

Designing balance training programs

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Balance training has been identified as one of the top 10 worldwide trends in the fitness industry. The 2008 “Physical Activity Guidelines for Americans” suggests balance training at least 3 days a week for inactive and active older adults (≥ 65 yr). Although the ACSM (2010) makes no specific recommendations for exercises to include in a balance training program, the guidelines state that neuromuscular training (i.e., balance, agility, and proprioceptive training) is effective for preventing falls. Also, a review of balance training studies concluded that balance exercises are effective for reducing the risk of ankle sprains in athletes; 6 wk of balance training after an acute ankle sprain substantially reduces the risk of a recurrent sprain (McKeon and Hertel 2008). General recommendations for designing balance training programs are presented in the following:

Balance Training Exercise Prescription

Compared to the other physical fitness components, there is a lack of research dealing with balance training for athletes, children, and older adults. It is difficult to compare studies examining the effects of exercise on balance because of diversity in the populations (e.g., young athletes to frail older adults), as well as the lack of standardization in balance outcome measures and training regimens. Also, there is no gold standard measure of balance. The following questions address issues you should consider when prescribing balance training for your clients.

- What types of physical activities may be used to improve balance?

Given that balance performance is affected by muscle strength and flexibility, resistance training and stretching programs may be useful for maintaining and improving balance. In addition to increasing strength and range of motion, Pilates, yoga, tai chi, dance, walking, and combinations of exercise modes may be suitable activities for improving balance. Balance discs, foam pads and rollers, balance boards, stability balls, and computerized balance training systems are tools that may add variety and challenge to balance training programs.

In a review of exercise interventions to improve balance, Howe and colleagues (2007) analyzed results from 34 studies having a total of 2883 participants. The researchers categorized the training interventions as follows: gait, balance, coordination, and functional tasks training; strength training; tai chi; general physical activity (walking); and multimodal physical activity programs that used a combination of exercise modes. Table 12.5 summarizes the positive effects of these interventions on direct and indirect measures of balance.

Table 12.5 Positive Effects of Various Physical Activity Interventions on Balance*

Type of training	Direct measures	Indirect measures
Gait, balance, coordination, functional tasks training	Static and dynamic stability with force platform Limits of stability	One-leg stance with eyes closed Berg Balance Test
Resistance training	Omni-directional tilt	Functional reach One-leg stance with eyes closed Tandem stance Gait speed
Tai chi training		Walking on balance beam One-leg stance with eyes closed
General physical activity (walking)		Tandem walking Tandem stance Functional reach Walking on balance beam Timed up and go
Multimodal training	Body sway Limits of stability	Functional reach Tandem stance Tandem walking

*Training significantly improved performance on the direct and indirect balance tests listed.

- What types of balance training activities can be used with older adults?

In addition to flexibility and resistance training, exercise programs specifically designed to improve the functional ability of the lower extremities may be effective for improving balance and preventing falls in older adults. Shigematsu and colleagues (2008) compared the effects of regular walking and square-stepping exercise on balance, leg power, agility, and reaction time of adults 65 to 74 yr. The participants exercised for 70 min, two times per week, for 12 wk. The square-stepping exercise program included forward, backward, lateral, and oblique stepping patterns performed on a felt mat (100 x 250 cm) that was partitioned into 40 squares, 25 cm each. Each stepping pattern was repeated 4 to 10 times, and the patterns became progressively more complex, ranging from elementary forward-backward stepping to advanced lateral, oblique, and anterior-posterior patterns of stepping. Compared to the walking program, square-stepping exercise produced significantly greater improvements in leg extension power, forward-backward tandem walking, stepping with both feet, walking around two cones, and reaction time. Preliminary results suggest that square-stepping exercise is more effective than regular walking in reducing risk factors associated with falling.

In another study, proprioceptive balance training involved bilateral dorsiflexion/plantar flexion and supination/pronation of the ankle and bilateral squats during standing on semicompressible foam roller devices (Bellew et al. 2005). These devices are approximately 13 x 6 in. (33 x 15 cm) and resemble a football cut lengthwise. During each exercise session, subjects performed two 2 min bouts of bilateral supination/pronation and two 2 min bouts of bilateral plantar flexion/dorsiflexion. Each 2 min set of bilateral movements of the ankle was followed by partial squats (one set of 10 reps). This balance training protocol was performed 2 days/wk for 5 wk. Compared to a sedentary control group, the training group showed significant improvements in functional reach test (25%) and a lower extremity reach test (16%).

Takeshima and associates (2007) compared the effects of aerobic, resistance, balance, flexibility,

and tai chi training on the functional fitness of older adults. Exercise programs were performed for 12 wk, 2 days/wk, for each exercise training mode except for the aerobic training (3 days/wk for 90 min). While resistance training elicited the greatest improvement (31%) in upper body strength, balance training produced the greatest increase in lower body strength (40%). Resistance training, tai chi, and balance training each produced similar gains in balance and agility (10%).

Hill and colleagues (2007) examined the effects of physical activity that combined yoga, tai chi, and resistance training. At the end of this 6 mo program, strength, balance, and gait endurance of older adults were significantly improved. Those who attended classes 2 days per week improved more than those averaging only once per week.

- Does resistance training improve balance?

Improved balance is often mentioned as one of the benefits of resistance training. Orr and colleagues (2008) recently published the first systematic review of studies that assessed the effect of progressive resistance exercise training on balance of older adults. They noted that only a small percentage of balance outcome measures were significantly improved due to resistance training: static balance (26%), dynamic balance (14%), functional balance (57%), and computerized dynamic posturography (8%). Thus, resistance training as an isolated intervention does not consistently improve balance of older adults. Part of the discrepancy in results may be a function of the fact that in many of these studies, the researchers selected universal whole-body and lower body strength exercises for the resistance training programs instead of identifying key muscles used for balance.

These results also suggest that strength alone is not the major underlying mechanism for poor balance. Muscle power (force \times velocity) may also be a limiting factor in balance control. Age-related decreases in neural processing may diminish the ability to develop force rapidly in response to postural challenges (Orr et al. 2008). Mayson and colleagues (2008) reported that leg press velocity was positively related to dynamic balance performance (i.e., Berg Balance Scale, POMA, and dynamic gait index), whereas greater leg strength was associated with better performance on static balance tests (e.g., unipedal stance test).

In future studies addressing the use of progressive resistance training, it may be prudent to focus on the type of balance to be developed (i.e., static, dynamic, or functional), as well as specific muscle groups critical for balance such as the ankle dorsiflexors and plantar flexors, the knee extensors and flexors, and the hip abductors and adductors. Hess and Woollacott (2005) reported that a high-intensity strength training program targeting key lower extremity muscle groups (i.e., knee flexors and extensors and ankle plantar flexors and dorsiflexors) significantly improved the postural control in balance-impaired older adults.

- Does balance training reduce the risk of ankle sprains?

Research demonstrates that balance training using balance boards, elastic tubing, ankle discs, and foam pads may reduce the risk of ankle injury and reinjury in physically active individuals (Han et al. 2009; Hoffman and Payne 1995; Verhagen et al. 2004). These programs use a combination of strengthening and coordination exercises to rehabilitate injured ankles and to improve balance. Han and colleagues (2009) reported that dynamic balance of healthy young adults with and without a history of ankle sprains was improved following a 4 wk elastic tubing exercise program with lower body resistance exercises performed in four directions (i.e., front pull, back pull, crossover, and reverse crossover). For this program, participants performed three sets of 15 repetitions, three times per week. Improvement in balance performance was retained up to 4 wk posttraining, suggesting that this form of balance training may improve ankle stability.

Sample Multimodal Balance Training Program			
Client data			
Age	65 yr	Method	Tai chi, Pilates, lunges, boxing, agility training
Gender	Female	Frequency	3 or more days/wk
Body weight	145 lb	Duration	45 to 60 min per session
Program goal	Improve static and dynamic balance; prevent falls		
Exercise mode	Principles	Actions	Progressions
Tai chi	<ul style="list-style-type: none"> ■ Increase limits of stability ■ Improve rhythmic movements ■ Increase ROM ■ Control of center of gravity 	<ul style="list-style-type: none"> ■ Prayer wheel: slow, rhythmical weight shifts coordinated with large arm circles ■ Cat walk: slow and purposeful steps, with diagonal weight shifts ■ Cloud hands: slow lateral steps with trunk vertical ■ Part the horse's mane: coordination of arms and legs while walking forward ■ Repulsing the monkey: slow, backward walking with diagonal weight shifts 	Learn one movement per week starting with weight shift and leg placement, progressing to coordinated arm and torso movements.
Agility	<ul style="list-style-type: none"> ■ Improve coordination ■ Quick change in direction ■ Increase mobility in tight spaces 	<ul style="list-style-type: none"> ■ High knee stepping with hand slapping knees ■ Lateral shuffle ■ Tire course: wide-based quick high steps and turns 	Begin exercises at self-paced tempo and gradually increase speed. Progress to quick changes in direction and pace. Add dual tasks like counting aloud while moving.
Lunges	<ul style="list-style-type: none"> ■ Stepping for postural correction ■ Increase limits of stability ■ Quick change in direction 	<ul style="list-style-type: none"> ■ Postural correction: lean until center of mass is outside base of support, requiring a step; in all directions ■ Multidirectional stepping in clockwise direction ■ Dynamic lunge walking 	Start with firm surface and progress to one foot on foam pad and then both feet on foam pad. Perform exercises in well-lit room and progress to wearing sunglasses and then blindfolded. Use arms reciprocally while lunging and then progress to lifting arms overhead while holding a ball.
Boxing	<ul style="list-style-type: none"> ■ Anticipatory postural adjustments ■ Postural corrections ■ Backward walking ■ Fast arm and foot motions 	<ul style="list-style-type: none"> ■ Jab: short, straight punch from shoulder ■ Cross: power punch with trunk rotation ■ Hook: short, lateral punch ■ Combination: two or more punches delivered quickly 	Start with lateral stance to punching bag; progress to pivoting on back foot and walking backward around bag. Start at a self-paced tempo and gradually increase bursts of speed for 15 to 30 sec.
Pilates	<ul style="list-style-type: none"> ■ Improve postural control, functional transitions, and sequencing actions 	<ul style="list-style-type: none"> ■ Sit-to-stand maneuvers ■ Floor transfers and bridging ■ Rolling prone lying ■ Bird dog, cat-camel ■ Half-kneeling to stand 	Gradually improve form and speed during the movements.

- How effective is tai chi for improving balance and preventing falls in older adults?

Over the past few decades, tai chi has increased in popularity. Between 1992 and 2001, there were 11 published randomized clinical trials in the tai chi literature compared to 31 published from 2002 to 2007 (Li et al. 2009). The National Institute on Aging sponsored two studies on tai chi for older adults (Wolf et al. 1996; Wolfson et al. 1996). In the first study, the effects of tai chi on strength, flexibility, cardiovascular endurance, body composition, functional ability, and occurrence of falls were examined. Tai chi reduced falls and had a favorable impact on components of fitness and functional ability. The second study demonstrated that improvements in balance (measured by one-leg stance, limits of stability, sensory organization tests) and lower body strength resulting from a 3 mo balance training intervention could be sustained by participation in a low-intensity maintenance program of tai chi for 6 mo after the intervention (Wolfson et al. 1996).

Li and colleagues (2005) studied the effects of a 6 mo tai chi program (three times per week) on

balance and number of falls in older men and women 70 to 92 yr. Compared to results for a control group that participated in a stretching program, the risk of multiple falls was 55% lower for the tai chi intervention. Tai chi participants showed significant improvements in all measures of balance including the Berg Balance Scale, Dynamic Gait Index, functional reach, and one-leg stance. Studies suggest that tai chi is an effective form of exercise for reducing falls and improving dynamic and functional balance performance of older adults (Kuramoto 2006; Maciaszek et al. 2007; Rogers, Larkey, and Keller 2009).

Wu (2002) reported that tai chi interventions improved one-leg stance with eyes open and Romberg test scores in 20 to 60 yr and older (>75 yr) adults. Tai chi training had only a limited effect on walking and timed get up and go scores.

- What is the optimal style of tai chi for improving balance?

Tai chi is practiced in a variety of styles, for example Yang, Wu, and Tai Chi Chih. Each style has its own movements and traditional length of practice. The Yang style uses a wide stance and steady, slow speed of movement with constant knee flexion. Shifting body weight in this stance demands strength and flexibility. In contrast, the Wu style uses higher stances with a narrower stance width and slower movements, requiring more balance than strength compared to other styles. Therefore, the Wu style of tai chi may be more appropriate for balance training programs and interventions (Wu 2002).

- How many tai chi sessions are needed to show improvement in balance?

The research clearly shows that the number of tai chi sessions makes a difference in terms of training effects on balance. Generally, 40 or more sessions are needed to show significant improvements in balance performance. To reduce risk of falls, tai chi training programs should be a minimum of 15 wk. Due to age-related declines in physical abilities, the duration and frequency of tai chi programs for older adults may need to be increased to derive the degree of improvement seen in younger adults.

- Is yoga an effective exercise mode for improving balance?

Despite the popularity of yoga, there are a limited number of randomized control studies assessing the effects of yoga on physical fitness and motor performance. Oken and colleagues (2006) reported that a 26 wk Hatha yoga intervention produced significant improvements in the timed one-leg stand with eyes open and chair sit-and-reach test scores of healthy older men and women 65 to 85 yr. The yoga training consisted of one 90 min session per week with unsupervised home practice during the week. During the training, participants were taught 18 poses; during the exercise sessions, seven or eight poses were held for 20 to 30 sec each.

Balance Training Programs

In light of the complex nature of balance and the paucity of research studies dealing with balance assessment and training, it is not possible at this time to make firm recommendations for prescribing

a balance training program for your clients. You can use the general guidelines presented in this section as a starting point. You should individualize programs to take into account your client's needs, goals, age, and physical activity status. Keep in mind that balance training is task specific. Task-specific exercises, targeting a single, specific balance or gait impairment, are more effective than generalized exercise for improving balance. Techniques from a variety of exercise modalities can be combined to form a comprehensive balance program that challenges your client. In the sample multimodal program, exercises from tai chi, Pilates, agility training, boxing, and lunges are used to improve balance and mobility of an older adult (see p. 311).

There are many excellent resources available for designing an individualized balance training program for your clients. ABLE Bodies Balance Training (see Scott 2008) presents a 16 wk exercise program that safely takes older adults through the exercise progressions for improving balance and mobility, flexibility, posture and core stability, strength, and cardiorespiratory endurance. Resources for developing safe exercise programs for improving balance and functional fitness of older adults are available (see Rose 2003; Scott 2008). For ideas about incorporating Pilates and yoga workouts into balance training programs, see Isacowitz (2006) and Shaw (2009).

GUIDELINES FOR DESIGNING BALANCE TRAINING PROGRAMS

- **Mode:** Tai chi, Pilates, yoga, static and dynamic balance training exercises, resistance training, or a combination of modes
- **Equipment:** Balance discs, foam pads and rollers, balance boards, stability balls, computerized balance systems, and force platforms to add variety and challenge to the program
- **Frequency:** Minimum of 2 or 3 days/wk
- **Time:** 45 to 60 min per session
- **Duration:** 4 to 6 mo depending on exercise mode

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