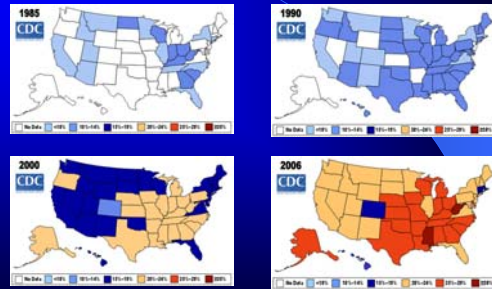


# Improving exercise adherence and long-term maintenance of weight loss

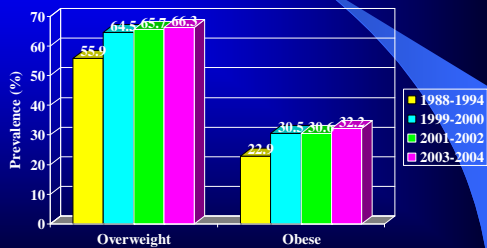
**John M. Jakicic, Ph.D.**  
 University of Pittsburgh  
 Chair, Department of Health and Physical Activity  
 Director, Physical Activity and Weight Management Research Center  
 Director, Obesity and Nutrition Research Center

## Obesity Trends\* Among U.S. Adults

(\*BMI ≥30, or about 30 lbs. overweight for 5'4" person)

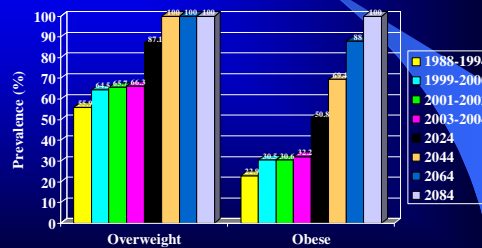


## Prevalence of Overweight and Obesity in Adults



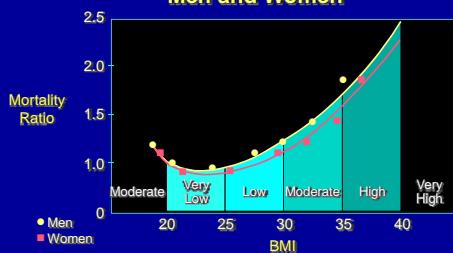
Ogden et al. JAMA, 2006

## Projected Prevalence of Overweight and Obesity in Adults



## Obesity and Mortality Risk

American Cancer Society Study of 750,000 Men and Women




Gray, Med Clin North Am, 1989; 73(1):1-13

## Energy Balance




Energy Intake versus Energy Expenditure

## Energy Balance



Energy Intake versus Energy Expenditure

## What are the Current Physical Activity Recommendations for the Management of Body Weight?



### Public Health Recommendation for Physical Activity

**“It is recommended that all Americans accumulate at least 30 minutes of moderate intensity physical activity on most, preferably all, days of the week.”**

Centers for Disease Control and Prevention  
American College of Sports Medicine  
JAMA, 1995

### History of Physical Activity Recommendations for Weight Control

- 2001 – American College of Sports Medicine
  - 150 min/wk: Improves health outcomes
  - 200-300 min/wk: Long-term maintenance of weight loss
- 2002 – Institute of Medicine
  - 60 min/d: Prevent weight gain and accrue additional weight independent health benefits
- 2003 – International Association for the Study of Obesity
  - 45-60 min/d: Prevention of weight gain
  - 60-90 min/d: Prevent the transition to overweight or obesity

### 2005 Dietary Guidelines for Americans

- To **reduce the risk of chronic disease** in adulthood: Engage in at least **30 minutes** of moderate-intensity physical activity, above usual activity, at work or home on most days of the week.
- For most people, greater health benefits can be obtained by engaging in physical activity of more vigorous intensity or longer duration.
- To help **manage body weight and prevent gradual, unhealthy body weight gain** in adulthood: Engage in approximately **60 minutes** of moderate- to vigorous-intensity activity on most days of the week while not exceeding caloric intake requirements.
- To **sustain weight loss** in adulthood: Participate in at least **60 to 90 minutes** of daily moderate-intensity physical activity while not exceeding caloric intake requirements. Some people may need to consult with a healthcare provider before participating in this level of activity.

### 2005 Dietary Guidelines for Americans

- To reduce the risk of chronic disease in adulthood: Engage in at least 30 minutes of moderate-intensity physical activity, above usual activity, at work or home on most days of the week.
- For most people, **greater health benefits can be obtained by engaging in physical activity of more vigorous intensity or longer duration.**
- To help manage body weight and prevent gradual, unhealthy body weight gain in adulthood: Engage in approximately 60 minutes of moderate- to vigorous-intensity activity on most days of the week while not exceeding caloric intake requirements.
- To sustain weight loss in adulthood: Participate in at least 60 to 90 minutes of daily moderate-intensity physical activity while not exceeding caloric intake requirements. Some people may need to consult with a healthcare provider before participating in this level of activity.

### Physical Activity Recommendations - 2007

- Aerobic Physical Activity
  - Moderate Intensity: 30 min/d, 5 d/wk
  - Vigorous Intensity: 20 min/d, 3 d/wk
- Moderate/Vigorous is in addition to light activity performed frequently during the day
- Can be accumulated in bouts lasting at least 10 minutes
- Muscle strengthening exercise are recommended 2 times per week
- Further improvements in fitness, chronic diseases, disabilities, or prevention of unhealthy weight gain may need to exceed this minimal recommended dose of physical activity

2009

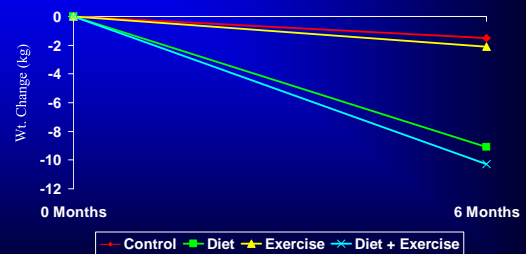
### American College of Sports Medicine

- Recommends that adults participate in at least 150 min/wk of moderate-intensity physical activity to prevent significant weight gain and reduce associated chronic disease risk factors.
  - This dose will elicit modest reduction in body weight
- There is likely a dose effect of physical activity with greater weight loss and enhanced prevention of weight regained with doses of physical activity that approximate 250-300 min/wk (~2000 kcal/wk) of moderate intensity physical activity.

Donnelly, Jakicic, Blair, Manore, Rankin, Smith. Med Sci Sports Exerc. 2009; 41(2): 459-471.

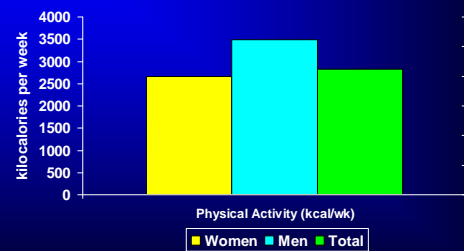
### What is the Short-Term Impact of Physical Activity in the Management of Body Weight?

### Short-Term Changes in Body Weight (Wing et al. 1998)

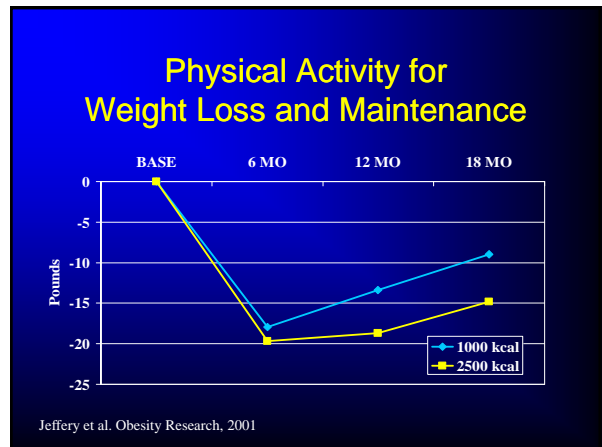
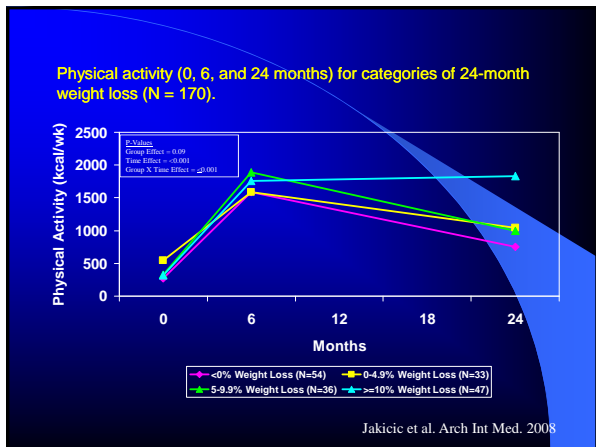
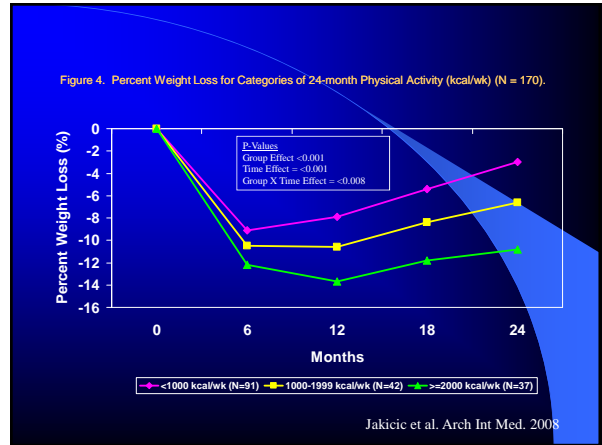
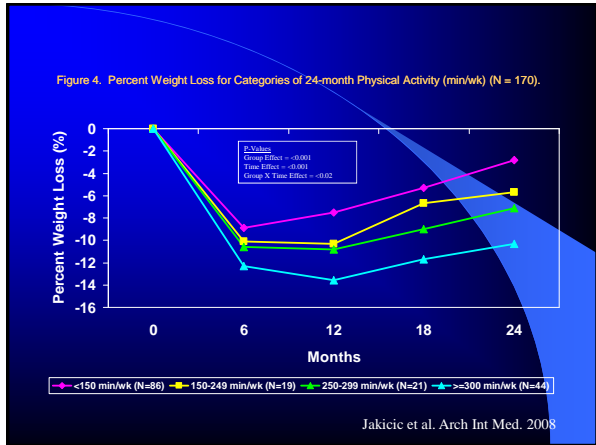
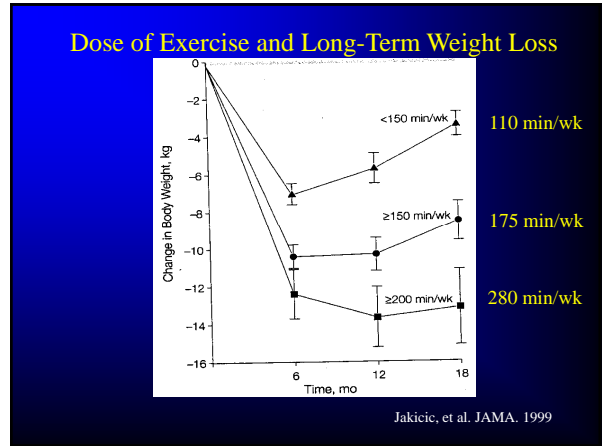
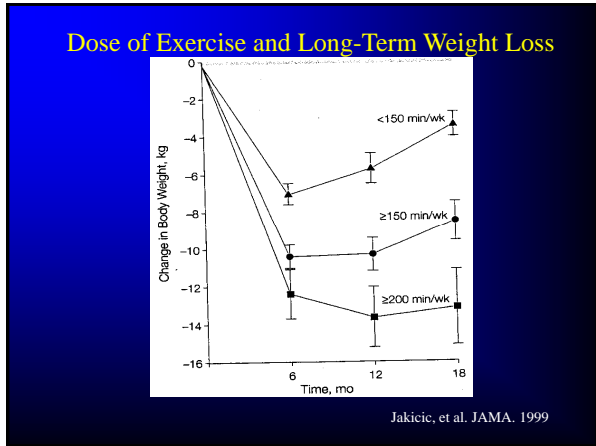


### What is the Long-Term Impact of Physical Activity in the Management of Body Weight?

### National Weight Control Registry



Reference: Klem et al. Am J Clin Nutr 1997; 66: 239-246.



## What is the Optimal Dose of Exercise for Weight Loss?

Exercise Intensity

Duncan et al. JAMA. 1991; 266(23): 3295-3299.

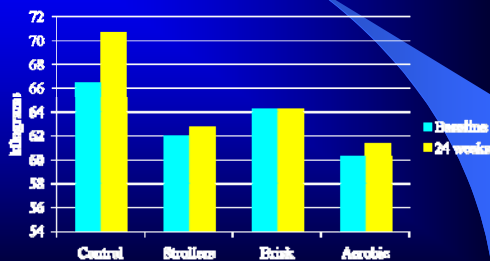
Duncan et al. JAMA. 1991; 266(23): 3295-3299.

- 24 week intervention
- 102 sedentary premenopausal women completed the study
  - 59 completed the study (58%)
- 20-40 years of age
- Randomized to 4 groups

### Randomized Groups

- Control (N=13)
  - Remained sedentary
- Strollers (N=18)
  - Intensity = 4.8 km/hr; Distance = 4.8 km, 5 d/wk
- Brisk Walkers (N=12)
  - Intensity = 6.4 km/hr; Distance = 4.8 km, 5 d/wk
- Aerobic Walkers (N=16)
  - Intensity = 8.0 km/hr; Distance = 4.8 km, 5 d/wk

### Body Weight



## What is the Optimal Dose of Exercise for Long-Term Weight Loss?

Energy Expenditure  
versus  
Exercise Intensity

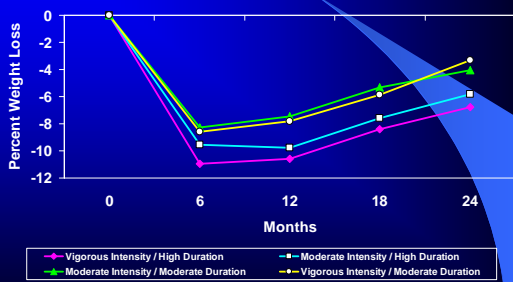
## Exercise Components

	Groups			
	Moderate/ Moderate	High/ Moderate	Moderate/ Vigorous	High/ Vigorous
Exercise Dose	≈1000 kcal/wk	≈2000 kcal/wk	≈1000 kcal/wk	≈2000 kcal/wk
Exercise Intensity	Moderate	Moderate	Vigorous	Vigorous

## Exercise Prescription

	Moderate/ Moderate	High/ Moderate	Moderate/ Vigorous	High/ Vigorous
Frequency	5 d/wk	5 d/wk	5 d/wk	5 d/wk
Duration	min/d (min/wk)	min/d (min/wk)	min/d (min/wk)	min/d (min/wk)
Weeks 1-4	20 (100)	20 (100)	20 (100)	20 (100)
Weeks 5-8	30 (150)	30 (150)	30 (150)	30 (150)
Weeks 9-12	40 (200)	40 (200)	30 (150)	40 (200)
Weeks 13-16	40 (200)	50 (250)	30 (150)	40 (200)
Weeks 17-20	40 (200)	60 (300)	30 (150)	40 (200)
Weeks 21-52	40 (200)	60 (300)	30 (150)	40 (200)
Weeks 53-104	40 (200)	60 (300)	30 (150)	40 (200)
Intensity	Moderate	Moderate	Progressed to Vigorous	Progressed to Vigorous

Percent weight loss based on randomized group assignment (N = 191).

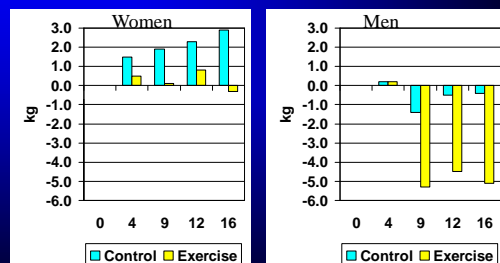


## Gender Effects?

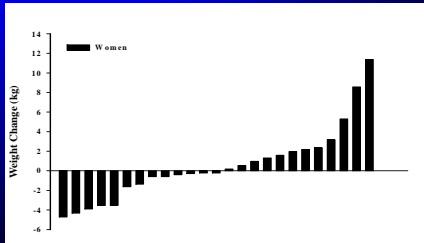
## 12-week Changes in Body Weight (Hagan et al. 1986)



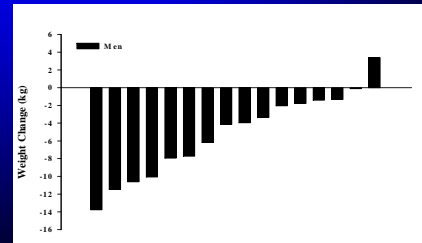
## Midwest Exercise Trial Weight Change (kg)



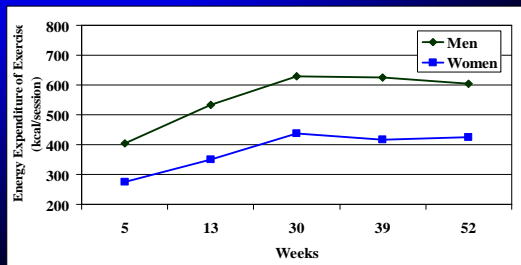
## Responders and Non-responders for Women



## Responders and Non-responders for Men



## Energy Expenditure of Exercise (kcal)



## Questions

- How much PA (aerobic and resistance) is needed for weight stability?
- How much and what type of PA is recommended for weight loss?

## Definitions

- **Weight Maintenance (weight stability)** defined as:
  - Change in body weight of  $\pm 5$  pounds of initial body weight.
    - St. Joer et al. 1997; Sherwood et al. 2000
  - More recently defined as less than  $\pm 3\%$  change in body weight
    - Stevens et al. 2006
- **Weight loss**
  - Clinically significant weight loss defined as:
    - $\geq 5\%$  reduction in body weight
      - Stevens et al. 2006

## Effect of PA on Body Weight

- Is Physical Activity sufficient to result in weight stability?
  - Less than  $\pm 3\%$  change in body weight
- Is Physical Activity sufficient to result in weight loss?
  - $\geq 5\%$  reduction in body weight

## Cross-Sectional Evidence

- 24 studies reviewed from the CDC database
  - 22 studies showed favorable effects of physical activity on body weight
  - Dose-response relationship between physical activity and body weight
    - Most favorable changes occur with 30-60 min/d of physical activity

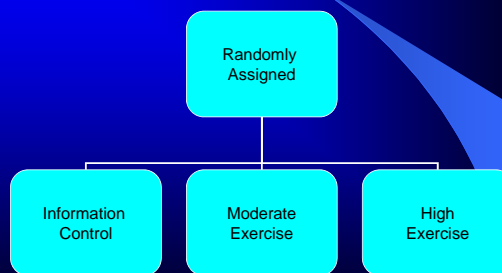
## Prospective Evidence

- 9 studies reviewed from the CDC database
  - 3 studies had a follow-up of 1-3 years
  - 6 studies had a follow-up of  $\geq 6.5$  years
- All studies reviewed showed a favorable effect on body weight
  - Sustaining levels of physical activity ranging from 233-327 min/wk may be necessary to reduce weight gain (Berk et al. 2006)

## Evidence from Randomized Studies

- 18 studies reviewed from the CDC database
  - 17 used a randomized study design
  - 1 did not include a comparison group
- 14 studies reported a significant effect of physical activity on body weight
  - Studies reporting a significant effect on body weight reported physical activity ranging from 180-270 min/wk
    - Weight change was a reduction of 0.5-3.0 kg
      - Corresponds to approximately 3% weight loss
      - Considered to be "weight maintenance" using the criteria of Stevens et al. (2006)
  - 4 studies reporting no effect included <150 min/wk of physical activity

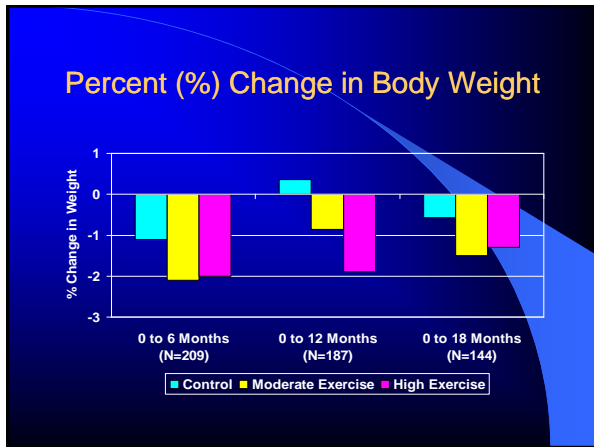
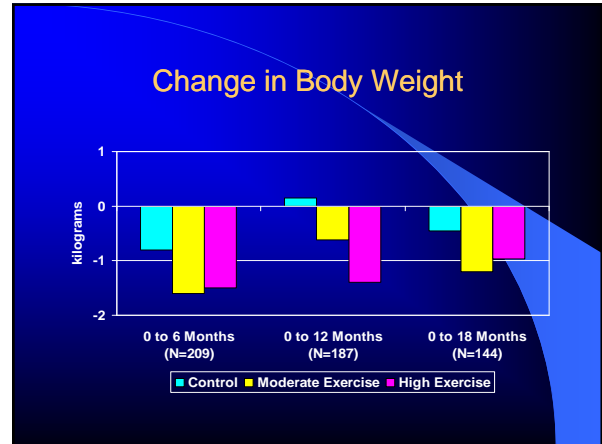
## Intervention



	Information Control	Moderate Exercise	High Exercise
"Healthy Living Everyday" book	<input checked="" type="checkbox"/>		
Monthly Newsletter	<input checked="" type="checkbox"/>		
<b>Behavioral Sessions</b>			
● Mailed Behavioral Materials	<input checked="" type="checkbox"/>		
● Wks 1-24: Weekly Behavioral Sessions			
● Wks 25-78: Biweekly Sessions + Biweekly Calls			
<b>Healthy Eating</b>			
● Exercise: progressed to 150 min/wk			
● Exercise: progressed to 300 min/wk			

	Information Control	Moderate Exercise	High Exercise
"Healthy Living Everyday" book	<input checked="" type="checkbox"/>		
Monthly Newsletter	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
<b>Behavioral Sessions</b>			
● Mailed Behavioral Materials	<input checked="" type="checkbox"/>		
● Wks 1-24: Weekly Behavioral Sessions		<input checked="" type="checkbox"/>	
● Wks 25-78: Biweekly Sessions + Biweekly Calls		<input checked="" type="checkbox"/>	
<b>Healthy Eating</b>		<input checked="" type="checkbox"/>	
● Exercise: progressed to 150 min/wk		<input checked="" type="checkbox"/>	
● Exercise: progressed to 300 min/wk			

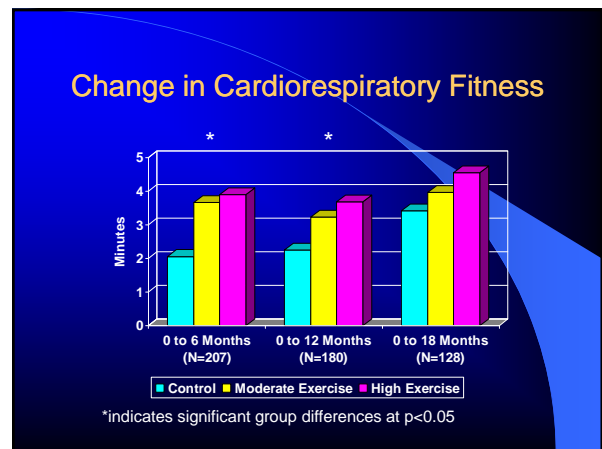
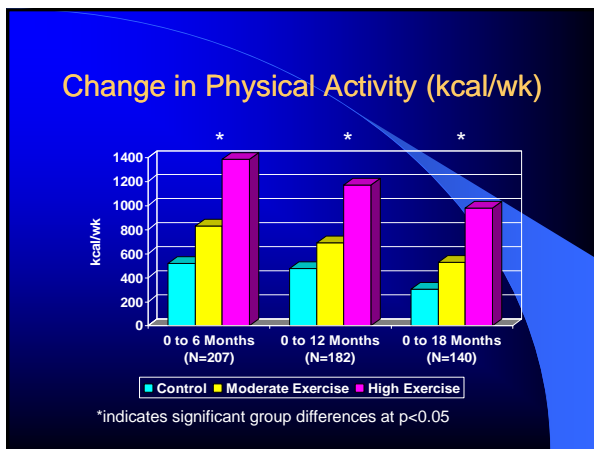
	Information Control	Moderate Exercise	High Exercise
"Healthy Living Everyday" book	☑		
Monthly Newsletter	☑	☑	☑
Behavioral Sessions			
• Mailed Behavioral Materials	☑		
• Wks 1-24: Weekly Behavioral Sessions		☑	☑
• Wks 25-78: Biweekly Sessions + Biweekly Calls		☑	☑
Healthy Eating		☑	☑
• Exercise: progressed to 150 min/wk		☑	
• Exercise: progressed to 300 min/wk			☑



### Prevalence of Weight Change

	Weight Gain	Weight Loss or Maintenance
<b>Control</b>		
0 to 6 Months	38% (1.8±1.5 kg)	62% (-2.4±2.0 kg)
0 to 12 Months	51% (4.1±5.6 kg)	49% (-3.9±2.5 kg)
0 to 18 Months	51% (2.4±1.0 kg)	49% (-3.5±2.9 kg)
<b>Moderate Exercise</b>		
0 to 6 Months	25% (1.8±1.5 kg)	75% (-2.8±2.3 kg)
0 to 12 Months	36% (3.7±4.0 kg)	64% (-3.1±2.3 kg)
0 to 18 Months	36% (2.9±2.2 kg)	64% (-3.6±2.1 kg)
<b>High Exercise</b>		
0 to 6 Months	24% (1.9±1.3 kg)	76% (-2.7±2.2 kg)
0 to 12 Months	33% (2.8±2.1 kg)	67% (-3.5±2.5 kg)
0 to 18 Months	41% (2.9±2.4 kg)	59% (-3.7±2.9 kg)

Note: No significant difference between groups based on Chi-Square Analysis

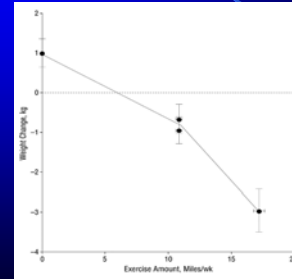


## Correlations between Change in Body Weight and Change in Fitness

	Weight Change (0 to 6 Mo.)	Weight Change (0 to 12 Mo.)	Weight Change (0 to 18 Mo.)
Change in Fitness (0-6 Months)	-0.36*	-0.35*	-0.27*
Change in Fitness (0-12 Months)		-0.39*	-0.51*
Change in Fitness (0-18 Months)			-0.39*

\*Indicates significant at  $p < 0.001$

## The Relationship Between Mean Amount of Weight Change and Amount of Exercise



Slentz, C. A. et al. Arch Intern Med 2004;164:31-39.

## Evidence from Randomized Studies

- Magnitude of weight loss consistent with prior reviews
  - NHLBI Expert Review Panel (1998)
    - Physical Activity alone results in 2.4 kg reduction in body weight.
  - Review conducted by Wing (1999)
    - Physical Activity alone results in approximately 1-2 kg reduction in body weight.

## Effect of Resistance Exercise

- 9 studies were reviewed
  - Modest change in body weight of <1 kg observed in these studies
    - Confirmed in a review by Donnelly et al. (2003)
- Potential reasons for this modest effect
  - Weight (fat) loss be accompanied by a concurrent increase in fat-free mass
    - May need to use body composition rather than body weight to determine the effect
  - Dose of resistance exercise may not be sufficient
    - Studies are typically short in duration (<6 months)
    - Typically involve 2-3 days of resistance exercise

## Endurance plus Resistance Exercise

- 5 studies were reviewed that used combined endurance (aerobic) plus resistance exercise
  - 2 studies used randomized designs
  - 1 study used a cross-over design
  - 2 studies did not include a control group
- 4 of these studies reported no effect on body weight
  - Studies were 8-10 weeks in duration
    - May have not provided a sufficient dose of physical activity to impact body weight
  - The 1 study showing an effect did not include a comparison (control) group.

## Strategies for Improving Physical Activity in Overweight and Obese Adults

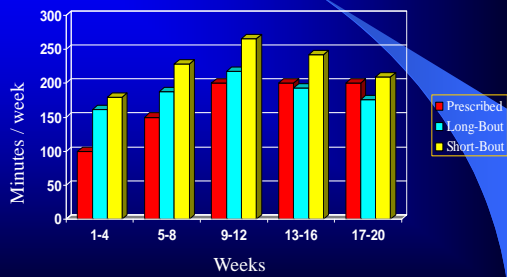
## Intermittent Activity versus Continuous Exercise

## Exercise Prescription

	Long-Bout Group	Short-Bout Group
Frequency	5 d/wk	5 d/wk
Duration	min/d (min/wk)	min/d (min/wk)
Weeks 1-4	1 X 20 (100)	2 X 10 (100)
Weeks 5-8	1 X 30 (150)	3 X 10 (150)
Weeks 9-12	1 X 40 (200)	4 X 10 (200)
Weeks 13-16	1 X 40 (200)	4 X 10 (200)
Weeks 17-20	1 X 40 (200)	4 X 10 (200)

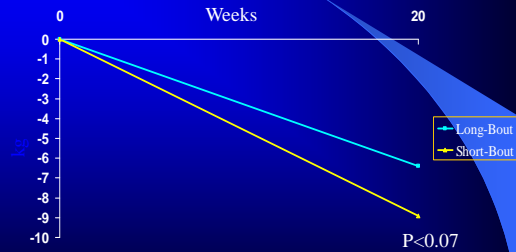
Reference: Jakicic et al. *Int J Obesity* 1995; 19: 893-901.

## Minutes of Exercise per Week



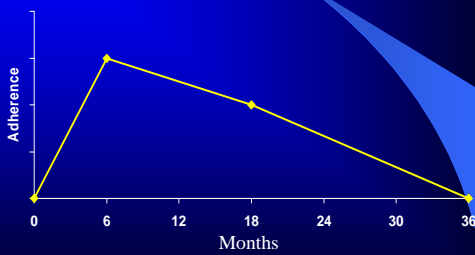
Reference: Jakicic et al. *Int J Obesity* 1995; 19: 893-901.

## Weight Loss

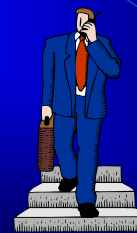


Reference: Jakicic et al. *Int J Obesity* 1995; 19: 893-901.

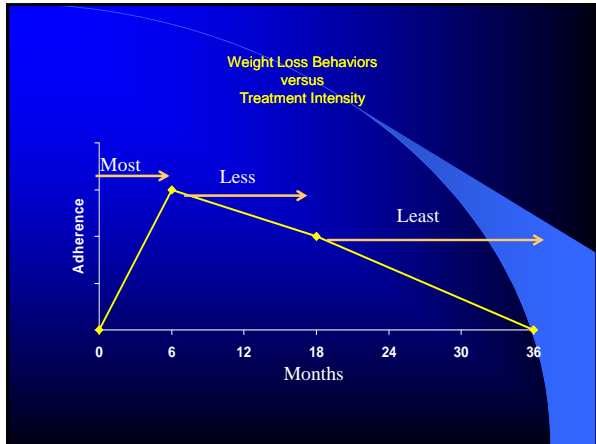
## Adoption and Maintenance of Obesity-Related Behaviors



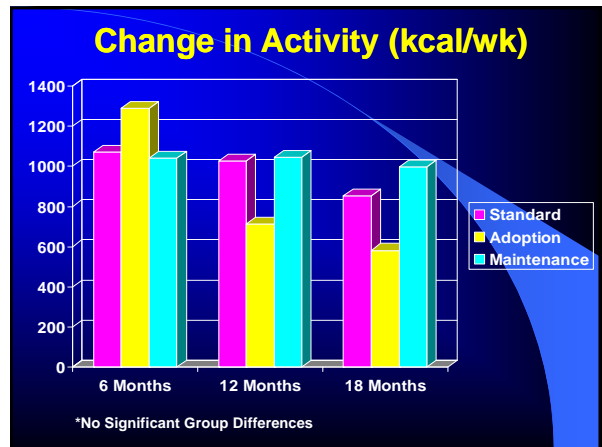
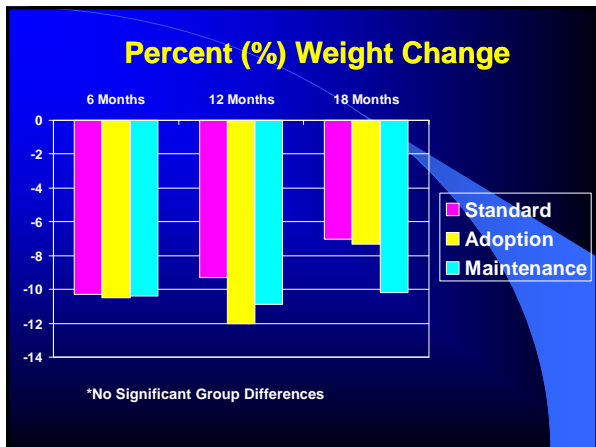
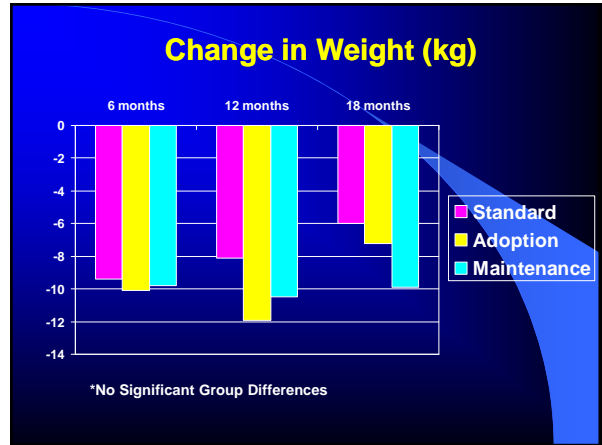
## Standard Behavioral Weight Loss Programs "Step Down" Approach?



More Care Needed – Less Care Available



	STANDARD	ADOPTION	MAINTENANCE
<b>Standard Treatment</b>			
• Weekly Meetings (Mo 1-6)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• Bi-Weekly Meetings (Mo 6-18)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• Bi-Weekly Phone Calls			
Months 1-3		<input checked="" type="checkbox"/>	
Months 4-6			<input checked="" type="checkbox"/>
<b>Exercise Component</b>			
• Progress to 200 min/wk	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
• Supervised Exercise			
Months 1-6		<input checked="" type="checkbox"/>	
Months 6-12			<input checked="" type="checkbox"/>
• Exercise Campaigns			
Months 3-9		<input checked="" type="checkbox"/>	
Months 12-18			<input checked="" type="checkbox"/>



What should be recommended?

Recommendation  
Exercise Dose and Long-Term Weight

**Change in Eating Behavior** +  $\geq 150$  Minutes of Moderate Intensity Physical Activity = **Good** Long-Term Weight Loss

**Change in Eating Behavior** + 250-300 Minutes of Moderate Intensity Physical Activity = **Better** Long-Term Weight Loss



“The winds and waves are always on the side of the ablest navigators.”

Edward Gibbon