

Physical Activity & the Metabolic Syndrome

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Disclosure

Affiliation: Advisory Board/Panel
Company: Weight Watchers International
Relationship: Active

Affiliation: Grants/Research Support
Company: Unpaid investigator on Weight Watchers grant paid to Univ of Pittsburgh
Relationship: Active

Learning Objectives

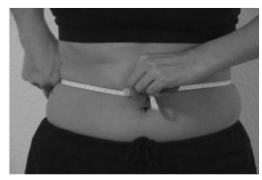
- Understand the theoretical framework for how technology may influence behaviors related to regulating body weight.
- Understand different intervention approaches to how technology can be used to influence behaviors related to regulating body weight.
- Understand the effectiveness of technology with regard to body weight compared to non-technology-based intervention approaches.

a group of risk factors that raises your risk for heart disease and other health problems, such as diabetes and stroke

Metabolic Syndrome

- A group of risk factors that raises your risk for heart disease and other health problems such as diabetes and stroke.
- Define by the presence of at least three (3) of the following:
 - Elevated waist circumference
 - Elevated triglycerides or taking medication to reduce triglycerides
 - Low HDL cholesterol or taking medication to treat low HDL
 - Hypertension or taking medication to treat hypertension
 - Elevated blood glucose to taking medication to treat elevated blood glucose

Effect of Exercise on Waist Circumference



Effect of Exercise on Waist Circumference

- In general, aerobic exercise, without dieting, appears to have a beneficial effect on abdominal adiposity.
- The exercise dose necessary to result in these alterations is rather high.
 - Irwin and colleagues
 - 176 minutes per week of moderate- to vigorous-intensity physical activity performed over 12 months resulted in a reduction in subcutaneous fat and intra-abdominal fat of 5.4% and 5.8%, respectively
 - McTiernan and colleagues
 - 60 minutes or more of moderate- to vigorous-intensity physical activity on 6 days per week over 12 months of training
 - Reported modest decreases in the subcutaneous abdominal fat (5% in women and 11% in men) and intra-abdominal fat (6% in women and 8% in men) depots and in the waist circumference (2% in women and 3% in men).

Effect of Exercise on Waist Circumference

- The exercise dose necessary to result in these alterations is rather high (Continued).
 - Studies of Targeted Risk Reduction Interventions through Defined Exercise (STRRIDE)
 - The highest amount of exercise performed (equivalent of jogging approximately 20 miles per week) over 8 months resulted in a 7% decrease in visceral and subcutaneous fat in men and women aged 40 to 65 years (9).
 - Ross and colleagues
 - Report an 18% reduction in total fat and a 20% reduction in abdominal fat among non-dieting abdominally-obese women who exercised every day for about 60 minutes (or 500 kilocalorie expenditure) for 14 weeks.

Effect of Exercise on Waist Circumference

- These findings support the contention that:
 - In the absence of coincident caloric restriction, aerobic physical activity results in decreases in abdominal adiposity.
 - This reduction is consistent with improved metabolic function.

Effect of Exercise on Triglycerides



Effect of Exercise on Triglycerides

- Evidence from 5 meta-analyses and 4 systematic reviews was examined with regard to the effect of **aerobic exercise** on changes in triglycerides, along with conclusions of the Advisory Committee for the Physical Activity Guidelines for Americans.
 - Meta-analyses that includes studies involving healthy adults ≥ 18 years of age showed non-significant increases in triglycerides of 0.2 mg/dl and 1.2 mg/dl.
 - Studies involving only women ≥ 18 years of age showed a significant decrease of 4.3 mg/dl, with the non-significant decrease in older adults being 7.0 mg/dl.
 - A significant decrease was observed in a meta-analysis of overweight and obese adults (16.1 mg/dl), with a non-significant decrease of 10.0 mg/dl observed in a meta-analysis of adults with type 2 diabetes.
 - In a meta-analysis of studies that included only patients with known cardiovascular disease or who had undergone a medical procedure for cardiovascular disease, a significant decrease in triglycerides of 20.4 mg/dl was observed.

Effect of Exercise on Triglycerides

- The observed changes in triglycerides are present when exercise is ≥ 15 weeks in duration, >3 days per week, 35-50 minutes per session, at a vigorous intensity ($>60\%$ of maximal oxygen consumption).
- One systematic review concluded that aerobic exercise has a consistent effect on reducing triglycerides, whereas another systematic review concluded that the effect is inconsistent.
- The report from the Advisory Committee for the Physical Activity Guidelines for Americans concluded that exercise results in favorable improvements in triglycerides.
- A systematic review concluded that an average increase of 2492 steps per day resulted in a non-significant decrease in triglycerides in outpatient adult studies.

AHA and ACC 2013 Report on Lifestyle Management to Reduce Cardiovascular Risk

- **Evidence Statement:**
 - Among adults, aerobic physical activity in the absence of weight reduction, as compared to control interventions, has no consistent effect on triglycerides.
- Strength of evidence
 - Moderate

Effect of Resistance Exercise on Triglycerides

- Evidence from 1 meta-analysis and 1 systematic review was examined with regard to the effect of **resistance exercise** on changes in triglycerides.
 - The meta-analysis that included studies involving healthy adults ≥ 18 years of age showed a significant decrease in triglycerides of 8.1 mg/dl. These observed changes are present when resistance exercise was
 - 24.0 \pm 19.0 weeks in duration and involved 2.9 \pm 0.4 days per week of exercise with the average session lasting 47.7 \pm 11.5 minutes.
 - Resistance exercise sessions included performing 9.2 \pm 3.1 different exercises, and engaging in 2.6 \pm 1.1 sets of 11.5 \pm 6.6 repetitions for these exercises.
 - The intensity was 70.3 \pm 10.4% of 1 maximal repetition.
- A systematic review of the literature for the effects of resistance exercise on change in triglycerides in patients with type 2 diabetes concluded that studies generally showed an improvement in triglycerides with this form of exercise.
 - The resistance exercise in these studies was typically performed over a range of 4 weeks to 12 months and was typically performed 3 days per week.

AHA and ACC 2013 Report on Lifestyle Management to Reduce Cardiovascular Risk

- **Evidence Statement:**
 - Among adults, resistance training, as compared to control interventions, reduces triglycerides by 6 to 9 mg/dL.
- **Strength of evidence**
 - Low

Effect of Exercise on HDL



Effect of Exercise on HDL

- Evidence from 8 meta-analyses and 3 systematic reviews was examined with regard to the effect of aerobic exercise on changes in HDL-C, along with conclusions of the Advisory Committee for the Physical Activity Guidelines for Americans.
 - Meta-analyses that included studies involving healthy adults ≥ 18 years of age showed non-significant increases in HDL total cholesterol of 1.4 mg/dl and 1.2 mg/dl.
 - One meta-analysis of adults (>20 years of age) that excluded studies in which participants may have been taking medication or prescribed a diet that may have influenced HDL reported a significant increase of 2.63 mg/dl.
 - Studies involving only women ≥ 18 years of age showed a significant increase of 1.8 mg/dl, with the increase in older adults being 2.5 mg/dl.
 - A non-significant increase was observed in meta-analysis of overweight and obese adults (1.6 mg/dl), with a non-significant increase of 0.9 mg/dl observed in a meta-analysis if adults with type 2 diabetes.
 - In a systematic review of studies that included only patients with known coronary heart disease engaged in exercise based cardiac rehabilitation, a non-significant decrease in HDL-C of 1.9 mg/dl was observed.

Effect of Exercise on HDL

- The observed changes in HDL-C reported in meta-analyses resulted are present when exercise is ≥ 15 weeks in duration, >3 days per week, 35-50 minutes per session, at a vigorous intensity ($>60\%$ of maximal oxygen consumption).
- Systematic reviews have concluded that the effect of aerobic exercise on increases in HDL-C are consistent.
- The report from the Advisory Committee for the Physical Activity Guidelines for Americans concluded that exercise results in favorable improvements in HDL-C.
- A systematic review concluded that an average increase of 2492 steps per day resulted in a non-significant increase in HDL-C in outpatient adult studies.

AHA and ACC 2013 Report on Lifestyle Management to Reduce Cardiovascular Risk

- **Evidence Statement:**
 - Among adults, aerobic physical activity alone, as compared to control interventions, has no consistent effect on HDL-C.
 - Strength of evidence: Moderate

Effect of Resistance Exercise on HDL

- Evidence from 1 meta-analysis and 1 systematic review was examined with regard to the effect of **resistance exercise** on changes in HDL-C.
 - The meta-analysis that included studies involving healthy adults ≥ 18 years of age showed a non-significant increase in HDL-C of 0.7 mg/dl.
 - These observed changes are present when resistance exercise was
 - 24.0 \pm 19.0 weeks in duration and involved 2.9 \pm 0.4 days per week of exercise with the average session lasting 47.7 \pm 11.5 minutes. R
 - Resistance exercise sessions included performing 9.2 \pm 3.1 different exercises, and engaging in 2.6 \pm 1.1 sets of 11.5 \pm 6.6 repetitions for these exercises.
 - The intensity was 70.3 \pm 10.4% of 1 maximal repetition.
 - A systematic review of the literature for the effects of resistance exercise on change in HDL-C in patients with type 2 diabetes concluded that studies generally showed an improvement in HDL-C with this form of exercise.
 - The resistance exercise in these studies was typically performed over a range of 4 weeks to 12 months and was typically performed 3 days per week. The dose of resistance exercise varied between the studies.

AHA and ACC 2013 Report on Lifestyle Management to Reduce Cardiovascular Risk

- **Evidence Statement:**
 - Among adults, resistance training, as compared to control interventions, has no effect on HDL-C.
- **Strength of evidence**
 - Low

Effect of Exercise on Blood Pressure



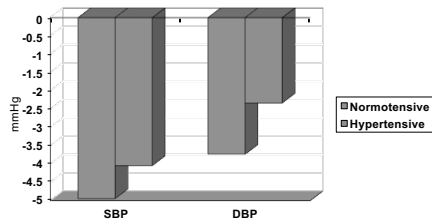
Effect of Exercise on Blood Pressure

- The 2008 Physical Activity Guidelines Advisory Committee reviewed the data from 10 meta-analyses and concluded that:
 - “Both aerobic and progressive resistance exercise yields important reductions in systolic and diastolic BP in adult humans, although the evidence for aerobic exercise is more convincing. Traditional aerobic training programs of 40 minutes of moderate-to-high intensity exercise three to five times per week that involve more than 800 metabolic equivalent of task (MET)-minutes of aerobic exercise per week appear to have reproducible effects on BP reduction.”

Effect of Exercise on Blood Pressure

- Whelton et al. conducted a meta-analysis that combined data from 54 RCTs lasting at least 2 weeks and included 2,419 subjects.
 - The median trial duration was 12 weeks, and the average resting BP at baseline was 127/77.
 - Three trials included patients on anti-hypertensive medication.
 - Among all subjects, the average reductions in systolic and diastolic blood pressure were 4 (3–5) and 3 (2–3) mmHg, respectively.
 - When only trials with supervised exercise were included, larger reductions of 4 and 3 mmHg were observed.

Change in Blood Pressure with Physical Activity Normotensive vs. Hypertensive

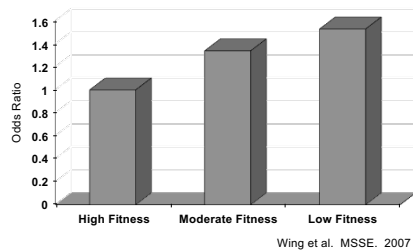


Whelton et al. Annals of Internal Medicine 2002

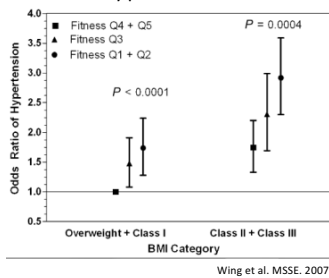
Effect of Exercise on Blood Pressure

- Among patients with CVD:
 - Taylor et al. pooled data from RCTs lasting ≥ 6 months of exercise-based cardiac rehabilitation versus comparison groups that did not involve exercise,
 - For systolic BP, eight trials with a total of 744 patients were included; exercise-based cardiac rehabilitation (that also may have included targeting other risk factors such as diet, stress management, smoking, and group support) resulted in a decrease of 3 (1–5) mmHg.
 - For diastolic BP, five trials with 482 patients were included. There was a decrease of 1.18 mmHg that was not statistically significant.
 - Jolly et al. compared home-based cardiac rehabilitation with supervised rehabilitation.
 - Based on only two studies, investigators found no significant difference with respect to systolic BP change with either type of program.

Association Between Fitness and Prevalence of Hypertension in Diabetics



Fitness vs. Fatness Hypertension

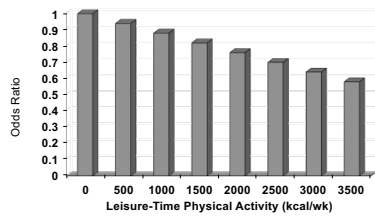


Effect of **Resistance** Exercise on
Blood Pressure

- Review of evidence does not provide consistent evidence on resistance exercise training for blood pressure reduction.

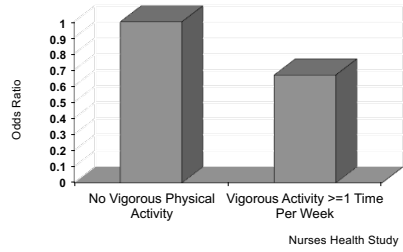
Effect of Exercise on Blood Glucose and
Diabetes Risk

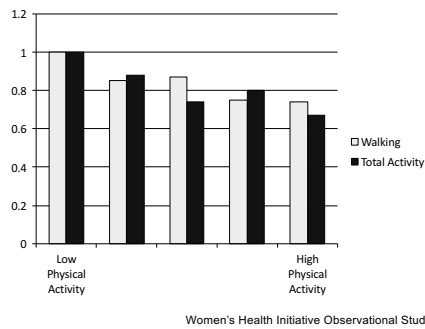
Each 500 kilocalorie increment in leisure-time physical activity reduced the risk of type 2 diabetes by 6%



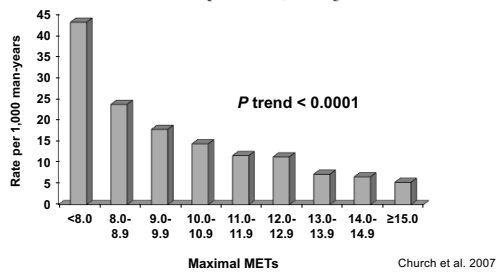
University of Pennsylvania Alumni Study

33% Reduction in Relative Risk of Developing Diabetes

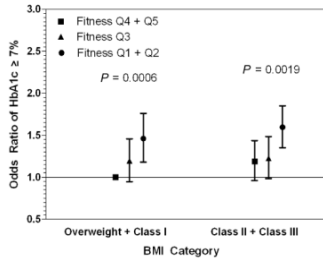




**Diabetes Incidence Rates by Fitness:
ACLS (n =13,190)**

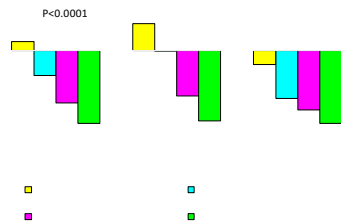


Fitness vs. Fatness
HbA1c >7.0%



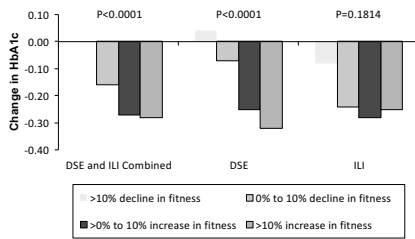
Wing et al. MSSE. 2007

4-Year Change in HbA1c by Category of
4-Year Percent Change in Fitness



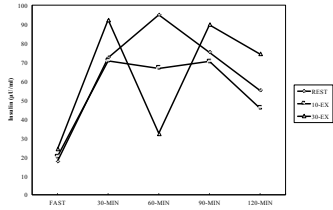
Jakicic et al. *Diabetes Care*. 2013; 36(5): 1297-1303

4-Year Change in HbA1c by 4-Year Percent Change in Fitness Adjusted
for Age, Gender, Weight Change and
Diabetes Medication Use



Jakicic et al. *Diabetes Care*. 2013; 36(5): 1297-1303

Acute Effect of Continuous vs. Intermittent Physical Activity on Insulin Response to a Meal

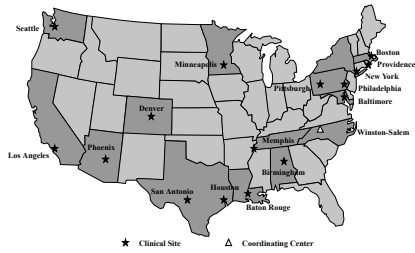


Mishler A. University of Pittsburgh
Doctoral Dissertation. 2012

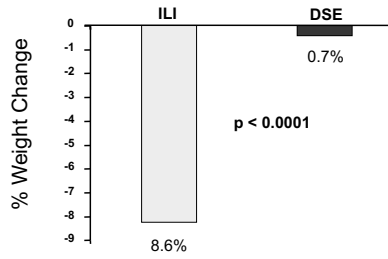
Intervention Strategies



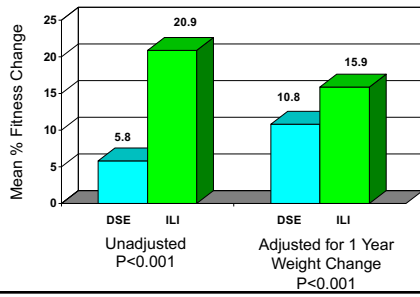
Clinical Sites



% Weight Loss at 1-Year



Fitness Change (%) at 1-Year



1-Year Changes in Markers of Diabetes Control

Markers of Diabetes Control	ILI	DSE	P-value
Hemoglobin A1c (%), BL	7.25	7.29	0.26
Hemoglobin A1c (%), Y1	6.61	7.15	<0.001
Y1 – Baseline	-0.64	-0.14	<0.001
Fasting glucose (mg/dl), BL	151.9	153.6	0.21
Fasting glucose (mg/dl), Y1	130.4	146.4	<0.001
Y1 – Baseline	-21.5	-7.2	<0.001
Diabetes medications, BL	86.5%	86.5%	0.93
Diabetes medications, Y1	78.6%	88.7%	<0.001
Y1 – Baseline	-7.8%	2.2%	<0.001

**1-Year Changes in Markers of
Blood Pressure Control**

Markers of Blood Pressure Control	ILI	DSE	P-value
Systolic BP (mmHg), BL	128.2	129.4	0.26
Systolic BP (mmHg), Y1	121.4	126.6	<0.001
Y1 – Baseline	-6.8	-2.8	<0.001
Diastolic BP (mmHg), BL	69.9	70.4	0.11
Diastolic BP (mmHg), Y1	67.0	68.6	<0.001
Y1 – Baseline	-3.0	-1.8	<0.001
Antihypertensive medications, BL	75.3%	73.7%	0.23
Antihypertensive medications, Y1	75.2%	75.9%	0.54
Y1 – Baseline	-0.1%	2.2%	0.02

**1-Year Changes in Markers of
Lipid Control**

Markers of Lipid Control	ILI	DSE	P-value
LDL-cholesterol (mg/dl), BL	112.2	112.4	0.78
LDL-cholesterol (mg/dl), Y1	107.0	106.7	0.74
Y1 – Baseline	-5.2	-5.7	0.49
HDL-cholesterol (mg/dl), BL	43.5	43.6	0.80
HDL-cholesterol (mg/dl), Y1	46.9	44.9	<0.001
Y1 – Baseline	3.4	1.4	<0.001
Triglycerides (mg/dl), BL	182.8	180.0	0.38
Triglycerides (mg/dl), Y1	152.5	165.4	<0.001
Y1 – Baseline	-30.3	-14.6	<0.001
Lipid lowering medications, BL	49.4%	48.4%	0.52
Lipid lowering medications, Y1	53.0%	57.8%	<0.001
Y1 – Baseline	3.7%	9.4%	<0.001

**1-Year Changes in Percent of Participants
Meeting ADA Goals**

ADA Goal	ILI	DSE	P-value
Hemoglobin A1c < 7%, BL	46.3%	45.4%	0.50
Hemoglobin A1c < 7%, Y1	72.7%	50.8%	<0.001
Y1 – Baseline	26.4%	5.4%	<0.001
Blood pressure < 130/80 mmHg, BL	53.5%	49.9%	0.01
Blood pressure < 130.80 mmHg, Y1	68.6%	57.0%	<0.001
Y1 – Baseline	15.1%	7.0%	<0.001
LDL-cholesterol < 100 mg/dl, BL	37.1%	36.9%	0.87
LDL-cholesterol < 100 mg/dl, Y1	43.8%	44.9%	0.45
Y1 – Baseline	6.7%	8.0%	0.34
All three goals, BL	10.8%	9.5%	0.13
All three goals, Y1	23.6%	16.0%	<0.001
Y1 – Baseline	12.8%	6.5%	<0.001

WARNING

Physical inactivity has been shown to be associated with increased risk of metabolic syndrome, mortality, morbidity, and lower quality of life.

Please consult with your physician
if you decide not
to engage in regular periods of
daily physical activity.

WARNING



SEE YOUR PHYSICIAN

Before sitting on this sofa or engaging in other forms of sedentary behavior for extended periods of time you should always consult with your doctor or physician, particularly if you have a medical condition that might be worsened by engaging in more sedentary behavior.

University of Pittsburgh

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To colleagues at the University of Nebraska-Kearney, the University of Kansas, Brown University and The Miriam Hospital

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Thank You!

