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Recommendations for Implementing an Aquatic Plyometric Program

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PLYOMETRICS HAVE BEEN UTILized as a training technique for many years to increase physical performance variables such as speed, strength, and power. Plyometric activity activates a muscle's stretch-shortening cycle, which is created by a rapid eccentric stretch of a muscle followed immediately by a rapid concentric contraction, producing a forceful explosive movement (2–4, 6, 8, 10, 11, 22). When used in conjunction with periodized strength training, plyometrics may be beneficial for athletes or physically active individuals. Research has shown improvements in vertical-jump performance, leg strength, power, and increased joint awareness and proprioception (2, 3, 10, 16, 22).

Practitioners can incorporate 4 basic training plyometric drills that elicit the stretch-shortening cycle in order to develop explosive lower-body movements (4, 11). The first drill, jumps, are defined as movements ending with a 2-foot landing. Examples include jumping in place (vertical jump) or the standing jump. Hops are classified as a movement beginning and ending with a 1- or 2-foot landing of the same foot or feet. Hops can be performed with 10 or fewer repetitions (short-response hops) or performed over a distance of 30 m or more (long-response hops). Examples of hops include 2-foot ankle hops, side-to-side ankle hops, or lateral cone hops. Bounds are classified as a series of movements where the individual lands successively on alternate feet. Bounds can be classified as long response (30 m or more in distance) or a series of short-response repetitions. Examples of bounds include single-leg bounding, skipping, or alternate bounding with single-arm action. Finally, shock drills include box jumps and in-depth jumps. Box jumps have individuals jumping on and off of boxes and include exercises such as the alternating push-off, side-to-side box shuffle, and pyramiding box hops. In-depth jumps have individuals step off a box and perform a maximal jump. In-depth jumps include jumping from a box, single-leg depth jumps, and depth jump over barrier.

Injury Potential

Although plyometrics have shown increases in several lower-extremity performance variables, the potential for injury exists. Plyometrics, in particular in-depth jumping, potentially increases the amount of force delivered to the musculoskeletal system, resulting in possible lower-extremity injuries (8). Some factors that may contribute to greater risk of injury include inadequate training procedures, improper warm-up, overall physical conditioning, type of shoes, training surfaces, improper progression, lack of skill, or inadequate supervisor and practitioner training (4). Research examining plyometric injuries is limited. Several researchers reported the risk of injury to be minimal if proper progression and precautionary measures were followed, such as regulating volume and intensities of exercises and training on shock-absorbing surfaces (5, 8, 9).

Plyometrics used in athletics are traditionally performed on land with limited plyometric programs conducted in the water. Studies investigating the use of plyometrics in water found that vertical jump increases were possible (1, 13, 19). They also found no significant difference between

Table 1
Recommended Aquatic Plyometric Drills

Low-intensity drills	Medium-intensity drills	High-intensity drills
Side to side ankle hops (1 leg)	Double-leg hop	Lateral jump over barrier
Side to side ankle hops (2 legs)	Lateral cone hops	Lateral jump with single leg
Standing jump and reach	Tuck jump with knees up	Single-leg hops
Front cone hop	Tuck jump with heel kick	Single-leg bounding
2-foot ankle hop	1-2-3 drill	Multiple box-to-box jump

Note. For a complete description of these exercises please refer to Chu (11).

land and water training on vertical-jump performance. The results from these studies demonstrate that plyometric programs conducted in water seem to have similar positive effects on performance variables when compared with land programs. The fact that the researchers found no differences in performance variables supports the development of more aquatic plyometric training programs for increasing performance.

Physical Properties of Water

Plyometric drills in water may provide athletes with several benefits. Due to the principles of buoyancy, water acts as a counterforce to gravity, providing support for the athlete's body as it moves downward and resisting movement in the upward motion (20). When the water level is waist high, the body bears approximately 54% of the weight, 35% at midchest and 8% at the neck (16). The buoyancy produced by the water reduces the amount of forces transmitted throughout the body as the athlete lands, thereby reducing the possible risk of injury.

Since water is denser than air, movement resistance in water is greater than on land. From an exercise standpoint, horizontal or lateral jumps performed in the water require an athlete to increase their physical effort to allow them to overcome water resistance. This increase may help an athlete strengthen muscles. In addition, the amount of resistance, or drag, can be dependent on the individual. Larger athletes will have more resistance exercise in water than a smaller athlete.

Aquatic Rehabilitation

Many healthcare professionals are using the pool to augment rehabilitation. Individuals and athletes immersed in water feel more relaxed and have a higher threshold for pain (7). Individuals suffering from arthritis in the lower extremity have shown significant improvements in proprioception and balance (14). In terms of muscular strengthening, individuals and athletes recovering from musculoskeletal injuries or who are deconditioned may be able to return to a functional status when engaged in an aquatic rehabilitation program. Studies investigating patients recovering from anterior cruciate ligament (ACL) surgery found decreases in joint swelling and increases in strength and range of motion when participating in aquatic therapy (17, 21). Patients with multiple sclerosis who participated in a swimming program and calisthenics demonstrated an increase in muscular strength in the upper extremity and increased quadriceps strength (12).

The importance of incorporating plyometrics with rehabilitation of injured athletes is beginning to emerge. *Athletic Therapy Today* has devoted an entire issue (May 1999) to plyometrics in sports injury rehabilitation. Although recommended guidelines for appropriate plyometric exercises on land and the importance of providing functional activities for injured athletes were discussed, the journal fails to mention incorporating aquatic plyometric exercises for rehabilitation. Because the physical properties of water—buoyancy and resistance—can support body weight and provide resistance for movement, it would be logical to use aquatic plyometrics for rehabilitative purposes. Unfortunately, available guidelines for aquatic plyometrics are nonexistent at this time probably because of the complexity and individualized characteristics of injuries. Until guidelines are established, the authors recommend following protocols of established rehabilitative programs that determine when an athlete can safely participate in functional activities

Table 2
An Eight-Week Plyometric Training Program

Training week	Training volume	Plyometric drill	Sets × repetitions	Training intensity
1	90	Side to side ankle hops	2 × 15	Low
		Standing jump and reach	2 × 15	Low
		Front cone hops	6 × 5	Low
2	120	Side to side ankle hops	2 × 15	Low
		Standing jump and reach	2 × 15	Low
		Front cone hops	6 × 5	Low
		Double leg hops	10 × 3	Medium
3	120	Side to side ankle hops	2 × 12	Low
		Standing jump and reach	2 × 12	Low
		Front cone hops	6 × 4	Low
		Double leg hops	8 × 3	Medium
		Lateral cone hops	2 × 12	Medium
4	120	Side to side ankle hops	2 × 12	Low
		Standing jump and reach	2 × 12	Low
		Front cone hops	6 × 4	Low
		Lateral cone hops	2 × 12	Medium
		Tuck jump with knees up	4 × 6	Medium
5	124	Side to side ankle hops	2 × 10	Low
		Standing jump and reach	2 × 10	Low
		Double leg hops	6 × 3	Medium
		Lateral cone hops	2 × 12	Medium
		Tuck jump with knees up	4 × 5	High
		Lateral jump over barrier	2 × 10	High
6	122	Standing jump and reach	2 × 10	Low
		Front cone hops	4 × 5	Low
		Double leg hops	6 × 3	Medium
		Lateral cone hops	2 × 12	Medium
		Tuck jump with knees up	4 × 5	High
		Lateral jump single leg	2 × 10	High
7	84	Standing jump and reach	2 × 8	Low
		Double leg hops	4 × 3	Medium
		Lateral cone hops	2 × 12	Medium
		Lateral jump over barrier	2 × 8	High
		Lateral jump single leg	2 × 8	High
8	80	Standing jump and reach	2 × 8	Low
		Lateral cone hops	2 × 12	Medium
		Tuck jump with knees up	2 × 4	Medium
		Lateral jump single leg	2 × 8	High
		Single leg hops	2 × 8	High

Figure 1. **Demonstration of an athlete performing a tuck jump in waist deep water.**

based on muscular strength and endurance, locomotion, range of motion, and body weight support.

■ Aquatic Program Design

The approach to an aquatic plyometric program in order to enhance performance variables is based on the same principles as those on land: the rules for intensity, volume, height of jumps, and frequency are the same. Piper and Erdmann (18) described a simple method of designing plyometric programs and the necessary progression(s). Although water does provide a safety net in terms of body weight support, too much too soon can still be detrimental. Until studies are conducted to determine impact forces on the body in water, the recommendations of Piper and Erdmann (18) should be used for program design and progression. Tables 1 and 2 and Figures 1, 2, and 3 provide examples of plyometric drills and intensities that athletes can perform safely in the water.

Coaches and strength and conditioning specialists must design plyometric training programs based on the needs of the individual(s) and sport(s). When developing a plyometric program in the water, beginning with basic jumping and hopping drills to allow the athlete to adapt to training in water is recommended. Examples include various jumps in place (side-to-side ankle hop and split squat jump) and standing jumps (standing long jump and standing jump over a barrier). Since the ability to change quickly from a lengthened to a shortened position is a key element when using the elastic components of muscles (15), avoid activities greater than 180° of rotations in the water. The water resistance slows the rotating speed, and athletes have difficulty performing these activities.

Before beginning any aquatic plyometric program, several key points must be addressed. First, it is recommended that all athletes wear a bathing suit that conforms to the body in order to minimize drag and facilitate a quick rebound from a stretched position. Wearing oversized shorts or T-shirts creates more resistance and slows the movement of jumping or bounding drills, thus reducing preload of the muscle. Athletes should be en-

Figure 2. **Demonstration of a vertical jump (arm swing should start above the water).**

couraged to wear aquatic shoes with nonslip soles. Aquatic shoes help to ensure proper foot contact, increasing the efficiency of the plyometric drill and decreasing the likelihood of slipping that may result in injury. It is recommended that athletes receive proper instruction on land regarding the plyometric drills before entering the water. It is very difficult to demonstrate jumping over or around obstacles that are submerged 2–3 feet. A dry-run performance before the athletes enter the water can be extremely beneficial for successful completion of the plyometric drills. Finally, when performing group work in succession (e.g., single-leg bounding or multiple-cone hops), athletes should maintain adequate distance between each other to avoid creating a current. A strong current will enable following athletes to be pulled across the water with minimal physical exertion, thereby decreasing the training effect.

The water level should be kept around waist height for all athletes. Water too deep creates an increase in resistance while performing the plyometric movement(s) and may affect the athlete's ability to maintain proper body control and coordination. Water too deep (above the waist) may decrease the stretch-shortening cycle reaction time. Although no published sources can confirm this hypothesis, the authors noticed an extended period of delay when contacting the pool bottom and the subsequent concentric motion. Deep-water jumping can cause increases in arm swing drag when propelling a submerged arm in the water. In addition, there is a possibility that the athletes will be totally submerged when performing jumping activities in water too deep.

■ Aquatic Plyometric Equipment

Equipment used for water plyometrics must be waterproof and rustproof with no jagged edges. Using wood and metal training equipment is not recommended because of deterioration. The training equipment must be heavy enough to be submerged to the bottom of the pool and remain in place during the training program (Figure 3). Training equipment that shifts or slides when an ath-

Figure 3. **Demonstration of lateral cone hops using submerged weighted plastic cones.**

lete jumps on or around it increases the potential for injury and alters the training program.

Aquatic equipment can be purchased in several aquatic therapy magazines and catalogs or may be fabricated to meet the needs of the plyometric training program. For example, the authors bought 8-inch plastic cones and added coated plastic weights to the inside to submerge them in water. The authors recommend purchasing plastic cones (6–10 inch) and boxes (with nonslip surfaces and coated with waterproof paint) of various heights. Other equipment can be purchased based on need, experience, and training adaptations.

■ Safety Concerns

There are additional safety concerns that must be addressed while in the pool. First, a lifeguard must be on duty and have rescue equipment readily available. Underwater lighting should be adequate so the athletes can see where the training equipment is located in order to ensure proper footing. Maintain a safe distance from the edge of the pool to prevent athletes from striking the side of the pool. The water temperature should be within acceptable limits. Most pools keep their temperatures between 78 °F and 81°F, but it can vary. Check with your aquatic facility for specific water temperatures. Plyometric exercises and rehabilitation of musculoskeletal injuries can be conducted in warmer water between 86°F and 94° F (aquatic rehabilitation centers), which may be beneficial for pain, reducing muscle spasms, and increasing range of motion (20). Although exercising in warm water might be more comfortable for the athlete, the increase in temperature may cause fatigue or dehydration and the strength and conditioning specialist should be cognizant of the signs and symptoms associated with these conditions.

■ Conclusions

By following the guidelines presented in this article, aquatic plyometrics can be beneficial and safe. Athletes may find exercising in a pool more enjoyable and a break from the monotonous drills and routines performed on land. Preliminary research has shown the effectiveness of plyometric training in water and can be an alternative for athletes who are recovering from an injury or beginning a plyometric program. Aquatic plyometrics are both fun and challenging. With proper use of the guidelines provided in this article, coaches and strength and conditioning specialists can incorporate many methods and techniques to facilitate their athletes' potential. ▲

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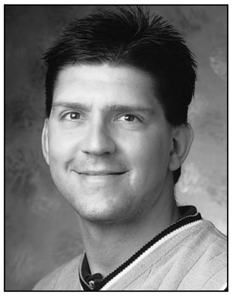

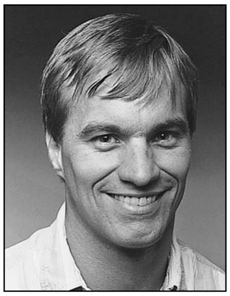

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