Injury Prevention: Tracking Technology in Football

Preventing injury is the ever-chased goal throughout elite sport, especially football. The price-tags attached to players is enormous and if injury strikes it not only affects the player but the club and business too. As the number of competitions increase, the match schedules become more compact, recovery time is challenged and the risks grow.

England captain Leah Williamson (include appropriate image) has recently been ruled out due to anterior cruciate ligament (ACL) injury and will miss the World Cup this summer due to the severity of her injury and the length of time needed to recover. Her name is added to the growing list of female footballers, including two other Arsenal players this season and 25% of the female Ballon d'Or nominees, who are currently taking a significant spell on the side lines. This serious injury issue in female football is mirrored in male football in the form of hamstring tears, with 24% of all injuries in male football this season being hamstring related.

Injuries can range in severity and lead to extended periods of time in the physio room and not on the training pitch, all the way to not only career-ending but potentially life-changing consequences for the player. It is imperative that researchers spend more time investigating the potential causes of these injuries and use the latest technology to try and combat these statistics.

Career profile
A physiotherapist working in elite sport will provide treatment for and rehabilitation of injuries, enhance performance and deliver maintenance and recovery interventions. They will work directly with players as part of an interdisciplinary team alongside for example; technical coaches, strength and conditioning coaches, and medical professionals. They may work from a specific club, within an institute of sport, private practice or medical centre but will usually travel alongside the athletes in competition.

Brentford FC B's physiotherapist Stella Zhang provides a real-life insight into what the job entails (see: https://youtu.be/-b15zlSC1EE).

Minimising Injury Risk

Injury is a multi-factorial event and it is impossible to pin-point just one cause. A variety of components have been implicated including; overtraining, lack of preparation, poor technique, incorrect equipment or clothing, or impact from a collision or fall. One of the most common ways we can reduce **soft tissue injury risk** such as a **strain,** is to monitor loading.

A player's 'load' refers to the physical work completed by an athlete during a training session and/or match. Football consists of low-intensity activities (e.g. walking), high-intensity activities (e.g. sprinting) and sport-specific activities (e.g. tackling, turning, and dribbling).

The loading will be unique to the player, their position, their playing style, the tactics employed, and the approach to training volume.

Loading is reported using measurements such as;

- **Sprint distance (m)** – The number of metres covered at a speed greater than 7 m/s
- **High-speed running distance (m)** – The number of meters covered at a speed greater than 5.5 m/s
- **Accelerations** – The average number of **acceleration** efforts per minute of the session
- **Decelerations** – The average number of deceleration efforts per minute of the session
- **Time in red zone (mins) -** The number of minutes spent with heart rate above 85% of the athlete's maximum heart rate

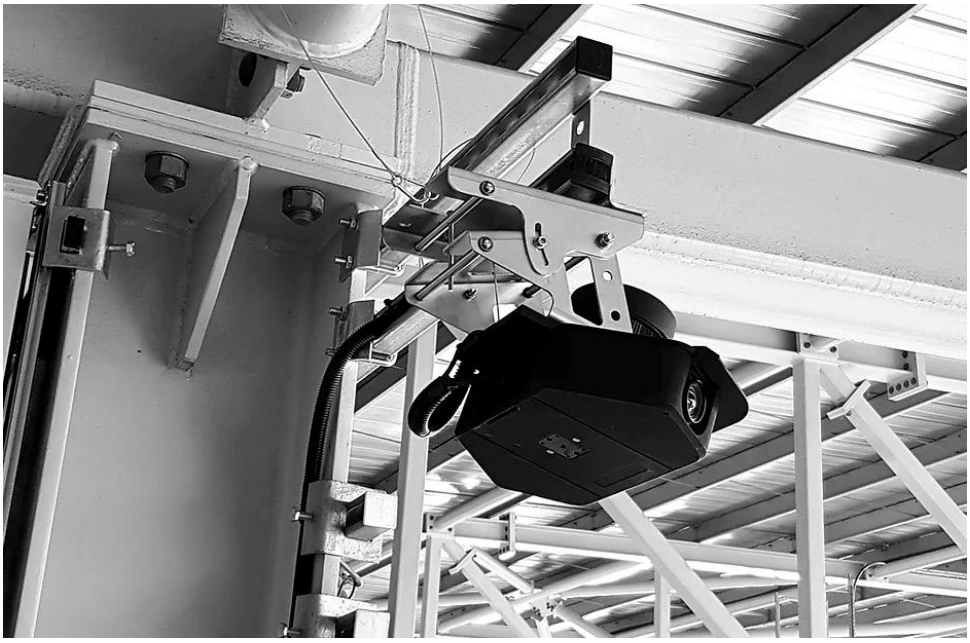
A strain is a tear or damage in the muscle fibres or tendon usually caused by overstretching or rapid muscular contraction. This can lead to a partial or complete rupture which carries a lengthy recovery and rehabilitation period. So, how does possessing this loading information reduce a player's risk of injury? It may be instinctive to think that we would use it to identify players that are running too much - overtraining and need to give their bodies a break. Although this is sometimes the case, more often it is to identify players that aren't sprinting or accelerating enough in training which reduces the protection of major muscle groups such as the hamstrings. It is crucial to expose players to the correct volume of sprint activity in a training week to reduce the risk of a tear in the match, which is where most hamstring injuries occur! (insert appropriate picture of footballers sprinting in a training session or looking tired during a training session)

How can we assess player loading? This is where tracking technology comes in to play. Have you ever seen football players wearing what appear to be sports vests under their match day tops? (could include an appropriate image of footballers training whilst wearing tracking vests) These undergarments house player tracking devices that are comprised of four different types of sensors: an accelerometer, a gyroscope, a magnetometer and a global positioning system (GPS) module. The accelerometer and the GPS module directly collect physical measures, such as acceleration in multiple planes of motion, whilst the gyroscope and the magnetometer provide orientation and direction of the data through detecting the earth's gravity and magnetic field.

Sports technology is a rapidly evolving field and wearable GPS sensors could soon become outdated by more advanced options, such as light detecting and ranging (LiDAR) technology - the same equipment used in driverless car design. LiDAR technology has recently broken onto the tracking scene providing sport scientists and performance analysts with metrics they have never had access to before! Due to LiDAR's hyper-accurate metrics (currently the most sophisticated and reliable way to measure speed, movement and position of athletes) Fujita laboratories used the technology to track the movements of elite gymnasts to assist with judging the degree of complexity in rapid movements.

Sportlight®

Maximising this new technology is a 'sports tech start-up with global ambitions' - Sportlight®, a company who have combined LiDAR and artificial intelligence (AI) to create a revolutionary new elite athlete tracking system. LiDAR units use infrared lasers to measure distances between a given target and a sensor. These sensors are located in the camera systems increasingly mounted within premier league stadiums and sample 1.2 million spatial readings per second over a 200 m range at 10 Hz. (include image as below)



Although still in the early stages Sportlight® could be the future of technological advancement in football. Considering a single match, a coach may want to compare a player's top speed and change of direction quickness in each half to assess fatigue rate and the degradation of performance. Tactics can be altered, training can be individualised and talent can be assessed. With data on individual player performance over time, downward trends or inconsistencies in metrics such as distance travelled, footfall intervals or exit velocities on a kicked ball can be identified quickly and inform squad selection and intervention strategies. Protecting the player early before injury occurs and huge sums of money are lost is always the best course of action. When player contracts are at stake the accuracy of this data is paramount.

GPS systems record relatively linear movements such as accelerations and sprints and there are several major aspects of game play that aren't being accounted for. Sportlight® and LiDAR technology solve this problem and provides data on two important metrics, change of direction and force-velocity profiling.

Change of Direction Metrics

Many refer to a turn as a change of direction; it may define how quickly a footballer can decelerate from top speed, turn and accelerate away in the opposite direction often seen when challenging for possession or in a counterattack. The ability to lose and quickly regain

momentum in a game such as football requires players to change direction in multiple planes and in response to a multitude of changing variables. A player may not be the strongest, achieve the highest speeds or have the technical prowess of others, however their change of direction metrics may be excellent and therefore have a superiority in transition and always make successful plays. Change of direction metrics may provide a more meaningful picture of a player to coaches and managers (e.g. stop-start ability, cutting explosiveness, lateral quickness and rounded acceleration).

Sportlight® using LiDAR technology classify 'significant turn' metrics at a fine level;

'where a player completed a deceleration (≤ −2 m/s/s), an angle change in the direction of travel (≥ 20°), and a subsequent acceleration (≥ 2 m/s/s) all within a 1 second duration.'

This movement will illicit significant 'loading' on the player's lower limbs and research is ongoing to build elite player data banks to understand whether this measure will be fully effective in predicting whether they have completed too much or not enough to reduce the risks of injury. Research projects currently underway at Lancaster University under the supervision of Dr Tim Barry are considering the relationship between significant turns in matches and whether training in small-sided games produce the same response and load. Dr Tim Barry is a Teaching Fellow for Sports and Exercise Science at Lancaster University and chief sports science consultant for Sportlight® technologies.

Horizontal Force Velocity Profiling

Physical 100 the South Korean Netflix hit series endeavoured to find the functionally perfect human physique and taught us individual metrics of strength or speed aren't enough on their own. The component of fitness – **power** comes the closest, the product of force and velocity.

Sportlight® and LiDAR technology collects accurate data to provide player force-velocity profiles across a game, training week and season. Research indicates any clear reduction in a player's horizontal force velocity during sprint acceleration is a risk for hamstring injury. This enables clubs to implement training interventions to minimise those risks. As much of a benefit as this is to the player it is crucial the data is accurate. Classifying players 'at risk' of hamstring injury is a complex business when considering potential transfer targets and contract signatures!

The face of technology in sport is evolving quickly. As many benefits as there may be to maximise performance and minimise risk of injury, the commercialisation of sport and treatment of players as commodities mean the data that decisions hinge upon must be accurate and reliable.

GPS wearables	LiDAR technology
Positives: Accessible and affordable (considered a norm even in lower league teams), portable from training grounds to stadiums with no reliance on external	**Positives**: Hyper-accurate, exceptional depth of data available, no impact on player comfort or concentration, change of direction data and force-velocity profiling

facilities, real-time data allowing adaptations during play	
Negatives: Accuracy and reliability limitations especially indoors, signal interference, player comfort and concentration, home-side data only, lack of change of direction data	**Negatives**: New technology, data not immediately available, need specialists to interpret the quantities of data, relatively exclusive state of the art equipment, expensive

Key Terms

Soft tissue injury – damage to the skin, muscle, tendon or ligament including a tear, strain and sprain

Strain – overstretch or tear in the muscle or tendon that connects muscle to bone

Acceleration – the rate of change in velocity. Acceleration = (final – initial velocity)/time (m/s/s)

Momentum – the quantity of motion possessed by a moving body. Momentum = mass x velocity (kgm/s)

Want to know more?

Check out Sportlight's® blogs at www.sportlight.ai/blog, including articles on:

- How LiDAR is capturing performance in the premier league
- How measuring change in direction can help mitigate injuries
- How personalised movement data can be used to develop game tactics
- How elite sports organisations can use force-velocity profiling
- Tips for a successful career in sports analytics

Exam Board Links

OCR: 1.3.a. Biomechanical principles, levers and the use of technology (velocity, force, momentum and acceleration)
1.2.c. Injury prevention and the rehabilitation of injury
3.2. Contemporary issues in physical activity and sport (modern technology in sport – its impact on elite sport)

AQA: 3.2.1.3 Injury prevention and rehabilitation of injury
3.2.2.3 Linear motion (velocity, acceleration and momentum)
3.2.4.8 The role of technology in physical activity and sport (data collection, use of GPS and motion tracking software and hardware)

Edexcel: 2.3 Injury prevention and the rehabilitation of injury
2.4 Linear motion

Ms Erin Griffiths is a postgraduate student studying at Lancaster University for a MSc by research in Medical Sciences, specifically loading and significant turns in matches compared to small-sided games in elite football

Dr Sarah Powell is a teaching fellow at Lancaster Medical School, for the BSc in Sports and Exercise Science, and author of a range of A-level PE textbooks and resources