who support youth with type 1 diabetes participate in physical activity. It is intended to be used as a reference guide about type 1 diabetes and physical activity.

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Type 1 diabetes

What is type 1 diabetes?

Type 1 diabetes is a lifelong condition whereby the body's immune system destroys its insulin-producing cells. As a result, little or no insulin is being produced. Since insulin promotes the storage of glucose and fat and prevents blood glucose levels from increasing to abnormally high levels, the lack of insulin in the blood impairs the storage of the glucose and fat derived from food. If left untreated, blood glucose levels build up to harmful levels, and the stores of fat are broken down and converted to ketone bodies. These changes over a long period of time can lead to further complications. A diagnosis of type 1 diabetes is no one's fault. There is no way of preventing the onset of type 1 diabetes and there is currently no cure for type 1 diabetes.

What is the difference between type 1 diabetes and type 2 diabetes?

TYPE 1 DIABETES: A condition that results in limited or no insulin production due to the destruction of the cells that make insulin and as such, people living with type 1 diabetes are **insulin dependent**. Type 1 diabetes is one of the most common chronic childhood conditions but can be diagnosed at any age and affects 1 in 300 young people in Australia. The exact causes of type 1 diabetes are not fully understood and there are currently no known ways of preventing this condition. However, there is evidence that genetic predisposition, environmental triggers, and exposure to some viral infections increase the risk of developing type 1 diabetes, and modifiable lifestyle factors are **not** involved.

TYPE 2 DIABETES: In contrast, type 2 diabetes develops over many years and is caused by a combination of non-modifiable (genetic) and modifiable (diet and physical activity) factors. It is a chronic condition that typically presents in adults but is becoming more prevalent in recent times in children and teens who are overweight and obese. With type 2 diabetes, the body is insulin resistant and unable to make enough insulin to oppose its resistance to insulin, thus causing blood glucose levels to increase. As such, people living with type 2 diabetes are **insulin resistant** but some may be insulin dependent based on the severity of the condition. Changes in lifestyle behaviours that include maintaining a healthy diet and weight along with regular physical activity can lower the risk of developing type 2 diabetes.

Why is it important for our body to regulate blood glucose levels, and what factors affect these levels?

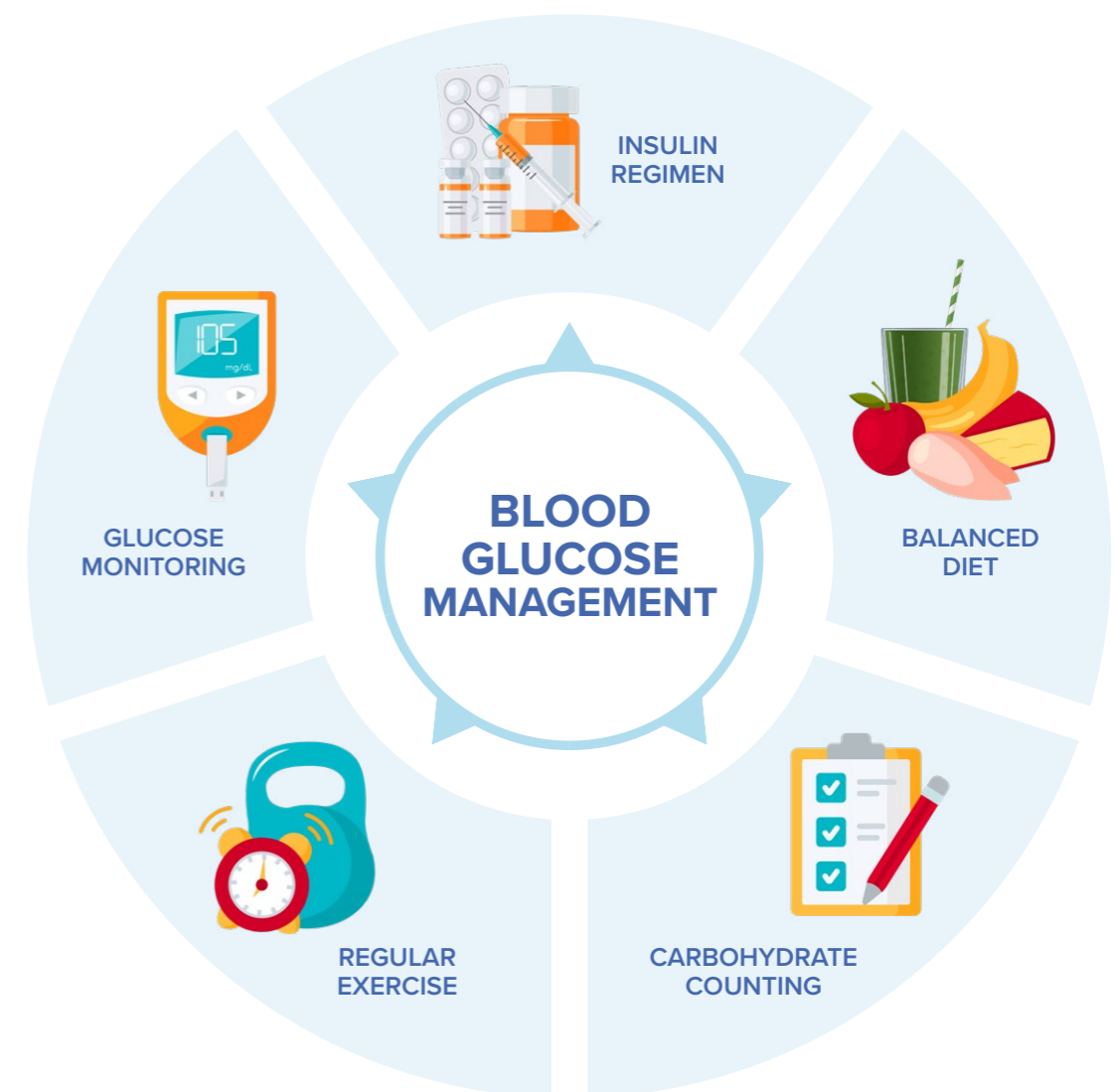
In diabetes, blood glucose levels can be too high or too low. Glucose is one of the body's most important sources of energy. When we eat foods that contain carbohydrates, our digestion converts this into glucose, which in turn is released into the blood to be either stored in the liver and muscles or burned to produce energy. The most common scenario in young people playing sport is too much glucose in the blood and this can be harmful. Improving the understanding of how to manage diabetes and blood glucose levels pre-, during and after exercise can lead to really positive outcomes such as reducing the risk of long-term complications. For these reasons, it is ideal that blood glucose levels are maintained within a relatively narrow healthy range. It is common, however, to notice fluctuations in blood glucose levels throughout the day due to environmental, physiological, and psychological factors. High blood glucose levels are treated with insulin and will result in a drop in blood glucose levels. However, it is important to note that too much insulin can cause blood glucose levels to drop to levels that are too low, and this can be dangerous.

How is type 1 diabetes treated and managed?

Since people living with type 1 diabetes produce little or no insulin, they must rely solely on the daily self-administration of insulin to lower their blood glucose levels, store fat and carbohydrates, and remain healthy. Also, people living with type 1 diabetes must balance their insulin dose with their food intake and physical activity to maintain their blood glucose levels within the healthy range. For many, this is a complex and challenging feat because there are several factors that can impact blood glucose levels such as exercise, diet, insulin therapy, sickness, and stress as illustrated in the following diagram.

Importance of exercise and type 1 diabetes

Being physically active every day is important for people of all ages as it can help them get stronger and fitter, improve their heart health, decrease their stress, help them manage their weight, and improve their general mental health. Despite the many factors that people living with type 1 diabetes must consider when exercising, they can experience additional benefits with being physically active such as a decrease in their reliance on glucose as fuel and an increase in insulin sensitivity (which is the opposite of insulin resistance) that results in lowering their daily insulin requirements. The psychological and social benefits of including and encouraging people with diabetes to participate in sport and exercise can lead to feelings of participation, wellbeing, success and enjoyment, especially if individuals can enjoy the sporting spirit and camaraderie, particularly in team sports.



Diabetes devices and equipment

Monitoring of blood glucose levels

Given that it is important for people living with type 1 diabetes to maintain their blood glucose levels within a healthy range, regular testing of blood glucose levels is important for the management of type 1 diabetes. In addition, it helps people living with type 1 diabetes understand the relationship between their blood glucose levels and factors such as medication, food, physical activity, stressors, hormonal changes and illness.

Glucose levels can be monitored using either a continuous glucose monitor, intermittent glucose monitor or blood glucose meters. Most people living with type 1 diabetes will play sport with their continuous or intermittent glucose monitors on.

CONTINUOUS GLUCOSE MONITORING



Continuous glucose monitoring (often referred to as CGM by their users) continuously reads the level of glucose between the cells just underneath the skin and converts these readings to blood glucose levels. The device consists of a sensor that is inserted just under the skin and a transmitter that sits on top of the skin and connects to the sensor. The sensor may be placed on the stomach, the buttock, or the arm. The continuous glucose readings can be sent to a receiver, smart phone application or insulin pump by Bluetooth. Smart phones or receivers must be kept within 6 metres of the continuous glucose monitor to display glucose levels. Continuous glucose monitors can be set to produce audible alarms when glucose levels are outside of the target range, a feature that is very useful for the prevention of hypoglycaemia during the day and especially at night.

INTERMITTENT GLUCOSE MONITORING



An intermittent glucose monitor reads the level of glucose between the cells just underneath the skin and converts these readings to blood glucose levels. The device consists of a sensor that is inserted just under the skin and a transmitter that sits on top of the skin and connects to the sensor. The sensor is placed on the arm. The sensor needs to be scanned with a reader or smart phone application (app) to display the result, hence the name intermittent glucose monitoring. Intermittent glucose monitors can be set to alarm the user when glucose levels are outside a pre-set target range.

BLOOD GLUCOSE METER



Blood glucose meters provide a single reading of blood glucose level. It requires the use of a finger-stick device (i.e. a lancet) to prick a clean finger, and place a drop of blood from the finger on a glucose strip inserted inside the blood glucose meter.

Insulin delivery

There are two ways to deliver insulin to the body, either by injections or through an insulin pump.

MULTIPLE DAILY INJECTIONS



Traditionally, insulin delivery into the body was performed via multiple insulin injections throughout the day. The therapy consists of three or more injections per day. This includes one injection of long-acting insulin in the evening or morning and an injection of rapid/short-acting insulin before each meal. Long-acting insulin is designed to release insulin slowly and evenly in the bloodstream for about 24 hours after it is injected. Long-acting provides basal levels of insulin that are required for normal metabolic functions throughout the day. Rapid/short-acting insulin acts like the insulin released around mealtimes in a person living without diabetes, and for this reason is injected before meals. The amount of rapid/short acting insulin that is injected should be adjusted to match the type and amount of food in the meal and current blood glucose level.

INSULIN PUMP



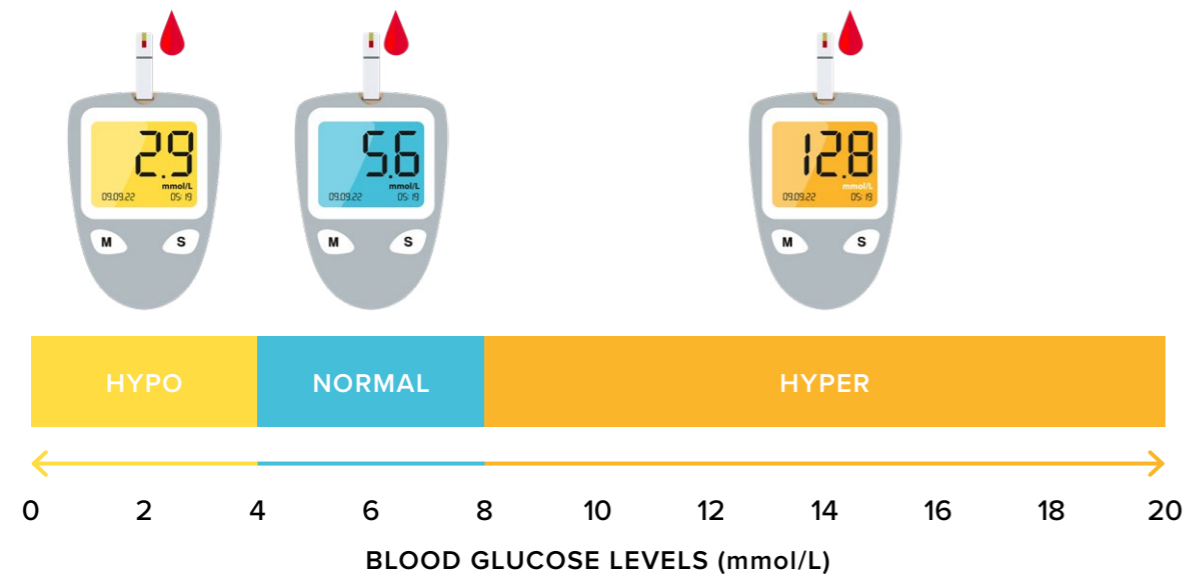
Insulin can also be administered with the help of an insulin pump. An insulin pump is a small device that is worn outside the body and designed to mimic some of the ways a healthy pancreas works. Insulin is delivered subcutaneously (or under the skin) via a cannula. The pump provides rapid/short-acting insulin to the body in two ways: **i) basal insulin infusion**: small amounts of insulin are released continuously throughout the day to mimic the background insulin production of the pancreas, and; **ii) bolus insulin**: additional insulin is delivered on demand by the individual with type 1 diabetes to match the amount and type of food that is eaten or to correct high blood glucose levels.

People living with type 1 diabetes may remove their insulin pump for physical activity, especially during contact sport or swimming. They will monitor their blood glucose levels during and after the activity and act if required. Some people will choose to keep their pump on. If a pump site comes out during the activity, this needs to be replaced quickly by the person or their carer, to prevent blood glucose levels from rising.

Hypoglycaemia & hyperglycaemia

What is hypoglycaemia & hyperglycaemia?

Typically, the blood glucose levels in an individual living without type 1 diabetes ranges from 4-8 mmol/L. Hence, a blood glucose level below 3.9 mmol/L can be considered hypoglycaemia and a blood glucose level above 8 mmol/L can be considered hyperglycaemia.



Stable glucose levels can improve a person's performance, reduce the risk of illness and fatigue, and avoid some longer-term complications which can arise if glucose levels are not well managed for long periods of time.

HYPOGLYCAEMIA OR LOW BLOOD GLUCOSE can be dangerous. If it is severe and prolonged (insert level and duration), it can starve the brain of glucose and cause unconsciousness or fitting. It can be caused by numerous factors such as missing a meal, too much insulin, unplanned physical activity, strenuous activity, illness or some medication. Hypoglycaemia is part of living with type 1 diabetes and the person with type 1 diabetes will have strategies to avoid or treat hypoglycaemia.

HYPERGLYCAEMIA OR HIGH BLOOD GLUCOSE can be caused by not enough insulin being administered, eating carbohydrate-containing food without enough insulin to cover the carbohydrate quantity, infection, stress or a decrease in physical activity.

Common signs and symptoms of hypoglycaemia & hyperglycaemia

HYPOGLYCAEMIA: It is important to recognise the symptoms of hypoglycaemia and to promptly initiate the appropriate corrective measures to increase blood glucose levels. Often, individuals can experience the symptoms of hypoglycaemia before blood glucose levels drop to or below 3.9 mmol/L. On the other hand, some individuals display few or no symptoms, making them unaware of being hypoglycaemic.

HYPERGLYCAEMIA: Hyperglycaemia may not cause symptoms until blood glucose levels are consistently over 10 mmol/L. The higher and more consistently elevated blood glucose levels are, the more obvious the symptoms are.

Some of the symptoms of hypoglycaemia and hyperglycaemia are listed opposite:

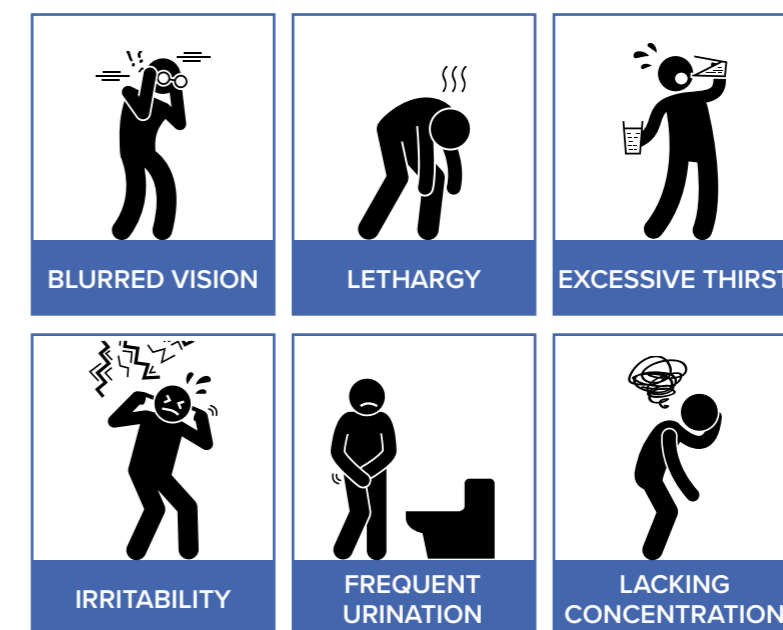
HYPOGLYCAEMIA SIGNS & SYMPTOMS

LOW BLOOD GLUCOSE (<3.9 mmol/L)



HYPERGLYCAEMIA SIGNS & SYMPTOMS

HIGH BLOOD GLUCOSE (>10 mmol/L)



Prevention and treatment of hypoglycaemia & hyperglycaemia

Prevention of hypoglycaemia

People living with type 1 diabetes will measure their blood glucose levels and sometime eat some carbohydrates before, during and after exercise to prevent hypoglycaemia. For this reason, they may have to suddenly interrupt their training or game. It is important not to prevent them from doing so and to provide them with the opportunities to monitor their glucose levels at will.

Treatment of hypoglycaemia

If people living with type 1 diabetes engage in activities that increase the risk hypoglycaemia, it is important to ensure that they have their glucose monitoring device and a personal hypoglycaemia-treatment kit that they carry with them at training and during games or competitions. If they do not have their kit, it is recommended that players should avoid physical activity. It is advisable to call the player's parent/guardian to confirm to pick them up or drop their kit to them. A hypoglycaemia-treatment kit needs to contain a few essential items such as those described below:

- 1**
Glucose monitoring equipment (e.g. blood glucose monitor, glucose strips and lancets or CGM).
- 2**
At least 4 serves of the player's preferred quick acting glucose treatments (e.g. glucose tablets, glucose gel, or similar).
- 3**
Optional: Longer acting carbohydrate (e.g. fruit, muesli bar or sandwich) for follow up treatment.

Reference: Managing Hypoglycaemia Fact Sheet (ndss.com.au)

It is important to treat hypoglycaemia quickly to stop blood glucose level from dropping further as untreated hypoglycaemia can be dangerous. Generally, if a person living with type 1 diabetes experiences an episode of hypoglycaemia, hypoglycaemia treatment should be guided by the treatment plan that is specific to the individual. An example is detailed below:

- 1**
Blood glucose level is below 3.9 mmol/L – Hypoglycaemia or Low blood glucose level.
- 2**
Take hypoglycaemia treatment. e.g. 4 glucose tablets, 100mls full-strength soft drink, or 150mls of juice. Rest and wait 15 min.
- 3**
Re-test. If below 3.9 mmol/L repeat Step 2. If above 3.9 mmol/L eat a snack or longer acting carbohydrate e.g. fruit, muesli bar, sandwich.

If the person becomes unconscious, drowsy or unable to swallow phone for an ambulance stating the person is unconscious and that the person has diabetes.

Prevention of hyperglycaemia

If the blood glucose level is above 13 mmol/L before exercise, it is important to determine the cause. Some reasons for a high blood glucose level include prior ingestion of an excessive amount of carbohydrate or a state of severe insulin deficiency brought about either by the skipping of daily insulin injection, the removal of insulin pump or a defective insulin pump. Although people living with type 1 diabetes would be expected to know whether they have skipped their insulin administration or not, failed memory recall is always possible and so is the possibility of a defective insulin pump.

Treatment of hyperglycaemia

Hyperglycaemia is treated with insulin, and it is advisable to measure blood ketone levels too. If ketone levels are very low or undetectable, hyperglycaemia can be treated by giving insulin to help decrease blood glucose levels. **Coaches should not initiate such a measure** but instead, help support players when they need to administer insulin. Only individuals who are proficient with diabetes management (e.g. parents of the player living with type 1 diabetes) should do so. If ketones are more than 1.0 mmol/L, **no exercise** should be performed, and urgent care is required. This is because exercising in an insulin deficient state can further increase the levels of blood glucose and ketone bodies in the blood, thus increasing the risk of diabetic ketoacidosis. Diabetic ketoacidosis, sometimes referred to as DKA, is a serious medical condition that, if left untreated, can lead to unconsciousness and coma. This condition can thus be life-threatening and requires urgent medical care. The symptoms of diabetic ketoacidosis include high blood glucose levels, high levels of ketones in the blood and urine.

If someone living with type 1 diabetes has high ketone levels and becomes confused or unconscious, or has the symptoms listed above, **call triple zero (000) for an ambulance.**

Exercise and type 1 diabetes





The effect of exercise on blood glucose levels

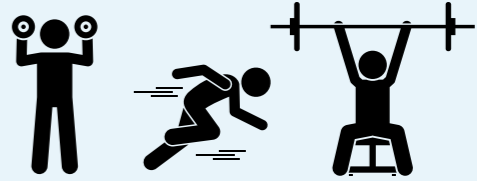





Exercise, by definition, is a subset of physical activity that is planned, structured, and repetitive. Generally speaking, exercise can be classified as:

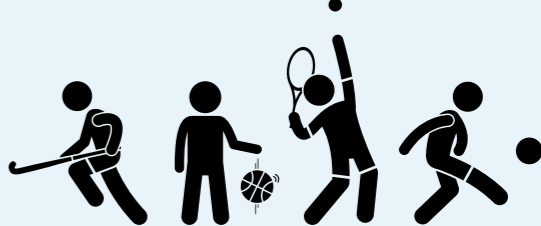





- 1. Aerobic exercise:** Activities whereby the muscles rely on oxygen to burn their fuels. Aerobic exercise tends to be of low to moderate exercise intensity and can be sustained for a long duration. Examples of aerobic activities include dancing, swimming, running, bicycling, and skateboarding.
- 2. Anaerobic exercise:** Activities whereby the muscles extract a large proportion of the energy of their fuels without using oxygen. Anaerobic exercise can involve one or several intermittent bouts of high intensity exercise with each bout being sustainable only for a very short duration. Examples of anaerobic activities include sprinting, weight training, and weightlifting.
- 3. Mixed exercise:** Activities that consist of a combination of both aerobic and anaerobic activities. Most forms of organised sports as well as the type of activities that youth engage in fall in this category. Examples of mixed exercise include basketball, soccer, rugby and organised general play.

Glucose is the main fuel used by the muscles during exercise and the rate at which glucose is used is dependent on the type of physical activity and increases with exercise intensity and the level of insulin.

In some players with type 1 diabetes, competitive sport can cause an increase in adrenaline which can increase blood glucose levels.

AEROBIC ACTIVITIES	
<p><i>Aerobic activities</i> typically tend to lower blood glucose levels both during and immediately after exercise. Additionally, in the following hours after a bout of aerobic exercise, a person living with type 1 diabetes is at a higher risk of hypoglycaemia. This is due, in part, to the increase in the insulin sensitivity of the muscles that were mobilized during exercise, a response that can last for up to 24 hours or more after exercise. This increase in insulin sensitivity favours the uptake of blood glucose levels to replenish muscle energy stores. Please note that if enough carbohydrates are ingested before and during exercise, aerobic activities can be associated with an increase or no marked change in blood glucose levels.</p>	<p>Aerobic activity examples:</p>  <p>When performing these activities without food, blood glucose can:</p> <p>  During exercise  Immediately after exercise  Hours after exercise </p>

ANAEROBIC ACTIVITIES	
<p><i>Anaerobic activities</i>, or high intensity activities, tend to increase blood glucose levels during exercise and for up to 2 hours after exercise if performed while insulin levels are low. This trend is thus more prominent when anaerobic exercise is performed before breakfast when insulin levels are at their lowest. Similar to aerobic exercise, there is an increase risk of hypoglycemia occurring hours after exercise due to an increased in insulin sensitivity. Also, in the presence of high insulin levels (e.g. within a couple of hours after the injection of a bolus of rapid acting insulin), anaerobic exercise can result in a decrease in the level of blood glucose levels. Please note that if enough carbohydrates are ingested before and during exercise performed in the presence of high levels of insulin, anaerobic activities can be associated with an increase or no marked change in blood glucose levels.</p>	<p>Anaerobic activity examples:</p>  <p>When performing these activities without food, blood glucose can:</p> <p>   During exercise   Immediately after exercise  Hours after exercise </p>

MIXED ACTIVITIES	
<p><i>Mixed activities</i> consist of a combination of aerobic and anaerobic exercise whereby bouts of intense exercise are combined with low to moderate intensity activity or rest. This results in blood glucose levels that can either increase or decrease during and after exercise, depending on insulin levels. The magnitude of these changes in blood glucose levels may be smaller as compared to purely aerobic or anaerobic activities. Again, please note that if enough carbohydrates are ingested before and during exercise, mixed activities can be associated with an increase or no marked change in blood glucose levels.</p>	<p>Mixed activity examples:</p>  <p>When performing these activities without food, blood glucose can:</p> <p>   During exercise   Immediately after exercise  Hours after exercise </p>

Helpful tips to support a person with type 1 diabetes

Despite the risk of hypoglycaemia associated with exercise, having type 1 diabetes should not be a barrier that prevents an individual from participating in sport and exercise or hold them back from their fitness goals. Just like with people who do not have type 1 diabetes, exercise and sport is not only 'do-able' for people living with type 1 diabetes, but also can be performed at the highest competitive level as exemplified by so many Olympians and professional/elite player who have type 1 diabetes.

Coaches and trainers should encourage their player living with type 1 diabetes to excel and are encouraged to adapt their gameday or training plans to help players manage their diabetes to make them feel more comfortable whilst participating in their chosen sports. A few examples of interventions that may help players living with diabetes include:

- Allowing for more frequent breaks or 'time-off' to allow the player to check and manage their blood glucose levels.
- Being aware that inconsistencies in the sport performance of the player during a game or at training may be related to blood glucose levels being too high or low.
- Adapting the game or training plan to accommodate the player living with type 1 diabetes, if possible, so that they are given equal opportunity at their chosen sport.
- Adjustments to accommodate for insulin pumps or continuous glucose monitors should be considered if possible.
- Allowing players to access their phones during the activity and don't ask for alarms to be switched off.
- Allowing parents, siblings, carers to attend sessions to observe.
- Consider sharing training sessions in advance – particularly for more strenuous sessions (amount and type of exercise likely in each session).

It is important to remember that every person with type 1 diabetes is different and it is essential to talk to the person with type 1 diabetes and their carer to find the best ways to support them and talk about their diabetes.

Precautionary measures before, during and after exercise

Before starting to coach someone living with type 1 diabetes

- ✓ Talk to them about their Type 1 diabetes management plan (i.e. symptoms, preferred hypoglycaemia treatment) and what support they may need
- ✓ Details of emergency contacts

Before training sessions/games

- ✓ Player must have access to their hypoglycaemia kit
- ✓ Players may supply coach/club with backup glucose for hypoglycaemia treatment (e.g. glucose tablets, glucose gels or player's preference)
- ✓ Details of emergency contacts
- ✓ Allow player time to make any adjustments

During training sessions/games

- ✓ Allow player time to make any adjustments or to have breaks if needed
- ✓ Player must have access to their hypoglycaemia kit
- ✓ Support player to:
 - Monitor glucose levels regularly
 - Regular fluid intake
 - Treat low blood glucose immediately as per management plan

After training sessions/games

- ✓ Support player to:
 - Check post-exercise glucose levels
 - Treat low blood glucose immediately as per management plan
- ✓ Do not let player leave unaccompanied if hypoglycaemic
- ✓ Check player has glucose for hypoglycaemia treatment for the trip home

Useful links and resources for more information

Rio Tinto Children's Diabetes Centre

The Rio Tinto Children's Diabetes Centre (The Centre), based at the Telethon Kids Institute and Perth Children's Hospital (PCH), is a research centre that aims to improve the lives of children and young adults living with diabetes by bringing together research, education and clinical care. diabetes.telethonkids.org.au



Diabetes Australia

Diabetes Australia was established in 1984 and is the national body for people affected by all types of diabetes and those at risk. Through leadership, prevention, management and research, Diabetes Australia is committed to reducing the impact of diabetes. diabetesaustralia.com.au



Diabetes WA

Diabetes WA informs, educates and supports thousands of Western Australians, helping them to better manage their diabetes. This in turn enables them to lead happier, healthier lives. diabeteswa.com.au



National Diabetes Services Scheme

The NDSS provides access to support and information services, diabetes programs and subsidised products to assist people to self-manage their life with diabetes. ndss.com.au/about-diabetes



JDRF Australia

JDRF Australia connects the leading individuals in every discipline, industry and organisation with a single focus of eradicating type 1 diabetes. jdrf.org.au



Diathlete

DiAthlete creates innovative techniques and hosts practical approaches to diabetes educational topics to make the essential info about type 1 diabetes relatable and enjoyable to learn and adapt to. diathlete.org





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