
# A PRACTICAL GUIDE TO WORKLOAD MANAGEMENT AND INJURY PREVENTION IN COLLEGE AND HIGH SCHOOL SPORTS

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## INTRODUCTION

Sports injuries are a widespread problem at college and high school. In the United States alone, 1.5 million high school and college athletes are injured every year (12,18). The cause of injuries is often multifactorial; however, recent research has identified that poor workload management may be a major contributor to injuries and illnesses in sport (5,7,20,25). This article will present evidence-based workload management recommendations to reduce the risk of illness and injury in athletes, while also optimizing performance.

## DEFINITIONS

**Workload**: Workload (often referred to as "load") is the combination of sport and non-sport stressors (25). Workload is more than competition and training loads alone, and also includes external stressors such as work, recreational activities, family, homework, etc. Workload can be divided into two sub-categories: external and internal load.

**External Load**: External load is the physical stresses applied to the athlete (25). It is the objectively measured physical work (e.g., number of sprints, weight lifted, total distance, etc.) performed by the athlete during competition, training, and daily life. External load is usually measured using global position system (GPS) devices, chronometers, accelerometers, dynamometers, etc.

**Internal Load**: Internal load is the individual physiological and psychological response to external loads, combined with daily life stressors and other environmental and biological factors (25). Measuring internal load can include objective measures, such as heart rate and blood lactate concentration, as well as subjective measurements, such as perceived effort and the overall perceived difficulty of sessions.

**Internal versus External Load**: While external load provides information about the work completed along with the performance capacities of the athlete, internal load is a critical factor in determining the appropriate stimulus for optimal training adaptations (25). Carefully monitoring internal load can help identify recovery needs, predict performance decrements, and anticipate health issues to adjust training and competition programs. Monitoring internal load is a cornerstone of an effective workload management program.

## WORKLOAD MANAGEMENT – A KEY TOOL TO A HEALTHIER PERFORMANCE

In competitive sport, excessive fatigue plays a key role in injuries as it impairs decision-making ability, coordination, and neuromuscular control (25). The risk of injury increases when the external load exceeds the capacity of the athlete (25). For example, in professional ice-hockey, players' average playing time per game is a significant predictor of concussions (26). Fatigue has also been shown to contribute directly to anterior cruciate ligament (ACL) injury (16).

Risk of injury increases when: 1) high loads are applied to athletes who are psychologically or physically unfit to tolerate the prescribed workload, or 2) when athletes are fit and well trained, but in need of rest (7,25). In both cases, workload exceeds athlete capacity, leading to excessive fatigue and increased risk of injury. The role of workload management is to reduce the risk of injury and optimize performance. Effective workload management detects excessive fatigue, identifies its causes, and constantly adapts rest, recovery, training, and competition loads, which are based on the athletes' individual fatigue, wellness, fitness, health, and recovery levels (25).

### FINDING THE "OPTIMAL" WORKLOAD

The "optimal" workload is a moving target. It differs for every athlete and changes constantly based on multiple factors, including phase of season, training status, fitness and fatigue levels, sleep quality, and non-sport stressors. Finding the optimal workload and constantly adapting training programs to the changing capacity of each athlete is complex. It is a continuous process that can require daily monitoring of internal load and at least one measure of external load (often duration or distance). Tracking and understanding how to correctly use these wellness metrics facilitates adjustment of the athlete's training program, recovery, and rest.

## THE TOOLS TO EFFECTIVE WORKLOAD MANAGEMENT

An effective workload management program requires a few conditions:

- **A relation of trust and open communication between players, coaches, and training staff**: Because self-reported information is used extensively to quantify internal load and pre-training readiness, monitoring programs work best when players report their data and feedback as honestly as possible. Having the entire coaching and management team supportive of the monitoring process increases the chances of a successful outcome (21).

- **A robust workload management software**: To maximize athletes' "buy-in," the software should be able to: 1) quickly collect quality and meaningful data from the athlete with minimal effort (21); 2) monitor wellness, internal load metrics, and external load metrics; and 3) help coaches interpret the key metrics in a time-effective manner.

### AN APPROPRIATE METHOD TO QUANTIFY INTERNAL LOAD

A simple, validated, and widely-used method to quantify internal load is the session rating of perceived exertion (sRPE) method (4,10). This technique combines objective and subjective measures (session duration and perceived difficulty). With the sRPE method, the athlete is asked to rate each session's overall difficulty on a 10-point scale (Table 1). The session's internal load (arbitrary units) is then calculated by multiplying the athlete's rating of the overall session difficulty by the session duration (load = sRPE x duration in minutes). The sRPE method does not require equipment and has been validated for use in a large range of sports, training, and competition activities (2,7,10).

**TABLE 1. THE 10-POINT SRPE SCALE USED TO RATE THE DIFFICULTY OF SESSIONS (4)**

| RATING | DESCRIPTOR |
|---|---|
| **0** | Rest |
| **1** | Very, very easy |
| **2** | Easy |
| **3** | Moderate |
| **4** | Somewhat hard |
| **5** | Hard |
| **6** | * |
| **7** | Very hard |
| **8** | * |
| **9** | * |
| **10** | Maximal |

### SPORT TECHNOLOGY

Effective workload management requires monitoring the athlete's individual response to external load, the detection of excessive fatigue, and the management of external stressors with a combination of subjective and objective metrics (25). While GPS sensors, accelerometers, dynamometers, and other tracking devices are useful for assessing performance and monitoring external loads, they do not measure internal load. Heart rate monitors do monitor internal load, but they underestimate internal load during anaerobic activities, limiting their use to a small range of activities, predominantly aerobic exercise (13).

Finally, while heart rate variability is often used as an objective tool to evaluate morning fatigue, recovery, and readiness, recent research has demonstrated that subjective self-reported perceived fatigue, sleep quality, and soreness are more sensitive than heart rate-derived indices to detect daily fluctuations in training load (27). For these reasons, and even if many professional teams have access to expensive tracking technology, such equipment is not required to keep athletes performing well and without injury.

## THE KEY WORKLOAD MANAGEMENT METRICS

Despite decades of scientific research and empirical experience, no single marker of athlete readiness has been shown to elevate the risk of injury or overtraining (23,25). Perhaps this is the reason why a multifaceted approach to workload and recovery management is now considered best practice (23,25). This approach includes the collection and analysis of both subjective and objective measures, and the careful monitoring and optimization of the following key metrics:

**Self-Reported Wellness**: Identifying athletes' recovery issues and readiness to train/compete is often the starting point of a workload management program. A reliable and accurate method to identify athletes' readiness to train, the intensity of output that can be expected from the athletes during a session, and to measure the impact of non-sport stressors on the recovery process is to ask athletes to complete a short pre-training wellness questionnaire (Figure 1) (8,22). Examples of such questionnaires include those proposed by McLean and Kellmann (11,15).

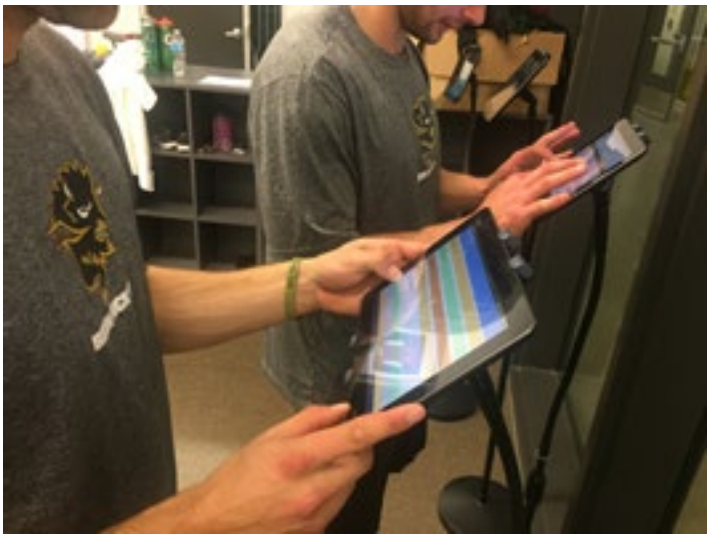

FIGURE 1. COLLEGIATE ICE-HOCKEY PLAYERS COMPLETING THEIR PRE-TRAINING WELLNESS QUESTIONNAIRE

Poor wellness scores indicate potential psychological or physical under-recovery and may lead to adjustments to the training or competition program. Self-reported wellness questionnaires are key injury prevention tools, and should be used to guide the adaptation of training and competition loads (25).

**Chronic Load**: This is the average weekly load (load = duration x sRPE) and is typically measured over the previous four weeks (7). It represents the level of load that athletes are used to. Usually, the higher the chronic load, the more fit the athlete. In some situations, chronic load can be calculated using exponentially weighted moving averages (17). Chronic load can also be tracked for periods longer than four weeks (1).

**Acute Load**: The acute load represents the cumulative load of the current week (7). Usually, exhausted athletes have higher acute load (compared to chronic load). In some situations, acute load can also be calculated using shorter periods (e.g., three days) (1).

**Acute:Chronic Workload Ratio**: The acute:chronic workload ratio (ACWR) measures the relationship between acute load (typically the current week load) and chronic load (typically the previous four-weeks average load) (7,9,17). Monitoring the ACWR helps to keep a player's workload in the "high-load, low-risk zone" (0.8 – 1.3). When ACWR is too low (less than 0.8) or too high (1.5 or more), risk increases and workload may need to be adjusted (Figure 2).

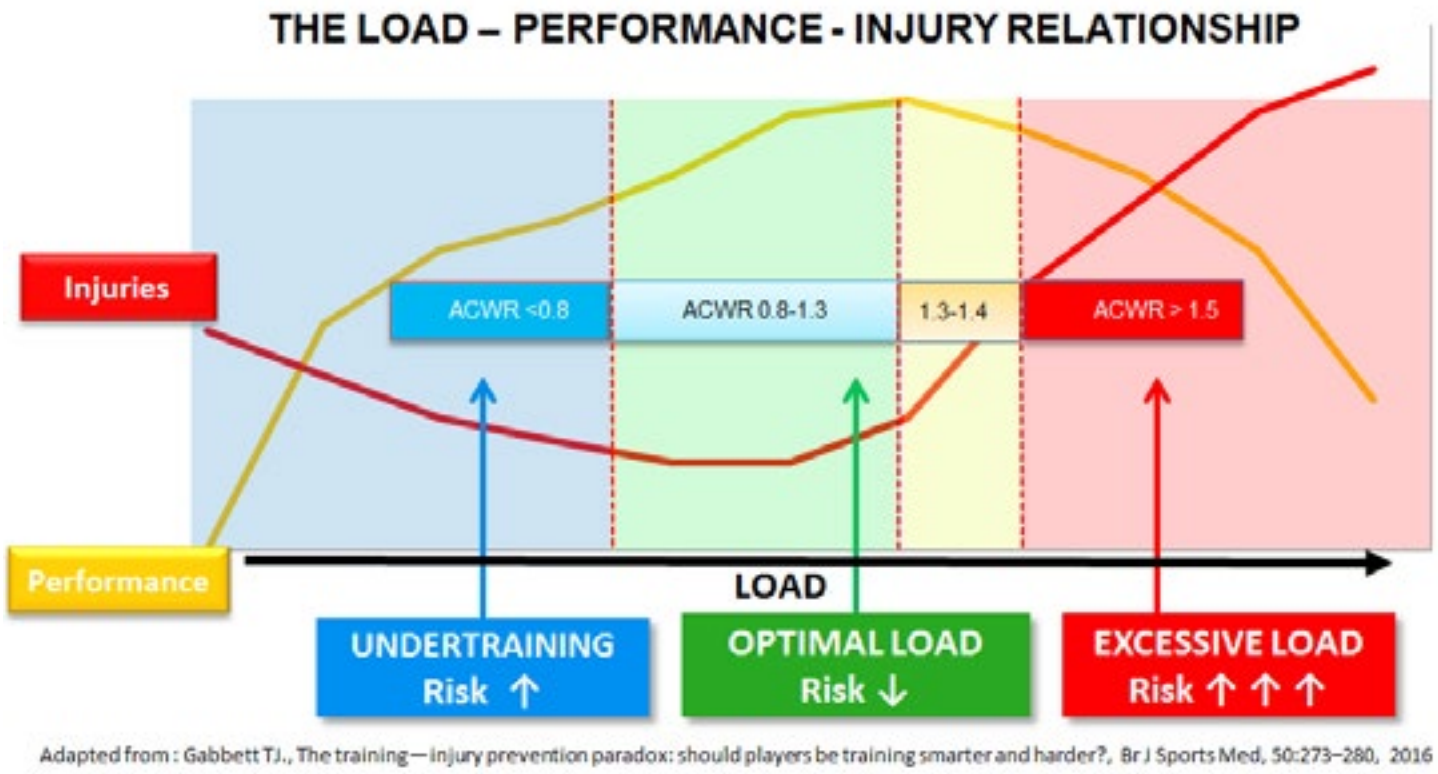


FIGURE 2. THE ACWR AND LOAD-PERFORMANCE-INJURY RELATIONSHIP

**Freshness Index**: The freshness index represents the difference between chronic and acute load or between "fitness" and "fatigue." A positive freshness index indicates an unloading phase where low fatigue and good performance levels are to be expected.

**Week-to-Week Load Increase**: This represents the percentage of load increase from one week to the next. Studies have shown a large percentage of injuries are associated with rapid changes, or "spikes," in weekly loads (7,19). When load increases by ≥ 15% from the preceding week, the risk of injury increases from 10% to almost 50% (7). Monitoring week-to-week changes for spikes in load, combined with limiting load increases to < 10% per week, plays a crucial role in injury prevention.

**Monotony Index**: The monotony index measures the fluctuation of daily internal load within the week. Intensive training combined with a high monotony index (> 2) is an important risk factor for illness and overtraining (5).

**Personal Feedback**: Personal oral or written feedback from the athlete can help identify potential motivation, stress, fatigue, and training issues. This is crucial information and can easily be overlooked by busy strength and conditioning coaches. When an athlete reports negative feedback, it must be taken seriously, as it could be the symptom of larger underlying issues, such as loss of interest/motivation, issues at home, burnout, etc.

**Enjoyment with Training**: Enjoyment with training and competition activities should be carefully monitored and maximized for two main reasons: 1) enjoyment is an important determinant of intrinsic motivation, which directly predicts effort and persistence (6); and, 2) a lack of enjoyment is associated with staleness and burnout (3). To maximize athlete engagement, motivation, and performance, strength and conditioning coaches are encouraged to create environments that allow athletes to have an enjoyable sport experience.

**Other Useful Measures**: When adequate equipment is available, additional daily tests of neuromuscular fatigue can provide useful information about neuromuscular recovery and/or injury (15). Results of these tests allow strength and conditioning coaches to manage athletes on an individual basis and based upon their training and recovery status.

## PUTTING IT ALL TOGETHER

Figure 4 illustrates the integration of all metrics and the decision-making process. This model may be used as a general template of practice in establishing an evidence-based workload management program.

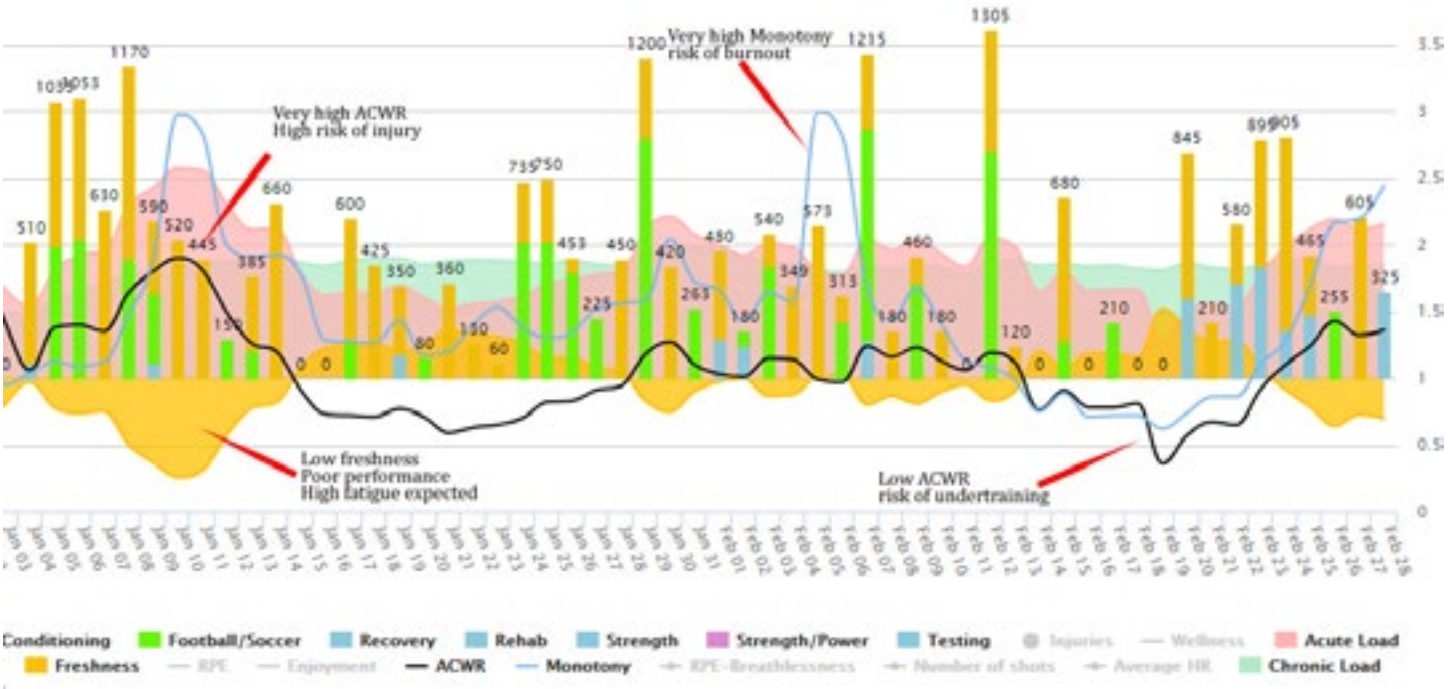


FIGURE 3. EXAMPLE OF WEEKLY CHANGE IN ACUTE AND CHRONIC LOADS, ACWR, MONOTONY, AND FRESHNESS INDEXES

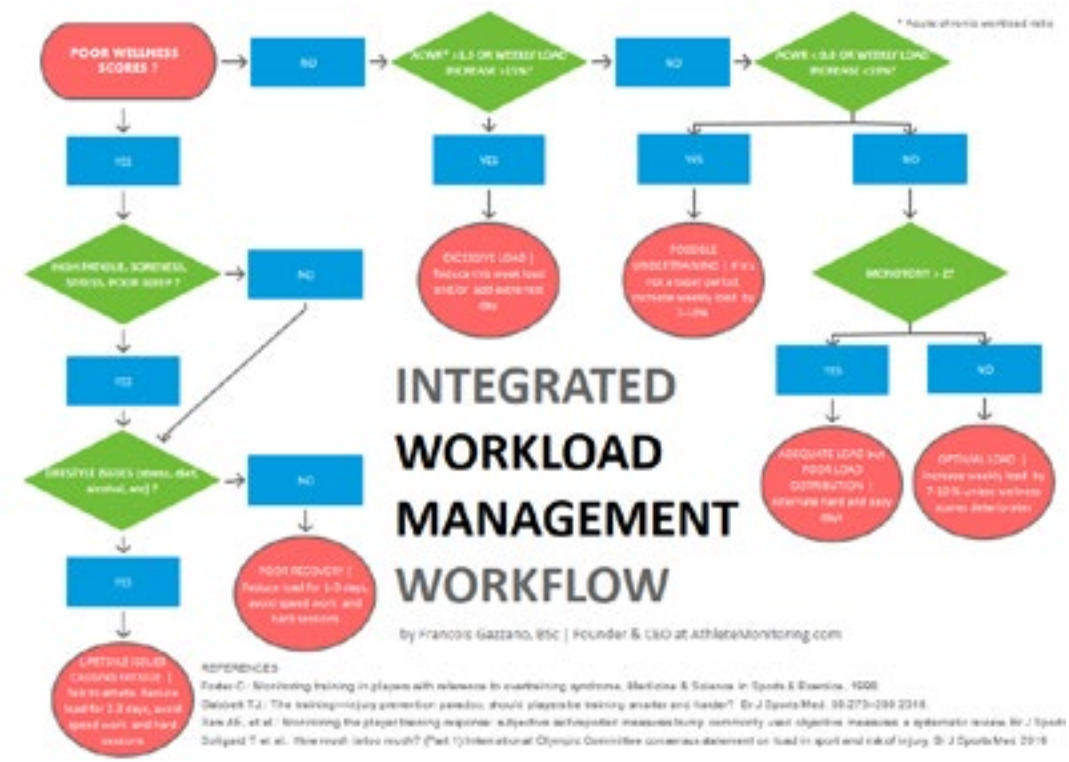


**FIGURE 4. THE INTEGRATED WORKLOAD MANAGEMENT WORKFLOW**

## CONCLUSION

Managing workload and optimizing athlete performance while promoting injury-free participation is relatively simple. To ensure athletes optimize performance and minimize injury risk, the following tips are advised:

1. Start with the right tools
2. Monitor the key metrics
3. Increase weekly loads progressively
4. Avoid spikes in load
5. Alternate between hard, moderate, and easy training days
6. Use athletes' wellness data to guide daily load adjustments
7. Proactively manage training and competition loads during stressful periods
8. Make sure athletes have an enjoyable sport experience

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