Global Diabetes Epidemic

Why Worry about Diabetes?
- 1 in 3 people to develop diabetes
- 50% chance for most minorities
- Average life span ↓ 12 years
- QOL ↓ for 20+ yrs

Who Is “At Risk”? 
- Overweight (BMI>85th percentile)
- Family history of type 2 diabetes
- Minorities (African-American, Native American, Hispanic/Latino, Pacific Islanders)
- Over age of 10 (mid to late puberty)
- Insulin resistant (acanthosis nigricans, hypertensive, dyslipidemic, PCOS)

What Causes Diabetes?
- Family history of T2 DM
- Loss of beta cells/less insulin release
- Poor dietary choices
- Overweight or obese
- Insulin resistance
- Physical inactivity

World 2000 = 171 million
2030 = 366 million
114% increase

Wild et al. Diab Care, 27: 1047–53, 2004

“1 in 3 people to develop diabetes
50% chance for most minorities
Average life span ↓ 12 years
QOL ↓ for 20+ yrs

**What Decreases Insulin Action?**

- Genetics
- Poor diet
- Excess body fat
- Visceral (intra-abdominal) fat
- Physical inactivity
- Low-level inflammation

**Genetics**

- How big of a role does family history of T2 DM play in children?
  - 54 white, healthy, non-DM children (~12 yrs)
  - In particular, adolescents with (+) family history had ↓ insulin sensitivity (IS), with impaired glucose disposition index (IS x 1st-phase insulin release)

*Arslanian S et al. Diab Care, 28(1): 115-119, 2005*

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**Genetic Effect on Insulin Action**

*Arslanian S et al. Diab Care, 28(1): 115-119, 2005*

**Poor Diet**

- *Ad lib* ↓ glycemic load diet (GL) vs. energy-restricted, low fat diet (conventional)
  - 14 obese adolescents (ages 13 to 21)
  - 40-45% CHO with low/moderate GI vs. 55-60% CHO with any GI
  - 30-35% fat vs. 25-30% in “low fat”
- Measured weight loss and degree of insulin resistance (IR) after 12 months

**Lower GI & GL ↑ Insulin Action**

- Increase: Fat Mass (kg), IR
- Decrease: Conventional, Low GI


**BMI and Physical Activity**


**Excess Body Fat (Pima Youth)**

- Correlation: \( r = -0.41, p < 0.0001 \)


**Activity in “At Risk” Youth**

- 90 “at risk” Pima Indian children (39M, 51F) studied at 5 and 10 years of age
  - Measured IS, adiposity, physical activity, and total energy expenditure
  - Children with greater ↓ in activity levels (from age 5 to 10) had greater ↓ in IS, independent of changes in weight or adiposity

Physical Activity = ↓ IS

Is Weight Loss Essential?

- In DPP, weight loss was the most important factor to prevent diabetes (↓ 58%)
- Every kg (2.2 lbs) lost ↓ risk 16%

Is Weight Loss Essential?

- Lower fat intake & physical activity predicted wt loss (5-7% usual)
- However, only exercise kept it off
- Insulin action ↑

Is Weight Loss Essential?

- Insulin resistance and T2 DM involve interaction of many genes with physical inactivity, dietary patterns, & weight gain
- Dietary changes alone improve insulin action without significant weight loss
  - Physical inactivity (low VO_max) poses an independently greater risk for insulin resistance than excess body fat
Exercise in Diabetes/Obesity

Aerobic Training ↓ Visceral Fat

- Giannopoulou et al. J Clin Endocrinol Metab. 90:1511–1518, 2005

Resistance Training ↓ Visceral Fat


Visceral Fat and Insulin Action

- Visceral fat may ↓ IS the most
- All types of exercise training cause loss of visceral fat
- Dieting alone (w/o exercise) may not

Low-Level Inflammation

- Inflammatory markers released by fat/macrophages (cytokines), such as IL-6, TNF-alpha, resistin, etc.
- Markers’ release decreased by:
  - Dietary improvements
  - Loss of visceral fat?
  - Physical activity
  - Salicylates, TZD, statins

Can Exercise Prevent Diabetes?

Can Vigorous Ex Prevent DM?
- Can vigorous aerobic exercise help prevent onset of type 2 diabetes?
  - Prospective study of 21,271 US male physicians, ages 40-84, followed 5 yrs
  - Self-reported “vigorous” exercise
  - Incidence of type 2 DM ↓ as frequency of vigorous exercise ↑

Manson JE et al. JAMA, 268(1): 63-7, 1992

Vigorous Ex ↓ DM Risk in Men

Can Walking Prevent Diabetes?
- Is moderate aerobic exercise (e.g., walking) enough to prevent onset of type 2 diabetes?
  - Prospective study of 70,102 female nurses ages 40-65 followed 8 years
  - Survey on leisure-time activities to determine weekly energy expenditure

Manson JE et al. JAMA, 268(1): 63-7, 1992
Diabetes Prevention Program

- Three-year study of 3,234 overweight, individuals with IGT (45% minorities)
- Intensive lifestyle intervention group ↓ risk of type 2 DM by 58%
  - 30 min of moderate, daily exercise
  - Moderate 5-7% ↓ in body wt (15 lb)
- Metformin (by ↑ IS) alone ↓ risk 31%

Lifestyle Most Effective in Older

- Metformin
- Lifestyle
- Lifestyle vs Met

**Improving Insulin Action with Physical Activity**

A single bout of exercise has long been known to increase insulin sensitivity, at least temporarily.

Acute exercise results in greater glucose storage in muscle (as glycogen) post-ex.

Exercise-induced improvements in IS can be partially negated by overfeeding.


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**Effects of Physical Activity**

- Improved Glucose Levels

Rogers et al. Diab. Care, 11(8): 613-18, 1988

- Improved Insulin Action

Rogers et al. Diab. Care, 11(8): 613-18, 1988
Chronic Physical Activity ↑ IS

Kriska AM et al. Diab Care, 24: 1175-1180, 2001

Exercise ↑ IS More than Dieting


Training Volume ↑ IS More


“Pick up the Pace” Training

- ↑ speed by 10% for 30 minutes per day, 3 days per week
- Cardiovascular fitness ↑ more with 90 faster min/wk
- Any type of intervals may be beneficial

Johnson S et al. Diab Care, 29(7): 1654-5, 2006
**Blood Glucose Responses to Exercise**

**Exercise Energy Systems**

<table>
<thead>
<tr>
<th>Time</th>
<th>ATP-CP</th>
<th>Glycolysis</th>
<th>Aerobic</th>
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<td>5 min</td>
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</table>

**Exercise Fuel Use**

- Carbohydrate is still the fuel of choice: muscle glycogen (~80%), blood glucose (~20% unless ↑ by hyperglycemia)
- Little insulin needed for carbohydrate use during exercise
- Glucose uptake occurs via a contraction-induced mechanism separately, *but additively with insulin*

**Glucose Uptake in Muscle**
Glycemic Responses to Exercise

- Nondiabetic Controls
- DM with Insulin


Maximal Exercise Effects

- Type 2 DM
- Control


Timing of Exercise


Exercise Recommendations
**Given that…**

- Regular physical activity of any type ↑ overall insulin action in most individuals
- Exercise has a more positive effect on insulin action than dietary changes, genetics, or fat loss
- Physical activity is essential to prevent type 2 diabetes with aging and long and live well with any type of diabetes

**Try to Get Your Patients to:**

- Be regularly physically active to keep their insulin action enhanced
- Exercise more vigorously (at least on occasion) to ↑ muscle glycogen use
- Do some “Pick Up the Pace” training
- Exercise longer at the same intensity to ↑ insulin action for a greater time
- Include both aerobic and resistance workouts to maximize muscle gains

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**Exercise Plan for Better Health**

- It’s never too late to start, but patients may need a checkup before, or at least a check of their heart rate & BP
- Different activities done on a rotating basis at least 30 minutes daily (20 minutes if more vigorous)
  - Endurance, Resistance, and Flexibility
  - ↑ SPA (Spontaneous Physical Activity)

**Endurance Activities**

- Walking at any speed (w/ good socks/shoes)
- “Cardio” machines
- Non-weight-bearing (lower extremity joint pain or neuropathy): stationary cycling, aquatic/pool or chair exercises, upper body
**Resistance Activities**
- Include exercises that work upper and lower body muscles, as well as “core”
- For upper body, minimally do double arm raises, biceps curl, triceps extension
- Can be done sitting or standing
- For legs, do knee and hip flexion & extension, calf raises, and side leg raises
- Abdominal crunches, low back

**Exercise in the Overweight**
- Excess fat weight may hinder movement
- Focus on activities that cater to inherent strengths (e.g., height, leg strength)
- De-emphasize activities such as running and jumping hard on lower extremities
- Water-based activities may lessen self-consciousness, exercise aversion
- Initial fitness levels may be very low

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**Chair Push-Ups Exercise**


**Sit-to-Stand Exercise**

Core Exercises

Flexibility Training
- Stretches best done at least 2-3 days per week or after any exercise session
- Include all major muscle groups
- Hold stretches for 10-30 seconds

Add in More SPA
- More spontaneous physical activity
- Leisure activities
- Adding in little bits of exercise during the day easier for many
- Fitness gains less
- Health benefits

It’s Good to Be Regularly Active!

“What fits your busy schedule better, exercising one hour a day or being dead 24 hours a day?”

Colberg S. The 7 Step Diabetes Fitness Plan, 2006
Guide for Diabetic Exercisers

*The Diabetic Athlete’s Handbook*

Human Kinetics © November 2008

Management of exercisers with type 1 and 2 diabetes

Thank You!

For more information, visit www.SheriColberg.com