

Data-Driven Approach in Football Training

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Physiology of Football

Football is a team sport characterized by intermittent exercise and performance under variable conditions, involving intensive activity related to technical, tactical, physiological, biomechanical, and psychological domains. Previous research has demonstrated that football places diverse demands across multiple areas. From a physiological standpoint, numerous studies have contributed to the literature by examining parameters such as total distance covered, distance covered at different speed zones, heart rate variability, blood lactate concentrations, ratings of perceived exertion, fatigue and its physiological consequences, and technical performance (Talovic, 2019). Average oxygen consumption during a match is a crucial parameter for evaluating performance. However, the numerous short and intense activities occurring throughout the game can lead to increases in oxygen consumption rates. The extent of this increase can be modified through high-intensity interval training (Açıkada, 2021). During football matches, activities such as standing, walking, and movements performed at moderate to high speeds constitute the majority of the total distance covered. In addition to these, other actions such as dribbling, tackling, feinting, shooting, and lateral movements require higher energy expenditure from the players (Ünver, 2023). To maintain high energy expenditure and use energy more efficiently, while also sustaining desired performance, various training methods must be implemented. Separately, for important short-distance performance outputs such as Dribbling Acceleration, specific training methods such as reaction and sprinting can be used rather than general training methods such as strength endurance (Bozkurt, Vural, & Demiryol, 2025; Önlü, Demiryol & Çakan, 2022; Padron-Cabo et al., 2020).

Player Tracking Methods in Football

With the evolving and modernizing understanding of football in recent years, the physical demands expected from players during both competition and training periods have also changed. The introduction of new approaches to football, the reorganization of many football competitions, and the increasing number of matches have emphasized the importance of maintaining players' physical performance throughout the season. Meeting these growing and changing demands has led to the integration of technological devices into football, making them an essential component of the modern game (Scott,

Scott, & Kelly, 2016).

The use of technological equipment has facilitated the monitoring of players' performance and provided coaches with rapid and practical tools for analysis. Today, multiple technological systems are employed to monitor players' physical activities during both matches and training sessions (Buchheit et al., 2014). These innovations have enabled coaches to track the performance metrics of their players throughout the season, design training programs tailored to individual needs, and monitor their health status (Di Salvo et al., 2013).

During competition and training, or through post-session data retrieval, several monitoring systems are used—such as camera-based systems, computer software, ultrasonic technologies, video analysis tools, and GPS devices. Although these systems share similar purposes, each method presents distinct advantages and limitations (Buchheit, 2014; Scott, Scott, & Kelly, 2016).

The Use of GPS Technology in Sports

The Global Positioning System (GPS) is a satellite network that transmits regularly encoded signals and determines precise locations on Earth by measuring the distance between satellites and receivers (Hewitt, Greenham, & Norton, 2016). Initiated by the U.S. Department of Defense in 1978, the GPS has become a globally accessible and free service. As the cost of integrating GPS technology into vehicles, machinery, computers, and mobile devices has decreased, it has become a universal and widely utilized tool (Bajaj, Ranaweera, & Agrawal, 2002).

The first GPS units designed to monitor athletes in team sports were developed by the company GPSports® in 2003. Since then, they have been widely used in football, Australian football, rugby, and hockey (Edgecomb & Norton, 2006). The three main manufacturers producing GPS devices for team sport monitoring are GPSports, CatapultSports®, and StatSports®. In later years, GPSports and CatapultSports merged. Advances in technology have allowed the miniaturization of electronic devices, making GPS units even smaller than mobile phones (Hewitt, Greenham, & Norton, 2016).

During matches and training sessions, GPS receivers worn by players utilize signals from at least four satellites orbiting the Earth to determine position (Larsson, 2003). The use of GPS technology in team sports enables the measurement of player positioning, speed, and movement patterns. GPS units provide valuable insights into the specific and position-dependent physiological demands of team sports, thereby facilitating the design of training programs aimed at optimizing on-field performance (Cummins et al., 2013). Modern GPS systems are now widely used by sports scientists and coaches, as they provide hundreds of data points that can guide athletes' training programs (Ünlü et al., 2018). Compared to other tracking systems, GPS devices are more advantageous due to their portability, wearability, and user-friendly software (Hewitt, Greenham, & Norton,

2016). The use of GPS technology with athletes was first introduced by Australian sports scientists in tennis and was later implemented in team sports for the first time by GPSports in 2003 (Edgecomb & Norton, 2006). Apart from brand differences, GPS systems are also categorized based on their data sampling frequency, measured in Hertz (Hz), which indicates the number of data transmissions per second and the number of satellites that can be connected simultaneously. Higher frequencies allow for more accurate data collection with reduced signal drift. Typically, models operating at 1 Hz, 5 Hz, 10 Hz, or 15 Hz are used to ensure reliable measurements (Scott, Scott, & Kelly, 2016). In current literature, GPS-based athlete tracking systems are employed to objectively measure players' individual efforts and physical stress, analyze competition performance, assess workload across different playing positions, determine training-induced fatigue, and monitor changes in physiological demands (McLellan, Lovell, & Gass, 2011). In addition to GPS systems, the development and integration of microtechnology in sports have led to the use of Micro-Electro-Mechanical Systems (MEMS)—including triaxial accelerometers, magnetometers, and gyroscopes—embedded within GPS devices. The combination of GPS and MEMS technologies provides practitioners with an extensive dataset describing athletes' physical loads and activity profiles (Akyıldız & Erdoğan, 2022).

Table 1

Frequently Used Gps Parameters

Accelerations & Decelerations A simple count of how many times you accelerated over 3m/s^2. Think of those short sharp explosive bursts to beat your opponent to the ball or quickly putting on the brakes to change direction.
Average Heart Rate This is the average heart rate score throughout your session, recorded in Beats per Min (BPM).
Distance Per Minute This is the distance you covered, divided by the duration of your session. A high value here indicates a high work rate throughout your session.
HSR (High Speed Running) This is the distance that you have covered over 5.5m/s (19.8km/h). Measured in meters or yards, the HSR distance tracks all those lung bursting runs, overlaps on the wings or tracking back to help your teammates. Pro players can tally upwards of 1,100 meters during a game depending on tactics and position played.
HSR (High Speed Running) Per Minute Is the average distance covered per minute at speeds above 5.5 m/s (19.8 km/h) across a session. It takes the total HSR distance and divides it by the total session duration in minutes.

High Intensity Distance

We developed a metric just for all those hard yards you put in during a session! This is a combination of all your HSR distance, and your distance covered while accelerating and decelerating. Pro players can cover 2,000 – 2,800 metres of HMLD in a game depending on tactics and position played.

HID (High Intensity Distance) Per Minute

is the average distance covered per minute from high-intensity actions. It combines two components:

High Speed Running (HSR) Distance → distance covered above 5.5 m/s (19.8 km/h)

Acceleration/Deceleration Distance → distance covered while rapidly changing speed

The total High Intensity Distance is divided by the session duration in minutes to show how much high-intensity work is sustained across time.

Max Heart Rate

Pair a BLE or Magnetic monitor to capture heart rate data. Your max HR score indicates the highest value recorded during your session.

Max speed

A single score of your maximum speed reached throughout the session. This can be measured in m/s, mph or km/h.

Sprints

A count of how many sprints you achieved throughout your session. Your sprint threshold can be increased or decreased via the ‘Configure Apex’ option located in the main menu. You must hold this speed or above for 1 second to register a sprint. The location of your Sprints can be seen in the Mapping section.

Step Balance

An excellent metric that can pick up on any imbalance in your running style. Ideally, we would like to see a 50:50 breakdown here but slight deviations +/- 2 may be normal for you. Large differences or sudden changes between right and left may be an indicator of a potential or historical injury.

Total Distance

A key measure of the volume of your session. Pro players typically cover between 7km – 11km during a game depending on their position. Make sure to edit your session start time / end time for the most accurate readings.

Sources: (Beato, Wren, & de Keijzer, 2024, Dawson, McErlain-Naylor, Devereux, & Beato, 2025, Hennessy & Jeffreys, 2018)

Distances Covered in Soccer

Studies have shown that football players at different levels cover approximately 10–12 km during a match at varying speeds and perform about 1,200–1,250 sudden directional

changes in different body positions every three minutes. Within 5 seconds, they perform 35–40 sliding tackles. They also complete more than 700 jumps, accelerations, and decelerations, as well as 30–50 sprinting actions (Iaia, Ermanno, & Bangsbo, 2009; Dellal et al., 2012). Video-based match analyses have revealed that elite-level football players perform 2–3 km of high-intensity running (>15 km/h) and approximately 0.6–1 km of sprinting (>20 km/h) during a match (Iaia, Ermanno, & Bangsbo, 2009; Bradley et al., 2010).

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The Concept of Game and Game in the Digitalization Process

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Introduction

The concept of play is one of the oldest phenomena in human history. Play began with the existence of living things. Not only humans but also animals play. Humans unconsciously created play by imitating what they saw around them and explaining their actions to each other through movement. For example, a person who caught prey would explain how they caught it to others through imitation. These imitations gradually evolved into conscious religious and magical ceremonies. Play thus acquired a cultural identity. As adults explained how they hunted, children began to emulate their actions and adopt them as role models in their daily lives. Such games were passed down from generation to generation and formed the basis of modern-day games. A statue in the British Museum in England, dating back to 800 BC, depicts two girls dancing the minstrel dance. A mural in the Akhor cemetery in ancient Egypt depicts a girl playing a game of hand-clapping. Blocks found in the ancient ruins of Ephesus have identified areas for tic-tac-toe and tic-tac-toe games. A game resembling backgammon appears in Greek pottery paintings. In Egypt, a girl was buried with her doll when she died. In ancient India, game boards depicting games played with dice and murals depicting spinning tops have been found. Leather balls have been unearthed in tombs excavated in ancient Egypt. Activities such as lifting stones in water and playing the rope game are widely known games worldwide. Furthermore, ancient Chinese sources indicate that kite flying has a history spanning more than three thousand years (Lefebvre, 2013). Games have been part of our lives since the dawn of time, representing an activity that people of all ages, young and old, spend a significant portion of their time on. With technology making life easier in every aspect, it has also become increasingly prevalent in the realm of entertainment and gaming. As people move away from traditional games, they are turning to digital games. With increasing digitalization, games have become an indispensable pastime in