Chapter 13

# Exercise and Diabetes

TOPICS:

**Physical Activity**

**Goal Setting and Problem Solving**

**TEACHING OBJECTIVES:**

1. **Discuss the importance of exercise as a critical component of diabetes management.**
2. **Explain exercise recommendations and precautions for people with type 1 or type 2 diabetes.**

**LEARNING OBJECTIVES:**

**Learners (parents, child, relative or self) will be able to:**

1. **List three reasons why exercise is important.**
2. **Develop an exercise plan which includes monitoring of blood sugars, use of snacks and medication adjustments.**

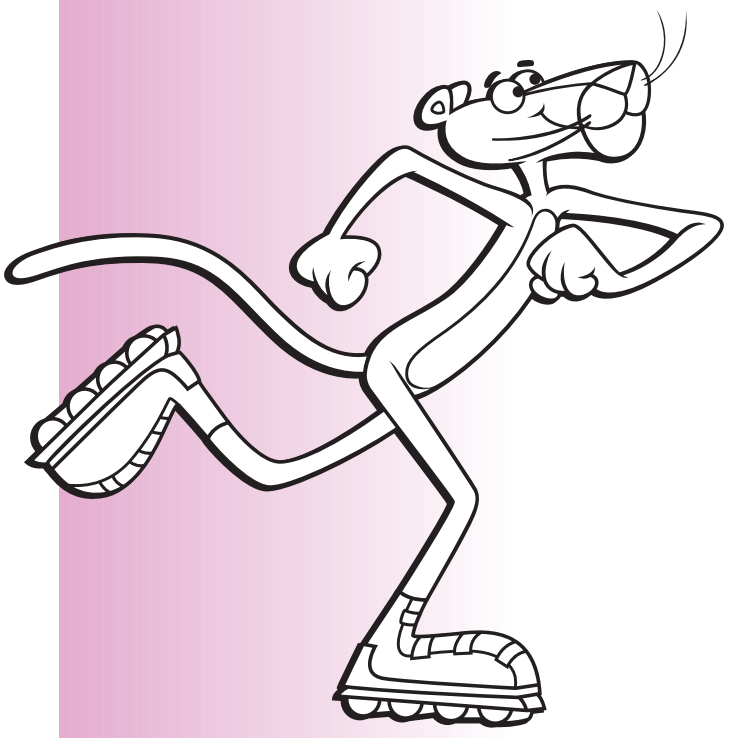
## INTRODUCTION

Many of the people with the best-controlled diabetes are those who exercise regularly. Exercise should be a normal part of life for everyone. The dietary guidelines for Americans, 2005 recommended 60 minutes of moderate to rigorous physical activity per day to prevent weight gain and a minimum of 30 minutes a day to reduce the risk of chronic disease (e.g., type 2 diabetes). We strongly encourage regular exercise for anyone who has diabetes, even if this means making a special effort to plan daily exercise. Young people from our Clinic have participated in almost every sport: football, baseball, golf, track, swimming, wrestling, dancing, skiing, basketball, soccer, weight lifting, horseback riding, jumping rope, jogging and tennis. In the Figure in Chapter 14, Monitoring Blood Sugar Control, **EXERCISE** is listed as one of the "Big 4" factors to help attain good sugar control. This is true for people with either type 1 or type 2 diabetes.

Many former and present professional athletes have diabetes. Professional baseball players with diabetes include Bill Gullickson (pitcher) and Ron Santo (third base). Gary Hall, Jr. won four medals (two gold) in the 2000 Olympics and the gold medal in the Free Style in the 2004 Olympics. Professional football players include Kenny Duckett (wide receiver), Johnathon Hayes (tight end), Wade Wilson (quarterback) and Jay Leeuwenberg, who was an All-American center for the University of Colorado in the 1990s and then went on to play professional football. At a recent conference Jay spoke about the importance of being "in a good range" for blood sugars to play optimally in pro football games. He related that he usually did at least 30 blood sugars during a professional football game. In the U.K., Gary Mabbott has type 1 diabetes and is a star football (American soccer) player. Hockey player Bobby Clarke, a former player of the

Table 1
## Why Exercise Is Important

- **Exercise lowers blood sugar levels**
- **Exercise helps people feel better**
- **Exercise helps maintain proper body weight**
- **Exercise helps keep the heart rate (pulse) and blood pressure lower**
- **Exercise helps keep blood fat levels normal**
- **Exercise improves insulin sensitivity**
- **Exercise may help maintain normal blood circulation in the feet**



Philadelphia Flyers, developed diabetes at age 15. He won the award for outstanding player in the National Hockey League twice. Nick Boynton, defenseman with the Boston Bruins in 2004, was diagnosed with diabetes at age 19 years. Billy Talbert began playing tennis at age 12, two years after he developed diabetes. He became one of the best tennis players in the world, winning 37 national tournaments and being captain of America's winning Davis Cup Team and a member of the Tennis Hall of Fame. When he was in Denver to instruct youth with diabetes about tennis, we asked Billy why he felt he had no complications after over 40 years with diabetes. He replied, "I have gotten some exercise every day of my life in which it has been possible." These examples are given to show that diabetes does not prevent participation in athletic activities.

## WHY EXERCISE IS IMPORTANT

*Exercise is important and helps people with or without diabetes in the following ways (Table 1):*

**Exercise Lowers Blood Sugar Levels:**

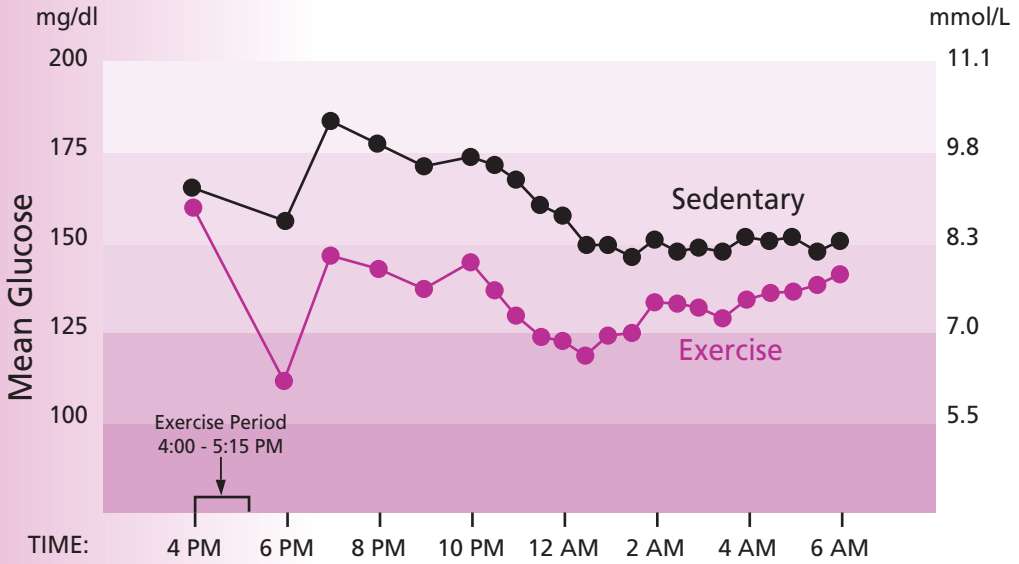
It is not completely understood why blood sugar levels are lower following exercise, but they clearly are. The **immediate effect** is likely due to muscles "burning" extra sugar during the exercise. As a result, blood sugars tend to be lower during the period of exercise.

However, there is also a **prolonged effect of exercise** on blood sugar levels. Following heavy afternoon exercise, blood sugars have been shown to be lower throughout the night until the next morning. It may be helpful to think of the exercise as causing increased insulin sensitivity over the next 12 to 16 hours. Figure 1 presents blood sugar (glucose) levels for the same 50 children on a day when they exercised compared to a day without exercise.

As a result of regular exercise, the person is more sensitive to insulin, the insulin can work more efficiently, and a lower daily dose is usually required. Regular exercise (and weight

**Figure 1**

## The Effect of Exercise on Blood Sugar Levels




This Figure presents blood glucose (sugar) levels for the same 50 children on a sedentary day (black circles) and an exercise day (red circles). The one hour of exercise at 4 p.m. resulted in lower glucose levels for the next 14 hours (through the night). Insulin doses and food intake were identical for the two days.

*(Data complements of the DirecNet Study Group: J Pediatr 147,528, 2005)*

loss) allows some people with type 2 diabetes to stop insulin injections and to change to oral medication. It is now believed many of the beneficial effects of exercise on the risk of heart disease, particularly in type 2 diabetes, are due to improvements with insulin sensitivity. It is important to exercise regularly and vigorously.

The old belief that people should not exercise if they have high blood sugar is wrong. Exercise usually helps lower the blood sugar. IT IS ONLY WHEN KETONES ARE PRESENT THAT PEOPLE SHOULD NOT EXERCISE.

Some families note a temporary rise in blood sugar levels during exercise. This may be due to eating extra snacks. It can also be due to adrenaline output with the excitement of exercise. Non-aerobic exercise (e.g., sprinting) tends to result in more adrenaline output and higher blood sugar levels than does aerobic exercise.

### Exercise Helps People Feel Better

There is a feeling of "well-being" and pride that comes from being in good physical condition. Many people just seem to feel better when they exercise daily. They tend not to tire as easily. Some people even say they are happier.

Teenagers get much of their support from friends. Friends often are made during sports activities. Exercise can give people the opportunity to mix with others. Some people like to watch TV and eat snacks that raise the blood sugar level. Exercise is a good way to improve a bad mood and to change a bad habit. In this way, exercise serves a double purpose.

### Exercise Helps Maintain Proper Body Weight

Exercise is important, not only for people with diabetes, but for everybody. For thousands of years, people had to hunt for food and were very active. In the last 100 years, modern

machines have made it possible for people to live with almost no exercise. This lack of activity has led to new health problems such as obesity, type 2 diabetes and heart trouble. THE ONLY WAYS TO PREVENT OBESITY ARE TO EXERCISE AND TO EAT MODERATELY. Exercise helps burn excess calories and prevents obesity. A recent national study in the U.S. (The Diabetes Prevention Program) showed exercise helped to prevent diabetes in people at high risk for type 2 diabetes. A person who keeps a normal weight is also less likely to have a heart attack later in life.

### Exercise Helps Keep the Heart Rate (pulse) and Blood Pressure Lower

The heart is helped by exercise for many reasons. The heart of a person who is in good physical shape can do the same work with fewer heartbeats. An average heart rate (pulse) is 80 beats per minute. Many people who exercise regularly will have values in the 60s. Blood pressure tends to be lower in people who exercise. Thus, the heart doesn't have to pump as hard. Lower blood pressure helps prevent heart attacks later in life. It is also important in preventing the eye and kidney complications of diabetes (see Chapter 22 on complications). Exercise helps to build extra blood vessels in the heart. This lets more blood flow to the heart.

### Exercise Helps Keep Blood Fat Levels Normal

We have discussed the importance of reducing cholesterol and saturated (animal) fat in the diet in Chapters 11 and 12. Many people with type 1 and type 2 diabetes have high levels of the blood fats, cholesterol and/or triglycerides. These high blood fat levels can lead to early aging of blood vessels. Exercise and good blood sugar control are the best ways to reduce blood triglyceride levels. One study showed that triglyceride levels could be reduced greatly after only four sessions of running 40 minutes a day. Exercise may also help remove cholesterol from blood vessel walls by increasing HDL (high density lipoprotein; see Chapter 11). Lowering the blood fat levels improves the health of blood vessels (including those supplying blood to the heart) and lessens the risk of heart attacks.

### Exercise Improves Insulin Sensitivity

The only way humans can increase insulin sensitivity is by exercising. As a result of exercise, the person is more sensitive to insulin, the insulin can work more efficiently, and a lower daily dose is usually required. Regular exercise (and weight loss) allows some people with type 2 diabetes to stop insulin injections and change to oral medication. It is now believed many of the beneficial effects of exercise on the risk of heart disease, particularly in type 2 diabetes, are due to improvements with insulin sensitivity. It is important to exercise regularly and vigorously.

### Exercise May Help Maintain Normal Blood Circulation to the Feet Later in Life

Data from the Pittsburgh Diabetes Registry showed that when boys with diabetes played in high school sports, they were more likely to keep normal foot circulation in later years. It is likely that the boys who were active in high school were also more apt to be active in later years. The same findings likely apply to females, although in the 1950s, when this study was begun, not many high school athletic programs were available for girls. It is important to get boys and girls with diabetes started in a sports activity at a young age so that they will be good enough to make a sports team (whether they are a star or not) as a teenager. However, it doesn't have to be a team sport. Any activity, such as walking, biking, swimming, playing or running is helpful. Most younger children are constantly active so that exercise is not a problem in the younger age group.

## TYPE 2 DIABETES AND EXERCISE

Although exercise is important for all people, it is **essential** for people with type 2 diabetes. It is also important for those people who are at high risk for type 2 diabetes. The

Diabetes Prevention Program (DPP) studied 3,234 people with impaired (not diabetic; see Chapter 4) glucose tolerance tests. (They were close to having type 2 diabetes.) **The DPP showed that 30 minutes of activity per day (five days per week) combined with a low-fat diet reduced the risk of developing type 2 diabetes by over half (58 percent).**

Why don't people with type 2 diabetes or those at high risk get into exercise programs? *Some reasons might be:*

- ✔ Psychological/stress /can't find the time
- ✔ Started too fast in the past (must start slowly)
- ✔ Too painful in the past (forgot stretching and "working-up" gradually)
- ✔ Lack of motivation (TV, computer games more fun)
- ✔ Not aware of the importance of exercise for good health

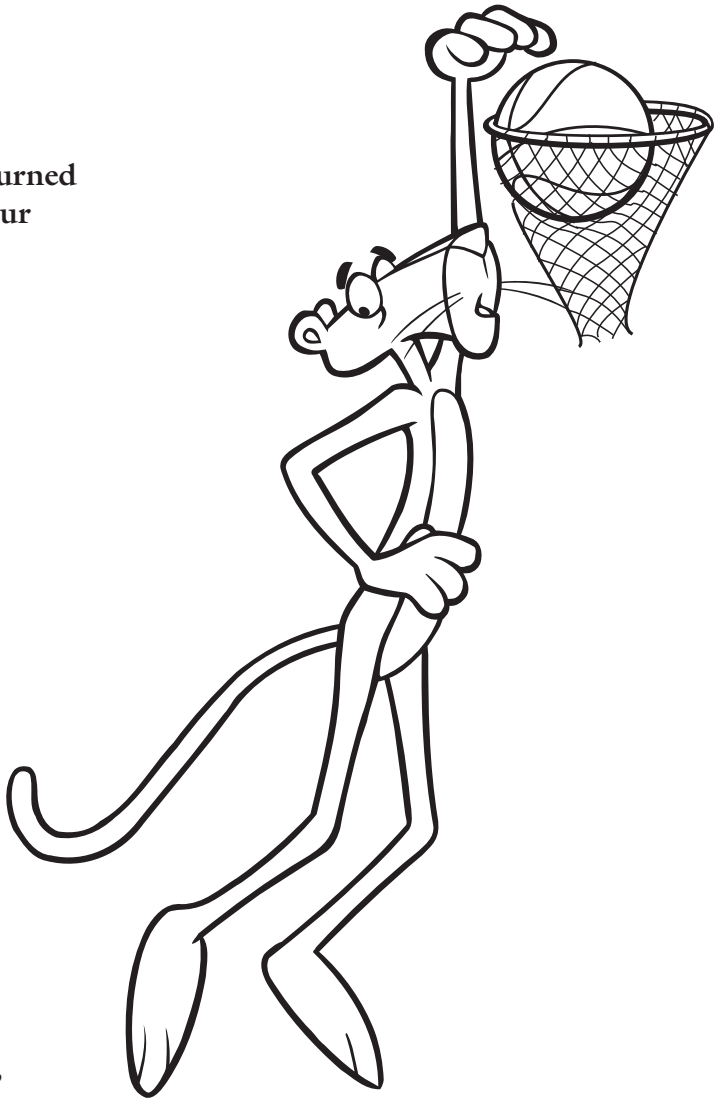
Whatever the reason, if the person is unable to achieve a lifestyle modification on his or her own, it may be helpful to join a supervised exercise and/or weight loss program. Counseling could be helpful as well. The cost of NOT modifying the lifestyle is just too great!

**Table 2**

## Calories Per Hour Expended In Common Physical Activities

| Moderate Physical Activity for One Hour | Calories Burned Per Hour |
|---|---|
| Hiking | 370 |
| Light gardening/yard work | 330 |
| Dancing | 330 |
| Golf (walking and carrying clubs) | 330 |
| Bicycling (< 10 mph) | 290 |
| Walking (3.5 mph) | 280 |
| Weight lifting (general light workout) | 220 |
| Stretching | 180 |
| **Vigorous Physical Activity for One Hour:** | |
| Running/jogging (5 mph) | 590 |
| Bicycling (> 10 mph) | 590 |
| Swimming (slow freestyle laps) | 510 |
| Aerobics | 480 |
| Walking (4.5 mph) | 460 |
| Heavy yard work (chopping wood) | 440 |
| Weight lifting (vigorous effort) | 440 |
| Basketball (vigorous) | 440 |

Source: Adapted from the 2005 *"DGAC Report"* and the *"Dietary Guidelines for Americans"*, 2005



## GETTING STARTED

Now that you know seven of the many reasons why exercise is important for a person with diabetes, you should ask yourself some questions.

### Which Kinds of Exercise are Best?

THE BEST EXERCISE IS THE ONE YOU LIKE. Different strokes for different folks! If you hate to jog or swim, but you do it because you are told to, you probably won't exercise regularly. Swimming five days a week in an outdoor pool is fun in the summer, but it may be more difficult to do in the winter. You may need to choose a different exercise, such as jumping rope or riding an exercise bicycle, in the winter. Approximate calories used per hour for different types of exercise are shown in Table 2.

Only aerobic exercises help heart fitness. Aerobic exercises include most continuous activities (such as jogging, walking, swimming or bicycling) that are done for a period of 30 minutes or longer. Many training programs use machines at health spas that feature continuous aerobic activity rather than short bursts of activity followed by a rest (a non-aerobic activity). When activities such as weight lifting are done in short bursts with rests in between, they are considered strength building, not aerobic.

Boxing is the only activity in which we have asked youth not to participate. The high incidence of eye injuries is not needed by a person who has diabetes (which can also cause eye problems). In addition, the high incidence of brain damage makes boxing dangerous for people with or without diabetes.

Careful diabetes management to prevent low blood sugar levels (as discussed in this chapter) is important in all activities. It is particularly important for those with which there is an associated danger (e.g., scuba diving). Fortunately, dangerous activities are not generally used for daily aerobic activity.

### When Should I Exercise?

The best time to exercise will vary with your schedule. Think ahead and make changes in insulin doses and snacks to help prevent low blood sugars. Children like to play after school, and most organized sports activities take place at that time. This is the time when most intermediate-acting insulins are having their main effect so taking extra care to prevent low blood sugar is important. When possible, pick an exercise time, preferably the same time each day, and adjust the snacks and insulin dose to fit the exercise. YOUR DIABETES MANAGEMENT CAN BE ADJUSTED TO SUIT YOUR LIFESTYLE. YOUR LIFESTYLE DOES NOT HAVE TO BE ADJUSTED TO FIT YOUR DIABETES.

### When Should I Not Exercise?

If blood or urine ketone levels are elevated, exercise can raise the ketone level even higher. Thus, it is not good for you to exercise when you have ketones. Remember to check ketones before exercising if you are not feeling well.

### How Should I Get Started?

The best way to make exercise a part of everyday living is to begin early in life. Older children may not be as willing to begin a regular exercise program. Exercise should be part of the normal routine. Many people prefer TV or computer games instead of exercise, and the parent may have to encourage exercise. The parent can reward the child for good behavior with exercise activities such as skating and swimming. It is helpful if the parent can have fun with the child in the activity. Jogging, walking or jumping rope is good for parents too! Whenever a child has a parent's attention and company, the time quickly becomes a reward. A child of any age will often pick up the parent's exercise behaviors. The parent needs to be a good example by exercising regularly even if it is not with the child. Exercising with a friend(s) can be fun. Friends can help each other continue the exercise plan.

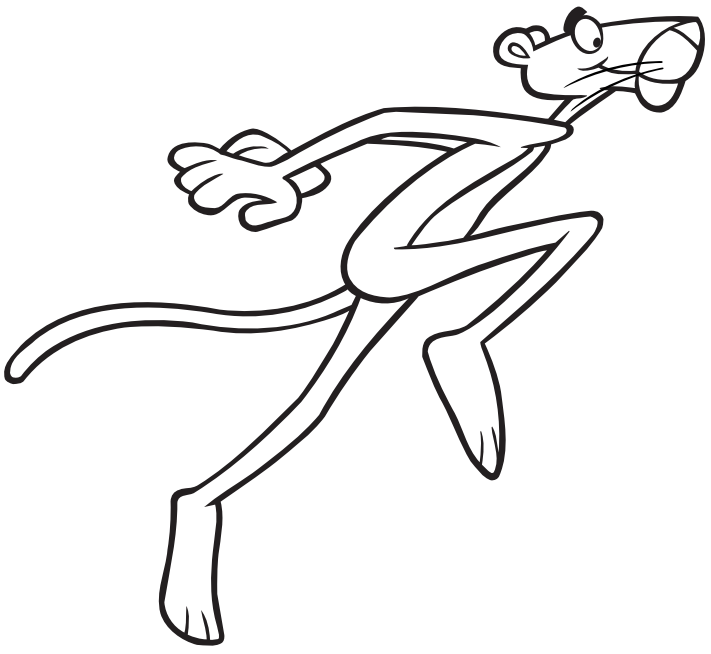
When beginning a new exercise program, it is always best to START SLOWLY and gradually extend the time and amount of exercise. This will result in fewer sore muscles

and a better chance to continue the program. Recommendations for people over 35 years old or who have other risk factors are discussed under "Age and Exercise" in Chapter 7.

### How Often and How Far?

How often should the person with diabetes exercise? THIRTY MINUTES OF AEROBIC EXERCISE, AT LEAST FIVE TIMES PER WEEK, IS NOW CONSIDERED IDEAL. The more exercise a person gets, the more fat that is "burned." Some people burn more calories with their exercise than others. This is partly related to how hard and how long the person exercises. For example, a person who runs at a rate of seven minutes per mile burns 300 calories in 30 minutes. However, if the person runs at 11 minutes per mile, 200 calories are burned in 30 minutes. If weight loss is one of the goals, it may be necessary to work harder or for a longer period to reach the desired goals.

It is wise to check the pulse immediately (for 10 seconds, and multiply by six) after stopping the activity. If the pulse is more than 160 beats per minute, the exercise has probably been too strenuous.



## PREVENTING LOW BLOOD SUGARS (HYPOGLYCEMIA) DURING EXERCISE

It is essential to prevent low blood sugar reactions during exercise. The DirecNet Study Group found that children were less apt to have low sugars during heavy exercise if their blood sugar level prior to the exercise was above 180 mg/dl (10.00 mmol/L). Preventing low sugars can be done in several ways.

### ✔ Check blood sugars before, during and after the exercise

The best way to know how any exercise affects a person is to check blood sugars before, during (when possible) and after the exercise. Once a pattern is detected (e.g., "swimming always makes my blood sugar fall" or "softball doesn't seem to affect my blood sugar"), more accurate insulin and food changes can be made. Sometimes blood sugars go up with exercise. This may be because of output of the hormones glucagon and adrenaline (epinephrine), which is a normal response in people with or without diabetes. These hormones cause sugar to be released from the liver, which stores and raises the blood sugar for varying periods of time. Therefore, don't be overly concerned about a high number immediately following an activity. Wait one to two hours and recheck the blood sugar to see if it has fallen. Keeping good records is important so when a similar exercise is done at a similar time of the day (with the same insulin peaking) and with a similar starting blood sugar level, the best plans for insulin changes and food can be made. A suggested exercise record is shown in Table 3. The overall effect of activity is to lower blood sugar levels.

Some people become frustrated with the "ups and downs" of blood sugars during exercise. It is important to remember, **"DIABETES IS A COMPROMISE."** One must put up with the changes in blood sugars in return for the better health of the heart, blood vessels and the entire body.

Table 3

## Exercise Record

| Day and date | Insulin or Oral meds (time taken) | Type of exercise | Time of day (start/end) | Pre-exercise blood sugar | Snack(s)eaten (and times) | Blood sugars during/after exercise (and times) | Hypoglycemic episodes (and when) |
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### ✔ Eat before heavy exercise

If you are going to exercise around mealtime, you should eat the meal first. When possible, allow a half-hour for digestion. Liquids such as milk and juices are absorbed most rapidly and generally prevent low blood sugar reactions for the next 30-60 minutes. Solid foods, such as those eaten at mealtime, are digested more slowly and usually provide protection for at least two to three hours. When it is possible to choose the exercise time, try to begin the exercise 30-60 minutes after a meal or snack (and omit or reduce the Humalog/NovoLog/Apidra). Table 4 gives suggestions for snacks for people who take insulin. Although detailed tables are available matching exercise energy spent with food energy to take in, nothing works better than **EXPERIENCE** and **FREQUENT BLOOD SUGARS.**

### ✔ Have extra snacks available during exercise

THE PERSON WITH DIABETES MUST ALWAYS HAVE A SOURCE OF SUGAR AVAILABLE. Parents have sewn pockets in basketball shorts, jogging pants and other clothes to hold three sugar packets, three sugar cubes or three glucose tablets for a possible emergency. Joggers' wallets on shoes work nicely. A sandwich or similar snack should be available nearby, as a sugar packet may last only a few minutes. It is helpful for the coach or instructor to have a tube of instant glucose or some other emergency source of sugar.

It is often difficult to guess the amount of a snack necessary for a particular activity. If the exercise is in the hour after a meal, an extra snack may not be needed. If a person is physically unfit, the blood sugar may drop more rapidly than if the person is physically fit. It is very useful to monitor the blood sugar to determine what the correct snack is prior to the exercise. If the blood sugar is low (e.g., below 100 mg/dl or 5.5 mmol/L), a larger snack is needed than when the blood sugar is high. **IN FACT, EXERCISING CAN BE A VERY EFFECTIVE WAY TO LOWER A HIGH BLOOD SUGAR (AS LONG AS URINE KETONES ARE NOT PRESENT).** Blood sugars may actually increase slightly during the first hour of exercise because the body releases the hormones glucagon and adrenaline. Blood sugars may then decline. The type of snack can be varied depending on the expected length of the activity. IN GENERAL, THE MORE RAPIDLY ABSORBED CARBOHYDRATES, SUCH AS MILK OR JUICE, ARE USED FOR SHORT-TERM ACTIVITIES. More food is added, such as crackers or bread, if the activity is to last longer. THE SNACK THAT KEEPS THE BLOOD SUGAR UP THE LONGEST IS ONE THAT INCLUDES PROTEIN AND FAT ALONG WITH THE CARBOHYDRATE. This might be a cheese or meat sandwich with a glass of juice. It is wise to check the blood sugar after the activity to help decide what to use for a snack the next time. Extra foods taken during the exercise period can help keep blood sugars in the normal range (see Table 4). **Experience is the best teacher!**

It is a good idea to keep packets of cheese and crackers in the glove box of the car to eat before or after an activity. This is especially important if the distance is great between home and the activity.

**"DELAYED HYPOGLYCEMIA"** refers to low blood sugars several hours after the exercise is over. These may occur three to four hours or up to 12 hours after exercise. Some people with type 2 diabetes who are not in good physical condition may experience delayed hypoglycemia. This may happen up to 24 hours after the exercise. The result may be a low blood sugar in the middle of the night. It may happen because extra sugar in the blood goes back into storage in the muscle. Hormone changes with sleep (e.g., lower adrenaline levels) may also be important.

*It is best prevented by:*

1. Extra carbohydrate at the next meal or snack (even when the blood sugar is above-range)
2. A longer-lasting snack (including solid carbohydrate, protein and fat) at bedtime
3. Reducing the insulin dose (see below)

Table 4

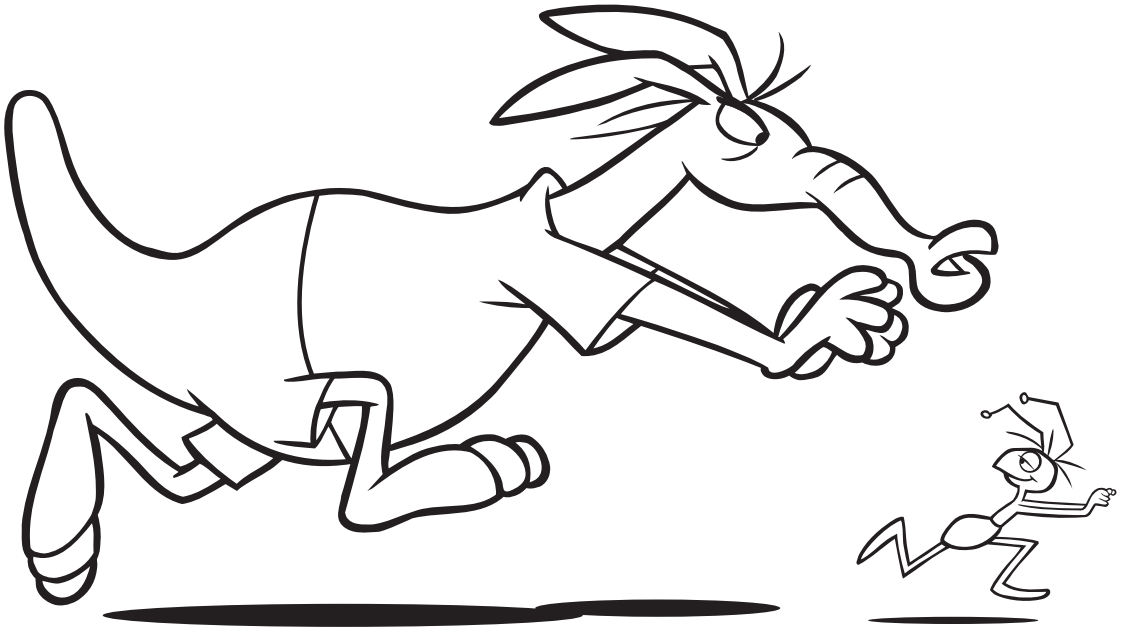
## Extra Food to Cover Exercise*†

| Expected length of exercise | Blood sugar level mg/dl | mmol/L | Examples of foods |
|---|---|---|---|
| **A.** Short (15-30 minutes)† | < 80 | < 4.5 | 8 oz Gatorade or milk** or 4-6 oz juice** |
| | 80-150 | 4.5-8.3 | A fresh fruit (or any 15 grams carbohydrate**) |
| | > 150 | > 8.3 | None |
| **B.** Longer (30-120 minutes)† | < 80 | < 4.5 | 8 oz Gatorade or milk** or 4 oz juice plus 1/2 sandwich |
| | 80-150 | 4.5-8.3 | 8 oz Gatorade or milk plus fresh fruit |
| | > 150 | > 8.3 | 1/2 sandwich** |
| **C.** Longest (2-4 hours)*† | < 80 | < 4.5 | 8 oz Gatorade or 4 oz juice, whole sandwich |
| | 80-150 | 4.5-8.3 | Fruit, whole sandwich |
| | > 150 | > 8.3 | Whole sandwich |

** Remember to also drink water, Gatorade or other fluids (one 8 oz glass for **A**, two 8 oz glasses for **B**, and three 8 oz glasses for **C**) before or during the exercise to prevent dehydration. This table is for a moderate degree of exercise (e.g., walking, bicycling leisurely, shooting a basketball or mowing the lawn). If heavier exercise (e.g., jogging, bicycle race, basketball game or digging in the garden) is to be done for the same amount of time, then more food may need to be added. Amounts vary for different people and the best way to learn is to do blood sugars before and after the exercise and keep a record of the blood sugar values (see Table 3).*

*** Each of these represent 15 grams of carbohydrate which will last for about 30 minutes of moderate exercise. A sandwich with meat or other protein lasts longer.*

*† May also need to reduce insulin dosage*



### ✔ Reduce the insulin dosage

Before trying an activity for the first time, discuss any changes that might be needed in insulin dosage with your diabetes care provider. The insulin dose is easy to decrease if you know which insulin is having its main effect during the time of exercise. Suggestions for insulin reductions for different aged children are shown in Table 5.

If extra morning exercise is planned, you can reduce or even leave out the morning rapid-acting insulin or Regular insulin. If late afternoon exercise is planned, you can reduce the morning NPH or noon rapid-acting insulin by 10-50 percent. If the activity is in the evening, the dinner rapid-acting insulin is often reduced. Similarly, Lantus insulin at dinner or in the evening may be reduced by a few units when heavy exercise will occur/occurs after dinner. People reduce insulin by different amounts. **EXPERIENCE IS THE BEST TEACHER.**

You should reduce the insulin that is active during the period of exercise. Suppose you are receiving 30 units of NPH insulin in the morning and you have a soccer game in the afternoon. You might reduce the dose by 10-20 percent (three to six units). You would then receive 24-27 units of NPH insulin.

If strenuous exercise is planned for all day, both the morning NPH (if taken) and the rapid-acting insulins can be reduced. The evening insulin dose may also need to be reduced to prevent "delayed hypoglycemia." If strenuous exercise is planned for the evening, the evening Humalog/NovoLog/Apidra or Regular insulin can be reduced or omitted. One reason the evening insulin (including the Lantus whenever taken) might be decreased is for overnights at friends' homes when a child may be staying up later than usual. More activity and excitement burn more sugar, and less insulin may be needed. You may have to try a few times before you find the best way to reduce your insulin for activities. Keep careful records and discuss them at clinic visits. Blood sugar tests before and after exercise can help you make these decisions.

### ✔ Changing the rapid-acting insulin

Most low blood sugars from rapid-acting insulins occur in the first 90 minutes after injection. Thus, if exercise is planned in the first hour after eating, it would be wise to reduce the rapid-acting insulin (often by half). It is important to THINK AHEAD as to whether to reduce the insulin when extra activity is scheduled. People with type 2 diabetes who tend to get low with exercise may also need to change their medicines (particularly if receiving sulfonylurea meds – see Chapter 4) when exercising.

### ✔ Reducing insulin pump basal and bolus doses

Reduction of Humalog, NovoLog or Apidra insulin in an insulin pump during exercise is discussed in Chapter 26. Use of pumps has the advantage that the insulin can be disconnected or a temporary basal used when spontaneous exercise occurs. (In contrast, insulin from an injection given earlier in the day cannot be negated.) Temporary basals are very useful for exercise (Chapter 26) and are often set at 50 to 75 percent of the usual basal for the period starting 30 to 60 minutes before the exercise and for the period during the exercise. Many people also set a temporary basal for the nighttime hours if the exercise has been strenuous (to help prevent "delayed" hypoglycemia).

### ✔ Change the injection site

The choice of where you inject the insulin can help prevent low blood sugars. Exercise increases blood flow into the part of the body that is moving. The increased blood flow takes up more insulin. When a person with diabetes exercises, the blood insulin level may increase; whereas insulin levels decrease in non-diabetics during exercise. If you inject insulin into an arm or leg that you will use heavily during exercise, your body may absorb the insulin too rapidly. If you are going to run, don't inject insulin into the leg. If you are going to play tennis, avoid the tennis arm. The abdomen is a good site for most strenuous exercise days.

Table 5

## Insulin Dosing Algorithms for *EXERCISE*

| Expected Time of Exercise | Infants | Preschool | School Age | Pre-Teen | Adolescents/ College Age |
|---|---|---|---|---|---|
| | *Birth - 2 yrs.* | *3 - 4 yrs.* | *5 - 9 yrs.* | *10 - 12 yrs.* | *13 - 25 yrs.* |
| **Before Breakfast** | ↓ dinner or p.m. N or Lantus by 1/4 to 1/2 unit (evening before) | ↓ dinner or p.m. N or Lantus by 1/2 unit (evening before) | ↓ dinner or p.m. N or Lantus by 1/2 -1 unit (evening before) | ↓ dinner or p.m. N or Lantus by 1 unit (evening before) | ↓ dinner or p.m. N or Lantus by 1-2 units (evening before) |
| **Mid-Morning** | ↓ a.m. RAI or R by 1/4 to 1/2 unit | ↓ a.m. RAI or R by 1/2 unit | ↓ a.m. RAI or R by 1/2 -1 unit | ↓ a.m. RAI or R by 1 unit | ↓ a.m. RAI or R by 1-2 units |
| **Afternoon** | ↓ a.m. N or noon RAI or R by 1/4 to 1/2 unit | ↓ a.m. N or noon RAI or R by 1/2 unit | ↓ a.m. N or noon RAI or R by 1/2 -1 unit | ↓ a.m. N or noon RAI or R by 1 unit | ↓ a.m. N or noon RAI or R by 1-2 units |
| **Evening** | ↓ dinner RAI or R by 1/4 to 1/2 unit | ↓ dinner RAI or R by 1/2 unit | ↓ dinner RAI or R by 1/2 -1 unit | ↓ dinner RAI or R by 1 unit | ↓ dinner RAI or R by 1-2 units |
| **All Day** | ↓ All insulins by 10-50% | ↓ All insulins by 10-50% | ↓ All insulins by 10-50% | ↓ All insulins by 10-50% | ↓ All insulins by 10-50% |

Appreciation is expressed to DeAnn Johnson, RN, CDE and others of the Barbara Davis Center staff who helped develop this table.

**morn. = morning; ↓ = lower, decrease; N = NPH**
**RAI = Rapid-acting insulin (Humalog, NovoLog or Apidra) R = Regular insulin**

### ✔ Make sure others know

It is important that coaches and teammates are aware of the diabetes. A team manager may be a good person to carry extra sugar snacks. It is helpful if the coach can have at least some awareness of the diabetes and know the symptoms and treatment of low blood sugar. A letter is included at the end of this chapter that you are welcome to copy as often as you like to share with coaches. Remember that when a low blood sugar occurs during a sporting event, it is important to rest for at least ten minutes to let the blood sugar rise. The coach should be aware of this. Suggestions for exercising safely are summarized in Table 6.

## NUTRITION FOR EXERCISE

We frequently have adolescents ask us, "Can I take a protein supplement and/or should I take amino acids?" The answer to these questions is "No." Taking extra protein or amino acid supplements will NOT build muscles. The only way to build muscles is to do the physical exercise necessary to expand the muscle mass. The foods to eat are described in Chapters 11 and 12. There is no better food plan for building muscles than the plans described in those chapters.

## HYDRATION AND EXERCISE

Proper hydration (drinking fluids) is essential during exercise. Exercising during hot weather requires special attention. Drinking extra fluids should begin an hour or two before starting to exercise. A general rule is to drink 8 oz of fluids for every 30 minutes of vigorous activity. Liquids such as milk, Gatorade and fruit juices help replace water, salts and carbohydrates. Drinking Gatorade (or other sports drinks) at half-hour intervals during strenuous exercise works well for many people. Table 4 recommends suggested fluid amounts for different levels of activity.

Table 6

### Suggestions for Exercising Safely

- Eat before heavy exercise
- Try to have the blood sugar above 180 mg/dl (10 mmol/L) before heavy exercise
- Have extra snacks available during exercise; some people use Gatorade, 4-8 oz, for every 30 minutes of vigorous exercise
- Always carry sugar
- Reduce the insulin dose (including the basal and/or bolus pump doses)
- Consider the injection site (the abdomen is usually best)
- Check blood sugars before, during and after exercise to learn the best insulin adjustment for the activity
- Wear an ID bracelet or necklace
- Try to exercise with a friend who knows about low blood sugar reactions
- Make sure coaches know about low blood sugars (see letter at end of this chapter)
- Do not exercise if ketones are present
- Drink plenty of water, especially in hot weather
- If delayed hypoglycemia occurs frequently, extra carbohydrates should be taken with the next meal or snack and the insulin dose decreased
- Have fun!! Find an exercise you enjoy and incorporate it into your daily life

## AGE AND EXERCISE

Adults are advised to discuss plans to begin a new exercise program with their diabetes care provider first. As with everyone, starting slowly and gradually increasing the amount of exercise is important. Proper stretching (five to 10 minutes) **BEFORE, DURING** and **AFTER** the exercise will help prevent cramps and stiffness that may otherwise discourage further exercise.

*Having a medical check-up before starting a new exercise program is recommended if you:*

- ✔ are over 35 years of age
- ✔ have had type 1 diabetes more than 15 years
- ✔ have had type 2 diabetes more than 10 years
- ✔ have additional risk factors for a heart attack
- ✔ have eye or kidney complications
- ✔ have neuropathy (Chapter 22)

*A graded exercise test might also be helpful. The maximum heart rate during exercise should not exceed 220 minus age.*

Strenuous activities, including weight lifting and jogging, are discouraged for people who have severe eye changes of diabetes (proliferative retinopathy). This should be discussed with the diabetes eye specialist. Similarly, people with neuropathy should discuss with their diabetes care provider the pros and cons of exercise. When peripheral neuropathy is severe, weight-bearing exercise should be limited. With both severe eye changes and neuropathy, exercises that involve straining, jarring, or that cause increased pressure on the eyes or feet must be avoided. It is sometimes wise to have a "baseline" electrocardiogram (ECG) done prior to beginning a new exercise program. Other tests are then possible if there are any suggestions of abnormalities. People may ask their diabetes care provider to review with them the ADA guidelines for exercise that were published in the January, 2005, Supplement to *"Diabetes Care"*.

## SUMMARY

Exercise is important for all people, but especially for a person with diabetes. Exercise can improve the blood lipids, reduce blood pressure and improve cardiovascular fitness. It is very helpful for people with type 2 diabetes to reduce weight. Choose exercises that you enjoy. If possible, the amount of exercise and the time of day should be fairly **CONSISTENT.** You can change the diabetes management to fit the exercise. It is not necessary to change the exercise to fit the diabetes. Suggestions for exercising safely are summarized in Table 6. You can plan the exercise after a meal, reduce the insulin dosage or take extra snacks to help prevent low blood sugars. YOU SHOULD CARRY A SOURCE OF SUGAR AT ALL TIMES AND YOU SHOULD ALWAYS HAVE A LONGER-LASTING SNACK AVAILABLE NEARBY. Remember, it is wise to THINK AHEAD about what the day's schedule will bring and plan accordingly.

## DEFINITIONS

**Abdomen:** The area around the belly button. The fatty tissue of the abdomen can be used as an injection site.

**Adrenaline (epinephrine):** The excitatory hormone. This normally increases early in exercise and may result in an initial rise in the blood sugar.

**Aerobic:** A continuous exercise usually lasting 25 minutes or longer.

**Buttocks (seat):** What a person sits on. The fatty tissue of the buttocks can be used as an injection site.

**Delayed hypoglycemia:** Low blood sugars occurring 4-12 hours after heavy physical exercise. This usually occurs as sugar leaves the blood to replace depleted muscle sugar stores.

**DPP:** The **D**iabetes **P**revention **P**rogram. A study of 3,234 people who were overweight and had impaired (not diabetic) oral glucose tolerance tests. Exercise and weight loss (see this chapter) reduced the development of diabetes by 58 percent.

**Glucagon:** A hormone (like insulin) which also is made in the islets of the pancreas. It has the opposite effect of insulin and raises the blood sugar.

## QUESTIONS AND ANSWERS FROM NEWSNOTES

**Q** **My daughter just started swimming practices everyday from 3:30-5:30 p.m. Her pre-dinner blood sugars are over 200 mg/dl (11.1 mmol/L) when she gets home. However, she has awakened at 3:00-4:00 a.m. the past two mornings feeling shaky. Is that possible?**

**A** Your daughter has the classic symptoms of "delayed hypoglycemia," which is not uncommon. Her blood sugar is high when she gets home from swimming as she has put out adrenaline (epinephrine), the excitatory hormone, during the exercise. All people, with or without diabetes, normally do this. The adrenaline causes breakdown of stored sugar in the liver (glycogen) to help keep the blood sugar up during the exercise. It is a safety mechanism.

At a later time, the sugar goes back into the muscle – often 4-12 hours later. When this happens, the blood sugar falls and she awakens feeling shaky. This is less likely to happen if the evening NPH insulin dose is decreased, and it is often necessary to decrease the dose by as much as two to six units to prevent delayed hypoglycemia.

**Q** **Our doctor has told us not to reduce the insulin dose on heavy exercise days, but just to eat more food. We were told on one of the Children's Diabetes Foundation's ski days to also reduce the insulin dose. We are now confused.**

**A** An important part of managing exercise with diabetes is to prevent low blood sugars or "insulin reactions." Planning ahead is very helpful. Some children can just eat more food and will do fine. Many teenage girls are watching their diets, and when told to eat more food, will refuse to do so. Severe reactions can then result. Reduction of insulin dosage is the only way to prevent reactions in such cases. Often a combination of some reduction in insulin dosage and eating extra snacks turns out to be the best solution.

Dear Coach,

This letter is on behalf of _____ who is participating in _____ this year. Although we do not want to single out people with diabetes, there are things that you need to be aware of to help _____'s performance and enjoyment of the sport.

Exercise is very important for children and adolescents with diabetes. The overall effect of exercise is to lower blood sugar. We hope _____ will take the right amount of insulin and eat according to the anticipated activity for the day. However, even when these things are done, there may be times, especially with increased activity, when he/she may have an "insulin reaction," a low blood sugar, a condition requiring immediate attention. The symptoms of an insulin reaction include one or more of the following: shakiness, dizziness, sweating, rapid onset of extreme hunger or tiredness and paleness. Some people complain of double vision and headaches. You may also notice _____'s performance to suddenly become very poor, or his/her overall mood may change to being very crabby or emotional.

If a low blood sugar occurs, a can of fruit juice, 8 oz of Gatorade, or two teaspoons of sugar followed in five to 10 minutes by solid food (fruit, cheese and crackers or a sandwich) will help correct this condition. He/She should rest for a minimum of ten minutes to let the blood sugar return to normal. However, some children will still have a headache and may not feel like continuing. We encourage families to be prepared for insulin reactions at all times by having the proper foods available.

Many people with diabetes will change their insulin dose on days they anticipate a practice or game. The scheduling (or cancellation) of these events ahead of time helps the person (and parents) to be prepared. Again, it is very important for youth with diabetes to be involved in sports. It helps with their sugar control and allows their insulin to work more effectively. A person with diabetes should not be and does not want to be treated differently because of having diabetes.

Please do not hesitate to call if you need more information or have any concerns. Our phone number is _____.

Sincerely,

*(You may copy this letter as often as you wish.)*