



Exercise in Patients with Diabetes

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Nothing to
declare



Objectives

Review the physiology of exercise in Type 2 diabetes mellitus

Prescribing exercise as a therapeutic treatment and for prevention of DM2

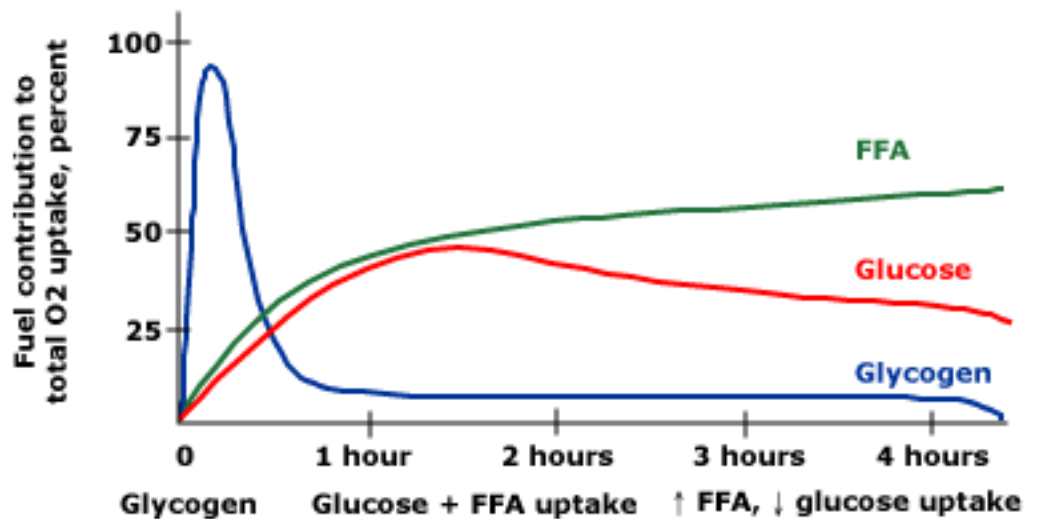
Pearls for caring for the active patient with DM1 and DM2

Type 2 Diabetes Mellitus

- 24 million Americans have DM2
- 60 million Americans have pre-diabetes
- Lifetime risk estimates suggest that **one in three** Americans born in 2000 or later will develop diabetes, but closer to 50% in high-risk ethnic populations

Metabolic substrate utilization during exercise

- Glycogen supplies most of the energy in working muscle for first 30 minutes
- Increased uptake of blood glucose by working muscle is offset by release of glucose from the liver.



Exercise in DM2



Exercise potentiates the affect of insulin on the working muscle.



This effect is primarily mediated through GLUT4 receptors.



Independent of weight loss or liver function.



Improvement occurs within the first week of initiating an exercise program

How much
does
exercise
improve
glycemic
control?

- Meta-analysis
 - 3x/week x 18 weeks
 - 10 exercises x 2 sets x 12 reps
 - A1C of 7.65% vs 8.31%; ($P < .001$).
 - ***Independent of change in BMI

Effects of exercise on glycemic control and body mass in type 2 diabetes mellitus: a meta-analysis of controlled clinical trials. BouléNG, Haddad E, Kenny GP, Wells GA, Sigal RJ JAMA. 2001;286(10):1218.

- The improvement in insulin action from a single bout of aerobic exercise lasts between 24 h and 72 hours.
 - Benefits last longer in young than older
 - Varies somewhat by type of exercise, intensity, and other factors.

**•Take Home point:
benefit of exercise
only lasts 1-2
days.**

“no more than 2 days between bouts of exercise”

- The improvement in A1c from exercise is the cumulative effect of transient improvements in glucose tolerance which follow each individual period of exercise

What is the impact of exercise on other CVD risk factors?



- Minimal affect on HTN in DM2
 - Perhaps 5mmHg systolic only
- Minimal affect on lipids
 - Small reduction in LDL-C and none on HDL-C

It's not about weight loss

- Weight loss without calorie restriction requires >60 min daily (7 hrs/week) of moderate intensity



Preventing CVD and mortality in DM2

- 5125 women with type 2 diabetes in the Nurses' Health Study,
 - at least four hours per week performing moderate or vigorous exercise
 - **40 percent** lower risk of developing cardiovascular disease (independent of other risk factors)
- In a prospective cohort study of 2896 diabetic adults
 - walked for at least two hours per week had lower CV mortality rates when compared with inactive individuals (HR 0.66)
 - three to four hours per week (HR 0.47).
 - NNT = 61 (prevent one death/year)

Does the type of exercise matter?

- Aerobic exercise improves insulin action, independent of changes in muscle mass, aerobic capacity, or weight loss
 - effects of moderate aerobic exercise are similar whether performed in a single session or multiple bouts with the same total duration
- Resistance training results in increased muscle mass without altering the muscle's intrinsic capacity to respond to insulin.

Does the type of exercise matter?

- A combination of aerobic and resistance training appears to be more effective for BG management than either type of exercise alone.
- NOTE: Individuals in combination training had a greater total duration and intensity of exercise

Effective exercise modality to reduce insulin resistance in women with type 2 diabetes.
Cuff DJ, Meneilly GS, Martin A, Ignaszewski A, Tildesley HD, Frohlich JJ Diabetes Care.
2003;26(11):2977

- “Exercise **intensity** predicts improvements in overall BG control to a greater extent than exercise **volume**”
- In other words, exercising harder results in greater improvement in insulin action and glucose control than working out longer.

Boulé NG, et al Meta-analysis of the effect of structured exercise training on cardiorespiratory fitness in type 2 diabetes mellitus. *Diabetologia*. 2003;46(8):1071-81.

Incremental Benefits of Exercise

- There is clinically significant decreased risk for every additional:
 - 1 MET/day
 - 2000 steps/day
 - Time up to 300 min/week
- 1 met/day = 10% reduction in all cause mortality
- HR 0.6 for all cause mortality, 0.5 for CVD

Kodama S, et al. Diabetes Care. 2013;36(2):471.

Sluik D, et al Arch Intern Med. 2012;172(17):1285.

Yates T, et al Lancet. 2014 Mar;383(9922):1059-66.

How much exercise do we need?

- US Federal guidelines = exercise volume of 500-1000 MET·min·wk⁻¹
 - 150 min/wk of walking 4 mph
- or
 - 75 min/wk of jogging at 6 mph

Physical Activity Guidelines Advisory Committee. *Physical Activity Guidelines Advisory Committee Report, 2008*. Washington (DC); US Department of Health and Human Services; 2008. 683 p.

but.....DM2
have a lower
maximum
exercise
capacity

- mean maximal aerobic capacity in diabetic individuals = 6.4 METs,
 - 4.8 METs (75% of maximal) = highest sustainable intensity.

Boulé NG, et al Meta-analysis of the effect of structured exercise training on cardiorespiratory fitness in type 2 diabetes mellitus. *Diabetologia*. 2003;46(8):1071-81.

It is *harder* to exercise when you have diabetes

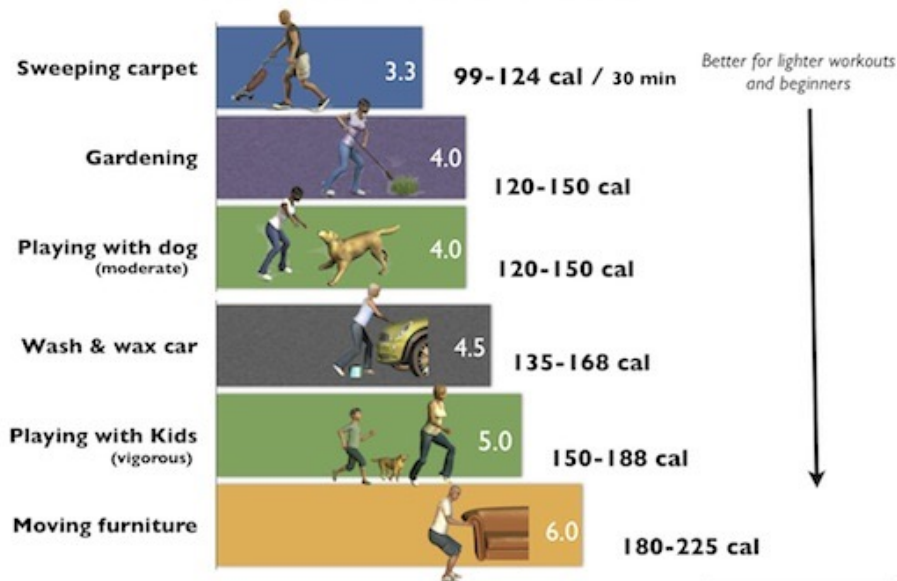
Decreased exercise tolerance in DM2

- Obesity
- Subclinical LV dysfunction and decreased HRR
- Decreased mitochondrial function and muscle oxidative capacity
- Microvascular damage



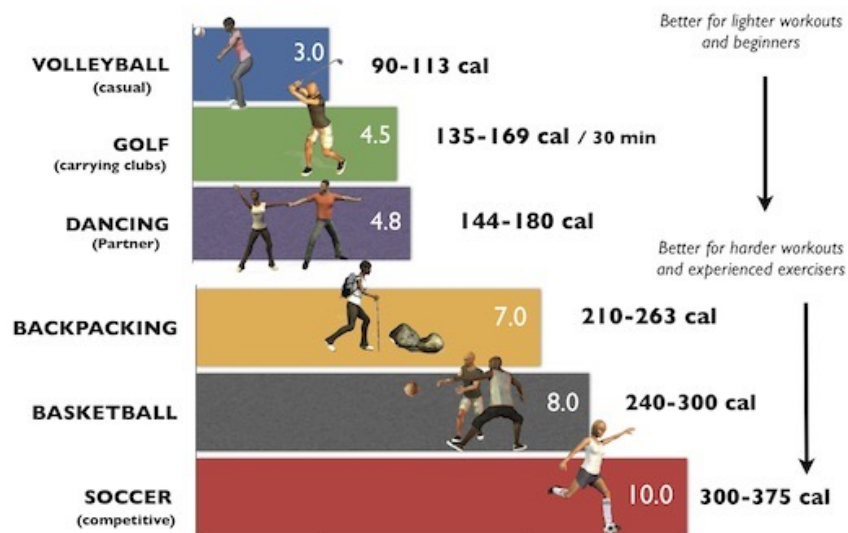
- “most diabetic individuals will require at least 150 min of exercise per week to achieve optimal CVD risk and A1c reduction”

AT HOME ACTIVITIES



whyiexercise.com

SPORTS and LEISURE



whyiexercise.com

Activity	MET Value	Calories Burned in 30 Minutes*	Calories Burned in 60 Minutes*
Light Weight Lifting	3	107	215
Water Aerobics	4	143	286
Step Aerobics, low impact	5	179	358
Step Aerobics, high impact	7	251	501
Stationary Cycling (moderate effort)	7	251	501
Lap Swimming (light to moderate effort)	7	251	501
Outdoor Cycling	8	286	573
Running 5 mph	8	286	573
Running 6 mph	10	358	716
Jumping Rope**	10	358	716
Running Up Stairs**	15	537	1074

“How long
does it
take you
to walk a
mile?”

- 1 MET = sitting quietly
- 2 METs = light housework, walk 2 mph
- 3 METS = stairs, walk 3 mph, 10# bag
- 4 METS = wash car, doubles tennis
- **5 METS = rake leaves, singles tennis, walk 4mph (15 min/mile)**
- > 7 METS = jog 5 mph (12 min/mile)

What does the basic exercise Rx look like?

- 150 min/week (more is better)
- 4-5 days a week
 - “no more than 2 consecutive days off”
- 5 METs of intensity (15 min/mile)
- 2 days a week of resistance exercise
- Higher Intensity training an option for some patients.



Can exercise prevent the onset of DM2 in pre- diabetics?

- 3234 nondiabetic persons with elevated FBS or GTT
 - Placebo vs metformin (850 mg BID) vs a lifestyle-modification program (7% weight loss, 150 minutes/week PA)
 - mean age 51 years, BMI 34.0; 68 % women, 45% from minority groups.
- RESULTS:
 - The lifestyle intervention reduced the incidence by 58%
 - metformin by 31 %

NNT = 7!

Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin.

Knowler WC, et al, Diabetes Prevention Program Research Group. N Engl J Med. 2002;346(6):393.

Can exercise prevent the onset of DM2 in pre-diabetics?

- The protective effect of physical activity is strongest in persons at highest risk for DM2
 - RR = 0.6 in women with 250 min/week brisk walking
 - 64% reduction in highest risk men with 40 min/week intense exercise
- Activities with less than an **intensity of 5.5 metabolic units**, regardless of their duration, may not be protective.

Exercise improves quality of life in DM2 and Pre- diabetes

- Improved SF-36 QOL scores with exercise
 - Greater improvement in pre-DM than with DM2
 - Least improvement if co-morbidities



Getting patients to exercise: the greatest challenge

- Most studies showing benefit had a supervised exercise program
- Patients stop exercising once the study is over
 - 80% success at 6 weeks
 - 50 percent at three months
 - less than 20 percent at one year

Ten-year experience with an exercise-based outpatient life-style modification program in the treatment of diabetes mellitus. Schneider SH, Khachadurian AK, Amorosa LF, Clemow L, Ruderman NB Diabetes Care. 1992;15(11):1800.

Why don't patients with diabetes exercise?

- Innate interest and lifestyle is sedentary
- "lack of time" the most frequently cited barrier to exercise participation by adults, irrespective of age, sex and ethnic background.
- "apathy" due to current recommendations that are unrealistic and unattainable.
- It's harder to do

Are there cultural barriers to exercise in Diabetes?

Cochrane Review 2014 – “culturally appropriate health education” improves glycemic control in short term but studies too variable to determine what actually works or for how long.

Beliefs about exercise > belief about illness

Differences are greatest in middle age, least in older age.

“altruism” and social motivation

50% of AA women modified their hair style to accommodate exercise

- 40% avoid exercise at times owing to hair related issues.

Cochrane Database Syst Rev. 2014 Sep. **Culturally appropriate health education for people in ethnic minority groups with type 2 diabetes**

J Gen Intern Med. 2011 Mar;26(3):245-50. **Racial/ethnic disparities in exercise and dietary behaviors of middle Aged and older adults.**

JAMA Dermatol. 2013 Mar;149(3):310-14. **Hair care practices as a barrier to physical activity in African American women.**

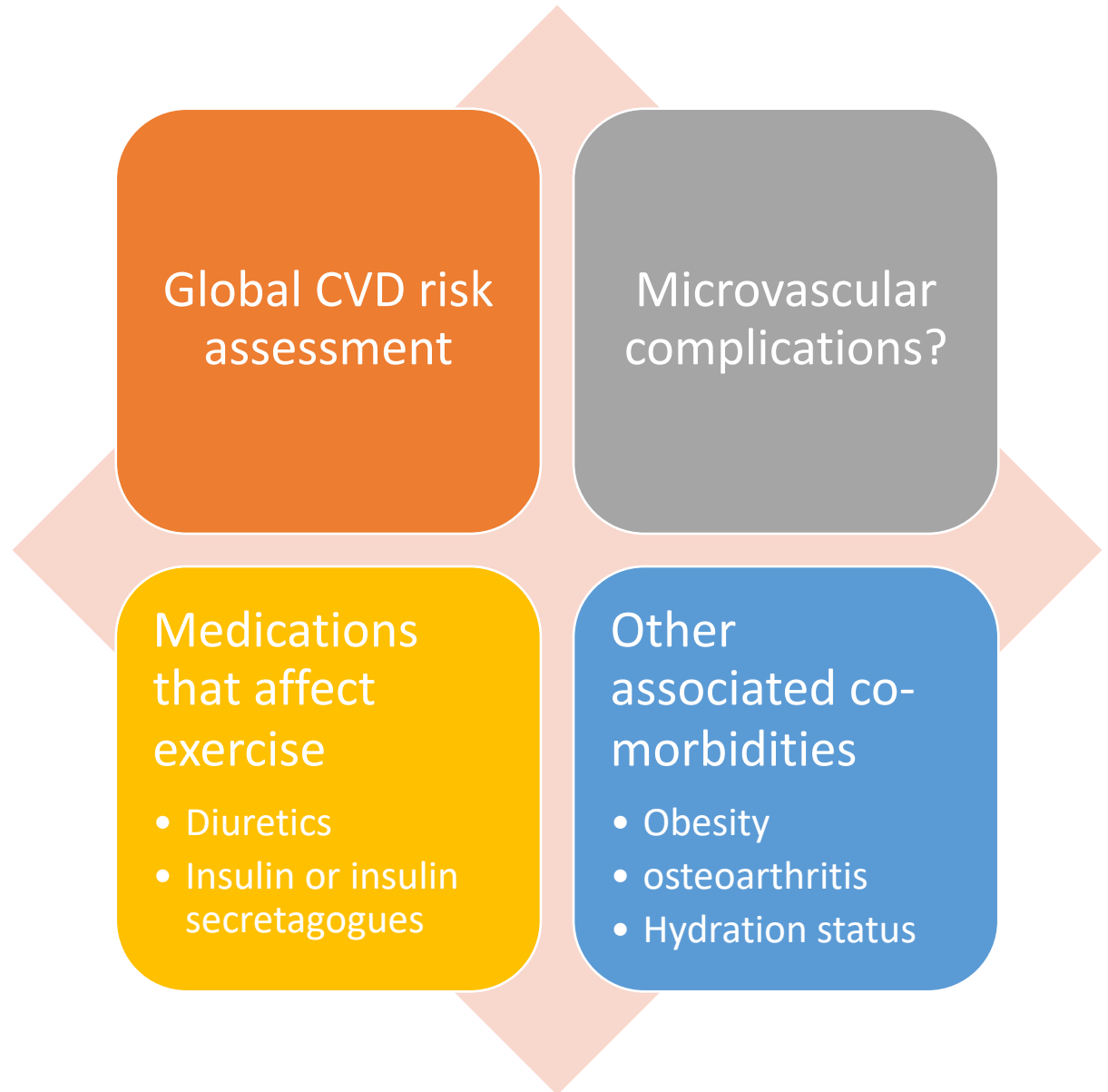
Abstracts for different ethnic groups: cultural considerations for exercise in DM2

- Diet and exercise adherence and practices among medically underserved patients with chronic disease: variation across four ethnic groups. Health Educ Behav. 2013 Feb;40(1):56-66. Orzech KM, et al
- Outcomes of a Latino community-based intervention for the prevention of diabetes: the Lawrence Latino Diabetes Prevention Project. Am J Public Health. 2012 Feb;102(2):336-42. Ockene IS, et al.
- Diet, psychosocial factors related to diet and exercise, and cardiometabolic conditions in Southern Californian Native Hawaiians. Hawaii Med J. 2010 May;69(5 Suppl 2):16-20. McEligot AJ, et al.
- Reducing diabetes risk in American Indian women. Am J Prev Med. 2008 Mar;34(3):192-201. Thompson JL, et al
- Promoting physical activity among South Asian women with coronary heart disease and diabetes: what might help? Fam Pract. 2007 Feb;24(1):71-6. Sriskantharajah J, Kai J.
- 'I can't do any serious exercise': barriers to physical activity amongst people of Pakistani and Indian origin with Type 2 diabetes. Health Educ Res. 2006 Feb;21(1):43-54. Lawton J, et al.

Encouraging exercise in DM2

- Start with something accessible and focus on consistency.
- ‘global’ health benefits don’t require as much exercise.
- **“It isn’t about the weight”**
- Identifying barriers and finding solutions takes time – keep at it.
- Cultural considerations?

Assessing risk of exercise in DM2



Who needs an exercise treadmill test?

- No outcomes studies to guide
 - “Despite the frequency of silent ischemia, it has not been proven that identifying asymptomatic disease or providing early intervention will improve outcomes in DM2” (ACSM position statement)
- Consider if known CVD or DM complications, especially if planning significant increase in exercise load
- May help with the Ex Rx by establishing a baseline MET fitness
- The UKPDS Risk Engine can be used to calculate 10yr CV risk
<http://www.dtu.ox.ac.uk/riskengine/download.htm>)

What about microvascular co-morbidities?

- Proliferative retinopathy
 - Retinal bleeding = Avoid valsalva/vigorous exercise
- Peripheral neuropathy
 - Stress fractures in foot/ankle = avoid traumatic weight-bearing exercise (long distance running)
 - pressure ulcers on the toes and feet = Well-fitting protective footwear and comfortable shoes (snow skiing).
- Chronic kidney disease
 - exercise can transiently increase urinary protein excretion (20% of individuals), but there is no evidence that exercise increases progression of chronic kidney disease

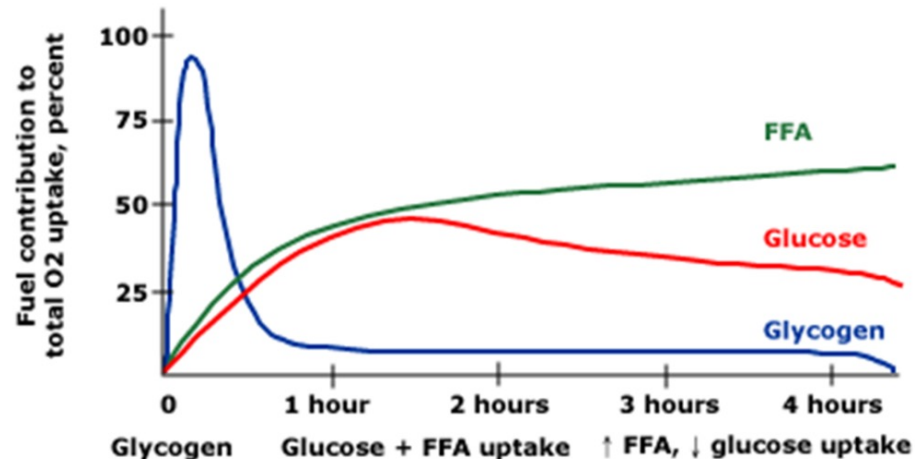
Can you safely exercise with a high blood sugar?

- Ok to exercise < 250 mg/dL
- Ok to do light exercise even > 300 mg/dL without ketosis, provided they are feeling well and are adequately hydrated.

American College of Sports Medicine. Position Stand: appropriate physical activity intervention strategies for weight loss and prevention of weight regain for adults. Donnelly JE, et al *Med Sci Sports Exerc.* 2009;41(2):459-71.

Beware of hypoglycemia in patients on insulin or secretagogues

NOTE: when used as monotherapy, metformin and GLP1's do not tend to cause hypoglycemia



- **Exercise induced hypoglycemia:** normally the pancreas decreases production with prolonged exercise.
- **Post-exercise hypoglycemia:** For *several hours* after exercise, the muscles take up glucose to replenish the glycogen stores, thereby lowering the blood glucose.


What if I take...

- Metformin – not harmful but possibly counter-productive?
- Ozempic – no apparent issues
- Statins – moderate intensity exercise is safe but may augment myalgias/transient CK elevation.


- Noyes AM, Thompson PD. The effects of statins on exercise and physical activity. J Clin Lipidol. 2017 Sep-Oct;11(5):1134-1144
- Neeltje A.E. et al J Am Coll Cardiol. 2023 Apr, 81 (14) 1353–1364

Pearls for exercising on insulin

- Decrease pre-exercise dosing or take on additional carbohydrates
 - 30% is rule of thumb – often trial and error
- Carry rapidly absorbed glucose with you
- Post-exercise = slowly absorbed carbs (jerky, dried fruit, granola bars)

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Additional considerations for insulin-requiring patients

- Insulin is more rapidly absorbed by exercising muscle.
 - Inject in a limb away from the area exercised or at least 60 minutes before exercise. (fastest absorption is abdominal)
 - Exercise can shift the glycemic threshold for the sympathoadrenal response to a lower plasma glucose concentration hours later, ie **there is a delayed *increased hypoglycemic unawareness***
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SUMMARY:
Exercise in
Patients with
Diabetes

Both aerobic and resistance training can improve glycemic control.

Higher intensity exercise may be better than longer duration.

For most DM2 = combined program of 150 min/week aerobic and 2 days of resistance training.

“No more than 2 consecutive days off”

“It’s not about the weight”

My approach....

Stages of change paradigm = Review and encourage at every visit like a vital sign or A1c.

Anything is better than nothing (but everyone can do more)

Schedule it (unlikely to ever be a habit)

“it’s not about the weight”

attitude towards exercise more important than perception of disease



Questions?