Colorado Sports Science data science internship

Literature Background and Concepts to Consider

This guide is designed to accompany the article titled, “Hamstring Strain Injuries: Incidence, Mechanisms, Risk Factors, and Training Recommendations” by Chris Wing and Chris Bishop (NSCA).

Hamstring Strain Injury Overview

In running-based sports, hamstring strain injuries (HSIs) are the most prevalent lower body injury.[1] During sprinting, the hamstrings can undergo forces up to 6-8 times bodyweight.[2] For those unfamiliar to kinesiology/biomechanics, one of the most vulnerable aspects of the hamstring during sprinting is that it is producing force *eccentrically.* This means that the muscle is lengthening under force. Thinking of a bicep curl, when you curl the weight towards your arm, the muscle is *shortening* under force (concentric), and then when you lower the weight, it is *lengthening* under force (eccentric). Eccentric forces are far more damaging to the muscle tissue, which is one of the many reasons why HSIs can occur under such high forces produced during sprinting.

HSIs, at the very core, are very tricky to predict. As you read through the article, you will realize that there are many factors that contribute to HSI risk. They will be detailed below, but one common concept is important to keep in mind: always view injury risk in a multifaceted framework. Injuries can occur simply because of an impact with another player, or they can be as complex as someone not sleeping, hydrating, being slightly sore, and not feeling excited about playing. Recognizing all the factors that may contribute to injury is crucial to building models or tools to predict them.

Risk Factors

These risk factors are where much of your data analysis will start – injury history, fatigue, high-speed running distance, strength, and limb imbalances/asymmetries will be important factors to consider.

Injury History

By far, the most predictive risk factor for future hamstring injury is a history of past hamstring injury, ACL injury, and in some models, a previous calf injury. Injuries impart structural changes, as well as neuromuscular changes. We would hypothesize that even in our smaller data set, athletes at CU with a history of HSI or ACL injury would have a greater risk of future hamstring injury.

Fatigue

Fatigue is a very broad descriptor of various muscular and neuromuscular inputs into how the body performs. Theories for HSI risk generally encompass the idea that when the body is fatigued, there is not enough input to the muscle to sufficiently generate enough force. When input and output are not synced, there can be risk for injury. Ways we measure fatigue can be through daily monitoring (inconsistent in our data set), wellness surveys (soreness, overall wellbeing, etc.), or through quantitative metrics that measure external load.

Wellness surveys ask the athletes a few questions to get an idea of fatigue:

1. How are you doing mentally (1-5)?
2. How are you feeling physically (1-5)?
3. How did you sleep last night (1-5)?
4. How sore are you (1-5)?

The reason we ask these questions is subjective feelings of fatigue are typically some of the most accurate, even when compared to more objective metrics of fatigue. Feeling very sore, very tired, and not sleeping well is usually a very good indicator that the athlete is fatigued.

High-Speed Running

As previously mentioned, when running at high speeds, the hamstrings will produce lengthening forces up to 6-8 times body weight. When we think about balancing force and adaptations to the muscle, we don't want to overtrain athletes and apply too much load to the hamstrings. Managing high-speed running distance is an excellent way to reduce the higher impact forces on the hamstrings. Just like goldilocks, it is important to give the athletes enough load so they are strong and can tolerate high-speed running, but not too much to where they could be at increased risk of injury.

Strength

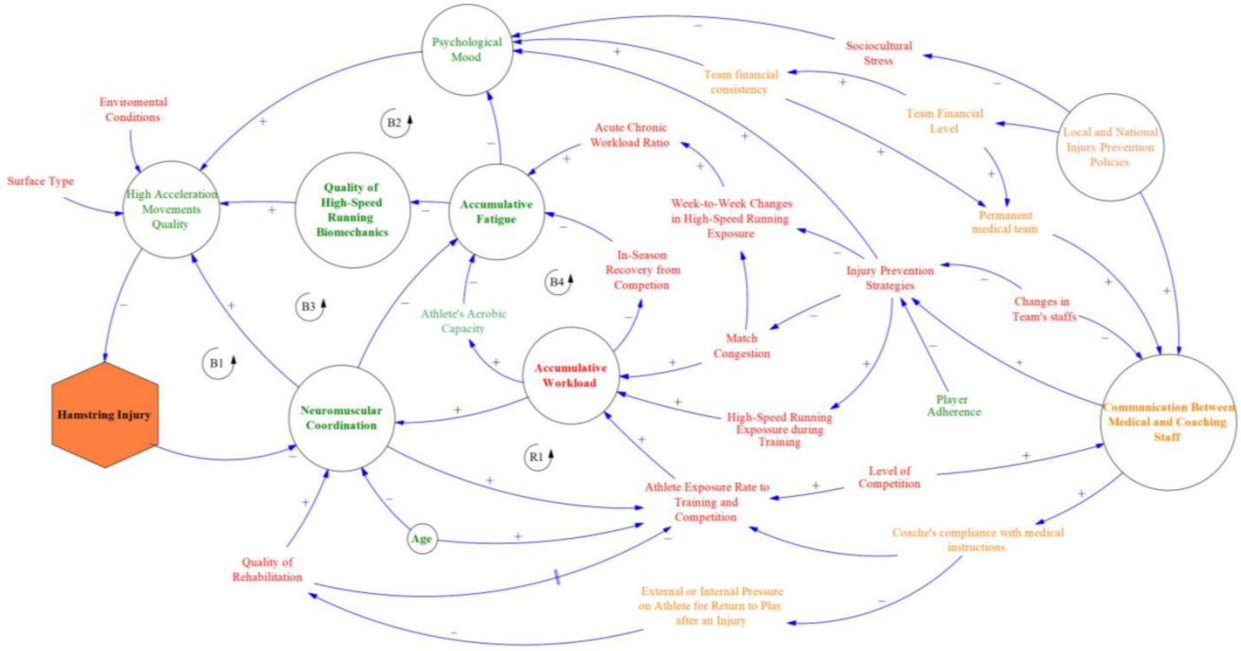
Hamstring strength, specifically eccentric strength, is a potential risk factor for hamstring injury. We test this mainly through Nordic Hamstring Curls. The athlete's ankles are locked in, and they slowly lower their chest to the floor using their hamstrings. By measuring the force they produce, we can see how strong their hamstrings are and how they can potentially absorb the very high forces we see when running.

Limb Imbalances/Asymmetries

Another interesting component of hamstring strength is how the limbs perform relative to each other. When there are large imbalances between left and right hamstrings, there is potential for compensation and overuse. Imbalances (typically expressed as a percentage) are not always advantageous for hamstring injury. Many practitioners use different cutoffs for what is considered ideal, so that is part of the exploratory analysis of your project.

Other Factors

As mentioned, there are countless factors that can be considered for hamstring injury risk. Below is a figure from Liveris et al (2024):



Notice how complex this model of hamstring injury is. The authors argue that the lack of statistical evidence supporting risk factors as predictors of HSI is rooted in the incorrect assumption of linearity. This may pose a challenge to you, as data scientists, as it will muddy the waters surrounding modeling tools. To overcome this inherent challenge, many of our research topics are centered around validating what we are currently using, defining thresholds specifically for Colorado athletes, or completing a series of case studies on athletes that might have undergone a hamstring or ACL injury.

Do not feel pressured to create an all-encompassing model that accurately predicts hamstring injury. For one, no study has successfully done this (at least statistically). Second, this requires very advanced data collection and cleaning. Third, we want to assess how we are *currently* defining risk and see if this is useful for *our specific athlete population.*

Conclusion

The article provided is very in-depth in certain sections. Don't pay attention to training plans or strengthening exercises (unless you're interested), as they are well beyond the context needed for data analysis. Understanding the risk factors for injury will help guide your decision-making for statistical analyses and considerations of other variables. Feel

free to look at more variables in the literature or explore the variables we collect that may not have been mentioned.

This will be challenging, especially if you have limited experience in sports science. That's okay! We believe your critical thinking, problem-solving skills, and data science experience will allow you to navigate these questions. Understanding the question and the data is just as important as getting an answer.

Please use all resources available to you and never hesitate to ask questions. We are interested in answering these questions just as much as you are!