INTRODUCTION

In the modern era of competitive sports, monitoring an athlete’s workload on any given training day, week, month, and year is becoming increasingly necessary to ensure the athlete’s health. It is well understood that periodizing an athlete’s training has several benefits, including peak performance and injury prevention. Research has been published about the advantages of monitoring an athlete’s training load to ensure monotony of training never occurs (4,5,6,7,8). This is critical because monotony of training load has been shown to increase the likelihood of non-contact, soft-tissue injuries, such as lower limb injuries including muscle strains, tears, and knee injuries (2,3,4,5,6,7,8). Optimal training loads can prevent these types of injuries both from overtraining and from undertraining. Many types of injuries have been linked to a decrease in individual and team performance when optimal training loads are not met (1,10,11).

There have been several proposed methods for monitoring training loads, including using a rating of perceived exertion (RPE) scale, as well as wearable technologies such as Global Positioning System (GPS), accelerometers, and heart rate monitors. An affordable and easy way to monitor athletes is by using a subjective scale, which involves a coach asking each athlete how difficult each training session or game was on a scale of 1 – 10, following the session.

Recent literature has defined several terms that are important in understanding the thought process of monitoring training loads (5,8). Acute workload is the absolute workload performed in one week; whereas chronic workload is the four-week average of the acute workload (8). Previous research has analyzed these types of workloads and used a calculation of acute workload divided by chronic workload to determine the acute:chronic workload ratio, also known as the training stress balance (5,8). This research indicates that an athlete is progressing and is not at a high risk of injury if the acute:chronic ratio is below 1.5 (8). An alternative way to simplify the acute:chronic ratio is by thinking about the value 1.5 as the athlete performing to 150% of their normal level of training. Consequently, an acute:chronic ratio of 0.8 means that the athlete is performing at 80% of their normal level. The purpose of this article is to provide strength and conditioning coaches and sport coaches with a simple method of monitoring the training loads of athletes that can be used to prevent overtraining and optimize performance.

METHODS

Advanced monitoring tools combine GPS, accelerometer, and heart rate monitors into one unit that can provide the coach with data on the volume and intensity of a training session or game. STATSports® is a popular wearable technology company whose software was used to gather the data presented in this article. The female soccer players wore a pod on their back in a pouch with a
separate heart rate strap. The strength and conditioning coach was responsible for charging and providing the pods and heart rate straps to players at every training session and game. This coach was also responsible for downloading the data from these units to the STATSports software on a computer where the analysis of the data occurred.

To simplify the data analytics process, a metric for external load and internal load can be monitored. External load describes work that is performed within the session that can be quantified, such as total distance covered, high metabolic load distance, and high speed running (5). High metabolic load distance is the distance an athlete covers in a high speed zone and number of accelerations/decelerations performed during a session. High speed running is the total distance that an athlete spends above a speed threshold set by the coach. Internal load is the physiological response to the external load (5). Examples of this type of load include RPE and heart rate data.

**FIGURE 1. OUTCOMES OF MONITORING ATHLETES**

Monitoring

- Team
- Athlete

Training Loads

- Daily
- Weekly
- Monthly
- Yearly

Periodization

- Peak Performance
- Injury Prevention

**CALCULATIONS**

The calculations that are performed for this model are simple and are made for coaches of any level. To calculate a baseline, the coach should collect the data they choose to use for 28 days. An example of this data can be seen in Table 1. At the end of this collection phase, the coach then takes the average from the last seven days of this period and divides it by the 28-day average. From this day forward, the rolling 7-day and 28-day average can be used to monitor each training session and game. An example of calculating the acute:chronic ratio from rolling averages can be seen in Table 2. Figure 2 illustrates one athlete’s acute:chronic ratio calculation throughout a season with regard to high speed running. When the acute (red line) spikes higher than 150% of the chronic (white line), coaches should consider transitioning from a practice that is expected to contain ample opportunities for high speed running to a session that requires less high speed running.

**PRACTICAL APPLICATION**

The acute:chronic ratio calculation has been shown to be an effective way to monitor athletes for peak performance and injury prevention (3,4,5,6,7,8). As a coach becomes familiar with the data, he or she can begin to make training decisions based on objective data, rather than coach’s intuition alone. For example, if a coach calculated the acute:chronic ratio for an individual athlete to be greater than 1.5, he or she may choose to have the athlete sit out or participate in a lighter practice the next day.

A similar thought process can also be applied to help athletes peak for certain performances at the right time. For example, a coach can periodize training leading up to games by gradually decreasing the training workload as game day approaches. Additionally, coaches can use this method to increase the athlete’s fitness levels by gradually increasing training loads, without going over the acute:chronic ratio of 1.5. In an ideal scenario, coaches would be able to calculate the acute:chronic ratio for an internal load and an external load and have various training goals for each athlete.
A coach could decide to have a high external load and a high internal load three days before a game but would like a low external load and medium internal load the day before a game. With all of this being said, this process absolutely should not take away from a coach’s intuition of what is right or wrong for their athletes. With emerging research and technology at hand, this process should simply be another tool for coaches to use to improve their coaching abilities.

CONCLUSION
Analyzing the acute:chronic ratio allows one to optimize training for the athlete and to continue in advancing fitness goals without overtraining. High chronic workloads have been shown to be associated with a reduced risk of non-contact, soft tissue injuries, while large spikes in acute training loads have been associated with an increased risk of these types of injury (7). It is the coach’s responsibility to ensure that training goals are set and accomplished.

Coaches can use the aforementioned monitoring tools to prescribe optimal loads in their training programs. They can also use this method to make decisions on how to treat individual athletes following a training session or game. This knowledge and process of monitoring athletes on an individualized level could help athletes reach goals faster while reducing the likelihood of injury.

It is important for a coach at any level to remember that despite the data collection method they choose to use, the key for this process to be successful is consistent data collection. Just like an athlete, the more a coach practices this technique, the easier it will become and the better it will be for the team. The technique discussed in this article can be an effective and simple way for coaches to determine the best course of action when it comes to planning training sessions properly for the athlete and team to be successful.

REFERENCES

ABOUT THE AUTHOR
Courtney Benjamin received an undergraduate degree from the University of West Florida in Exercise Science with a Minor in Sport and Exercise Psychology. She also was part of the women’s soccer team the four seasons she attended the University of West Florida. Recently, she completed her Master’s degree in Sports Sciences from Florida State University, while working with the women’s soccer, cheer, and dance teams. Benjamin is also a Certified Strength and Conditioning Specialist® (CSCS®) through the National Strength and Conditioning Association (NSCA).
### TABLE 1. HIGH METABOLIC LOAD DISTANCE FOR 28 DAYS

<table>
<thead>
<tr>
<th>DAY</th>
<th>WEEK 1</th>
<th>WEEK 2</th>
<th>WEEK 3</th>
<th>WEEK 4</th>
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<td>226</td>
<td>274</td>
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7-day average of week 4 = 107
28-day average of weeks 1 - 4 = 144
Acute:chronic workload ratio = 7-day average/28-day average
Acute:chronic workload ratio = 107/144 = 0.74

### TABLE 2. HIGH METABOLIC LOAD DISTANCE FOR NEXT 7 DAYS

<table>
<thead>
<tr>
<th>WEEK 5</th>
<th>7-DAY AVERAGE</th>
<th>28-DAY AVERAGE</th>
<th>CALCULATION</th>
<th>TRAINING STRESS BALANCE</th>
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