

# Exercise and diabetes: a balancing act

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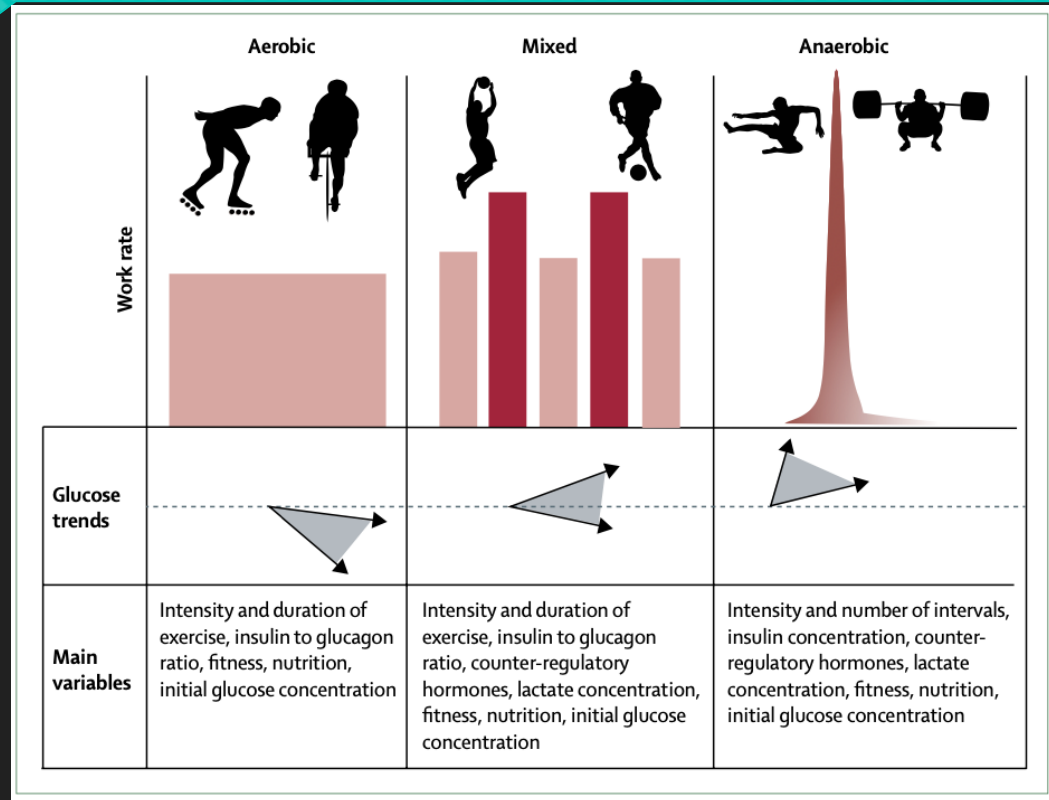
# Conflicts of interest

None

# Objectives

- As a result of this talk, participants will be able to...
  - Identify the impact of different types of exercise on blood glucose (BG)
  - Assess contraindications to exercise in Type 1 diabetes
  - Apply strategies for BG monitoring, carb dosing, and insulin adjustment around exercise
    - Emphasis on utilization of diabetes technology
  - Summarize exercise considerations for those with Type 2 diabetes

# Impact of exercise on BG - YDWV

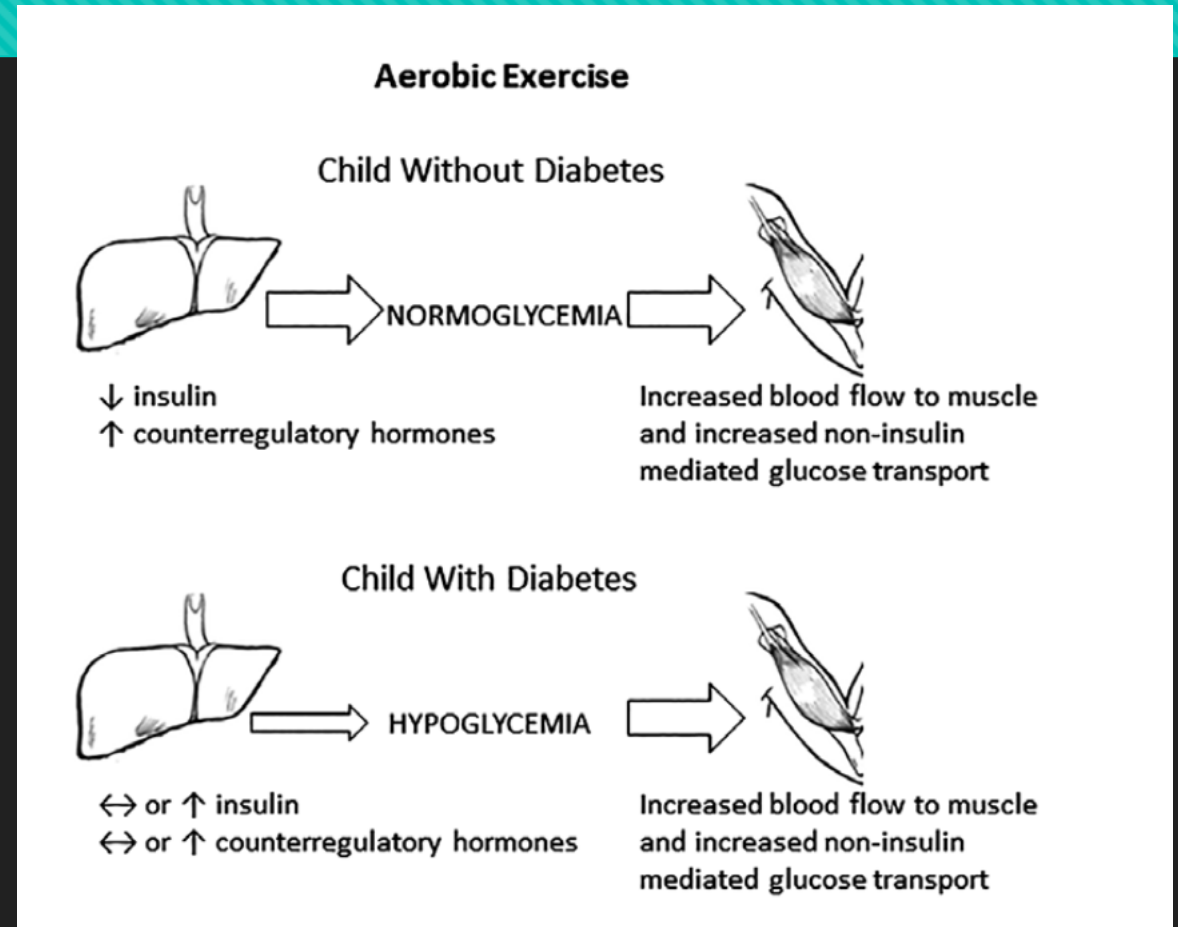


Riddell MC, Gallen IW, Smart CE, et al. Exercise management in type 1 diabetes: a consensus statement. *Lancet Diabetes Endocrinol.* May 2017;5(5):377-390.

- Competition tends to have different effects than practice
- Activity can lower BG up to 24 hours after the activity has ended!

# Big picture considerations

- What type and what duration of activity is going to be performed?
- Was there hypoglycemia in the last 24-48hrs?
- How much insulin is “on board”?
- Physiology
  - During exercise
  - After exercise



# Contraindications to beginning exercise

- Moderate or large ketones
  - Small ketones can be treated and then exercise started
  - Moderate Ketones can be treated and should be verified to be trending down over 60 minutes prior to exercise
- Severe hypoglycemia (BG <54 mg/dL) in the last 24 hr

## **Below 0.6 mmol/L**

Readings below 0.6 mmol/L are in the normal range.

← Negative to trace

## **0.6 to 1.5 mmol/L**

Readings between 0.6 and 1.5 mmol/L may indicate the development of a problem that may need medical help. Patient should follow health care provider's instructions.

← Small to moderate

## **Above 1.5 mmol/L**

Readings above 1.5 mmol/L indicate the patient may be at risk for developing diabetic ketoacidosis (DKA). Patient should contact a health care provider right away.

← Large

# What's a ketone?

- Insulin is promiscuous!
  - Glucose uptake
  - Stops breakdown of fat
- Too little insulin
  - High blood sugar
  - Ketones (which become acids)
- Ketones can be measured in the urine or blood and should be checked when a child is feeling unwell or their blood glucose is elevated.
  - Potentially signaling insulin deficiency

# Carbs: before and during exercise

| Before activity BG  | Treatment – stabilize BG at outset   |
|---------------------|--|
| <54 mg/dL           | Treat low BG (~0.6g/kg carbs) <b>but do not begin exercise</b>   |
| 55-90 mg/dL         | Take ~0.3g/kg quick-acting carbohydrate. <b>Do not begin exercise until BG over 90.</b>  |
| 91-150 mg/dL        | Consider taking ~5-15 g (0.5-1.0g/kg) of carbohydrates with protein prior to exercising. Likely will need more within 30-60 min. May begin exercise. |
| 151 mg/dL-240 mg/dL | No treatment needed to begin exercise, may need carbs soon if starting aerobic exercise and on the lower end   |
| 240+mg/dL           | Check ketones prior to starting. Consider insulin correction esp if doing anaerobic exercise.  |

| During activity BG        | Treatment – needs reassessment q30-60 mins  |
|---------------------------|---|
| <54mg/dL                  | Stop all exercise. Start with at least 15g quick-acting carbs. Reassess in 15-30 mins. <b>DO NOT RESUME EXERCISE.</b> |
| 55-75 mg/dL               | <b>Stop all exercise.</b> Take ~15g quick-acting carbohydrate and reassess BG prior to resuming.                      |
| 76-180 mg/dL              | Take ~5-15g (0.2-1.5g/kg) of carbohydrates. Can be carb-containing fluids. May continue exercising.                   |
| 180+ mg/dL and no ketones | Carb-free fluids for hydration. May continue exercising.  |



# Carbs: before and during exercise with CGM

| Pre-exercise sensor glucose for different groups in T1D    |                                     |                                     | Trend arrow   | Action  |  |
|--|-------------------------------------|-------------------------------------|---|---|--|
| Ex 2 and/or low hypo risk                                  | Ex 1 and/or moderate hypo risk      | Ex 0 and/or high hypo risk          |   | Increase in sensor glucose expected                           | Decrease in sensor glucose expected                            |
| >15.0 mmol/l (>270 mg/dl)<br>AND >1.5 mmol/l blood ketones |                                     |                                     | ↗↗↗↘↘↘  | No Ex,<br>Insulin correction                                  |  |
| >15.0 mmol/l (>270 mg/dl)<br>AND ≤1.5 mmol/l blood ketones |                                     |                                     | ↗↗  | Consider insulin correction <sup>a</sup> ,<br>Can start AE    | Consider insulin correction <sup>a</sup> ,<br>Can start all Ex |
|  |                                     |                                     | →   | Consider insulin correction <sup>a</sup> ,<br>Can start AE    | Can start all Ex   |
|  |                                     |                                     | ↘↘  | Can start all Ex  |  |
| 10.1–15.0 mmol/l<br>(181–270 mg/dl)                        | 11.1–15.0 mmol/l<br>(199–270 mg/dl) | 12.1–15.0 mmol/l<br>(217–270 mg/dl) | ↗↗  | Can start AE  | Can start all Ex   |
|  |                                     |                                     | →   | Can start all Ex  |  |
|  |                                     |                                     | ↘↘  | Can start all Ex  |  |
| 7.0–10.0 mmol/l<br>(126–180 mg/dl)                         | 8.0–11.0 mmol/l<br>(145–198 mg/dl)  | 9.0–12.0 mmol/l<br>(162–216 mg/dl)  | ↗↗  | Can start all Ex  |  |
|  |                                     |                                     | →   | Can start all Ex  |  |
|  |                                     |                                     | ↘↘  | ~5 g CHO<br>(0.2 g/kg),<br>Can start all Ex                   | ~10 g CHO<br>(0.3 g/kg),<br>Can start all Ex                   |
| 5.0–6.9 mmol/l<br>(90–125 mg/dl)                           | 5.0–7.9 mmol/l<br>(90–144 mg/dl)    | 5.0–8.9 mmol/l<br>(90–161 mg/dl)    | ↗↗  | Can start all Ex  | ~5 g CHO<br>(0.2 g/kg),<br>Can start all Ex                    |
|  |                                     |                                     | →   | ~5 g CHO<br>(0.2 g/kg),<br>Can start all Ex                   | ~10 g CHO<br>(0.3 g/kg),<br>Can start all Ex                   |
|  |                                     |                                     | ↘   | ~10 g CHO<br>(0.3 g/kg),<br>Delay all Ex <sup>b</sup>         | ~15 g CHO<br>(0.4 g/kg),<br>Delay all Ex <sup>b</sup>          |
|  |                                     |                                     | ↓   | Individual amount CHO ingestion,<br>Delay all Ex <sup>b</sup> |  |
| <5.0 mmol/l<br>(<90 mg/dl)                                 |                                     |                                     | Individual amount CHO ingestion,<br>Delay all Ex <sup>b</sup> |   |  |

| During exercise sensor glucose for different groups in T1D              |                                     |                                     | Trend arrow  | Action   |  |
|---|-------------------------------------|-------------------------------------|--|--|--|
| Ex 2 and/or low hypo risk   | Ex 1 and/or moderate hypo risk      | Ex 0 and/or high hypo risk          |  | Increase in sensor glucose expected  | Decrease in sensor glucose expected                          |
| >15.0 mmol/l (>270 mg/dl)<br>AND >1.5 mmol/l blood ketones              |                                     |                                     | ↗↗↗↘↘↘   | Stop Ex,<br>Consider insulin correction,<br>No restart of Ex   |  |
| >15.0 mmol/l (>270 mg/dl)<br>AND ≤1.5 mmol/l blood ketones <sup>a</sup> |                                     |                                     | ↗↗   | Consider insulin correction <sup>b</sup> ,<br>Proceed all Ex   | Proceed all Ex,<br>Consider AE                               |
|   |                                     |                                     | →  | Consider insulin correction <sup>b</sup> ,<br>Proceed all Ex   | Proceed all Ex   |
|   |                                     |                                     | ↘↘   | Proceed all Ex   |  |
| 10.1–15.0 mmol/l<br>(181–270 mg/dl)                                     | 11.1–15.0 mmol/l<br>(199–270 mg/dl) | 12.1–15.0 mmol/l<br>(217–270 mg/dl) | ↗↗   | Proceed all Ex,<br>Consider insulin correction <sup>b</sup>  | Proceed all Ex   |
|   |                                     |                                     | →  | Proceed all Ex   |  |
|   |                                     |                                     | ↘↘   | Proceed all Ex   |  |
| 7.0–10.0 mmol/l<br>(126–180 mg/dl)                                      | 8.0–11.0 mmol/l<br>(145–198 mg/dl)  | 9.0–12.0 mmol/l<br>(162–216 mg/dl)  | ↗↗   | Proceed all Ex   |  |
|   |                                     |                                     | →  | Proceed all Ex   |  |
|   |                                     |                                     | ↘↘   | Proceed all Ex   |  |
| <7.0 mmol/l<br>(<126 mg/dl)   | <8.0 mmol/l<br>(<145 mg/dl)         | <9.0 mmol/l<br>(<162 mg/dl)         | ↗↗   | Proceed all Ex   |  |
|   |                                     |                                     | →  | ~5 g CHO<br>(~0.2 g/kg),<br>Proceed all Ex <sup>c</sup>  | ~10 g CHO<br>(~0.3 g/kg),<br>Proceed all Ex <sup>c</sup>     |
|   |                                     |                                     | ↘  | ~10 g CHO<br>(~0.3 g/kg),<br>Proceed all Ex <sup>c</sup>   | ~15 g CHO<br>(~0.4 g/kg),<br>Proceed all Ex <sup>c</sup>     |
|   |                                     |                                     | ↓  | ~15 g CHO<br>(~0.4 g/kg),<br>Proceed all Ex <sup>c</sup>   | ~20 g CHO<br>(~0.4–0.5 g/kg),<br>Proceed all Ex <sup>c</sup> |
| <5.0 mmol/l<br>(<90 mg/dl)  |                                     |                                     | ↗<br>↘<br>→<br>↘<br>↓  | Stop all Ex,<br>Consider confirmatory SMBG,<br>Individual amount CHO ingestion,<br>Restart of all Ex possible <sup>d</sup> |  |
| <3.0 mmol/l<br>(<54 mg/dl)  |                                     |                                     | Stop all Ex,<br>Confirmatory SMBG,<br>Individual amount CHO ingestion,<br>No restart of Ex |  |  |

# Carbs: After exercise

| Post-exercise sensor glucose, including nocturnal phase, for different groups in T1D |   |   | Trend arrow | Action                          |
|--|---|---|-------------|---------------------------------|
| Ex 2 and/or low hypo risk  | Ex 1 and/or moderate hypo risk <sup>a</sup> | Ex 0 and/or high hypo risk <sup>b</sup> | Direction   | CHO                             |
| <4.4 mmol/l<br>(<80 mg/dl)   | <5.0 mmol/l<br>(<90 mg/dl)                  | <5.6 mmol/l<br>(<100 mg/dl)             | ↑           | No CHO                          |
|  |   |   | ↗           |                                 |
|  |   |   | →           | ~10 g CHO                       |
|  |   |   | ↘           | ~15 g CHO                       |
|  |   |   | ↓           | Individual amount CHO ingestion |

# Insulin Adjustments for post-prandial exercise

- Temporary basal rates should be initiated ~90 mins prior to initiating exercise
  - 50-80% dose reduction is reasonable (probably more like 30-50% reduction for PE)
- Can consider disconnecting insulin pumps for certain types of exercise for up to 2 hours
  - Longer than this increases risk of ketosis
  - More likely to need correction insulin post-exercise
- Meal insulin dose reductions should consider time-to-peak of meal insulin as well as duration and type of anticipated exercise

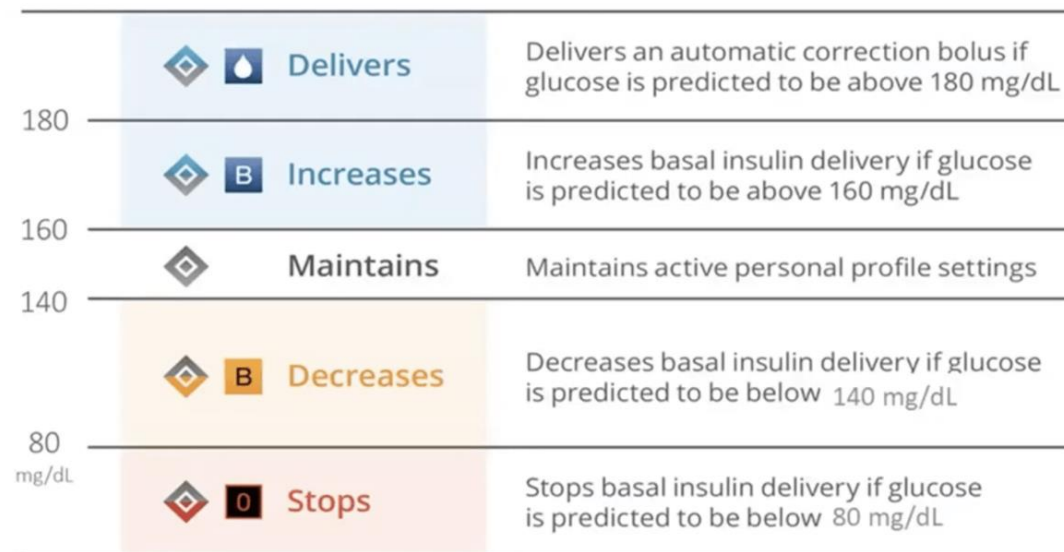
**TABLE 6** Prandial (bolus) insulin adjustments for postprandial exercise when exercise is conducted in hyperinsulinemic state

|   | Meal before exercise             |                                | Meal after exercise       |
|---|----------------------------------|--------------------------------|---------------------------|
|   | Activities lasting 30-45 minutes | Activities lasting >45 minutes |                           |
| Continuous, moderate to vigorous intensity aerobic activities (eg, jogging/running, moderate intensity swimming, bicycling, cross country, aerobic play)        | 25%-50% bolus reduction          | 50%-75% bolus reduction        | Up to 50% bolus reduction |
| Mixed aerobic and anaerobic burst activities (eg, hopping, skipping, dance, gymnastics, tag, dodgeball, field and team sports, individual racquet sports, etc.) | ~25% bolus reduction             | ~50% bolus reduction           | Up to 50% bolus reduction |

# Incorporating Sensor augmented pumps and Hybrid Closed Loop

- T slim +Medtronic 670/770Gboth have Exercise mode
- Consider active insulin/insulin on board in carb dosing pre-exercise
- Consider Low glucose suspend in your carb dosing for low treatments

## EXERCISE MODE



# T2D and Exercise

- Much less likely to have hypoglycemia or ketosis, but not impossible
- BG should be tested prior to, during, and after exercise
  - If not on insulin, do not have strict BG goals
- Consideration of insulin dose reduction pre and post-exercise
- No dose adjustments required if only metformin only
- Rare to have exercise-induced hypoglycemia with GLP-1 agonists, but can reduce dose on exercise days

# Glucagon

- Used for low blood glucose (unable to consume carbohydrates, unconsciousness, seizure)
  - 3 forms now – kit, nasal, autoinjector
- Call 911 or peds endo emergency line after giving
- Give quick acting carbs after child is awake and alert, and then something with carbs and protein

Glucagon Emergency Kit ®

or

GlucaGen HypoKit ®



# Big picture plans to help students and athletes

## ○ **Help them avoid hypoglycemia**

- Make sure they have access to carbs before and during activity
- Help them figure out when to take carbs + How many carbs to take
- Help them figure out if they should decrease their pre and/or post-exercise meal insulin dose
- Help them determine if they should change pump settings
- Evaluate CGM alarms

## ○ Make sure they have diabetes ID

- Every participant on a sports team should be aware and know where to find hypoglycemia treatment

## ○ Make sure they stay hydrated

## ○ **Help them avoid ketosis**

- Ask them to check for ketones/assist them in checking for ketones if BG is elevated

# Questions?





# Bibliography

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- Riddell MC, Gallen IW, Smart CE, et al. Exercise management in type 1 diabetes: a consensus statement. *Lancet Diabetes Endocrinol*. May 2017;5(5):377-390.
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