STRIVE

Visualizing Periodization and Its Effects on an Imbalance of Muscle Input to Output Ratio

Introduction

Periodization in sport is important. Seasons can be long and grueling, and an organization always needs to be aware of the fatigue status of its athletes. With the influx of wearable tech, the increasingly common way to monitor load status in athletes is to obtain an external load metric (traditional player load) and monitor it over the course of a season. This has worked well for visualizing periodization of athlete training. With an external workload quantified, teams now have a better idea of what a “normal” external workload is at an individual athlete level or a more general team level. This is a good start but is missing a key piece of information. When measuring external load, one is essentially measuring an estimation of the output of an athlete. The problem is that output does not always equal input. Running a seven minute mile well-trained, on a stress-free day, and a full nights rest feels very different to the body than running a seven-minute mile after chronically over training, on a day with a lot of stressors, and a poor night’s sleep the nights prior. An external load estimation would value these seven-minute miles the same.

External load essentially becomes a hopeful estimation of a way to visualize the periodized longitudinal training plans. Traditional player load (TPL) becomes a good tool to evaluate the result of careful planning of biomechanical output in exercises throughout a season, fails to evaluate the actual results of the programming. Internal load measurements can aid in completing the full visual of the programming and help teams analyze longitudinal load monitoring from a results-based perspective. Internal player load is a measurement that is based off EMG data collected from the left and right thighs, hamstrings, and glutes, which provides a scalable muscle output metric. Examining the ratio of input to output over a large amount of days that include similar activities (figures below are based off of a seven-day rolling average) should provide a good estimation of a fatigue ratio. The logic being that if an athlete or team of athletes’ external output remains equal, but their muscles have to work harder to achieve that same output, they are experiencing the symptom known as fatigue. From this point, a closer analysis can then be completed to determine the stressor. One stressor that can be a result of a long grueling season is chronic fatigue.

When considering the three figures below one can clearly see the periodization of external and internal workload and how they interact with one another. All these examples include only the regular seasons and immediate preseasons from each of the teams. As stated before, each point on the line represents the average internal and external loads for the entire team of that day and six days prior for a total of seven days. Using an average of the entire team as well as seven days data works to eliminate noise from the evaluations. One student-athlete having a bad night’s sleep resulting in a low external to internal load ratio (efficiency ratio) will have a minimal effect on the displayed result. However, coming back after an extended break in training where a majority of the team did little to no training will make a larger impact on the resulting display.

Team 1

Team 1 is an NCAA division 1 field hockey team. This particular dataset spans three and a half months. The longitudinal review of the team's loading displays very little evidence of de-loading practices periodically throughout the season. The team's internal and external load metrics remain at approximately a 1:1 ratio through the first three quarters of the season, at which point the internal load begins to steadily separate from the relatively more stable external load. This seems to be representative of fatigue. While it is difficult to draw absolute conclusions from de-identified data because of the lack of context, assuming that there was no major change in data collecting practices over the final weeks of Team 1's season, the change of the internal to external load ratio suggests that the team was working harder internally to output similar external results. Because of the lack of periodical de-loading, the question must be asked, "Is the increase in inefficiency towards the end of the season due to chronic fatigue of the team?" Seasons can be long and grueling for athletes and chronic fatigue is always something that athletes and trainers should be cognizant of.

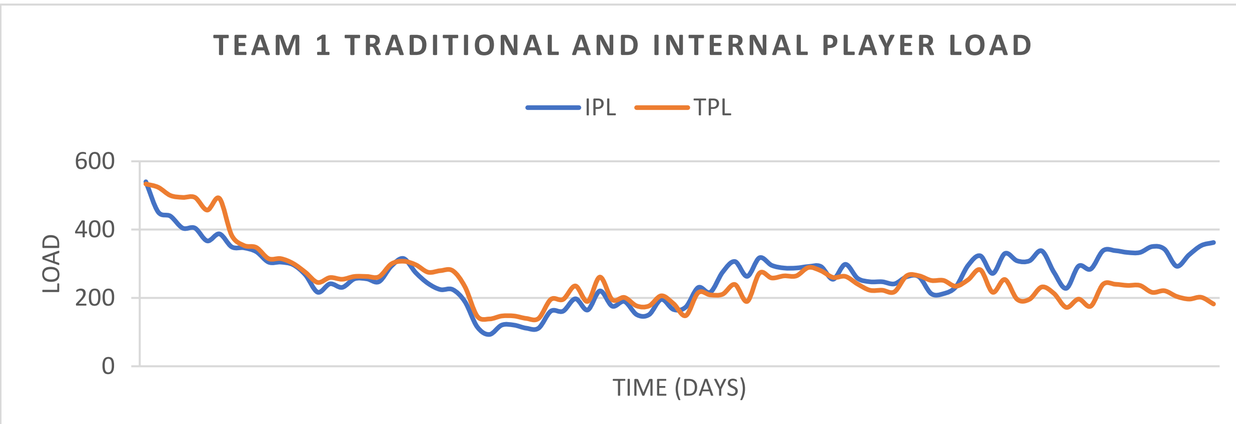

Figure 1 Division 1 Field Hockey Team

Team 2 and 3

Figures 2 and 3 represent Teams 2 and 3 respectively. These figures display comparatively more de-loading than the first team. Both of these datasets contain data spanning four months. Season scheduling presents different challenges when planning periodization periods. Both Teams 2 and 3, have a noticeable schedule break that resulted in a drop in the average load. Team 2 drops to approximately 100 while Team 3 drops to 0. Note that this is a seven-day average; 0 load represents a period where the team recorded no data for seven days in a row. The data keeping and recording practices were not verified as exactly the same between each team, therefore exact conclusions cannot be drawn from these analyses. However, it is easy to see the difference in differentiation of internal and external load when comparing before the break and after the break for each team. In both instances, the internal load is noticeably higher than the external load. This seemingly demonstrates the effect of an elongated de-loading period. When planning a training program, accounting for and evaluating the effects of schedule breaks such as bye weeks in football and December break in college basketball can be hard. These two visualizations clearly show some effect. Coming off a break lends itself to a period of less efficient (high internal to external load ratio) exercises. In each case, immediately following the break, the internal loads immediately were higher than the external load and then returned to an approximate 1:1 ratio. The difference is found after this return to "normal." Team 2 remains seemingly "normal" for the rest of the season. Comparatively, Team 3 struggles to keep internal loads at a comparable level relative to the external load. While it does return briefly to an approximately 1:1 ratio during another brief de-loading period. Following this period, the internal load remains significantly higher than the external load to close the season.

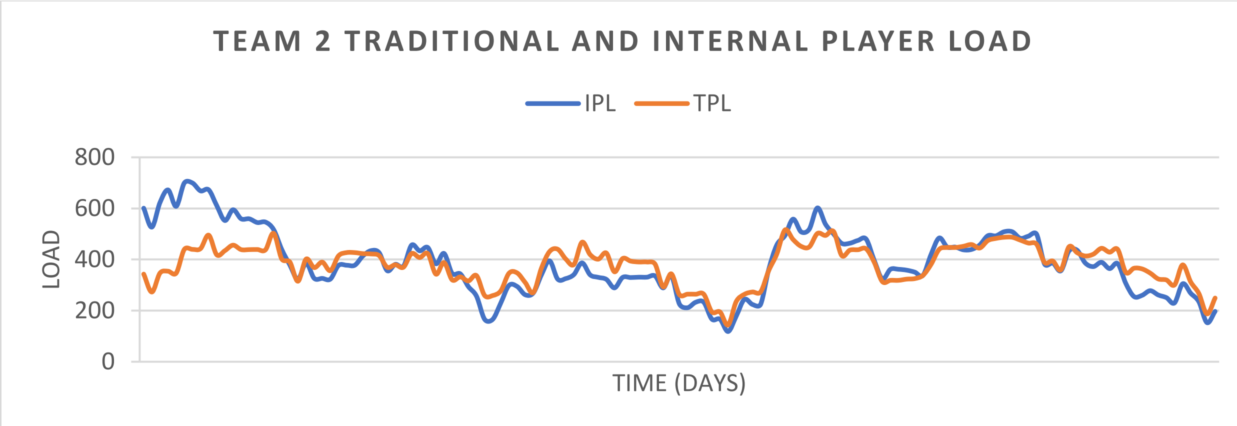

Figure 2 Division 1 Basketball Team

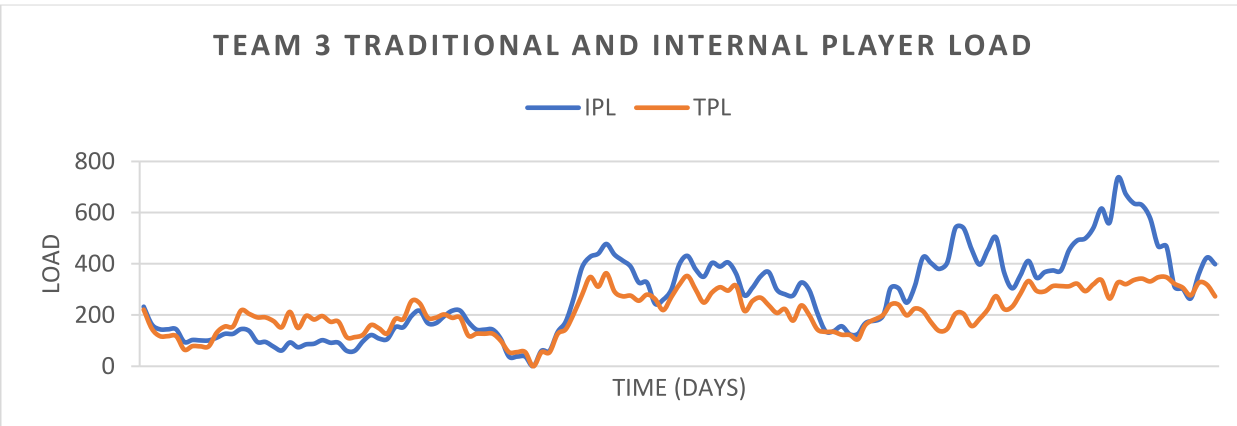

Figure 3 Division 1 Basketball Team

Conclusion

It is important to note that this data, very similar to traditional load metrics, are unique to each team. Comparing workloads or workload ratios between teams is not as effective as comparing the more general trends over time of each team's data. Each team's "normal," is unique to that team. This does not diminish the value of the data that is provided by measuring internal muscle load. Internal load is an important piece of the puzzle when visualizing and evaluating longitudinal periodization of a team's training program. The Internal load metric aids in showing the results and removes the guess work when evaluating longitudinal programming. External load does a good enough job measuring how much an athlete does, which aids in evaluating expectations of output to actual output. However, internal load provides a good measurement of how hard that work actually was for the athletes. This knowledge can unlock the internal effects of programming as opposed to just measuring the external output of the training. Figures 1, 2, and 3 display one way in which the data can be easily used along with exploratory analysis in order to maximize an organization's athletes throughout the entirety or the season.