

THE DIABETIC ATHLETE

Informative session for taking care of type 1diabetic athletes

What athletes will be able to do

Predict	How aerobic, interval, and strength sessions may affect glucose
Prepare	Fuel, insulin strategy, monitoring, and backup supplies
Respond	Treat lows, manage highs, and recognize ketone stop rules
Recover	Reduce delayed hypoglycemia and refuel for the next session

Keys to exercise success

- Optimize athletic performance via fuel availability
- Preventing and treating athletic injuries
- Prevent and rapidly manage hypoglycemia caused by or following exercise.
- Prevent and manage hyperglycemia caused by or following exercise
- Ups and downs of insulin and other medications
- Guidelines for blood glucose monitoring with exercise
- Thinking and acting like an athlete

The type of exercise needs must be known or addressed frequently to accommodate for rise and fall of blood glucose.

- An exercise program incorporates the type of exercise that you choose to do (mode), how hard you perform it (intensity), how long you engage in it (duration), how often you exercise (frequency), and how quickly you advance with your training (progression). (Colberg, 2009)

Why glucose can fall or rise

STEADY AEROBIC

Working muscle pulls in glucose while injected insulin cannot fall quickly. Glucose often trends down.

SPRINTS + HEAVY LIFTS

Adrenaline and other counter-regulatory hormones increase liver glucose output. Glucose may rise.

MIXED SPORTS

Stops, starts, skill work, and intensity shifts create variable responses. Personal patterns matter most.

The same athlete may drop during practice, spike during competition, and go low overnight.

Typical glucose response by workout

Workout	Common response	Main risk		Planning emphasis
Easy run, ride, swim	Falls	Low during or after		Less active insulin, planned carbohydrate
Long endurance	Progressive fall	Low plus fuel deficit		Hourly fuel, frequent monitoring
Intervals or repeated sprints	Stable or rises	Post-session high, later low		Avoid overcorrection, watch recovery
Heavy resistance	Stable or rises	Short-term high		Conservative correction, cool-down
Field or court sport	Variable	Both high and low		Use personal game-day patterns
Low-intensity recovery	Gentle fall	Low if insulin is active		Short check intervals

DIABETES AND PHYSICAL EXERCISE

- Physical exercise is important for everyone's health and well-being, but it's especially important for people with diabetes. The steps a person with diabetes takes to improve overall fitness can be greatly beneficial, because regular exercise helps lower blood sugar levels and keep them in target range.

During exercise in type 1 diabetes, the body cannot naturally lower exogenous insulin levels or properly balance counterregulatory hormones like glucagon and catecholamines, leading to high risks of blood glucose fluctuations.

Normal vs. Disrupted Physiology

- **Normal response:** Healthy pancreases decrease insulin secretion and increase glucagon/catecholamines to boost liver glucose production (glycogenolysis and gluconeogenesis), matching skeletal muscle uptake.
- **Type 1 response:** Circulating exogenous insulin remains fixed or elevated (depending on insulin-on-board), inhibiting hepatic glucose output while contracting muscles aggressively clear glucose.
- **Counterregulatory failure:** Prolonged disease duration or antecedent hypoglycemia can blunt autonomic and neuroendocrine responses, increasing severe hypoglycemia risks.

Aerobic vs. Anaerobic Differences

- **Aerobic exercise:** Continuous, moderate activities (running, cycling) increase insulin sensitivity and glucose uptake, sharply elevating hypoglycemia risk during or hours after activity.
- **Anaerobic/High-intensity exercise:** Short bursts or heavy resistance work (sprinting, heavy lifting) stimulate catecholamine surges, promoting hepatic glucose release and potential transient *hyperglycemia*.

Recommended training mix

A balanced program builds capacity and reduces overuse

AEROBIC BASE	STRENGTH + POWER	SPEED + SKILL
Moderate continuous work for cardiovascular fitness and sport-specific endurance	Two or more sessions weekly for strength, bone health, durability, and performance	Intervals, agility, technique, and sport practice matched to goals and recovery

Adults: aim for at least 150 minutes of moderate-to-vigorous aerobic activity weekly, plus resistance work on 2–3 nonconsecutive days. Youth: average 60 minutes daily, with vigorous and muscle/bone-strengthening activity at least 3 days weekly.

A sample week

Mon	Tue	Wed	Thu	Fri	Sat	Sun
Strength 45–60 min	Easy aerobic 30–45 min	Sport practice 60–90 min	Strength + short intervals	Recovery or rest	Competition / long session	Easy aerobic + mobility

Programming priorities

- Avoid hard sessions every day
- Practice the glucose plan during training before competition
- Schedule recovery nutrition and sleep as part of the program

Managing type 1 diabetes during a workout requires balancing **insulin-on-board (IOB)** with **carbohydrate intake** based on the type, timing, and duration of the exercise.

Insulin Adjustments

- Adjusting your insulin reduces the risk of hypoglycemia by lowering the amount of active insulin during your workout. The strategy depends heavily on your delivery method and workout timing.

Mealtime (Bolus) Insulin

- If you are exercising within **2 to 3 hours** of a meal, you will likely need to decrease your rapid-acting bolus.
- **Moderate Aerobic Exercise (30–60 mins):** Reduce the mealtime bolus by **20% to 50%**.
- **Prolonged Endurance Exercise (>60 mins):** Reduce the mealtime bolus by **50% or more**, depending on intensity.
- *Note:* If you are performing brief anaerobic exercises (like powerlifting), a bolus reduction is often unnecessary and may even lead to temporary spikes.

Insulin Pump & AID Users vs. Multiple Daily Injection (MDI) Users

Insulin pumps

- Set a **Temporary Basal Rate** reduction of **20% to 50%**. [1]
- **Timing is key:** Activate this reduction **60 to 90 minutes before** your workout starts. Turning it off right as you start will not lower your IOB quickly enough, as insulin remains active in your tissue for hours. [1, 2]
- If using an Automated Insulin Delivery (AID) system, switch the pump to its built-in **"Exercise" or "Activity" mode** 1 to 2 hours prior to the workout.

Multiple Daily Injection (MDI) Users

- Because long-acting basal insulin (like glargine or detemir) cannot be dynamically adjusted or "turned off" mid-day, you cannot easily lower active basal insulin for a sudden afternoon workout. [1]
- If you exercise consistently every morning, you can work with your care team to lower your baseline daily long-acting dose, but you will otherwise rely more heavily on the carbohydrate strategies below. [1]

Daily nutrition supports glucose and performance

ENERGY	Chronic under-fueling impairs recovery, hormones, bone health, immunity, and glucose predictability
CARBOHYDRATE	Match intake to training demand. General sports ranges span about 3–12 g/kg/day
PROTEIN	Most athletes benefit from about 1.2–2.0 g/kg/day, distributed across meals and snacks
FAT + MICRONUTRIENTS	Include unsaturated fats and varied whole foods. Screen iron, vitamin D, and other needs clinically

Athletes do not need a special "diabetes diet." They need adequate performance nutrition with carbohydrate counted and insulin matched safely.

Carbohydrate Adjustments

Pre-Exercise Snack (Based on Blood Glucose)

Check your glucose right before starting. Clinical guidelines, including those from the American Diabetes Association (ADA), suggest the following baseline adjustments for moderate activity

Initial glucose level	**Action needed**
Below 90 mg/dl	Delay exercise. eat 15-30 grams of fast acting carbs. wait until glucose rises above 120-130
90-150 mg/dl	Eat 15-30 grams of carbs before starting. complex carbs with a little protien are ideal an hour prior to exercise.
150-250 mg/dl	Safe to initiate exercise. no intake needed
Above 250 mg/dl	Test for ketones. if ketones are moderate to high avoid exercise. if low monitor for glucose spikes.

Carbohydrate Intake During Exercise

- For workouts lasting **longer than 30 to 45 minutes**, plan to consume hourly carbohydrates without dosing insulin for them: [1, 2]
- **Gentle/Low-intensity:** ~15g of carbohydrates per hour.
- **Moderate Aerobic (e.g., jogging, cycling): 30–60g of carbohydrates per hour**.
- **Intense/Endurance:** Up to **60–75g of carbohydrates per hour**.
- **Source:** Use liquid or fast-acting options like sports drinks, energy gels, or glucose tablets for easy absorption

Fuel during exercise

Session	Typical performance fuel	Diabetes overlay
Under 45 min	Often water only	Carbohydrate may still be needed when glucose is falling or active insulin is high
45–75 min	Small, repeated carbohydrate may help	Use trend arrows and planned check intervals
1–2.5 h endurance	Often 30–60 g carbohydrate/hour	Needs can be higher with usual insulin exposure and lower after successful insulin reduction
>2.5 h endurance	Up to 90 g/hour can support performance if gut-trained	Use multiple carbohydrate types and a detailed glucose/insulin plan

Start with a tested plan, then adjust from glucose trend and the athlete's own data.

The five-point pre-workout check

1. **Glucose + trend**
2. **Insulin on board**
3. **Workout type + duration**
4. **Ketones when indicated**
5. **Fuel + emergency supplies**

Ask one question

"What is most likely to happen in the next 30 minutes?"

Low glucose before or during exercise

STOP	Pause activity. Sit somewhere safe
TREAT	Use fast carbohydrate. A common starting treatment is 15 g for adults, individualized for children
WAIT + RECHECK	Recheck in about 15 minutes or follow the athlete's written plan
REPEAT	Treat again if still low. Resume only when glucose and symptoms have recovered
FOLLOW UP	Long or demanding sessions may need longer-acting carbohydrate after recovery

Do not exercise through a low. Symptoms and decision-making can deteriorate quickly!!!!!

HYPOGLYCEMIA
SIGNS AND SYMPTOMS

- Hunger
- Sweating, shaking
- Pale or flushed face
- Headaches
- Weak, irritable or confused speech and coordination changes
- Eyes appear glassy, dilated or “big” pupils
- Personality changes such as crying or stubbornness
- Inattention, drowsiness or sleepiness at unusual times
- If not treated, loss of consciousness and/or seizure

Severe hypoglycemia

Unable to swallow, seizure, loss of consciousness, or severe confusion

- Give glucagon immediately
- Call emergency services
- Place on side if unconscious
- Do not give food or drink by mouth
- Stay with the athlete and follow the emergency action plan

Coaches, athletic trainers, teammates, and family should know the location and form of glucagon before the season starts.

High glucose during or after exercise

Stress response	Competition, sprints, heavy lifting, pain, or anxiety can raise glucose
Insulin interruption	Disconnected pump, failed site, missed dose, or degraded insulin
Fuel mismatch	More carbohydrate than the session required or uncovered carbohydrate with AID
Dehydration / illness	May concentrate glucose and increase insulin resistance

Avoid aggressive correction after intense exercise. Sensitivity may rise during recovery, and full corrections can cause a later low.

Delayed and overnight lows

0–2 h	2–8 h	Overnight	Up to 24 h
Refuel, review trend, avoid correction stacking	Insulin sensitivity remains higher; monitor and use the established recovery plan	Risk can persist, especially after afternoon endurance or unfamiliar activity	Continue awareness after prolonged or demanding exercise

Overnight strategy may include CGM alerts, an AID exercise target, a planned snack, or insulin adjustment. Use the athlete's individualized plan

Troubleshooting recurring patterns

Pattern	Likely contributors	Discussion with diabetes team
Low in first 30 min	High insulin on board; target started late	Earlier strategy; meal-bolus plan; pre-start carbohydrate
Stable, then low late	Duration exceeds available fuel	Earlier hourly fuel; check interval; basal strategy
High after intervals	Stress hormones; uncovered fuel	Cool-down; conservative correction plan
Overnight low	Residual sensitivity; inadequate recovery fuel	Overnight target, snack, or insulin plan
High plus ketones	Insulin delivery failure or illness	Stop exercise; troubleshoot insulin; sick-day plan

Travel and environmental stress

Heat	Protect insulin from extreme temperature; reinforce adhesion; expect dehydration and variable absorption
Cold	Keep insulin and devices from freezing; CGM circulation lag and battery behavior may change
Altitude	Expect appetite, hydration, stress, and meter/device performance changes; verify unexpected readings
Travel	Carry supplies and insulin with the athlete; bring duplicates, prescriptions, and time-zone plan
Contact / water	Use tested device protection and a written disconnection/reconnection plan

Two athlete scenarios

Scenario A: 75-minute run

Start: 112 mg/dL, diagonal-down trend, meal bolus 90 minutes ago

Discuss

- What predicts the next 30 minutes?
- What changes before the start?
- How often should the athlete check?
- What fuel is carried?

Scenario B: heavy lifting

Finish: 278 mg/dL, flat trend, no symptoms, infusion site intact

Discuss

- What caused the rise?
- When are ketones appropriate?
- Why avoid a full aggressive correction?
- What should happen over the next 2 hours?

Build the personal exercise plan

Plan field	Write the athlete-specific answer
My common glucose response	Aerobic: _____ Intervals: _____ Strength: _____ Competition: _____
Safe starting range + trend rules	_____
Planned insulin strategy	_____
Carbohydrate plan	Before: _____ During: _____ Recovery: _____
Ketone and stop rules	_____
Overnight plan	_____
Emergency contacts + glucagon	_____

The athlete’s repeatable system

Predict	Use glucose trend, insulin on board, workout demand, and context
Prepare	Match nutrition and insulin strategy to the session
Protect	Treat lows early; stop for significant ketones or severe symptoms
Review	Watch recovery and overnight trends, then refine one variable at a time

SUMMARY

- All athletes with type 1 diabetes (T1D) need a strong support network at work, school, and home to help them properly manage their type 1 diabetes on a daily basis. Cultivating good relationships with support staff is key. With new and more effective approaches to diabetes management, such as sophisticated, portable testing equipment and “smart pumps”, no physical activity should be ruled out.

Resources and Selected Studies Related to Exercise, Sports and Type 1 Diabetes

- Preventing Post-Exercise Nocturnal Hypoglycemia in Children with Type 1 Diabetes.
- **Conclusions:** A basal insulin rate reduction was safe and effective in raising post-exercise nocturnal BG nadir and in reducing hypoglycemia in children with type 1 diabetes mellitus. Although effective at preventing hypoglycemia, a 2.5-mg dose of terbutaline was associated with hyperglycemia.
- National Athletic Trainers' Association Position Statement: Management of the Athlete With Type 1 Diabetes Mellitus.
- Physical activity and sports participation in children and adolescents with type 1 diabetes mellitus.
- Self-monitoring adherence to physical activity in children and adolescents with type 1 diabetes.
- Diet and physical activity in patients with type 1 diabetes.
- Physical exercise and diabetes during childhood.
- Managing insulin therapy during exercise in type 1 diabetes mellitus.
- Type 1 Diabetes and Vigorous Exercise: Applications of Exercise Physiology to Patient Management.
- Type 1 Diabetes and Exercise: Using the Insulin Pump to Maximum Advantage.
- The 10-s Maximal Sprint: A novel approach to counter an exercise-mediated fall in glycemia in individuals with type 1 diabetes.
- Inflammatory cytokine, growth factor and counterregulatory responses to exercise in children with type 1 diabetes and healthy controls.
- Acute, Same Day, Effects of Antecedent Exercise on Counterregulatory Responses to Subsequent Hypoglycemia in Type 1 Diabetes Mellitus.
- It is now widely recognized that antecedent hypoglycemia can blunt neuroendocrine, autonomic nervous system (ANS), and metabolic counterregulatory responses to subsequent hypoglycemia. Thus, blunted counterregulatory defenses against falling plasma glucose levels are a major risk factor for hypoglycemia in people with diabetes.
- The Effects of Aerobic Exercise on Glucose and Counterregulatory Hormone Concentrations in Children With Type 1 Diabetes.
- Stroke - Spin - Stride - The Diabetes Training Camp for Athletes with Type 1 Diabetes.