Central European Journal of Sport Sciences and Medicine | Vol. 43, No. 3/2023: 63–71
ISSN (print): 2300-9705 | ISSN (online): 2353-2807 | DOI: 10.18276/cej.2023.3-07

ASSESSMENT OF MAXIMUM VELOCITY: A CASE STUDY OF POGOŃ SZCZECIN FOOTBALL PLAYERS IN POLISH EKSTRAKLASA

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Abstract The aim of this study was to assess the maximum velocity achieved by professional soccer players. The study involved 20 professional football players. The analysis of the achieved velocities during the season was based on individual maximum velocity values obtained in a preseason period test using the GPS monitoring device Catapult Vector S7. The study covered 20 match units and 77 training units.

A velocity equal to or greater than 100% of the maximum velocity was achieved 24 times - 21 times (accounting for 88%) during a competitive match (MD 0), 1 time (accounting for 4%) two days before (MD-2), and two times (accounting for 8%) three days before (MD-3). A velocity in the range of 90-99% of the maximum velocity was achieved 207 times.

The results confirm that football players can achieve values equal to or greater than 100% of their maximum velocities; however, this occurrence is rare. Due to the low probability of high maximum velocity values during a training microcycle, it is recommended to incorporate specific training methods that allow for achieving high maximum velocities to reduce the risk of hamstring muscle injuries among players, especially among reserve players (who rarely participate in competitive matches).

Key words: soccer, training load monitoring, GPS, maximum velocity, speed training

Introduction

The study was conducted to gain a better understanding of the topic of individualization of training loads, aimed at improving the athletic performance of soccer players and assisting in reducing the incidence of injuries resulting from mismanagement of training loads.

Speed is one of the most sought-after physical skills in most team and individual sports. It is defined as the highest velocity at which a player can perform a sprint (Williams, 2005). Sprint, a very fast run, is considered the most frequently occurring action leading to goal scoring, performed by either the shooting or assisting player (Faude, 2012). Faude (2012) analyzed 360 video materials that included goal-scoring situations in the German Bundesliga and highlighted the actions preceding each goal. Sprint preceded 161 (45%) of all analyzed goals, out of which 109 were executed without pressure from opponents, and 121 without the ball. The assisting player sprinted in a straight line 137 times (38%), with most sprints being performed with the ball – 93 out of 360 goal-scoring situations.

Sprinting in a straight line is the most frequently performed action by players assisting or scoring goals in direct match situations. The intensity of work performed by professional footballers in top leagues appears to be relatively consistent (Barros, 2007). The distances covered by players at high speeds are usually short and dependent on the tactical setup of the team. The players' positions on the field also directly determine the volume of work they can accomplish. It is worth noting that players in positions with limited space on the field may face challenges in developing high-speed abilities over longer distances, and a specific training approach should be considered to address this (Owen, 2013).

In football, players rarely reach their maximum velocity during a sprint; the initial start and acceleration phases are deemed more critical (Jovanović, 2011). Unlike sprinters who reach their maximum speed between 50 and 70 meters, football players rarely have such open spaces on the field, with distances typically ranging from 30 to 40 meters at most. A high level of overall physical fitness is crucial for players competing at the highest levels, regardless of the league (Arnason, 2004). It has been observed that the most common speed values among footballers are around 32 km/h (Rampinini, 2007). A player's speed capabilities depend on various factors, including their training level and age (Buchheit, 2015). Depending on their position on the field, players achieve different values of their maximum speeds. Maximum values for central midfielders from one team were as low as 85% of their maximum velocity, central defenders 89%, full-backs 90%, wingers 92%, and forwards 93% (Al Haddad, 2015). These results indicate that players only approach their maximum speeds and that the position on the field plays a crucial role in these values. External load measurement in football, which often focuses on fixed speed zones, is widespread (Weston, 2018). However, this approach does not consider individual speed capabilities and predispositions of the player (Lovell, 2009).

Increasingly, research and scientific reports in football suggest interpreting player loads individually and tailoring training loads based on their physical predispositions (Abbott, 2018). Individualized training loads can help better match training and match demands among players, consequently reducing the risk of injury while maintaining high performance during competitions (Hunter, 2014). Since speed zones in football are classified and fixed for individual monitoring devices, conducting tests to determine the player's individual measures is necessary to obtain detailed data regarding their speed capabilities (Scott, 2018).

The aim of the study is to provide answers to the following research questions:

1. Can players achieve values equal to or greater than 100% of their individual maximum velocity?
2. Are velocities equal to or greater than 100% of maximum velocity achieved more frequently by professional footballers during matches compared to training sessions?
3. Which players most frequently achieve values equal to or greater than 100% of their maximum velocity?
4. Does a player's position on the field influence their ability to reach values equal to or greater than 100% of their maximum velocity?

Materials and Methods

The study involved 20 players aged between 19 and 34 years old. The players were divided based on their positions on the field into five groups (forwards – 1 player, wingers – 4 players, central midfielders – 7 players, full-backs – 4 players, central defenders – 4 players). Data from 17 matches in the Polish PKO Ekstraklasa, 1 match in the Fortuna Polish Cup, and 2 matches in the UEFA Europe Conference League were utilized, along with 77 training sessions. These data were used for the percentage analysis of individual maximum speed values achieved by the players. Individual maximum speed values were obtained through speed tests over 100 meters using the CATAPULT VECTOR S7 GPS system, which is used for monitoring training loads. Based on the obtained results – the maximum speed values, an individual analysis of maximum speed values during both training sessions and matches was conducted.

For the study, the GPS monitoring devices Catapult Vector S7 were used, which employ two systems – GPS and GLONASS. The transmitters are placed in a specialized vest on the player's back. The GPS transmitter determines the player's position by measuring the time of signals emitted by satellites. Catapult devices are equipped with inertial sensors that allow for detailed measurements. These sensors include an accelerometer, gyroscope, and magnetometer. The accelerometer identifies specific movements such as jumps and accelerations. The gyroscope is used for measuring rotations around three axes. The magnetometer acts as an electronic compass, providing information about the direction and orientation of individual movements.

Results

The highest speed achieved was 34.88 km/h by player number 3 (Group II – winger), while the lowest speed of 29.84 km/h was recorded by player number 17 (Group V – central defender) (Figure 1).

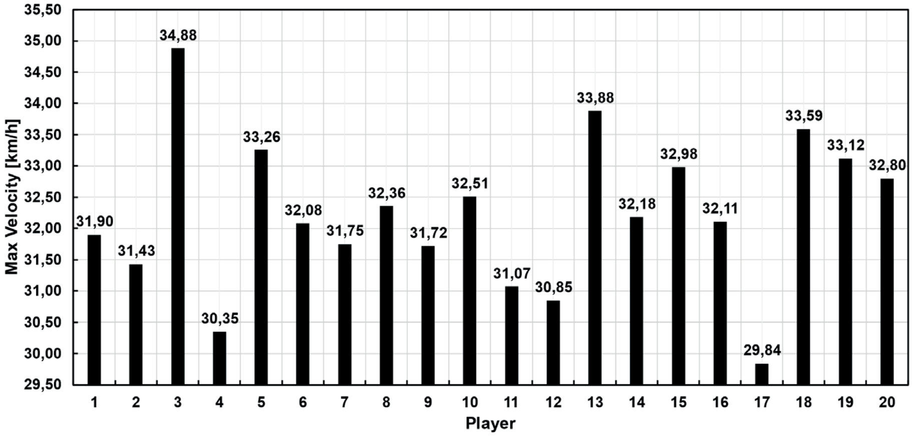

Figure 1. Maximum speed values attained by each player during the study

Figures 2 and 3 present the player groups and the number of occurrences where players achieved specific values of maximum velocity – values equal to or greater than 100% of maximum velocity (Figure 2) and values in the range of 90–99% of maximum velocity (Figure 3).

The group with the highest number of repetitions of maximum velocity equal to or greater than 100% was Group II – the wingers, while Group III – the central midfielders achieved the highest number of repetitions with velocities in the range of 90–99% of maximum velocity.

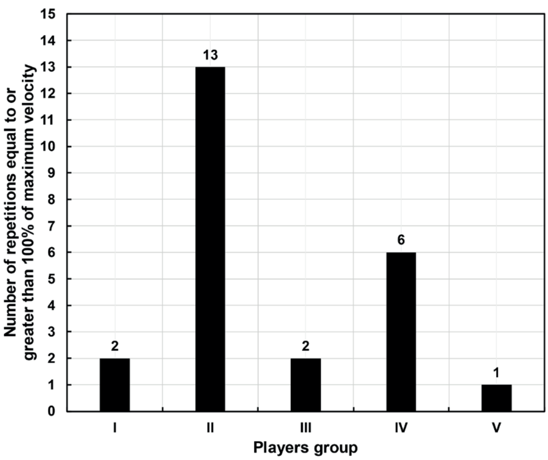

Figure 2. Repetitions equal to or greater than 100% of maximum velocity achieved by each player *group*

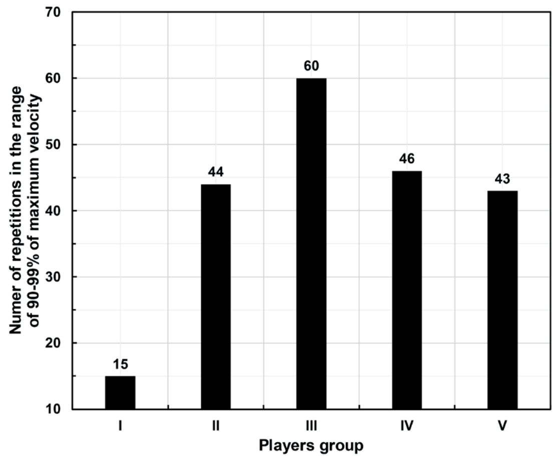

Figure 3. Repetitions in the range of 90–99% of maximum velocity achieved by each player group

Figure 4 illustrates individual days during the microcycle and the number of recorded occurrences of values equal to or greater than 100% of maximum velocity. Values equal to or greater than 100% of maximum velocity were most frequently achieved by the players during competitive matches (21 repetitions). One repetition was recorded two days before the match (MD-2), and two repetitions were recorded three days before the match (MD-3).

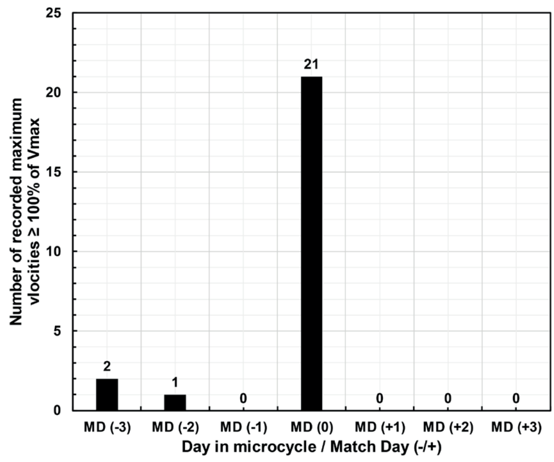

Figure 4. Repetitions equal to or greater than 100% of maximum velocity on each day of the microcycle

The group with the highest number of repetitions of maximum velocity equal to or greater than 100% was Group 2 – the wingers, while Group 3 – the central midfielders achieved 59 repetitions with velocities in the range of 90–99% of maximum velocity.

Table 1. Groups and the number of recorded individual values of maximum velocity

GROUP	90–99% of Maximum Velocity	≥ 100% of Maximum Velocity
I	15	2
II	44	13
III	59	2
IV	46	6
V	43	1
SUM	**207**	**24**

Table 2. *The number of recorded individual maximum speed values in each of the 17 microcycles*

MICROCYCLE	90–99% of Maximum Velocity	≥ 100% of Maximum Velocity
1	19	3
2	16	1
3	12	1
4	12	2
5	13	2
6	11	1
7	14	2
8	12	4
9	9	1
10	11	2
11	10	1
12	14	0
13	14	3
14	13	1
15	14	0
16	5	0
17	8	0
SUM	**207**	**24**

Discussion

The conducted study confirms that football players can achieve values equal to or greater than 100% of their maximum speed, but this occurrence is rare. During 17 league matches, 3 cup matches, and 77 training sessions, maximum speed equal to or greater than 100% of maximum speed was achieved only 24 times, with this event happening 21 times during match sessions and only 3 times during training sessions. Matches involving a live audience may result in higher arousal of the nervous system among players. Fans and the awareness of a competitive match are external factors positively influencing the physical capabilities of the players.

It can be observed that fatigue increases among players due to the frequency of occurrences of maximum speed values during the first and last microcycle (Table 2).

As shown in the study (Djaoui et al., 2017) on a group of professional football players from the French first division, similarities were noticed, indicating that maximum speeds among football players are much more frequently achieved during matches than during training sessions. Similarly, it was observed that wingers achieve their maximum speed values more frequently than players in other positions.

The obtained results from the conducted study indicate a low probability of achieving maximum speeds among the players. Similarly, in a study encompassing two 21-day training microcycles conducted by Gualtieri et al. on a group of 20 professional players competing in the top-tier Italian league (Serie A), it was found that players who regularly start competitive matches from the first minute exhibit significantly higher internal and external loads compared to reserve players, considering both match and training loads (Gualtieri, 2020). The study emphasizes the importance of individualizing speed thresholds for load optimization. These findings are of paramount importance in football due to the continually emerging evidence supporting the use of high-intensity runs as a preventive measure against injury occurrences (Buckthorpe, 2019). The research confirms that football matches are a pivotal component during the microcycle, where players engage in more very high-intensity runs and football-specific activities, which can be challenging to replicate during training sessions (Morgans, 2018). During training units, coaches may struggle to reproduce match-equivalent running conditions, especially high-intensity runs. Individualized speed thresholds (runs exceeding 80% of maximum speed) for players not regularly participating in matches can serve as a crucial preventive tool throughout the season (Gualtieri, 2020).

It should be noted that developing maximum speed in players can serve as a preventive measure, reducing the risk of injury due to the specific work of the hamstring muscles, which are highly active during maximal intensity sprints (Edouard, 2019).

Additionally, players who serve as substitutes for the starting lineup may find themselves in situations where they do not reach their maximum speed for days, weeks, or even months, exposing themselves to the risk of injury if they are required to perform sprints at maximal or submaximal speed during matches.

Based on our own research, it can be concluded that continuous monitoring and control of players are crucial aspects, along with creating conditions during training sessions that enable players to engage in specific exercises aimed at achieving speeds close to maximum.

Conclusions

1. Professional football players can achieve values equal to or greater than 100% of their maximum speed.
2. Velocity equal to or greater than 100% of maximum speed are significantly more frequently achieved by players during competitive matches than during training sessions.
3. Football is a sport in which players rarely reach values equal to or greater than 100% of their maximum speed.
4. Wingers achieve values equal to or greater than 100% of maximum speed most frequently, indicating that the player’s position on the field plays an important role.

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Cite this article as: Rosiński, Ł., Rzepiela-Podlecka, A., Buryta, R. (2023). Assessment of Maximum Velocity: A Case Study of Pogoń Szczecin Football Players in Polish Ekstraklasa. *Central European Journal of Sport Sciences and Medicine*, *3*(43), 63–71, https://doi.org/10.18276/cej.2023.3-07