

DIABETES AND EXERCISE: TIPS FOR BETTER PERFORMANCE

With proper experience, planning, conditioning, and strategies for managing diet and insulin, the person with uncomplicated diabetes can engage in any type of exercise at any level of intensity. The goal is to complete the exercise and recovery period with minimal changes in blood glucose. For non-obese people with Type 2 diabetes mellitus (insulin is produced by the pancreas but is ineffective at stimulating glucose uptake from the blood into the cells of the body) who can control their disease simply with diet and regular exercise, no additional precautions are required. The key components of a successful regimen for those with Type 1 diabetes mellitus (no insulin is produced) are to reduce the amount of insulin administered prior to exercise and/or to supplement the diet with carbohydrate. While these are seemingly simple strategies, it is the fine-tuning of these actions that spells success or failure.

Many of the recommendations that follow have been adapted from the publications cited in the list of suggested additional resources at the end of this supplement.

What is the Optimal Time of Day for Exercise?

Disturbances in blood glucose are less likely if exercise is performed in the morning before breakfast and before the morning administration of insulin. This is because circulating insulin is low at this time, and if a regular meal was consumed the night before, both liver and muscle glycogen stores should be filled.

What Should Be Done Before Exercise?

1. Measure blood glucose concentration to determine how well it is under control.
 - If blood glucose is <5 mM (90 mg/dl), extra carbohydrate before exercise will likely be required.
 - If blood glucose is 5–15 mM (90–270 mg/dl), extra carbohydrate may not be required.
 - If blood glucose is >15 mM (270 mg/dl), delay exercise and measure urine ketones.
 - a. If urine ketones are negative, exercise can be performed, and extra carbohydrate is not required.
 - b. If urine ketones are positive, take insulin and delay exercise until ketones are negative.
2. Determine the appropriate pre-exercise carbohydrate meal.

Before exercise one can estimate the intensity, duration, and the energy requirement of the exercise by consulting standard tables. By dividing the estimated calorie requirement by four (each gram of carbohydrate is equivalent to four calories), the potential carbohydrate requirement in grams can be predicted. Diabetics should eat or drink an appropriate carbohydrate-containing snack or meal 1–3 h prior to exercise. This food or beverage should contain about 15 g of carbohydrate per 30 min of anticipated moderate-intensity exercise. Foods such as fig bars, crackers, yogurt, muffins, oatmeal cookies, soups, dried fruit, bread sticks, and granola bars are appropriate. Drinks that contain simple carbohydrates and electrolytes are excellent for helping avoid hypoglycemia and plasma volume depletion during exercise (for example, an 8-oz serving of Gatorade contains 14 G of carbohydrate). Even whole milk, skim milk, and orange juice are better than water alone. On the other hand, meal replacement drinks designed to provide complete supplementation, i.e., carbohydrate, fat and protein, can lead to an inappropriate rise in blood glucose during and after exercise.

3. Administer the appropriate pre-exercise insulin dose.
 - Inject insulin (or adjust the output of an insulin pump) about 1 hour before exercise.
 - Decrease the dose of insulin so that the greatest increase in circulating insulin does not occur during the exercise period.
 - Do not use an arm or leg that will be involved in exercise as an injection site and be sure that the insulin is injected into subcutaneous tissue not muscle.

What Should Be Done During Exercise?

1. Monitor blood glucose during long exercise sessions. For running, cycling, swimming and other endurance types of activities, this may require setting a circular course so that glucose meters are periodically available.
2. Always replace fluid losses adequately. The goal should be to replace all or nearly all of the body weight lost as sweat during the exercise period itself. This weight loss can be estimated by recording the difference in body weight before and after exercise on prior occasions.

3. If required, use supplemental carbohydrate feedings (an additional 40–50 g for adults, 20–30 g for children) every 60 min during extended periods of moderate intensity exercise. For example, Gatorade restores blood glucose very rapidly during exercise in people with Type 1 DM who are becoming hypoglycemic. Other sports drinks with a similar composition (~6% carbohydrate plus electrolytes) may also be effective but have not been studied.

What Should Be Done After Exercise?

1. Monitor blood glucose, including overnight monitoring if exercise is not habitual and/or is performed in the late afternoon. Avoid alcohol consumption after exercise because alcohol diminishes the ability to monitor marked or subtle feelings that would otherwise alert the person with diabetes to the fact that blood glucose is either too high or too low.
2. Adjust insulin administration downward to decrease immediate and delayed actions of insulin. If required, increase carbohydrate intake for up to 24 hours after activity, depending on the intensity and duration of exercise (more intense and prolonged exercise requires more carbohydrate) and the risk—based on prior experience—of the occurrence of low blood glucose. Ingestion of ~1.5 g carbohydrate/kg body weight (0.7 g/lb) soon after exercise will help restore muscle and liver glycogen after very prolonged or exhausting exercise. It should be noted, however, that although low blood glucose can occasionally occur several hours after exercise in diabetics, some insulin is needed late after exercise to fully restore muscle glycogen levels.
3. Ingest the appropriate amount of carbohydrate on a daily basis.

The type of exercise—endurance, sprint, resistance, intensity of exercise—high, medium, low, and duration of exercise—brief, moderate, prolonged—(or as in most sports some combination of these) must be considered:

- If aerobic exercise of a moderate intensity is to be undertaken on a daily basis and usually lasts less than 1 hour, the diabetic athlete should ingest 5–6 g of carbohydrate/kg body weight (2.3–2.7 g/lb) on a daily basis.
- If the athlete trains more than 1–2 hours per day, 6–8 g of carbohydrate/kg body weight (2.7–3.6 g/lb) may be required daily.

Which is Worse, Low Blood Glucose (Hypoglycemia) or High Blood Glucose (Hyperglycemia)?

The answer is that both hypoglycemia and hyperglycemia should be avoided whenever possible. For athletic competitions, hypoglycemia must be avoided because fatigue, loss of mental focus, and reductions in strength are obviously not compatible with athletic success. Thus, it may seem reasonable that maintaining a state of hyperglycemia is one way to insure athletic success. In the short run this may work, but the consistent state of hyperglycemia must be avoided because even mild but consistent hyperglycemia significantly increases the likelihood of serious medical complications of diabetes. Unfortunately, some diabetic athletes apparently sacrifice glucose control in favor of avoiding hypoglycemia so they can perform at high levels.

Other Practical Considerations

Here are some additional tips for the diabetic exerciser:

- Frequent glucose monitoring is obviously essential for safe exercise.
- Carry some form of carbohydrate snack (simple sugars).
- Carry medical identification.
- If convenient, exercise with a friend who knows you have diabetes. Carry a cell phone in case of a diabetic emergency.
- Invest in good footwear if walking, jogging, and/or running are among your chosen activities.
- Use extra care to avoid large fluctuations in plasma glucose when exercising in the cold or heat.

SUGGESTED ADDITIONAL RESOURCES

American Diabetes Association (2002). Clinical Practice Recommendations: 2002. *Diabetes Care* 25 (suppl. 1):S64–S68.

Peirce, N.S. (1999). Diabetes and exercise. *Br. J. Sports Med.* 33:161–173.

N.B. Ruderman, J.T. Devlin, S.H. Schneider, and A. Kriska (eds.) *Handbook of Exercise in Diabetes*. Alexandria, VA: American Diabetes Association.

For additional information: In the U.S.A. and Canada: 1-800-616-GSSI (4774)
www.gssiweb.com

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