The Special Populations Column provides personal trainers who work with apparently healthy or medically cleared special populations with scientifically supported background information.

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Physical Activity and Traumatic Brain Injury

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SUMMARY

COMPLETING THE RECOMMENDED AMOUNTS OF PHYSICAL ACTIVITY IN THE FORM OF STRENGTH AND CONDITIONING EXERCISES EACH WEEK MAY PREVENT REGRESSION OF PERFORMANCE, DECREASE THE RISKS OF SECONDARY HEALTH CONDITIONS, AND IMPROVE THE FUNCTIONAL CAPACITY OF AN INDIVIDUAL WITH A TRAUMATIC BRAIN INJURY HELPING REGAIN INDEPENDENCE AFTER INJURY.

OVERVIEW OF TRAUMATIC BRAIN INJURY

Traumatic brain injury (TBI) is defined as an impact to the head that impairs brain function and is most often caused by falls (28% of cases), motor vehicle accidents (20%), collisions (19%), or assaults (11%) (8). As the leading cause of death and disability in the United States (11), 1.4 million Americans suffer a TBI each year (greatest risk = 15–19 years old), proving fatal for 50,000 and requiring hospitalization for 235,000. Currently, 5.3 million individuals in the United States live with physical and psychological impairments as a result of TBI (11).

Physical functions, cognitive skills, emotions, social interaction, and quality of life can be affected, and the severity of the disability depends on the region of the brain damaged and the force of the impact (10). There are a number of resulting cognitive, sensory, and motor impairments that can lead to reduced functional capacity or ability to complete activities of daily living independently (e.g., walking, shopping, cooking, cleaning) (10).

The range and complexity of impairments experienced after TBI result in extremely high lifetime economic costs, which have been estimated at $60 billion annually in the United States (4). Consequently, modes of rehabilitation that pave the way for improved functioning and reduced healthcare costs can play an important role in the long-term rehabilitation and recovery of individuals after TBI. One important part of a rehabilitation program is physical activity (PA). The purpose of this column is to educate the reader about the benefits of PA and also help understand how to create a PA program for individuals with TBI. This column discusses the benefits, considerations, precautions, and recommendations for performing strength and conditioning (S&C) training.

BENEFITS OF STRENGTH AND CONDITIONING FOR INDIVIDUALS AFTER TRAUMATIC BRAIN INJURY

PA, which includes S&C, is the number 1 indicator of health and is associated with reduced mortality, incidence of disease, and occurrence of secondary conditions (12). The U.S. Department of Health and Human Services recommends that individuals with disabilities, where possible, complete 150 minutes of moderate-intensity activity (moderate-intensity activities are defined as those needing 3.0–5.9 METs [MET refers to metabolic equivalent]. One MET is the rate of energy expenditure while sitting at rest. It is an oxygen uptake of 3.5 mL/kg/min. PAs are frequently classified by their intensity using the MET as a reference (12).), and an example is walking briskly at 3.0 mph. On an absolute scale of 1–10, moderate-intensity activity is completed at 3.0–5.9 times the intensity of rest. Alternatively, individuals can complete 75 minutes of vigorous-intensity PA, which is defined as activities needing 6.0 METs, and an example includes running at 10 minutes per mile (6.0 mph). On an absolute scale, vigorous-intensity PA is completed at 6.0 or more times the intensity of rest (Table 1).

In addition to the moderate- and vigorous-intensity PAs, it is also recommended that individuals complete 2 days of strength training each week (12). Individuals who complete the recommended amount of PA have a decreased risk of developing adverse chronic conditions, such as cardiovascular disease, osteoporosis, hypertension, poor mental health, and premature death (12). Specific to individuals with a TBI, aerobic conditioning and strength training can result in the following benefits:

- increased aerobic capacity because of aerobic conditioning (6);
- decreased risks of secondary and chronic conditions (e.g., hypertension, osteoporosis, cardiovascular disease) (12);
- increased muscle strength, aerobic capacity, and endurance when strength training is added to aerobic conditioning in a circuit program (1);
- potential improvements and greater independence in daily tasks, although more research is needed in this area (Table 2) (3).

CONSIDERATIONS, PRECAUTIONS, AND RECOMMENDATIONS FOR STRENGTH AND CONDITIONING TRAINING

Because of the complexity of the brain, variety of impairments associated with a TBI, and range of severity, it is necessary to use several considerations when developing an individualized program for each person's specific needs. A multidisciplinary approach to programming for individuals with a TBI by consulting key personnel within the rehabilitation process, including physical, occupational, recreational, educational, psychological, speech, and vocational therapists, is often warranted.

Each specialist will have valuable insight into the "best practices" for the individual, which may be used to effectively meet his or her unique needs. Each individual's capacity to exercise is largely influenced by the extent and location of damage to the brain. Thus, knowing the areas of the brain that were damaged will help with individualized activity prescription as there are unique cognitive and motor functions associated with different areas of the brain (see Table 3 for examples) (2). This knowledge will help practitioners plan more effectively for the individual and create a PA program because cognitive and motor impairments play a significant role in planning and prescription. Impaired cognition may cause problems with setting realistic goals, memory, communication, information processing, and following multistep directions. Each of these limitations could hinder the individual's ability to safely carry out a trainer's instructions (2). Subsequently, an individual's ability to make safe and suitable decisions in exercise settings (e.g., intensity, duration, mode) can be compromised (14). Individuals with a TBI may also suffer from psychological impairments, such as depression, anger, anxiety, and irritability (7), which can also negatively affect their behavior (2).

Because cognitive functioning warrants serious consideration, it is important to understand that individuals are classified based on levels of cognitive functioning with the Ranchos Los Amigos Cognitive Functioning Scale (RLACFS). There are 8 levels to the scale ranging from I = "no response" to VIII = "purposeful and appropriate." Consequently, RLACFS scores can be used as indicators of the skills an individual can complete. For example, an individual who scores V on the RLACFS may frequently demonstrate confusion when following and remembering instructions and have difficulty staying focused, whereas an individual who scores VII will require less instruction and monitoring. The type of instruction, supervision, and support provided to individuals with differing cognitive and motor functioning is

Table 1
Recommendations for aerobic exercise program

Part of the body	Mode	Primary muscles worked	Frequency	Duration	Intensity	Progression
Lower body	Treadmill	Glutei, quadriceps, hamstrings	3–5 d/wk	20–60 min/session (or multiple 10-min sessions)	40–70% of $\dot{V}o_2$peak	Increase walking or ergometer speed/distance
	Seated stepper					
	Cycle ergometer					
Upper body	Arm ergometer	Deltoid, triceps, biceps				
Upper and lower body	Upper- and lower-body ergometer	Deltoid, triceps, biceps, glutei, quadriceps, hamstrings				

Safety of the individual exercising should not be compromised, and modifications to the exercise should be made to suit individual requirements.

Modified from Durstine (4).

critical to an individual's success in an exercise program.

Two other measures used to classify the severity of TBI and the resulting disabilities are the Glasgow Coma Scale and posttraumatic amnesia (PTA). The Glasgow Coma Scale is a standardized 15-point test that uses 3 measures–eye opening, best verbal response, and best motor response–to determine the severity of the patient's brain injury. Scores of 13–15, 9–12, and 3–8 represent mild, moderate, and severe disability, respectively. PTA duration is used by clinicians and researchers as an index of severity of TBI. PTA scores of 1–4 hours represent mild brain injury, and those of 1–6 months represent extremely severe brain injury. Professionals should use the scores from these measures to better understand the cognitive functioning of the individual and implement appropriate programs.

Along with motor and cognitive impairments, there are a number of potential medical complications an individual may experience after TBI. These can include low oxidative capacity and decreased vital capacity (9), resulting in reduced exercise capacity and increased fatigue, especially during higher-intensity activities. Thus, exercise sessions should be initiated at a lower intensity to avoid hyperventilation. Seizure disorders are another important medical consideration when planning an S&C program for people after a TBI. Seizure disorder medication can negatively impact cognitive functioning, and individuals with a TBI who experience seizures are at a greater risk of having a seizure during exercise because of the increased intensity and demand on the cardiovascular system (2). As a result, seizure threshold testing is an important consideration and should be conducted by a trained physician (13).

When working with an individual who typically experiences seizures, that person should always have assistance in case a seizure occurs. In general, it is important for practitioners to provide a safe and supportive environment for each client depending on his or her

Table 2
Recommendations for resistance exercise program

Part of the body	Equipment	Movement	Muscles worked	Frequency	Duration	Intensity	Progression
Chest	Chest (bench) press	Shoulder adduction and elbow extension	Pectorals, triceps	3 d/wk	1–2 sets of 8–12 repetitions	To moderate volitional fatigue, rest 2 min between sets	Increase resistance as tolerated by 2–5%
Back	Cable front pull-down	Shoulder adduction and elbow flexion	Latissimus dorsi, biceps brachii				
Abdomen	Abdominal crunch	Trunk flexion	Abdominals				
Low back	Back extension	Trunk extension	Erector spinae				
Arms	Biceps (arm) curls	Elbow flexion	Biceps brachii				
Legs	Leg extension	Knee extension	Quadriceps				
Legs	Seated leg curls	Knee flexion	Hamstrings				
Lower legs	Heel raises	Ankle plantar flexion	Gastrocnemius, soleus				

Safety of the individual exercising should not be compromised, and modifications to the exercise should be made to suit individual requirements.

Modified from Durstine (4).

Table 3
Physical activity and traumatic brain injury (2)

Location of injury	Category of impairment	Specific impairments
Cerebellum, cerebral cortex, frontal cortex	Motor	Ataxia (e.g., poor coordination)
		Apraxia (e.g., loss of ability to plan movements)
		Spasticity (e.g., abnormally high levels of muscle tone or stiffness)
		Hypotonia (e.g., loose or floppy muscles)
Frontal lobe	Cognitive	Disorientation
		Attention
		Concentration
		Memory
		Poor judgment
		Inability to plan
		Problem-solving difficulties

individual needs. Exercises are contraindicated in individuals experiencing severe seizures, spasticity, ataxia, and difficulties (15).

CONCLUSION

Because of the nature of the impairments experienced after TBI, individuals often have trouble retaining the physical (e.g., flexibility, coordination) and cognitive (e.g., exercises included in strength program) skills learned if they are not completed regularly. Thus, activities must be completed on a regular basis.

Completing the recommended amounts of PA in the form of S&C exercises each week may also decrease the risks of secondary conditions, such as hypertension, osteoporosis, and cardiovascular disease. This underscores the importance of regular S&C for a population already at increased risk of adverse health conditions. Most importantly, improvements in strength and aerobic capacity have the potential to improve the functional capacity of an individual with a TBI and help regain independence after injury.

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ERRATUM

Exercise Guidelines for Pregnant and Postpartum Women: Erratum

In the article that appeared on page 100 of volume 33, issue number 3, the author headshots and biographies were mislabeled. The corrected author headshots and biographies appear below.

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