A Multidimensional Approach to Enhancing Recovery

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Summary
Optimum performance requires a balance between training stress and recovery. Thus, programming recovery needs to be an active and integral part of an athlete’s program. Because the nature of fatigue and subsequent recovery is complex and related to a large number of diverse factors, a recovery program needs to be multidimensional and address fatigue and recovery from a number of directions, utilizing both short- and long-term strategies.

In designing any training program, it must be remembered that athletes can achieve optimal performance only when they are able to “optimally balance training stress and subsequent recovery” (13). Unfortunately, despite the importance of optimal recovery within any training program, recovery is often inadequately addressed. Time devoted to planning the training is often far disproportionate to the time spent planning the recovery. For athletes to achieve optimal performance, proactive recovery must become a planned and systematic part of any training program.

Recovery can be defined as an “inter- and intra-individual multilevel process in time for the re-establishment of performance abilities” (14). Recovery needs to include an action-orientated component and incorporate “self-initiated activities, that can be systematically used to optimize situational conditions, to build up and refill personal resources and buffers” (14).

The above clearly highlights the following key aspects that need to be addressed in setting up a recovery strategy:

- Recovery is a multidimensional process involving a number of systems.
- Optimum recovery strategies will vary among individuals depending upon the type of fatigue, their current levels of training and nontraining stress, and their capacity to cope with the stressors.
- Recovery needs to be a proactive process and an integral part of the entire training plan. This process needs to involve both short- and long-term planning. In the short-term planning, athletes need to reestablish performance capabilities (e.g., replacing glycogen stores). In addition, long-term planning is equally important to develop athletes’ stress tolerance in the physical, psychological, and emotional domains.

Optimal recovery needs to encompass a range of methods and techniques that are all systematically integrated into athlete programs, ideally on an individual basis. Each method needs to be carefully planned and have a specific aim to ensure optimal return.

The Nature of Fatigue
According to the fitness fatigue theory, any training bout will initiate both potentiation effects and fatigue effects (29). The interplay between these will depend upon the amplitude and duration of potentiation and the amplitude and duration of fatigue. Any mechanisms that can reduce either the amplitude or the duration of fatigue will clearly have a beneficial
effect on the entire training process. To effectively plan recovery strategies, it is vital to comprehend the nature of fatigue. A general definition of fatigue is "any exercise induced reduction in the maximal capacity to generate force or muscle output" (3). In addition, Calder (5) identifies a number of types of fatigue, namely, metabolic, neural, psychological, and emotional (social).

The relative importance of each of these types of fatigue will influence the type of recovery strategy that will be optimal. An understanding of the nature of fatigue and the stress-related factors on athletes is an important step in setting up the optimal recovery program.

**The Aims of the Recovery Period**

According to Viru (25), the main functions of the recovery period are:

- Normalization of functions.
- Normalization of homeostatic equilibrium.
- Replenishment and temporary supercompensation of energy resources.
- Reconstructive functions, especially cellular processes and enzymatic functions.

These functions have different time scales, with a stage of rapid recovery followed by a delayed restitution. The first 2 functions occur in the rapid stage, whereas the latter two require much longer periods of time (25).

Fatigue cannot be seen as having a single cause; therefore, the appropriate recovery strategy will depend upon the contribution of each type of fatigue on total fatigue (5).

**The Athlete as a “Psychosociophysiological Entity”**

The term *psychosociophysiological entity*, coined by Kentta and Hassmen (15), stresses the complexity of monitoring total stress on an athlete. As strength coaches, we are able to closely monitor the training load placed on an athlete, and periodized training plans are essential in the optimal development of athletic performance. However, we often have little control over training and nontraining stresses outside our control (12), and we need to monitor the total load placed on the athlete in the entire psychosociophysiological domain.

To totally predict the effects of training stress on the body, we must not see the athlete as a machinelike entity. Nontraining and training factors will greatly affect the dose-response relationship. Stressors can originate from many sources, all of which accumulate in the same melting pot. An athlete’s response to any training load will depend upon the total stress load and how this relates to his or her capacity to handle the stressors. Therefore, it is vital that an interdisciplinary approach be taken to monitor the level of stress and the related recovery requirements and that this addresses the individual needs of the athlete.

In simple terms, stressors fall into 3 main categories: (a) physical stressors, (b) psychological stressors, and (c) emotional stressors. The effects of each of these are cumulative and will depend upon both the amount of stress and the athlete’s stress tolerance in each domain. Although we progressively build athletes’ physical capabilities and allow them to handle large loads, all too often their psychological and emotional capabilities are less than optimally developed. Where this is the case, emotional or psychological stressors can have a dramatic effect on total stress and may therefore negatively affect recovery and the level of athletic performance. Thus, a total recovery strategy must focus on developing all the domains if we wish it to be maximally effective, and athletes need to develop their abilities to both identify and deal with psychological and emotional stressors.

Kentta and Hassmen (16) recommend that the approach to enhancing recovery needs to attempt to achieve a balance in the training and nontraining stress experienced, the athlete’s ability to cope with the stress, and the recovery actions taken.

**Identifying the Cause of Underrecovery**

Given the complex psychosociophysiological nature of athletic performance, identifying the causes of underrecovery can be a complex task and requires a multidimensional approach.

The use of training logs and other recording systems is vital in our attempt to identify patterns of performance and training stress. Within the training logs, athletes should log all their physical activities both within the performance environment (e.g., school, college) and outside the performance environment (e.g., other teams they play for or activities they undertake). The use of a rating of perceived exertion for the sessions, along with the duration of the session, gives information on both volume and intensity of the exercise carried out.

This log, combined with a system of monitoring recovery, such as that proposed by Jeffreys (12), provides a tool to allow athletes to identify times when their recovery is less than normal. One of the great values of such a monitoring system is that it helps athletes develop self-awareness and the ability to identify periods of optimal and less-than-optimal performance. If an athlete is experiencing underrecovery, he or she must be encouraged to bring this to the attention of the coach, who then needs to attempt to identify the cause of underrecovery.

Although identifying the cause of underrecovery can be difficult, it may be
facilitated by using a multidimensional approach. Whereas the overall training load can be effectively monitored with the athlete's training log, other stressors are less easily identified. To facilitate this, lifestyle profiles can be used, which can be set up to identify areas within an athlete's lifestyle that could be compromising his or her recovery and performance. Areas to address may include:

- The quality and quantity of sleep.
- The level of performance stress.
- The level of academic, work, or money stresses.
- The quality of the athlete's primary relationships (e.g., family, friends).
- The quality of the athlete's secondary relationships (e.g., within the team and the training environment).
- The quality of lifestyle management.

The results from this type of approach can indicate where any additional stressors may be coming from. Where possible, athletes can be given advice or guided to the appropriate support to assist them in rectifying any specific problems.

Educating the Athlete

Although the coach can direct the recovery process, the athlete will perform much of the work, often away from the training environment. Therefore, the athlete needs to be empowered to make the correct choices in terms of recovery and be proactive in facilitating the recovery process. This requires a commitment to athlete education. Indeed, the education program must be seen as an essential part of the recovery program and should address the following key aspects:

- Why recovery is vital to optimum performance.
- The different mechanisms of stress and fatigue.
- Lifestyle management.
- Options for enhancing recovery, including opportunities to experience and evaluate various methods.

- How to incorporate the various options into daily and weekly schedules.

The goal is to develop athletes who are self-aware in terms of training and nontraining stress, are aware of their bodies and how they are recovering, and are empowered to make appropriate interventions to enhance these areas.

Individualizing the Program

In the education program, athletes must be given a number of options as to how to enhance recovery, for many of the methods available can work on a multi-level basis. For example, massage may enhance physiological recovery in some athletes (18, 26) but not in others (22, 23) and also facilitate psychological relaxation and recovery in some athletes (8). Athletes have to choose appropriate strategies that they are comfortable with and that address their own recovery needs. This empowerment can also facilitate enhanced compliance with the program.

Planning the Recovery Program

Recovery needs to be an integral part of the planning of any training program, and it appears to work best when psychosociophysiological aspects are addressed as follows:

- Planning the training program.
- Nutrition and hydration strategies.
- Sleep.
- Postworkout or postgame strategies.
- Emotional and relaxation strategies.
- Psychological strategies.

Planning the Training Program

A well-planned, periodized training program that incorporates the hard-easy principle greatly reduces the likelihood of underrecovery (29). However, to further facilitate recovery, rest or active rest days should be scheduled into the program and athletes should be educated as to why these are in place. This develops an empowered athlete who is able to make appropriate decisions on these days, and it facilitates an athlete's adherence to this rest. In general, active rest is normally prescribed because it facilitates recovery and is ideal on days after games, hard training, and so on (5).

Active recovery needs to incorporate light aerobic-type activity with stretching activities. This initially needs to happen immediately after games and workouts (a cool down), with the duration depending upon the intensity of the exercise undertaken. This facilitates blood flow and the removal of metabolites while restoring muscle length and function (5).

Additionally, this type of active recovery session needs to take place the day after games and hard training sessions. This is preferable to taking the whole day off. Ideally, the activities should be different from normal training activities to provide psychological recovery and must be of a sufficiently low intensity not to induce further fatigue (i.e., to facilitate rather than hinder recovery). These activities must be normally performed in a noncompetitive environment to ensure that a low intensity of effort is maintained. Pool sessions can be used as active recovery sessions (see Table 1), although a number of strategies can be used.

Nutrition and Hydration Strategies

A nutritional strategy must attempt to facilitate a high standard of overall nutrition and not focus simply on nutrition before, during, and after the game. This focus needs to be both quantitative and qualitative. In general, the nutritional foundation for the diets of the athletes in terms of the relative calorific intake of macronutrients (carbohydrates, proteins, and fats) is similar to the current recommendations for the general population (2). The fundamental differences are that athletes require additional fluid to cover sweat losses and additional energy to fuel physical
activity (2). The focus should be on ensuring that sufficient calories are consumed to adequately replenish energy stores and that sufficient water and electrolytes are taken in to replace water and electrolytes that are lost during exercise.

Regarding hydration, athletes need to be encouraged to drink an adequate amount of water to maintain fluid balance in relation to weather and training conditions (16). Also, they need to be advised that thirst is a poor indicator of hydration status (11). The minimum requirement of water to maintain normal hydration is 3.7 L/d for men and 2.7 L/d for women (11). This needs to be supplemented by additional fluid to replace any sweat loss (11) and may require an intake of up to 10 L/d in very hot and humid conditions (11). In addition to water intake, the replacement of electrolytes lost in perspiration is also vital, with a minimum of 1.5 g/d of sodium and 4.7 g/d of potassium recommended as a base value (11). Monitoring pre- and postworkout weights, together with urine-color charts, can be used to give an indication of whether an adequate amount of water is consumed (11).

Athletes should be encouraged to experiment with preworkout meals to find what suits them best individually, providing they conform to basic guidelines. Preworkout meals should consist of 500 mL of fluid ingested about 2 hours pre-exercise to allow for adequate hydration and for the excretion of excess ingested water (1). Food ingested should be low in fat and fiber (to assist in gastric emptying), moderate in protein, and high in carbohydrates (1). Carbohydrates should be low glycemic index (GI) (20).

During exercise, the main goal should be the replacement of water and electrolytes and the provision of carbohydrates at the rate of 30–60 g/h (2). Concentration of carbohydrate should be 4–8% carbohydrates (2), predominantly medium to high GI (20). The inclusion of sodium (0.5 g/L) is also recommended for exercise lasting longer than 1 hour (2). The general advice regarding hydration is to drink the maximal amount of fluids during exercise that can be tolerated without gastric distress (2).

Postworkout or postgame meals are vital in the recovery process, and the goal is to provide adequate carbohydrates to replace muscle glycogen (2). Consuming carbohydrates immediately after exercise results in higher glycogen levels 6 hours postexercise than if the carbohydrate were ingested 2 hours postexercise (2). The meal should incorporate both carbohydrates and protein in a 4:1 ratio (5) with 1.5 g of carbohydrate per kilogram of bodyweight in the first 30 minutes (2). This mix of protein and carbohydrate maximizes the replenishment of muscle glycogen (30), provides the amino acids necessary for muscle protein synthesis, and may promote a more anabolic state (2). Carbohydrate intake at this time should be high GI (2, 20).

### Table 1

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<thead>
<tr>
<th><strong>Pool Sessions</strong></th>
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<td>The goal of a recovery-based pool session is to promote regeneration with gentle aerobic exercise, together with stretching activities, that mobilize all the key joints involved in performance. The stretches and the swimming strokes should focus on full range of movement. Water depth will determine the degree of weight supported and thus the degree of ground contact. Additionally, deep water can provide resistance against the upper-body movements. The intensity of work should be kept low, and poor swimmers may need to reduce the quantity of swimming or split the time into a number of shorter workouts. Sessions take approximately 20–30 min, during which time the athletes should ensure that they are constantly hydrating.</td>
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#### Sample session

- Swim 3 lengths while alternating the backstroke, breaststroke, and front crawl.
- Walk for 3 min in waist-high water with a range of upper-body activities (e.g., sprint action, reaching up, side bends, rotations).
- Walk 2 widths with full high knee action in shoulder-high water.
- Walk 2 faster widths with high knee running action in shoulder-high water.
- Walk 2 widths with an ankling action in waist-high water.
- Swim 2 lengths with a sidestroke (alternating side).
- Walk 2 widths sideways with a side lunge action in waist-high water.
- Swim 3 lengths while alternating backstroke, front crawl, and backstroke.
- Walk 2 widths, crossover step style, in waist-high water.
- Walk 2 widths with a hip-circling action in shoulder-high water (width 1 forward, width 2 backwards).
- Walk 2 widths, lunging in waist-high water, with a variety of lunging combinations.
- Walk 2 widths backwards, taking large steps, in waist-high water.
- Swim 2 lengths sidestroke (alternating side).
- Walk 2 widths with a sprinter’s paw-back action in waist-high water.
- Walk 2 widths with a high kick action in waist-high water.
- Jog 2 widths in waist-high water.
- Spend 5 min statically stretching key muscles in the water.
Logging overall nutritional quality within an athlete’s training log can further stress the importance of nutrition and remind athletes of their requirements in this area. The nutritional guidelines for during and after workouts are summarized in Table 2.

Sleep
Sleep is fundamental to optimal recovery, and both the quantity and the quality of sleep are vital. Indeed, athletes need a greater quantity and quality of sleep than do nonathletes (17). However, many athletes, especially those in high school and college, are sleep deprived (6, 10). In general, athletes should be encouraged to aim for 8–9.5 hours of sleep per night (10); those involved in heavy training should aim for the top end of this range. Of equal importance is the quality of sleep (24). Sleep cycles occur in approximately 90-minute patterns, with the important deep sleep (stages 3 and 4) and rapid eye movement (REM) sleep occurring toward the end of these cycles. Deep sleep is vital for maximizing physiological growth and repair (10), and REM sleep is vital for the restoration of neural functions (5). If sleep is disturbed before deep and REM sleep is achieved, the whole process restarts, and deep and REM sleep stages are further delayed. Because disturbed sleep can result in the interruption of 1 or more sleep cycles and is likely to reduce the recovery effects of sleep, athletes need to be encouraged to optimize the duration and quality of sleep in order to maximize recovery. Some guidelines for enhancing sleep patterns are given in Table 3.

Postworkout or Postgame Strategies
Athletes need to develop appropriate postgame workout strategies that optimize their recovery on physical, psychological, and emotional bases.

Immediately postworkout, the stress should be on physical recovery by using physical and nutritional approaches. Recovery can take an active and a passive form. Active recovery should involve an appropriate cool-down, as outlined previously, but can additionally involve a number of passive methods that can enhance recovery on a multi-level basis. Hydrotherapies and massage (either self-massage or by a therapist) may both enhance the physical recovery (18, 26) and provide a degree of psychological recovery (8). Hydrotherapies may involve ice baths, contrast showers, whirlpools, and so on, working on the principle that the contrasting hot and cold temperatures force the blood to move quickly back and forth from the skin to the internal organs, thereby facilitating the removal of metabolites (24). Hydrotherapies are normally used at the end of the training

### Table 2

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<th>Timing</th>
<th>Type of intake</th>
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<td>Preworkout (2 h preworkout)</td>
<td>Low–glycemic index (GI) carbohydrate (or mixed meal with medium and low GI) with a moderate amount of protein. Drink 500 mL of water 2 h before exercise.</td>
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<tr>
<td>Immediately preworkout if needed (&lt;10 min)</td>
<td>Medium- or high-GI carbohydrate with a small amount of protein.</td>
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<tr>
<td>During game or workout</td>
<td>Medium- or high-GI sport product. Drink as much fluid as possible and replace electrolytes during longer sessions.</td>
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<tr>
<td>Immediately postworkout</td>
<td>High-GI carbohydrate and protein (4:1 ratio carbohydrate/protein, using 1.5g/kg carbohydrate).</td>
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<tr>
<td>Postexercise follow-up</td>
<td>Moderate- or high-GI carbohydrates and mixed meals with protein.</td>
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### Table 3

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<th>Guidelines for Sleep Enhancement</th>
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<td>• Identify your sleep requirements and try to get this amount daily.</td>
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<td>• Develop a pattern of sleeping and waking times.</td>
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<td>• Practice relaxation techniques before retiring to bed.</td>
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<tr>
<td>• Try to switch off from any worries before retiring to bed.</td>
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<tr>
<td>• Make the bedroom as dark as possible, using masks if required.</td>
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<tr>
<td>• Try to maintain a quiet environment, using earplugs if required.</td>
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<tr>
<td>• Use as big of a bed as possible (6 in. longer than the body is ideal).</td>
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<tr>
<td>• Maintain a cool environment within the bedroom.</td>
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<tr>
<td>• Keep your head cooler than your body.</td>
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<tr>
<td>• If you do not fall asleep within 30 min, get up and do some relaxation work.</td>
</tr>
<tr>
<td>• Avoid ingesting high-protein meals, caffeine, or alcohol in the few hours before retiring to bed.</td>
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day (5); however, contrast showers should be seen as the main tool for hydrotherapy, given their accessibility, and can be used at any time during the training day (5). General guidelines for the use of various hydrotherapies are shown in Table 4.

After the game or workout, relaxation and social recovery should be facilitated. Table 5 outlines some strategies that can be used postgame to facilitate recovery on a multidimensional basis.

**Emotional and Relaxation Strategies**

Athletes should develop methods that facilitate relaxation and emotional recovery. However, the most appropriate methods tend to be individual (21), and coaches need to work with and educate the athletes to make informed and appropriate decisions regarding these activities (9). The relaxation strategies used will depend upon both the nature of stressors the athletes experience and personal preferences.

Athletes should be encouraged to participate in alternative activities that will enable them to relax and think about something other than their sport. Methods such as watching movies and listening to music are useful but also depend upon the mood they induce, so they should be chosen appropriately (9). For example, television can be relaxing when an athlete is watching a program of his or her choice, but when he or she is forced to watch someone else's program the produced effect may not necessarily be relaxation. Used appropriately, music may develop the positive mood states of calmness, happiness, reduced tension, and reduced depression (9). Athletes should be encouraged to develop a range of strategies that they can use in a variety of settings and in their recovery programs.

Emotional strategies may focus on developing emotional intelligence (EI).
Goleman (7) maintains that the most powerful domain of total fitness is the emotional domain, and emotionally healthy athletes have an enormous capacity for handling physical loads with enjoyment and efficiency (4). If athletes are unable to handle their own emotions, major performance and health problems can result. Athletes therefore need to be encouraged to develop their emotional health and their EI. This should involve identifying key emotions and feelings that they will face in and out of competition, including fear, anger, guilt, embarrassment, surprise, sadness, happiness, and interest. Athletes then need to develop coping strategies (7), which must be seen as a long-term strategy. EI competencies need to be developed in 4 main domains:

- **Self-awareness**: the athletes’ ability to identify their own emotions and the effect they have on themselves and other people.
- **Self-management**: the athletes’ ability to control emotions and develop strategies to cope with these emotions.
- **Social awareness**: the athletes’ ability to recognize the emotional states of others and their effects on their own emotional state.
- **Social skills**: the athletes’ ability to interact socially in the most appropriate way to enhance the quality of relationships, thus reducing levels of interpersonal stress.

An emotionally intelligent athlete is more likely to develop excellent interpersonal relationships and build a strong social and emotional support network, thereby resulting in low levels of emotional stress.

**Psychological Strategies**

The development of psychological strategies is very important because they can be used to enhance recovery and performance. The development of effective psychological skills can promote recovery by reducing the psychological stressors on athletes and also by enhancing their stress tolerance (7). This has the effect of increasing their ability to handle the stressors in the future and can be vital at times of major psychological stress, for example, during major competitions (19, 27).

Weinberg and Gould (27) recommend the following strategies be included in a program to prevent burnout. These also provide an excellent model on which to build a psychological strategy for enhancing recovery:

- Develop psychological and self-regulation skills. These require developing psychological skills such as anxiety control, relaxation techniques, mental imagery, and so on that can have a huge influence on performance and recovery.
- Set short-term goals for competition and practice. Effective goal setting is fundamental to the planning of an athlete’s training program. Goals should follow the SMART principle (Specific, Measurable, Action Oriented, Realistic, Timely) and should be a part of the athlete’s training log, which should be monitored at regular intervals.
- Analyze and communicate feelings between the athlete and the coach, thus identifying periods of psychological stress. This requires the development of a trusting environment where athletes feel able to communicate their feelings regarding any aspect of performance or any factor affecting performance. This also requires the development of effective self-awareness skills in both the athletes and the coach.
- Take relaxation breaks from training. These breaks are vital for long-term psychological health and need to be written into the program and enforced, for some athletes are reluctant to take time off.
- Manage postcompetitive and post-training emotions and provide a supportive atmosphere. The effective management of postgame emotions requires the development of EI. A postgame debrief that focuses on the emotional requirements of the athlete, not the coach, should always follow competition. This debrief may result in an athlete not overde- liberating on a poor performance and may lead to a significant reduction in postgame stress. This should be followed by appropriate opportunities for social and emotional recovery in a “safe” environment away from media.
- Keep a positive outlook. Encourage athletes to stay positive and focus on aspects of performance within their control and not dwell on factors outside their control. Creating a positive social support network is vital.

**Conclusion**

Optimal recovery requires effective planning in a multidimensional domain. Recovery needs to be proactive and an integral part of the planning process. It needs to work where possible on an individual basis and be based on an education program, empowering athletes to take control of their own recovery. In an optimal recovery environment, the quality of the athletes’ lives will be enhanced, and the following will be evident (28):

- A balance of all aspects of their lives.
- A balance between training commitments and recovery activities (e.g., rest, nutrition, active recovery, relaxation).
- Time to deal with non-sport matters (e.g., school work).
- Unconditional support from their primary social group (e.g., family).
- Support and acceptance from their secondary social group (e.g., coaches, teammates).

Athletes should take responsibility for their own recovery and should follow
the adage “train smart, train hard, recover well.”

References

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