Promoting Physical Activity in Diabetes: why, how and wow.

The physiology of exercise in relation to diabetes

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Victory over diabetes has always been through three important strategies:

1. Sound nutrition
2. Insulin management/ oral hypoglycaemic agents
3. Regular exercise

Joslin "Victory" Medal

extod

JDRF PEAK
T1D Performance in Exercise and Knowledge

Drs Andrews and Narendran

Exercise has long been know to act like insulin to lower blood glucose levels

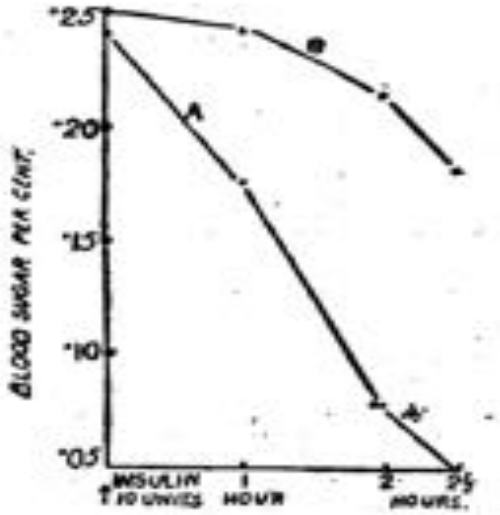
THE EFFECT OF EXERCISE ON INSULIN ACTION IN DIABETES.*

BY

R. D. LAWRENCE, M.D.,

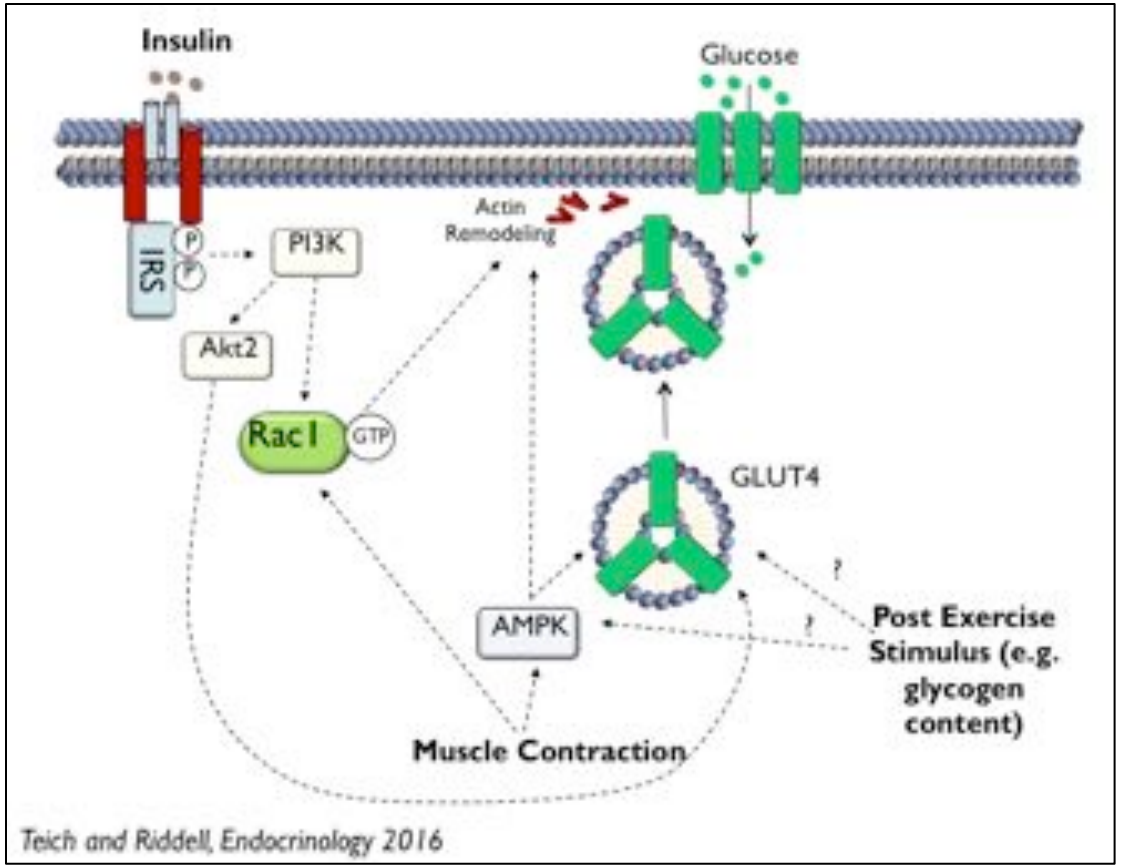
CHEMICAL PATHOLOGIST, KING'S COLLEGE HOSPITAL.

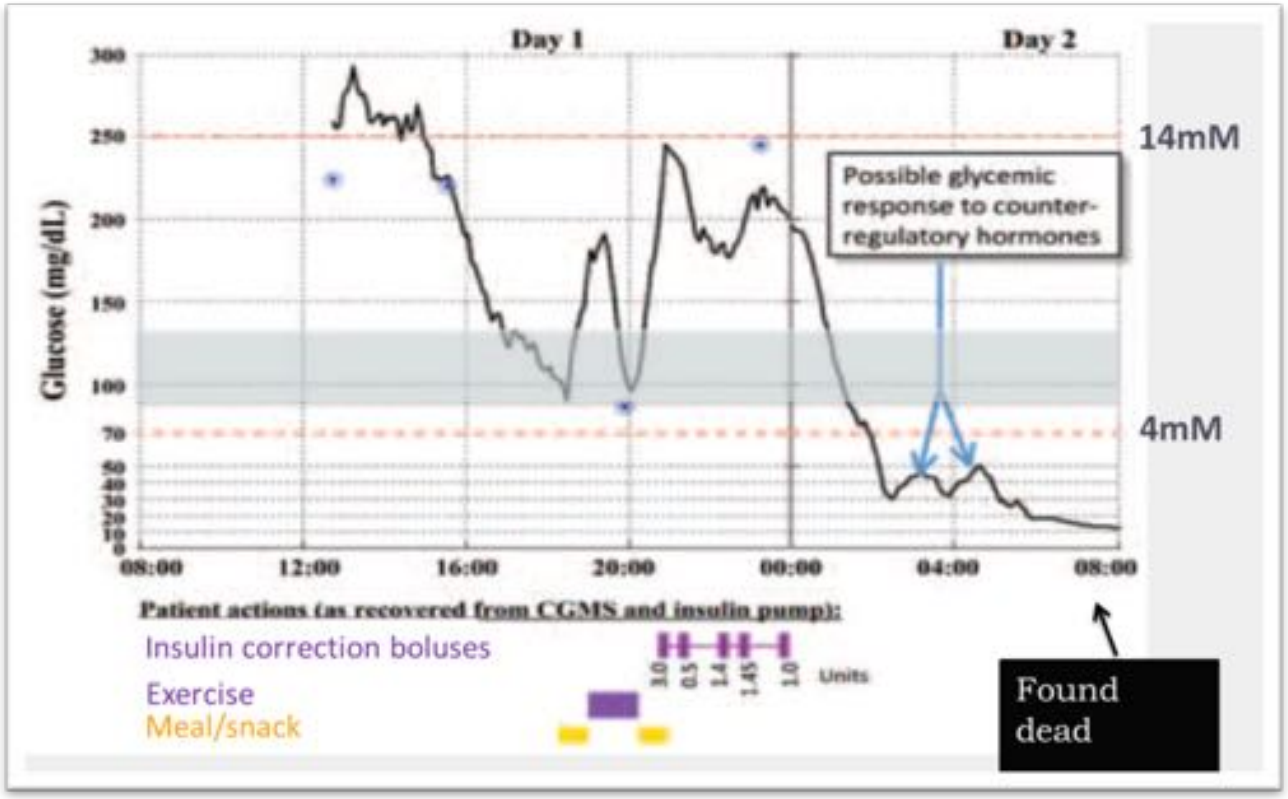
Time. Minutes.	A. Insulin + Exercise.	B. Insulin, no Exercise.
2 p.m.	240 Insulin 10 units	254 Insulin 10 units
20	245	—
30	—	242
45	219	—
60	175	239
90	116	230
120	73*	211
150 4.30 p.m.	51*.	181



The British Medical Journal 1926

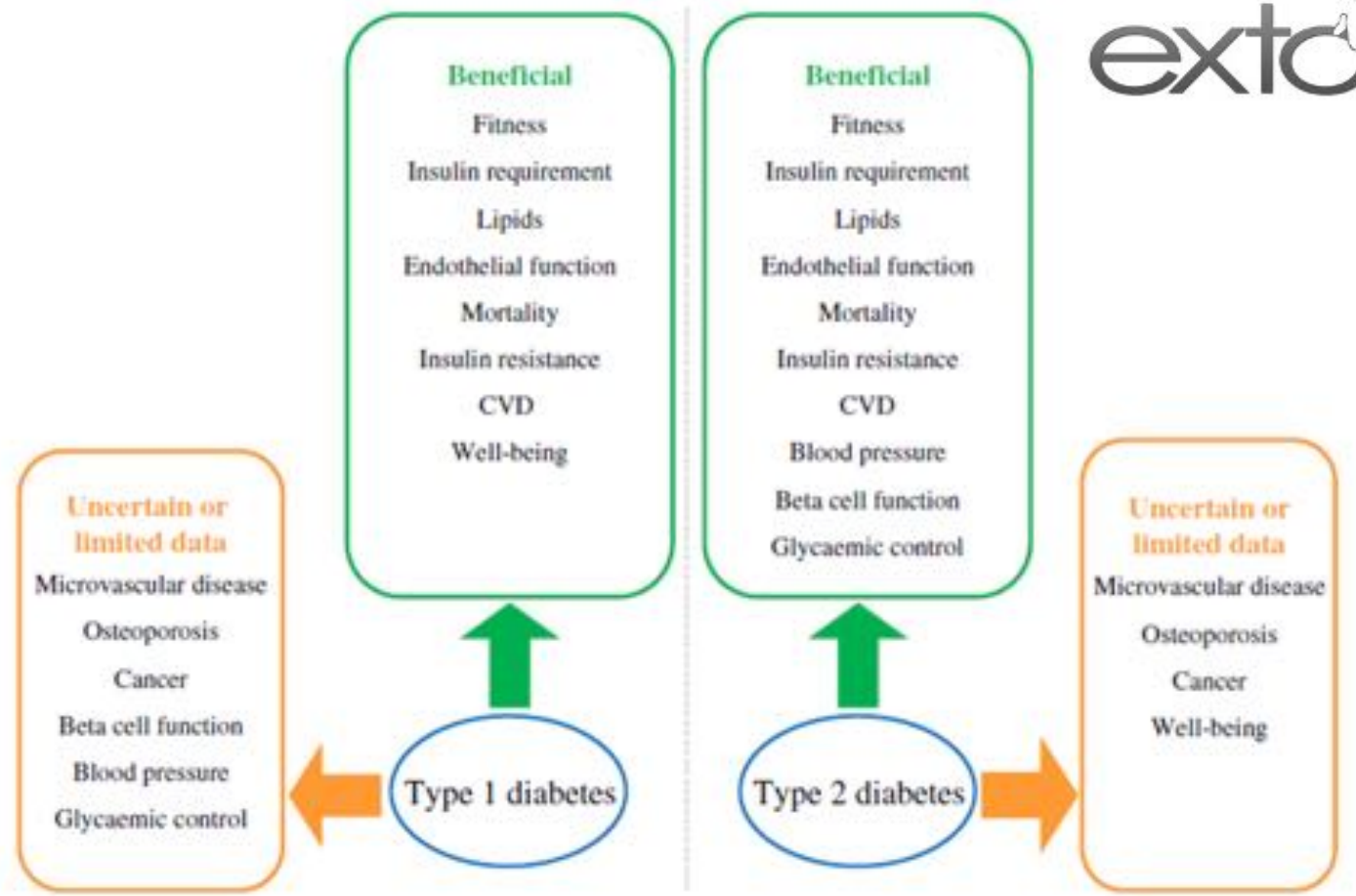
Insulin sensitivity in skeletal muscle post exercise is elevated for 24-48 hours- this can promote nocturnal hypoglycemia in T1D





Regular exercise has numerous health benefits for diabetes

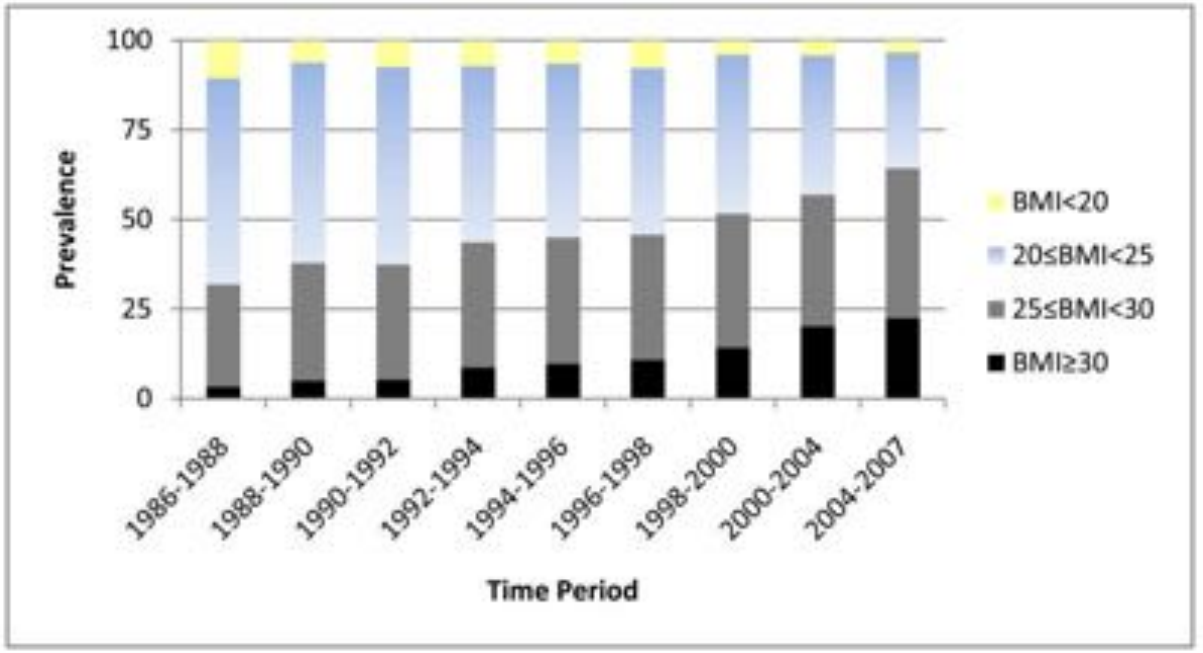
- Enhanced fitness
- Improved CVD risk factors
- Reduced microvascular disease
- Enhanced insulin sensitivity
- Enhanced beta cell function
- Reduced hepatic glucose production (at rest)
- Enhanced glycemic control (lower A1C)
  - ✓ by **~0.6-1.0%** in T2D
  - ✓ by **~0.3-0.5%** in T1D



Chimen et al., Diabetologia (2012) 55:542–551

In spite of all its challenges, diabetes can be a disease that focuses you on the things in life that can help keep you healthy…

- Energy balance
- Good nutrition
- Exercise and fitness



Temporal patterns in overweight and obesity in type 1 diabetes

Conway et al., Diabet Med. 2010 Apr;27(4):398-404.

Benefits of regular physical activity in the general population

- Reduced mortality & risk of recurrent breast cancer (by **~50%**)
- Reduced risk of colon cancer (by **~30-60%**)
- Reduced risk of developing Alzheimer's disease (by **~40%**)
- Decreased depression (by **~30-60%**)
- Lower the risk of developing type 2 diabetes (**by 40-70%, or delay onset by about 10 years**)
- Increased cardiorespiratory fitness and vigour (by **~10-50%**)
- Reduced incidence of hypertension (by **~33-60%**)
- Reduced risk of stroke (by **~30%***)
- Reduced incidence of cardiovascular disease (by **~33-60%***)
- Reduced risk of premature death (by **~30-60%***)

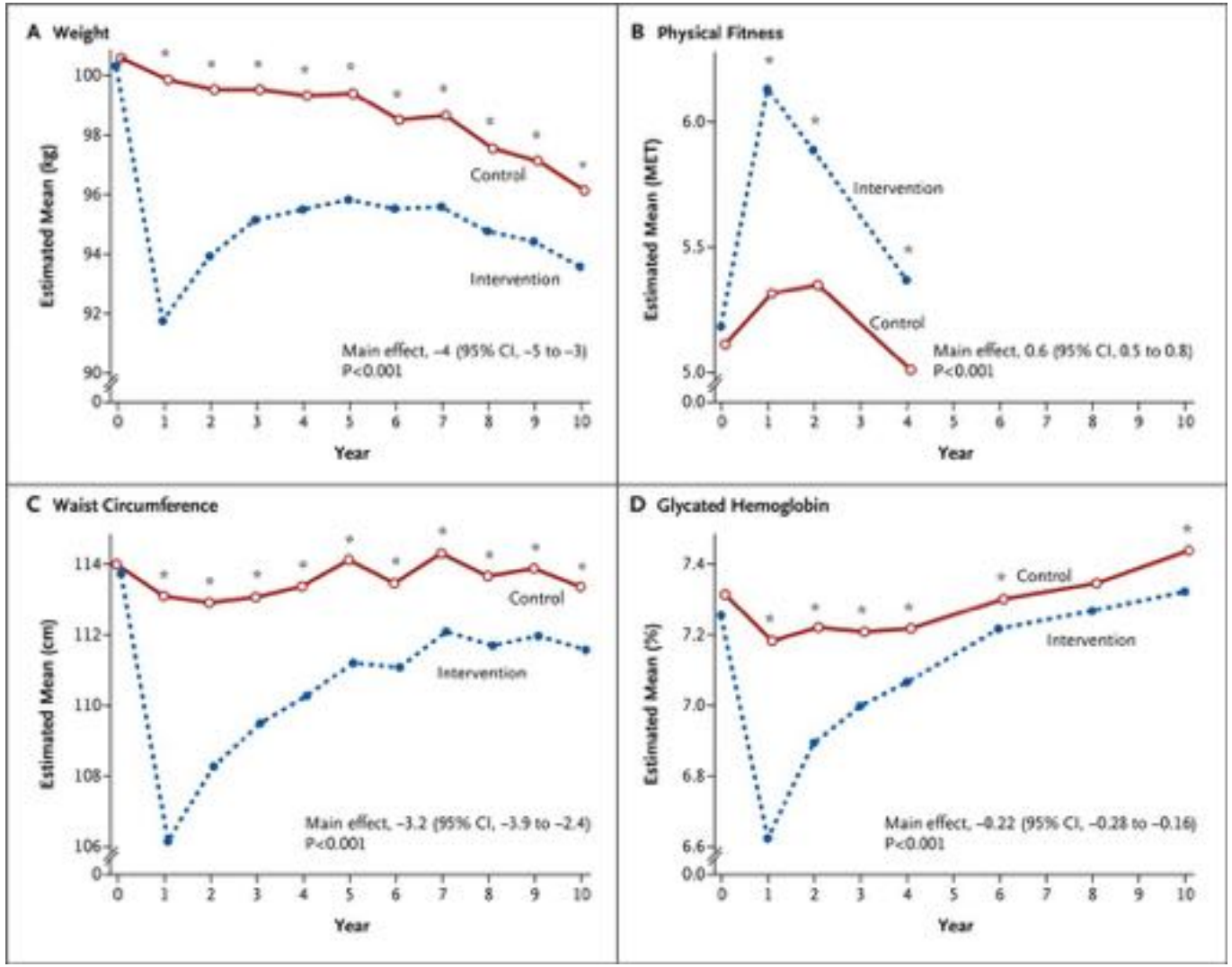
* May not lower CVD endpoints if started too late in T2D

Colberg et al., Diabeets Care 2016; Nov;39(11):2065-2079; Blair SN & Morris JN. *Ann Epidemiol* 2009; 19(4): 253-6. ; Warburton DE, et al. *Int J Behav Nutr Phys Act* 2010; May 11;7:39. doi: 10.1186/1479-5868-7-39.; Evert AB & Riddell MC. *Med Clin North Am* 2015; 99(1): 69-85.; Armstrong MJ & Sigal RJ. *Can J Diabetes* 2015; doi: 10.1016/j.jcjd.2015.09.081. [Epub ahead of print]

Physical Activity in Adults with Type 2 Diabetes (the Look AHEAD trial)

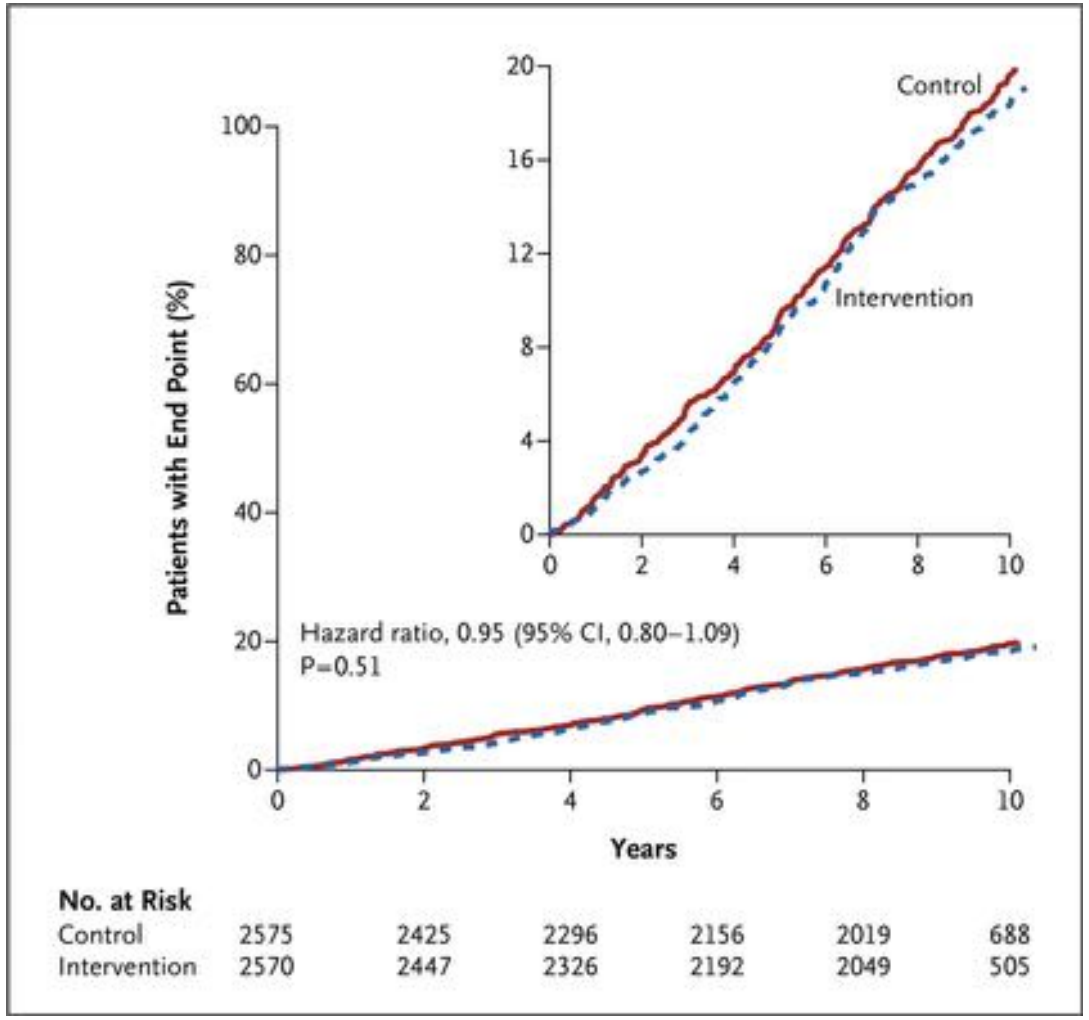
- Large RCT (n=5145) that evaluated lifestyle intervention in adults with type 2 diabetes compared with diabetes support/education

- The intensive lifestyle intervention was aimed at achieving and maintaining weight loss of at least 7% by focusing on reduced caloric intake and increased physical activity.



The Look AHEAD Research Group
N Engl J Med 2013; 369:145-154

Physical Activity in Adults with Type 2 Diabetes (the Look AHEAD trial)



- No difference in incidence of major CV events (death, nonfatal MI, nonfatal stroke, or angina)
- The lifestyle intervention group did have more sustained weight loss, less medications, better fitness, better glucose control, better blood pressure and lipids, less sleep apnea, less severe diabetic kidney disease and retinopathy, depression, sexual dysfunction, urinary incontinence, and knee pain; and better physical mobility maintenance and quality of life, with lower overall health care costs…

The Look AHEAD Research Group
N Engl J Med 2013; 369:145-154

Diabetes Care Volume 39, November 2016 2065

Physical Activity/Exercise and Diabetes: A Position Statement of the American Diabetes Association

Sheri R. Colberg,[1] Ronald J. Sigal,[2] Jane E. Yardley,[3] Michael C. Riddell,[4] David W. Dunstan,[5] Paddy C. Dempsey,[5] Edward S. Horton,[6] Kristin Castorino,[7] and Deborah F. Tate[8]

Diabetes Care 2016;39:2065–2079 | DOI: 10.2337/dc16-1728

Recommendations

- **All adults with diabetes should decrease the amount of time spent in daily sedentary behavior. B**
- **Prolonged sitting should be interrupted with bouts of light activity every 30 min for blood glucose benefits. C**
- Structured lifestyle interventions that include at least 150 min/week of physical activity and dietary changes resulting in weight loss of 5%–7% are recommended to prevent or delay the onset of T2D in populations at high risk. **A**
- Daily exercise is recommended to enhance insulin action. **B**
- Adults should ideally perform both aerobic and resistance exercise training for optimal glycemic and health outcomes. **C**
- Children and adolescents should be encouraged to meet the same physical activity goals set for youth in general. **C**

In adults with T2D, those who are meeting the PA prescription of 150 minutes/week of exercise have higher health-related QOL scores…

- √ Physical functioning
- √ Bodily pain
- √ General health
- √ Vitality
- √ Role-physical
- √ Role-emotional
- √ Mental health

Note: Participants who did not meet exercise recommendations were more likely to have less education, be smokers, have more comorbidities and report more depressive symptoms

Thiel et al., Can J Diabetes 41(1): 58-63, 2017

What Type of Exercise is Best for Pre-Diabetes or T2D?

150-170 min/week of brisk walking, post meals

?

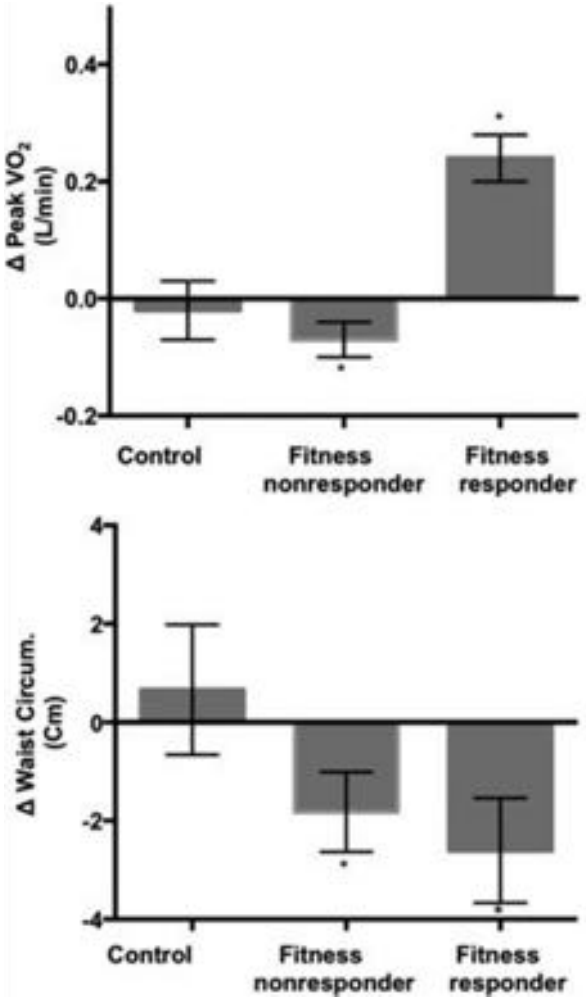
2-3 x 30 min weekly of high intensity circuit training

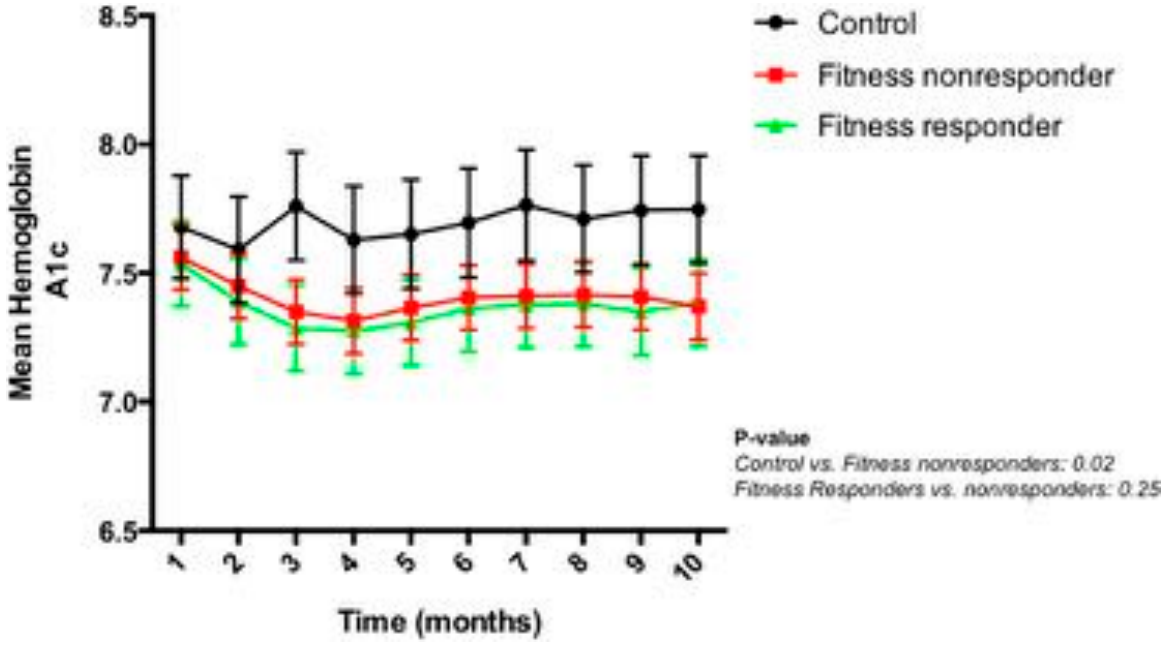
6 sessions of high intensity interval training (10 times 60 seconds= 3600 seconds (1 hour of training over a few weeks)

Reynolds et al. Diabetologia. 2016 Dec;59(12):2572-2578; Fatone et al., . J Endocrinol Invest. 2010 Jul-Aug;33(7):489-95. ; Little et al., . J Appl Physiol (1985). 2011 Dec;111(6):1554-60

Some Individuals with T2D Are Exercise Non-Responders

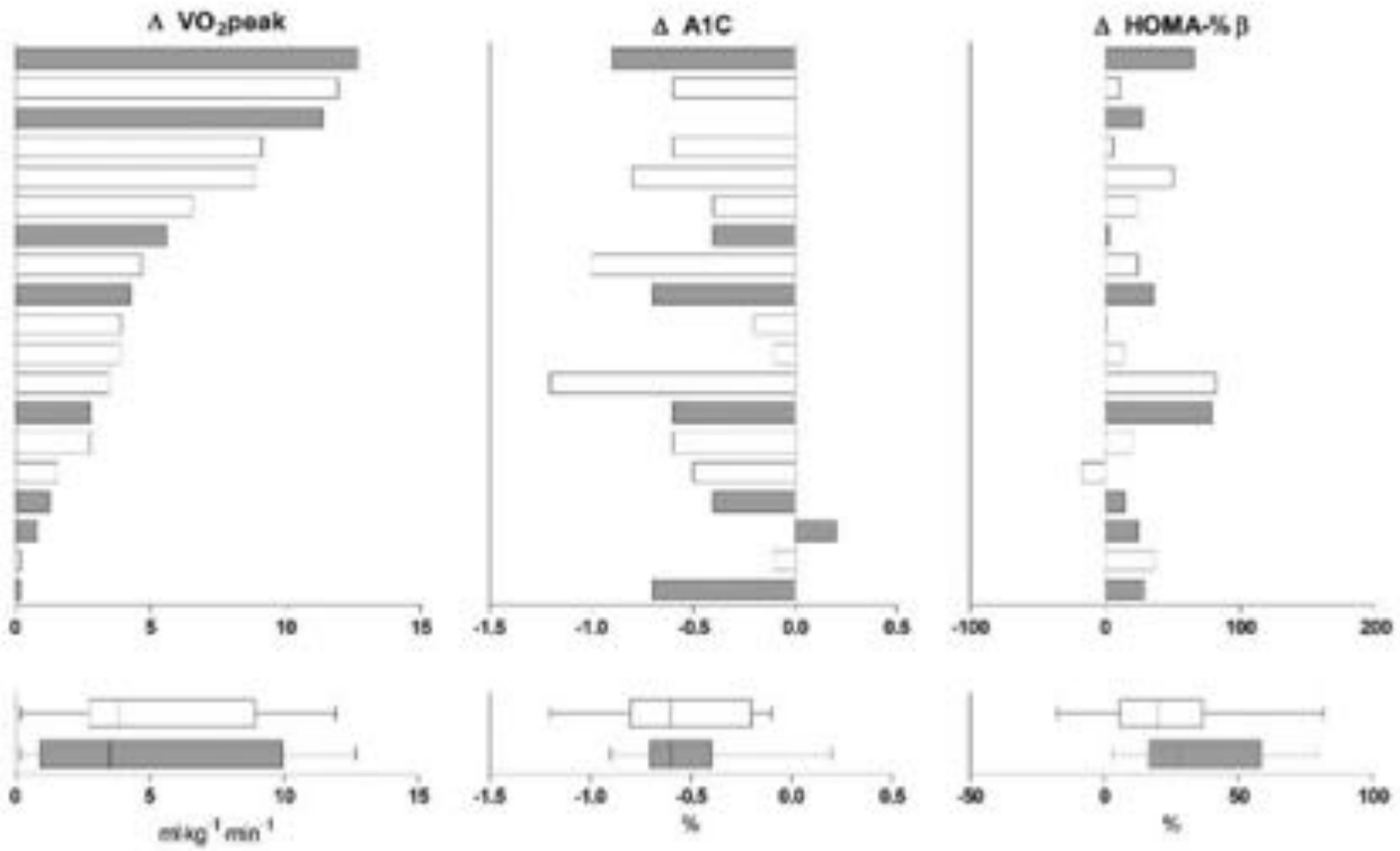
- 161 adults with T2D underwent 9 month supervised exercise intervention
  - ~60% improved VO_2max
  - ~40% non-responders
- 41 controls





Pandey et al., Diabetes Care 2015;(**38**):1494–1501

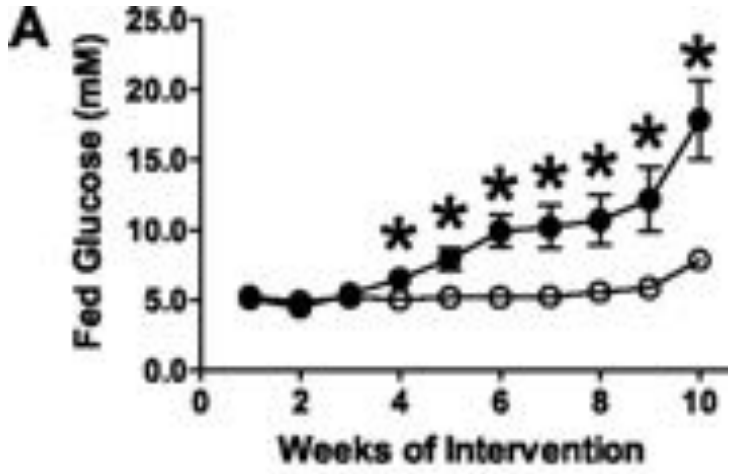
Individual responses to continuous aerobic vs. intermittent high-intensity exercise in men and women with pre-diabetes

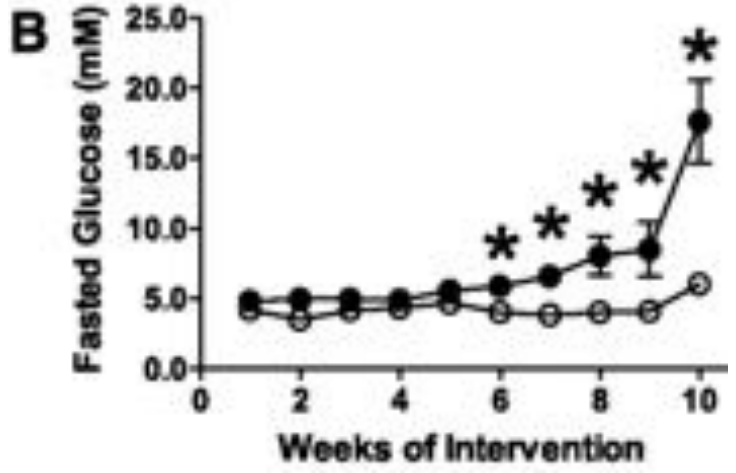


Int HI Ex
Continuous aerobic

Rowan e al., MSSE 2017

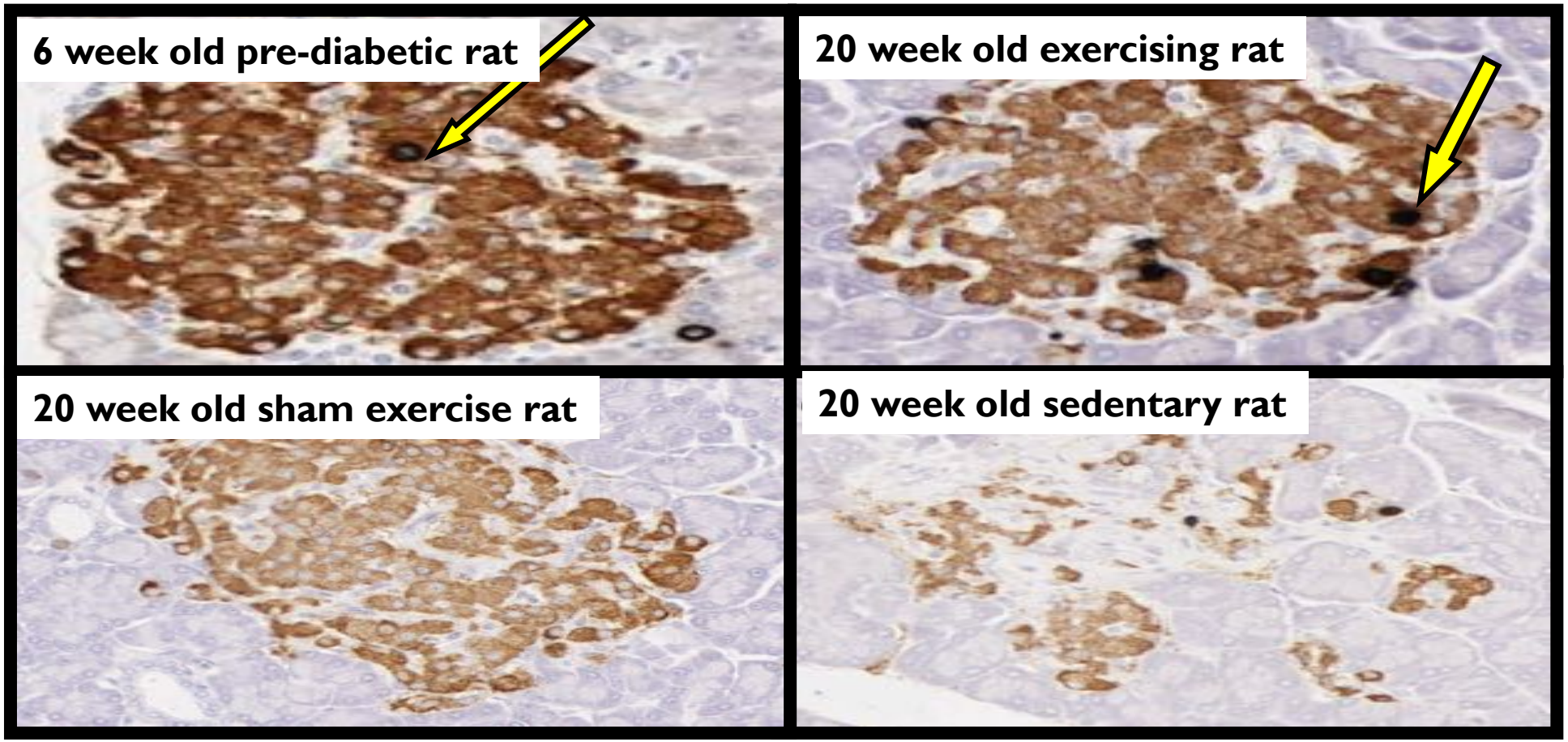
Regular exercise and beta cell mass in a rodent model of pre-diabetes/T2D



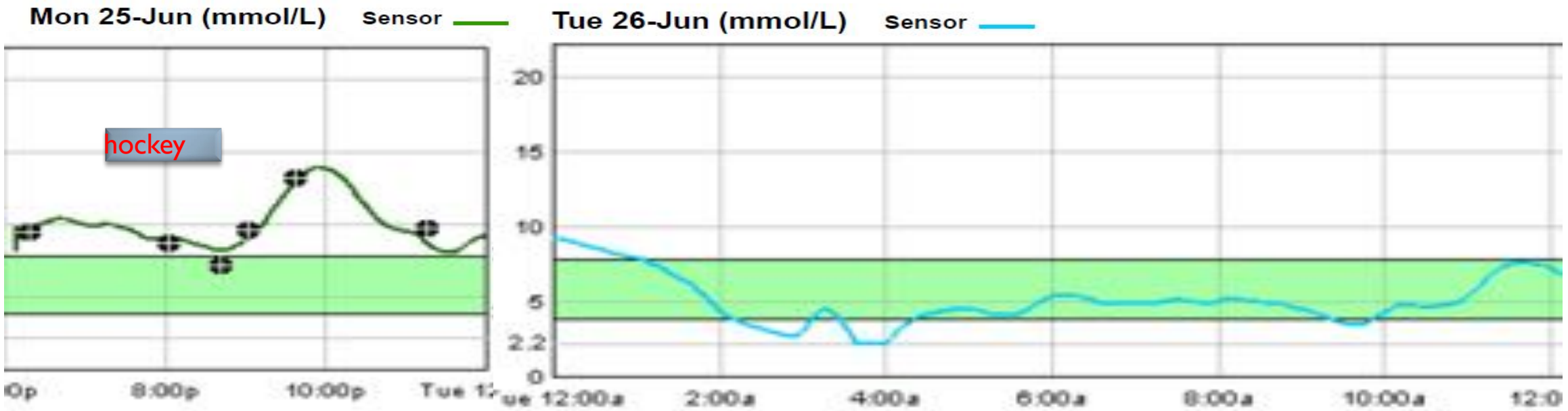


Campbell et al., Am J Physiol Regul Integr Comp Physiol. 2010, 299(1):R168-76; Király Am J Physiol Endocrinol Metab. 2010, 298(3):E671-82; Király et al., Am J Physiol Endocrinol Metab. 2008, 294(2):E271-83; Király et al., Metabolism. 2007, 56(6):732-44.

Regular exercise preserves beta cell mass in the Zucker diabetic fatty rat

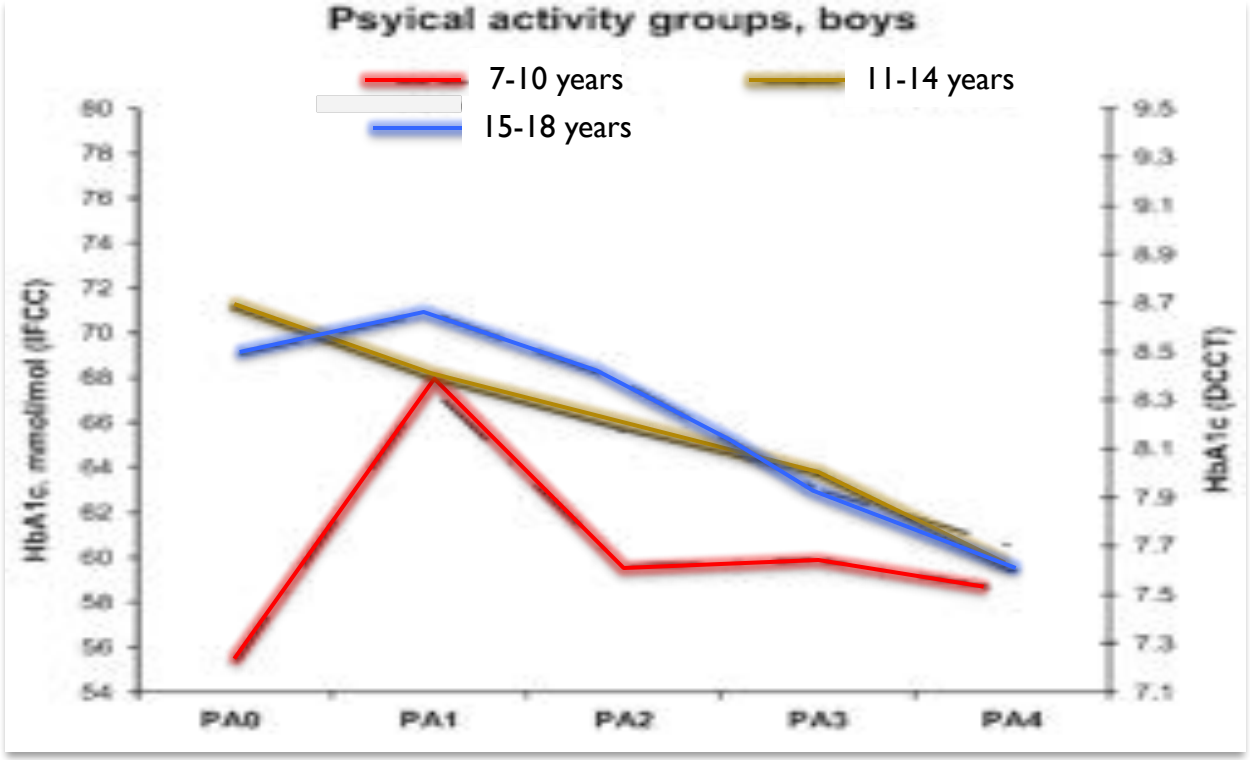


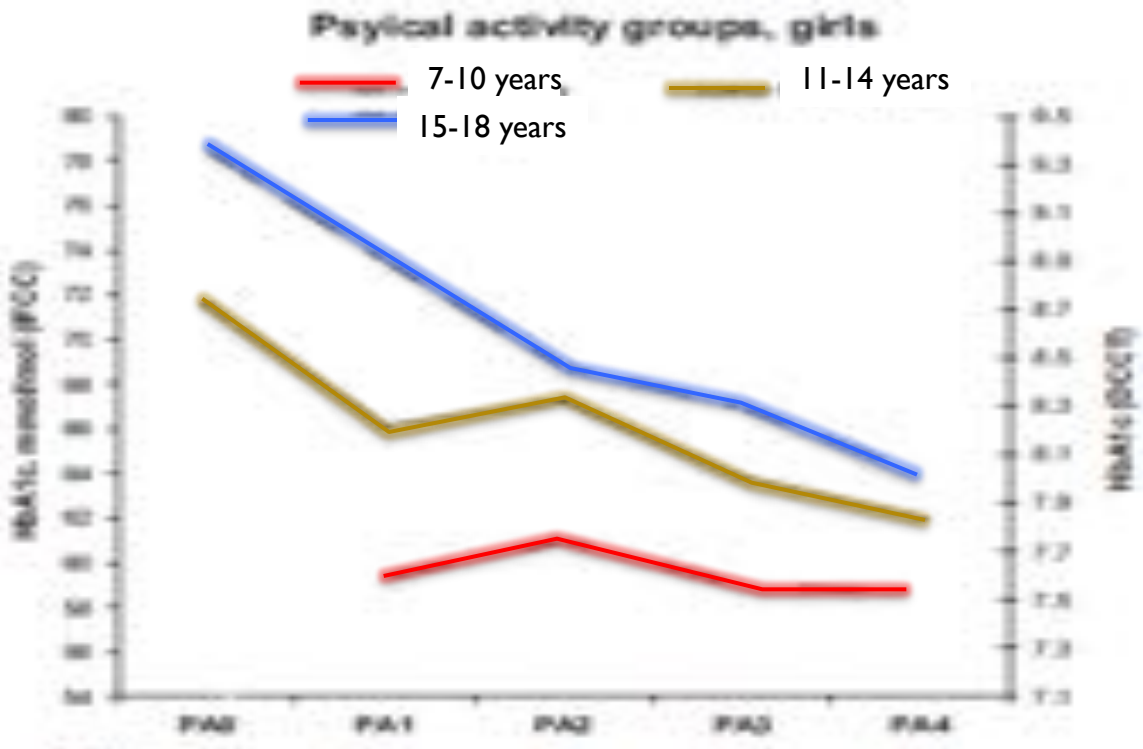
Exercise and Type 1 diabetes



Higher physical activity levels tend to be associated with lower HbA1c levels in boys and girls with type 1 diabetes

N= 4655 Swedish patients

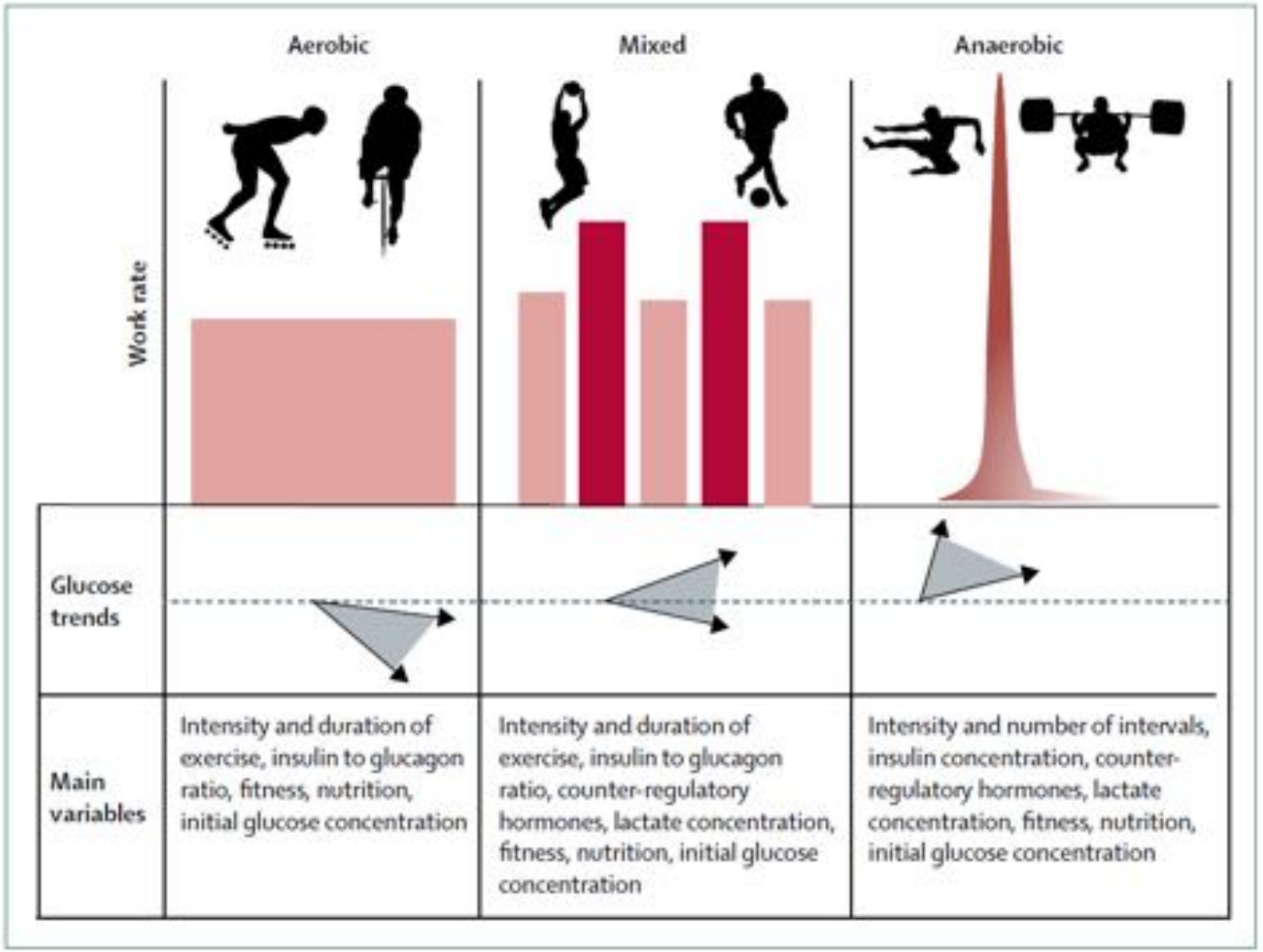




PA0, none, PA1, less than once a week, PA2, 1–2 times per week, PA3, 3–5 times per week, and PA4, every day.

Beraki et al., *Diabetes Res Clin Pract., 2014*

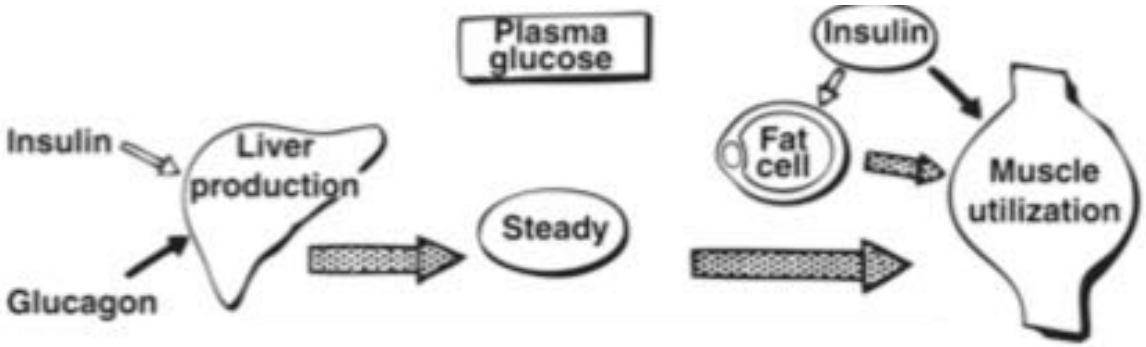
General trends and patient variability in blood glucose responses to exercise in T1D



Riddell MC et al., Lancet Diabetes Endocrinol. 2017

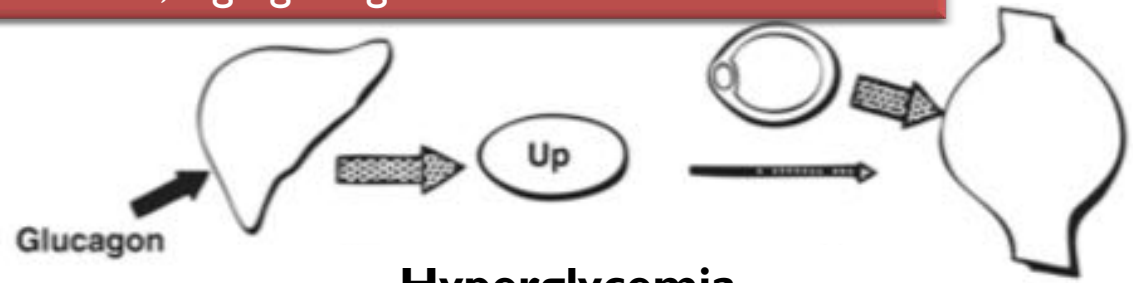
Normal and abnormal metabolic responses to aerobic exercise in T1D

Low insulin, high glucagon



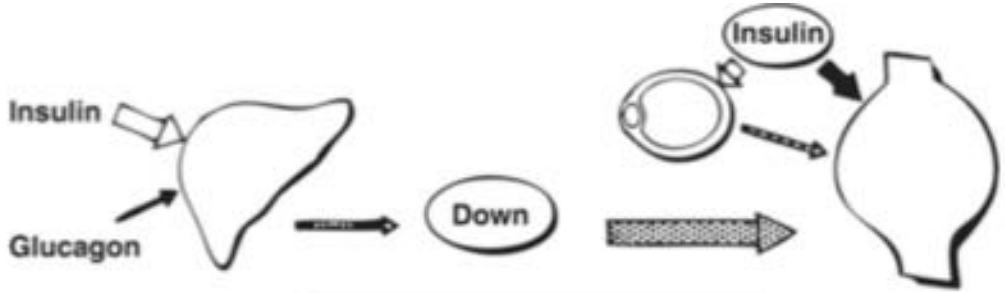
Euglycemia

Low insulin, high glucagon and/or stress hormones



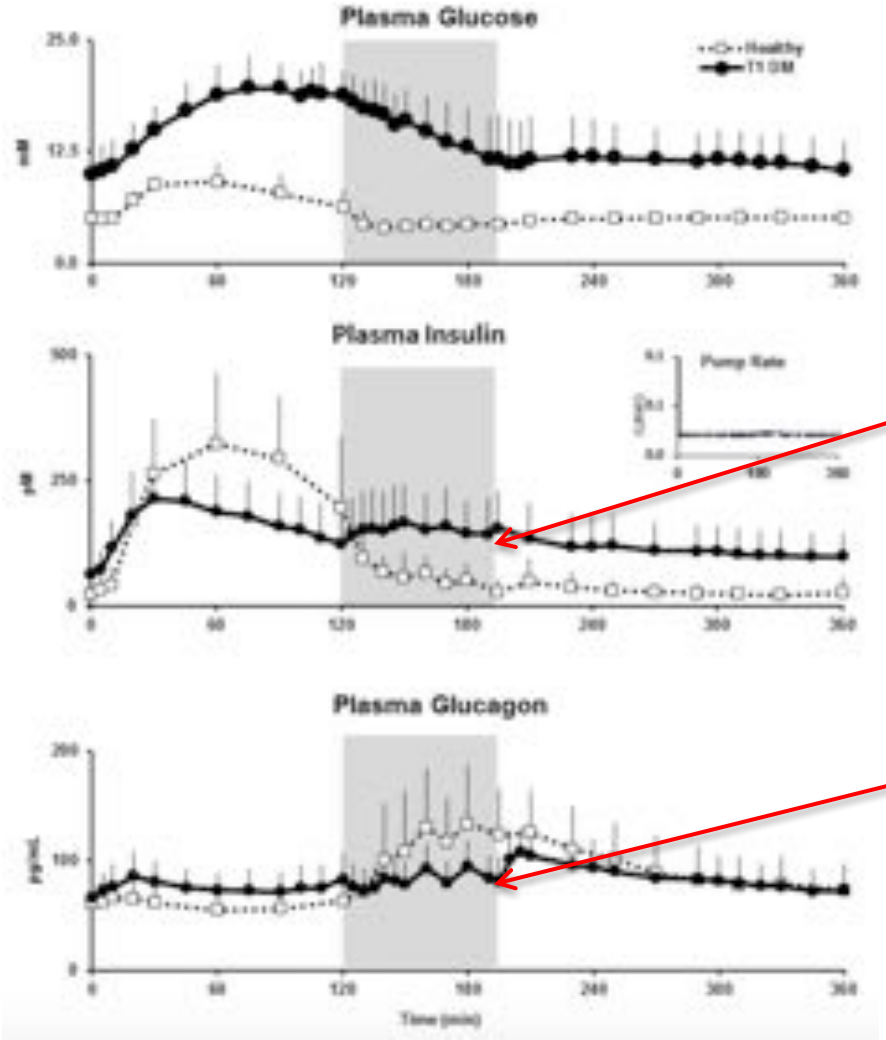
Hyperglycemia

High insulin, defective glucagon counterregulation



Hypoglycemia

Aerobic exercise without basal rate adjustments promote an increase in insulin absorption and a drop in glycemia



Insulin levels increased even though basal rates were not changed

Glucagon levels do not rise with exercise

Mallad et al, Am J Physiol Endocrinol Metab (April 21, 2015)

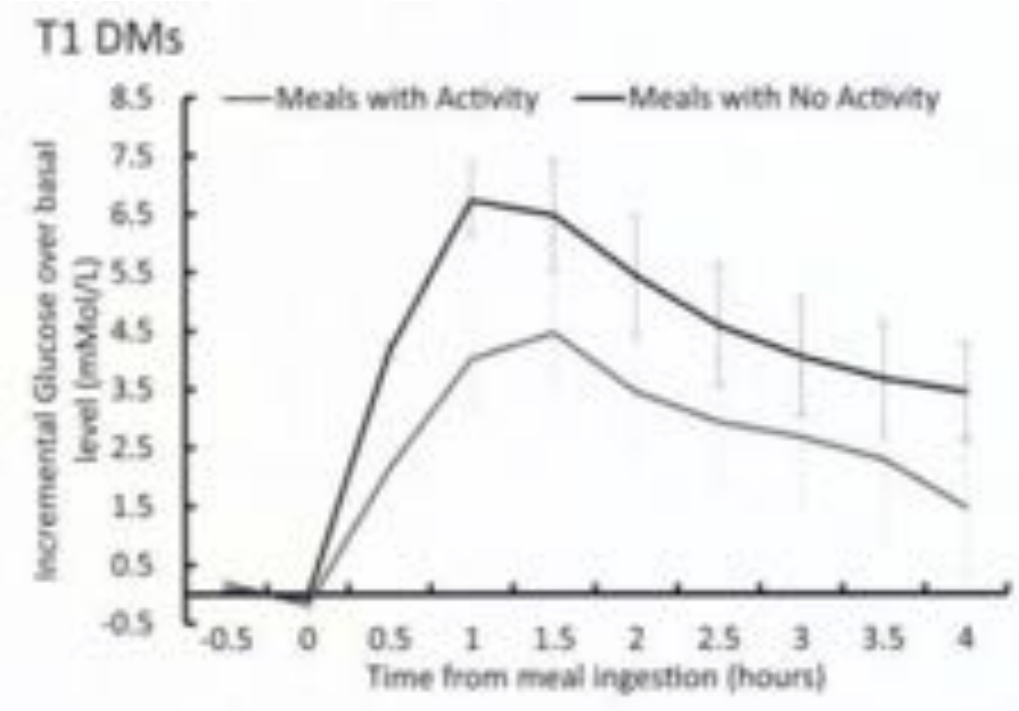
A fear of hypoglycemia in T1D is a barrier to exercise

- Adolescents with T1D were shown to spend more time lying down and resting than non diabetic peers (2.0 vs. 1.3 h/day)
- In the global TEENS study, about ⅔rds of youth with T1D were not participating in 30 min of exercise daily

Hanas et al., ISPAD Meeting, Toronto, abstract #217; Lobelo et al., Pediatrics 2010; Mohammed et al., Can J Diabetes 2014.

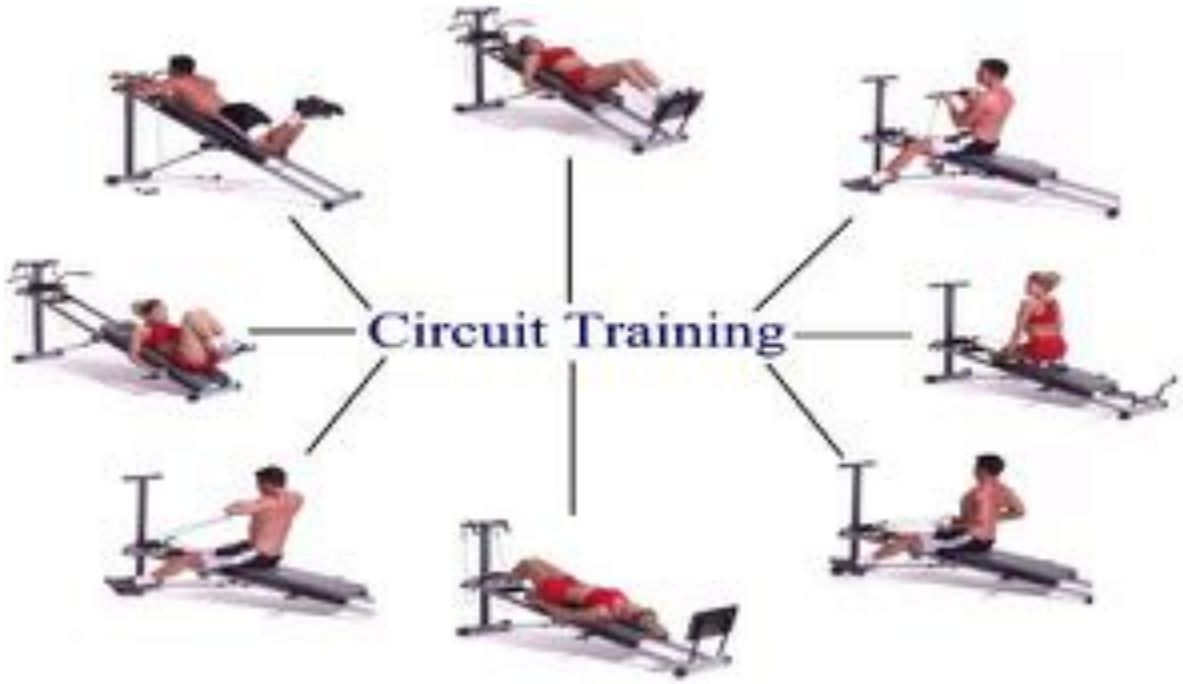
When is safest to perform light aerobic exercise in T1D?

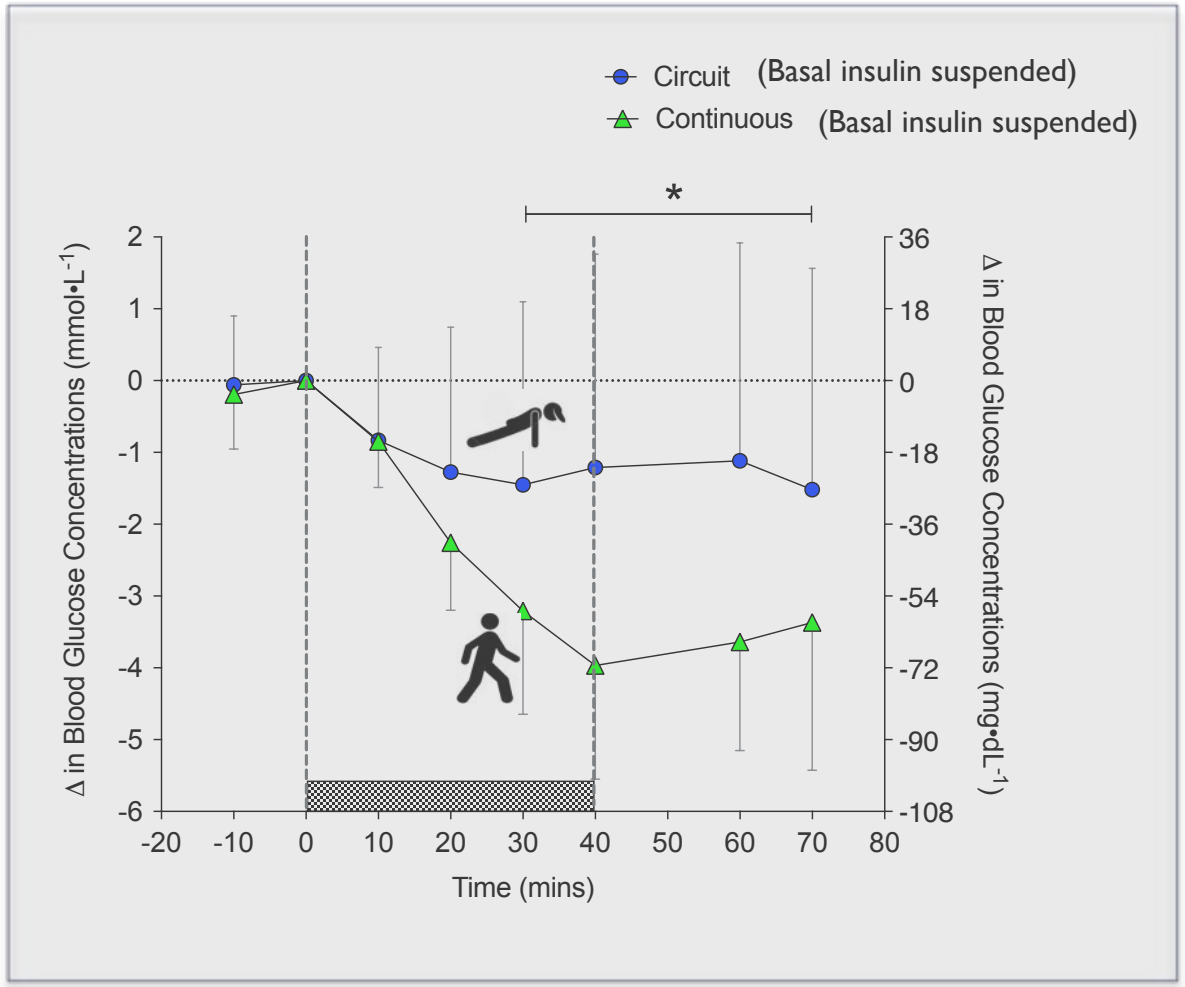
Perhaps right after a large meal



Manohar C, et al. Diabetes Care 2012;35:2493-9.

Circuit training exercise associated with better glucose stability than continuous aerobic exercise in type 1 diabetes

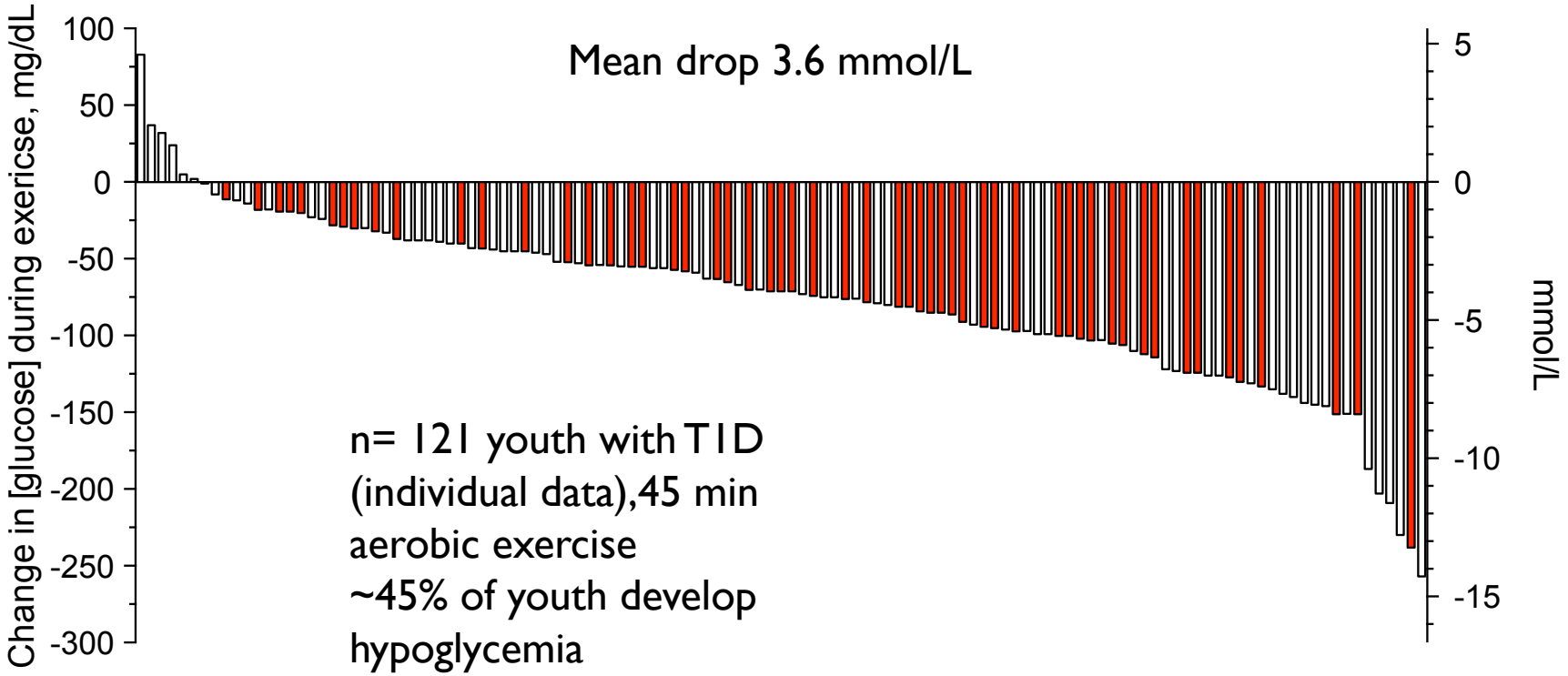




Zaharieva et al., Diabetes Technol. Ther. In revision

Exercise and T1D Patient Variability

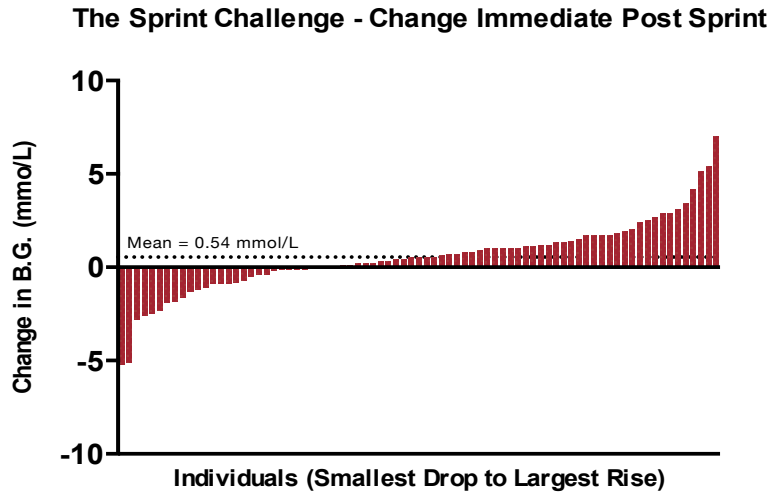
Individual changes in the blood glucose response to aerobic exercise

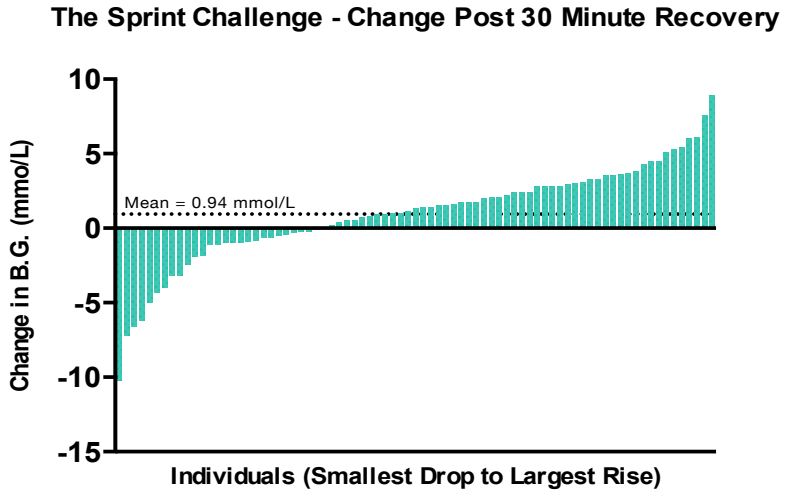


Riddell et al., in preparation

Patient variability to intense anaerobic exercise

~90 kids with T1D performed pre and post blood sugars with sprinting . Each participant was ranked from largest decrease to greatest rise in glycemia…





Riddell et al., in preparation

Summary and conclusions

- Exercise is an important component of diabetes management
- Nearly all forms of exercise likely have benefits for type 2 diabetes
- Patients with type 1 have fears of exercise-related dysglycemia:
  - Aerobic exercise= hypoglycemia
  - Anaerobic exercise= hyperglycemia
- Patients with type 1 diabetes likely benefit from mild exercise soon after large meals or from doing intermittent high-intensity activities
- Other forms of exercise likely require complex decision-making around exercise

Acknowledgments

- Riddell lab
- Extod
- JDRF-Peak

extod

JDRF PEAK
T1D Performance in Exercise and Knowledge