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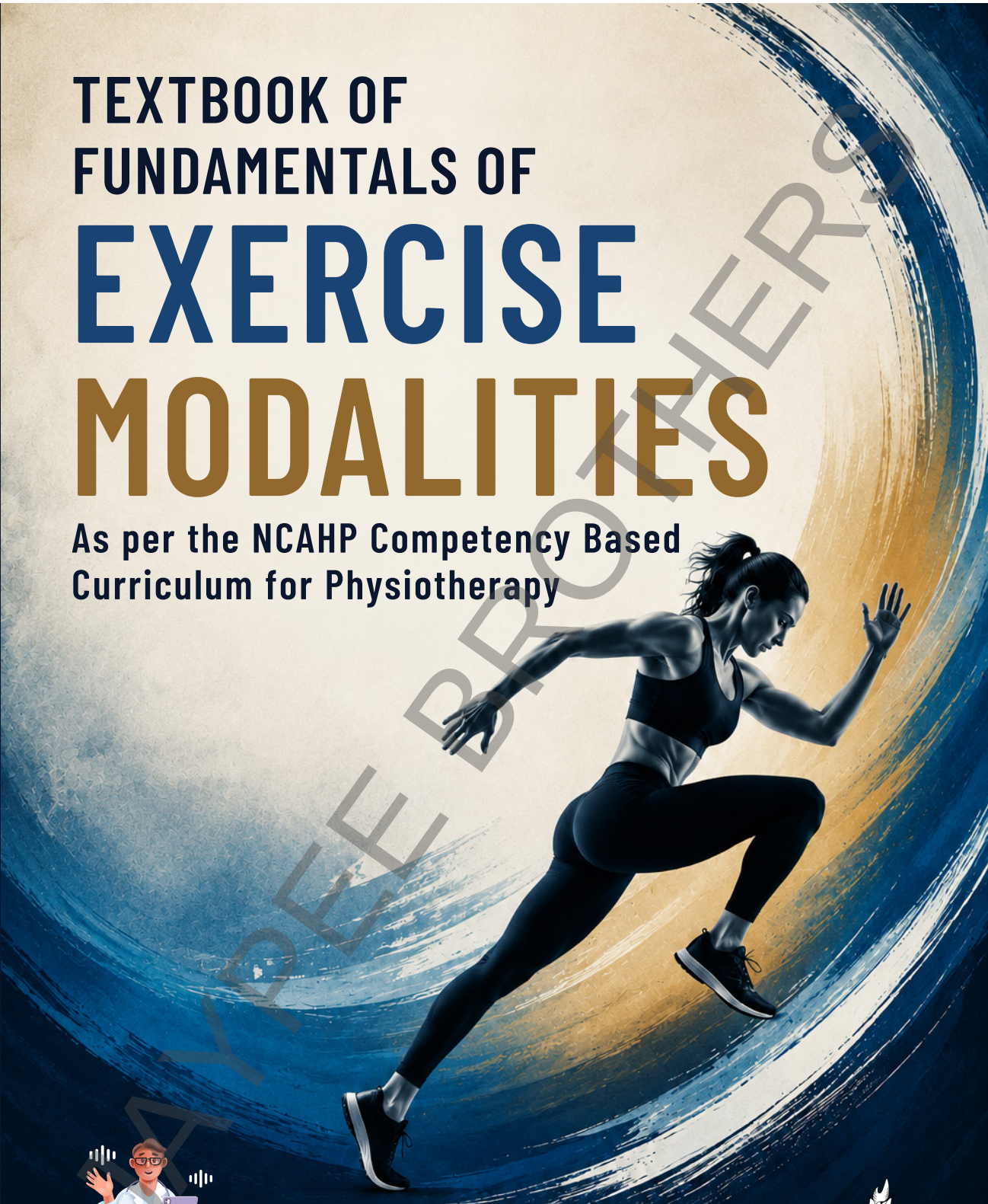
TEXTBOOK OF FUNDAMENTALS OF EXERCISE MODALITIES

As per the NCAHP Competency Based Curriculum for Physiotherapy



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7. Passive Movement 68
- ❖ Causes of Joint Immobility *68*
- ❖ Definition of Passive Movement *69*
- ❖ Classification *69*
- ❖ Relaxed Passive Movement *70*
- ❖ Procedure for Giving Passive Movement Joint-Wise *71*
- ❖ Effect and uses of Passive Movement *81*
- ❖ Indications and Contraindications of Passive Movement *81*
- ❖ Continuous Passive Motion *81*

8. End Feel 87
- ❖ Types *87*
- ❖ Significance of End Feel *88*
- ❖ Restriction of Joint Range of Motion *89*
- ❖ Causes of Restriction of Joint Range of Motion *89*

9. Active Movement 94
- ❖ Classification *94*
- ❖ Assisted Exercise *96*
- ❖ Assisted-Resisted Exercise *97*
- ❖ Resisted Exercise *98*

10. Resisted Exercise 101
- ❖ Modes of Application of Resistance *101*
- ❖ Principles of Resistance Training *103*
- ❖ Indications, Contraindications and Precautions of Resisted Exercise *104*
- ❖ Techniques/Procedure of Resisted Exercise *105*
- ❖ Progressive-Resisted Exercise *105*
- ❖ Daily Adjustable Progressive Resisted Exercise (DAPRE) *107*
- ❖ Constant vs Variable Resistance Exercise *108*
- ❖ Effects and uses of Resisted Exercise *110*
- ❖ Physiological Adaptation to Training *111*

11. Free and Resisted Exercise of the Individual Muscle Group 116
- ❖ Exercises for Upper Limb *116*
- ❖ Exercises for Lower Limb *131*
- ❖ Knee Joint *136*
- ❖ Ankle Joint *140*
- ❖ Exercise for the Foot *141*
- ❖ Exercise for Spine *142*
- ❖ Thoracolumbar Spine *146*

12. Physiological Effect of Exercise 157
- ❖ Effect of Exercises on the Cardiovascular System *157*
- ❖ Effect of Exercises on the Respiratory System *159*
- ❖ Effect of Exercises on the Musculoskeletal System *160*
- ❖ Effect of Exercises on the Endocrine System *161*

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- ❖ Effect of Exercises on Mental Health/Effect of Exercise on Emotions *162*
- ❖ Pharmacological Effect of Exercise *164*

13. Trick Movement 168

- ❖ Types of Trick Movement *168*
- ❖ Advantages of Trick Movement *170*
- ❖ Disadvantages of Trick Movement *170*

14. Fundamental Starting and Derived Position 173

- ❖ Fundamental Starting Position *173*
- ❖ Derived Position *173*
- ❖ Standing *174*
- ❖ Kneeling *188*
- ❖ Sitting *192*
- ❖ Lying *198*
- ❖ Hanging *204*

15. Pelvic Tilt 210

- ❖ Anatomical Position of the Pelvis *210*
- ❖ Pelvic Movement *210*
- ❖ Clinical Importance of Pelvic Tilt *215*

16. Manual Muscle Testing 220

- ❖ Grading Systems *220*
- ❖ Grading System for Muscles Supplied by Cranial Nerves *224*
- ❖ Procedure for Assigning a Muscle Test Grade *224*
- ❖ Test Procedure *225*
- ❖ Grading a Muscle When Range is Restricted *226*
- ❖ Need for Manual Muscle Testing *226*
- ❖ Fundamental Principles of Manual Muscle Testing *227*
- ❖ Principles of Application of Resistance *227*
- ❖ Principle of Isolation, Substitution, and Stabilization *228*
- ❖ MMT for Muscles of the Cervical Spine *229*
- ❖ Capital Extension *230*
- ❖ Cervical Extension *232*
- ❖ Combined Extension *233*
- ❖ Capital Flexion *234*
- ❖ Cervical Flexion *235*
- ❖ Combined Flexion *237*
- ❖ Combined Cervical Flexion to Isolate a Single Sternocleidomastoid *237*
- ❖ Cervical Rotation *239*

Testing the Muscles of the Trunk 240

- ❖ Trunk Extension *240*
- ❖ Lumbar Spine Extension *241*
- ❖ Thoracic Spine Extension *241*
- ❖ Lumbar and Thoracic Spine Combined Extension *242*

JAYPEE BROTHERS

❖ Elevation of the Pelvis *243*
❖ Trunk Lateral Flexion *244*
❖ Trunk Flexion *245*
❖ Trunk Rotation *247*
Muscles of Respiration 250
❖ Quiet Inspiration *250*
❖ Grade *250*
❖ Forced Expiration *251*
Muscles of the Upper Limb 253
❖ Scapular Muscles *253*
❖ Scapular Abduction and Upward Rotation *253*
❖ Scapular Elevation *255*
❖ Scapular Adduction (Retraction) *256*
❖ Scapular Depression and Adduction *258*
❖ Scapular Adduction and Downward Rotation *259*
❖ Alternate Rhomboid Test *261*
Muscles of the Shoulder Joint 261
❖ Shoulder Flexion *261*
❖ Shoulder Extension *263*
❖ Test to Isolate Latissimus Dorsi *264*
❖ Alternate Test for Latissimus Dorsi *265*
❖ Shoulder Scaption *265*
❖ Shoulder Abduction *266*
❖ Shoulder Horizontal Abduction *268*
❖ Shoulder Horizontal Adduction *269*
❖ Shoulder External Rotation *271*
❖ Shoulder Internal Rotation *273*
Elbow Muscles 275
❖ Flexion *275*
❖ Elbow Extension *277*
Forearm Muscles 278
❖ Supination *278*
❖ Pronation *280*
Muscles of the Wrist 282
❖ Flexion *282*
❖ Extension *284*
❖ Radial Deviation *286*
❖ Ulnar Deviation *286*
Muscles of the Hand 286
❖ Finger MP Flexion *286*
❖ Finger Pip Flexion *288*
❖ Finger Dip Flexion *289*
❖ Finger MP Extension *291*
❖ Finger Abduction *292*
❖ Finger Adduction *293*

JAYPEE BROTHERS

Muscles of the Thumb 294
❖ Thumb MCP, IP Flexion *294*
Muscles of the Lower Limb 302
❖ Hip Muscles *302*
❖ Flexion *302*
❖ Test for Sartorius (Hip Flexion, Abduction with External Rotation with Knee Flexion) *304*
❖ Hip Extension *306*
❖ Hip Extension Test to Isolate Gluteus Maximus *308*
❖ Hip Extension Test Modified in Case of Hip Flexor Tightness *309*
❖ Hip Abduction *311*
❖ Hip Abduction from Flexion *313*
❖ Hip Adduction *314*
❖ Hip External Rotation *316*
❖ Hip Internal Rotation *318*
Muscles of the Knee 319
❖ Knee Flexion *319*
Muscles of the Ankle 324
❖ Ankle Plantar Flexion *324*
❖ Test to Isolate the Soleus *326*
❖ Ankle Dorsiflexion *328*
❖ Foot Dorsiflexion and Inversion *328*
❖ Foot Inversion *329*
❖ Foot Eversion with Plantar Flexion *330*
❖ Isolation of Peroneus Longus *331*
❖ Foot Eversion with Dorsiflexion *332*
❖ Mtp Flexion (Hallux and Toes) *332*
❖ Hallux *332*
❖ Toes *333*
❖ Dip, PIP Flexion *334*
❖ MTP and IP Extension *335*
Muscles Innervated by Cranial Nerve 336
❖ Muscles of the Face *337*
❖ Eye-Opening *337*
❖ Eye Closing *338*
❖ Frowning *338*
❖ Raising Eyebrows *339*
❖ Wrinkling the Bridge of the Nose, Expression of Distaste *339*
Muscles of Mastication 344
❖ Jaw Opening (Mandibular Depression) *344*
❖ Jaw Closure (Mandibular Elevation) *345*
❖ Lateral Jaw Deviation *346*
❖ Jaw Protrusion *346*

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17. Goniometry 351
- ❖ Range of Motion *351*
- ❖ Goniometer *352*
- ❖ Uses of Goniometer *353*
- ❖ Procedure for Measuring Joint Range of Motion *353*

Upper Extremity Goniometry 355
- ❖ Shoulder Joint *355*
- ❖ Elbow Joint *359*
- ❖ Joints of the Hand *365*

Lower Extremity Goniometry 375
- ❖ Hip Joint *375*
- ❖ Knee Joint *379*

Goniometry of Spine 385
- ❖ Cervical Spine *385*
- ❖ Thoracolumbar Spine *391*

Temporomandibular Joint 395
- ❖ Type of Joint *395*
- ❖ Measurement of Depression of the Mandible (Mouth Opening) *396*
- ❖ Protrusion of the Mandible *398*
- ❖ Reliability and Validity of Goniometric Measurements (Universal Goniometer) *400*

18. Home Exercise 405
- ❖ Indication *405*
- ❖ Essentials for Home Exercise *405*
- ❖ Barriers to Home Exercise Program *406*

19. Soft Tissue Manipulation and Massage 409
- ❖ History of Massage *409*
- ❖ Classification of Massage *410*
- ❖ Effect of Massage *411*
- ❖ Contraindications for Massage *414*
- ❖ Preparation for Massage *415*
- ❖ Different Techniques of Massage, their Effects, and uses *416*
- ❖ Massage for Upper Limb *430*
- ❖ Massage for Lower Limb *432*
- ❖ Massage for the Back *434*
- ❖ For Neck *434*
- ❖ To the Thoracolumbar Region *435*
- ❖ Massage to the Gluteal Region *436*
- ❖ Massage to the Chest (for Respiratory Condition) *436*
- ❖ Massage for Face *437*
- ❖ New Techniques in Massage *438*

Index 443

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CHAPTER

6

Classification of Therapeutic Exercise

FoEM 4.1: Classify therapeutic exercises: Technique, effects, therapeutic use
FoEM 4.2: Demonstrate active movements
FoEM 4.3: Discuss active movements in terms of definition of strength, power and work, endurance, muscle actions, causes of decreased muscle performance
FoEM 4.4: Explain the physiological adaptation to training: Strength and power, endurance.
FoEM 4.5: Demonstrate free exercise: Classification, principles, techniques, indications, contraindications, effects and uses
FoEM 4.6: Demonstrate active assisted exercise
FoEM 4.7: Discuss the principles, techniques, indications, contraindications, effects and uses assisted-resisted exercise: Principles, techniques, indications, contraindications, effects and uses

Chapter Outline

- Classification of Movement
- Factors Essential for Active Movements/ Causes of Decreased Muscle Performance
- Strength, Power and Endurance
- Grading of Muscle Power
- Isometric Exercise
- Dynamic Exercise – Concentric and Eccentric Exercise
- Isokinetic Exercises
- Close and Open Kinematic Chain Exercise
- Range of Motion Exercise

INTRODUCTION

Movement is the act or process of moving. It is the fundamental characteristic of animals. Movement is produced by the action of muscles on the bones. Before learning movements in detail, let us take a look at these basic concepts.

CLASSIFICATION OF MOVEMENT

Movements of the human body can be broadly classified into two types based on conscious control.

- **Voluntary movement:** These movements are performed under the conscious control of an individual, i.e., the movement is produced and stopped according to the desire of the person and are under the control of the individual.
- **Involuntary movement B:** These movements are not under the conscious control of the individual. These movements take place automatically and can neither be initiated nor stopped by the individual. For example, reflexactions, movement of the food pipe, movements of the heart and lungs, etc.

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In this chapter, we will discuss only the voluntary movements and their types.

Voluntary movements are further classified into two types based on the force producing the movement: passive movement and active movement.

Passive Movements

Passive movement is the movement produced by an external force with no voluntary muscle contraction by the subject. Passive movements are commonly used to maintain joint mobility, prevent stiffness, and promote circulation, when active movement is not possible due to some reason.

Passive movement can be classified into three types.

1. **Relaxed passive movement:** Relaxed passive movement is performed by the therapist within the normal range of motion without causing pain or tissue strain. This includes both anatomical and accessory movements.
2. **Forced passive movement:** Forced passive movement is carried out beyond the available range to increase mobility, usually applied cautiously and for therapeutic purposes. It includes mobilization of the joint, manipulation of the joint and sustained stretch.
3. **Mechanical passive movement** is produced using mechanical devices, such as continuous passive motion (CPM) machines, to move a joint in a controlled and repetitive manner.

Active Movement

Active movement or active exercise (the terms movement and exercise can be used interchangeably) is defined as the movement produced by the muscular force of the individual without the complete assistance of an external force.

Active movement can be further subdivided into four types.

1. **Free exercise:** Free exercise is performed independently by the subject without any assistance or resistance from an external force other than gravity
2. **Assisted exercise:** Assisted exercise occurs when the subject performs the movement with partial assistance from an external source, such as a therapist or gravity, to complete the range of motion.
3. **Assisted–resisted exercise:** Assisted–resisted exercise involves assistance during a weaker part of the range and resistance during the stronger part, ensuring smooth and effective movement throughout the range.
4. **Resisted exercise:** Resisted exercise is performed when the subject moves against an opposing force, applied manually or mechanically, to improve muscle strength and endurance.

We will discuss in detail all these movements in subsequent chapters.

FACTORS ESSENTIAL FOR ACTIVE MOVEMENT/CAUSES OF DECREASED MUSCLE PERFORMANCE

Active movement is the voluntary movement produced by the contraction of muscles and requires the coordinated function of several body systems. Various factors contribute to the production of smooth and accurate movement. Deficits in any of these lead to decreased muscle performance. They are as follows:

- **Intact nervous system:** It includes the brain, spinal cord, and peripheral nerves, which initiate, transmit, and coordinate motor impulses to the muscles. Motor impulse is responsible for the initiation of muscle contraction and the production of movement.

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- **Musculoskeletal I integrity:** The integrity of bones and joints is also vital in the production of movement. Bones act as levers and joints provide the axes around which movement occurs, while joint stability and mobility allow smooth motion.
- **Healthy muscle tissue:** Healthy muscle is necessary to generate force and produce movement through contraction.
- **Adequate joint range of motion**: Adequate range of motion at the joint is required so that movement can occur freely without restriction from stiffness, contractuers, or pain.
- **Postural control and balance:** Proper postural control and balance are important to provide a stable base for movement, especially during functional activities.
- **Sensory feedback:** Feedback from various sense organs, including proprioception, vision, and vestibular input, plays a crucial role in guiding, correcting, and refining active movement.
- **Motivation:** Finally, sufficient energy, motivation and desire to move is necessary for movement production, as fatigue, poor endurance, pain, or lack of willingness can limit the ability to perform active movements effectively.

STRENGTH, POWER AND ENDURANCE

These are the key elements of muscle performance. A clear understanding of this is essential before learning further in active exercise.

Strength

Strength is the greatest measurable tension produced in a muscle or a group of muscles in order to overcome a resistance applied to it during a single maximum effort. While lifting a heavy weight, the tension in the muscles responsible for lifting increases. If the tension is sufficient enough to overcome the resistance offered by the weight to be lifted, then the weight is lifted, so we can say the muscle has enough strength to lift the weight. It depends on factors such as the cross-sectional area of the muscle, muscle fiber type, neuromuscular coordination, and mechanical advantage of the joint. Strength is commonly assessed using manual muscle testing (MMT) or repetition maximum (RM) methods and is improved through resisted exercise and progressive resistance training.

Power

Power is the ability of a muscle or muscle group to generate force quickly and is mathematically expressed as the product of strength and speed. It reflects how fast a muscle can contract to overcome resistance and is crucial for activities requiring explosive or rapid movements, such as jumping, sprinting, throwing, or quickly rising from a chair. Power depends largely on fast-twitch (Type II) muscle fibers**,** efficient neuromuscular activation**,** and the ability to recruit motor units rapidly.

Power can be either aerobic power or anaerobic power.

Aerobic Power

It is the power required to perform a repeated burst of less intense muscle activity, as in climbing a flight of stairs.

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Anaerobic Power

It is the power to produce a single burst of high-intensity muscle activity, i.e., performing a high jump.

Endurance

It is the ability of the muscle to perform a low-intensity repetitive activity over a prolonged period of time without the onset of excessive fatigue. It includes both:

- **Cardiorespiratory endurance:** It is the total body endurance required while performing activities involving the whole body. It is the ability of the heart and lungs to meet the requirement of increased demand for oxygen by muscles working for a prolonged period of time, e.g., running, swimming, cycling, etc.
- **Local endurance:** It is the ability of a particular muscle to perform a repeated activity. It is influenced by aerobic capacity**,** mitochondrial densiy, capillary supply**,** and the efficiency of energy production systems within the muscle.
  Muscular endurance is essential for activities of daily living such as walking, standing, maintaining posture, and performing repetitive tasks.
  Endurance is commonly developed through low-resistance, high-repetition exercises.

GRADING OF MUSCLE POWER

An optimum level of muscle power is required to perform a movement. The power of a muscle is graded according to its ability to contract and produce movement. The grades are as follows:

- 0—no contraction
- 1—flicker contraction
- 2—full range of motion in a gravity eliminated position
- 3—full range of motion against gravity
- 4—full range of motion against gravity with minimum resistance
- 5—full range of motion against gravity with maximum resistance

The type of exercise to be given is based on the grade of muscle power exercise. For grades 0 and 1, passive movement is given; for grades 2 and 3, suspension therapy, assisted exercise, and free exercise are given; and for grades 3 and 4, resisted exercise is advised.

ISOMETRIC EXERCISES

Definition

Isometric exercise is a type of static muscle work in which the muscle develops tension without producing movement at the joint and without appreciable change in muscle length.

Characteristics of Isometric Exercise

- Muscle fibers generate force without shortening or lengthening.
- Cross-bridge formation occurs between actin and myosin filaments.
- Intramuscular tension increases, leading to activation of motor units.
- Joint angle remains constant.
- Isometric contractions can activate both slow-twitch and fast-twitch muscle fibers, depending on the intensity of contraction.

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Types of Isometric Exercise

Several forms of isometric exercises are used in different phases of rehabilitation.

- **Muscle setting exercise (submaximal isometric contraction):** It involves a low-intensity isometric contraction performed against little or no resistance. This is the safest form of exercise performed after any surgery or trauma. It is the most effective form of exercise performed in the acute phase of rehabilitation or in any painful conditions.
- **Maximal isometric contraction:** The muscle is made to contract with maximum voluntary effort. It is generally used for strength testing and advanced training. This form of isometric exercise increases cardiovascular load.
- **Multiple-angle isometric exercise:** This form of isometric exercise involves applying resistance to an isometric muscle work, with the joint held in different ranges of motion.
- **Stabilization exercise:** This exercise involves sustained muscle work with submaximal resistance, provided either manually or by gravity in a weight-bearing position. It is commonly used for postural stabilization.

Indications of Isometric Exercise

- Active movement is painful
- Joint instability is present
- Joints immobilized in plaster casts
- Acute inflammation or swelling present
- Early stages of muscle re-education and strengthening programs

Contraindications

- Uncontrolled hypertension
- Cardiac conditions (e.g., recent myocardial infarction)
- Severe pain during contraction
- Acute muscle tears

Effect and Uses of Isometric Exercise

- Reduce pain and muscle spasm, improve blood circulation to the muscles and induce relaxation
- Useful in activating a larger number of muscle fibers.
- Prevent disuse atrophy of the muscle during immobilization and the acute phase of rehabilitation.
- Provides stability to the joint and helps to maintain posture.
- Though isometric exercises are not designed primarily for strength training, they can be used for strengthening when movement is not allowed or painful. Mainly, multiple-angle isometric or stabilization exercises are used for this purpose.

Precautions

- Monitor blood pressure in cardiac patients
- Avoid breath-holding
- Avoid the Valsalva maneuver
- Ensure proper positioning

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Common isometric exercises performed in a physiotherapy clinic are:

- Quadriceps setting
- Gluteal setting
- Hamstring setting
- Abdominal setting
- Scapular stabilization exercises
- Cervical isometric exercises

This exercise will be explained in detail under the respective regional sections.

DYNAMIC EXERCISE

The following are examples of dynamic exercise:

Concentric and Eccentric Exercises: (Isotonic Exercise)

Concentric and eccentric exercises refer to dynamic forms of muscle work in which the tension in the muscle remains constant, but the muscle changes its length while producing force.

Concentric exercise: Concentric exercise involves muscle shortening while overcoming an external resistance to produce movement. During this type of contraction, the force generated by the muscle is greater than the external load, resulting in joint movement in the direction of the muscle's action. Concentric exercises are commonly used to initiate movement, accelerate body segments, and perform functional activities such as lifting objects, climbing stairs, or raising a weight during a biceps curl.

Eccentric exercise: Eccentric exercise involves muscle lengthening while the muscle is actively contracting to control or resist an external force (most of the time, gravity) that is greater than the force produced by the muscle. In this type of contraction, the muscle acts as a brake to decelerate movement and control joint motion. Eccentric exercises are essential for activities such as lowering a weight, walking downhill, or descending stairs, and they play a significant role in shock absorption, joint stability, and controlled movement.

ISOKINETIC EXERCISES

Isokinetic exercise is a form of dynamic resisted exercise in which the joint moves at a constant, pre-set angular velocity throughout the entire range of motion, while the resistance automatically accommodates the force generated by the muscle (greater force → greater resistance).

This type of exercise is performed using specialized isokinetic dynamometers that adjust resistance continuously, allowing the muscle to exert maximal tension at all joint angles without acceleration or deceleration. As a result, isokinetic training provides uniform muscle loading across the range of motion, eliminates the sticking point commonly seen in constant resistance exercises, and enhances neuromuscular control. It permits both concentric and eccentric muscle contractions and allows objective measurement of parameters such as torque, power, and work.

Due to its controlled speed and accommodating resistance, isokinetic exercise is considered safe and effective for muscle strengthening, rehabilitation, post-operative training, and assessment of muscle performance.

This type of exercise is performed using specialized equipment called isokinetic dynamometers (e.g., Cybex, Biodex), which are expensive and nonportable.

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Important Physiotherapy Terms to Remember

- **Strength:** Maximum force a muscle can generate to overcome resistance in a single effort.
- **Power:** Ability to generate force quickly (strength × speed).
- **Endurance:** Ability of muscle to sustain repeated or prolonged activity without fatigue.
- **Concentric contraction:** Muscle shortens while producing movement.
- **Eccentric contraction:** Muscle lengthens while controlling or resisting movement.

CLOSE AND OPEN KINEMATIC CHAIN EXERCISE

Exercises can be again classified into two types based on the position of the distal joints, i.e., close kinematic chain exercises and open kinematic chain exercises. These exercises are also commonly referred to as weight-bearing exercises and nonweight-bearing exercises, respectively.

Closed Kinetic Chain (CKC) Exercises (Weight Bearing Exercise)

Close kinetic chain exercises involve movements where the distal segment is fixed or in contact with a stable surface, leading to multiple joints and muscle groups being activated simultaneously. In these exercises, the movement of the proximal segment occurs against the fixed distal segment. This leads to simultaneous contraction (co-contraction) of muscles around multiple joints.

Examples include squats, push-ups, and pull-ups.

Effect and Uses

- ❖ Exercises are widely used in functional training to develop the strength of multiple muscle groups at a time.
- ❖ These exercises lead to the co-contraction of muscles around multiple joints, enhancing joint stability and proprioception.
- ❖ These exercises closely resemble functional activities as they engage multiple joints and muscle groups, which improve coordination and movement patterns relevant to daily activities.
- ❖ They are particularly useful in the later stages of rehabilitation

Advantages and Disadvantages

Advantages:

- ❖ Engages multiple joints and muscle groups simultaneously.
- ❖ Enhances joint stability and proprioception.
- ❖ Promotes functional movement patterns.
- ❖ Can be adapted to various levels of difficulty and functional needs.

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Disadvantages:

- ❖ May place more stress on joints and healing tissues.
- ❖ Requires more coordination and balance.
- ❖ May be challenging for individuals with limited mobility or severe weakness.

Open Kinetic Chain (OKC) Exercises (Nonweight Bearing Exercise)

Open kinematic chain exercises are characterized by movements where the distal segment (e.g., hand or foot) is free to move in space. These exercises typically involve a single joint and focus on isolating specific muscles. During OKC exercises, the force generated by the muscle acts on the distal segment, which moves freely. This results in isolated joint motion and strengthens a targeted muscle.

Examples: High-sitting knee extensions, bicep curls, standing shoulder abduction, etc.

Effect and Uses

- ❖ Exercises are often used in rehabilitation settings to isolate and strengthen specific muscles without placing excessive stress on surrounding joints. They are particularly beneficial during the early phases of rehabilitation when joint stability might be compromised.
- ❖ OKC exercises are effective for targeted muscle strengthening and increasing the range of motion of a particular joint.
- ❖ These exercises are more appropriate for early-stage rehabilitation to isolate and strengthen weakened muscles without overloading healing joints conversely.

Advantages and Disadvantages

Advantages:

- ❖ Isolates specific muscles for targeted strengthening.
- ❖ Allows for controlled, precise movements.
- ❖ Can be performed with minimal equipment.
- ❖ Useful in early rehabilitation stages to protect healing tissues.

Disadvantages:

- ❖ Limited functional training for real-life activities.
- ❖ Less effective in improving joint stability or proprioception.
- ❖ Exercise only one group of muscles at a time.



Role of Physiotherapist

- **Assessment and exercise selection:** Evaluates muscle performance (strength, power, endurance) and selects appropriate exercises (passive, active, resisted) based on patient condition.
- **Rehabilitation planning and progression:** Designs and progresses exercise programs (isometric, isotonic, isokinetic, CKC/OKC) to restore movement, strength, and function.
- **Improving functional movement:** Ensures safe, coordinated, and efficient movement by addressing factors like ROM, balance, neuromuscular control, and motivation.

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RANGE OF MOTION EXERCISE

It is a general term used to explain all types of exercise that aim to increase the ROM of any joint. It includes all types of active exercises and passive movement, which aim to increase and maintain the ROM of a particular joint.

SUMMARY

This chapter explains the classification of therapeutic exercises and their importance in physiotherapy for improving movement and muscle performance. Movements are broadly classified into voluntary and involuntary, with voluntary movements further divided into passive and active movements. Passive movements are produced by external forces and help maintain joint mobility, while active movements are generated by muscular effort and include free, assisted, assisted-resisted, and resisted exercises. Effective movement depends on factors such as intact nervous and musculoskeletal systems, adequate range of motion, balance, and motivation. Muscle performance is defined by strength, power, and endurance, which are essential for functional activities. Therapeutic exercises include isometric, isotonic (concentric and eccentric), and isokinetic exercises, each having specific indications and uses in rehabilitation. Additionally, exercises are classified into closed and open kinetic chain types based on movement patterns. Overall, these principles guide physiotherapists in designing safe, effective, and goal-oriented rehabilitation programs.

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Self-Assessment

Long Notes

1. Describe the classification of movement. Discuss active and passive movement in detail.
2. Define active movements, discuss the effects and uses of active movement.
3. Describe isometric, isotonic, and isokinetic exercises with clinical applications.

Short Notes

1. Types of active movement.
2. Active movement
3. Passive movement

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4. Assisted active movement
5. Open kinetic chain exercise.
6. Isometric exercise
7. Isotonic exercise
8. Isokinetic exercise
9. Concentric contraction
10. Eccentric contraction

Short Answer Questions

1. Define movement.
2. What is active exercise?
3. Define isometric contraction.
4. What is concentric muscle work?
5. What is eccentric muscle work?
6. What is an open kinetic chain exercise?
7. Mention any two examples of closed kinetic chain exercises.

Multiple Choice Questions (MCQs)

1. Movement performed entirely by an external force is called:
a. Active movement
b. Assisted movement
c. Passive movement
d. Resisted movement

2. Eccentric contraction occurs when:
a. Muscle shortens against gravity
b. Muscle lengthens while contracting
c. No joint movement occurs
d. Muscle relaxes completely

3. Isometric exercise is characterized by:
a. Change in muscle length
b. Joint movement
c. No joint movement
d. Variable speed

4. Isokinetic exercise is performed using:
a. Dumbbells
b. Weight cuffs
c. Elastic bands
d. Isokinetic dynamometer

5. Exercise performed without external resistance is called:
a. Resisted exercise
b. Free exercise
c. Passive exercise
d. Assisted exercise

6. Which contraction is important for shock absorption?
a. Concentric
b. Isometric
c. Eccentric
d. Isokinetic

7. Squats are an example of:
a. Open kinetic chain exercise
b. Passive movement
c. Closed kinetic chain exercise
d. Isometric exercise

8. Lifting a weight upward mainly involves:
a. Eccentric contraction
b. Isometric contraction
c. Concentric contraction
d. Relaxation

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9. Movement initiated and controlled by the patient is:
a. Passive
b. Active
c. Assisted
d. Resisted

10. In assisted active movement:
a. Patient does nothing
b. Therapist performs full movement
c. Patient performs movement with help
d. Machine performs movement

11. Walking is classified as:
a. Passive exercise
b. Free exercise
c. Isometric exercise
d. Assisted exercise

12. Lowering a dumbbell slowly involves:
a. Concentric contraction
b. Isometric contraction
c. Eccentric contraction
d. Passive movement

13. Exercise classification based on muscle work includes:
a. Active and passive
b. Aerobic and anaerobic
c. Concentric and eccentric
d. Free and resisted

14. Passive movements are useful mainly to:
a. Increase strength
b. Maintain joint range
c. Improve endurance
d. Improve coordination

15. Which exercise uses accommodating resistance?
a. Isometric
b. Isotonic
c. Isokinetic
d. Free exercise

16. A patient recovering from ACL injury is prescribed squats instead of seated knee extension in early rehabilitation. Why are squats preferred?
a. They isolate quadriceps completely
b. They are open chain exercises
c. They provide joint stability and co-contraction
d. They reduce muscle activation

17. A patient with acute joint inflammation is advised static muscle contractions. What is the primary benefit?
a. Improves joint range quickly
b. Prevents muscle atrophy without joint movement
c. Increases speed of contraction
d. Enhances coordination only

18. A bedridden patient is unable to move the limbs independently. The therapist moves the joints through full range regularly. This type of exercise is:
a. Active ROM
b. Active-assisted ROM
c. Passive ROM
d. Resisted exercise

Answers

1. c	**2.** b	**3.** c	**4.** d	**5.** b	**6.** c
7. c	**8.** c	**9.** b	**10.** c	**11.** b	**12.** c
13. c	**14.** b	**15.** c	**16.** c	**17.** b	**18.** c

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