### Essential concepts of balance

The ability to maintain postural control or balance is a fundamental component of performance, injury resistance, and rehabilitation that follows an injury. Technically, balance can be defined as the ability to maintain one’s centre of gravity within that person’s base of support. The centre of gravity is the approximate midpoint of the body; while the location may vary between individuals, it is typically located at the midportion of the trunk. The base of support represents the area beneath a person that consists of every point of contact made between the body and the support surface (i.e., the floor). For example, the width between the feet of a standing individual would define the base of support. If an individual is standing still, the centre of gravity can move within the limits of stability, as found within the base of support. The limits of stability mean the area within which an individual can move one’s centre of gravity without changing the base of support (i.e., moving the feet) without falling.

Balance can be classified into static, semi-dynamic, and dynamic. Static balance applies to situations when an individual seeks to maintain postural control within a stationary position; for example, the individual is standing still on one foot. Semi-dynamic balance refers to instances when an individual seeks to maintain balance within a stationary limit of stability, yet the base supporting the body is in movement (e.g., individual riding on a skateboard). Dynamic balance occurs when a person seeks to maintain their centre of mass over an ever-changing limit of stability; for example, the individual is running on uneven surfaces.

Maintaining balance in these various conditions requires integration of multiple systems, including vision, vestibular, and somatosensory systems, as well as properly timed muscle contractions, to maintain the centre of mass within the limits of stability. The ability to maintain balance during various conditions is important for optimizing performance, reducing injury risk, and enhancing rehabilitation efforts. Thus, it is important for fitness professionals to understand the mechanisms and benefits of balance training as a vital component of care for all clients.

There may be many reasons why an individual has impaired balance. In general, an individual with a musculoskeletal injury (i.e., a ligament sprain or a muscle pull) or an alteration of sensorimotor function (i.e., due to a concussion or the normal process of aging) may have deficits in balance and likely benefits from balance training programs. The fitness professional can improve clients’ functionality across the spectrum of health and wellness by using individualized, comprehensive, and systematic balance training programs.

**Mechanisms of balance**

The ability to feel that the centre of mass (COM) is moving toward a person’s limits of stability is a product of three sense-based systems: vision, vestibular, and somatosensation. Vision is typically used to provide information to the central nervous system about the body’s location in space. Balance may be more difficult when an individual’s eyes are closed, because this person is no longer able to use vision to determine bodily position in space. Individuals may use vision to determine the best foot placement to maintain balance when moving over unstable surfaces. The vestibular system is controlled by sensory receptors in the inner ear and provide the brain information about spatial orientation and the movement of the head in space.

Vestibular receptors are important for maintaining balance while bending over, as well as dynamic movements, like hopping or squatting. Somatosensation refers to the ability to feel changes in pressure on the skin, muscle length, and joint angles. Somatosensation is critically important for balancing on unstable surfaces and tasks that involve dynamic balance. It is possible that individuals may prioritize information gained from one sense over the other two. Therefore, fitness professionals should incorporate balance training techniques that stress each of these senses to ensure their clients’ capability in attending to sensory information that arises from each of these three critical senses.

**Scientific rationale for balance training**

Researchers have shown that balance training can be effective at optimizing performance, improving resistance to injury, and enhancing rehabilitation. It is important for fitness professionals to understand the scientific basis for balance, ways to design a balance routine catering to the needs of the client, and methods to effectively communicate and efficiently implement a balance training program.

Performance

Several studies have demonstrated successful improvement in balance ability after healthy, physically active individuals have completed a balance training program. A systematic review found that 10-minute balance training programs, in which children performed three times per week for 4 weeks, appear to improve both their static and dynamic balance ability. Balance training has been shown successful in improving motor function of muscles in the lower extremity, as well as neuromuscular control, especially for those who have suffered from chronic ankle sprains. Individuals with musculoskeletal injuries can improve their ability to maintain their centre of mass within their limits of stability by specifically engaging in balance training.

Balance training should be incorporated into overall training programs, because balance training may improve additional performance metrics important to clients. For example, adding balance training to a resistance-training program can enhance lower extremity muscle strength gains, indicating that resistance-training regimens should include balance training to optimize strength gains.

In older individuals, balance training can improve functionality when applied to activities of daily living (e.g., chores, shopping, grooming, bathing), which may decrease their overall disability.

Furthermore, balance training tends to improve vertical jump performance in youth basketball players when compared to isometric strength training. Similarly, performing balance training along with agility exercises may improve dynamic balance during eyes-open and eyes-closed conditions, as well as improve agility-based outcomes and reaction time. Therefore, balance training should be considered as an important component of improving performance.

|  |
| --- |
| Improves static and dynamic balance  Improves neuromuscular control in the lower extremities  Improves balance after injury  Improves lower extremity muscular strength (especially when combined with resistance training)  Improves ability to participate in activities of daily living and decreases self-reported disability in older adults  Improves agility-based outcomes in athletes |

TRAINING TIP

Balance training has been shown to improve balance and coordination, which are necessary components in the process of becoming a well-rounded athlete. For safety reasons, balance exercises and equipment (e.g., foam pad, balance disc, wobble board) should not be used in conjunction with heavy loads, such as maximal or near maximal lifts.

Injury resistance

Balance training is an important component to emphasize when developing a program to improve injury resistance, whether the fitness professional is working with an athlete participating in a sport or a client whose goal is to perform daily living activities without falling.

Balance exercises are commonly included in lower extremity programs, referred to as injury prevention programs, for athletes to bolster resistance to injury. When designing injury prevention programs, these components are typically incorporated: stretching, strength, plyometric, and balance activities. Comprehensive injury prevention programs that include balance training have been shown to improve landing mechanics, which may decrease the risk of lower extremity injuries. Youth soccer athletes who participated in a 9-week injury prevention program demonstrated improvements in time-to-stabilization (a measure of balance ability), as well as vertical jump height. Female basketball athletes who participated in a 5-week balance training program improved landing movement mechanics and muscle activation during a single-limb landing, which may reduce the risk of certain lower extremity injuries, like an anterior cruciate ligament (ACL) injury. In fact, collegiate athletes with poor balance during landing tasks were at an increased risk of ACL rupture. A systematic review demonstrated that athletes undergoing balance training reduced the risk of suffering an ankle sprain by 46% when compared to athletes lacking any balance training.

The fitness professional can also tailor balance activities to be sport specific; for example, a basketball athlete can balance on one leg while passing the basketball back and forth. When incorporating balance training into an injury prevention program for athletes, ensuring activity performance in the sports environment with minimal equipment may improve compliance and overall adherence across a season.

Balance training is also beneficial for older adults. Falls are one of the leading causes of injuries and health-related complications in older adults. While both external (i.e., environmental) and internal (i.e., muscle strength) factors may influence the risk of falling, the body’s balance system plays a critical role in allowing an individual to maintain control over their own body’s placement and prevent a fall. In exercise programs that include balance training, research has shown up to a 20% reduction in the risk of falls in older healthy adults.

Balance training is a recommended intervention to be included in multifactorial training programs, which also include stretching and strengthening, for adults older than 65 years of age with a history of falling. Physical exercise interventions, including balance training that challenges posture in different positions, have been shown to reduce the number of falls in healthy older adults. A comprehensive 8-week exercise program that included progressively challenging balance activities showed older adults’ improvement in both physical performance and psychological confidence. When working with an older adult, it is important to ask the client if they have complaints of imbalances, such as feelings of unsteadiness or fear of falling, because individuals with these perceptions show a higher rate of falls. This information will help the fitness professional to properly incorporate balance training activities into the training plan.

|  |
| --- |
| Improves landing mechanics, which may reduce lower extremity injury, such as ACL injury and ankle sprains  Improves performance in athletes, such as vertical jump height  Reduces risk of falling in older adults  Improves physical performance and overall confidence during activities of daily living in older adults |

CRITICAL

When working with an older adult client, make sure to conduct a thorough preparticipation health screening and identify if your client is capable of performing balance training exercises. Some clients may need clearance by their healthcare provider to take part in a balance training program. Fitness professionals must ensure they are informed of any medical conditions that may influence the ability to balance, from a safety standpoint.

Rehabilitation

Balance training has been shown to enhance rehabilitation for various individuals following lower extremity injuries, such as ankle sprains and ACL injuries. Because some clients may have decreased balance, it is imperative to understand balance and how to design a balance routine that caters to the needs of the client.

High school athletes with chronic ankle instability who completed a 4-week balance training program during rehabilitation using a biomechanical ankle platform system board significantly improved both static and dynamic single-limb balance compared to those who did not do balance training as a part of their rehabilitation. Using either a traditional single-limb balance program (single-limb stance, single-limb stance with ball toss and kicking, step-down with single-limb stance) or a progressive hop-to-stabilization balance program (various single-limb hop-to-stabilization exercises) improved self-reported function, semi-dynamic balance, and joint position sense in athletes with chronic ankle instability.

Deficits in balance ability may persist for an extended period following an injury. A recent study found that individuals following an ACL reconstruction demonstrated worse semi-dynamic balance on both injured and uninjured limbs as far as 1 year postsurgery compared to healthy controls. Therefore, athletes with a prior knee injury will benefit from balance training programs for both limbs when working with a Certified Personal Trainer.

Additionally, balance training is important to enhance rehabilitation of individuals at risk for a fall or after a fall. Using perturbation-based balance training in a safe and controlled environment significantly reduced the incidence of falls in older adults. A perturbation is a mechanism where a postural disturbance is added to a task (i.e., lightly pushing on a client’s shoulders as they are balancing), which causes the client to learn to maintain or recover balance.

|  |
| --- |
| Improves performance during single-limb activities  Improves proprioception and self-reported function in athletes with ankle instability  Enhances rehabilitation outcomes for both limbs in athletes who suffer an ACL injury and surgery on one limb  Enhances rehabilitation outcomes that focus on decreasing the risk of falls in older adults |

CRITICAL

Certified Personal Trainers are not qualified to diagnose an injury or perform medical rehabilitation, as it is beyond their scope of practice. However, once the client has been cleared by a medical professional (i.e., physician, physical therapist), fitness professionals play an important role in helping balance-impaired individuals regain and continue to improve functionality, whether for simple activities of daily living or high-level sports. Consistent, clear communication between medical and fitness professionals is critical to ensure safety for the client and optimize the exercise program to help the client achieve personal goals.

**Importance of properly training the balance system**

An effective balance training program should challenge the threshold of an individual’s limit of stability. This threshold must be stressed in a multiplanar, proprioceptively enriched environment, using functional movement patterns to improve static, semi-dynamic, and dynamic balance.

Training in a proprioceptively enriched environment with appropriate types of balance equipment (i.e., floor, balance beam, half-foam roll, foam pad, balance disc, wobble board), correct technique, and at varying speeds facilitates maximal sensory input to the central nervous system. It also prepares the body for various scenarios that it may encounter in the real world, such as landing from a jump for an athlete or stepping off a curb for an older adult.

Fitness professionals are encouraged to implement progressive, systematic training programs to develop consistent, long-term changes in their clients. Training program designs that only focus on strength training protocols often deliver incomplete results, because the training program does not challenge the balance mechanisms of the human body. Balance training fills this gap by focusing on functional movement patterns in a multisensory, unstable environment. The design and implementation of balance exercises into a training program is critical for developing, improving, and restoring the synergy of muscle firing patterns required for dynamic balance and coordinated movement.

**Guidelines for balance training**

Balance exercises are a vital component of any integrated training program, because they help ensure optimal muscle recruitment and coordinated movement. Balance training exercises must be systematic and progressive. Fitness professionals should follow specific program guidelines, including proper exercise selection criteria and milestones for progression. Balance is improved through repetitive exposure to a variety of proprioceptively enriched environments.

| **Exercise Selection** | **Variables** |
| --- | --- |
| * Safe * Progressive   + Easy to hard   + Simple to complex   + Stable to unstable   + Static to dynamic   + Slow to fast   + Eyes open to eyes closed   + Known to unknown (cognitive task)   + Single task to dual task * Balance equipment examples   + Floor   + Balance beam   + Half-foam roll   + Foam pad\*   + Balance disc\*   + Wobble board\* | * Plane of motion   + Sagittal   + Frontal   + Transverse * Lower-body progressions   + Two-legs/stable (e.g., standing on the floor)     - Wide stance → Narrow stance → Tandem stance (heel-to-toe)   + Single-leg/stable (e.g., standing one-legged on the floor)   + Two-legs/unstable (e.g., standing two-legged on a balance modality)   + Single-leg/unstable (e.g., standing one-legged on a balance modality) * Perturbation   + Mild to moderate (e.g., gentle push in one direction → gentle push in multiple directions) |

\*These modalities come in many shapes and sizes that will dictate proper progression.

The main goal of balance training is to continually increase the client’s awareness of their limit of stability by increasing the proprioceptive demands of the exercise. An example of challenging the proprioceptive demand could range from having a 65-year-old client balance on the floor in a tandem stance (heel-to-toe posture) to having a 25-year-old athlete balance on one foot while standing on a balance disc.

**Designing a balance training program**

A proper balance training program should be systematic and progressive. Exercises can be progressed or regressed by changing the requirements for surface, visual condition, and body position or movement. Surfaces will change in difficulty as an individual moves from a stable surface (floor) to an unstable surface (e.g., half-foam roll, foam pad, or balance disc). Keeping the eyes open during an exercise is easier than having the eyes closed (visual input), moving the head around to look at various objects (vestibular input), or performing a cognitive task simultaneously (dual-task condition). Moving the contralateral (opposite) leg, trunk, or arms also makes a balance exercise more challenging, whereas standing on two legs (versus a single leg) simplifies the exercise. Caution should be used to change only one variable at a time. Following this strategy of progressions will enable the fitness professional to easily adapt exercises for each individual client, regardless of age or level of fitness.

Balance training progressions

When introducing balance exercises into an exercise program, the exercises should initially involve little joint motion of the balance leg. These entry-level balance exercises are designed to improve reflexive (automatic) muscle contractions to increase joint stability. Using this protocol, the body is placed in an unstable environment, so it learns to react by contracting the right muscles at the right time to maintain balance.

TRAINING TIP

The market currently offers several training modalities (i.e., types of equipment) that challenge one’s balance, and they can be very useful tools. However, to ensure the safety and effectiveness of balance training, individuals must start in an environment they can safely control and go through a systematic progression (i.e., floor, balance beam, half-foam roll, foam pad, and balance disc). Wobble boards can also be included in the progression, but the type of structure of the wobble board will dictate proper progression. Failing to follow the proper progression can cause movement compensations and improper executions of the exercise, decreasing the effectiveness of the exercise and increasing the risk for injury.

These types of exercises should be mastered before moving to more difficult forms of balance training. Sample exercises that follow this protocol include (but are not limited to) the following:

* Tandem stance
* Single-leg balance
* Single-leg balance reach
* Single-leg hip internal and external rotation
* Single-leg lift and chop
* Single-leg arm and leg motion
* Single-leg windmill
* Single-leg throw and catch

The next progression involves dynamic eccentric and concentric movement of the balance leg through a full range of motion. Movements require dynamic control in the mid-range of motion, with isometric stabilization at the end-range of motion. The speed and neural demands of each exercise are progressed. Sample exercises following this protocol include (but are not limited to) the following:

* Single-leg squat
* Single-leg squat touchdown
* Single-leg Romanian deadlift
* Multiplanar step-up to balance
* Multiplanar lunge to balance.

The last progression includes exercises that are designed to develop proper deceleration ability to move the body from a dynamic state to a controlled stationary position. In other words, these exercises combine hopping motions with a single-leg stance landing (holding the landing position for 3–5 seconds). Exercises in this level include (but are not limited to) the following:

* Multiplanar hop with stabilization
* Multiplanar single-leg box hop-up with stabilization
* Multiplanar single-leg box hop-down with stabilization.

The preceding paragraphs described methods for progressing balance exercises by increasing demands to body position and limb movement.

To reiterate:

Progression 1. Exercises should initially involve little joint motion of the balance leg.

Once these types of exercises have been mastered, a fitness professional can choose to make these exercises more challenging (if deemed appropriate) by integrating the following:

1. Balance modalities (e.g., balance beam, half-foam roll, foam pad, balance disc, wobble board)
2. Cognitive, dual-task scenarios (e.g., naming the months of the year while balancing on one limb)
3. Closing eye tasks
4. Head or eye movement

Progression 2. Exercises should involve movement of the balance leg through a full range of motion.

Once these types of exercises have been mastered, a fitness professional can again choose to make these exercises more challenging (if deemed appropriate) by integrating the following:

* Balance modalities
* Cognitive, dual-task scenarios
* Closing eye tasks
* Head or eye movement

Progression 3. Exercises should combine hopping motions with a single-leg stance landing, and holding the balance position for 3–5 seconds.

Once these types of exercises have been mastered, a fitness professional can again choose to make these exercises more challenging (if deemed appropriate) by integrating the following:

* Balance modalities
* Cognitive, dual-task scenarios
* Closing eye tasks
* Head or eye movement

It is important to plan exercise progressions to challenge the balance system by manipulating one variable at a time. The progressions implemented should be client-specific based on their own unique physical capabilities.

**Five kinetic chain checkpoints**

As with any training method, proper form and technique must be mastered to ensure proper muscle activation and to avoid injury. The skill required for balance training requires adequate focus and conscious attention during regular practice, especially to minimize the risk of falls while ensuring the lower limbs and trunk remain in ideal posture. As with all exercises, quality should always come before quantity or weight progression, and the five kinetic chain checkpoints should be monitored (see Figure 17-4):

1. *Feet* pointing straight ahead
2. *Knees* in line with the second and third toes (avoid allowing knees to cave inward)
3. *Hips* level and in a neutral position
4. *Shoulders* in a neutral position (not protracted or elevated)
5. *Head* with cervical spine in a neutral position (chin tuck)

**Balance exercises**

Tandem Stance

If necessary, position client next to a sturdy object that they can hold on to in case they lose their balance.

Single-Leg Balance

Make sure the gluteal musculature of the balance leg remains contracted while performing this and all balance exercises to help stabilize the lower extremity.

Single-Leg Balance Reach

Keep the hips level when performing balance exercises. This will improve balance and decrease stress to the low-back.

Single-Leg Hip Rotation

Make sure when performing this exercise to rotate through the hip of the balance leg versus the spine. This will decrease stress to the spine and enhance control of the core.

Single-Leg Lift and Chop

When performing balance exercises, make sure the knee of the balance leg always remains aligned with the toes.

Single-Leg Arm and Leg Motion

Move the contralateral limbs in a range of motion that can be safely performed while maintaining ideal posture.

Single-Leg Windmill

Move the trunk through a range of motions that can be safely performed while maintaining ideal posture. This requires adequate core stabilization in addition to maintaining balance.

Single-Leg Throw and Catch

The fitness professional can use several methods to increase the demand of this exercise:

* Toss the medicine ball at various heights and across the body
* Increase the distance between both individuals
* Increase velocity of each throw

Single-Leg Squat

As mentioned earlier, make sure the knee always remains aligned with the toes without moving inside or outside the second and third toes. This will decrease stress to the knee.

Single-Leg Squat Touchdown

If the client cannot touch their foot, have them first work on reaching to their knee, next to their shin, and finally to their foot.

Single-Leg Romanian Deadlift

Use the same progression with this exercise as performed in the single-leg squat touchdown:

1. Reach to the knee
2. Reach to the shin
3. Reach to the foot

Multiplanar Step-Up to Balance

At the end position, make sure that the hip of the balance leg is in full extension for maximal recruitment of the gluteal musculature.

Multiplanar Lunge to Balance

When performing a lunge, make sure the stride length is not too large, particularly if one has tight hip flexors. This can force the lumbar spine into excessive extension, increasing stress to the lower back.

Multiplanar Hop with Stabilization

Make sure the landing is soft and quiet to ensure efficient acceptance of forces through the tissues, and keep the knee aligned with the second and third toes.

Multiplanar Single-Leg Box Hop-Up with Stabilization

Choose a box or platform with a height suitable for the client’s ability level.

Multiplanar Single-Leg Box Hop-Down with Stabilization

Once again, keep the knee in line with the toes when landing, and land as softly as possible.