

Resistance Exercise for Impaired Muscle Performance

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Definition

- ▶ Resistance exercise is any form of active exercise in which a dynamic or static muscular contraction is resisted by an outside force. It depend on:
- ▶ Strength
- ▶ Endurance
- ▶ Power

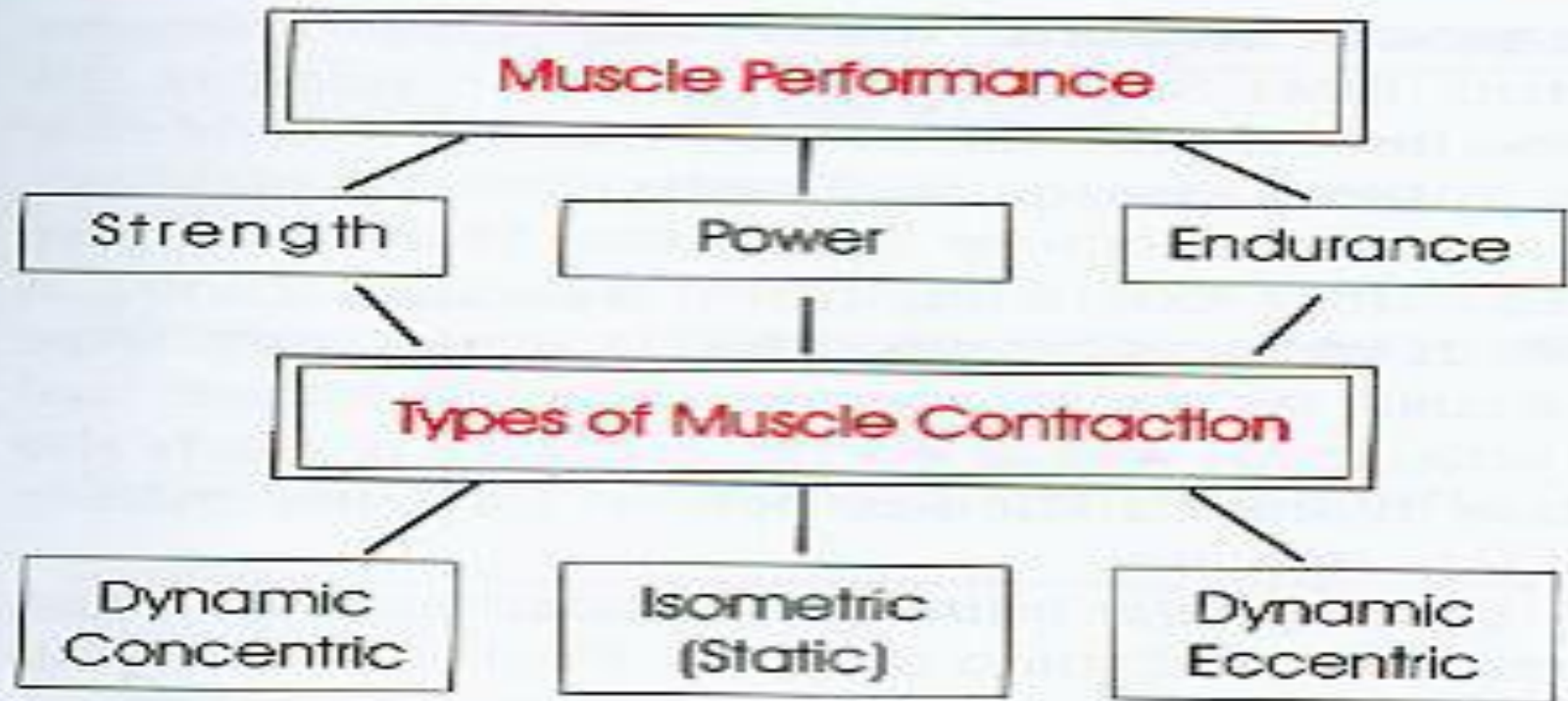


Figure 3-1 Types of muscle contractions: their relationships to muscle performance and their tension-generating capacities.

Purposes of resisted Ex.

► Increase Strength

Strength is the amount of tension a contracting muscle can produce.

Strength training has been shown to cause selective hypertrophy of type II muscle fibers.

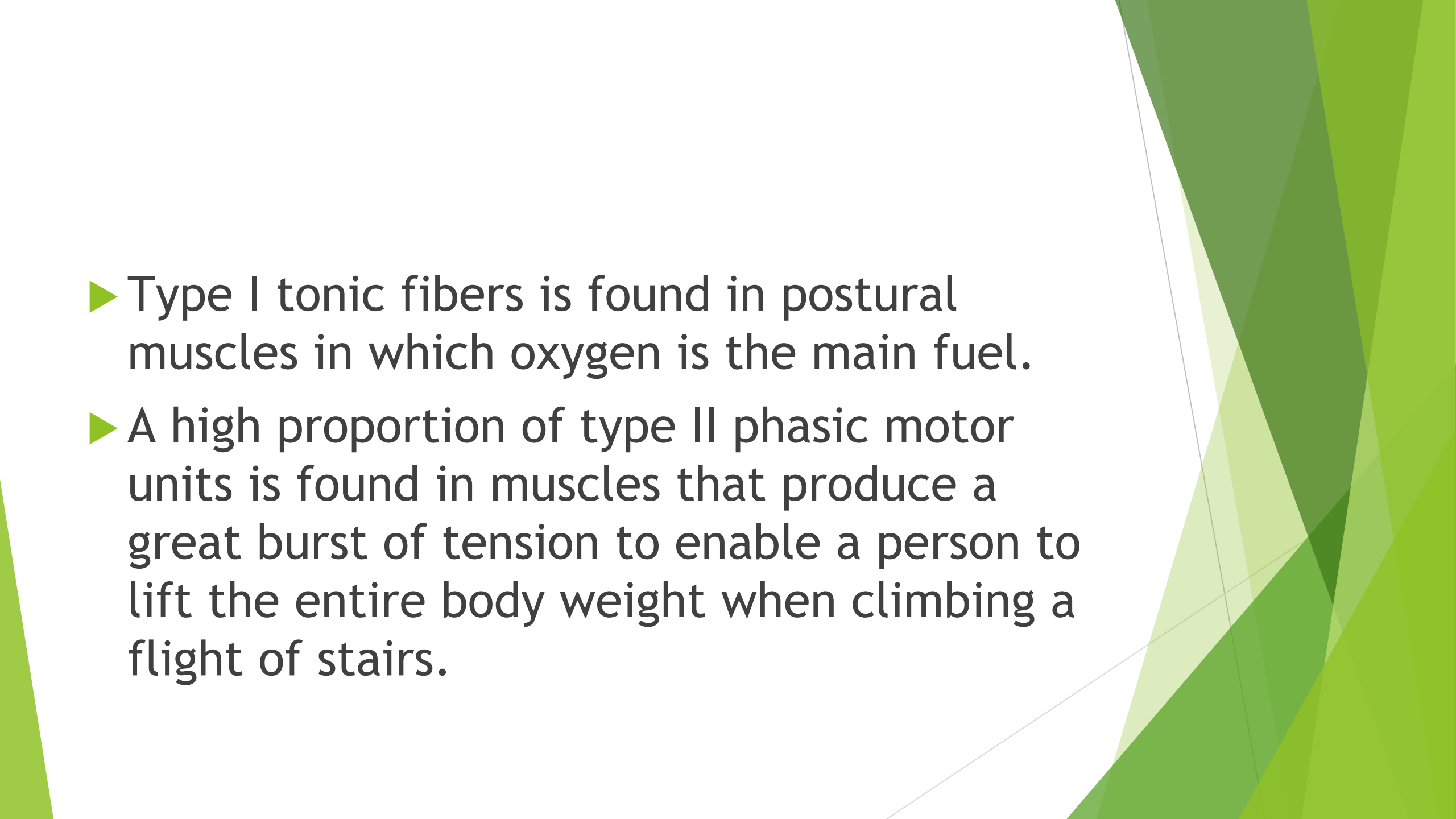
► Increase Muscular Endurance

Endurance is the ability to perform low-intensity repetitive exercise over a prolonged period of time.

Purposes cont.

▶ Increase Power

- ▶ Power is defined as work per unit of time (force \times distance/time).
- ▶ **Speed** and **force** are both factors that affect power.
- ▶ Type II (phasic fast- twitch) muscle fibers
- ▶ Type I (tonic, slow- twitch) muscle fibers

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- The background of the slide features abstract, overlapping green geometric shapes, primarily triangles and polygons, in various shades of green, creating a modern and dynamic visual effect.
- ▶ Type I tonic fibers is found in postural muscles in which oxygen is the main fuel.
 - ▶ A high proportion of type II phasic motor units is found in muscles that produce a great burst of tension to enable a person to lift the entire body weight when climbing a flight of stairs.

Muscle fibers hypertrophy

- ▶ Muscle fibers experience two specific types of hypertrophy.

1- Myofibrillar hypertrophy refers to the increase in size or thickness of individual actin and myosin protein filaments, which can improve the force-production capacity of individual fibers.

- ▶ Myofibrillar hypertrophy does not lead to larger muscles; rather, it results in thicker muscle fibers capable of generating more force.

Muscle fibers hypertrophy

- ▶ **Sarcoplasmic hypertrophy** is an increase in the volume of the semifluid interfibrillar substance surrounding an individual muscle fiber. This fluid contains the proteins used to promote tissue repair and growth.
- ▶ The muscle “pump” that bodybuilders work to achieve is actually sarcoplasmic hypertrophy—the cross-section of muscle fibers will increase, but most of the enhanced muscle size is due to an increased volume of the sarcoplasm and non-contractile proteins not directly involved with force production.

- ▶ Using light weights for high repetitions can improve the aerobic efficiency of type I fibers, but unless the exercise is performed to fatigue which occurs only after recruiting the type II fibers,
- ▶ it will not result in the desired goal of definition. However, if time is an issue (as it is for many people), using a heavier weight for fewer repetitions is an effective technique for stimulating growth and definition from the type II fibers.

- ▶ It is important to note that exercising with **higher repetition ranges** will result in muscle growth from sarcoplasmic hypertrophy, while **using heavier loads for fewer reps** induces **myofibrillar hypertrophy**, which increases strength without necessarily inducing significant gains in muscle growth.

Basic Principals Before Beginning a Program

□ Overload

- Use more resistance than your muscles are used to.
- Lift enough weight so that you only complete the desired number of reps.
- You should finish your last rep with difficulty (but still keeping good form).

□ Progression

- Avoid plateaus by increasing your intensity regularly.
 - Increase the amount of weight you use
 - Change the number of sets or repetitions
 - Change the exercises
 - Change the type of resistance (weekly/monthly)

- ▶ **Specificity (SAID principle)**
 - ▶ **Train to your goal(Specific adaptation to imposed demands)**
 - ▶ **Training for strength** - use higher weight and lower reps
 - ▶ **Training for weight loss** - use a variety of rep ranges to target different muscle fibers
- ▶ **Rest and Recovery**
 - ▶ Rest days are just as important as workout days
 - ▶ During rest days, muscles grow and change
 - ▶ Do not work same muscles two days in a row

Basic Training Principles

▶ **Reversibility principle**

- ▶ *Adaptive change in the body's systems, such as increased strength or endurance, in response to a resistance exercise program and lose it in response to detraining.

SAID principle

► **Specificity of training** is a widely accepted assumption, or even principle, that suggests that the adaptive effects of training, such as the improvement of strength, power, and endurance, tend to be highly specific to the training method employed.

► **Transfer of training**

Carryover of training effects, this phenomenon is called transfer of training, overflow, or cross training.

Cross-training

- ▶ **Cross-training** is athletic training in sports other than the athlete's usual sport. The goal is improving overall performance. It takes advantage of the particular effectiveness of one training method to deny the shortcomings of another.

The reversibility principle

- ▶ The **reversibility principle** is a concept that states when you stop working out, you lose the effects of training. It is sometimes referred to as the "**use it or lose it**" principle. This sounds like common sense, but the science behind the reversibility principle is more complex.
- ▶ **Moreover**, on the plus side, it states that when you resume working out, you begin to make gains again. While the reversibility principle is often perceived as a negative thing, exercise physiologists are discovering that it can be a positive thing as well.

Detraining and Loss

- ▶ The reversibility principle is sometimes called **detraining**. When athletes work out on a regular basis, they are said to be "**in training**." When athletes stop working out, for whatever reason, they are said to be "**in detraining**."

Using reversibility to train

- ▶ Some weightlifter may reach a plateau after a period of training where they can no longer improve,
- ▶ they take few weeks of rest and then return back and use overload principle to breakdown that plateau.

There are several reasons an athlete may quit working out and go into detraining:

- Illness
- Injury
- Lack of motivation
- Other time factors
- Prohibitive costs for certain sports
- Travel obligations
- Weather

What happen After athletes
stop their workout routines?

Enter into a detraining period,
reversibility occurs rather quickly.

Training loss occurs at
about one-third the
rate of the gains.



There is no exact rule
because everyone's body
is unique

The loss of various
physical skills can occur in
just one to two weeks.

Most athletes tend to lose **muscular endurance**
the most, followed by **muscular power**, and
finally followed by **muscular strength**.

Athletes also tend to lose their aerobic capacity, gained through sports such as running and cycling, more quickly than they lose muscle strength.

The reversibility principle (De training)

**1- Muscular
endurance**

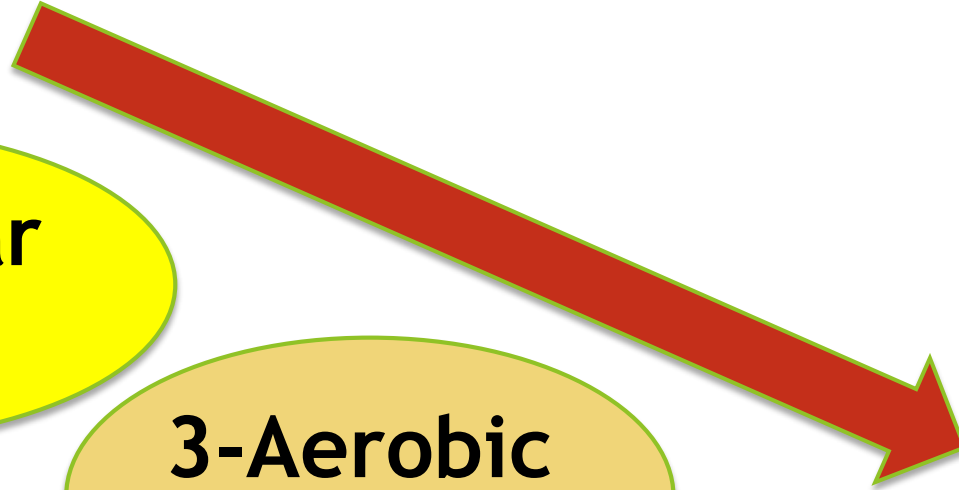
**2- Muscular
power**

**3- Aerobic
capacity**

**4- Muscular
strength.**

6- balance

5- flexibility



How quickly athletes lose their gains depends on several factors

- ▶ Age
- ▶ how fit the athlete is
- ▶ how long the athlete has been exercising
- ▶ what level the athlete was at in a particular exercise
- ▶ what type of exercise the athlete was doing.

Types of Resistance Exercise

► **Manual Resistance Exercise**

Manual resistance exercise is a type of active exercise in which resistance is provided by a therapist or other health professional.

► **Mechanical Resistance Exercise**

Mechanical resistance exercise is a form of active exercise in which resistance is applied through the use of equipment or mechanical apparatus.

Types of Muscle Contraction

- ▶ Isometric Exercise
- ▶ Isotonic Exercise
- ▶ Isokinetic exercise
- ▶ Eccentric Exercise
- ▶ Open kinematic chain
- ▶ Closed kinematic chain

Isometric Exercise

- ▶ Isometric exercise is a static form of exercise that occurs when a muscle contracts **without an appreciable change in the length of the muscle or without visible joint motion.**
- ▶ Muscle-setting exercise
 - **Muscle-setting exercises** are low-intensity, isometric exercises performed against little to no resistance.

Isometric Exercise

► Stabilization exercises

Stability is achieved by activating co-contraction, that is, the contraction of antagonist muscles that surround proximal joints.

1. Stabilization exercises are usually performed in weight-bearing postures in a closed kinematic chain.
2. Rhythmic stabilization and dynamic stabilization

Precautions with isometric exercise

- ▶ Isometric exercise, particularly when performed against substantial resistance for large muscle group, may be precluded or even contraindicated for patients with a **history of cardiovascular disease or cerebrovascular accident.**

Isotonic Exercise

- ▶ Isotonic resistance exercise is a dynamic form of exercise that is carried out against a constant or variable loads a muscle lengthens or shortens through the available range of motion.
- ▶ Manual or mechanical resistance
- ▶ Constant versus variable resistance
- ▶ Traditionally isotonic resistance exercise has been performed using a fixed load such as free weights.
- ▶ The term isotonic literally means same or constant tension
- ▶ Variable-resistance exercise

Isotonic Exercise(Concentric versus eccentric exercise)

- ▶ Isotonic resistance exercise can also be performed concentrically, eccentrically, or both.
- ▶ Resistance can be applied to a muscle as it shortens or lengthens.
- ▶ Depending on a patient's strength capabilities and functional needs.
- ▶ **A maximal concentric contraction produces less force than a maximal eccentric contraction.**

Isotonic Exercise(Concentric versus eccentric exercise)

- ▶ Greater numbers of motor units must be recruited to control the same load with a concentric contraction as compared with an eccentric contraction,
- ▶ suggesting that concentric exercise has less mechanical efficiency than eccentric exercise.

Isotonic Exercise(Concentric versus eccentric exercise)

- ▶ Isotonic strength training performed concentrically appears primarily to improve concentric muscle strength.
- ▶ The velocity at which concentric or eccentric exercise is performed directly affects the force-generating capacity of the neuromuscular unit.
- ▶ In a strength-training program, when heavy loads are lifted or lowered, isotonic exercises are usually performed at slow speeds to safely control momentum and minimize the possibility of injury.

Force-Velocity relationship

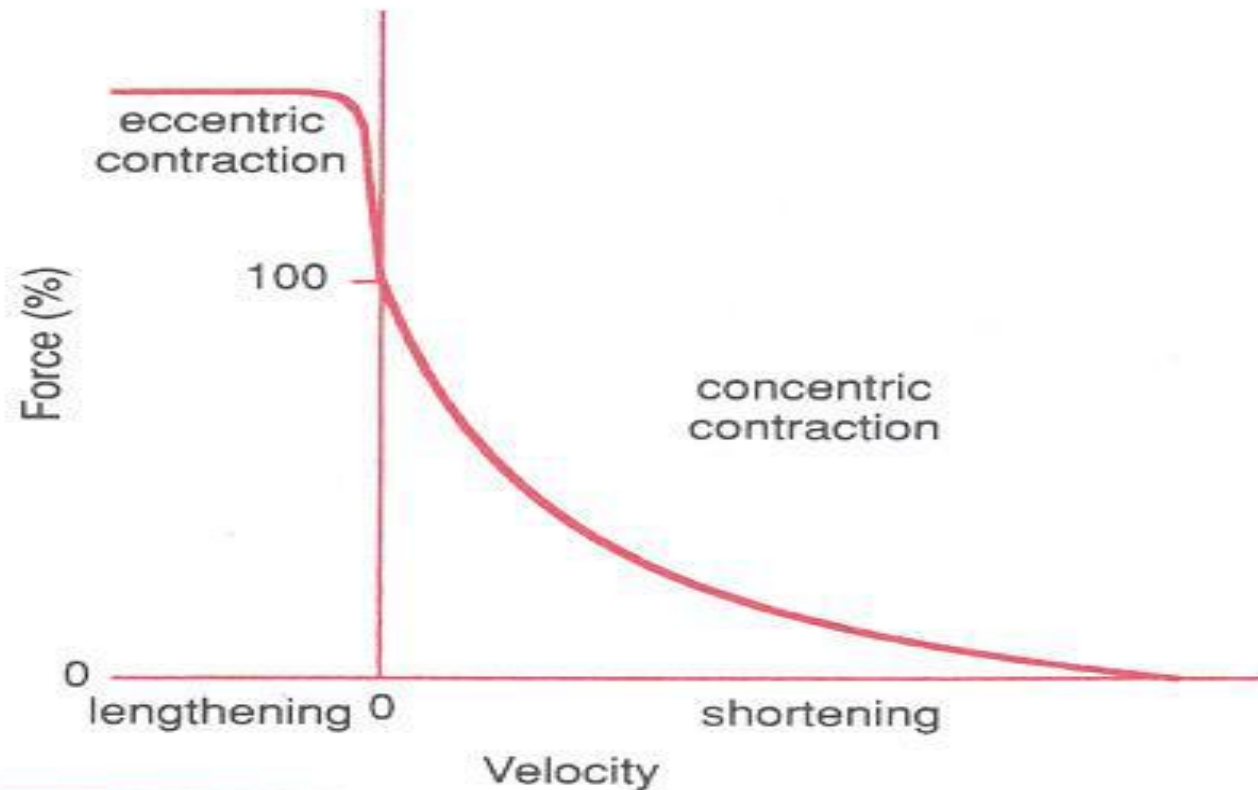


Figure 3–2 Force-velocity curve for concentric and eccentric exercise. (From Levangie, PK, and Norkin, CC: Joint Structure and Function—A Comprehensive Analysis, ed. 3. FA Davis, Philadelphia, 2001, p 97, with permission.)

Isokinetic exercise

- ▶ Isokinetic exercise is a form of dynamic exercise in which the velocity of muscle shortening or lengthening is controlled by a rate-limiting device that controls (limits) the speed of movement of a body part.
- ▶ The velocity of limb movement allowed is constant, the resistance, which the isokinetic exercise unit provides, will vary.
- ▶ Isokinetic exercise is sometimes referred to as accommodating resistance exercise.
- ▶ If the patient is well motivated and is performing with maximum effort, the muscle contracts and works maximally at all points in the range of motion.

The Biodex isokinetic dynamometer



Isokinetic exercise

- ▶ Isokinetic exercise programs can strengthen muscles more efficiently than isotonic exercise.
- ▶ Isokinetic training occurs in either a concentric or eccentric mode depending on the desired functional outcome.
- ▶ Speeds of exercise may range from a slow velocity (15 to 30 degrees per second) to a very fast velocity (over 300 to 400 degrees per second).
- ▶ Speed of an eccentric muscle contraction increases, the force-producing capabilities of the muscle also increase. **Training effects tend to be speed specific.**
- ▶ **Isokinetic exercise** has been shown to be an effective means of increasing muscle power and endurance in addition to strength.

Eccentric Exercise

- ▶ Eccentric exercise is a type of dynamic muscle loading where tension in the muscle develops and physical lengthening of the muscle occurs as an external force is applied to the muscle.
- ▶ As a patient begins to return to functional activities, high-speed eccentric exercise against substantial resistance in the form of stretch-shortening drills prepares a patient for high-intensity sports or work-related activities that require eccentric muscle control for deceleration or quick changes of direction during movement.

Eccentric Exercise

- ▶ Precautions for eccentric exercise
- ▶ There is potential for excessive stress on the cardiovascular system(i.e., increased heart rate and mean arterial pressure) due to a pressure response when eccentric exercise is performed with maximum effort.
- ▶ Delayed-onset muscle soreness (DOMS)has been reported to be more severe and last longer as the result of maximum-effort eccentric exercises compared to concentric exercise.

Open kinematics chain exercise

- ▶ Open-chain exercise refers to movement that occurs in an open kinematic chain, in which the distal segment (the foot or hand) moves freely in space.
- ▶ For example, open-chain movement occurs when the arm lifts or lowers a hand-held weight.
- ▶ Open-chain exercise alone will not adequately prepare a patient for functional weight-bearing activities such as walking, stair climbing, or jumping, which involve muscle action in a closed kinematic chain.

Closed kinematic chain exercise

- ▶ Closed-chain exercise refers to movement that occurs in a closed kinematic chain where the body moves over a fixed distal segment.
- ▶ For example, a closed-chain movement occurs in a weight-bearing position when the foot is planted on the ground and muscle action lifts or lowers the body as in stair-climbing or squatting activities.

Closed kinematic chain exercise

- ▶ Closed-chain activities are done in weight bearing, they stimulate certain mechanoreceptors in and around joints more effectively than open-chain exercises, thereby stimulating muscle co-contraction and adding to joint stability
- ▶ In addition to improve stability, balance, coordination, and quickness in functional, weight-bearing postures.

Manual resistance Exercise

- ▶ Definition
- ▶ Manual resistance exercise is a form of active resistance exercise in which the resistance force is applied by the therapist to either a dynamic or a static muscular contraction.
- ▶ Exercise is carried out in the anatomic planes of motion, in diagonal patterns known as proprioceptive neuromuscular facilitation (PNF) techniques, or in combined patterns of movement that simulate functional activities.

Principles of Applying Manual Resistance Exercise

Prior to initiating the exercise

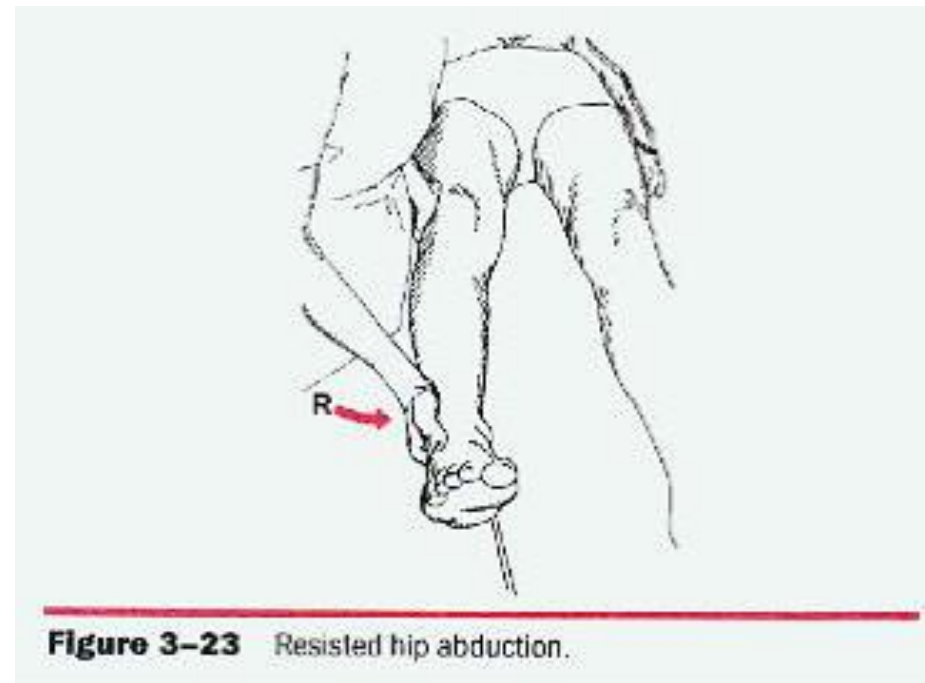
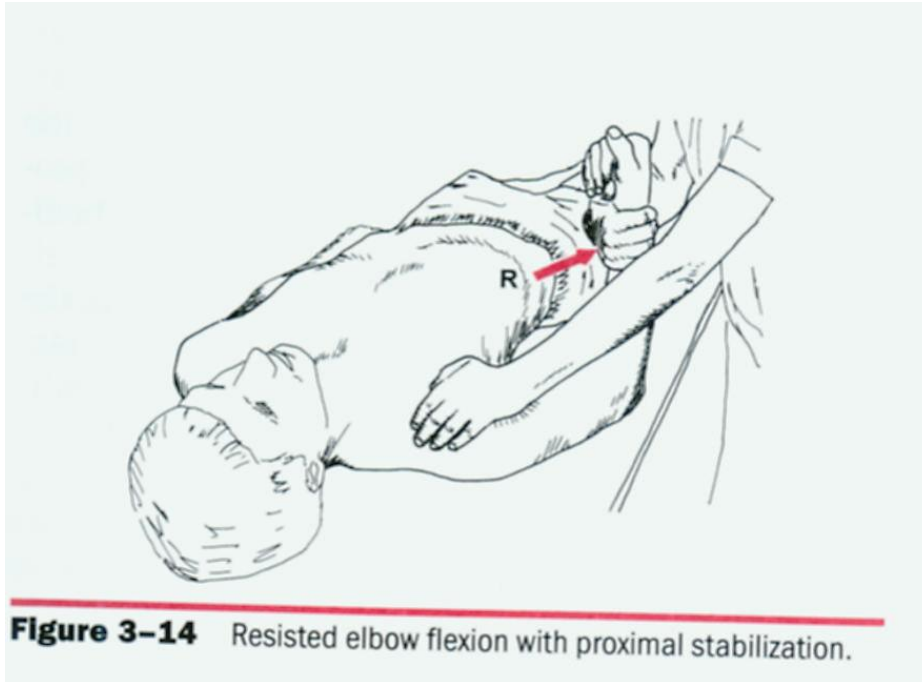
- ▶ Evaluate the patient's range of motion and strength, and identify functional limitations.
- ▶ Explain the exercise plan and procedures to the patient.
- ▶ As with ROM exercise , place the patient in a comfortable position.
- ▶ Patient's extremity through the motion.
- ▶ Maximum but pain-free effort.
- ▶ Avoid the Valsalva maneuver.

Principles of Applying Manual Resistance Exercise

During manual resistance exercise

- ▶ Consider the site of application of resistance.
- ▶ Determine the direction of resistance.
- ▶ Provide stabilization.
- ▶ Apply the appropriate amount of resistance.

Principles of Applying Manual Resistance Exercise



Principles of Applying Manual Resistance Exercise

Revise the site of application of resistance or decrease the amount of resistance if:

- ▶ The patient is unable to complete the full range of motion.
- ▶ The site of application of resistance is painful.
- ▶ Muscular tremor develops.
- ▶ Substitute motions occur.

Provide appropriate verbal commands.

Establish the number of repetitions.

Techniques of Manual Resistance Exercise

- ▶ Manual Muscle Test
- ▶ Muscle position and motion
- ▶ Provide resistance
- ▶ Static or dynamic exercise
- ▶ Exercise time / rest time
- ▶ Total set and total exercise time
- ▶ How the patient feel ?
- ▶ Check manual resistance exercise programs

Mechanical Resistance Exercise

Definition

- ▶ **Mechanical resistance exercise** is any form of exercise in which resistance (the exercise load) is applied by the use of some type of equipment.
- ▶ They include **progressive resistive exercise(PRE)**, active-resistive training, overload training, and **load-resisting exercise**.
- ▶ Mechanical resistance exercise is any form of exercise in which resistance (the exercise load) is applied by the use of some type of equipment.
- ▶ They include progressive resistive exercise(PRE), active-resistive training, overload training, and load-resisting exercise.

Mechanical resistance exercises



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Variables in Mechanical Resistance
Exercise Programs
strengthen ex protocols

For research paper

Variables in Mechanical Resistance Exercise Programs

1- Intensity of exercise and number of repetitions :

- The intensity of an exercise program is directly related to the degree to which a muscle or muscle group is loaded, resulting in submaximal or maximal muscle contractions.
- **Submaximal exercise**, submaximal exercise is also appropriate when **slow-velocity isokinetic exercise** is performed to minimize compressive forces to joints.

Intensity of exercise and number of repetitions :

- ▶ Exercise should be performed with **maximum** intensity in the **later stages of rehabilitation** when functional levels of strength or power are desired.

Variables in Mechanical Resistance Exercise Programs

- The exercise load refers to the amount of resistance imposed in the contracting muscle during exercise.

Repetition maximum (RM).

□ A repetition maximum is the **greatest amount** of weight (load) a muscle can move through the range of motion a specific number of times.

□ 10RM= 10 repetitions.

Variables in Mechanical Resistance Exercise Programs

Bouts, frequency and duration of exercise

- **Exercise repetition and bouts** are the numbers, or sets, respectively performed during each exercise session.

- **Exercise frequency** is the number of times an exercise is done within a day or within a week.

Duration of exercise , Exercise duration is the total number of days, weeks, or months during which an exercise program is performed.

Variables in Mechanical Resistance Exercise Programs

Speed of exercise

□ **Mode of exercise**

- The mode of exercise refers to the type of muscle contraction, dynamic or static, eccentric or concentric, that occurs during exercise.

□ **Range of movement-short-arc versus full-arc exercise**

- Resistance exercise may be done through the entire range of motion (full-arc exercise) or through a limited range (short-arc exercise).

● **Position of the patient-open-chain versus closed- chain exercise**

General Principles for the Use of Equipment

- **Evaluate the patient's** strength, range of motion, joint stability, bone or joint deformities, pain, and integrity of the skin before using the equipment.
 - ❑ Determine the most advantageous **types of exercise**.
 - ❑ Adhere to **all safety** precautions when applying the equipment
 - ❑ During dynamic exercise, avoid use of **substitute** motions.
 - ❑ If ROM must be limited to protect healing tissues or to avoid pain, be sure that **appropriate range-limiting** devices are employed.
 - ❑ **Observe and re-evaluate** the patient to determine how the exercise program was tolerated by the patient.

Specific Exercise Regimens

- **Isotonic Regimens**
- **ProgressionResistiveExercise(PRE)**

Isotonic Resistance Equipment

□ Free weights

Weight boots

■ Barbells

■ Dumbbells

■ Cuff weights with Velcro closures

■ Sandbags

Plyometric training (stretch-shortening drills)

- **High-intensity, high-velocity exercises** emphasize the development of muscular power and coordination.
- Plyometric training, often called **stretch-shortening drills**, is an approach to **isotonic exercise** that combines speed, strength, and functional activities.
- Plyometric is defined as **exercises in which muscles exert maximum force in short intervals of time, with the goal of increasing power (speed-strength).**

► Plyometric training



Precaution

Plyometric training should be implemented only in the **late stages of rehabilitation** with patients who can **tolerate high-impact, ballistic forces** in an exercise program.

PRE

Progressive resistance exercise is a dynamic resistance training in which a constant external load is applied to the contracting muscle by some mechanical means and incrementally increased.

The RM is used as the basis of progression in the resistance.

Multiple sets are used in a session, which may consist of 2-3 sets of 6-12 repetitions of 6-12 RM

Common variants are DeLorme, Oxford and McQueen method.

Delorme Method

- A systematic method of applying progressive resistive exercise.
 - Classified as a light to heavy approach.
 - Originally referred to as the Delorme-Watkins method.
 - Both Delorme and Watkins were orthopedic surgeons who used resistance training for faster recovery of their patients.
- Delorme Procedure:
 - Determine the 10 RM for the client/patient.
 - Perform 3 sets:
 - 1st set – 10 reps at 50% of the 10 RM
 - 2nd set – 10 reps at 75% of the 10 RM
 - 3rd set – 10 reps at 100% of the 10 RM
 - When 10 reps are exceeded on the 3rd set, establish a new 10 RM.

Oxford Method

- Developed in England as an alternative to the Delorme method.
 - Involves a heavy to light approach.
 - Designed to accommodate the cumulative fatigue of each set of maximal resistance.
- Oxford Procedure:
 - Following a brief warm up, determine the 10 RM.
 - Perform 3 sets:
 - 1ST set – 10 reps at 100% of 10 RM
 - 2nd set – 10 reps at 75% of 10 RM
 - 3rd set – 10 reps at 50% of 10 RM
 - When 10 reps are exceeded on the 1st set, establish a new 10 RM.

Resistance Training Techniques Used in Rehabilitation

- DeLorme's method
 - Based on repetition maximum of 10
 - Designed for early rehab
 - Designed for beginning rehab
 - Introduced PRE – “progressive loading”
 - Builds in warm-up period
- MacQueen's method
 - Utilizes varying sets for beginning/intermediate & advanced
 - Set of 10 RM
- Oxford method
 - Used during early, intermediate & advanced levels of rehabilitation
 - Percentages of 10 RM
 - Diminishes resistance as muscle fatigues – “regressive load”
- Sander's program
 - Utilized in advanced stages of rehabilitation
 - Utilizes percentages of body weight

%s for power (supertraining)

- Load % of 1RM: 70-100
- Reps per set: 1-5
- Sets per exercise: 3-5
- Rest between sets: 2-6m
- Duration (sec/set): 4-8
- Speed per rep: *90-100%*
- Training sess/wk: 3-6

Isometric Regimens

▪ **Brief repetitive isometric exercise**

- Strength gains occurred in **6 weeks** when subjects performed a single isometric contraction against maximum resistance **five to six times per week**.

- Each maximum voluntary contraction was held for **5 to 6 seconds**.

- Up to **20 maximum contractions**, each held for 6 seconds, were performed daily.

Isometric Regimens

- ▶ A **20-second rest** after each contraction as well as rhythmic breathing during the contractions was recommended to prevent increases in blood pressure.
- ▶ Isometric exercise can improve muscular endurance, the effect is minimal; **dynamic (isotonic and isokinetic) exercises** are a more effective means of increasing muscle endurance.

Isometric Regimens

- ▣ **Multiple-angle isometrics** are necessary if the goal of exercise is to improve strength throughout the range of motion.
- ▣ Resistance applied to each point in the ROM should be gradually increased to ensure that the muscle contraction is **pain free** but that the muscle is progressively overloaded so that strength gains will occur.

Isometric Regimens

- Mechanical resistance can be superimposed on multiple-angle isometric muscle contractions.

- Resistance should be applied **at least every 20 degrees** throughout the range.

- Davies suggests **10 sets of 10 repetitions of 10- second contractions every 10 degrees** in the range of motion.

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Thank you