T1D and sports: riding the ups and downs of blood glucose

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Why Exercise?

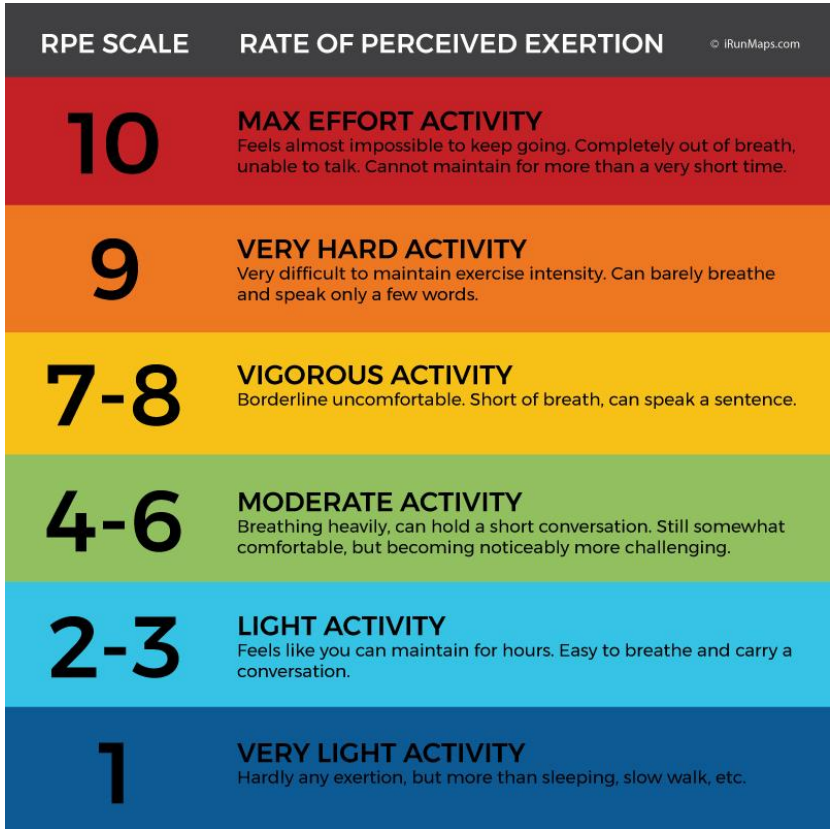
- Increased insulin sensitivity in the short and long term
- More efficient cardiovascular system
  - Lower resting heart rate, lower blood pressure
- More efficient respiratory system
  - Improved oxygen uptake and expulsion of carbon dioxide
- Maintaining or improving independence with muscular strength
  - Opening doors, opening jars, standing up from the toilet - all require strength!
- But the biggest reason is...
- People who are physically active enjoy their lives, more!
  - Really! https://pubmed.ncbi.nlm.nih.gov/32635457/

How to do cardio

1) Choose something you like - seriously, anything! Walking, running, cycling, swimming, hiking, cross country skiing, stand up paddleboarding, rowing
2) Aim for a **long duration** and keep your intensity low < 5 RPE and do it **often** (3-5x/week)
3) Do **one** shorter duration and higher intensity workout ~ 5-7 RPE per week, this helps to increase your lactic acid threshold and *increase* your cardiovascular fitness (increased VO2 max, lower resting heart rate, lower blood pressure, increased low exertion stamina)

RPE chart on next slide :)

What are RPE, lactic acid threshold, and VO2 max?



Lactic acid threshold is the point where your metabolism switches from using oxygen and fat or glucose, to using only glucose **in the absence of oxygen (anaerobic)**

This threshold will correspond to a heart rate and to an RPE of 9-10

The *higher* your lactic acid threshold is, the higher your **physical workload** is compared to your **perceived workload**

VO2max is the *maximum* amount of oxygen in millilitres per kilogram of body weight per minute that a person can use

VO2max Examples

From ACSM's Health-Related Physical Fitness Assessment Manual, 5th Edition - Table 8.9: Fitness Categories for Maximal Aerobic Power for Men and Women updated from 2009 to 2013 (pages 151-156)

Men, age 30-39

Excellent	51.6 mLO2/kg/min	10:02 run 2.4 km	4:11 min/km run pace
Good	47.0 mLO2/kg/min	11:06 run 2.4 km	4:38 min/km run pace
Fair	43.9 mLO2/kg/min	11:58 run 2.4 km	4:59 min/km run pace

Women, age 30-39

Excellent	45.3 mLO2/kg/min	11:33 run 2.4 km	4:49 min/km run pace
Good	41.0 mLO2/kg/min	12:53 run 2.4 km	5:22 min/km run pace
Fair	37.1 mLO2/kg/min	14:25 run 2.4 km	6:00 min/km run pace

Converting total time to run 1.5 miles to minutes per km pace

VO2max - Putting it Together

Using the previous example:

If a man aged 30-39 needs to run a pace of 4:11 min/km to reach his VO2max (RPE 9-10), this means that all his paces that are slower than that are at a lower RPE.

His *perceived* workload for running 6 min/km will be a lower RPE than a woman aged 30-39 whose VO2max is running a 6 min/km pace - her physical workload is **maximum** at that pace, which also matches her perceived maximum workload.

Blood flow during exercise and feeding strategies

At rest, 90% of our blood flow is to our trunk: our internal organs

When we exercise, the blood from our trunk is shunted to our skeletal muscles to help with our physical activity

This means that if we eat something during exercise, there may not be enough blood flow to power our organs for digestion

Play around with timing of nutrients, liquid foods, solid foods, and keep in mind that absorption may be delayed until blood returns to your trunk and organs

As the blood sugar drops, the liver starts to release glycogen and elevate blood sugar levels - meaning if your blood sugar drops rapidly during exercise, you are more likely to have a post-workout glucose rise (more info later in slides)

Why resistance train?

Muscle STRENGTH is a leading factor of all cause morbidity and mortality

Lifting weights for HEAVY resistance training (1-5 reps, 85-100% 1RM) causes long-term training adaptations to increase insulin sensitivity, even when there are NO changes to body mass, dietary intake, or VO2max

An untrained adult can store about ~135g of glycogen (stored glucose) in the liver and in skeletal muscle stores, combined

The effect of heavy resistance training and increasing lean muscle mass can increase skeletal muscle stores by up to 500%!

WHY does exercise lower blood sugar immediately?

GLUT4 is a cell transporter that brings glucose into muscle and fat cells

GLUT4 works by two pathways:

1) Exercise
2) Insulin

GLUT4 works to pull glucose out of the circulating blood into muscle cells, replenishing glycogen stores

When the skeletal muscle cells are “full” (storage capacity has been reached), GLUT4 will transport additional glucose into fat cells

WHY does exercise lower blood sugar after activity has stopped?

The higher the RPE of your activity, the harder your body has to work to rebuild skeletal muscle glycogen stores

GLUT4 is working hard to pull circulating blood glucose into the muscle cell to replenish stored glycogen

This effect can be felt for 4-48 hours after activity, depending on the type of activity

WHY does blood glucose RISE after activity?

A body that doesn't produce sufficient insulin is going to have an impaired closed loop hormone system - our bodies don't release enough insulin to manage blood glucose rises AND our bodies also have a delayed response in secreting glucagon to release glycogen from the liver

Since the insulin-glucagon loop is impaired or delayed, our blood glucose may need to drop a lot before glucagon kicks in and releases glucose from our liver

But we feel low, so we eat glucose to raise our blood glucose levels

This can have an **additive effect** on our glucose levels after activity

Links!

Active people and overall life happiness

VO2max tables from ACSM

Running metrics conversion calculator

Muscle strength as a predictor of all cause morbidity and mortality

Effects of resistance training on skeletal muscle glycogen storage capacity

How to find your 1 rep max (1RM)

Glucagon axis impairment in people with type 1 diabetes

Contact me!

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