Diabetes-
What Do You Need to Do

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Common Myth:
You have to run a marathon
to benefit from regular physical activity!
Fitness Testing

• Maximal exercise test on a treadmill (Balke)
• Standardized fitness categories based on age, gender & time on treadmill:
• Fitness => measure of physical activity habits
Fitness Classifications

• **Low Fitness** = “Unfit”
  – Lower 20% time on treadmill for gender and age

• **Moderate Fitness**-
  – Next 40% time on treadmill for gender and age
  – @150 minutes of walking per week

• **High Fitness**-
  – Highest 40% time on treadmill for gender and age
CVD Mortality Rates by Fitness: Aerobic Center Longitudinal Study (ACLS)

Fitness and All-Cause Mortality, ACLS Men, 1970-1989

Adjusted Death Rate per 10,000 PY vs. GXT Test Performance (minutes)

- Expected Relation

50 100 150 200 250 300

0 5 10 15 20 25 30
Fitness and All-Cause Mortality, ACLS Men, 1970-1989

Adjusted Death Rate per 10,000 PY

GXT Test Performance (minutes)

Expected Relation
CVD Mortality by Fitness
Men with Diabetes

Church et al, Arch Int Med, 2005
Diabetes Incidence Rates By Fitness Groups, Men (n=8633)

Cardiorespiratory Fitness Groups

Diabetes incidence/1000 men

Low: 5.9
Moderate: 2.7
High: 1.6

Diabetes Incidence Rates by Fitness: ACLS (n = 13,190)

Rate per 1,000 man-yrs

Maximal METs

unpublished
Health Benefits of Aerobic & Resistance Training in Individuals with Diabetes: HART-D

Tim Church, M.D., M.P.H., Ph.D.
Pennington Biomedical Research Center
Most national organizations recommend individuals with diabetes participate in exercise program composed of a combination of aerobic and resistance training for maximal health benefits.
Effect of Exercise Type on HbA1c
N = 251 & 6 month intervention

Effect of Exercise Type on HbA1c

N = 251

- Primarily Caucasian (92%)
- 70% Men
- No insulin users
- Fairly healthy participants

**Exercise Prescription**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time (min/wk)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic</td>
<td>135</td>
</tr>
<tr>
<td>Resistance</td>
<td>135</td>
</tr>
<tr>
<td>Combo</td>
<td>270</td>
</tr>
</tbody>
</table>

Was it the combination of AT & RT or time?
• **NIDDK funded**

• **Primary Outcomes Published**
  – Church et al, JAMA Nov 24 2010

• **Participants:**
  – Sedentary individuals with diabetes
  – HbA1c: >6.5% but <11.0%
  – Tried to be VERY inclusive
• Compare benefit to HbA1c of:
  – Control group
    • Stretching
  – Aerobic training (AT)
    • 12 kcal/kg/week
  – Resistance training (RT)
    • 3 days per week: 21 sets per day
  – Combination of RT & AT (Combo)
    • 10 kcal/kg/week & 1 set of 9 RT 2 days/week

• 9 Month Intervention
• All exercise supervised (@ 20K sessions)
HART-D

• Primary Outcomes:
  – Hemoglobin A1c

• Secondary Outcomes:
  – Fitness and strength
  – DEXA
Telephone screens  
\textit{n = 2421}

Completed assessment  
\textit{(n = 1,924)}

Randomized  
\textit{n = 262}

Control  
\textit{n = 41}

RT  
\textit{n = 73}

AT  
\textit{n = 72}

Combo  
\textit{n = 76}

STOPPED ENROLLMENT
## Participants

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Mean (SD)</td>
<td>55.8 (8.7)</td>
</tr>
<tr>
<td>Female</td>
<td>63.0%</td>
</tr>
<tr>
<td>Ethnicity/race, %</td>
<td></td>
</tr>
<tr>
<td>African-American</td>
<td>43.5%</td>
</tr>
<tr>
<td>White</td>
<td>52.7%</td>
</tr>
<tr>
<td>Other</td>
<td>3.8%</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>34.9 (5.9)</td>
</tr>
<tr>
<td>Waist Circumference, cm</td>
<td>112 (13.8)</td>
</tr>
<tr>
<td>Relative VO2, mL/kg/min</td>
<td>19.2 (4.2)</td>
</tr>
<tr>
<td>METs</td>
<td>6.9 (1.3)</td>
</tr>
<tr>
<td>HbA1c, %</td>
<td>7.7 (1.0)</td>
</tr>
<tr>
<td>Duration Diabetes, years</td>
<td>7.1 (5.5)</td>
</tr>
</tbody>
</table>
### Participants

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antidepressant Medication</td>
<td>18%</td>
</tr>
<tr>
<td>Previous Myocardial Infarction</td>
<td>2%</td>
</tr>
<tr>
<td>Previous Cardiac Catheterization</td>
<td>18%</td>
</tr>
<tr>
<td>Coronary Artery By-Pass</td>
<td>5.0%</td>
</tr>
<tr>
<td>Neuropathy</td>
<td>17.6%</td>
</tr>
<tr>
<td>Low-density Lipoprotein</td>
<td>96 (29)</td>
</tr>
<tr>
<td>High-density Lipoprotein</td>
<td>49 (11)</td>
</tr>
<tr>
<td>Cholesterol Medications</td>
<td>64%</td>
</tr>
<tr>
<td>Systolic BP, mmHg</td>
<td>126 (13)</td>
</tr>
<tr>
<td>Diastolic BP, mmHg</td>
<td>76 (8)</td>
</tr>
<tr>
<td>Blood Pressure Medications</td>
<td>79%</td>
</tr>
</tbody>
</table>
## Hart-D DM Medication Use

<table>
<thead>
<tr>
<th>Medication Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any</td>
<td>97.3%</td>
</tr>
<tr>
<td>Biguanides (metformin)</td>
<td>65%</td>
</tr>
<tr>
<td>Sulfonylureas (glipizide)</td>
<td>24%</td>
</tr>
<tr>
<td>Thiazolidinediones (glitazones)</td>
<td>18%</td>
</tr>
<tr>
<td>Combination Drugs</td>
<td>16%</td>
</tr>
<tr>
<td>Incretin Mimetics (exenatide)</td>
<td>10%</td>
</tr>
<tr>
<td>DPP-4 Inhibitors (sitagliptin)</td>
<td>5%</td>
</tr>
<tr>
<td>Meglitinides</td>
<td>3%</td>
</tr>
<tr>
<td>Insulin</td>
<td>18%</td>
</tr>
<tr>
<td><strong>TOTAL (combo counted 2X)</strong></td>
<td><strong>176%</strong></td>
</tr>
</tbody>
</table>
Retention & Compliance

• Retention: 94% with follow-up data
  – All participants used in analysis
• Compliant (>70% adherence):
  – Aerobic: 72%
  – Resistance Training: 82%
  – Combo: 82%
HART-D Intervention Data
Resistance: Combo Group

Mean Pounds Lifted Per Week

Month

1 2 3 4 5 6 7 8 9
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>5</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aerobic Group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sessions/Week</td>
<td>3.0</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
<td>3.0</td>
</tr>
<tr>
<td>Intensity, % peak VO2</td>
<td>60.1</td>
<td>64.3</td>
<td>64.8</td>
<td>64.5</td>
<td>66.9</td>
<td>66.7</td>
<td>65.6</td>
</tr>
<tr>
<td>Speed, MPH</td>
<td>2.9</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
</tr>
<tr>
<td>Grade, %</td>
<td>2.0</td>
<td>3.7</td>
<td>5.0</td>
<td>5.4</td>
<td>6.0</td>
<td>6.1</td>
<td>6.8</td>
</tr>
<tr>
<td>Mean METs level</td>
<td>4.1</td>
<td>5.0</td>
<td>5.6</td>
<td>5.8</td>
<td>6.0</td>
<td>6.1</td>
<td>6.4</td>
</tr>
<tr>
<td>Time, min/wk</td>
<td>123.4</td>
<td>140.0</td>
<td>127.7</td>
<td>122.3</td>
<td>115.0</td>
<td>118.3</td>
<td>112.9</td>
</tr>
<tr>
<td><strong>Combo Group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sessions/Week</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Intensity, % peak VO2</td>
<td>58.5</td>
<td>63.6</td>
<td>65.8</td>
<td>65.4</td>
<td>64.8</td>
<td>65.4</td>
<td>66.1</td>
</tr>
<tr>
<td>Speed, MPH</td>
<td>2.8</td>
<td>3.0</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
<td>3.1</td>
</tr>
<tr>
<td>Grade, %</td>
<td>1.8</td>
<td>3.5</td>
<td>4.8</td>
<td>5.1</td>
<td>5.6</td>
<td>5.7</td>
<td>6.0</td>
</tr>
<tr>
<td>Mean METs level</td>
<td>3.9</td>
<td>4.7</td>
<td>5.4</td>
<td>5.5</td>
<td>5.8</td>
<td>5.9</td>
<td>6.0</td>
</tr>
<tr>
<td>Time, min/wk</td>
<td>102.4</td>
<td>125.2</td>
<td>108.6</td>
<td>106.6</td>
<td>103.7</td>
<td>101.3</td>
<td>101.4</td>
</tr>
</tbody>
</table>

Month 3 & 6 removed for presentation purposes
## Time Exercising

<table>
<thead>
<tr>
<th>Type</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance</td>
<td>141 min/wk</td>
</tr>
<tr>
<td>Aerobic</td>
<td>140 (130-150) min/wk</td>
</tr>
</tbody>
</table>
| Combo      | RT: 30-40 min/wk  
               | AT: 110 (100-120) min/wk |
HART-D Intervention
Goals Achieved!!!

• Total exercise time similar across groups
• Delivered aerobic interventions that met current recommendations
Steps per Day: Exercise Groups

Month

Mean Steps per Day
No change in caloric intake as assessed by FFQ
HART-D Outcome Data
HbA1c by Month and Group

Intention-to-Treat Analysis (n=262)

- Control
- Resistance
- Aerobic
- Combo

Month

HbA1c, %
Control Subtracted Change in HbA1c after 9 months

P = 0.03
HbA1c: Baseline > 7.0% & PPT

<table>
<thead>
<tr>
<th></th>
<th>Change HbA1c</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance</td>
<td>-0.34</td>
<td></td>
</tr>
<tr>
<td>P = 0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combo</td>
<td>-0.63</td>
<td>P = 0.002</td>
</tr>
<tr>
<td>P = 0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerobic</td>
<td>-0.43</td>
<td></td>
</tr>
</tbody>
</table>
Improve HbA1c $\geq 0.5\%$ or Decrease DM Medications

![Bar chart showing prevalence of different conditions. The chart indicates that the Combo group has the highest prevalence with 41, followed by AT with 29, RT with 26, and Control with 22. The p-value is 0.02.](image)
Strength Testing

*Different from all other groups
METs: From Speed & Grade

Sig vs. Control & RT

- Control
- Resist
- Aero
- Combo
Waist Circumference

All Sig Vs Control

Control Resist Aero Combo
Weight

Change Weight, Kg

-0.3

-0.8

-1.5

Sig. vs Control & RT

RT
AT
Combo
DEXA Data

Fat Mass

Lean Mass

Change, Kg

Sig. Vs. Control

Sig. Vs. Control & AT

Sig. Vs. AT & Combo

RT

AT

Combo
For a given amount of time……

- a physical activity program composed of aerobic and resistance is superior to either activities alone
  - Blood sugar control
  - Fitness
  - Fat Mass

The HART-D combination program consisted of:
- 110 minutes per week of mod/vig intensity walking
- 2 days of 9 resistance training exercises each
  - 10 to 12 repetitions per exercise
  - ~20 minutes per day
How Do My Recommendations (opinions) Compare to New Federal Guidelines?
2008 Physical Activity Guidelines for Americans
At-A-Glance:
A Fact Sheet for Professionals

The Physical Activity Guidelines for Americans
At-A-Glance: A Fact Sheet for Professionals is designed for
June professionals as a quick desk-side reference to the 2000
Physical Activity Guidelines for Americans published by the
U.S. Department of Health and Human Services.

These Guidelines are needed because of the importance
of physical activity to the health of Americans, whose
screen time is typically at unnecessary risk. The latest
information shows that inactivity among American children,
adolescents, and adults remains relatively high, and little
progress has been made in increasing levels of physical
activity among Americans.

Key Guidelines

Substantial health benefits are gained by living physical
activity according to the guidelines presented below for
different groups.

Children and Adolescents (ages 6-17)
  - Children and adolescents should do 1 hour (60 minutes)
or more of physical activity every day.
  - Most of the 1 hour or more a day should be either
    moderate- or vigorous-intensity aerobic physical activity.
  - As part of their daily physical activity, children and
    adolescents should do vigorous-intensity activity on
    at least 3 days per week. They also should do muscle-
    strengthening and bone-strengthening activity on at
    least 3 days per week.

Adults With Disabilities

Follow the adult guidelines. If this is not
possible, these persons should be as physically
active as their abilities allow. They should
avoid inactivity.

Children and Adolescents With Disabilities

Work with the child's health care provider to
identify the types and amounts of physical
activity appropriate for them. When possible,
these children should meet the guidelines for
children and adolescents—or as much activity
as their condition allows. Children and
adolescents should avoid being inactive.

Pregnant and Postpartum Women

Healthy women who are not already doing
vigorous-intensity physical activity should get
at least 2 hours and 30 minutes (150 minutes)
of moderate-intensity aerobic activity a week. Perferably, this activity should be spread
throughout the week. Women who regularly
engage in vigorous-intensity aerobic activity
or high amounts of activity can continue their
activity provided that their condition remains
unchanged and they talk to their health care
provider about their activity level throughout
their pregnancy.
For all individuals, some activity is better than none.

**Adults (aged 18–64)**

- Adults should do 2 hours and 30 minutes a week of moderate-intensity, or 1 hour and 15 minutes (75 minutes) a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic physical activity. Aerobic activity should be performed in episodes of at least 10 minutes, preferably spread throughout the week.

- Additional health benefits are provided by increasing to 5 hours (300 minutes) a week of moderate-intensity aerobic physical activity, or 2 hours and 30 minutes a week of vigorous-intensity physical activity, or an equivalent combination of both.

- Adults should also do muscle-strengthening activities that involve all major muscle groups performed on 2 or more days per week.

**Health Benefits of Physical Activity—Summary of the Strength of the Scientific Evidence**

**Adults and Older Adults**

**Strong Evidence**

- Lower risk of:
  - Early death
  - Heart disease
  - Stroke
  - Type 2 diabetes
  - High blood pressure
  - Adverse blood lipid profile
  - Metabolic syndrome
  - Colon and breast cancers
  - Prevention of weight gain
  - Weight loss when combined with diet
  - Improved cardiorespiratory and muscular fitness
  - Prevention of falls
  - Reduced depression
Health Benefits of Physical Activity—A Review of the Strength of the Scientific Evidence

Adults and Older Adults

Strong Evidence
- Lower risk of:
  - Early death
  - Heart disease
  - Stroke
  - Type 2 diabetes
  - High blood pressure
  - Adverse blood lipid profile
  - Metabolic syndrome
  - Colon and breast cancers
- Prevention of weight gain
- Weight loss when combined with diet
- Improved cardiorespiratory and muscular fitness
- Prevention of falls
- Reduced depression
- Better cognitive function (older adults)

Moderate to Strong Evidence
- Better functional health (older adults)
- Reduced abdominal obesity

Moderate Evidence
- Weight maintenance after weight loss
- Lower risk of hip fracture
- Increased bone density
- Improved sleep quality
- Lower risk of lung and endometrial cancers
2008 Physical Activity Guidelines for Americans
At-A-Glance: A Fact Sheet for Professionals


These Guidelines are needed because of the importance of physical activity to the health of Americans, whose current inactivity puts them at unnecessary risk. The latest information shows that inactivity among American children, adolescents, and adults remains relatively high, and little progress has been made in increasing levels of physical activity among Americans.

Key Guidelines
Substantial health benefits are gained by doing physical activity according to the Guidelines presented below for different groups.

Children and Adolescents (aged 6–17)
- Children and adolescents should do 1 hour 30 minutes or more of physical activity every day.
- Most of the 1 hour or more a day should be either moderate- or vigorous-intensity aerobic physical activity.
- As part of their daily physical activity, children and adolescents should do vigorous-intensity activity on at least 3 days per week. They also should do muscle-strengthening and bone-strengthening activity on at least 3 days per week.

Adults With Disabilities
Follow the adult guidelines. If this is not possible, these persons should be as physically active as their abilities allow. They should avoid inactivity.

Children and Adolescents With Disabilities
Work with the child’s health care providers to identify the types and amounts of physical activity appropriate for them. When possible, these children should meet the guidelines for children and adolescents—or as much activity as their condition allows. Children and adolescents should avoid being inactive.

Pregnant and Postpartum Women
Healthy women who are not already doing vigorous-intensity physical activity should get at least 2 hours and 30 minutes (150 minutes) of moderate-intensity aerobic activity a week. Preferably, this activity should be spread throughout the week. Women who regularly engage in vigorous-intensity aerobic activity or high amounts of activity can continue their activity provided that their condition remains unchanged and they talk to their health-care provider about their activity level throughout their pregnancy.
“What fits your busy schedule better, exercising 30 minutes a day or being dead 24 hours a day?”