

Identifying and Managing Shoulder Pain in Competitive Swimmers

How to Minimize Training Flaws and Other Risks

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In Brief: Shoulder pain resulting from glenohumeral instability is common among competitive swimmers. The biomechanics inherent to swimming promote muscular imbalances that stress the capsuloligamentous structures and contribute to shoulder instability. Most swimmers respond favorably to conservative treatment of rest and rehabilitation, while a small percentage may ultimately require surgical intervention. Swimmers who respond well to rehabilitation have a better prognosis for a successful return to swimming than those who require surgery. Overall, education in proper stroke and training techniques can minimize the likelihood that a competitive swimmer will experience disabling shoulder pain.

Swimming is a rigorous sport that has been included in the modern Olympics since 1896.²⁰ Because of its popularity, it is common for children to start competitive swimming at 5 or 6 years of age. In a typical 2-hour pool session, an elite-level competitive swimmer may swim between 6,000 and 7,000 yd, or about 3.5 to 4 miles. This amounts to swimming an average of 20 to 40 miles per week, which is the aerobic equivalent of running 80 to 160 miles.² This high yardage means that competitive swimmers perform between 1,500 and 4,000 stroke cycles per day, or about 1,000,000 stroke cycles per year.^{3,4} Since female swimmers, on average, have shorter arm strokes, they may perform an additional 660,000 stroke cycles per year.^{3,5}

Thus, it should be no surprise that shoulder pain is one of the leading ailments among competitive swimmers. The causes of shoulder pain are multifactorial and include the athlete's sex, swimming experience, training distance, stroke choice, workout intensity, upper extremity weight training, stretching (especially when done with a partner), and use of hand paddles.^{4,6,7} A survey by McMaster et al⁸ demonstrated that 35% of senior national and Olympic swimmers experienced shoulder pain that prevented them from training effectively.

Since Neer and Welsh⁹ coined the term "swimmer's shoulder" in 1977, many researchers have sought to elicit the cause of shoulder pain in swimmers. The current understanding is that swimming selectively strengthens the anterior chest musculature and internal rotators of the shoulder, and, when combined with repetitive microtrauma to the shoulder, fosters an imbalance in the dynamic stability of the joint.^{2,10} Studies¹¹⁻¹³ have found that this abnormal internal-to-external rotator torque ratio is an unavoidable consequence of swimming and is present even at the high school level. It is therefore prudent to adjust training programs accordingly, especially for beginning swimmers, to minimize the risk of future injury.

The terms *laxity* and *instability* are commonly used when referring to joint pathology, and there is a significant difference between the two definitions. Laxity refers to the normal, painless freedom of movement around a joint, while instability refers to the pathologic tendency of a joint to subluxate or dislocate, resulting in pain or functional impairment.^{14,15} Asymptomatic, increased range of motion (ROM), or laxity, of the shoulder can be found in a

large portion of swimmers, especially those at the highly competitive level. Significant controversy surrounds whether swimmers acquire shoulder laxity as a result of repetitive motion, or whether swimmers with inherent shoulder laxity are more efficient in the water, which leads them to stay in the sport longer and compete at a higher level.^{8,11,16}

Regardless of its origin, glenohumeral laxity is facilitated by the repetitive overuse and muscular imbalances associated with swimming. This laxity may lead to glenohumeral instability and secondary impingement, causing shoulder pain.

Stretching: Help or Hindrance?

Similar to athletes in other competitive sports, most swimmers conduct a stretching routine prior to exercise. Unfortunately, stretching may be more harmful than helpful. For example, most of the stretches that swimmers perform (figure 1), including buddy stretches (figure 2), serve to stretch the anterior capsule of the shoulder. If the capsule is overstretched, the risk of instability and subsequent injury permanently increases.¹⁰ Therefore, the indication for stretching in swimming is limited. Any stretching should be specific to the individual and designed to correct specific muscular or capsular tightness.¹⁶

Figures 1-6: Courtesy of Casey J. O'Donnell, DO



FIGURE 1. Performing this wall stretch may promote excessive stretching of the anterior shoulder capsule.



FIGURE 2. Two types of "buddy" stretches (A, B) commonly performed by swimmers should be avoided to prevent excessive stretching of the anterior shoulder capsule.

Because swimmers tend to have a relatively tight posterior capsule, which can promote impingement pain, swimmers without pain should focus on stretching the posterior capsule and anterior chest musculature.⁷ To selectively stretch the posterior capsule without stretching the scapular stabilizer muscles, it is necessary to stabilize the scapula. The easiest way to do this is to stretch the shoulder while lying supine, partially rolled onto the lateral border of the

scapula. In swimmers who have kyphotic posture because of tight anterior chest and shoulder musculature, stretching those muscles without stretching the anterior capsule helps decrease the forward shoulder posture and increase the subacromial space.⁷ Swimmers with shoulder pain should be instructed to cease all anterior capsule stretching and instead focus on posterior capsule stretching.^{5,11}

Swimmers with multidirectional instability or a history of subluxation should avoid all stretching.² Buddy stretching should be avoided altogether, because it can easily range a shoulder beyond its physiologic barrier and promote further anatomic damage.¹⁰ For athletes in whom stretching is contraindicated, a gentle warm-up is sufficient to increase blood flow to the muscles and prepare them for the workout.^{10,17}

A Role for Weight Training

Most swimmers incorporate either weight lifting or dry land exercises into their training routine. Before embarking on a high-volume training program, all young swimmers, especially those with a previous injury, should be screened for glenohumeral joint laxity (table 1) and be instructed in a shoulder conditioning program. Care should be taken when performing exercises that require shoulder abduction and external rotation, such as lat pull-downs and the military press, which may cause apprehension and possible subluxation of the unstable shoulder. Bascharon et al¹⁸ demonstrated that a weight lifting circuit performed three times a week can successfully decrease shoulder pain in swimmers, both with and without a history of injury.

Pathology	Test	Test Description
Anterior instability	Anterior apprehension	With the patient supine, the shoulder is abducted to 90° and externally rotated. The test is positive if the patient becomes apprehensive about the shoulder subluxating or dislocating.
	Relocation maneuver	During the apprehension test, the examiner applies a posterior force at (Fowler test, Jobette glenohumeral joint through the abducted and externally rotated relocation test) shoulder. The maneuver is positive if the apprehension is relieved.
Posterior instability	Posterior apprehension	With the patient supine or seated, an axial load is applied through the elbow to the adducted and internally rotated arm. The test is positive if the maneuver produces pain or apprehension.
Inferior instability	Sulcus sign	With the patient standing, the examiner grasps the forearm and pulls inferiorly. The test is positive if a gap appears between the acromion and the humeral head.
Impingement	Neer's impingement	The patient's arm is internally rotated and flexed at the shoulder in the plane of the scapula. Subacromial pain indicates a positive test.
	Hawkins-Kennedy impingement	The patient's shoulder is flexed to 90°, then internally rotated. Subacromial pain indicates a positive test.

Source: Magee DJ: Orthopedic Physical Assessment, ed 4. Philadelphia, Saunders, 2002, pp 247-264.

Dry land exercises should emphasize the scapular retractors (figure 3), lower trapezius, glenohumeral external rotators (figure 4), and "core" muscles, such as the abdominals and lower back, to prevent a strength imbalance between the internal and external rotators of the

shoulder. [2,8,11,19](#) Multiple types of training should be incorporated into the dry land or weight lifting programs. A combination of concentric, eccentric, force coupled, endurance, and speed training exercises better emphasizes the typical motions of a competitive swimming session, rather than one technique alone. [20](#)



FIGURE 3. Anterior (A) and posterior (B) views of a dry land rowing exercise using a resistance band to strengthen the scapular retractors. To perform the exercise, the patient pulls against the resistance of the band using constant, sustained velocity concentrating on squeezing the scapulae together at the end of range of motion. This exercise typically consists of three to five sets of 15 to 20 repetitions.

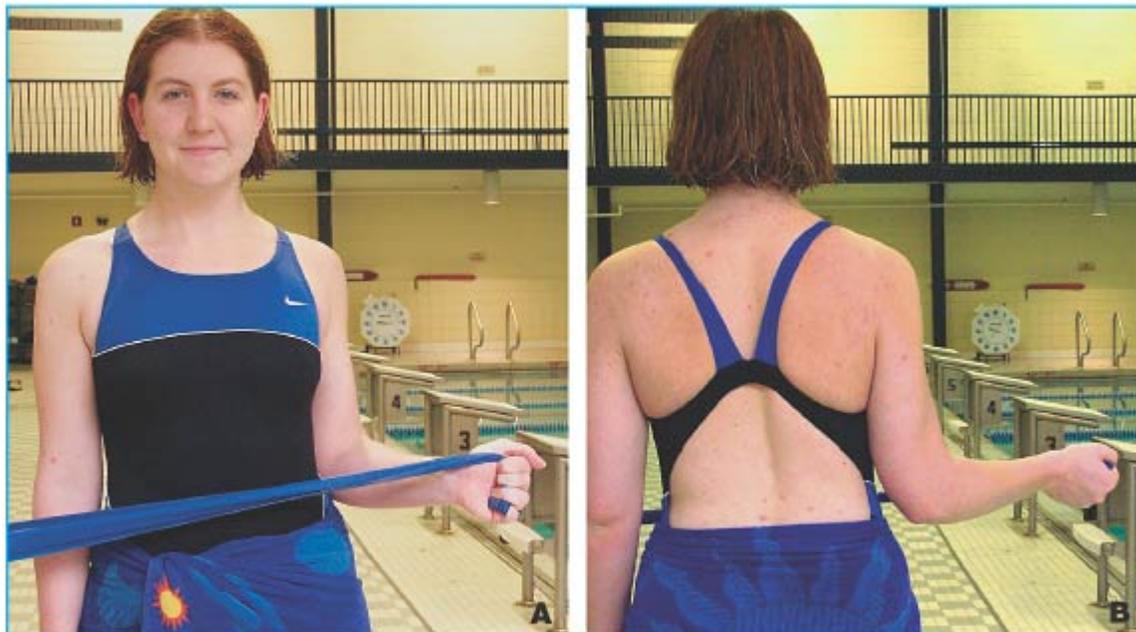


FIGURE 4. Anterior (A) and posterior (B) views of a resistance band exercise to strengthen the glenohumeral external rotators. To perform the exercise, the patient externally rotates the shoulder against the resistance of the band. This exercise typically consists of three to five sets of 15 to 20 repetitions.

Analyze Stroke Mechanics

The best way to prevent swimming injuries is to use proper stroke technique. Poor body mechanics resulting from fatigue or improper stroke technique will lead to more drag on the swimmer, causing additional stress on the shoulder. However, ensuring proper body mechanics can be a challenge. Many amateur-level coaches have little or no training in how stroke technique, or changes in technique, relieve or worsen overuse injuries.² The most popular ways to analyze stroke technique include the use of underwater windows, videotaping, and swimming in a flume.

Since most practice time is spent swimming freestyle, it is the focus of this article. Information about the other three competitive strokes (ie, butterfly, backstroke, breaststroke) is included in a review by Jones² about specific stroke changes observed in each of the four competitive strokes during fatigue and injury.

Each phase of the stroke cycle in freestyle presents an injury risk to the shoulder. During the pull phase, crossing the midline with the hand underwater or maintaining a "flat" body position (not rolling side to side properly) promotes shoulder impingement (figure 5). Swimmers who breathe consistently to one side stress the ipsilateral shoulder and should be encouraged to breathe bilaterally. Activities such as kicking with a kickboard or performing dips or the bench press may also foster shoulder laxity, leading to secondary impingement.⁷

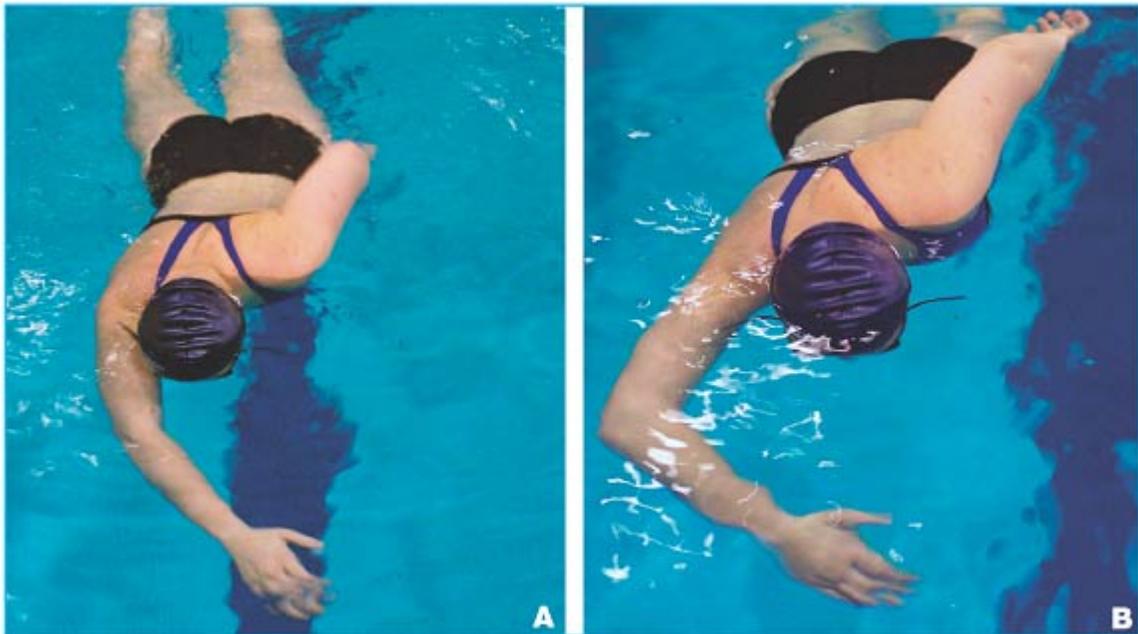


FIGURE 5 During the underwater pull phase of the freestyle stroke, a swimmer demonstrates incorrect "flat" body position (not rolling side to side properly) and excessive crossing over (A), as opposed to proper midline hand position (B).

Modifications to minimize shoulder pain include increasing the body roll, maintaining a high elbow, and avoiding excessive elbow extension during recovery (figure 6).⁸ Increasing the body roll reduces the amount of scapular protraction needed to maintain proper alignment of the glenohumeral joint, and thus lessens the demand on the serratus anterior and the other scapular muscles.¹¹

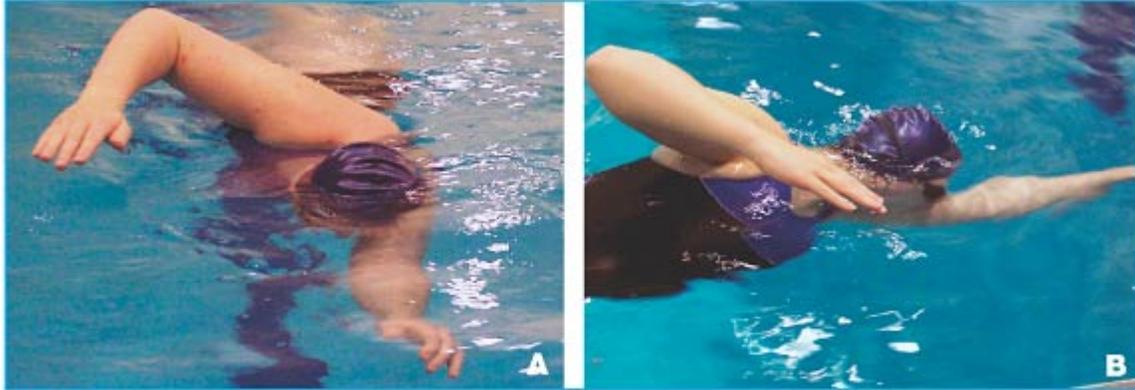


FIGURE 6. A swimmer demonstrates a "dropped" elbow (A), which suggests muscle fatigue or shoulder pain. In contrast (B), a swimmer demonstrates proper freestyle stroke, with a "high" elbow during recovery and good body roll.

Pink and Tibone¹⁰ explain some of the subtle modifications that swimmers may use to compensate for a painful shoulder during the freestyle stroke. The first sign of a potential injury is the "dropped" elbow during recovery (see figure 6). By dropping the elbow, a swimmer decreases the amount of internal rotation needed to clear the hand over the water, thus avoiding painful subacromial impingement. The dropped elbow also allows for a wider hand entry, which does not require as much scapular upward rotation or retraction, and therefore not as much humeral forward flexion. Over time, a wider entry may lead to an asymmetric pull, as evidenced by difficulty swimming straight. An asymmetric pull is usually compensated for by decreasing the force at the noninjured arm or changing the beat of the kick, which varies between individuals and degree of fatigue. Therefore, it is prudent that a swimmer who demonstrates a consistently dropped elbow be pulled from the workout and examined for signs of muscle fatigue, impingement, and joint instability.

During training, it is common for swimmers to use hand paddles to increase strength and water perception. Unfortunately, hand paddles increase the amount of stress placed on the swimmer's shoulder and they should be avoided, especially during periods of shoulder pain.⁵

Rehabilitation Steps

When a swimmer becomes injured to the point where he or she cannot complete a normal practice session, he or she commonly undergoes rehabilitation apart from the team. This may not be the best approach. From a psychological standpoint, it may be better for a swimmer to keep training with the team rather than be isolated during complete rest or outside therapies.² Modified rest and practice sets, such as kicking without a kickboard or performing dry land shoulder rehabilitation exercises on deck during team practices, can help the swimmer still feel like part of the team.

Because muscular endurance will promote better glenohumeral stability during repetitive practice sessions, it is recommended that once the swimmer has obtained pain-free ROM, strengthening exercises be quantified by duration (eg, 5 minutes) rather than number of repetitions.⁷ This can help minimize dynamic glenohumeral instability resulting from muscular fatigue.⁸

Pepe and Rodosky²⁰ describe a comprehensive treatment program for swimmers with shoulder pain that is divided into three phases: acute, recovery, and functional.

Acute phase tasks consist primarily of rest and activity modification, which includes avoiding overhead activities, especially in the impingement zone above 90° of abduction. A stretching program should initially be performed passively or actively assisted, with the athlete avoiding mobilization techniques that stretch the anterior capsule. For the acutely inflamed shoulder,

they recommend glenohumeral internal rotation and horizontal adduction while in the supine position (to maintain fixation of the scapula); adduction stretching with the hand behind the head (to emphasize the posterior-inferior capsule); and adduction stretching in the back-scratching position (to emphasize the posterior-superior capsule).

Recovery phase goals are to achieve normal active and passive ROM, strength, muscular balance, and scapular control. High numbers of repetitions with light weights or low-resistance resistance bands are used initially to develop endurance and to avoid further damage to the rotator cuff. The priority of this phase is to restore the normal kinematics of the shoulder by normalizing ROM and returning the agonist and antagonist muscles to their proper strength ratios. Emphasis should be placed on obtaining pain-free forward flexion, adduction, and internal rotation, since this is the position that typically provokes shoulder pain in swimmers, while strengthening the scapular stabilizers and external rotators of the shoulder.

Functional phase criteria are: shoulder ROM of at least 90% of full, pain-free, active ROM; rotator cuff strength graded as at least 4/5; and a normal functioning kinetic chain. The purpose of this phase is to resume sport-specific activities. The athlete may resume activity by using a swim bench, followed by slow laps in the pool, and gradually integrate into the prior workout routine. The swimmer should not be allowed to return to full training unless he or she can consistently maintain proper shoulder mechanics despite a fatiguing workout.

Rotator Cuff Strengthening and Plyometrics

Kibler²¹ also outlines a comprehensive rehabilitation program for swimmers with shoulder pain. The program is divided into eight phases: diagnosis, pain reduction, integration of the kinetic chain, scapular stabilization, achievement of 90° of abduction, closed-chain rehabilitation, plyometric exercises, and rotator cuff exercises. The progression is similar to Pepe and Rodosky's approach, with a few differences.

Kibler explains that, because rotator cuff muscles do not work in isolation and are part of an overall force couple relationship, they should be rehabilitated as a unit, rather than as individual muscles. In addition, he incorporates plyometric exercises, which involve an initial eccentric loading of the muscle. After this "pretensioning phase," the muscle performs a rapid, concentric contraction to develop a large amount of momentum and force.

A study by Swanik et al²² demonstrated that after 6 weeks of training, a group of swimmers performing plyometric exercises improved significantly more than the control group in five of six proprioceptive tests and in six of six kinesthetic tests. Both Kibler and Swanik et al explain that plyometric exercises fine-tune muscle activity patterns by fostering joint proprioception, and are therefore the most appropriate open-chain exercises for functional shoulder rehabilitation. In addition, they both caution that, because of the large amount of force generated during both the eccentric and concentric phases, plyometric exercises should not be initiated until complete healing has occurred and the swimmer has a full, pain-free, active ROM.

When to Consider Surgery

As with most other sports-related injuries, surgery for shoulder pain is considered a last resort, and pain itself should not be the only indication for surgical stabilization.²³ Some possible indications for surgery include paresthesias (eg, "dead arm" syndrome), recurrent instability, or difficulty with activities of daily living.⁶ Furthermore, a surgical evaluation should only be sought if 3 to 6 months of conservative treatment have failed.^{5,6} The decision to perform surgery is not without consequences. It is important for swimmers to understand that surgery will most likely result in decreased ROM and may reduce their level of performance.¹¹ In fact, the lengthy recovery time and inherent variability in successful outcomes may end a swimmer's competitive career.²

Surgical procedures range from the open capsular shift first described by Neer and Foster²⁴ to less invasive, modern arthroscopic techniques. Since each case is individual, it is unlikely that a single procedure will reliably result in shoulder stability for every patient. For example, an inferior capsular shift may be appropriate for a patient with multidirectional instability, while an anterior capsulolabral reconstruction would be indicated for anterior glenohumeral instability.^{15,25,26} While open reconstruction is still considered the gold standard for treatment of shoulder instability, the trend is toward less invasive arthroscopic surgical repairs.¹⁵ Newer techniques allow surgeons to identify and repair multiple coexisting pathologies relatively noninvasively, thus giving arthroscopic surgery an advantage over traditional open techniques.^{19,25}

Although once promising for the treatment of shoulder instability, thermal shrinkage techniques have become less common due to the lack of basic science data and rigorous clinical evaluations.^{4,7} Andrews and Dugas²⁷ conducted a review of papers comparing traditional arthroscopic surgical treatment with and without thermal-assisted capsular shrinkage (TACS). Patients who underwent TACS in addition to repair of their primary injury obtained the best return-to-play results at their previous level of competition, reinforcing that TACS alone is insufficient for treatment.

D'Alessandro et al²⁸ found that 41% of patients with multidirectional instability reported unsatisfactory outcomes after TACS, with 20% requiring a surgical revision secondary to persistent instability. Similarly, Miniaci and McBirnie²⁹ found that TACS had a substantial failure rate for treatment of multidirectional instability. Furthermore, there is mounting concern about the strength and mechanical properties of capsular tissue after thermal shrinkage, and what effects this could have on subsequent open or arthroscopic capsulorrhaphy.^{4,30}

Returning to Swimming

About 95% of swimmers are able to return to their prior level of competition after intensive functional rehabilitation, while the remaining 5% may benefit from surgical intervention.^{5,26} Unfortunately, the longer the recovery period, the less likely a swimmer is to return to his or her previous level of competition. Due to the amount of cumulative training lost, few swimmers have returned successfully to the highest elite ranks after a prolonged absence, including those who have undergone surgery.⁴

However, to emphasize that each case is individual, Russ³¹ details a case study in which a swimmer missed 6 weeks of the season because of shoulder pain and subsequent rehabilitation, and then posted a lifetime best swim after returning. He suggests that perhaps too much emphasis is placed on total yardage and not enough on the *quality* of the yardage. By decreasing their overall yardage to minimize the risk of overuse injuries, swimmers may be able to spend a proportionately greater amount of yardage as "quality" time in the pool.

To ensure that swimmers perform at their peak, prevention of injuries is paramount. Increased effort devoted to educating coaches on early injury prevention and recognition, along with collaboration among the coach, swimmer, physician, and physical therapist, are important measures to make this a possibility.⁵

Simple Steps Yield Big Benefits

Shoulder pain is often experienced by competitive swimmers. The most common causes are related to repetitive overuse of the shoulder, leading to muscular imbalances and subsequent secondary impingement from glenohumeral joint instability. A large majority of swimmers diagnosed with glenohumeral joint instability can successfully return to the sport after adequate rehabilitation. Other swimmers may benefit from surgical stabilization, but they have a poorer prognosis for a successful return to a highly competitive level.

Despite advances in rehabilitation and surgical techniques, the best "treatment" remains prevention. In order to accomplish this, coaches and swimmers need to become familiar with proper training techniques and be able to recognize the typical changes in stroke patterns associated with shoulder dysfunction. A small change in training habits now may lead to a large payoff in the future.

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