Exercise Therapy

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Define Resisted Exercise. Explain in detail about the types, Physiological and Therapeutic Effects of Resisted exercise.

Definition

Resisted exercise (also called resistance exercise or strength training) involves actively contracting muscles against an external load or force. In other words, the mover works against some form of resistance (body weight, free weights, machines, elastic bands, water resistance, etc.) during muscle contraction.

This resistance can be manual (a therapist or partner provides force) or mechanical (weights, springs, fluid in pistons, gravity, etc.). The goal is to improve muscle strength, power, and endurance (and ultimately function) by overloading the muscle beyond its usual demand.

Types of Resisted Exercise

Resisted exercises can be classified in mainly five types:

1. **Source of resistance:** Manual resistance (therapist or partner presses against the limb) versus mechanical resistance (external devices). For example, manual resisted exercises use a therapist's hands to provide resistance, while mechanical methods include dumbbells, weight machines, hydraulic or pneumatic machines, resistance bands, or aquatic equipment.
2. **Muscle contraction type:**
   Isometric: Muscle contracts without joint motion (the muscle length and joint angle remain constant). e.g. pushing against an immovable object or holding a plank.
   Isotonic (dynamic): Muscle changes length while moving a load. This includes concentric contraction (muscle shortens, e.g. lifting a weight) and eccentric contraction (muscle lengthens under load, e.g. lowering a weight).
   Isokinetic: Performed at a constant speed (using specialized machines that adjust resistance so the limb moves at a set velocity throughout the range). The resistance accommodates the changing leverage, allowing maximal muscle force throughout the motion.
3. **Kinetic chain (body segment movement):**
   Open-chain exercises: The distal segment (hand or foot) moves freely in space. These are usually single-joint or isolation movements (e.g. seated knee extensions, biceps curls). The distal limb is not fixed, so joints and muscles can be isolated.
   Closed-chain exercises: The distal segment is fixed (e.g. feet on the floor or hand on a bar), so movement occurs through multiple joints. These are typically weight-bearing compound movements (e.g. squats, push-ups). Closed-chain exercises tend to engage co-contractions and often mimic functional activities.
4. **Body position or environment:** e.g. upright weight-bearing (standing barbell squat) versus non-weight-bearing (lying leg press); land-based versus aquatic (water offers drag resistance).
5. **Modality:** e.g. elastic band exercises, suspension training, spring-loaded machines, and progressive vs. fixed resistance. (Often in rehab we also categorize "progressive resistive exercises" where the load is increased over time.)

Each category has its own advantages. For example, manual resistance allows tailoring to a patient without equipment, whereas machines and free weights allow quantifiable loads and high intensity. Isometric exercises are useful when movement is contraindicated (e.g. in acute injury), whereas isotonic exercises improve both strength and joint motion.

PHYSIOLOGICAL EFFECTS

Resisted exercise produces a wide range of physiological adaptations across muscle, bone, and whole-body systems:

1. **Muscle hypertrophy and architecture:** Repeated overload stimulates muscle fiber growth. Fast-twitch (Type II) fibers increase in cross-sectional area, and overall muscle mass and volume enlarge. Satellite cells are activated to add myonuclei, supporting growth. Pennation angles of muscle fibers may increase, allowing greater force generation. These changes increase a muscle's maximal force output. Early strength gains (first weeks) are largely neural, but sustained training induces true hypertrophy.
2. **Neuromuscular adaptations:** Resistance training enhances motor control. The nervous system learns to recruit a higher proportion of motor units, fire them at higher rates, and coordinate agonist/antagonist activation more efficiently. As a result, muscles can produce more force. Enhanced neuromuscular coordination also improves balance and reduces the risk of injury during movement. (Neural adaptations explain why novices gain strength quickly before much visible hypertrophy.)
3. **Skeletal system:** Bone mineral density (BMD) increases at the sites of stress (Wolff's law). The mechanical loading of weight-bearing or resisted movements stimulates osteoblast activity. Clinical trials show that regular high-intensity resistance training significantly increases BMD at the lumbar spine, femoral neck and hip in postmenopausal women, helping to prevent osteoporosis. Tendons and ligaments also adapt by becoming thicker and stronger, improving joint stability.
4. **Metabolic and endocrine changes:** Contracting muscle uptakes glucose and improves insulin sensitivity. After resistance exercise, muscles continue to consume more glucose, which helps lower blood sugar (glycemic control). Chronic training improves lipid metabolism (raising HDL and lowering LDL cholesterol) and can reduce systemic inflammation. Skeletal muscle, acting as an endocrine organ, releases myokines (like IL-6) which may modulate inflammation and metabolism. Resistance exercise also acutely elevates hormones such as growth hormone, testosterone, and IGF-1, which further promote muscle growth and fat metabolism.
5. **Cardiovascular effects:** While primarily anaerobic, high-intensity resistance training does produce significant cardiovascular effects. It can lower resting blood pressure and improve endothelial function (via increased shear stress). Regular resistance training improves traditional cardiovascular risk factors: it raises HDL cholesterol, lowers LDL cholesterol and triglycerides, and improves arterial compliance. An American Heart Association scientific statement notes that resistance training has favorable clinical effects on cardiovascular disease and risk factors, and is a safe, effective way to improve cardiovascular health in both healthy people and those with CVD.
6. **Muscular endurance and metabolic rate:** By increasing muscle mass, resting metabolic rate goes up (since muscle is metabolically active). Resistance training also enhances enzymes involved in anaerobic and aerobic metabolism, enabling muscles to work longer against load before fatiguing. This translates to better muscular endurance.
7. **Other systemic effects:** Improved body composition (higher lean-to-fat mass ratio) aids weight control. Some studies suggest cognitive benefits (e.g. slowed cognitive decline in older adults) and improved mood and confidence, likely via neurochemical and psychosocial pathways. In summary, resistance exercise induces multi-system improvements: muscular strength/endurance, bone density, metabolic health, and cardiovascular conditioning.

Therapeutic Effects

In rehabilitation and preventive health, resisted exercise yields important functional and therapeutic benefits across many populations:

1. **Muscle atrophy and frailty prevention:** In hospitalized or immobilized patients (e.g. older adults in acute care), muscle atrophy can set in rapidly. Resistance exercise is the most effective intervention to prevent hospital-related muscle wasting and deconditioning. For example, bed-bound or post-surgical patients who perform even modest resistance exercises lose far less muscle mass and maintain greater functional ability than those who do not. Preventing muscle loss helps maintain mobility and independence.
2. **Strength, function and mobility gains**: Stronger muscles translate directly into improved functional performance. Numerous trials show that progressive resistance programs significantly increase patients' ability to perform daily activities. In one RCT of older adults awaiting hip replacement, those in a resistance training group achieved greater improvements in muscle strength, muscle mass, and functional mobility than controls (standard rehab). Likewise, meta-analyses find that resistance training markedly improves gait speed, balance, stair-climbing, and other functional tasks. Higher strength and power reduce disability and help patients recover independence faster.
3. **Pain reduction and arthritis management:** In conditions like knee or hip osteoarthritis, muscle weakness around the joint exacerbates pain and dysfunction. A recent systematic review found that progressive resistance training significantly decreases pain and improves strength and function in patients with knee or hip OA. Strengthening the quadriceps and hip muscles offloads the joint and improves biomechanics, leading to less pain during activities. Thus, resisted exercise is a core non-surgical therapy for arthritis (as recommended by international guidelines).
4. **Metabolic disease control:** For patients with diabetes or metabolic syndrome, resistance training is a powerful therapy. By increasing muscle mass and insulin sensitivity, it helps lower blood glucose and HbA1c over time. In patients with both type 2 diabetes and osteoarthritis, dynamic resistance exercise programs improved functional performance and muscle strength (though glycemic control gains may require longer duration). In stroke survivors, resistance training (even with lower-limb exercises) significantly improved insulin resistance (HOMA-IR), fasting glucose and lipid profiles. Thus, resistance exercise aids in glycemic control and lipid management in diverse patient groups.
5. **Cardiovascular health:** Incorporating resistance exercise into cardiac rehab or general health programs improves cardiovascular risk profiles. Alongside aerobic training, resistance training lowers blood pressure, improves cholesterol, and reduces central obesity. AHA guidelines now explicitly endorse resistance training to reduce CV risk[10]. Even in hypertensive or heart disease patients, supervised moderate-intensity resistance exercise is beneficial for vascular health and overall fitness.
6. **Bone health and fall prevention:** By increasing bone density, resistance exercise reduces the risk of osteoporosis-related fractures. Weight-bearing strengthening also improves balance and reaction time, lowering fall risk. In older adults, gains in leg strength and power help maintain gait and posture, thereby preventing falls and fractures. A meta-analysis showed that regular high-intensity resistance training significantly increased spine and hip BMD in postmenopausal women.
7. **Psychosocial and quality-of-life effects:** Patients who gain strength and function often experience less pain and greater confidence, which boosts mood and self-efficacy. In older adults, resistance training programs have been associated with reduced symptoms

of depression and anxiety, and improved cognitive function over time. Enhanced independence and ability to engage in social or daily activities further improve quality of life.

Reference: Kisner, Carolyn Therapeutic exercise: foundations and techniques / Carolyn Kisner, Lynn Allen Colby. — 5th ed.