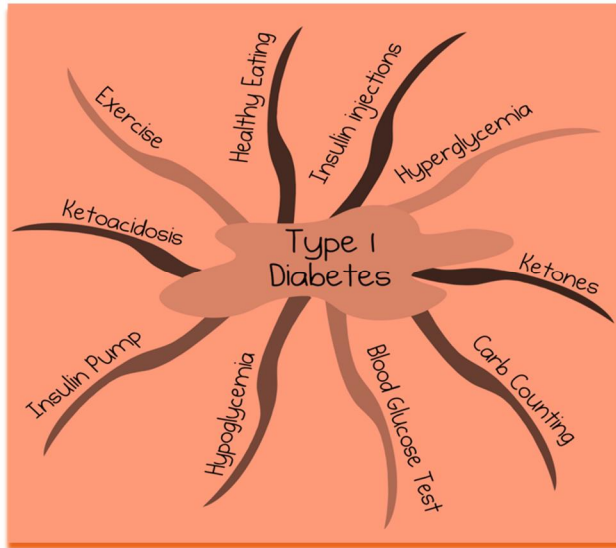


Diabetes Exercising and Competing with Type 1 Diabetes

By: Brett Stinogel



Literature Review:

Lifestyle modifications that include exercise, a strict diet, along with proper insulin management have proven to be effective in type 1 diabetics. These factors are especially important for type 1 diabetics that are athletes or anyone that is physically active. Managing diabetes in sport and exercise is a challenging but essential skill for type 1 diabetics. Research says that with proper management of this disease, a person with type 1 diabetes can be just as active and perform at the same levels both physically and cognitively as someone who does not have the disease. However, complications in type 1 diabetics are more likely to occur and can have a negative impact on the performance of athletes in whatever activity or sport they may participate in. It is evident that hypoglycemia and hyperglycemia are the two aspects of type 1 diabetes that can become serious.

Research says that hypoglycemia has a negative effect on performance. One study that proved this was done on 28 youth age kids attending a sports camp. They carried out and then were tested on multiple skill based tests that included tennis, basketball, and soccer skills with glucose monitoring over 4 days. Glucose levels at the time of testing were categorized as hypoglycemic (<3.6 mM), within an acceptable glycemic range (3.6-13.9 mM), or hyperglycemic (>13.9 mM). They found that performance skill was approximately 20% lower when glucose concentrations were hypoglycemic compared to acceptable or in the hyperglycemic range. They also found that color recognition and reading skills also degraded in those with hypoglycemia. This puts an emphasis on the fact that hypoglycemia is something that athletes need to avoid in order to meet their full performance potential during activities that require mental processing and performance (Kelly, Hamilton, Riddell, 2010).

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during performance, it is accepted that hyperglycemia will not affect physical performance. A high blood glucose is something that some athletes may even aim for prior to exercise with the plan that it will go down as they begin exercise. In a study done by Stettler et al, they assessed exercise capacity in eu- and hyperglycaemic conditions in subjects with type 1 diabetes. Eight moderately exercise-trained male subjects with type 1 diabetes were randomly selected to perform two stepwise ergometer tests in eu- and hyperglycaemic conditions. What they looked at in the study were peak power output, perceived exertion, lactate levels, heart rate, and respiratory exchange ratio. Normal and hyperglycaemic conditions were observed at plasma glucose concentrations of 5.3 +/- 0.6 mmol/L and 12.4 +/- 2.1 mmol/L. The levels remained stable throughout the exercise. Hyperglycemia did not result in a significant increase in the peak power output compared to euglycemia. They came to the conclusion that in subjects with type 1 diabetes, exercise capacity is not influenced by hyperglycemia. This article proved that mild hyperglycemia likely will not diminish physical performance levels in athletes (Stettler et al., 2006).

Two studies showed how hypoglycemia can also effect performance levels in the form of cognitive ability. In a study by Tonoli et al, researchers looked at the brain and the effects of cognitive performance in type 1 diabetics. The participants (control and experimental groups) performed moderate intensity exercise for 20 minute intervals. The results showed that there was a small to modest decrease in cognitive performance in type 1 diabetic subjects compared with non-diabetic controls. Type 1 diabetes participants performed worse while testing for executive function, motor speed, memory, and spatial memory. Some of these cognitive variables are more important in sports that are mentally/cognitively demanding such as football, baseball, basketball, or golf (Tonoli et al., 2014). Another similar study by Gonder et al showed similar findings involving hypoglycemia in cognitive performance with exercise in type 1 diabetics. This study looked at child aged performance with mental math and also reaction times. Participants completed several trials per day over 4-6 weeks for a total of 70 trials. The results that they obtained showed that time to complete both mental math and reaction time was significantly longer during hypoglycemia. Cognitive deterioration equals that associated with significant hypoglycemia. This is an important challenge to consider for type 1 diabetics when they are physically active (Gonder et al., 2006).

With the research of the topic of type one diabetes and response to exercise, it was a common theme that most articles and studies expressed the consequences of having a low blood glucose on performance as opposed to a normal or slightly hyperglycemic level. With that, it is also certain that a proper diet and insulin plan prior to, during, and after exercise bouts or activity can help ensure a normal glucose level is achieved and allow type 1 diabetics to perform at their maximum potential with no restrictions.

The daily nutrient requirements for type 1 diabetics are very similar to anyone else. Carbohydrate is the most important nutrient because it does influence their blood glucose levels. Many elements need to be considered when it comes to what they eat, how much they eat, and when they eat. Aspects such as exercise intensity, duration of exercise, and the person performing the activity are a few variables that have an effect on the persons response and dietary needs. Every athlete and person is different. Blood glucose control for type 1 diabetics during intense exercise and athletic competition is a trial-and-error process with variations between individual athletes. With that said, there can be some recommendations for diet and fluid that should be considered when it comes to performance and being safe and healthy

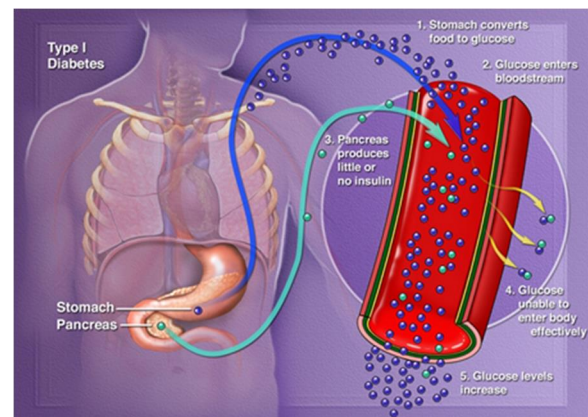
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ll look at what research says about type 1 diabetes and how are posed to them with exercise and their nutritional guidelines.

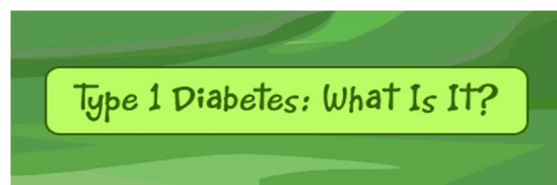
Introduction:

Insulin dependent diabetes, also known as type 1 diabetes, is a chronic disease that affects millions of people across the world. Many of these individuals live an active lifestyle and compete in competition events. For people training and competing with type 1 diabetes, the challenges are greater and more complicated than individuals who do not suffer from this disease. For anyone with diabetes, especially competitive athletes, the underlying issue to consider is maintaining normal blood sugar levels. Every aspect of their life has an effect on their blood glucose levels, including exercise and nutrition. Success in sporting events and competitions has a large dependence on an individual's blood sugar levels. Although type 1 diabetes presents many challenges, with the proper diet and management, type 1 diabetes should not be an inhibitor for an athlete's performance. Around the clock maintenance should be a priority for athletes in order to maximize their athletic performance. This chapter will investigate the additional challenges surrounding athletes and how they deal with them. The first part of this chapter will discuss a summary of type 1 diabetes, how blood sugar levels impact performance, and treatment and management ideas. The last section will present diet and fluid recommendations for before, during, and after competition.

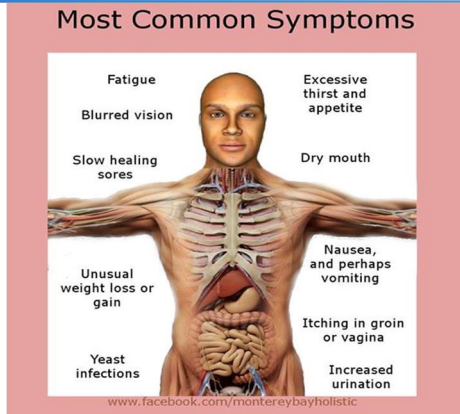
which the body is no longer able to produce its own insulin. The source of insulin secretion in the body is the beta cells in the islets of Langerhans within the pancreas. Insulin is essential at the physiological level of the body because it is a hormone in the blood that allows sugar to enter the cells to provide energy (Goodyear & Kahn, 1998). In individuals who have a normal functioning pancreas, insulin is released in response to high glucose levels such as after eating a meal. For those affected by insulin dependent diabetes, the beta cells in the pancreas are no longer able to perform the function of releasing insulin. The muscles normally require insulin to take up glucose from the blood. This can lead to complications associated with high blood glucose levels known as hyperglycemia.



Some of the more common signs and symptoms associated with the onset of insulin dependent diabetes often include frequent urination, excessive thirst, unintended weight loss, irritability, fatigue, and blurred vision.



Insulin dependent diabetes is characterized as an autoimmune disorder in



The development and diagnosis of insulin dependent diabetes is often associated with risk factors such as family history, genetics, geography, and age.

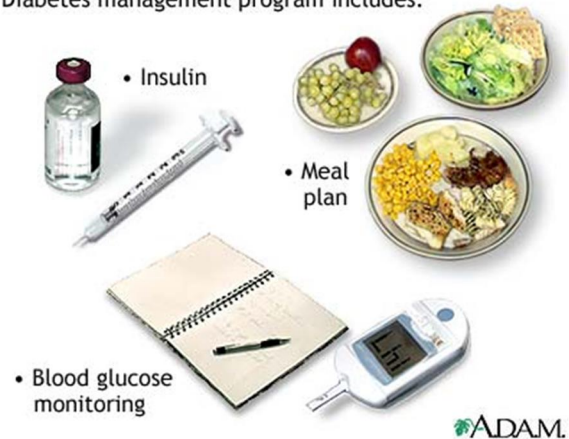
Some studies suggest that certain viruses that develop in early childhood may contribute to the development of insulin dependent diabetes. One theory proposes that type one diabetes is a virus-triggered autoimmune response in which the immune system attacks virus-infected cells along with the beta cells in the pancreas (Devendra et al). It is believed that there is nothing that can directly prevent the onset of insulin dependent diabetes.



Exercise presents a unique challenge for individuals battling with insulin

dependent diabetes. In order to live their preferred lifestyle, a reasonably stable balance between food, insulin, and physical activity pose a daily challenge that many take for granted.

Diabetes management program includes:



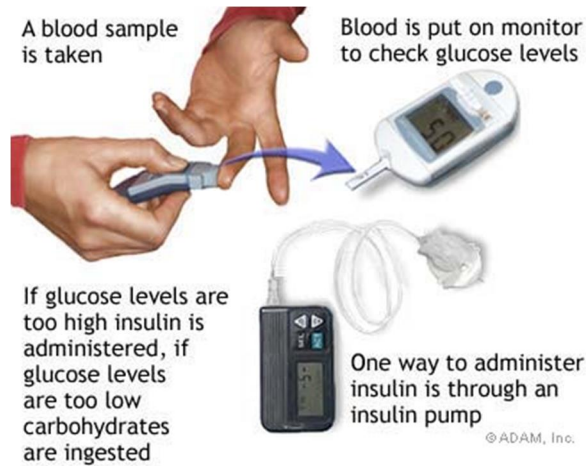
Management places many demands on the individual and often times the people around them in order to keep blood sugar levels consistent. The management of insulin dependent diabetes focuses on preventing hyperglycemia and hypoglycemia. Despite these challenges, many people are able to maintain control of their disease and also live a normal healthy lifestyle. However, this largely depends on the motivation, persistence, and circumstances surrounding the person.

There are two types of hyperglycemia. Fasting hyperglycemia is generally caused by fasting of longer than eight hours in which blood sugar rises above 130 mg/dl. Hyperglycemia that occurs postprandial is defined by blood sugar levels above 180 mg/dl. This is a concern for diabetics because in people with a normal working pancreas, these levels will rarely increase above 140 mg/dl. With frequent or long periods of hyperglycemia, damage to the nerves, blood vessels, and other organs can occur. Some causes of hyperglycemia include not taking insulin regularly or when

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include eating too many grams of carbohydrate in relation to the amount of insulin administered, infection, and less than expected or planned exercise.

Insulin administration is performed via an insulin pump or subcutaneous injection. Depending on the person and their circumstances, control can be maintained through four different insulin types.



These are ultra-short-acting insulin, short-acting insulin, intermediate-acting insulin, and long-acting insulin. A look at the different types of insulin and their differences can be seen in the chart.

TYPE	BRAND NAME(S)	ONSET Time until reaches bloodstream	PEAK Time when most effective	DURATION How long works
Rapid-acting	Humalog Novolog Apidra	10 to 30 minutes	30 minutes to 3 hours	3 to 5 hours
Short-acting	Regular (R)	10 to 30 minutes	2 to 5 hours	Up to 12 hours
Intermediate-acting	NPG (N)	1.5 to 4 hours	4 to 12 hours	Up to 24 hours
Long-acting	Lantus Levemir	0.8 to 4 hours	Minimal peak	Up to 24 hours

A decrease in blood sugar levels that is also of concern to diabetics is called hypoglycemia. Hypoglycemia is defined as blood sugar levels that fall below 70 mg/dl. Symptoms of hypoglycemia may include any of the following; headache, hunger, sweating, shaking, or weakness. This decrease in blood sugar is often due to the treatment of diabetes. This can be caused by injecting too much insulin, exercising too much without eating, alcohol, illness, and some medications.



An additional way to combat fluctuations in blood glucose levels is through regular exercise. The responses in blood glucose levels to exercise depend on blood glucose levels before exercise, intensity and length of training, and any changes in the insulin doses. During activity, cells become more sensitive to insulin. Because of this, insulin can be used more efficiently. Regular exercise is an effective way for individuals to lower blood glucose levels and improve glycated hemoglobin (Kirk, 2009). In people with a decreased glycated hemoglobin level, they may be able to take less insulin. A glycated

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Many people with type 1 diabetes engage in a variety of lifestyles. All kinds of exercise can be performed by those with type 1 diabetes who maintain proper blood glucose levels. During exercise, glucose is not only burned in the muscle but also taken up from the blood very quickly. In type 1 diabetics, this is a problem due to the onset of hypoglycemia. Blood glucose is relatively unchanged during exercise in individuals without diabetes because glucose uptake by skeletal muscles is precisely matched by glucose released from the liver (Goodyear & Kahn, 1998). The increasing use of insulin therapy along with proper diet has allowed the diabetic to engage in any kind of exercise or competition event. Glycemic response is imperative for diabetics to monitor and control during exercise. It is important for each individual to know how their body responds to exercise and what works best for them. This will depend on the intensity or duration of exercise and how they balance their nutrition and insulin to maintain consistent glucose levels (Lisle & Thomas, 2006). What many normal people take for granted, the monitoring of blood glucose levels before, during, and after exercise is especially important for a type 1 diabetic wanting to live an active lifestyle. Improper or poor diabetes control that results in hypoglycemia or hyperglycemia will hinder an individual's athletic performance in areas such as strength training, speed, stamina, and flexibility.

An Inside Look: Beating the Blitz



The Chicago Bears starting quarterback, Jay Cutler, knows all about the challenges and complications that come with battling type 1 diabetes. After losing nearly 35 pounds, in May 2008, Cutler joined a team of nearly 2 million other Americans who have type 1 diabetes (Piper, 2014). "I was relieved when we figured out what it was and that it was treatable," he says, "Now I can play at 100 percent of my ability." Cutler has had to make permanent daily changes to his routine such as adjusting to wearing insulin pump (removed for games) and needle injections. With that comes a strict diet that has included changes such as more control over his favorite items such as tea, lemonade, and Reese's peanut butter cups. Counting his calories, getting enough rest, and weight lifting to reverse weight loss are also things he has had to be more diligent with. "I eat a lot of lean seafood and lean meats," Cutler says. "I always have a Snickers or Milky Way nearby to offset a low." Cutler learned to go into the game with a blood sugar between 100 and 150 mg/dL. He checks his levels about 4-5 times before games and then will also check every time he comes off the field during the first and second quarters (Piper, 2014). "When you get the adrenaline rushing,

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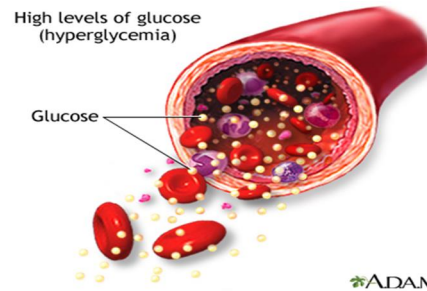
en series in the first half, I'll test to make sure I'm not getting low.ö During games, Cutler will have Gatorade nearby if his levels are low. These days, by halftime, Cutler says he pretty much knows where his blood glucose levels will be for the rest of the game. When his eyes are not downfield, they are on his most recent blood glucose test results. öIt's a disease that I've got. It isn't my fault, and I deal with it the best I can" (Piper, 2014).

How can Diabetes Impair Performance?



Strength training, speed, and stamina are three keys to improving aerobic and anaerobic athletic performance. These goals of exercise and performance can be hindered by either a hypoglycemic or hyperglycemia response to the exercise bout. Athletes with diabetes frequently describe early fatigability physically and cognitively in their performance. The cognitive decline was evident in a study by Tonoli et al, in which type 1 diabetes was shown to have an effect on the brain structure and function. According to the study, children with type 1 diabetes showed a decline in motor speed, memory, spatial memory, and executive function in response to moderate aerobic exercise. Episodes of hypoglycemia during exercise can be significant factors

influencing cognitive function in type 1 diabetes patients (Tonoli Et al., 2014). The two mechanisms of importance in response to exercise are hypoglycemia or hyperglycemia, which can both occur during exercise.



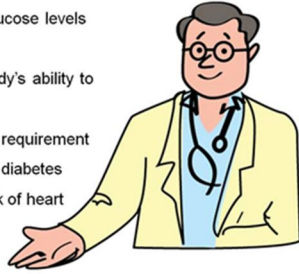
Hyperglycemia is more likely to arise with the anticipation of high anaerobic activity or during short intense forms of anaerobic activity. This response is due to increased adrenal and emotional responses. Hyperglycemia can also occur when carbohydrate or insulin intake exceeds utilization. Hypoglycemia usually occurs one to two hours after exercise (Kirk, 2009). Any type of physical activity should not be a barrier to someone with type 1 diabetes. Exercise brings health benefits to type 1 diabetics that include improved insulin sensitivity, improve glucose tolerance, healthy weight management and a decreased risk for heart disease and other diseases. Insulin sensitivity can be beneficial for athletes because with training and exercise they adapt and do not need as much insulin in their dosages to get the effects. In a study done by Landt et al, they investigated the influence of a program of exercise training on type 1 diabetes. They concluded from 9 type 1 diabetic subjects who underwent a 12 week training program that insulin sensitivity, assessed by the euglycemic clamp technique at insulin infusion rates of 100 mU/M²/min, showed an increase of insulin-mediated glucose disposal from 274 ± 33 to 338 ± 28 mg/M²/min, representing an increase in insulin sensitivity of 23 ± 5%

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there is a strict diet and insulin administration plan (Landt et al., 1985).

How does Exercise help?

- ✓Lowers blood glucose levels quickly
- ✓Improves the body's ability to use insulin
- ✓Reduces insulin requirement
- ✓Better control of diabetes
- ✓Reduces the risk of heart disease



SANOFI DIABETES

However, the challenge to perform a variety of exercise tasks increases with this disease. Some of the symptoms and physiological downfalls of hypoglycemia include shakiness, impaired vision, tingling of your hands or tongue, sweating, mental confusion, irritability, poor physical coordination and clumsiness.



The common result with impaired physical performance is due to inadequate fuel supply to a muscle which will result in fatigue and inability to maintain work output. Moderate hyperglycemia will change carbohydrate oxidation, but does not change performance capability. One study that investigated exercise capacity in subjects with type 1 diabetes mellitus in eu- and hyperglycemia was done by Stettler et al on 8 moderately trained type 1 diabetics. With their study, they concluded that hyperglycemia did not result in a significant

increase in the peak power output compared to normal blood glucose levels. Both control and type 1 diabetic subjects had similar levels of lactate and respiratory exchange ratios, and exercise capacity is not influenced by hyperglycemia (Stettler et al., 2006).

A study done in 2010 investigated kids and adolescents ages 6-17 with type 1 diabetes on different skill based tasks with glucose monitoring over 4 days. Glucose levels at the time for three groups were classified as hypoglycemia, normal or acceptable, and hyperglycemic (Kelly, Hamilton, & Riddell, 2010). The results of the performance indicated sports performance skill was roughly 20% lower when glucose concentrations were hypoglycemic compared to either acceptable or hyperglycemic at the time of skill testing. These imminent glucose responses to physical activity in type 1 diabetics can impair the body's ability to perform at its peak.

Nutrition for the Athlete

For an athlete attempting to perform at their peak both physically and cognitively, a proper diet and insulin regiment is the key to a high performance level. Another study that showed implications of hypoglycemia and hyperglycemia on cognitive effects was done by Gonder et al, 2009. With an onset of hypoglycemia, a cognitive effect was seen by a decreased reaction time and mental math ability. The time to complete both mental math and reaction time was significantly longer during hypoglycemia. The decrease in certain mental capacities can influence exercise performance in certain sports in which sharp cognitive function is crucial such as football, baseball, or basketball. The negative hypoglycemic effects during exercise can be eliminated via

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recommendations for type one diabetics performing exercise. The importance of planning fluid and food intake is magnified for anyone that is competing or doing any kind of physical exercise. This is important because athletes with diabetes are as capable and feel just as well exercising as those who do not have it, at least until complications occur (Hume, 2012). Pre-competition, during competition, and post competition dietary guidelines are needed for people with this type of diabetes. Different sports have their own effects on diabetes management. The type and timing of food depends greatly on the activity, duration, intensity, and blood glucose levels prior to activity (Gallen, Hume, & Lumb, 2010).

Daily Macronutrient Recommendations:



The daily macronutrient recommendations are very similar for type 1 diabetics compared to those that do not have this disease. Carbohydrate and protein intakes must be met in order to maximize training effects. Fat consumption in the range of 20-25% of total daily calories provides needed calories, fat soluble vitamins, and essential fatty acids. The requirements for carbohydrate and protein are expressed in grams/kilogram body weight. Protein for endurance athletes ranges from 1.2-1.4 g/kg body weight and

1.2-1.7 g/ kg body weight for strength athletes (MacKnight et al. 2009).



In general, carbohydrate recommendations increase as daily exercise duration and intensity increases. For people engaging in a combination of aerobic or strength training exercise would require 5-7 grams of carbohydrate/kg body weight/day. For individuals that perform endurance exercises such as running or cycling the carbohydrate intake should be in a range of 7-10 grams of carbohydrate/kilogram of body weight/day. For ultra distance or very prolonged exercise, the requirement increases to 10-12 grams of carbohydrate/kilogram body weight/day. A summary of some different daily recommendations can be seen in the following charts.

Training Load	CHO recommendations
Light Intensity	3-5
Moderate Intensity (1 hr/day)	5-7
Moderate to high intensity 1-3 hr/day	7-10
Moderate to high intensity 4-5 hr/day	10-12

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		weight
1-3 (combo of aerobic and strength) ex football, rugby	5-7	1.4-2.0
1-3 hour endurance (running/cycling)	7-10	1.2-1.4
>4-6 ultra endurance	10-12	1.2-1.4

Pre-exercise guidelines:



Depending on present blood glucose levels, the pre-exercise dietary guideline intake can vary. With type 1 diabetics in exercise, carbohydrate intake is the most important nutrient to monitor as metabolism of this fuel affects glucose levels (Sports Nutrition and Diabetes, 2014). A lower blood glucose level in the person prior to exercise would require them to consume more carbohydrates prior to exercise. If blood glucose levels are at or under 100 mg/dl, physical activity should not be performed until levels are brought up closer

to normal. Along with hypoglycemia, if a person's blood glucose levels are greater than 250 mg/dl and ketones are present in the urine, he or she should not exercise (Goodyear & Kahn, 1998). Dehydration due to exercise along with ketone body buildup can result in ketoacidosis, a life threatening condition. Because hypoglycemia is a more common problem associated with physical activity, the main goal of food and fluid consumption in the time leading up to activity is to prevent hypoglycemia either during the bout or post exercise. A good start for anyone, especially those with type 1 diabetes who lives an active life, is to consume complex carbohydrates, lean protein sources, and appropriate amounts of mono and polyunsaturated fats. This is a good way to maintain glucose concentrations as well as preserving glucose stores for anticipated activity. Performance levels may be improved if an easily digested meal of 60-100 grams of carbohydrate is consumed between 3-6 hours prior to activity or competition (MacKnight et al).

Some common and healthy pre-workout foods choices include:

Pre-workout foods



If not planning to eat for more than an hour leading up to exercise, 15 grams of carbohydrate and 7 grams of protein will be needed. Before physical activity, easily digestible and well tolerated foods should be consumed. About 3-4 hours before exercise or competition, a meal containing

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digestion meal that may include bread, pasta, chicken, eggs, or cottage cheese would be ideal as they are considered low glycemic index and would continue to affect glucose levels by the start of activity (Gallen, Hume, & Lumb, 2010). In anticipation of activity that is longer than 60 minutes, extra carbohydrates accompanied with appropriate adjustments of insulin are needed. Anaerobic activities of high intensity and short duration such as weight lifting, sprints, diving and baseball may not necessarily require carbohydrate intake prior to the activity, but may produce a delayed drop in blood sugar that would be dealt with post exercise (Lisle & Trojian, 2006). Activities that are long duration and lower intensity are considered to be a mixture of anaerobic and aerobic. For these types of activities such as cycling, jogging, and swimming, more carbohydrate intake will be required before exercise. An adjusted carbohydrate recommendation based on someone's blood glucose levels pre-activity can be seen in the following chart.

Exercise duration & Intensity	Blood glucose < 100 mg/dl	bg 100-180 mg/dl	180-250 mg/dl
<30 min @ low intensity	15 g CHO	No CHO needed	No CHO needed
30-60 min moderate intensity	15 g CHO	bg 100-120 eat 15 g CHO 120-180 no CHO needed	No CHO needed
30-60 min: High	30 g CHO	15 g CHO	No CHO needed

intensity			
>60 min: High intensity	15 g CHO/hr of activity	15 g CHO/hr activity	15 g CHO after each hr of activity

Nutrition Recommendations During Exercise:



A continued monitoring of blood glucose and the consumption of appropriate carbohydrate is also necessary during physical activity. Carbohydrate is the most important nutrient for type 1 diabetics to consume during exercise. Maintaining muscle glycogen stores during exercise has an increased importance in diabetics because of the risk of blood glucose fluctuations. As fuel demands during exercise increase, more glucose is taken up into the muscle and tissue causing a decrease in glucose levels in the blood. As mentioned previously, optimal performance during exercise can be achieved by meeting proper glucose levels through nutrition. Most of the carbohydrate intake during exercise for athletes will come in the form of commercial sporting drinks. According to Macknight et al, there is a wide variety of recommended carbohydrate

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ities that last 45-60 minutes or activities greater than 80% VO₂ max, a carbohydrate intake of 15 grams every 30-60 minutes is a good guideline starting point. For activity in excess of 60 minutes, an increased level of fluid consumption with carbohydrate is recommended because of its added contribution to maintaining proper hydration (MacKnight et al). In long duration events or exercise sessions lasting 1-4 hours, another guideline is that a type 1 diabetic should consume 30-60 grams of carbohydrate/hour during the session. According to David Lisle and Thomas Trojian, an increased carbohydrate intake with increased intensity and duration is also accompanied by a decrease in insulin dosage. For the appropriate amount of carbohydrate intake during exercise based on duration and intensity, see the following table. (Lisle & Trojian).

Intensity	<20 min	20-60 min	>60 min	>60 min (Insulin Dosage)
<60%	0 g	15 g	30 g/h	-20%
60-75 %	15 g	30 g	75 g/h	-20%
>75%	30 g	75 g	100 g/h	-20%

Some easy diet suggestions for longer events such as cycling, walking, and swimming would include foods such as bananas, trail mix, or cereal bars (Sports Nutrition & Diabetes, 2014). In contrast, for short periods of intense anaerobic exercise, people with diabetes may develop spikes in blood glucose in which an onset of hyperglycemia occurs. This is due to

catecholamine levels acting to promote glucose production. In these cases, the added increase of carbohydrate during activity is not needed due to glucose levels that are high. The following table provides an overview of some carbohydrate recommendations during activity for type 1 diabetics.

Duration of activity	CHO intake
30-60 min	CHO intake beneficial for performance of high intensity exercise of 1 hr
Events 1-3 hours	Fluid replacement and 30-60 g CHO per hour exercise
Events greater than 3 hours	30-60 g CHO per hour exercise. Replace fluid, sodium, CHO

Post-exercise recommendations:



The time after exercise is as important as any other time to monitor blood glucose levels and to prevent hypoglycemia and hyperglycemia. The post exercise needs will most likely vary by individual. The length of exercise, intensity, and the type of athlete are a few things to consider when

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Following exercise, glycogen stores in the muscle and liver are needed to be replenished. Hypoglycemia is often seen 2 hours post exercise. It can also occur and should be monitored up to 48 hours, particularly if carbohydrate stores were not replaced following exercise (Kirk, 2009). The post exercise snack or food intake should consist of carbohydrate and protein.



The quicker consumption of carbohydrate immediately after exercise will replace carbohydrate stores more efficiently. There are many different general requirements for type 1 diabetics when it comes down to how much carbohydrate consumption they should consume after exercise. Within 20 minutes post exercise is when muscle is most receptive to glucose. According to MacKnight et al., an intake of 1.0 gram of carbohydrate/kilogram body weight within 30 minutes of finishing extended exercise along with the same amount 1-2 hours post exercise will restore glycogen to pre-exercise levels and reduce risk of hypoglycemia. As always, it is important to remember to monitor blood glucose at 1-2 hour intervals to assess the response to a particular exercise bout (MacKnight et al, 2009). Further adjustments can be made with food intake or insulin dosages. The daily total carbohydrate consumption during periods of training should be in the range of 6-10 g/kg body weight is required to

maintain blood glucose levels after exercise for replacement of glycogen stores. Protein intake should range from 1.2-1.7 grams/kg body weight to help with tissue repair and muscle growth. This protein intake will be in the range of 1.2-1.4 gram/kilogram body weight for endurance athletes and 1.6-1.7 gram/kilogram of body weight for strength training athletes.

Some carbohydrate food options for a post exercise meal would be whole grain bread, crackers, cereal, granola bars, fruit juice, yogurt, and milk. Some easy and common food protein sources would be lean meat, peanut butter, or cheese. After training or activity, readily available sources of carbohydrate should be available. Just 15 grams of carbohydrate can raise blood glucose 30-50 points within a 15-30 minute timeframe. Fast acting sources of glucose may include glucose tablets, fruit juice, milk, or raisins (Gallen, Hume, & Lumb, 2010).

Fluids and electrolytes:



Fluid and electrolyte intake before, during, and after exercise is another consideration when examining training requirements for the type 1 diabetic. In order to prevent complications from dehydration, diabetic athletes should monitor and consume adequate fluids before, during, and after exercising. For diabetics engaging in physical activity, 24 ounces of water should be consumed roughly two hours prior to an event. Another 8-16 ounces of water would be

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2009). If possible, the monitoring of weight changes during exercise is useful in determining how much fluid is needed to replace body weight. For each pound of body weight lost, 16 ounces of fluid is recommended for replacement. During more intense activity, 4-8 ounces of fluid should be consumed at 10-20 minute intervals. Fluid requirements are very similar to normal people with exercise, assuming the athlete is within a reasonable range of blood glucose levels and is not suffering from hypoglycemia or hyperglycemia. For exercise sessions of greater than 60 minutes, beverages that contain 8% carbohydrate such as sports drinks or diluted fruit juices are the best replacement sources (MacKnight et al, 2009.)

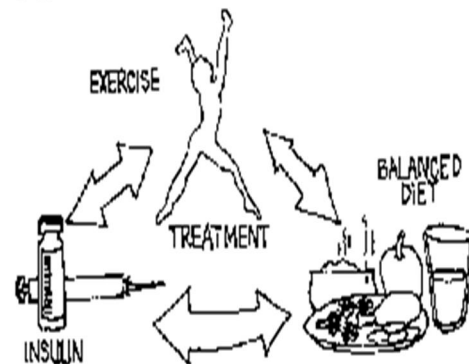


There was an interesting article regarding fluid in type 1 diabetics done by Hernandez et al on post exercise fluid recommendations. They investigated whether whole milk, skim milk, or two commercially available sports drinks are effective in preventing late onset post exercise hypoglycemia in type 1 diabetics. Subjects ingested water, whole milk, skim milk, sport drink A (carbohydrate and electrolytes), or sport drink B (carbohydrate, fat, and protein) before, during, and after 1 h of bicycle exercise at 60% VO₂max. All subjects that consumed water became

hypoglycemic. With their study, the result showed that whole milk and sports drinks that are designed for both quick (sport drink A) and long lasting (sport drink B) nutrient replenishment can be used by persons with type 1 diabetes in an effort to avoid post exercise hypoglycemia (Hernandez et al., 2000). Beverages that contain sugar concentrations of 10% or higher may cause cramps, bloating, or diarrhea during activity. Metabolism during exercise is something that can be very different among individuals. During the post exercise period, it may be best for individuals to work with professional consultants to determine how much water or carbohydrate drinks should be consumed to ensure proper hydration and normoglycemia (Sports Nutrition & Diabetes, 2014).

Take Away:

Controlling Type 1 Diabetes



Individuals with type 1 diabetes face a unique challenge when it comes to living an active life. The management of this disease has become an increasingly important skill in order for individuals to stay healthy and to also enhance their physical performance. The management of type 1 diabetes can vary greatly between individuals. Athletes and individuals with type 1 diabetes can participate in any athletic event if they carefully monitor their insulin administrations along with proper

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for every individual. Patients with this disease should develop plans of treatment that work best for them based on factors such as the extent of their disease and what kinds of activity they often engage in. It is crucial that the individual pay strict attention to the steps needed to prevent hypoglycemia and hyperglycemia. Most complications can be avoided with the proper amounts of insulin, food, and fluid intake before, during and after exercise. With intense

management, type 1 diabetics can perform in athletics and lead a relatively normal and healthy life.



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Reference List:

- Alonso, A., & Coyle, E. (1995). Fluid And Carbohydrate Ingestion Independently Improve Performance During 1 H Of Intense Exercise. *Medicine & Science in Sports & Exercise*, 200-210. Retrieved November 14, 2014, from PubMed.
- Devendra Devasenan, Liu Edwin, Eisenbarth George S.(2004) Type 1 diabetes: recent developments. *BMJ* 2004; 328:750.
- Hernandez, J., Moccia, T., Fluckey, J., Ulbrecht, J., & Farrell, P. (2000). Fluid snacks to help persons with type 1 diabetes avoid late onset postexercise hypoglycemia. *Medicine & Science in Sports & Exercise*, 904-910. Retrieved November 8, 2014, from PubMed.
- Gallen I. W., Hume, C., Lumb, A. (2010) Fueling the Athlete with Type 1 Diabetes.
- Gonder, F., Zrebiec, J., Bauchowitz, A., Ritterband, L., Magee, J., Cox, D., & Clark, W. (2009). Cognitive function is disrupted by both hypo- and hyperglycemia in school-aged children with type 1 diabetes: A field study. *Diabetes Care*, 1001-06. Retrieved November 8, 2014, from PubMed.
- Goodyear, LJ. Kahn, BB. (1998). Exercise, glucose transport, and insulin sensitivity. PUBMED. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/9509261>.
- Hume, C. (2012). Fueling the athlete with type 1 diabetes. *Type 1 diabetes* (pp. 151-165).
- Kelly, D., Hamilton, J., & Riddell, M. (2010). Blood Glucose Levels and Performance in a Sports Camp for Adolescents with Type 1 Diabetes Mellitus: A Field Study. *International Journal of Pediatrics*, 1-8. Retrieved November 10, 2014, from <http://www.ncbi.nlm.nih.gov/pubmed>
- Kirk, Susan. (2009) Hypglycemia in Athletes with Diabetes. *Clinical Sports Medicine*. Pp455-468.
- Landt, K., Campaigne, B., James, F., & Sperling, M. (1985). Effects Of Exercise Training On Insulin Sensitivity In Adolescents With Type I Diabetes. *Diabetes Care*, 461-465. Retrieved November 11, 2014, from PubMed.
- Lisle, David K., and Trojian H. Thomas. (2006). Managing the Athlete with Type 1 Diabetes. *Current Sports Medicine Reports*. volume 5, (Issue 2), pp 93-9.
- Macknight John, M., Mistry, Dilaawar J., Pastors, Joyce., Holmes, Viola., & Rynders, Corey. (2009) The Daily Management of Athletes With Diabetes. *Clinical Sports Medicine*. Pages 479-95.
- Nugent, A., Steele, I. C., Al-Modaris, F., Vallely, S., Moore, A., Campbell, N. P. S., et al. (1997). Exercise responses in patients with IDDM. *Diabetes Care*, 20(12), 1814-1821. doi:10.2337/diacare.20.12.1814
- Piper, Pat. (2014). Number Six and Diabetes: Jay Cutler On Numbers. *Diabetes Health*. Retrieved from <http://diabeteshealth.com/read/2014/11/03/7270/number-six-and-diabetes--jay-cutler-on-numbers/>
- Sports Nutrition and Diabetes. (2014). *DIAPEDIA*. Retrieved from <http://www.diapedia.org/management/sports-nutrition-and-diabetes>



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, R., Hoppeler, H., Trepp, R., Diem, P. (2006). Exercise capacity in elderly men with type 2 diabetes mellitus in eu- and hyperglycaemia. *Diabetes/metabolism Research and Reviews*, 300-306. Retrieved November 15, 2014, from PubMed.

Tonoli, C., Heyman, E., Roelands, B., Pattyn, N., Buyse, L., Piacentini, M., Meeusen, R. (2014). Type 1 diabetes-associated cognitive decline: A meta-analysis and update of the current literature. *Journal Of Diabetes*, 499-513. Retrieved November 13, 2014, from PubMed.