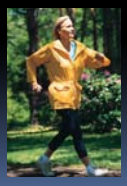
Rx

PRINCIPLES OF EXERCISE PRESCRIPTION

EXERCISE IS MEDICINE



GXT Case Study

- Ms WB is a 40Y/O Caucasian mother of 2. Her doctor evaluated her and cleared her to enter an exercise program. Works full time and wishes to begin an exercise program and lose 50lbs (currently 64 inches tall and 180 lbs . Waist circumference is 45". Has not been running for 15yrs .
- **Lifestyle Assessment:** She does not smoke and has no known serious medial conditions. She was a cross country runner in college and would like to begin jogging again. The only activity she engages in is walking her dog and chasing her children. She generally eats 3-4 meals/day and consumes what the family eats .
- **Physical Exam:** Normal cardiovascular, pulmonary and neurologic exam. Her recent laboratory tests reveal the following: HDL 70mg/dl, Chol 250mg/dl, LDL 190mg/dl. Fasting glucose 87mg/dl. Her body mass index is 31.4mg/kg/m2 . 32% body fat. She does not have a family history of cardiovascular disease.
- The local hospital was offering free exercise testing for all employees as part of a company wellness program that they were starting. Ms. WB decided to take advantage of the hospital's performance assessment program to establish a baseline fitness assessment from which to gain specific training recommendations. She may also join the employee wellness program.
- **Exercise Test Results:** **Maximal symptom limited test performed using a Bruce Protocol**
- **Resting HR = 76 bpm, Peak HR = 190bpm**
- **Resting Blood pressure = 136/80, Peak BP = 200/70**
- **Resting ECG = Normal sinus rhythm, normal complex configuration, Peak ECG = No ST depression, No arrhythmia noted. No chest pain reported.**
- **Symptoms = Test terminated due to leg fatigue. RPE at peak exercise 18/20**
- **Functional Capacity = Test terminated at 3min of Stage 4 (2.5mph at 12% elevation)**

PURPOSE

- To provide a reliable, valid guide for optimal health and fitness improvements
- To provide a safe environment in which to achieve these improvements

There **is no ONE program that is best for everyone**

Health Benefits Associated with Regular Physical Activity

Adults and Older Adults

Strong evidence

- Lower risk of early death
- Lower risk of coronary heart disease
- Lower risk of stroke
- Lower risk of high blood pressure
- Lower risk of adverse blood lipid profile
- Lower risk of type 2 diabetes
- Lower risk of metabolic syndrome
- Lower risk of colon cancer
- Lower risk of breast cancer
- Prevention of weight gain
- Weight loss, particularly when combined with reduced calorie intake
- Improved cardiorespiratory and muscular fitness
- Prevention of falls
- Reduced depression
- Better cognitive function (for older adults)

Moderate to strong evidence

- Better functional health (for older adults)
- Reduced abdominal obesity

Moderate evidence

- Lower risk of hip fracture
- Lower risk of lung cancer
- Lower risk of endometrial cancer
- Weight maintenance after weight loss
- Increased bone density
- Improved sleep quality

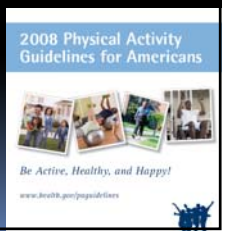
Source: U.S. Department of Health and Human Services. 2008 Physical Activity Guidelines for Americans. ODPHP Publication No. U0036, October, 2008. www.health.gov/paguidelines.

Exercise Prescription Pyramid

BASIC PRINCIPLES FOR EXERCISE PROGRAM DESIGN

- SPECIFICITY
- REVERSIBILITY
- PROGRESSIVE OVERLOAD

(FITT)



SPECIFICITY

Adaptations that occur are directly related to the physiologic systems being trained

(e.g. weight lifting produces muscular strength, power or endurance whereas distance running produces cardiovascular endurance)

The body will adapt in specific ways to specific modes of training

(e.g. 5-15% higher VO2 peak difference in healthy people tested using treadmill Vs. cycle ergometer *Cyclist will have a capacity similar to that on TM tested on the cycle)

Specificity

Table 5.5 Selected Modes and Types of Exercise Training and General Skeletal Muscle Adaptations

Mode	Adaptation	Comment
I. Cardiovascular: general cardiorespiratory endurance and improved body composition (aerobic)		
Walking	Leg endurance	Easy to perform for most
Running	Leg endurance	Increased injury risk over walking
Cycling	Leg endurance	Good for those with walking difficulty
Rowing	Arm and leg endurance	Often difficult to perform
Stair stepping	Leg endurance	Seated is better option for many clinical patients
Swimming	Arm and leg endurance	Poor technique will require a lot of exertion to perform; easy on joints
Rope skipping	Primarily leg endurance	Likely difficult for most clinical patients to perform
Elliptical training	Leg and arm endurance	Easy on joints
Cross-country skiing	Leg and arm endurance	Stationary machines require good coordination
II. Power: submaximal and peak exercise power increases (anaerobic)		
Sprint running	Leg power	Any of the sprinting modes are potentially dangerous for most clinical populations
Sprint cycling	Leg power	
Sprint swimming	Arm and leg power	
Resistance training	Muscle-specific power	Excellent for most clinical patients but requires proper instruction

REVERSIBILITY

The changes which are brought about by training are reversible if the individual becomes sedentary.

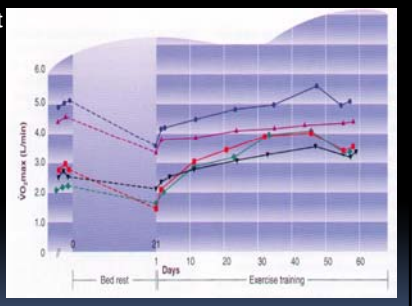
The opposite of overload occurs, the body can adapt to **INACTIVITY**.

Untrained can expect 10-30% improvement VO2 peak and work capacity 8-12 wks

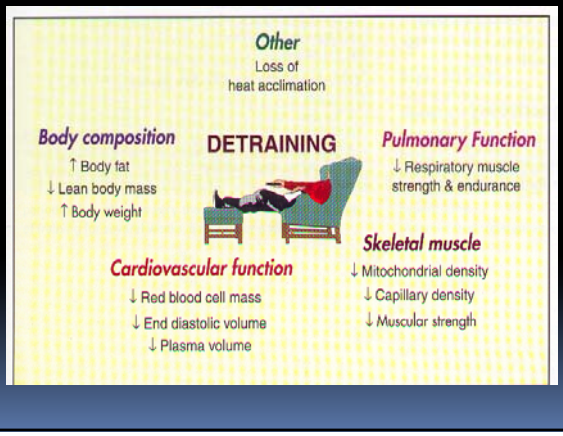
Less fit achieve faster and greater gains

CHANGES IN VO2MAX WITH 20 DAYS OF BEDREST N=5

- Least fit (**green**) at The start of bed rest Showed smaller Decrements with inactivity
- Greater gains with training
- Higher fitness was most affected by inactivity



Saltin B. Response to submaximal and maximal exercise After bed rest and training." Circulation 38(7):75, 1968

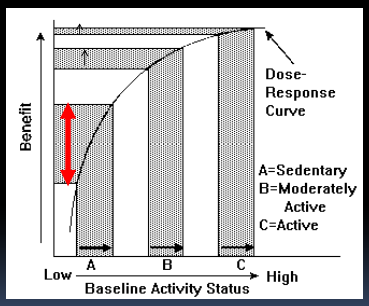


PROGRESSIVE OVERLOAD "Dose Response Relationship"

For adaptation to occur, the body and various systems must be stimulated at levels greater than those encountered habitually

DOSE-RESPONSE RELATIONSHIP

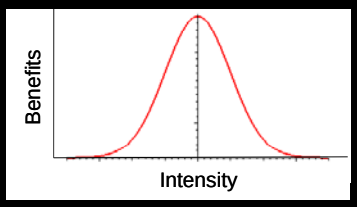
Physical Activity and Health Benefits



FOR EVERY HOUR A PERSON EXERCISED, LIFE EXPECTANCY WAS INCREASED BY 2 HOURS.

Paffenbarger RS et al. N Engl J Med 1993;328:538-45

"Threshold Effect"



Physical activity threshold at which physiologic benefits, disease and mortality benefits are lost

Ex. Harvard Alumni study dose response for all-cause mortality with a caloric expenditure of ≥500kcal-3,500kcal/wk
All cause mortality rate rose slightly when > 3,500kcal/wk expended

10% RULE

INCREASE THE TOTAL AMOUNT OF EXERCISE DONE PER WEEK BY NO MORE THAN **10%**

Ex. If a client is running 120 minutes per week, then your progression should be to increase 10% (12 minutes). Therefore the new intensity per week is 132 minutes.

OVERLOAD = Total Work Performed Above and Beyond Normal Activity

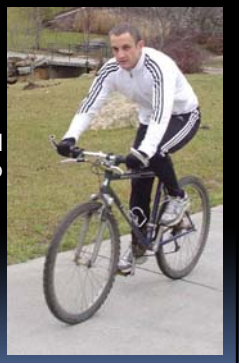
- Frequency
- Intensity
  - Objective
  - Subjective
- Duration

FITT

Aerobic F.I.T. (Frequency, Intensity, Time)

Frequency:

- **3 or more times weekly if exercising vigorously; 5 or more for moderate intensity.**
  - ≥150 min/wk of moderate, or ≥75 min/wk vigorous, purposeful physical activity (range of 500 to 1,000 MET-min/wk).
- Minutes can be accumulated throughout the week, ≥10 min bouts.
- **For health, frequency less important than total amount and intensity**

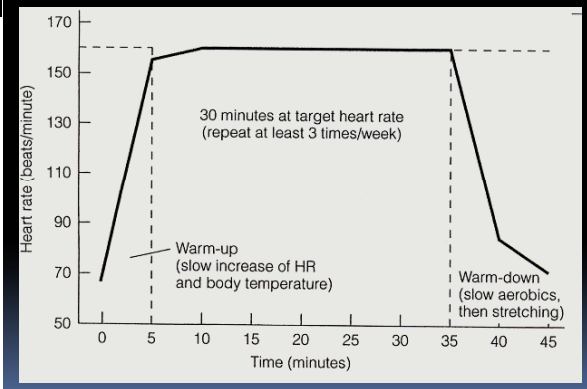


INTENSITY
"TOOLS OF THE TRADE"

Nomograms, Charts, Tables, Graphs

Intensity

- ACSM recommends that the intensity of exercise be between 40% and 85% of maximum heart rate reserve (HRR), which is approximately the same as 40-85% of maximum oxygen uptake reserve (VO_2R) (calculated from the difference between resting and maximum heart rate and resting and maximum VO_2, respectively).
- If improved health and lowered disease risk is the goal, intensity of exercise can drop to 40%, with duration and frequency becoming the more important standards.
- For athletes, the greatest improvements in aerobic power occur when intensity is high (>75% VO_2R).



Calculating Exercise Intensity

MET method

- Estimate VO_{2max} from an exercise test, and multiple by desired exercise intensity.
  - Disadvantages: must consult table of MET values for physical activities ; environmental factors can alter workload; with improvement in fitness, desired workout MET values change.

Training heart rate method

- **% HR_{max}:** Underestimates training (estimated formula's).
- **Karvonen formula, %HRR** . This methods relates best to $VO_{2max}R$, not %VO_{2max}.
  - Training HR = [(Maximum HR - resting HR) x intensity %] + resting HR
  - Best to measure maximum HR and resting HR
- **$VO_{2max}R$ method:** Calculate by subtracting 1 MET from subject's exercise VO_{2max} (e.g., 40-3.5), and multiple difference by intensity (36.5 x .60 = 21.9), and then add back 1 MET (21.9+3.5=25.4 ml/kg/min).

DETERMINING AN APPROPRIATE HEART RATE RANGE

- True maximal heart rate
  - Most accurate as long as true peak exercise was reached and individual has taken beta blockers and there is no alteration in the prescription
- Estimated heart rate
  - 220-age = estimated HR
  - 210-(0.5 x age) = estimated HR
  - SD ± 10-12 beats, highly variable
  - Inaccurate with those on Beta-blocker medications: **162 – (0.7 x age) = estimated HR**

Estimating Maximum Heart Rate

- Best to measure actual maximum heart rate (MHR).
- Older equation (MHR=220-age) assumes a decay of Hr max of 5-7% per decade, but recent studies show 3-5%.
- ACSM supports Tanaka equation:

  MHR=208-[0.7(age)].
- Thus for a 50-year old client:

  MHR=208-[0.7(50)]=173 bpm.

AGE-PREDICTED METHOD
Estimated Heart Rate

TARGET HEART RATE = (%INTENSITY) (210 - {0.5 x AGE})

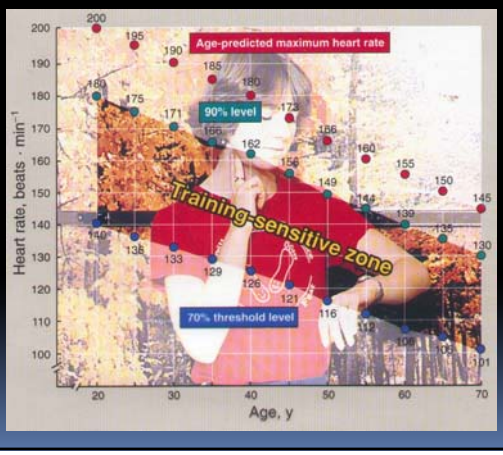
Example: Your client is 62 years old and you want to train at 60% of maximal heart rate. What is the target heart rate?

USE IF YOU DO NOT HAVE A RESTING HEART RATE!

Target heart rate = (0.60) (210 - {0.5 x 62})
Target heart rate = (0.60) (210-31)
Target heart rate = (0.60) (179)
Target heart rate = 107 bpm

What if he was on a beta-blocker?

Target HR = (0.60) (162- {0.7 x age})
Target HR = (0.60) (162- 43)
Target HR = (0.60) (119)
Target HR = 71bpm



HEART RATE RESERVE
OR
KARVONEN METHOD

Target heart rate = (% intensity) [estimated or true HR - resting HR] + resting HR

You want your 76 year old client, who has a maximum HR of 144bpm and a resting HR of 80bpm to exercise at 75% intensity. What would the target heart rate be?

CAN ONLY USE IF YOU HAVE A RESTING HEART RATE
CAN BE BASED ON ACUTAL OR ESTIMATED MAXIMAL HEART RATE!

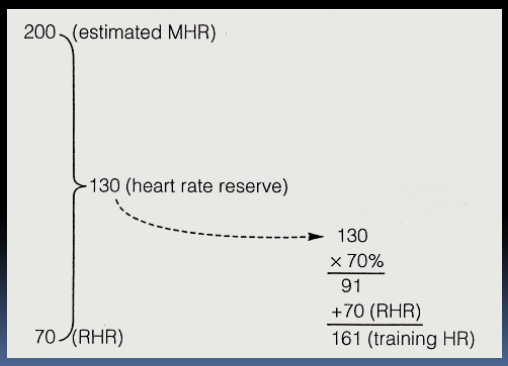
You have been given the maximal HR

Target HR = (0.75) [(144-80)] + 80
Target HR = (0.75) (64) + 80
Target HR = 48 + 80
Target HR = 128 bpm

What if you did not have the maximal HR?
Patient is NOT on a beta-blocker!

Target HR = (0.75) (210 – {0.5 x age} – 80) + 80
Target HR = (0.75) (210 – {0.5 x 76} - 80) + 80
Target HR = (0.75) (210 - 38) - 80) + 80
Target HR = (0.75) (92) + 80
Target HR = 69 + 80
Target HR = 149 bpm

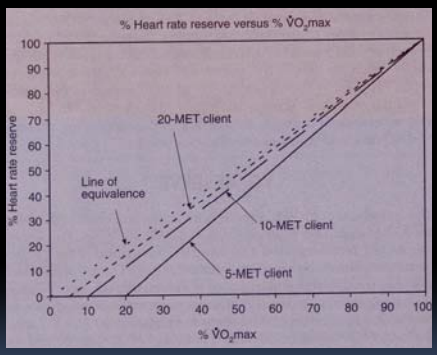
Karvonen Method (HRR)

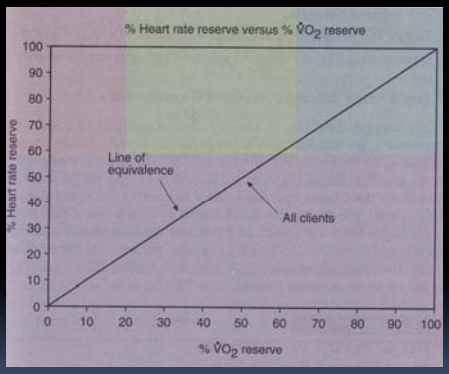


VO2 RESERVE METHOD
VO_2R

- VO2 RESERVE = VO2max – VO2 rest

%VO2R = (exercise intensity %) (VO2max – VO2rest) + VO2rest





VO_2 Reserve = (% intensity) [VO_{2peak} – resting VO_2] + $VO_{2\ rest}$

A patient has a GXT and achieves 30ml/kg/min at peak exercise. You want to train this person at 60% of VO2 reserve

- VO2R = (.60) [30ml/kg/min – 3.5 ml/kg/min] + 3.5 ml/kg/min
- VO2R = (.60) [26.5 ml/kg/min] + 3.5 ml/kg/min
- VO2R = (15.9) + 3.5 ml/kg/min
- VO2R= 19.4 ml/kg/min

- HOW MANY METS IS THIS EQUIVALENT TO?

5.54 METS

CONSIDERATIONS INVOLVED IN FORMULATING AN EXERCISE PRESCRIPTION BASED ON HEART RATE

EXERCISE MODALITY

Leg exercise will yield a higher HR compared with arm

A prescription based on lower body measurements will be an **OVERESTIMATION!**

If swimming is used an adjustment of 13 bpm must be made.

Ex. If you want to prescribe swimming for a 30 yr old at 70% of HR select a swimming speed corresponding to a heart rate of 123bpm . [(.70) x (210 – (0.5 x 30)]

.70 x 195 = 136bpm – 13 = 123

Cardiorespiratory Endurance: REVERSIBILITY

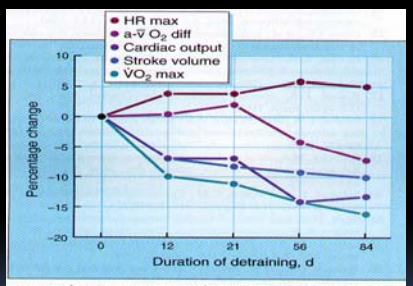
- Def: Loss of exercise training adaptations due to inactivity
- Less fit achieve gains faster and to a greater degree than more fit
- Alterations in body comp, BP, lipid profile may take a variable amount of time

CR: Reversibility

Initial decline in VO2

is related to reduced

SV and later to a reduced avo2diff.



Average changes in maximum heart rate (HRmax), stroke volume, arteriovenous oxygen differences (a-v̄ O_2 diff), cardiac output, and $\dot{V}O_2$max over 84 days of detraining.

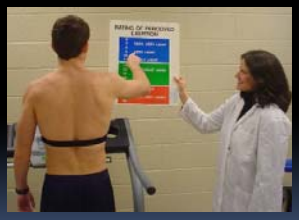
Coyle EF et al. Time course of loss of adaptations after stopping prolonged intense endurance training. J Appl Physiol 57;1857-1864. 1984

Reversibility Concepts

- CR conditioning can be maintained with reduced levels of activity Vs. complete rest
- The more fit the individual becomes the greater the loss of fitness
- All individuals are prone to de-conditioning
- Sedentary lifestyle compounds the problem that naturally occurs with aging

USING THE CHARTS

- Ratings of perceived exertion (Borg Scale)
- Dyspnea scale
- Claudication scale



6 - 20% effort

7 - 30% effort - Very, very light (Rest)

8 - 40% effort

9 - 50% effort - Very light - gentle walking

10 - 55% effort

11 - 60% effort - Fairly light

12 - 65% effort

13 - 70% effort - Somewhat hard - steady pace

14 - 75% effort

15 - 80% effort - Hard

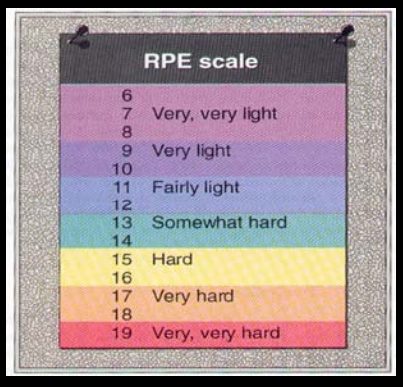
16 - 85% effort

17 - 90% effort - Very hard

18 - 95% effort

19 - 100% effort - Very, very hard

20 - Exhaustion



EXERCISE PRESCRIPTION BY RPE

Using a 6-20 scale

- A rating of 12-13 corresponds to approximately 60%-70% of the target heart rate range.
- A rating of 16 corresponds to approximately 85% of the target heart rate range
- "Somewhat Hard" level

10-Point Scale

CHOOSE AN RPE CORRESPONDING TO THE INDIVIDUALS LEVEL OF EXERTION.

DO NOT EXPECT AN EXACT MATCHING OF THE RPE TO %HRR

USE RPE AS A GENERAL GUIDELINE IN SETTING INTENSITY

- 0 - Nothing at all
- 1 - Very light
- 2 - Fairly light
- 3 - Moderate
- 4 - Some what hard
- 5 - Hard
- 6
- 7 - Very hard
- 8
- 9
- 10 - Very, very hard

Time

- Moderate intensity 30 min/d in bouts of at least 10 minutes
  20 min/d for vigorous intensity activities.
- Total exercise volume: at least 500 to 1,000 MET-minutes a week.
- Exercise volume is the product of the intensity, duration, and frequency of the physical activity, and these can be manipulated to individualize the exercise prescription.
- Volumes of less than 500-1000 MET-minutes a week have some positive effects, especially in inactive and de-conditioned persons.
- For adults with weight concerns, volumes of exercise greater than 1,000 MET-minutes a week may be needed to prevent weight gain, to promote weight loss, and to maintain weight loss
- Pedometers provide a surrogate measure of exercise volume, and 7,000-10,000 pedometer steps per day attained by purposeful walking or jogging are recommended.

Estimating the Caloric Cost of the Activity

Net caloric cost (kcal/min) =
(MET's-1MET) x 3.5 x body weight in kg/200
Subtract resting rate (1met)

A 60kg woman is exercising at an intensity of 7 MET's five times per week. Calculate her net caloric cost.

NCC = 7MET's x 3.5 x 60 kg / 200
= 6 MET's x 3.5 x 60kg / 200
= 6.3 kcal/min

If she is performing 30 minutes of this exercise what is her NCC each session? Each week?

Exercise Volume and Adverse Events

- **Large volumes of exercise - associated with an increasing risk of musculoskeletal injury.**
- **Exercise can increase the risk of adverse cardiovascular events in individuals at high risk for heart disease**
- **Participation in contact or collision sports, such as soccer or football, has a higher risk of injury than participation in non-contact physical activity, such as swimming or walking**
- **When performing the same activity, people who are less fit are more likely to be injured than people who are fitter.**
- **Risks can be minimized by maintaining a regular exercise habit within target volumes, engaging in moderate intensity cardiorespiratory exercise such as brisk walking, employing a gradual progression of exercise intensity, and reducing environmental hazards.**

Duration in Minutes Per Week

- The 2008 *Physical Activity Guidelines for Americans* uses a slightly different approach than ACSM and recommends that duration be measured in minutes per week.
- There is insufficient scientific evidence to determine whether the health benefits of 30 minutes on 5 days a week are any different from the health benefits of 50 minutes on 3 days a week. As a result, the *2008 Physical Activity Guidelines* allow a person to accumulate 150 minutes a week in various ways.
- When adults do the equivalent of 150 minutes of moderate-intensity aerobic activity each week, the health and disease prevention benefits are substantial, but additional benefits accrue as a person moves from 150 toward 300 minutes a week. The benefits continue to increase when a person does more than the equivalent of 300 minutes a week of moderate-intensity aerobic activity.
- The *2008 Physical Activity Guidelines* emphasize that many adults will need to do more than 150 to 300 minutes a week of moderate-intensity aerobic physical activity to lose weight or keep it off. Combined with restricting caloric intake, overweight adults should gradually increase minutes or the intensity of aerobic physical activity per week, to the point at which the physical activity is effective in achieving a healthy weight.

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Mode of Exercise

- Activity modest should be selected on the basis of individual functional capacity, interests, time availability, equipment and facilities, and personal goals and objectives.
- See Table 6.6 for a rating of cardiorespiratory exercises, using a "total" fitness emphasis.

Types and Intensities of Aerobic Physical Activities

Moderate Intensity
• Walking briskly (3 miles per hour or faster, but not race-walking)
• Water aerobics
• Bicycling slower than 10 miles per hour
• Tennis (doubles)
• Ballroom dancing
• General gardening
Vigorous Intensity
• Racewalking, jogging, or running
• Swimming laps
• Tennis (singles)
• Aerobic dancing
• Bicycling 10 miles per hour or faster
• Jumping rope
• Heavy gardening (continuous digging or hoeing, with heart rate increases)
• Hiking uphill or with a heavy backpack

Note: This table provides several examples of activities classified as moderate-intensity or vigorous-intensity, based on absolute intensity. This list is not all-inclusive. Instead, the examples are meant to help people make choices.

Source: U.S. Department of Health and Human Services. 2008 Physical Activity Guidelines for Americans. ODPHP Publication No. U0036, October, 2008. www.health.gov/paguidelines.

Rate of Progression

- During the initial phase of the exercise program, an increase in exercise duration per session of 5-10 min every 1-2 wks over the first 4-6 wks of an exercise training program is reasonable for the average adult.
- After the individual has been exercising regularly for ≥1 month, the frequency, intensity, and/or time of exercise can be gradually adjusted upward over the next 4-8 months to meet the recommended quantity and quality of exercise.
- This process may take longer for older adults and very deconditioned persons.
- Any progression in the exercise prescription should be made gradually.

Supervision

- ACSM recommends that individuals with a low aerobic capacity (<7 METS) who also have or are at high risk of CVD, or who have a chronic disease or health condition that may be exacerbated by exercise, should be supervised by a well-trained clinical exercise professional.
- These include the ACSM Registered Clinical Exercise Physiologist® (RCEP) or ACSM Certified Clinical Exercise Specialist® (CES).
- These individuals should continue to be supervised until exercise can be performed safely without supervision.
- Individuals with a functional capacity of 7 METS and higher who have a moderate CVD risk (see Chapter 2) or those at high risk but with stable disease and a regular habit of exercise can be supervised by a professional such as the ACSM Certified Health Fitness Specialist® (HFS) or RCEP and ES.

Warm-Down (Cool-Down)

- Purpose: to slowly decrease the pulse rate and body temperature in the transition from exercise to rest.
- Physiologic rationale:
  - Promotes faster recovery from exercise fatigue and blood/muscle lactic acid.
  - Leg muscle pumps promotes venous return.
  - Cardiac irregularities in high risk subjects often occur during the post-exercise period; moving may help.

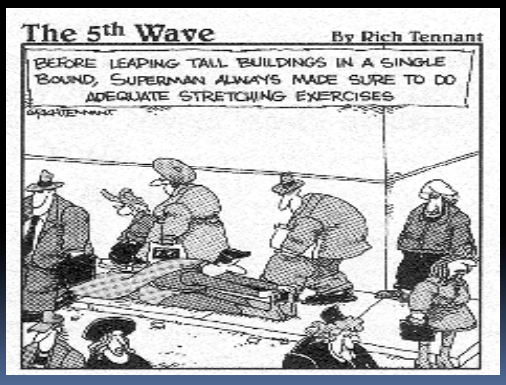
Guidelines for severely de-conditioned or bed rest individuals

- Emphasize strength training of back and lower limb postural muscles
  - Back extensors, quads, hip extensors, ankle flexors
- Start with low-intensity training
- Use gradual progressive overload
- Be aware of increased risk of bone fracture
- Incorporate training for postural stability and dynamic balance

Reversibility

- Maximal adaptations in skeletal muscle strength and endurance can be expected within 8-12 wks
- Anticipated improvement in strength is 25-30%
- Complete loss of training adaptations will occur after several wks or months of inactivity

WHAT ABOUT FLEXIBILITY?



GUIDELINES FOR STRETCHING AND FLEXIBILITY

• Frequency:	At least 3 days per week
• Intensity:	To a position of mild discomfort
• Duration:	10 to 30 seconds for each stretch
• Repetitions:	3 to 5 for each stretch
• Type:	Static, with a major emphasis on the lower back and thigh area

Specificity

- Flexibility and joint range of motion (ROM) are specific to the joint
- Flexibility is determined by the joint structure and the surrounding muscles and tendons and the use of that joint for activities
- A joint that is used during daily activities especially if it requires ROM will demonstrate good flexibility

Reversibility

- Very little exists on rate of loss of ROM
- Factors involved in the rate of loss of ROM include injury, specific individual physiology, degree of overall inactivity and posture
- If you re-introduce the training routine rapid improvements in ROM will occur