

Exercise – JDRF PEAK Guidelines

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Plan

- Why a guideline?
- Basic exercise physiology
- Strategies for managing T1D for exercise
 - Before
 - During
 - After

Why do we need exercise guidance?

- Most people with T1D do not achieve recommended levels of physical activity
 - Majority are above recommended body weight
 - Significant proportion have dyslipidaemia and hypertension
- Health benefits of exercise are well recognized for those with and without T1D:
 - Improvements in cardiometabolic profile
 - Association with a reduction in complications
 - Potential mortality benefit seen in observational studies

Barriers to exercise in type 1 diabetes

- **FEAR OF HYPOGLYCAEMIA**
- Also of concern to people with T1D are:
 - **Loss of glycaemic control**
 - **Lack of knowledge around exercise management**
- The sit alongside more general concerns:
 - Lack of time
 - Problems with access to facilities
 - Lack of motivation
 - Issues around body image

JDRF PEAK Programme

Review

Exercise management in type 1 diabetes: a consensus statement



Michael C Riddell, Ian W Gallen, Carmel E Smart, Craig E Taplin, Peter Adolfsson, Alistair N Lumb, Aaron Kowalski, Remi Rabasa-Lhoret, Rory J McCrimmon, Carin Hume, Francesca Annan, Paul A Fournier, Claudia Graham, Bruce Bode, Pietro Galassetti, Timothy W Jones, Iñigo San Millán, Tim Heise, Anne L Peters, Andreas Petz, Lori M Laffel

Type 1 diabetes is a challenging condition to manage for various physiological and behavioural reasons. Regular exercise is important, but management of different forms of physical activity is particularly difficult for both the individual with type 1 diabetes and the health-care provider. People with type 1 diabetes tend to be at least as inactive as the general population, with a large percentage of individuals not maintaining a healthy body mass nor achieving the minimum amount of moderate to vigorous aerobic activity per week. Regular exercise can improve health and wellbeing, and can help individuals to achieve their target lipid profile, body composition, and fitness and glycaemic goals. However, several additional barriers to exercise can exist for a person with diabetes, including fear of hypoglycaemia, loss of glycaemic control, and inadequate knowledge around exercise management. This Review provides an up-to-date consensus on exercise management for individuals with type 1 diabetes who exercise regularly, including glucose targets for safe and effective exercise, and nutritional and insulin dose adjustments to protect against exercise-related glucose excursions.

Lancet Diabetes Endocrinol 2017

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Why is exercise a challenge in T1D?

Aerobic activity

- Lower intensity, longer duration
e.g. long distance running or cycling
- Primary driver of increased metabolic fuel production is a change in the glucagon:insulin ratio at the liver
- CHO metabolism is predominantly aerobic, with NEFA also a significant energy source



Aerobic activity in diabetes

- Circulating insulin is often higher than is required
- This suppresses mobilisation of both CHO and NEFA fuel stores, and also promotes peripheral glucose uptake
- The main problem is therefore **hypoglycaemia**
- **Remember: Fear of hypoglycaemia is the most important factor preventing people with T1DM undertaking a more active lifestyle**

Anaerobic activity

- Higher intensity, shorter duration
- Significant rise in catecholamines (14-18 times normal levels) stimulates increase in rate of glucose production (7-8 times normal)
- CHO metabolism predominates
- Anaerobic metabolism so significant lactate production



Anaerobic activity - diabetes

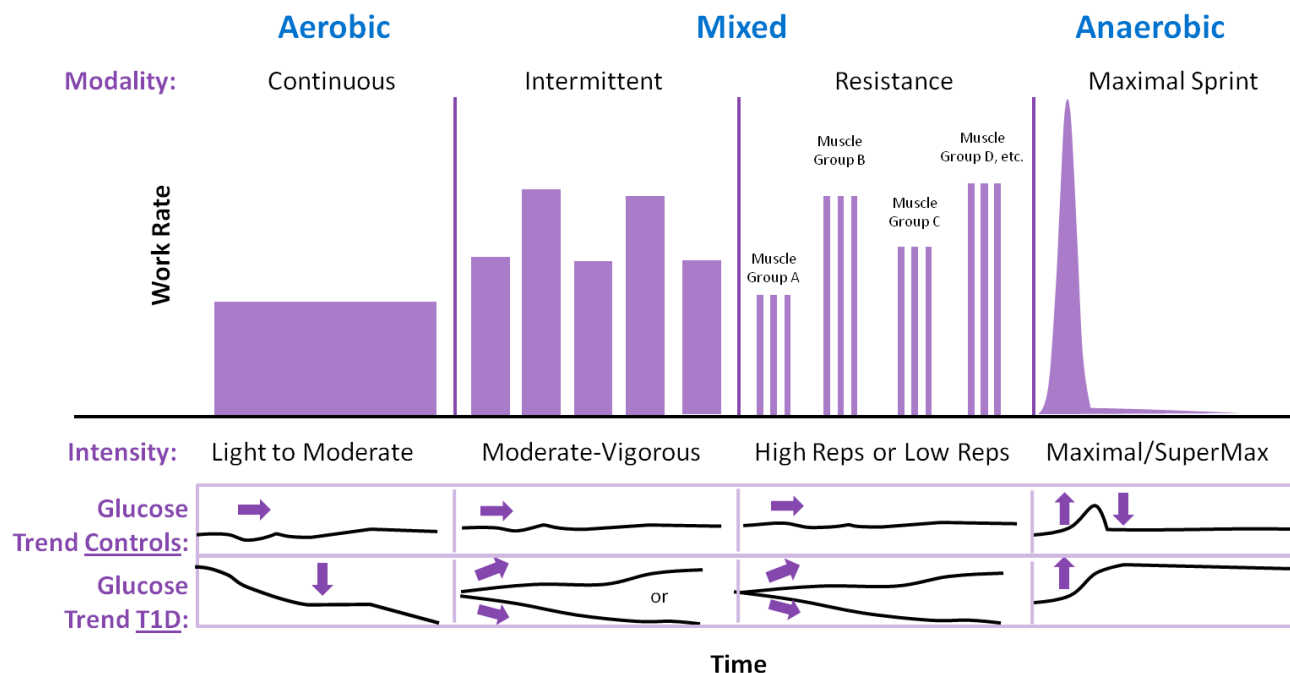
- Circulating insulin is often not sufficient to counterbalance the significant rise in glucose production
- The result is often **hyperglycaemia**
- Glucose can subsequently fall as counter-regulatory hormones return to normal levels
- This can be **very frustrating**, especially when it is not what the person with diabetes expects.

Intermittent High Intensity Activity

- A mixture of high and moderate intensity activity
- Bursts of high intensity interspersed with moderate intensity
- Characteristic of team sports, also children's play

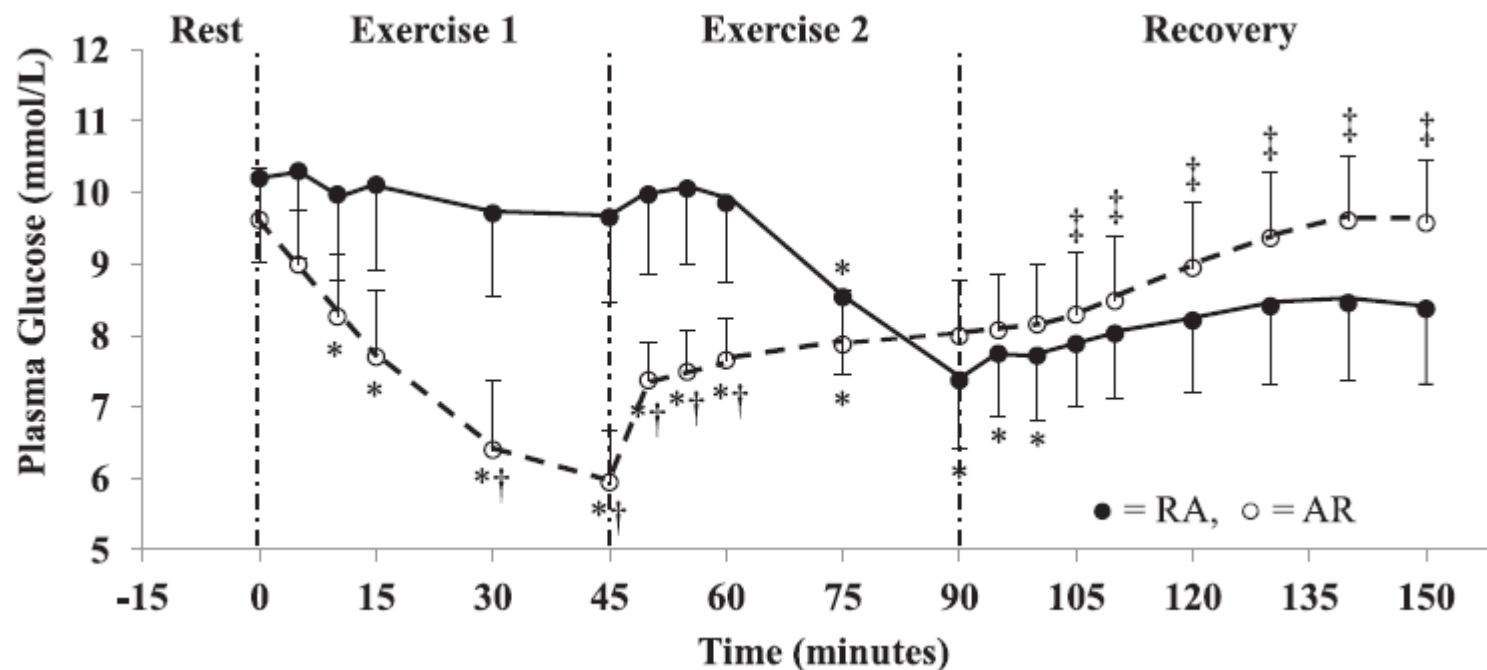


Effect on BG of different sports



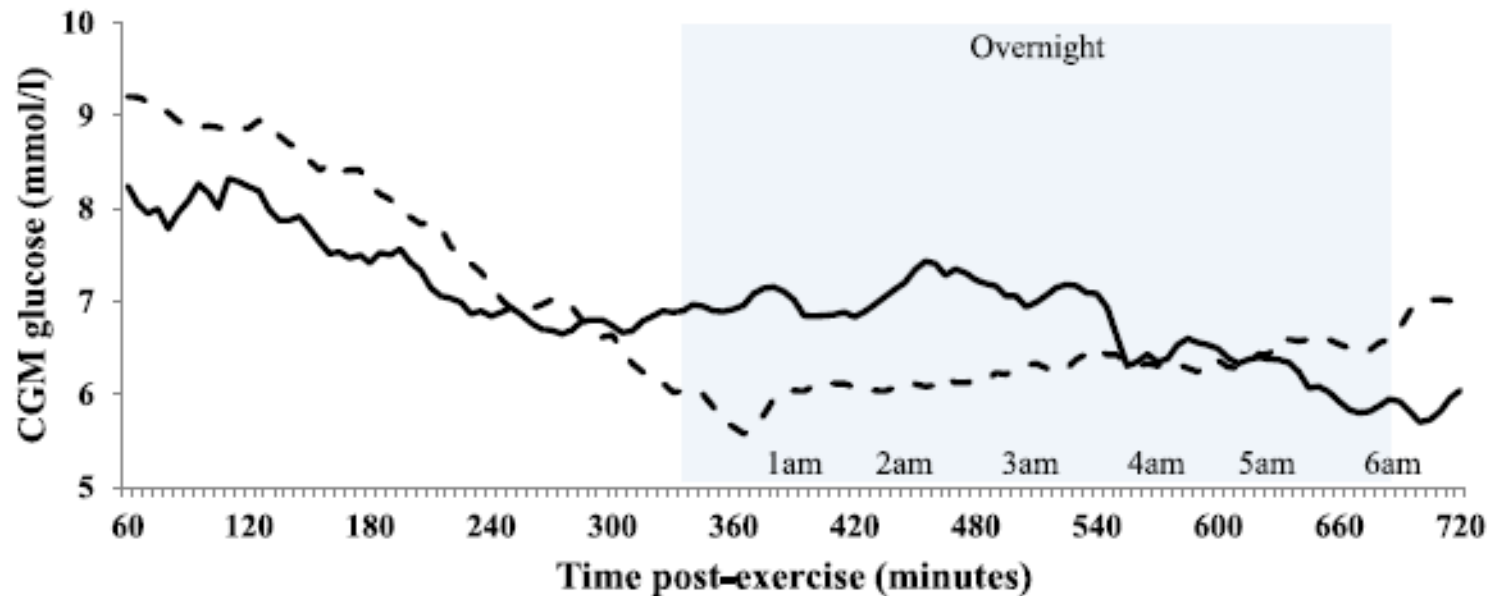
Graphic courtesy Professor Mike Riddell

Cardio and weights in the gym



Yardley et al (2012) *Diabetes Care* **35**: 669-675

Late hypoglycaemia after exercise



Yardley et al (2012) *Diabetes Care* **35**: 669-675

Late hypoglycaemia after exercise

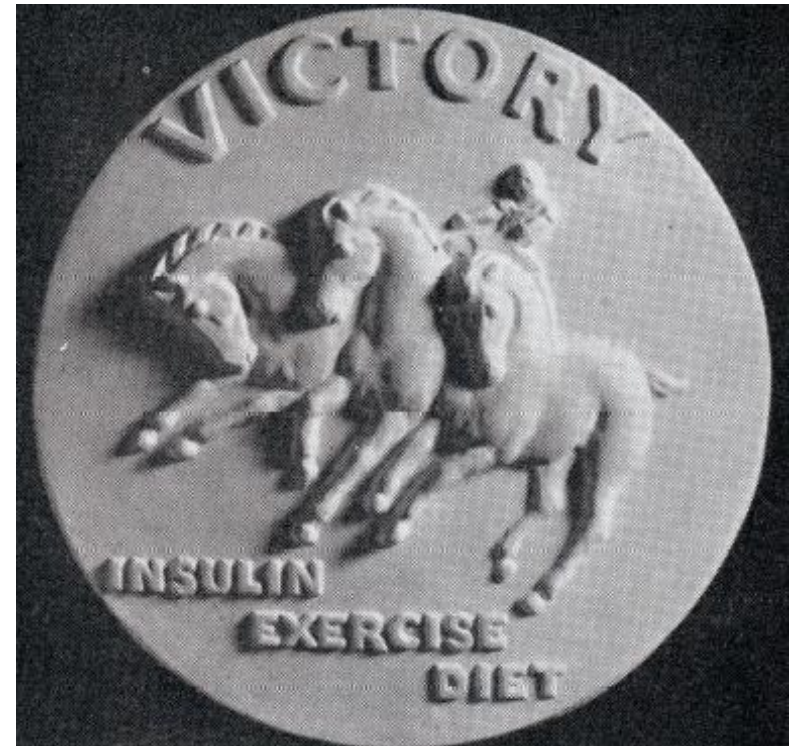
- Hypoglycaemia after exercise (including overnight) is a well-recognised problem in diabetes
- A number of causes combine to cause this
 - Energy stores need to be replenished
 - Sensitivity to insulin is increased
 - The counter-regulatory response to a falling glucose is blunted

Management strategies for exercise with T1

Before
During
After

Key management strategies

- Elliot Joslin identified the importance of the 3 pillars of diabetes management:
- Insulin
- Exercise
- Diet
- These give us our management strategies...



Before Exercise

Diet
Insulin
Exercise

Before exercise

- A number of factors which will affect the right management strategy:
 - What is the BG now? Is it rising/falling?
 - When/what was the last meal?
 - What insulin is on board?
 - What sort of exercise is planned?

Diet: Overall Nutrition

- Ensure that nutritional intake is adequate for exercise to be undertaken
- Meal consumed before exercise – aim for low fat/low GI and include 1g CHO per kg bodyweight

Training load	CHO recommendations (g/kg/day)
Very light training (low intensity exercise or skill-based exercise)	3–5
Moderate intensity exercise for 1 h/day	5–7
Moderate to high intensity exercise for 1–3 h/day	7–10
Moderate to high intensity exercise for 4–5 h/day	≥10–12

Diabetes, Obesity and Metabolism (2011) **13**:130-136

Diet: Carbohydrate before exercise

- Ideally low fat/low GI meal consumed before exercise – include 1g CHO per kg bodyweight

Blood glucose concentrations	Recommendations (rule of thumb)*
<5 mmol/L [#]	<ul style="list-style-type: none"> ▪ Ingest 10-20 g of glucose before exercise ▪ Delay exercise until blood glucose >5 mmol/L
5 – 6.9 mmol/L [#]	<ul style="list-style-type: none"> ▪ Ingest 10 g of glucose before aerobic exercise ▪ Anaerobic and Interval high intensity exercise can be started
7 –10 mmol/L [#]	<ul style="list-style-type: none"> ▪ Aerobic, anaerobic, and interval high intensity exercise can be started
10.1-15.0 mmol/L	<ul style="list-style-type: none"> ▪ Aerobic exercise can be started. ▪ Anaerobic exercise can be started but glucose may rise

Basal insulin – aerobic activity

- MDI
 - Generally not advised to reduce basal insulin prior to activity
 - Would only recommend this for extended periods of aerobic activity
- Insulin pump
 - Ideally reduce basal rate 60-90 minutes before exercise
 - Best reduction **will be individual**, starting point reduction by 50-80%
 - Can remove pump, but think about reconnecting approximately every hour to replace missed basal

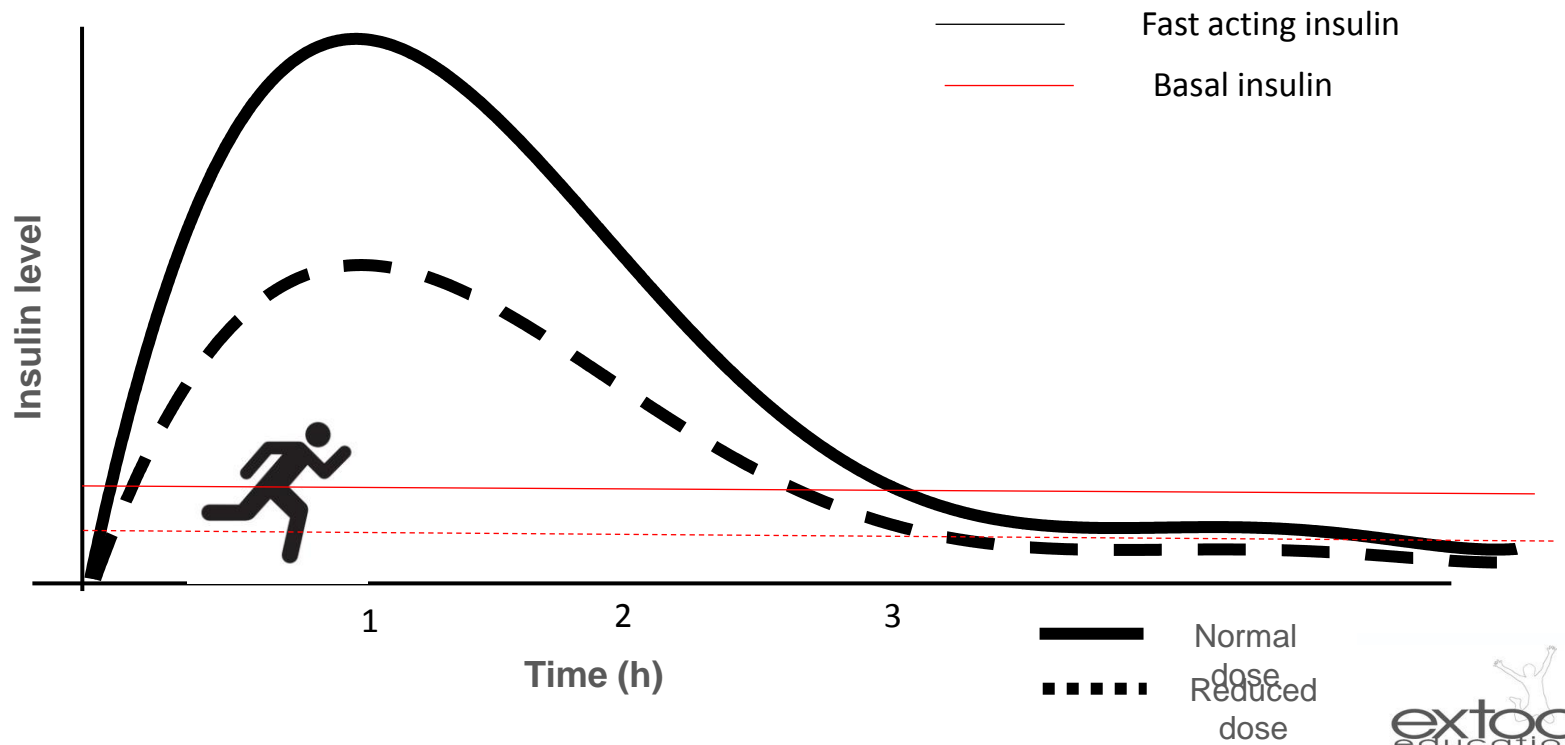
Bolus insulin before aerobic exercise

	Exercise duration	
	30 min	60 min
Mild aerobic exercise (~25% VO_2 max)	-25%	-50%
Moderate aerobic exercise (~50% VO_2 max)	-50%	-75%
Heavy aerobic exercise (70–75% VO_2 max)	-75%	NA
Intense aerobic or anaerobic exercise (>80% VO_2 max)	No reduction recommended	NA

Our recommendations are based on published studies.^{52,56,75,101} NA=not assessed, since exercise intensity is typically too high to be sustained for 60 min for most individuals. VO_2 max=maximal oxygen consumption.

Table 3: Suggested reduction in bolus insulin dose before exercise, based on intensity of exercise, for exercise started within 90 min of consumption of the meal

Effect of lowering insulin by 50%



Slide courtesy Professor Rob Andrews

Using exercise to help you

- If glucose is high before activity – might a low intensity warm-up be helpful?
- If on the low side – might a 10s sprint be helpful?
- If going to the gym – can you the order of activity be adjusted to help?

Blood glucose levels that say “no”

Low blood glucose

- Blood glucose < 3.5 mmol/L
- Severe hypoglycaemia (needed help)
 - Don't exercise for 24 hours
- Self treated hypoglycaemia
 - Be careful for 24 hours
 - If it occurs before exercise – treat and have stable glucose for 60 minutes before starting
 - If it occurs during exercise – stop, treat, recommence after stable for 45 minutes

High blood glucose

- Blood glucose >15 mmol/L
- Ketone greater than 1.5 mmol/L
 - Take insulin wait until have gone before exercise
- Ketones less than or equal to 1.5 mmol/L
 - Eaten <2 hours: just monitor
 - Eaten >2 hours: take extra insulin
 - Can do low to moderate intensity exercise

If you cannot measure your blood ketones we suggest you take a 1/3 of your normal correction dose and then wait until your blood glucose is below 15 before exercising and ensure that you do not do anaerobic exercise on that day

During Exercise

Diet
Insulin
Exercise

Diet - during aerobic exercise

	Endurance exercise performance in people both with and without diabetes
Up to 30 min	No CHO required
30-60 min	Small amount of CHO (10-15g/h) could enhance performance
60-150 min	30-60g CHO per hour
More than 150 min	60-90g CHO per hour spread across the activity (e.g. 20-30g every 20 min) Use CHO sources with difference gut transporters (e.g. glucose/fructose)

Diet - during aerobic exercise

	Hypoglycaemia prevention under low insulin conditions
Up to 30 min	10-20g CHO if BG less than 5 mmol/l beforehand
30-60 min	Aerobic activity: Small amount of CHO (10-15g/h) depending on BG and intensity Anaerobic activity: no CHO required unless BG less than 5 mmol/l during activity
60-150 min	30-60g CHO per hour
More than 150 min	Follow sports nutrition guidelines (60-90g CHO per hour) with appropriate insulin adjustment

Diet - during aerobic exercise

	Hypoglycaemia prevention under high insulin conditions
Up to 30 min	Might require 15-30g CHO
30-60 min	Might require 15-30g CHO every 30 mins
60-150 min	Up to 75g CHO per hour
More than 150 min	Follow sports nutrition guidelines (60-90g CHO per hour) with appropriate insulin adjustment

Insulin and exercise during activity

- Adjusting insulin during activity is rarely helpful
- However, may be helpful to respond to rising glucose seen on glucose monitoring (capillary or CGM) – remember the possibility of short reconnections if pump is off
- Exercise:
 - During a longer event 10s sprint could be used to delay/prevent hypoglycaemia
 - Again – could adjust exercise (e.g. in the gym) in response to glucose levels

After Exercise

Diet
Insulin
Exercise

After exercise - nutrition

- Aim for 1.0-1.2 g/kg CHO with a meal taken after activity to aid recovery
- Protein will aid muscle recovery and may be beneficial in prolonging absorption of CHO
- Protein not necessary for ensuring adequate CHO uptake into glycogen stores (especially muscle)

After exercise – bolus insulin

- Bolus insulin may need to be reduced by up to **50-70%** with meals taken soon after activity (muscle glucose uptake is already increased)
- Where glucose has risen during high intensity activity, a reduced (**50%**) correction bolus is beneficial in reducing hyperglycaemia

After exercise – basal insulin

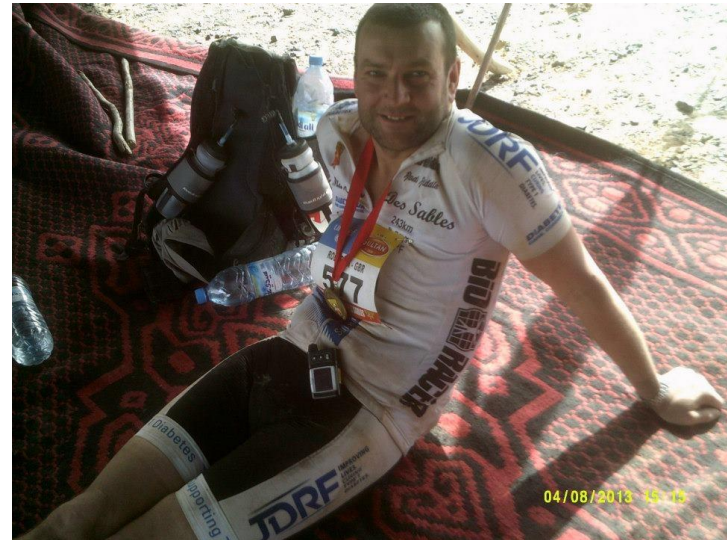
- To combat late hypoglycaemia after activity, a reduction in basal insulin after exercise may be helpful
 - Consider this especially when exercise is of higher intensity/longer duration than is typical for the individual
- MDI – 10-20% reduction in basal insulin dose taken after exercise
- Insulin pumps – 20% basal reduction for 4-6 hours from bedtime

After exercise – can more exercise help??

- Where glucose is elevated after exercise, consider a low intensity warm-down to help to bring this down and ensure well hydrated
- The 10s sprint performed before or during exercise can protect against falling glucose immediately afterwards

Summary

- Why a guideline?
- Basic exercise physiology
- Strategies for managing T1D for exercise
 - Before
 - During
 - After





EXTOD/PEAK conference



Extod/PEAK: Exercising for Type 1 Diabetes Performing at your PEAK

19th October 2018, Manchester Conference Centre

