EXERCISE PRESCRIPTION

M.M. Hadavi

Sports medicine specialist, ICCPR CRFC

Cardiovascular Research Institute

Isfahan University of Medical Sciences

IASEM

Iranian Association of Sport and Exercise Medicine

انجمن علمی پزشکی ورزشی ایران

Definitions

- **Physical activity** :

  Bodily movement that is produced by the **contraction of skeletal muscle** and that substantially increases **energy expenditure**

- **Exercise**:

  A type of physical activity, is defined as **planned, structured, and repetitive** bodily movement done to improve or maintain one or more components of **physical fitness**.

Sports

- **Activities require specific skilled movements performed during organized game situations.**

Exercise prescription

- A written direction for the proper volume (amount) and intensity of exercise to cause desired improvements in fitness, and to maintain a certain fitness level once it has been achieved.

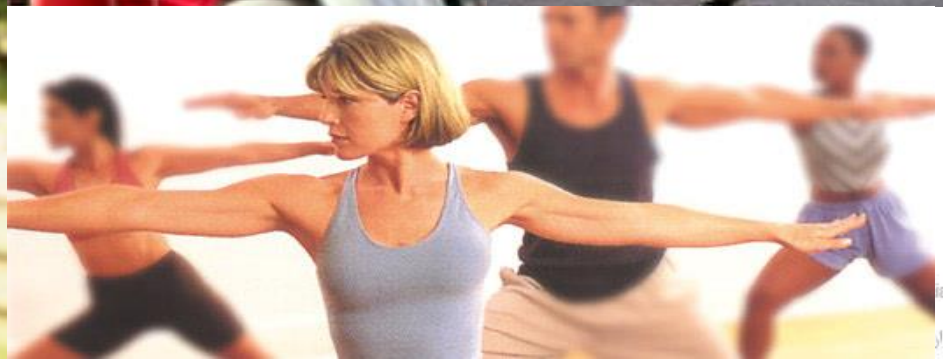
The Art of Exercise Prescription

- **A fundamental objective of exercise prescription is to bring about a change in personal health behavior to include habitual physical activity. Thus, the most appropriate exercise prescription for a particular individual is the one that is most helpful in achieving this behavioral change.**

Exercise testing before exercise program

- **Men >45 Women > 55**
- **High risk persons(two or more major risk factors or one or more signs or symptoms of CHD)**
- **Persons with cardiac , pulmonary or metabolic disease**
- **Vigorous exercise (>60% VO2 max)**

Endurance exercises



The FITT Principle

- **F** = Frequency (How often?)
- **I** = Intensity (How hard?)
- **T** = Time (How long?)
- **T** = Type (What?)

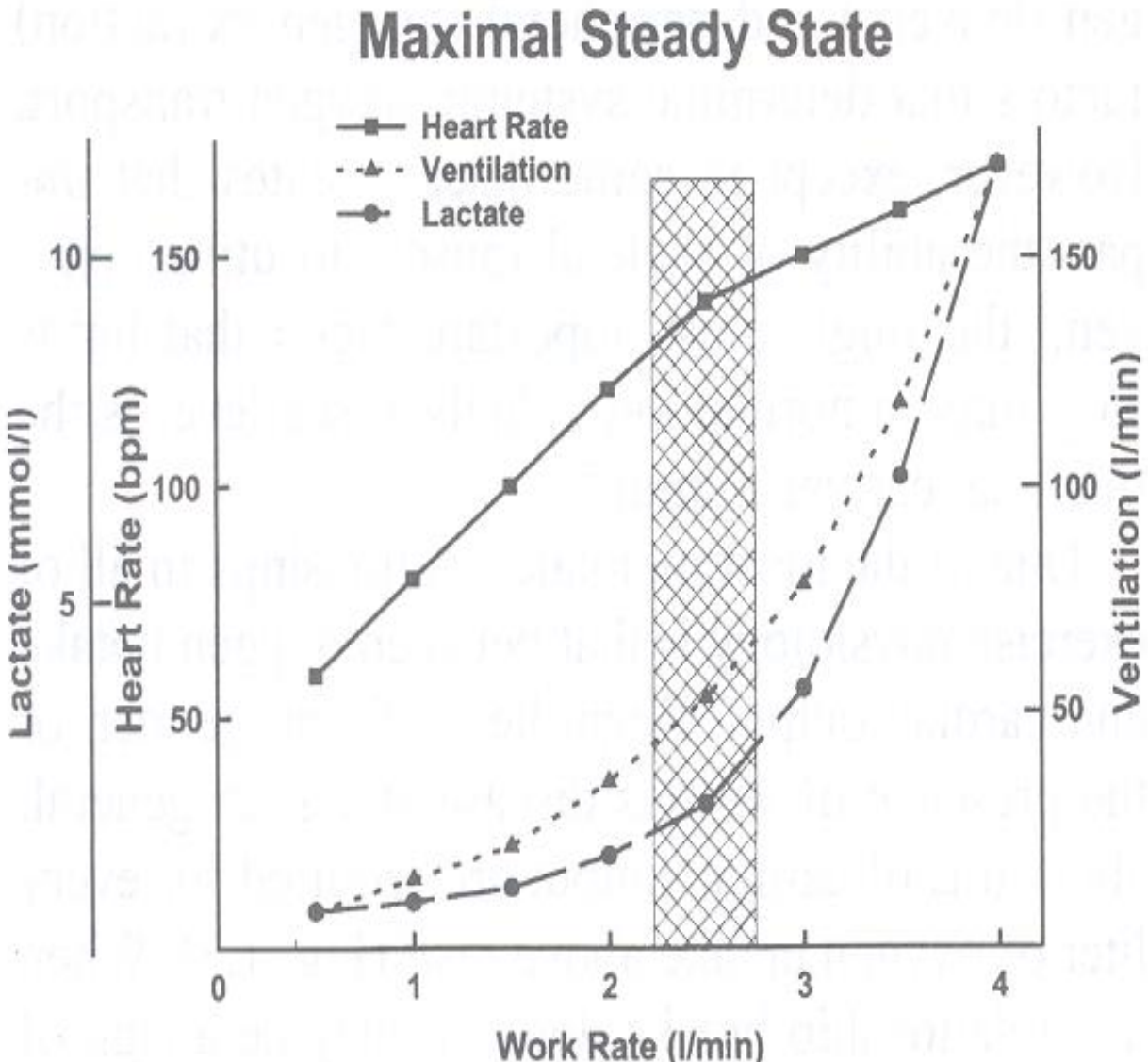
Frequency

- The frequency (number of times per week) that the exercise program should be carried out is 3 –5 times (days) per week.
- Exercising less than three times per week may not provide any fitness benefit.
- Exercising more than five times per week has little additional benefit compared to exercising five times per week and it increases the risk of overuse injuries.

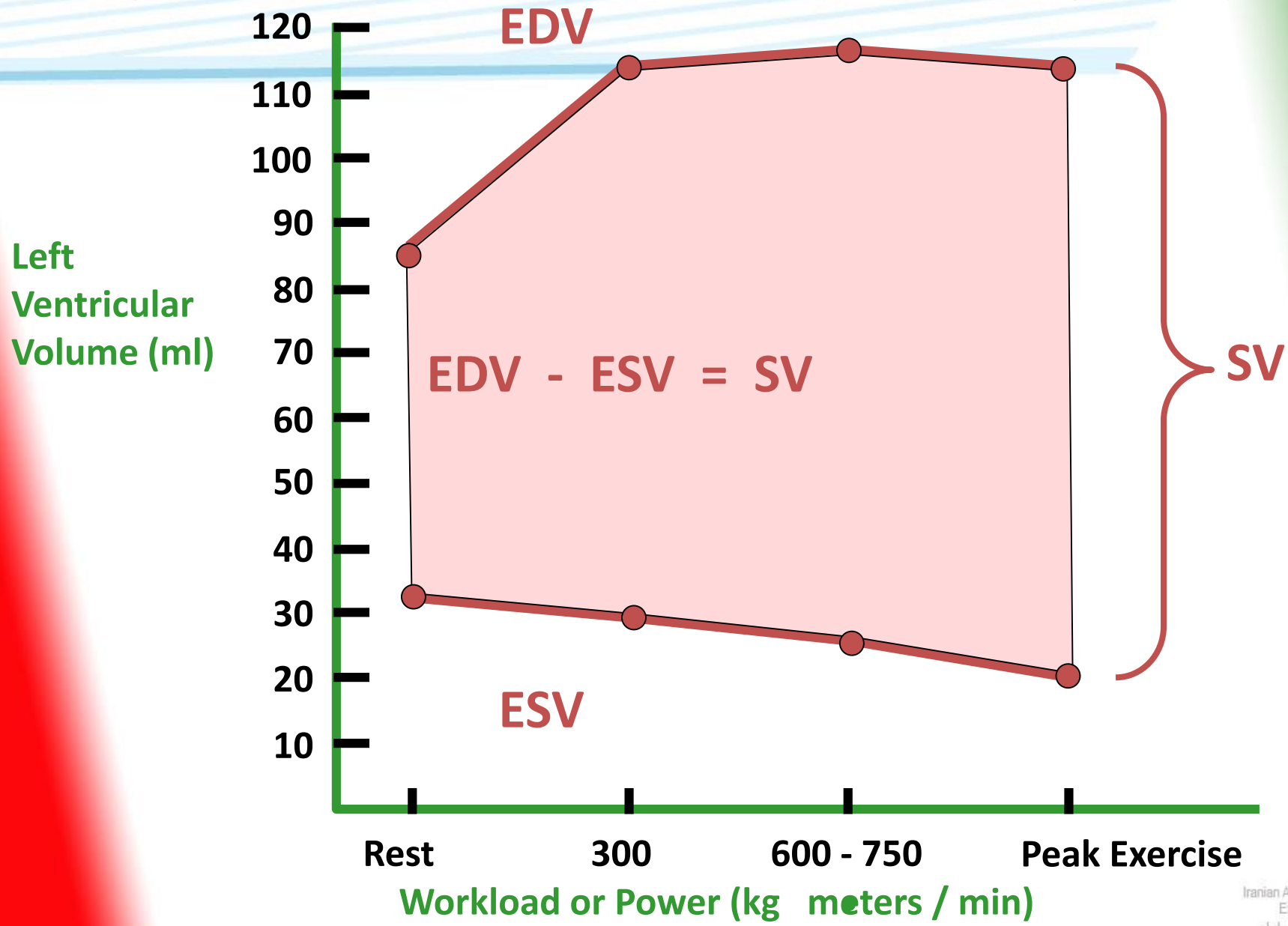
Intensity

- Maximal oxygen uptake (VO2 max)
- VO2 Reserve
- Maximal heart rate (MHR)
- Target Heart Rate Range (THRR)
- Rating of Perceived Exertion (RPE)
- The Talk Test

Heart rate



Changes in Left Ventricular Volumes with Exercise of Increasing Intensity



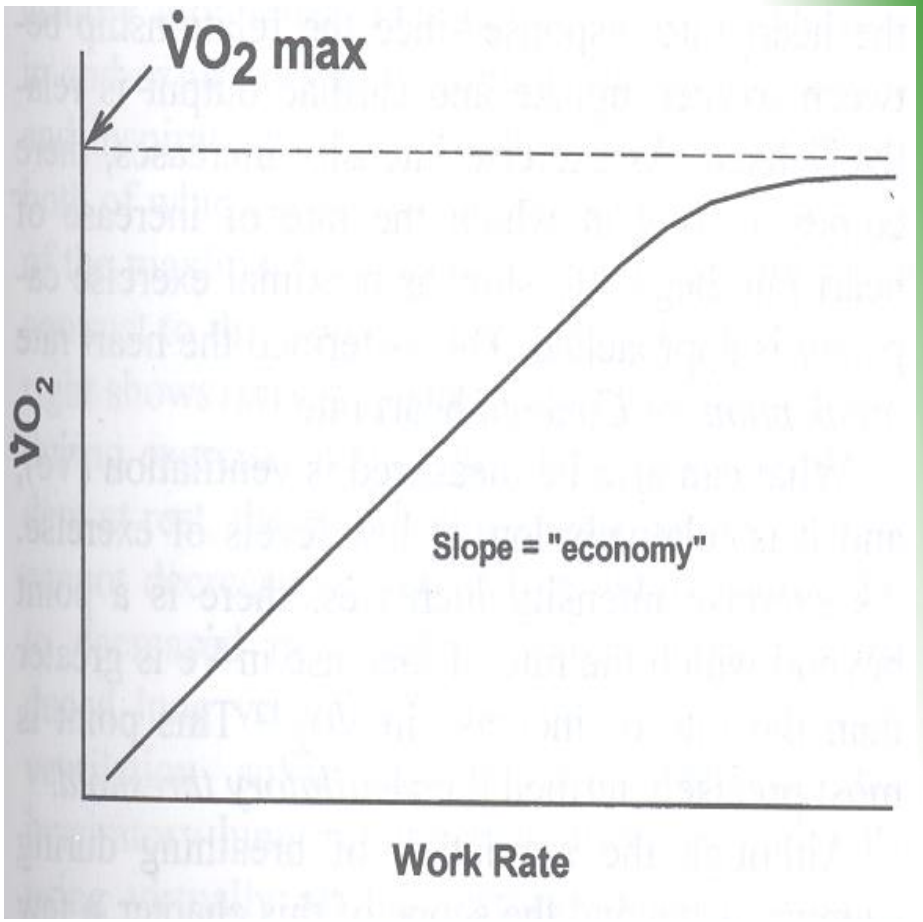
Definitions

- **Cardiac Output: (Q)** = HR X SV
- **Oxygen Consumption (VO_2)** - the rate at which oxygen can be used in energy production and metabolism
  - "absolute" measures: L O_2 / min , ml O_2 / min
  - "relative" measures: ml O_2 / kg body wt. / min
  - Fick equation: **$VO_2 = Q \times AVO_2D$**
- **Maximum Oxygen Consumption (VO_{2max})** maximum rate at which a person can take in and utilize oxygen to create usable energy
  - defined as plateau of consumption rate increase
  - often estimated with VO_{2peak}

VO2 max

- VO2max below 20% for age and gender is associated with increase risk of death from all causes.

- With exercise training VO2max can be increased between 15%-30%.



VO2 max

- Open-circuit spirometery is used to measure VO2max.
- Because of the costs associated with these tests, direct measurement of VO2max generally is reserved for max research or clinical settings.
- When direct measurement of VO2max is not feasible or desirable, a variety of submaximal and maximal exercise and tests can be used to estimate VO2max.

VO2 max

- % VO2 max is a way to determine the exercise intensity.
- ACSM recommends % VO2 Reserve (% VO2 R) as the best and most accurate measure of exercise intensity VO2 R is the difference between VO2 max and resting O2 consumption.
- Since most people do not have access to a laboratory where they can have their VO2max measured, exercise is generally prescribed on the basis of heart rate reserve.

Target Heart Rate Range (THRR)

karvonen equation

1)Estimate your maximal heart rate (MHR).

MHR = 220 –age or 208 -(0.7 ×age)

2)Determine your resting heart rate (RHR).

3)Determine the heart rate reserve (HRR).

HRR = MHR –RHR

4)THR 50% = (.50 × HRR) + RHR

THR 85% = (.85 × HRR) + RHR

Example

- A 50 year old patient with rest HR of 80 wants to exercise with intensity of 40% - 60% THR :
- So…
- MHR = 220 – 50 = 170
- Resting HR : 80
- RHR = 170 – 80 = 90
- THR = 40% (90) + 80 = 36+80=116
- THR = 60% (90) + 80 = 54+80=134

NOTE

- ***THRR should be recalculated after several weeks of training*. As the fitness improves, resting heart rate often will become lower . Therefore, THRR should be recalculated using new resting heart rate.**

- **It is best to increase the exercise time first, then the intensity when applying the principle of progression.**

- **In patients on beta blockers the use of heart rate to guide exercise intensity would be inappropriate and other methods to prescribe intensity need consideration.**

Rating of Perceived Exertion (RPE) (Borg Scale)

- The RPE is a subjective way to determine your exercise intensity.
- The average RPE range associated with physiologic adaptation to exercise is 12-16(somewhat hard to hard)

Rating	Intensity
6	No exertion at all
7	
8	Extremely light
9	
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Rating of Perceived Exertion (RPE)

- When exercising, your effort level should be between 2 (weak/light) to 5 (strong/heavy). This rating matches very well with a THRR of 50% to 85% of HRR.

Borg Rating of Perceived Exertion	
0	Nothing At All
0.5	Very, Very Light (Just noticeable)
1	Very Light
2	Light (Weak)
3	Moderate
4	Somewhat Hard
5	Heavy (Strong)
6	
7	Very Heavy
8	
9	
10	Very, Very Heavy (Maximal)

The Talk Test

- While exercising at an appropriate intensity, you should be able to carry on a conversation with someone without gasping for air every other word or two.
- If it is difficult to do this, your exercise intensity is likely too high, therefore you need to slow down the pace. Keep this in mind while exercising.

- **Prescribe intensities between 55% and 90% of maximal heart rate or between 40% and 85% of the or heart rate reserve (HRR) and or 3-8.8 METs.**

- **40%-50% for very low initial fitness levels.**

- **ACSM recommends a target range of 150 to 400 kcal of energy expenditure per day in physical activity and/or exercise .**

METS

- A MET is the unit equal to resting metabolic rate and is approximately 3.5 ml oxygen per kg body weight.

- Walking 5.5 km/hr, level surface = 4.0 MET
- Cycling < 16 km/hr, leisurely =4.0 MET
- Running 8 km/hr = 8.7 MET
- Swimming, leisurely = 6.0 MET
- Swimming, crawl fast = 10.0 MET

Caloric expenditure

- A 70 kg patient jogging at a rate of 8km/hr (MET = 8.7) for 20 minutes per day, three times per week
- Caloric expenditure
- (8.7 ×3.5 ×70)/200 = 10.7 kcal/min
- 10.7 kcal ×20 min = 214 kcal per
- exercise session
- 214 ×3 = 642 kcal per week

TABLE 7.1. Methods of Estimating Intensity of Cardiorespiratory and Resistance Exercise

	Cardiorespiratory Endurance Exercise											Resistance Exercise
	Relative Intensity				Intensity (%$\dot{V}O_{2max}$) Relative to Maximal Exercise Capacity in MET			Absolute Intensity	Absolute Intensity (MET) by Age			Relative Intensity
Intensity	%HRR or %$\dot{V}O_2R$	%HR_{max}	%$\dot{V}O_{2max}$	Perceived Exertion (Rating on 6–20 RPE Scale)	20 METs %$\dot{V}O_{2max}$	10 METs %$\dot{V}O_{2max}$	5 METs %$\dot{V}O_{2max}$	MET	Young (20–39 yr)	Middle Age (40–64 yr)	Older (≥65 yr)	% One Repetition Maximum
Very light	<30	<57	<37	Very light (RPE ≤9)	<34	<37	<44	<2	<2.4	<2.0	<1.6	<30
Light	30–<40	57–<64	37–<45	Very light to fairly light (RPE 9–11)	34–<43	37–<46	44–<52	2.0–<3	<4.8	<4.0	<3.2	30–<50
Moderate	40–<60	64–<76	46–<64	Fairly light to somewhat hard (RPE 12–13)	43–<62	46–<64	52–<68	3.0–<6	4.8–<7.2	4.0–<6.0	3.2–<4.8	50–<70
Vigorous	60–<90	76–<96	64–<91	Somewhat hard to very hard (RPE 14–17)	62–<91	64–<91	68–<92	6.0–<8.8	7.2–<10.2	6.0–<8.5	4.8–<6.8	70–<85
Near maximal to maximal	≥90	≥96	≥91	≥ Very hard (RPE ≥18)	≥91	≥91	≥92	≥8.8	≥10.2	≥8.5	≥6.8	≥85

HR_{max}, maximal heart rate; HRR, heart rate reserve; MET, metabolic equivalent; RPE, rating of perceived exertion; $\dot{V}O_{2max}$, maximum oxygen consumption; $\dot{V}O_2R$, oxygen uptake reserve.

Adapted from (20).

Time

- ACSM recommends 20 to 60 min. of continuous or intermittent (minimum of 10 min. bouts) aerobic activity accumulated throughout the day.
- Lower intensity exercise (50% of HRR; rating of 2 on the RPE scale) should be carried out for a minimum of 30 minutes per exercise session to achieve fitness benefits, while higher intensity exercise (70% of HRR; rating of 4 on the RPE scale) can achieve fitness benefits with only 20 minutes per session.

Type

- The ACSM recommends that the mode of activity should use large muscle groups, maintain a continuous pace, and be rhythmical and aerobic in nature (eg , walking, , jogging, running, cycling, cross country skiing, rowing, swimming, skating, combined arm and leg ergometery , aerobic dance, or machine-based stair climbing).

Grouping of Cardiorespiratory Endurance Activities

- **Group 1 : Can be readily maintained at a constant intensity and interindividual variation in energy expenditure is relatively low. Desirable for more precise control of exercise intensity, as in the early stages of a rehabilitation programe.**
- **Examples: Walking and cycling, especially treadmill and cycle ergometry.**

Grouping of Cardiorespiratory Endurance Activities

- **Group 2 : The rate of energy expenditure is highly related to skill, but for a given individual can provide a constant intensity. Such activities may also be useful in early stages of conditioning, but individual skill levels must be considered.**
- **Examples: Swimming and cross-country skiing.**

Grouping of Cardiorespiratory Endurance Activities

- **Group 3 : Both skill and intensity of exercise are highly variable. Must be cautiously employed for high-risk, low-fit, and/or symptomatic individuals. Competitive factors must also be considered and minimized.**
- **Examples: Racquet sports and basketball.**

The Exercise Program

- **Warm-up (~ 10 min)**
- **Stimulus or endurance phase (20-60 min)**
- **Recreational activities (optional)**
- **Cool down (~ 5-10 min)**

Basic Principles

- principles of proper exercise are :
- Overload
- Progression
- Specificity
- Reversibility

OVERLOAD

- In order to make improvements in fitness, you must make your body physically work at a level beyond what it is accustomed to.
- Three factors can be manipulated to induce exercise overload: frequency, intensity, and time (duration).

PROGRESSION

- Overload principle should be implemented gradually in an exercise program.
- In other words, do not do too much too soon and too fast.
- This principle, if followed, will minimize setbacks in the exercise program such as muscle soreness, tendon injury, and joint injury (ankles, knees, back, etc.)

NOTE:

- Always increase the time first when increasing the overload, and then increase the intensity.
- A person just starting a jogging program who is jogging 15 minutes per session should increase the time gradually over several days or weeks to 30 minutes before trying to increase the speed.

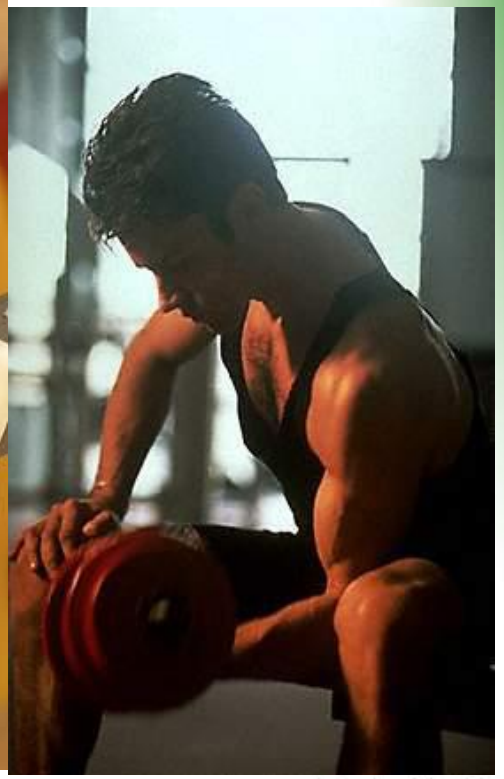
SPECIFICITY

- Fitness improvements that are achieved are specific to the type of exercise that is performed and to the specific muscles that are being exercised.
- Jogging, walking, biking, and swimming are modes of exercise that will improve aerobic fitness, whereas muscular strength training will not significantly improve aerobic fitness.
- Also, fitness improvements will be greatest in the activities that are consistently used for the exercise program.

REVERSIBILITY

- **Fitness improvements that are achieved will quickly be lost if the exercise program is stopped for an extended period of time. This is a good example of the saying “ use it or lose it. “**

Resistance exercises



GOALS FOR A HEALTH-RELATED RESISTANCE TRAINING

- Make activities of daily living (ADL) *(e.g.,* stair climbing, carrying bags of groceries)

- Effectively manage , attenuate, and even prevent chronic diseases and health conditions such as osteoporosis, Type 2 diabetes mellitus, and obesity.

- *For these reasons, although resistance training* is *important across the age span, its importance becomes even greater with age*

Elements of a Resistance Exercise Program

- ***Intensity:*** **the exercise load (level of resistance)**
- **Volume: number of repetitions and sets; number of exercises per session**
- ***Frequency:*** **the number of exercise sessions per day or per week**
- ***Rest interval:*** **time allotted for recuperation between sets and sessions of exercise**
- ***Duration:*** **total time frame of *a* resistance training program**
- ***Mode* of exercise :type of muscle contraction, position of the patient, application of resistance,**

Repetition Maximum

- **One method of documenting the effectiveness of a resistance exercise program and calculating an appropriate exercise load is to determine a repetition maximum.**

- **This method was developed by DeLorme.**

- **A repetition maximum (RM) is the greatest amount of weight (load) a muscle can move through the available ROM a specific number of times.**

Repetition Maximum

- **A repetition maximum can be used in a number of ways.**
- **DeLorme reported determination of a 1RM (the greatest amount of weight a subject could lift through the full ROM just one time) as a useful baseline measurement of a subject's maximum effort.**

1RM; problems

- Is not safe for patients, for example, with joint impairments, patients who are recovering from or who are at risk for soft tissue injury, or patients with known or who are at risk for osteoporosis or cardiovascular pathology.
- Determination of a 1 RM for a particular muscle group involves a lot of trial and error and, therefore, may not be accurate if the patient fatigues before the 1 RM is identified.
- Some patients may not understand or may be apprehensive about exerting one maximum effort

Two Practical Ways

1) The higher RM value can be used as the baseline. If the patient was able to lift the selected weight 10 times, then the baseline measurement for future comparisons is a 10 RM.

2) 1 RM can be calculated from a conversion table.

Volume

- In resistance training the volume of exercise is the summation of the total number of repetitions and sets of a particular exercise during a single exercise session

- There is an inverse relationship between the volume and intensity of resistance exercise. The higher the intensity (load), the lower the volume must be, and the converse is true.

To *Improve Muscle Endurance*

- Training to improve local endurance involves performing many repetitions of an exercise against a sub maximal load. For example, as many as three to five sets of 40 to 50 or more repetitions against a light grade of elastic resistance might be used.
- Endurance training, because it is performed against very low levels of resistance, can and should be initiated very early in a rehabilitation program without risk of injury to healing tissues.

Duration

- Exercise duration is the total number of weeks or months during which a resistance exercise program is carried out.
- Strength gains, observed early in a resistance training program (after 2 to 3 weeks) are the result of neural adaptations. For significant changes to occur in muscle, such as hypertrophy or increased vascularization, at least 6 to 12 weeks of resistance training is required.

Rest Interval (Recovery Period)

- Rest intervals for each exercising muscle group are dependent on the intensity and volume of exercise. For example, between sets of moderate intensity and volume exercise (at an 8-to 12-RM level), a 30-to 60-second rest period is common. With higher intensity, near-maximal loading (at a 3-to 5-RM level), a longer rest period before performing another set of the same exercise is necessary.

Resistance exercises

- MODE : all major muscle groups 8 –10 exercises
- NUMBER OF SETS : 1
- REPETITION PER SET : 10 –15
- FREQUENCY : 2 days per week
- TIME : 10 –20 min

Flexibility Training

- Flexibility training can be included as part of the warm-up or cool-down, or undertaken at a separate time.

Flexibility training

- **Type**: A general stretching routine that exercises the major muscle and/or tendon groups using static or PNF techniques.
- **Frequency**: A minimum of 2-3 d/w
- **Intensity**: To a position of mild discomfort.
- **Duration**: 10-30 seconds
- **Repetitions**:3-4 for each stretch

NEUROMOTOR EXERCISE

- Neuromotor exercise training involves motor skills such as balance , coordination, gait, and agility, and proprioceptive training and is sometimes called ***functional fitness training***.
- Other multifaceted physical activities sometimes considered to be neuromotor exercise involve varying **combinations** of neuromotor exercise, resistance exercise, and flexibility exercise and include physical activities such as **tai ji (tai chi)**, **qigong**, and **yoga**.

NEUROMOTOR EXERCISE

- For older individuals, neuromotor exercise training results in improvements in balance , agility, and muscle strength, and reduces the risk of falls.

- There are few studies of the benefits of neuromotor training in younger adults.