

COMPLIMENTARY CE

Fundamentals of Glucose and Insulin Management Before, During, and After Exercise for Patients With T1D

Jointly Provided by

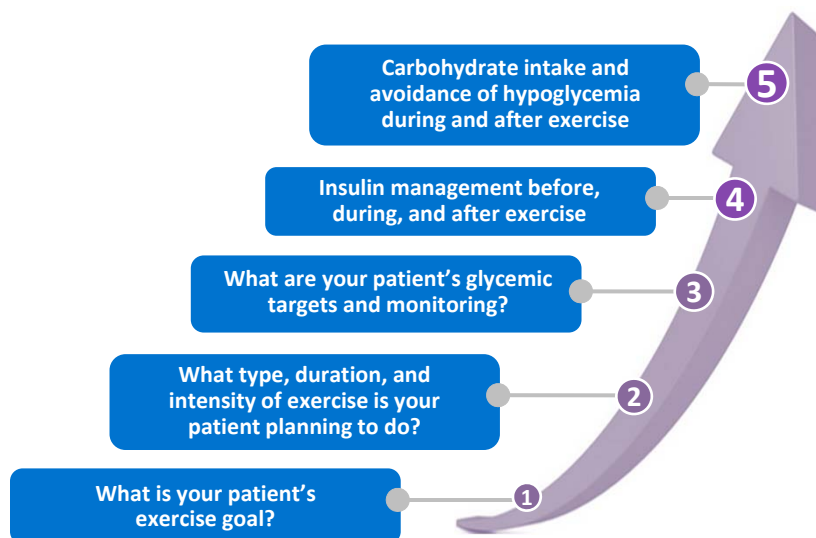


Developed in collaboration with



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Plan Your Interview



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What Is Your Patient's Exercise Goal?

✓
**Weight
management**

✓
**Improvement
of fitness**

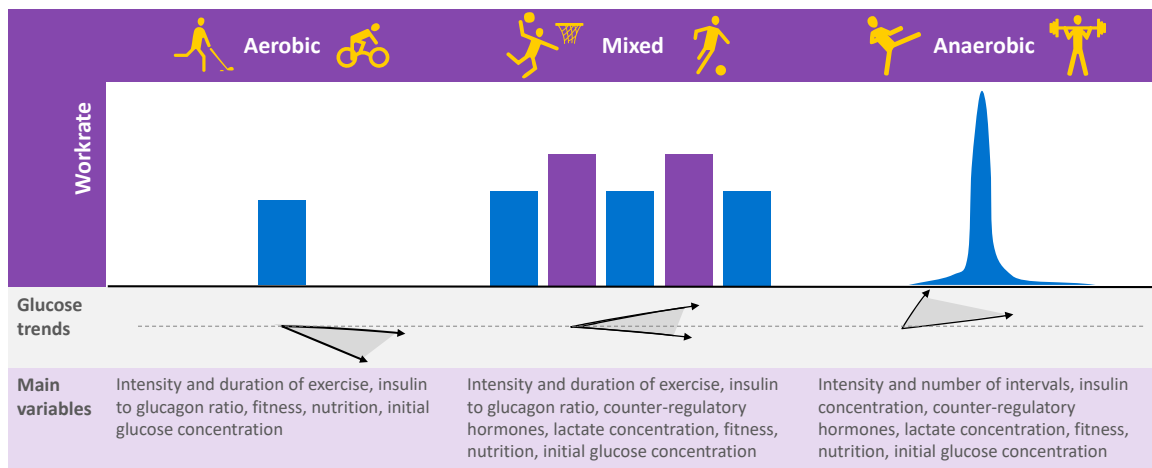
✓
**Enjoyment
of sports**

KEY CONSIDERATIONS

5 Factors to Consider



Blood Glucose Effects of Different Types of Exercise



Getting It Right with Food Requires Planning

- Distribute food across day to fuel body
 - Timing of both carbohydrate and proteins are important
- Education about portion sizes needed
- Particularly need to include iron- and calcium-rich foods
- Appropriate insulin adjustment for carbohydrate intake; may need to consider glycemic impact of high-fat and high-protein foods

Key Points for Nutritional Planning

- Nutrition advice for people with T1D performing regular exercise should:
 - Be individualized
 - Meet the nutritional demands of the sport and the person
 - Include management of glycemia
 - Incorporate opportunities to adjust food intake and insulin-management plans
 - Address adequate hydration

General Carbohydrate Recommendations Related to Exercise

- Carbohydrate is the *major* fuel source for exercise performed at 60–70% VO_2 max
- Requirements will vary widely
- **Carbohydrate may be needed during exercise for performance, hypoglycemia prevention, or both**
- Distribution and timing of carbohydrate intake is important
- Consider including part of daily carbohydrate intake in the period 4–5 hours after exercise

Thomas DT, et al. *J Acad Nutr Diet.* 2016;116:501-28; Burke LM, et al. *J Sports Sci.* 2011;29 Suppl 1:S17-S27; Bartlett JD, et al. *Eur J Sport Sci.* 2015;15:3-12.

Daily Protein Requirements for Sports

Protein intake is important for muscle recovery and repair, growth, and sports performance

1.2–1.7 g/kg body weight/day

Lower Protein Requirements

- Meeting energy requirements
- Endurance exercise

Higher Protein Requirements

- Children and adolescents
- Older adults
- Weight loss
- Strength and power sports

ADA, et al. *Med Sci Sports Exerc.* 2009;41:709-31; Phillips SM. *Sports Medicine.* 2014;44 Suppl 2:149-53; Phillips, SM, et al. *Int J Sport Nutr Exerc Metab.* 2007;17:S58.

Tools Available for Use



T1D glycemic management toolkit

- 1 Use of a glucose meter/ testing instrument
- 2 Pre- and post-exercise insulin
- 3 Basal insulin adjustment
- 4 Carbohydrate intake
- 5 Maximum sprint

Frequent Glucose Monitoring Is Critical During Exercise

1. The best way to avoid hypoglycemia is to regularly monitor/check glucose level before, during, and after exercise
2. People with T1D should not exercise if their glucose meter (or CGM) and strips are not readily available

BEFORE EXERCISE

Bolus Insulin Dose Adjustment Before Aerobic Exercise

Recommendations

Consider the amount of insulin on board

- | | |
|---|--|
| Exercise ≤120 mins after bolus insulin dose | ▪ Reduce pre-exercise insulin dose by 25–75%* and consume carbohydrate with a low glycemic index at mealtime |
| Exercise >120 mins after bolus insulin dose | ▪ If blood glucose is running low, must consume carbohydrate |

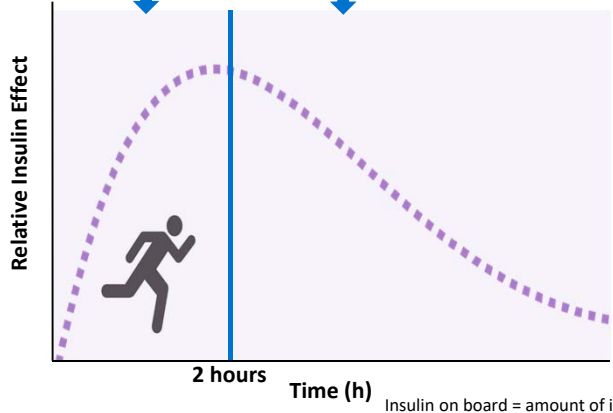
*Not beneficial for exercise in the late post-prandial period

For patients who use exercise for weight management, reduce the insulin dose to limit the need for extra carbohydrate consumption during and after exercise

Mauvais-Jarvis F, et al. *Diabetes Care*. 2003;26:1316-7; Hernandez JM, et al. *Med Sci Sports Exerc*. 2000;32:904-10; Rabasa-Lhoret R, et al. *Diabetes Care*. 2001;24:625-30; West, et al. *Diabetic Med*. 2009;26:60; DirecNet Study Group, et al. *Diabetes Care*. 2006;29:2200-4.

Additional Carbohydrate Intake Can Offset Insulin On Board

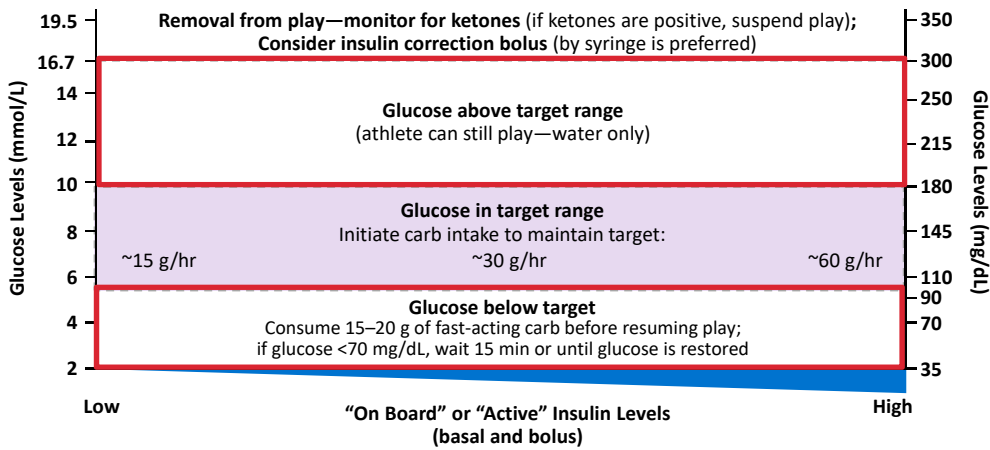
- Reduce pre-exercise insulin dose
- Consume carbohydrate with low glycemic index
- If blood glucose is running low, must consume carbohydrate



Insulin on board = amount of insulin in circulation;
 Nosek L, et al. *Diabetes Obes Metab.* 2013;15:77-83; Riddell M, et al. *Lancet Diab Endo.* 2017;5:377-90.



T1D Athlete Protocol



Riddell M, et al. *Lancet Diab Endo.* 2017;5:377-90.



Basal Insulin

- **Basal** insulin provides background insulin that the body needs even in the fasted state (overnight and between meals) and for exercise
- Basal insulin, delivered either by pump or long-acting insulin analog, generally reaches a steady, stable level
- Therefore, in preparation for exercise, basal insulin needs to be reduced **in advance** of planned exercise

Expert opinion.

Basal Insulin

- **Basal** insulin delivered by pump needs to be reduced about 90 minutes before exercise to reduce circulating insulin levels for exercise
- Changes to **basal** insulin delivered by injection needs to be individualized due to differences in long-acting analogs; some can be reduced in the morning of the planned exercise
- Following exercise, **basal** insulin can be reduced in the evening or at bedtime to reduce risk of nocturnal hypoglycemia

Expert opinion.

Basal Insulin Dose Adjustment Before Aerobic Exercise

Patients on MDI

- Basal insulin dose adjustment need individualization
- If on BID basal, one could consider reducing one or both of the basal doses by 20%

Patients on Insulin Pumps

- Basal insulin dose reduction of 50–80% may be useful for exercise over 45–60 minutes
- Dose could be reduced up to 90 minutes before exercise

Riddell M, et al. *Lancet Diab Endo*. 2017;5:377-90.



Nutrition Before Exercise

1–4 Hours

Carbohydrate	A meal based on low-fat, low-GI carbohydrate 1–4 g/kg body weight
Protein	Include 20–30 g low-fat, high-quality protein (eg, lean meat, fish, milk, yogurt)
Fluid	5–10 mL/kg body weight in the 2–4 hours before exercise

Thomas DT, et al. *J Acad Nutr Diet*. 2016;116:501-28; Burke LM, et al. *J Sports Sci*. 2011;29 Suppl 1:S17-S27; Coyle EF. *J Sports Sci*. 2004;22:39-55; Phillips SM. *Sports Med*. 2014;44 Suppl 2:149-53; Phillips SM, et al. *Int J Sport Nutr Exerc Metab*. 2007;17:SS8; Riddell M, et al. *Lancet Diab Endo*. 2017;5:377-90.

Recommendations Based on Starting Blood Glucose-1

Blood Glucose Concentrations	Recommendation
<90 mg/dL (<5 mmol/L)	<ul style="list-style-type: none"> Ingest 10–20 g of glucose before exercise Delay exercise until blood glucose >90 mg/dL
90–124 mg/dL (5–6.9 mmol/L)	<ul style="list-style-type: none"> Ingest 10 g of glucose Exercise can start, anaerobic and high-intensity interval training can start without CHO
125–180 mg/dL (7.0–10 mmol/L)	<ul style="list-style-type: none"> Aerobic exercise can start Anaerobic exercise and high-intensity interval training can start, but levels may rise
181–270 mg/dL (10.1–15 mmol/L)	<ul style="list-style-type: none"> Aerobic exercise can start Anaerobic exercise can start, but glucose concentrations may rise

Riddell M, et al. *Lancet Diab Endo*. 2017;5:377-90.



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Recommendations Based on Starting Blood Glucose-2

Blood Glucose Concentrations	Recommendation
>270 mg/dL (>15 mmol/L)	<ul style="list-style-type: none"> Check blood ketones, perform low-intensity exercise if ketones are not elevated, small corrective dose of insulin may be needed If modestly elevated (0.6–1.4 mmol/L), exercise should be restricted to a light intensity for only a brief duration (<30 min), small corrective dose of insulin may be needed If blood ketones are ≥ 1.5 mmol/L, exercise is contraindicated and corrective insulin dose should be given

Riddell M, et al. *Lancet Diab Endo*. 2017;5:377-90.



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DURING EXERCISE

Carbohydrate Needs Vary Based on Many Factors

Carbohydrate Need Factors



- Blood glucose below 90 mg/dL
- Aerobic exercise
- New sport/unfamiliar activity

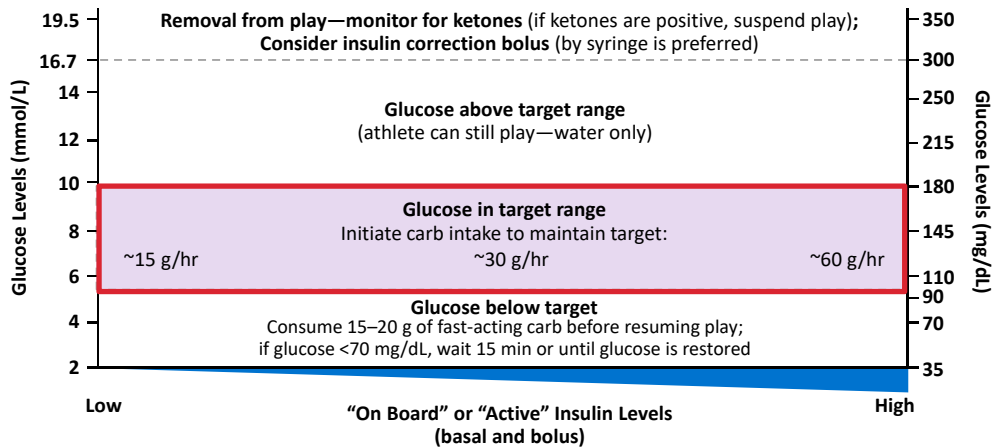


- Anaerobic exercise
- Short duration
- Exercise without insulin on board
- Insulin dose reduced (adjusted) with meal before exercise





- Competition

T1D Athlete Protocol



Riddell M, et al. *Lancet Diab Endo*. 2017;5:377-90.

Nutrition Needs During Exercise

	30 mins	30–60 mins	>60 mins
Carbohydrates 	<ul style="list-style-type: none"> Not needed unless blood glucose dropping 	<ul style="list-style-type: none"> May be needed if very strenuous activity or no insulin adjustment 	<ul style="list-style-type: none"> May be needed for fuel 30–60 g/h (0.5–1 g/kg BW Child) For ultraendurance (>3 hr) Up to 90 g/h; consider high-GI choices
Fluid 	<ul style="list-style-type: none"> Water should be adequate for hydration 	<ul style="list-style-type: none"> Drink appropriate amount* of fluids to replace sweat losses so that total body fluid deficit is <2% BW 	<ul style="list-style-type: none"> May benefit from use of sports drinks

* Depends on exercise intensity, duration, fitness, heat acclimatization, altitude, and environment (eg, humidity)

Thomas DT, et al. *J Acad Nutr Diet*. 2016;116:501-28.

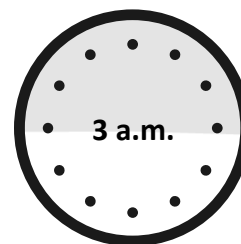
AFTER EXERCISE

Basal Insulin Dose Adjustment After Exercise: MDI vs Insulin Via Pump



MDI

- Reduce nighttime dose by 20%
- Encourage increased carbohydrate consumption to prevent nocturnal hypoglycemia
- Check blood glucose during the night



Pump

- Reduce insulin dose by 20% for up to 6 hours (eg, 9 p.m. to 3 a.m.)
- Encourage increased carbohydrate consumption
- Check blood glucose during the night



Nutrition After Moderate-to-Intense Exercise

Carbohydrate:Protein

- 2:1 ratio
 - Example 20g carbohydrates, 10g protein
- Within approximately 30 minutes of training

Fluid

- Drink fluids post exercise with food to maximize rehydration

Thomas DT, et al. *J Acad Nutr Diet*. 2016;116:501-28.

OTHER CAVEATS AND CONSIDERATIONS

Some Therapies Will Require Additional Considerations

- Insulin adjustments may be more challenging for patients using hybrid closed-loop pumps or ultra-long-acting basal insulins
- Consider differences in absorption times for various insulin preparations (inhaled, faster acting, etc.)
- Impact of emerging therapies for T1D on glycemic control during exercise are largely unknown



Supplements Require Caution and Some Should Be Avoided

Sports Foods

- Useful when active and impractical to consume everyday foods
- Sports drinks
- Sports gels
- Liquid meals
- Whey protein
- Sports bars
- Electrolyte replacement

Medical/ Nutritional Supplements

- Used to treat clinical issues
- Iron supplements
- Calcium supplements
- Multivitamins
- Vitamin D
- Probiotics

Performance Supplements

- Caffeine
- B-alanine
- Bicarbonate
- Beetroot juice
- Creatine

Low-Carb Diets

ADA Definitions

What is meant by low carbohydrate?

- Very-low-carbohydrate diet:
21–70 g/day of carbohydrate
- In sports nutrition, literature studies have investigated impact of <25% energy from carbohydrates
- Low-carbohydrate/high-fat (LCHF) diets impair capacity for high-intensity exercise
- Other potential impacts: poor growth, fatigue, high blood fats
- Individual range of carbohydrate requirements exist; **evidence does not support LCHF as a strategy**

Burke L. *Sports Med.* 2015;45 Suppl 1:33-49; Wheeler ML, et al. *Diabetes Care.* 2012;35:434-45; Riddell M, et al. *Lancet Diab Endo.* 2017;5:377-90.



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Disordered Eating and Diabetes

- Eating disorders are more common in females with diabetes than females without diabetes
 - 38% women, 16% men with T1D have disordered eating behaviors
- Increased risk of disordered eating with poor body image or heightened concerns about weight gain
- Eating disorders in diabetes are present in all forms
 - Bulimia is common (“Diabulimia”)

Griffith E, et al. *Cur Diab Reports.* 2013;13:909-16; Gringolon RB et al., *Eat Weight Disord.* 2017[epub ahead of print].



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Eating Disorders and Athletes

- Higher risk associated with the following:
 - Sports focusing on appearance, weight requirements, or muscularity
 - Sports focusing on individual performance over that of a team
 - Endurance sports
 - Focus or belief that lower body weight will improve performance

Key Considerations for Managing Glucose Levels in Physically Active Patients with T1D

- Consider patient goals
- Type, duration, and intensity of exercise play a significant role in management
- Evaluate the timing of exercise and meals
- Assess insulin “on board” (active insulin) at exercise time
- Consider the impact of antecedent exercise and/or antecedent hypoglycemia
- Delivery modality is an important factor in management
- Discuss glucose targets, trends, and available tools to measure
- Some individuals require special considerations