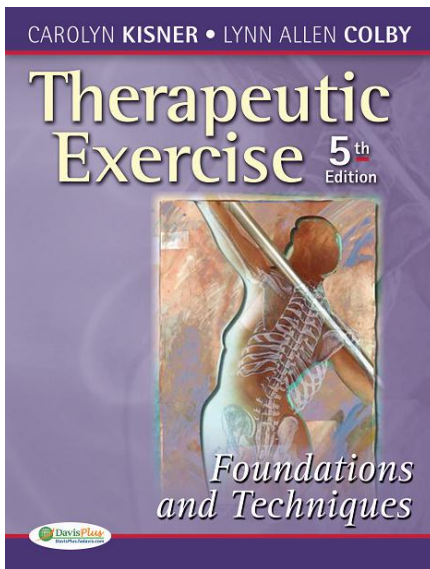


# Bài tập Plyometrics



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15/4/2014

# Resistance Exercise For Impaired Muscle Performance

## 6

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## Muscle performance

- Strength
- Power
- Endurance

## Resistance exercise

## Strength

*Muscle strength* is a broad term that refers to the ability of contractile tissue to produce tension and a resultant force based on the demands placed on the muscle.<sup>184,193,233</sup> More specifically, muscle strength is the greatest measurable force that can be exerted by a muscle or muscle group to overcome resistance during a *single* maximum effort.<sup>10</sup>

*Functional strength* relates to the ability of the neuromuscular system to produce, reduce, or control forces, contemplated or imposed, during functional activities, in a smooth, coordinated manner.<sup>39,219</sup> Insufficient muscular strength can contribute to major functional losses of even the most basic activities of daily living.

**Strength training.** The development of muscle strength is an integral component of most rehabilitation or conditioning programs for individuals of all ages and all ability levels.<sup>8,91,226</sup> *Strength training (strengthening exercise)* is defined as a systematic procedure of a muscle or muscle group lifting, lowering, or controlling heavy loads (resistance) for a relatively low number of repetitions or over a short period of time.<sup>30,32,103</sup> The most common adaptation to heavy resistance exercise is an increase in the maximum force-producing capacity of muscle, that is, an increase in muscle strength, primarily as the result of neural adaptations and an increase in muscle fiber size.<sup>9,121,193</sup>

# Strength (sức cơ)

- Sức cơ là lực lớn nhất có thể đo được, được tạo ra bởi cơ hay nhóm cơ để vượt qua kháng lực trong một lần cố gắng tối đa duy nhất
- Strengthening exercise (bài tập mạnh cơ)
  - Heavy load (resistance)
  - Low number of repetitions
  - Short period of time

## Power

*Muscle power*, another aspect of muscle performance, is related to the strength and speed of movement and is defined as the work (force  $\times$  distance) produced by a muscle per unit of time (force  $\times$  distance/time).<sup>10,184,193,201,237</sup>

In other words, it is the *rate* of performing work. The rate at which a muscle contracts and produces a resultant force and the relationship of force and velocity are factors that affect muscle power.<sup>30,201</sup> Because work can be produced over a very brief or an extended period of time, power can be expressed by either a single burst of high-intensity activity (such as lifting a heavy piece of luggage onto an overhead rack or performing a high jump) or by repeated bursts of less intense muscle activity (such as climbing a flight of stairs). The terms *anaerobic power* and *aerobic power*, respectively, are sometimes used to differentiate these two aspects of power.<sup>193,237</sup>

**Power training.** Many motor skills in our lives are composed of movements that are explosive and involve both strength and speed. Therefore, re-establishing muscle power may be an important priority in a rehabilitation program. Muscle strength is a necessary foundation for developing muscle power. Power can be enhanced by either

increasing the work a muscle must perform during a specified period of time or reducing the amount of time required to produce a given force. The greater the intensity of the exercise and the shorter the time period taken to generate force, the greater is the muscle power.<sup>201,237</sup>

For power training regimens, such as *plyometric training* or *stretch-shortening drills* the speed of movement is the variable that is most often manipulated.<sup>19,20,284,286,302</sup>

# Power (công suất)

- Rate = work (force  $\times$  distance) / time
- Công cơ tạo ra trong đơn vị thời gian
- Hai loại: anaerobic power (yếm khí) và aerobic power (hiếu khí)
- Bài tập plyometric training hay stretching-shortening drills (kéo giãn-co ngắn)

## Endurance

Endurance is a broad term that refers to the ability to perform low-intensity, repetitive, or sustained activities over a prolonged period of time. *Cardiopulmonary endurance (total body endurance)* is associated with repetitive, dynamic motor activities such as walking, cycling, swimming, or upper extremity ergometry, which involve use of the large muscles of the body.<sup>8,32</sup> This aspect of endurance is explored in Chapter 7.

*Muscle endurance* (sometimes referred to as *local endurance*) is the ability of a muscle to contract repeatedly against a load (resistance), generate and sustain tension, and resist fatigue over an extended period of time.<sup>8,10,14,32,233</sup> The term *aerobic power* is sometimes used interchangeably with muscle endurance.<sup>237</sup> Maintenance of balance and proper alignment of the body segments requires sustained control (endurance) by the postural muscles. In fact, almost all daily living tasks require some degree of muscle and cardiopulmonary endurance.

Although strength and muscle endurance, as elements of muscle performance, are associated, they do not always correlate well with each other. Just because a muscle group is strong, it does not preclude the possibility that muscular endurance is impaired. For example, an individual in the workplace who is strong has no difficulty lifting a 10-pound object several times—but does the worker have sufficient muscle endurance in the upper extremities and the stabilizing muscles of the trunk and lower extremities to lift 10-pound objects several hundred times during the course of a day's work without excessive fatigue or potential injury?

**Endurance training.** *Endurance training (endurance exercise)* is characterized by having a muscle contract and lift or lower a light load for many repetitions or sustain a muscle contraction for an extended period of time.<sup>9,32,193,264</sup> The key elements of endurance training are low-intensity muscle contractions, a large number of repetitions, and a prolonged time period. Unlike strength training, muscles adapt to endurance training by increases in their oxidative and metabolic capacities, which allows better delivery and use of oxygen. For many patients with impaired muscle performance, endurance training has a more positive impact on improving function than strength training. In addition, using low levels of resistance in an exercise program minimizes adverse forces on joints, produces less irritation to soft tissues, and is more comfortable than heavy resistance training.

# Endurance (sức bền)

- Sức bền là khả năng thực hiện những hoạt động cường độ thấp, lặp lại, hay kéo dài trên một thời gian dài
  - Cardiovascular endurance (total body endurance): walking, cycling, swimming, upper extremity ergometry
  - Muscle endurance (local endurance)
- Endurance training (endurance exercise)
  - Light load (tải nhẹ)
  - Many repetitions (lặp lại nhiều)
  - Extended period of time (thời gian dài)

# Lợi ích của bài tập kháng lực

## BOX 6.1 Potential Benefits of Resistance Exercise

- Enhanced muscle performance: restoration, improvement or maintenance of muscle strength, power, and endurance
- Increased strength of connective tissues: tendons, ligaments, intramuscular connective tissue
- Greater bone mineral density or less bone demineralization
- Decreased stress on joints during physical activity
- Reduced risk of soft tissue injury during physical activity
- Possible improvement in capacity to repair and heal damaged soft tissues due to positive impact on tissue remodeling
- Possible improvement in balance
- Enhanced physical performance during daily living, occupational, and recreational activities
- Positive changes in body composition: ↑ lean muscle mass or ↓ body fat
- Enhanced feeling of physical well-being
- Possible improvement in perception of disability and quality of life

- Cải thiện cả ba khía cạnh của chức năng cơ cơ
- Tác động toàn thân

# Plyometric training – stretching-shortening drills

**TABLE 6.12** Calculation of the Adjusted Working Weight for the DAPRE Regimen

Adjustment of Working Weight		
Repetitions in Set 3	Set 4	Next exercise session 3
0–2	↓ 5–10 lb	↓ 5–10 lb
3–4	↓ 0–5 lb	Same weight
5–6	Keep same weight	↑ 5–10 lb
7–10	↑ 5–10 lb	↑ 5–15 lb
11 or more	↑ 10–15 lb	↑ 10–20 lb

formed,<sup>19,199</sup> with a minimum amount of rest (15 to 20 seconds) between sets and stations. The program is progressed by increasing the number of sets or repetitions, the resistance, the number of exercise stations, and the number of circuit revolutions.

*Exercise order* is an important consideration when setting up a weight training circuit.<sup>15,20,206</sup> Exercises with free weights or weight machines should alternate among upper extremity, lower extremity, and trunk musculature and between muscle groups involved in pushing or pulling actions. This enables one muscle group to rest and recover from exercise while exercising another group and, therefore, minimizes muscle fatigue. Ideally, larger muscle groups should be exercised before smaller muscle groups. Multijoint exercises that recruit multiple muscle groups should be performed before exercises that recruit an isolated muscle group to minimize the risk of injury from fatigue.

## Plyometric Training—Stretch-Shortening Drills

High-intensity, high-velocity exercises emphasize the development of muscular power and coordination. Reactive bursts of force in functional movement patterns are often necessary if a patient is to return to high-demand occupational, recreational, or sport-related activities. Plyometric

**BOX 6.18** Example of a Resistance Training Circuit

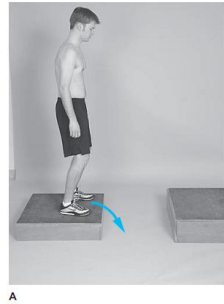
Station #1: Bench press → #2: Leg press or squats → #3: Sit-ups → #4: Upright rowing → #5: Hamstring curls → #6: Prone trunk extension → #7: Shoulder press → #8: Heel raises → #9: Push-ups → #10: Leg lifts or lowering

training is integrated into the advanced phase of rehabilitation as a mechanism to train the neuromuscular system to react quickly in order to prepare for activities that require rapid starting and stopping movements. This form of training is appropriate only for carefully selected patients.

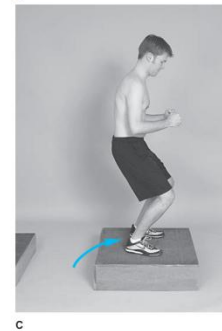
## Definitions and Characteristics

*Plyometric training*,<sup>37,193,284,286</sup> also called *stretch-shortening drills*,<sup>302</sup> or *stretch-strengthening drills*,<sup>285</sup> employs high-velocity eccentric to concentric muscle loading, reflexive reactions, and functional movement patterns. Plyometric training is defined as a system of high-velocity resistance training characterized by a rapid eccentric contraction during which the muscle elongates, immediately followed by a rapid reversal of movement with a resisted shortening contraction of the same muscle.<sup>285,286,302</sup> The rapid eccentric loading phase is the *stretch cycle*, and the concentric phase is the *shortening cycle*. The period of time between the stretch and shortening cycles is known as the *amortization phase*. It is important that the amortization phase is kept very brief by a rapid reversal of movements to capitalize on the increased tension in the muscle.

Body weight or an external form of loading, such as elastic bands or tubing or a weighted ball, are possible sources of resistance. An example of a stretch-shortening drill against the resistance of body weight is represented in Figure 6.44.



**FIGURE 6.44** Plyometric activity against the resistance of body weight. (A) Patient stands on a low platform;



**FIGURE 6.44** (continued) (B) Jumps off the platform to the floor, controlling the impact with a loaded, lengthening contraction of the hip and knee extensors and plantar flexors—the stretch phase; and (C) then without delay jumps forward onto the next platform using a concentric contraction of the same muscle groups—the shortening phase.

**BOX 6.18** Plyometric Activities for the Upper and Lower Extremities

## Upper Extremities

- Catching and throwing a weighted ball with a partner or against a wall; bilaterally then unilaterally
- Stretch-shortening drills with elastic tubing using anatomical and diagonal motions
- Dribbling a ball on the floor or against a wall
- Drop push-ups: from boxes to floor and back to boxes
- Clap push-ups

## Lower Extremities

- Repetitive jumping on the floor; in place; forward/backward; side to side; diagonally to four corners; jump with rotation; zigzag jumping; later, jump on foam
- Vertical jumps and reaches
- Multiple jumps across a floor (bounding)
- Box jumping: initially off and freeze; then off and back on box increasing speed and height
- Side to side jumps (box to floor to box)
- Jumping over objects on the floor
- Hopping activities: in place; across a surface; over objects on the floor
- Depth jumps (advanced): jump from a box, squat to absorb shock, and then jump and reach as high as possible

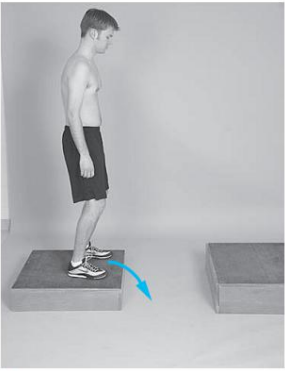
Additional examples of plyometric training for the upper and lower extremities are noted in Box 6.19.

## Neurological and Biomechanical Influences

Plyometric training is thought to utilize the series-elastic properties of soft tissues and the stretch reflex of the neuromuscular unit. The spring-like properties of the series-elastic components of muscle-tendon units create elastic energy during the initial phase (the stretch cycle) as the muscle contracts eccentrically and lengthens while loaded. This energy is briefly stored and then retrieved for use during the concentric contraction (shortening cycle) that follows. The storage and release of this elastic energy augments the force production of the concentric muscle contraction.<sup>203,7,284</sup>

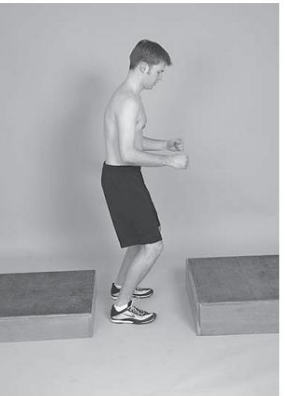
Furthermore, the stretch-shortening cycle is thought to stimulate the proprioceptors of muscles, tendons, ligaments, and joints, increase the excitability of the neuromuscular receptors, and improve the reactivity of the neuromuscular system. The term *reactive neuromuscular training* has also been used to describe this approach to exercise. More specifically, the loaded, eccentric contraction (stretch cycle) is thought to prepare the contractile elements of the muscle for a concentric contraction (short-

# Definitions and characteristics

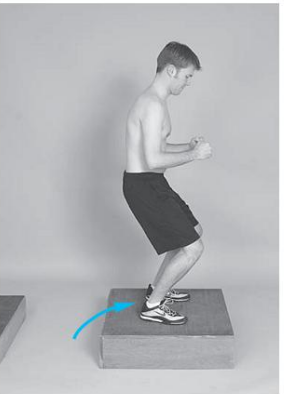


A

FIGURE 6.44 Plyometric activity against the resistance of body weight.  
(A) Patient stands on a low platform;



B



C

FIGURE 6.44 (continued) (B) jumps off the platform to the floor, controlling the impact with a loaded, lengthening contraction of the hip and knee extensors and plantarflexors—the stretch phase; and (C) then without delay jumps forward onto the next platform using a concentric contraction of the same muscle groups—the shortening phase.

- Sử dụng mẫu vận động chức năng, phản ứng phản xạ, tải lên cơ tốc độ cao từ ly tâm sang hướng tâm
- Gồm ba giai đoạn:
  - Cơ cơ ly tâm nhanh (giai đoạn kéo dẫn)
  - Giai đoạn nghỉ ngắn (giai đoạn giảm chấn –amortization)
  - Cơ cơ hướng tâm nhanh (giai đoạn rút ngắn)
- Tải lên cơ thường là trong lượng cơ thể hay tải nặng thêm vào

**BOX 6.19****Plyometric Activities for the Upper and Lower Extremities****Upper Extremities**

- Catching and throwing a weighted ball with a partner or against a wall: bilaterally then unilaterally
- Stretch-shortening drills with elastic tubing using anatomical and diagonal motions
- Dribbling a ball on the floor or against a wall
- Drop push-ups: from boxes to floor and back to boxes
- Clap push-ups

**Lower Extremities**

- Repetitive jumping on the floor: in place; forward/backward; side to side; diagonally to four corners; jump with rotation; zigzag jumping; later, jump on foam
- Vertical jumps and reaches
- Multiple jumps across a floor (bounding)
- Box jumping: initially off and freeze; then off and back on box increasing speed and height
- Side to side jumps (box to floor to box)
- Jumping over objects on the floor
- Hopping activities: in place; across a surface; over objects on the floor
- Depth jumps (advanced): jump from a box, squat to absorb shock, and then jump and reach as high as possible

# Plyometric cho chi trên và chi dưới

**Chi trên**

- Bắt và ném bóng
- Bài tập dây thun
- Tăng banh xuống nền
- Hít đất rơi
- Hít đất vỗ tay

**Chi dưới**

- Nhảy trên sàn
- Nhảy tại chỗ
- Nhảy nổi bước
- Nhảy bụi
- Nhảy bên
- Nhảy vượt
- Nhảy ếch
- Nhảy xỏm

## BOX 6.21 Precautions for Plyometric Training

- If high-stress, shock-absorbing activities are not permissible, do not incorporate plyometric training into a patient's rehabilitation program.
- If a decision is made to include plyometric activities in a rehabilitation program for children or elderly patients, select only beginning-level stretch-shortening drills against light resistance. Do not include high-impact, heavy-load activities—such as drop jumps or weighted jumps—that could place excessive stress on joints.
- Be sure the patient has adequate flexibility and strength before initiating plyometric exercises.
- Wear shoes that provide support for lower extremity plyometrics.
- *Always* warm-up prior to plyometric training with a series of active, dynamic trunk and extremity exercises.
- During jumping activities, emphasize learning techniques for a safe landing before progressing to rebounding.
- Progress repetitions of an exercise before increasing the level of resistance used or the height or length of jumps.
- For high-level athletes who progress to high-intensity plyometric drills, increase the rest intervals between sets and decrease the frequency of drills as the intensity of the drills increases.
- Allow adequate time for recovery with 48 to 72 hours between sessions of plyometric activities.
- Stop an exercise if a patient can no longer perform the plyometric activity with good form and landing technique because of fatigue.

# Chú ý khi tập plyometrics

- Nếu hoạt động cường độ cao không cho phép thì không thực hiện plyometrics
- Chọn loại nhẹ cho trẻ em và người già
- ROM và sức cơ đủ
- Mang giày khi tập chi dưới
- Luôn khởi động trước
- Khi nhảy, đảm bảo đáp đất an toàn, đúng kĩ thuật
- Tăng số lần lặp lại trước khi tăng tải hay độ cao, độ dài
- Cần nghỉ 48-72 giờ giữa hai lần tập
- Cần nghỉ khi BN không còn làm đúng kĩ thuật

**BOX 6.20****Sample Plyometric Sequence  
for the Upper Extremities**

- Warm-up activities
  - Trunk exercises holding lightweight ball: rotation, side-bending, wood-chopping
  - Upper extremity exercises in anatomical and diagonal planes of motion with light-grade elastic tubing
  - Prone push-ups
- Throwing motions with a weighted ball to and from a partner: bilateral chest press; bilateral overhead throw; bilateral side throw
- ER/IR against elastic tubing (90/90 position of shoulder and elbow)
- Diagonal patterns against elastic resistance
- Unilateral throwing motions with weighted ball: baseball throw; side throws
- Additional exercises
  - Trunk exercises holding weighted ball: abdominal curl-ups; back extension; sit-up and bilateral throw; long sitting throws
  - Clap push-ups
  - Prone push-ups from box to floor and back to box

# Ví dụ về qui trình tập Plyometrics cho chi trên

Khởi động: thân, chi  
trên, hít đất

Cử động ném

Xoay trong/xoay  
ngoài với dây thun

Dây thun chéo góc

Cử động ném một  
bên

Bài tập thêm

- Thân mình
- Hít đất vỗ tay
- Hít đất bật

# Plyometrics dịch sang tiếng Việt như thế nào?

- Tiếng Nhật: Để nguyên “Plyometrics” hay dùng Katagana
- Tiếng Trung Quốc: “Tăng cường thể huấn luyện”
- Tiếng Pháp: “Pliométrie”
- Tiếng Anh: “Jumping training”
- Tiếng Việt: “plyometrics”, “co-bật”