Running Demands of U17 League of Ireland Soccer Players Considering Absolute and Individualized Speed Thresholds.

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This project has been submitted in partial fulfilment of the Bachelor of Science (Honours) Degree in Sports Coaching and Performance

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Statement of originality and ownership of work

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Abstract

High intensity running only accounts for 10-20% of the Total Distance cover during match play in soccer, however, it is shown to be performed during the more important phases of play. Players may cover different distances at various speeds throughout the game depending on playing position. These speeds and distances can be monitored using GPS (Global Positioning Systems), LPS (Local Positioning Systems) and VTS (Video Tracking Systems). Speed zones can be banded using Absolute (generalized) and or Individual (based on a physiological marker) speed thresholds. This purpose of this study is to describe the running demands of under 17s League of Ireland (LOI) soccer players, while analysing how position alters the demands imposed on players. This study will also assess whether absolute or individualised High Speed Running (HSR) thresholds should be applied during under 17s soccer performance. Eighteen males under 17s LOI soccer were physically tested for MAS (Maximal Aerobic Speed) and MSS (Maximum Sprint Speed) to attain ASR (Anaerobic Speed Reserve). Once this was completed, Individual speed zones were applied to each player. GPS data (STATSports, Apex) was collected over five competitive games where ten GPS metrics were analysed based (Total Distance, Sprints, Accelerations, Decelerations, THSR (Ab), THSR (Rel), HSR (Ab), HSR (Rel), vHSR (Ab), vHSR (Rel)). Data was analysed between playing position. Central Midfielders covered the most distance and Central Defenders covered the least. Sprints and HSR varied greatly between position with wide players completing more sprints and HSR than central players. Absolute HSR thresholds may not recognize HSR effort in LOI soccer players. However, Individual HSR thresholds may not be great enough to distinguish differences between positions. Therefore, fitness levels should be considered when applying HSR running thresholds in under 17 soccer players.

Keywords: Soccer, Youth, GPS, High Speed Running,

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Table 1. Glossary of Terms

Term	Definition
MAS	Maximal Aerobic Speed; Lowest running velocity at which V02Max will occur (vV02max).
MSS	Maximum Sprint Speed; Peak velocity achieved during study.
ASR	Anaerobic Speed Reserve; Difference of Maximum Sprint Speed and Maximal Aerobic Speed.
HSR	High Speed Running.
VHSR	Very High Speed Running.
THSR	Total High Speed Running.
TD	Total Distance.
CD	Central Defender.
WD	Wide Defender.
CM	Central Midfielder.
WA	Wide Attacker.
CA	Central Attacker.
LOI	League of Ireland.
GPS	Global Positioning Systems
(Rel)	Relative; Individualized
(Ab)	Absolute; Generalized

1. Literature Review

1.1 Introduction

On average during match play, outfield soccer players cover between 10-13km with most of the distance covered at low to moderate speeds (Di Salvo, Baron, Tschan, Calderon Montero, Bachl & Pigozzi, 2007; Tierney, Young, Clarke & Duncan, 2016). High intensity running in soccer only makes up 10-20% of the distance covered (Bloomfield, Polman & O' Donoghue, 2007) but is shown to be performed during the more important phases of play (Barnes, Archer, Hogg, Bush & Bradley, 2014; Di Salvo, Gregson, Atkinson, Torfdoff & Durst, 2009). The use of time motion analysis has been shown as a valuable tool to help understand the physical requirements and demands of the game dating back as far as 1967 (Reilly & Thomas, 1976). Many different time motion analysis tools are implemented in soccer to track and monitor these demands, such as, Global Positioning Systems (GPS) or Global Navigation Satellite Systems (GNSS), Local Positioning Systems (LPS) and Video Tracking Systems (VTS) (Beato, Coratella, Stiff & Iacono, 2018; Buchheit, Allen, Poon, Mondonutti, Gregson & Di Salvo, 2014; Di Salvo, Collins, McNeill & Cardinale, 2006). These tracking systems help provide an understanding of the of the running demands exerted by utilising distance, speed and time.

1.2 Energy System Requirements in Soccer

Helegrud, Engen, Wisløff and Hoff (2001) noted that during match play heart rate (HR) values of 85% of maximum heart rate are present. Stolen, Chamari, Castagna and Wisløff (2005) noted this workload intensity as a corresponding value near to the anaerobic threshold. Furthermore, elite soccer players complete 150-250 short intensive actions during games (Mohr, Krustrup & Bangsbo, 2003), these high intensity efforts are reflected through many different technical skills, movement patterns and tactical transitions of play (Ade, Fitzpatrick & Bradley, 2016). Bangsbo, Mohr and Kenstrup (2006) suggested that during intensive periods of play, the rate of anaerobic energy turnover is significant with a high rate of creatine phosphate breakdown. However, low intensity exercise bouts during the game and aerobic contribution may lead to the resynthesise and recovery of players following these bouts. Mc Gawley and Bishop (2015) showed that during repeated sprint exercise, the aerobic energy system plays a key role in performance and not the anaerobic system alone. This finding further supports the study by Helegrud et al. (2001) who found that improved maximal oxygen uptake (VO2max) enhanced the performance of soccer players particularly within variables such as level of intensity (average HR), distance covered, number of sprints and number of involvements with the ball. These findings suggest that during match play contribution from all energy systems is required.

1.3 Running Demands of Soccer

1.3.1 High Speed Running

Barnes et al. (2014) observed an evolution in the physical output of soccer players in the English Premier League with a substantial increase in the high-speed activities during games over seven consecutive seasons (2006-07 to 2012-13). This study showed an increase in the amount of High-Speed Running Distance (HSR) (>19.8km/h) and a higher amount of Very High Speed Running Distance (vHSR) (>25.1 km/h) achieved by players (*+35%*). However, there was a reduction in the average individual sprint distance with an increased number of sprints achieved. This study substantiated earlier findings by Di Salvo et al. (2009) who found a similar trend in the progressive increase of HSR and vHSR over three English Premier League Seasons (2003-04 to 2005-06). Both studies suggest a greater requirement for high intensity activities during a soccer match. The increase in high intensity activities could possibly be explained by the findings of Wallace and Norton (2013) who observed a distinct increase from 1996 to 2010 in ball speed, passing rate and duration of pauses of play. This finding suggests that with longer duration of pauses of play leads to an increased recovery time for players and a lower proportion of game time in play, therefore, allowing these periods of play to be more intense.

Due to the intermittent nature of the game players are required to move at many different speeds in various directions (Bloomfield et al., 2007) including maximal sprint efforts of up to 32 km/h (8.8m/s) (Rampinini, Coutts, Castagna, Sassi & Impellizzeri, 2007). Bradley, Sheldon, Wooster, Olsen, Boanas and Krustrup (2009) found that the mean total HSR (>19.8km/h) covered during English Premier League games is 905m. Although this study was conducted using data from the 2006-07 season, it further supports the findings of Barnes et al. (2014) who noted a progressive increase in mean total HSR of 890 ± 299m (2006-07) to 1151 ± 337m (2012-13). This trend was also present in mean vHSR (>25.1 km/h) with values of 232 ± 114m increasing to 350 ± 139m from 2006-07 to 2012-13. Interestingly, Tierney et al. (2016) found mean HSR values of 580 ± 314 m for soccer players playing in English lower league over the course of a season, however, this discrepancy could be explained by the influence of playing level of HSR output as described by Mohr et al. (2003) who found that top level players perform more high intensity running and sprints during games when compared with moderate level players.

1.3.2 Acceleration and Deceleration Activity

Although a strong relationship was found between high speed running and perceived subjective fatigue (Thorpe, Strudwick, Buchheit, Atkinson, Drust & Gregson, 2015), metabolic demands can be very high even when running speeds are relatively low in soccer, when there is an elevated emphasis on acceleration and deceleration. Therefore, if only high-speed data is analysed, significant data and workload may be misinterpreted (Osgnach, Poser, Bernardini, Rinaldo & Di Prampero, 2010). Acceleration and deceleration output (magnitude >1m.s^2) make up 18% of the total distance covered in a soccer match (Akenhead, Hayes, Thompson & French, 2012). Both accelerations and decelerations have been shown to be a sensitive and effective measure of physical match performance, this was shown through variations within matches with significant differences observed in each half and 15-minute segments of play (Vigh-Larsen, Dalgas & Andersen, 2018). Common methods of classifying the acceleration or deceleration strains within team sports include using the distance, time spent, or number of efforts performed within banded zones based on magnitude of acceleration or deceleration (Cummins, Orr, O'Connor & West, 2013). Previous studies have used acceleration and deceleration zones based on the magnitude of the action and classified them as low (1-2m/s^2), moderate (2-3m/s ^{2}) and high (>3m/s ^{2}) (Abbott, Brickley, Smeeton & Mills, 2018a; Akenhead et al., 2014; Hodgson, Akenhead, & Thomas, 2014).

1.4 Factors Affecting Running Demands

1.4.1 Effects of Formation and Position

Playing position and role on a team requires players to possess different technical and tactical skills and characteristics during a game (Hughes, Cauldrelier, James, Redwood-Brown, Donnelly, Kirkbride & Duschesne, 2012), thus, eliciting different physical output and match play distribution for players. Tierney et al. (2016) showed how playing position produces various player output but also the formation style set out by the team can be influential. Players in each position may be required to perform different technical and tactical tasks when formation is altered and therefore formation should be noted when describing the positional demands in soccer. Using a 4-3-3 formation, Abbott, Brickley and Smeeton (2018b) found that Central Defenders (CD) covered significantly less Total Distance (TD) than other positions. Central Midfielders (CM) covered the most TD, however, this was not significantly greater than Wide Attackers (WA). Di Salvo et al. (2007) also highlighted how players covered different distances at various speeds depending on position in the team finding that central defenders (CD) covered the least amount of Total Distance (TD) with Wide Midfielders (WM) covering the most. These positional differences were also present in the study by Bradley et al.

(2009) with WM and CM covering the most TD and CD covering the least. These findings were also present in high intensity running distances. Although, it is hard to directly compare without acknowledging the playing formation employed in the study by Di Salvo et al. (2007) and Bradley et al. (2009), these findings appear similar to those of Abbott et al. (2018b). Duthie, Thornton, Delaney, Connolly and Serpiello (2018) also observed significant differences in peak running intensities of elite youth soccer players when comparing playing position.

1.4.2 Effects of Fitness Levels

Aerobic fitness levels have been shown to promote an increase in TD covered in rugby union (Swaby, Jones & Comfort, 2016) and soccer (Helegrud et al., 2001). Yet, when exploring the match play intensity distribution in elite youth soccer Mendez-Villanueva, Buchheit, Simpson and Bourdon (2012) found that increased aerobic fitness was less likely to increase total distance covered yet may lead to decreased level of relative work intensity. Furthermore, this study stated noteworthy findings of how younger players (u13, u14, u15) covered less distance at low relative running intensity and covered more distance at high relative running intensities when compared with older players (u16, u17, u18).

1.4.3 Effects of Playing Level

Although, it was found that top level players covered greater distance at higher speeds throughout gameplay than moderate level players (Mohr et al., 2003). When running performance of players playing at elite domestic and international were examined, high intensity running, mean recovery and maximal running velocities appeared similar during gameplay (Bradley, Di Mascio, Peart, Olsen and Sheldon, 2010).

1.5 Speed Thresholds in Team Sports

Absolute speed thresholds refer to an arbitrary or generic speed that is determined as High Speed Running, typically these values are set at 19.8km/h (Prozone, STATSports) but can vary due to the subjective nature of HSR definitions. Absolute Speed Thresholds apply to all players and do not differentiate amongst athletes even when physiological differences are present (Sweeting, Cormack, Morgan & Aughey, 2017). Individual speed thresholds refer to the speed an athlete reaches to determine HSR using a physiological marker reflected in that specific athlete. There are many ways in which speed thresholds are individualised. Abbott et al. (2018a) used two physical characteristics to define individual HSR. This was done by attaining each athletes Maximal Aerobic Speed (MAS) or velocity at VO2max (vVO2max) and Maximal Sprint Speed (MSS). Using these variables, Anaerobic Speed Reserve (ASR) was calculated (difference in MAS and MSS) and speed thresholds were set as distance covered between MAS and 30%ASR (HSR) and distance covered ≥31%ASR. This method was also used by Mendez-Villanueva et al. (2012) to assign individual speed thresholds. Other methods include attaining the second ventilatory threshold (VT2) through a VO2max test and therefore classifying HSR as distance cover at speeds greater than the VT2. This method was used in studies by Abt and Lovell (2009) and Clarke, Anson and Pyne (2014). Reardon, Tobin and Delahunt (2015) devised individual speed thresholds based on the participants max velocity. Each individual's max velocity was multiplied by 0.60 to define individual HSR (60% of max velocity). Although this method could be questioned as it was previously highlighted that using one single physical characteristic may not provide an accurate or complete running profile of a player (Hunter, Bray, Towlson, Smith, Barrett, Madden, Abt, Lovell, 2015; Weston, 2013).

HSR and TSD can be difficult to directly compare between literature due to the context of how it is defined. Many studies use arbitrary (absolute) speed thresholds to define HSR and TSD (19.8km/h and 25.1km/h) (Barnes et al, 2014; Di Salvo et al, 2007; Bradley et al, 2008; Tierney et al., 2016), whereas, some studies have devised individualised speed thresholds based on the athlete's physiological capacities (Abbott et al., 2018a; Mendez-Villanueva et al., 2012). HSR demands may be underestimated using absolute speed thresholds, rather than individualised speed thresholds depending on the individual's physical capacities (Abt & Lovell, 2009; Gabbett, 2015). Absolute speed thresholds produced an underestimation in HSR distance women's sevens rugby (Clarke et al., 2014). Reardon et al. (2015) found significant discrepancies between absolute and individualised HSR distances in rugby union players, with absolute thresholds providing an overestimation for forwards and underestimation for backs. When examining the Repeated Sprint Sequences (RSS) during youth soccer Buchheit, Mendez-Villanueva, Simpson and Bourdon (2010) found that absolute speed thresholds produced a greater amount of RSS bouts in older youth players than younger players, conversely when applying individual speed thresholds, the younger players produced a greater amount of RSS bouts than older players. Applying individual speed thresholds based of a physiological derived measure could potential provide a benefit to training prescription (Sweeting et al, 2017) and create a clearer representation of relative exertion. Due to absolute speed thresholds being an arbitrary or generic value applied to all players with no specificity to any given player and are commonly used across sports, this makes it a valuable tool for comparison of absolute distance at given velocity across sports and by player position.

1.6 Summary and Rationale

The purpose of this study is to describe and differentiate the running demands of youth soccer players when both absolute and individual speed thresholds are considered. Utilisation of absolute speed thresholds may provide a powerful tool to compare players amongst playing position and age group (Abt & Lovell, 2009). Absolute speed thresholds can also offer comprehensive information which could lead to a structured training prescription to meet the required running demands of that given sport (Hunter et al., 2015). However, the physiological demands imposed on a player are not considered when using these absolute speed thresholds and have been shown to misinterpret HSR demands (Abt & Lovell, 2009; Gabbett, 2015; Clarke et al., 2014; Delahunt et al., 2015). Therefore, using both individual speed thresholds as well as absolute thresholds, whether the demands of HSR in youth soccer players is underestimated or overestimated will be outlined. Individual based speed thresholds will account for various fitness levels and physical capacity of players, therefore, allowing HSR performance to be analysed with reference to equal relative demands.

Thorpe et al. (2015) mentioned how HSR had a strong relationship with perceived next day fatigue, therefore, being a taxing factor of soccer performance. However, it was identified by Osgnach et al. (2010) that even when players are performing accelerations and decelerations at relatively low speeds, metabolic demands can be significant. Therefore, accelerations and decelerations are an important aspect of workload and running exertion in soccer performance.

1.7 Research Questions

1. What are the running demands of under 17s League of Ireland soccer?
2. How does player position influence running performance?
3. Are differences present when using Individualised Speed Thresholds?
4. Is High Speed Running misinterpreted for youth soccer players when using Absolute Speed Thresholds?

2. Methodology

2.1 Conceptual Framework

This study carried out quantitative research to determine the running demands imposed on youth soccer players during match play according to position. An experimental approach was carried out to assess player's physical abilities to devise individualised speed thresholds and compare with absolute (generic) speed thresholds.

2.2 Data Sources

Eighteen youth male outfield soccer players were recruited from one League of Ireland (LOI) under 17 squad. The participants ages were 16 years ± 7 months. Players were split into groups based on playing position in each game including Central Defender (CD) (n = 4), Wide Defender (WD) (n = 3), Central Midfielder (CM) (n = 3), Wide Attacker (WA) (n = 5), Central Attacker (CA) (n = 3). Due to the unpredictable nature of the game and variance in physical output (Carling, Gregson, McCall, Moreira, Wong & Bradley, 2015; Gregson, Drust, Atkison & Di Salvo, 2010), five games were analysed to achieve more accurate findings in the given timeframe. Players who did not play the full game, through substitution, were excluded for data analysis to reflect a more accurate representation of game demands.

2.3 Variables and Concepts

Variables were derived from testing methods and match performances. During testing protocols, Maximal Aerobic Speed (MAS) and Maximal Sprint Speed (MSS) were attained from each participant. From these variables Anaerobic Speed Reserve (ASR) was calculated (MSS – MAS = ASR). Based on these variables, individual speed thresholds were implemented for each athlete. This is the same method displayed by Mendez-Villanueva et al. (2012) and Abbott et al. (2018). Although individual speed thresholds were initially prescribed using extensive laboratory testing by Abt and Lovell (2009) to attain the second ventilatory threshold (VT2), these methods may not be feasible or accessible to extensively test eighteen athletes in order to attain such physiological measures, therefore, MAS, MSS and ASR can suffice as an alternative for this.

Global Positioning Systems (GPS) was used to collect data from game performances. The Metrics that were analysis are highlighted in Table 2.

Table 2. GPS Metric Definitions.

GPS Metric	Definition
Total Distance (m)	Distance covered in metres at all speeds.
Sprints (n = number of)	Count of efforts above 5.5m/s, lasting at least one second.
Accelerations (n = number of)	Count of accelerations ≥3 m/s^2
Decelerations (n = number of)	Count of decelerations ≥3 m/s^2
HSR (Ab) Absolute High Speed Running (m)	Distance covered between 5.5 m/s (19.8km/h) and 7 m/s (25.1km/h).
vHSR (Ab) (Absolute Very High Speed Running) (m)	Distance covered ≥7 m/s (25.1km/h).
THSR (Ab) Total Absolute High Speed Running) (m)	Total distance covered above 5.5m/s (19.8km/h) [HSR (Ab) + vHSR (Ab)].
HSR (Rel) (Relative High Speed Running) (m)	Distance covered between MAS and 30% ASR.
vHSR (Rel) (Relative Very High Speed Running) (m)	Distance covered ≥30% ASR.
THSR (Rel) (Total Relative High Speed Running) (m)	Total distance covered above MAS [HSR (Rel) + vHSR (Rel)].

2.4 Data Collection

Data were collected with two main focuses, physical testing and game data collection. All data was collected using a 10Hz GPS unit (STATSports, Newry, Northern Ireland). These units have been shown to be used with confidence in soccer match and training settings as a valid and reliable measure both speed and distance (Beato et al., 2018). Each participant was equipped with a GPS unit for data collection, the unit was placed in a pocket of a tight fitting vest underneath the players jersey and positioned on the thoracic spine between the two scapulae. Prior to data collection, the units were turned on for 15 minutes to secure GPS lock for increased signal and more accurate data collection. Each player used the same GPS unit throughout the study to avoid inter unit error.

During the testing protocol participants were assessed for their individual MAS, MSS and ASR using GPS units. This was performed using two testing protocols; 1) Set Distance Time Trial (TT) (MAS), set distance time trials of 1600m, 1800m, 2000m and 2200m have been found to be a valid measure of MAS (Bellenger, Fuller, Nelson, Hartland, Buckley & Debenedicits, 2015). It is recommended that individual training age is considered when performing TT, therefore, athletes performed a 1600m TT to attain MAS. This is a maximal test where athlete's aim to reach the set distance (1600m) in the fastest time possible. MAS is then calculated as the average speed over this time. 2) 40m Sprint Test (MSS), 40m should provide sufficient distance for athletes to reach max velocity. Participants performed three trials taking the peak velocity as MSS. To account for potential outliers in using the GPS derived velocity, if the athlete did not reach within 10% of their peak velocity achieved in either of their other trials, that MSS would not have been used. To ensure ecological validity, both testing protocols were performed on grass in football clothing and boots. Athletes performed both testing procedures three weeks prior to data collection to familiarise each with the protocol, this also allowed participants to understand how they should pace themselves for the set distance time trial. Massard, Eggers and Lovell (2017) suggested that players may not reach peak speeds in speed testing protocols when compared with match play, due to motivation and the competitive nature of the game, therefore max speeds achieved during game play were also considered for MSS and ASR.

2.5 Data Analysis

Post data collection, the GPS units were downloaded using STATSports Apex Software (STATSports, Newry, Northern Ireland) and exported to Microsoft Excel for descriptive analysis. Descriptive statistics were presented by positional group for each GPS metric calculating the mean, standard deviation, median and range to allow for potential outliers. The data was analysed using JASP (0.9.2.0). After checking the normality of the data using the Shapiro-Wilk test, a one way ANOVA test was used followed by a Bonferroni post-hoc test to determine differences between player position on each variable (Total Distance, Sprints, Accelerations, Decelerations, THSR (Ab), THSR (Rel), HSR (Ab), HSR (Rel), vHSR (Ab), vHSR (Rel). Statistical significance was set at $p < 0.05$.

2.6 Ethical Considerations

Prior to commencing data collection, participants were briefed with the purpose of the study and had the option to refuse participation or withdraw from the study at any time without question. Those who agreed to participate were asked to sign a consent form, due to participants being younger than eighteen, all required written consent from a parent or guardian to participate in the study. All participants have remained anonymous throughout the study with only the participant's age being shared in the study. Data collected was only shared through academic literature and not exploited. All data has stored on a private laptop and saved externally on an encrypted hard drive.

3. Results

The descriptive statistics for TD, number of sprints, number of accelerations, number of decelerations, THSR (Rel), THSR (Ab), HSR (Rel), HSR (Ab), vHSR (Rel) and vHSR (Ab) distances during match play are displayed in Table 3. The results showed under 17 youth soccer players covered 10,019.8 ± 697.7m while performing 37.4 ± 8.4 sprints, 72.6 ± 7.7 accelerations and 77 ± 12.6 decelerations. When using individualised speed thresholds THSR distances accumulated for 15% of TD covered during match play (HSR (Rel) = 1,052.6m, 10.51%; vHSR (Rel) = 445.5m, 4.49%). When absolute speed thresholds were employed THSR distances made up 5.35% of TD covered during match play (HSR (Ab) = 449m, 4.48%; vHSR (Ab) = 87.3m, 0.87%).

Table 3. Mean, max and median of GPS metrics during match play regardless of position.

	Mean (± Std)	Max	Median
Total Distance (m)	10019.8 (± 697.7)	11536.1	10027.7
Sprints (n)	37.4 (± 8.4)	54	38
Accelerations (n)	72.6 (± 7.7)	95	72
Decelerations (n)	77 (± 12.6)	105	79
THSR(Rel) (m)	1501.3 (± 226.5)	2062.6	1491.8
THSR(Ab) (m)	530.7 (± 151.1)	796.1	539.3
HSR(Rel) (m)	1052.6 (± 179.1)	1455.34	1048.8
HSR(Ab) (m)	449 (± 122.1)	697.36	460.4
vHSR(Rel) (m)	445.5 (± 138)	751.15	432.3
vHSR(Ab) (m)	87.3 (± 40)	166.87	88.2

(n) = number of; (m) =meters;

The positional differences in output of TD, number of sprints, number of accelerations, number of decelerations, THSR (Rel), THSR (Ab), HSR (Rel), HSR (Ab), vHSR (Rel) and vHSR (Ab) distances are displayed in Table 4. Central Midfielders covered significantly more TD when compared with Central Defenders ($p = 0.019$; 10,517.2 ± 520.6m vs 9,443.9 ± 426.7m). Wide players (Wide Defenders and Wide Attackers) completed more sprints than central players (Central Defenders, Central Midfielders and Central Attackers). Wide Defenders and Wide Attackers performed significantly more sprints than Central Defenders ($p = <.001$; 42.1 ±7.1 and $p = <.001$; 46.9 ± 4.9 vs 29.3 ± 4.9) and Central Midfielders ($p = <.001$; 42.1 ±7.1 and $p = <.001$; 46.9 ± 4.9 vs 29.7 ± 4.5). Central Attackers completed significantly more sprints than Central Defenders ($p = 0.020$; 37.9 ± 4 vs 29.3 ± 4.9), but significantly less than Wide Attackers ($p = 0.020$; 37.9 ± 4 vs 46.9 ± 4.9). There were little discrepancies between positional groups in acceleration output, with the exception of Central Midfielders and Wide Defenders ($p = 0.010$; 66.6 ± 4.1 vs 78.7 ± 7.5). Central Defenders (60 ± 5.5) performed significantly less decelerations than Wide Defenders ($p = <.001$; 82.2 ± 8.7), Central Midfielders ($p = <.001$; 87.9 ± 10), Wide Attackers ($p = 0.004$; 78.4 ± 6.5) and Central Attackers ($p = 0.005$; 76.9 ± 12.2).

Table 4. Mean, max and median of GPS metrics during match play per position.

		Central Defender	Wide Defender	Central Midfielder	Wide Attacker	Central Attacker
Total Distance (m)	*Mean (± Std)*	9443.9 (± 426.7)*	10283.2 (± 584.3)	10517.2 (± 520.6)	10120.8 (± 719.6)	9773.7 (± 766.2)
	Max	10027.7	11074.3	11230.3	11457.6	11536.1
	Median	9531.58	10311.4	10458	10132.1	9532.4
Sprints (n)	*Mean (± Std)*	29.3 (± 4.9)ϒ#Ŧ	42.1 (± 7.1)	29.7 (± 4.5)ϒ#	46.9 (± 4.9)	37.9 (± 4)ϒ
	Max	36	51	39	54	41
	Median	29.3	42.1	29.7	46.9	37.9
Accelerations (n)	*Mean (± Std)*	70.75 (± 7.3)	78.7 (± 7.5)	66.6 (± 4.1)#	73.4 (± 8.7)	71.7 (± 6)
	Max	82	95	72	83	84
	Median	72	77.5	67	75	70
Decelerations (n)	*Mean (± Std)*	60 (± 5.5)ϒ#*Ŧ	82.2 (± 8.7)	87.9 (± 10)	78.4 (± 6.5)	76.9 (± 12.2)
	Max	69	98	105	86	92
	Median	59.5	82	85	77	70
THSR(Rel) (m)	*Mean (± Std)*	1517.5 (± 312.6)	1646.2 (± 195.7)	1323.1 (± 100.5)#	1545.5 (± 185.7)	1430.1 (± 181.4)
	Max	2062.6	1853.6	1423.6	1782.9	1653.7
	Median	1509.3	1654.8	1363.5	1563.5	1482
THSR(Ab) (m)	*Mean (± Std)*	408.4 (± 78.1)ϒ#Ŧ	629.6 (± 116.5)	354.5 (± 104)ϒ#Ŧ	680.7 (± 88.4)	549.9 (± 71.9)
	Max	555.5	796.1	588.6	756.5	689.3
	Median	386.6	617.3	318.9	706.9	539.3
HSR(Rel) (m)	*Mean (± Std)*	1089 (± 207.3)	1198.9 (± 156.5)	1009 (± 101.3)	963.5 (± 142.8)#	961.2 (± 161.9)#
	Max	1455.3	1419.5	1125.9	1129.9	1153.2
	Median	1052.3	1200.5	1018.5	965.3	1027.5
HSR(Ab) (m)	*Mean (± Std)*	338 (± 63.9)ϒ#Ŧ	533.4 (± 103.3)	324.5 (± 82.1)ϒ#Ŧ	565.6 (± 84.9)	459.8 (± 41.5)
	Max	471.0	697.4	505.2	678.9	522.4
	Median	326.3	523.2	305.0	588.4	460.4
vHSR(Rel) (m)	*Mean (± Std)*	400.6 (± 134.7)ϒ	471.4 (± 125.4)	330.8 (± 116.1)ϒ	598.5 (± 118.9)	472.4 (± 76.1)
	Max	607.24	751.15	588.5517	722.64	596.91
	Median	413.05	432.33	299.05	621.066	462.035
vHSR(Ab) (m)	*Mean (± Std)*	70.4 (± 25.6)ϒ	100.9 (± 22.5)	31.7 (± 24.7)ϒ#Ŧ	127.1 (± 27.4)	100 (± 32.4)
	Max	109.6	148.3	83.3	160.4	166.9
	Median	78.5	96.1	20.3	134.2	95.7

(n) = number of; (m) =meters;
ŦSignificantly different (p <0.05) from Central Attackers.
#Significantly different (p <0.05) from Wide Defenders.
*Significantly different (p <0.05) from Central Midfielders.
ϒSignificantly different (p <0.05) from Wide Attackers.

When individualised speed thresholds were applied the only significant difference in THSR (Rel) was between Wide Defenders and Central Midfielders (p = 0.033; 1,646.2 ± 195.7 vs 1,323.1 ± 100.5). HSR (Rel) was significantly less for Central Attackers and Wide Attackers when compared with Wide Defenders (p = 0.025; 961.2 ± 161.9m, p = 0.049; 963.5 ± 142.8m vs 1,198.9 ± 156.5m). Both Central Defenders and Central Midfielders covered significantly less vHSR (Rel) compared to Wide Attackers (p = 0.021; 400.6 ± 134.7m, p = 0.001; 330.8 ± 82.1m vs 598 ± 118.9m). Absolute speed thresholds showed greater variance in HSR amongst positional groups. CA covered significantly more THSR (Ab) than CD (p = 0.038; 549.9 ± 71.9m vs 408.4 ± 78.1m) and CM (p = 0.002; 549.9 ± 71.9m vs 354.5 ± 104m). WA and WD also covered significantly more THSR (Ab) than CD (p = <.001; 680.7 ± 88.4m, p = <.001; 629.6 ± 116.5m vs 408.4 ± 78.1) and CM (p = <.001; 680.7 ± 88.4m, p = <.001; 629.6 ± 116.5m vs 354.5 ± 104m). These positional differences were also present in HSR (Ab) with CA covering more distance than CD (p = 0.029; 459.8 ± 41.5m vs 338 ± 63.9m) and CM (p = 0.016; 459.8 ± 41.5m vs 324.5 ± 82.1m). WA covered significantly more HSR (Ab) than CD (p = <.001; 565.6 ± 84.9m vs 338 ± 63.9m) and CM (p = <.001; 565.6 ± 84.9m vs 324.5 ± 82.1m). WD also covered significantly more HSR(Ab) than CD (p = <.001; 533.4 ± 103.3m vs 338 ± 63.9m) and CM (p = <.001; 533.4 ± 103.3m vs 324.5 ± 82.1m). Finally, CM covered significantly less vHSR (ab) when compared with WA (p = <.001; 31.7 ± 24.7m vs 127.1 ± 27.4m), WD (p = <.001; 31.7 ± 24.7m vs 100.9 ± 22.5m) and CA (p = <.001; 31.7 ± 24.7m vs 100 ± 32.4m). CD also covered significantly less vHSR (Ab) when compared with WA (p = 0.002; 70.4 ± 25.6 vs 127.1 ± 27.4m).

4. Discussion

The purpose of this study was to describe the running demands of youth soccer while considering individualised and absolute speed thresholds. The aim was to provide coaches with an understanding of the physical demands imposed on under 17s LOI players accounting for differences in output depending on playing position.

Tierney et al. (2016) noted how the running demands imposed on players during match play is dependent on team formation. The formation employed in this study was 4-2-3-1, using this formation players on average covered a TD of 10,019.8m (± 697.7) while performing 37.4 (± 8.4) sprints, 72.6 (± 7.7) accelerations and 77 (± 12.6) decelerations. THSR (Ab) distance covered was 530.7m (± 151.1) (HSR (Ab) = 449 ± 122.1m & vHSR (Ab) = 87.3 ± 40) and THSR (Rel) distance covered was 1501.3m (± 226.5) (HSR (Rel) = 1052.3 ± 226.5 & vHSR (Rel) = 445.5 ± 138). The current findings of this study are similar to the findings of Tierney et al (2016) within mean TD covered (10,044 ± 538m), THSR (ab) (538 ± 174m) and number of decelerations (61 ± 12) when a 4-2-3-1 formation was employed. There are a greater number of accelerations during match play when comparing this study to the one by Tierney et al. (77 ± 12.6 vs 38 ± 8). The study by Tierney et al. (2016) was conducted using elite level soccer players from under 21s and under 18s squads. Following the results of the current study, it is suggested that running demands are similar within under 17s LOI and elite level under 21s and under18s. However, number of sprint efforts were not recorded in the study by Tierney et al. (2016) and therefore cannot be compared to the current findings.

It is evident that playing position affects physical output and this study further supports these findings. CM covered the most TD, with CD covering the least, these results are similar to findings of Abbott, Brickley and Smeeton (2018b), Bradley et al. (2009) and Di Salvo et al. (2009). No other positions had significant differences between TD covered, yet HSR and number of sprints varies greatly between position. Wide players (WD and WA) performed more sprint efforts when compared with central players (CD, CM and CA). Bradley et al. (2009) also found that wide players in the English Premier League produced the greatest amount of very high intensity running and sprinting when compared with any other position. Such findings were mirrored by Abbott, Brickley and Smeaton (2018b) within English Premier League Academy soccer. Tierney et al. (2016) also produced similar findings, although positional groups were named differently, with Wide Defenders, Wide Midfielders and Forwards producing the greatest amount of HSR of all groups. A common finding between all studies was that CD and CM produced the least amount of HSR compared to any other playing position. Therefore, it appears regardless of standard or level of soccer, playing position and role on a team will produce different physical output for players, likely due to the various technical and tactical skills and characteristics performed during match play (Hughes et al.,2012).

There were little significant differences in THSR (Rel) when Individual speed thresholds were used, except for WD and CM (1646.2 ± 195.7 vs 1323.1 ± 100.5). Individual speed thresholds were constructed based on MAS, MSS and ASR, in which these methods also conducted in studies by Abbott, Brickley and Smeeton (2018b) and Mendez-Villanueva et al. (2012). However, when analysing HSR (Rel) and vHSR (Rel), WD covered significantly HSR (Rel) more than CA and WA, with WA covering significantly more vHSR (Rel) than CD and CM. Utilising absolute speed thresholds produces greater amount of significant differences between positional groups making the positional demands more evident. CA, WD and WA covered more THSR (Ab) distance than CD and CM as found by previous studies (Tierney et al., 2016; Barnes et al., 2009). Yet, contrasting findings from Abbott, Brickley and Smeeton (2018b) suggest significant differences between positional groups in HSR distances when using individualized speed zones in the English Premier League Academy. It is possible that this is explained due to greater fitness levels of elite English Premier League Academy players with increased MAS and therefore a greater speed threshold when compared with under 17s LOI players.

Although Individual speed thresholds can be assigned to provide detail of the individual effort exerted by that player, applying an absolute threshold may allow for examination of position and individual differences over time (Sweeting et al., 2017). However, the findings of this study indicate that absolute high speed thresholds (5.5m/s) underestimate the HSR effort for all positional groups. Therefore, it is possible that an absolute high speed threshold be altered for youth players, similarly to the suggestion of Clarke et al. (2014) whereby a fixed threshold of 3.5 m/s could be applied across a cohort of players within elite team sports.

4.1 Limitations

Due to lack of accessibility to teams, only one team was used in this study. Style of play may alter how physical output of players as highlighted by Tierney et al. (2016), therefore, this study only examined a 4-2-3-1 formation by one team in the LOI. Sampling from one team also meant limited numbers of players per positional group. Positional groupings did not consider for side of pitch that players were playing (i.e. left and right back = Wide Defenders). This could potentially arise as future research for analysis of playing style. Outcome of match was not recorded during this study (i.e. win, lose or draw, score or opposition league position), nor was possession status. Physical output in and out of possession could provide a better representation for coaches of the demands on the ball versus off the ball.

4.2 Practical Applications

This study provides coaches with an overview of the running demands of under 17s LOI soccer. Coaches should consider the demands that are imposed during a game and ensure athletes are capable to perform at that level by inducing these demands within training sessions. When using individualised HSR thresholds based on MAS and ASR, there appeared little differences amongst positional groups. Thus, indicating that regardless of playing position players should have high levels of aerobic capacity to meet the demands of the game. Finally, following this study coaches should consider the fitness levels of athletes when applying either individual or absolute speed thresholds. When using absolute speed thresholds for youth soccer players it is possible that the speed could be altered for the cohort following the suggestion from Clarke et al. (2014).

4.3 Conclusion

TD distance covered within a under 17s LOI soccer game does not vary significantly, with the exception of CM compared to CD. This study indicates that HSR distances and number of sprints vary greatly based on playing position which has also been found in previous studies (Abbott, Brickley & Smeaton, 2018b; Tierney et al., 2016; Barnes et al., 2009). Using a 4-2-3-1, wide players (WD and WA) produce more sprints and HSR distances than central players (CD, CM and CA). Individual speed thresholds prescribed using MAS and ASR produce less differences amongst positional groups when compared with absolute speed thresholds (5.5m/s). This could be due to low aerobic fitness levels of players and ultimately decreased individual HSR thresholds. Therefore, fitness levels of the group should be considered when utilising speed thresholds individual or absolute. Future research could look to create a general high speed threshold for youth soccer players, similarly to the suggestion by Clarke et al. (2014) altering the high speed threshold of elite women's team sport athletes.

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6. Appendices

Appendix A: STATSports Apex GPS unit and vest.

Appendix B: Informed Consent Forms

Running Demands of U17 League of Ireland Soccer Players Considering Absolute and Individualized Speed Thresholds.

Researcher: Jack Traynor

Researcher Contact Details:

Phone: 0873183815 email: 12jacktraynor@gmail.com

Please confirm that you understand the purpose of the study and had the opportunity to ask the researcher any further questions on the study. This study is voluntary, and participants have the ability to withdraw from the study at any time. Please confirm that a) participants and b) parent/guardians agree to participate in this study by signing below.

Participant name (BLOCK CAPITALS): ___________________________

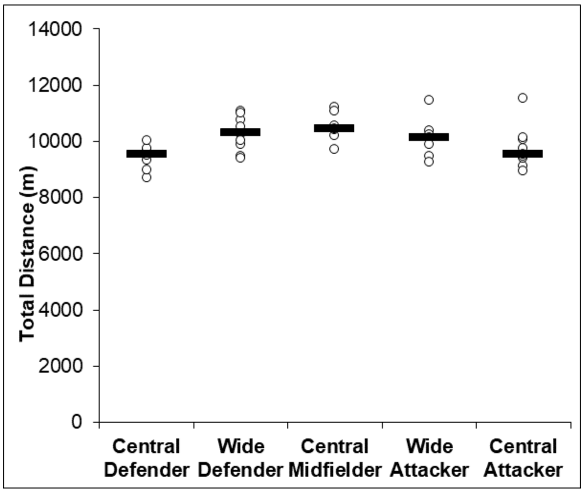
Participant signature: _______________________________________

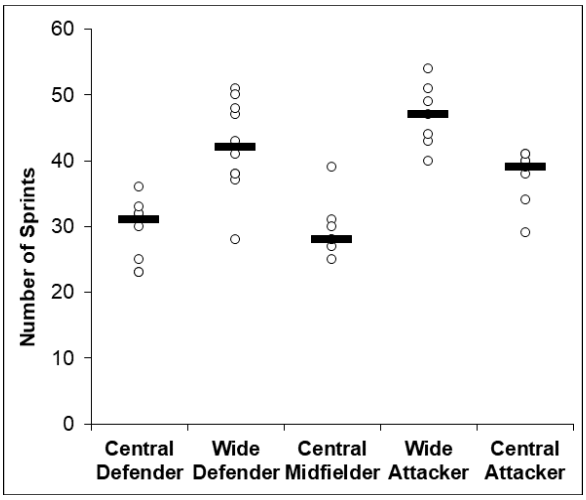
Parent/ Guardian name (BLOCK CAPITALS): _____________________

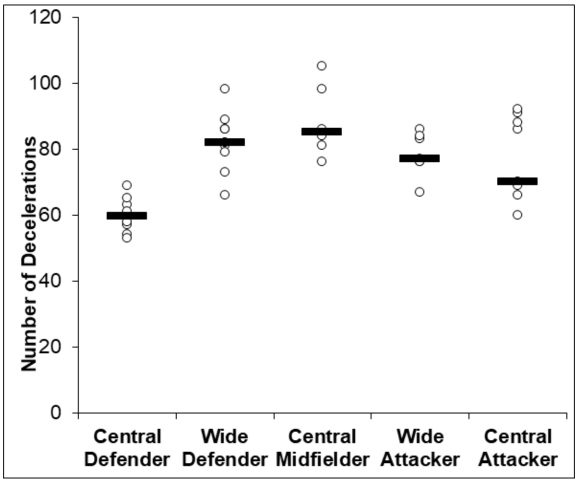
Parent/ Guardian signature: __________________________________

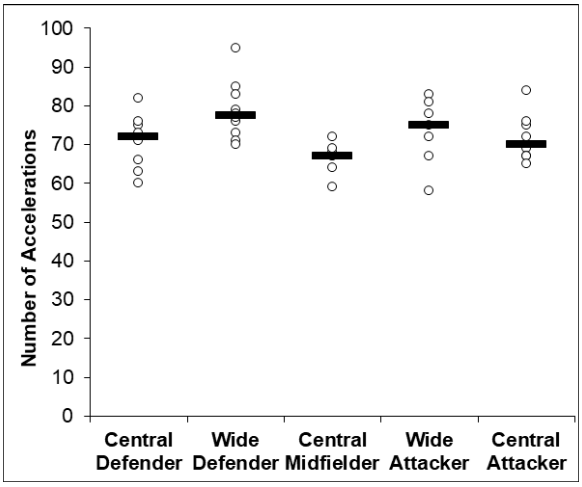
Date Signed (DD/MM/YYYY): ___/___/______

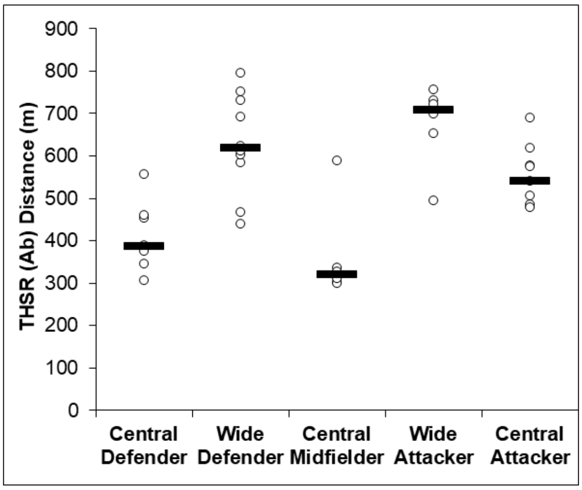
Appendix C: Spread and Median of Metrics Per Position

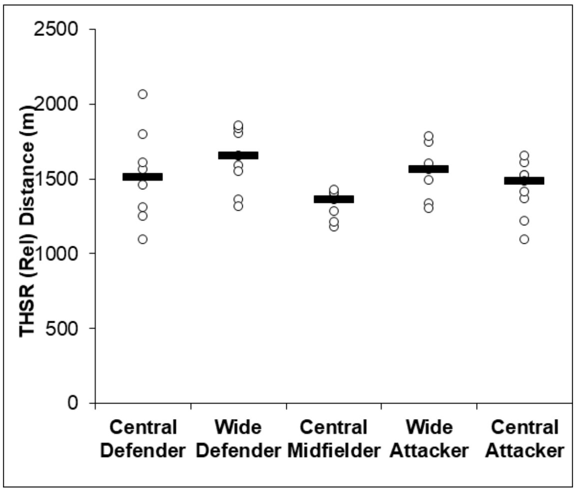


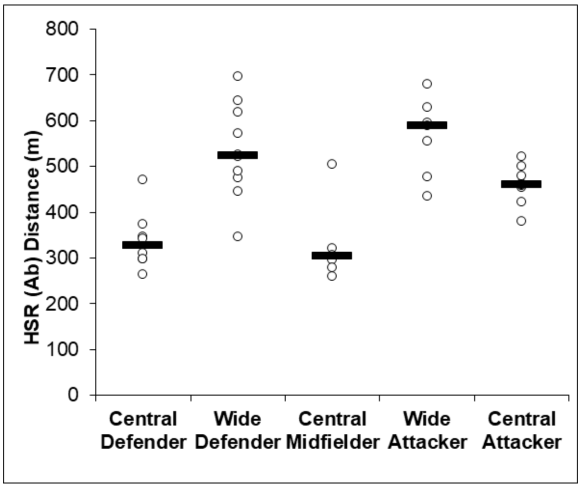




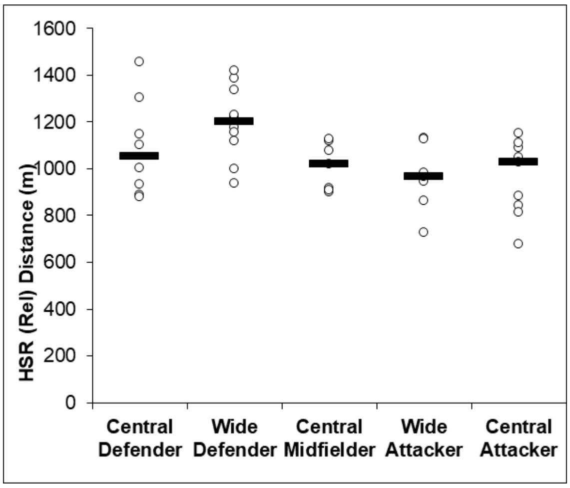




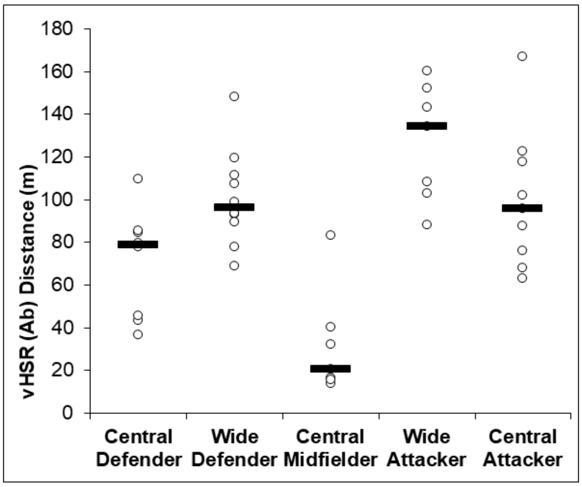




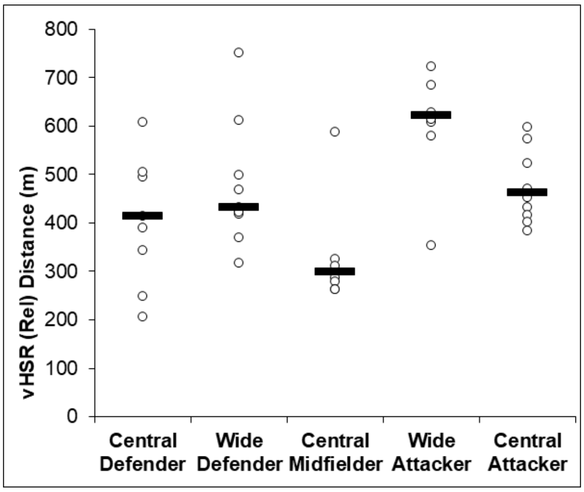
HSR (Ab) Distance (m)
0
100
200
300
400
500
600
700
800
Central Defender
Wide Defender
Central Midfielder
Wide Attacker
Central Attacker



HSR (Rel) Distance (m)
0
200
400
600
800
1000
1200
1400
1600
Central Defender
Wide Defender
Central Midfielder
Wide Attacker
Central Attacker



vHSR (Ab) Disstance (m)
0
20
40
60
80
100
120
140
160
180
Central Defender
Wide Defender
Central Midfielder
Wide Attacker
Central Attacker



vHSR (Rel) Distance (m)
0
100
200
300
400
500
600
700
800
Central Defender
Wide Defender
Central Midfielder
Wide Attacker
Central Attacker