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TIME-MOTION ANALYSIS OF ELITE UNDER-19 FEMALE NETBALL PLAYERS USING GPS

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ABSTRACT

In this study, physical characteristics of and physiological demands on elite junior (under-19A) netball players during competition were investigated. Physical attributes, heart rate and accelerometer data were collected using GPS (Catapult OptimEye X4) technology from 44 players during 16 competitive matches. Overall, physical attributes of players and physiological demands during match play, playing positions were divided into three groups with similar attributes: goal keeper and goal attack; wing attack, wing defence, goal attack and goal defence; and center. Compared to the other playing positions, the goal keeper and goal shooter tend to be heavier and taller, cover significantly smaller distances during match play (all ten pairwise p-values relative to other five playing positions <0.0001) at significantly lower maximum velocity (all p-values <0.0101), and have lower player load. Similarly, the center covers significantly more total distance (all six pairwise p-values relative to other five playing positions <0.0013) in the highest velocity bands, and has significantly higher player load than the other positions (all p-values <0.0001). The findings accentuate the variation in physical demand between the different playing positions and type of load placed on those positions. Strength and conditioning coaches should consider these factors when training netball players.

***Keywords*:** Junior netball; Player load; Physical profile data; Physiological demands; GPS.

INTRODUCTION

Netball is a team sport that involves short bursts of movement and less intense periods (Venter *et al*., 2005). A team comprises seven players in specific court positions, namely goal shooter (GS), goal attack (GA), wing attack (WA), center (C), wing defence (WD), goal defence (GD), and goal keeper (GK). Court restrictions and specific positions determine the demands on players during a match (Davidson & Trewartha, 2008; Fox *et al*., 2013). To optimise performance and construct appropriate conditioning programmes, players and coaches should know these sport- and position-specific requirements (Thomas *et al*., 2016). Time-motion analysis (TMA) provides such information (INF, 2018). Time-motion analysis research in

netball, especially junior netball, is limited (Yong *et al*., 2015; Sweeting *et al*., 2017), as previous TMA research focussed mostly on senior players (Davidson & Trewartha, 2008; Chandler *et al*., 2014; Cormack *et al*., 2014; Fish & Greig, 2014; McCabe, 2014). Therefore, to establish normative values for monitoring players' capabilities, more research is needed to understand the workload, strength and power characteristics of netball players at different competition levels (Thomas *et al*., 2017).

Thomas *et al*. (2016) reported the height and body weight of under-19 (u/19) female netball players. Defenders were significantly taller than centers (Thomas *et al*., 2016), similar to elite senior players (Hopper, 1997; Cormack *et al*., 2014; McCabe, 2014; Van Jaarsveld, 2015). The mean weight of these players was 69.8 kg (Thomas *et al*., 2016). Heart rate (HR) is monitored to investigate the physiological demands of netball. The mean HR of college-level netball players during a match was 174 beats per minute (b/min) (Chandler *et al*., 2014). Similarly, the HR of international netball players was 152–178 b/min (McCabe, 2014). The C and WA had the highest HR during match play and the GA the lowest (Chandler *et al*., 2014). Differing findings have also been reported (McCabe, 2014). The court restrictions and responsibilities of each position probably contribute to the higher mean HR of the C and WA. These two positions cover a larger area and are responsible for getting the ball to the GS and GA, the only players that may score a goal. The level of participation influences player load (PL) (Davidson & Trewartha, 2008) and might explain the contrasting results reported previously (Chandler *et al*., 2014; McCabe, 2014).

Catapult's player load metric (PL) measures work performed independent of distance. Player load is highest in the C position and lowest in the GS and GK (Davidson & Trewartha, 2008; Cormack *et al*., 2014; Fish & Greig, 2014; McCabe, 2014), confirming that the latter are physically less demanding. The GS and GK also cover the lowest total distances, and the lowest distances while jogging, running and sprinting. Chandler *et al*. (2014) reported a greater PL per minute for the C (9.6 arbitrary units [AU/min]), followed by the GD (6.7 AU/min). The C and WA are the most active players in all the planes of movement (Fox *et al*., 2013). Higher PL could be obtained by accumulating a greater distance covered, or covering a shorter distance at higher intensity. Greater acceleration in the vertical plane by jumping to compete for a rebound, for example, also contributes to PL (Fish & Greig, 2014).

Previous research (Yong *et al*., 2015) on adolescent netball players reported that midcourt positions (WA, C, WD) cover a greater distance during match play. However, only one match comprising six 10-minute periods, and categorising the playing positions in three groups (defence [GD, GK], midcourt [WA, C, WD] and attack [GS, GA]), was investigated (Yong *et al*., 2015). Davidson and Trewartha (2008) reported that the C covered a substantially greater distance (8km) than the other positions, with the GK and GS covering a distance of approximately 4.2km (Davidson & Trewartha, 2008; Fox *et al*., 2013). Similar to other authors (Loughran & O'Donoghue, 1999), Davidson and Trewartha (2008) found a significant difference between the C, GK and GS in the distance covered while jogging and running. The C jogged and ran 1756 m and 1758 m, respectively. The GK and GS jogged a distance of 195–283m, and ran only 143–362m. These studies, however, used subjective movement classifications. The C can move in all areas of the court except the goal circle, while the GK and GS are restricted to one third of the court. Furthermore, when the ball is at the opposite end of the court, the GS or GK of the other team are stationary until the ball reaches their side of the court. However, the C follows the ball either attacking or defending.

PURPOSE OF STUDY

The demands of the different playing positions of netball clearly vary substantially. The aim of this study, therefore, was to investigate the physical characteristics of and physiological demands on elite u/19 netball players in different playing positions during competition, by means of TMA using GPS.

METHODOLOGY

Subjects

Forty-four (n=44) elite junior netball players (u/19A), 16–18 years of age, from six schools in Bloemfontein in the Free State Province, South Africa, participated in the study. All participants were injury-free and healthy, and competed in the 2017 u/19A league (two teams qualified for the South African Top Schools Championship).

Ethical compliance

The Health Sciences Research Ethics Committee of University of the Free State (UFS-HSD 2017/0048) approved the protocol. Written informed consent was obtained from all participants. Players younger than 18 years provided assent, with consent by a parent or legal guardian. Permission for the study was obtained from the provincial Department of Education, Netball South Africa, participating schools and coaches. All the matches were played outdoors as the Bloemfontein U/19 league is only played on outdoor courts.

Research methods and techniques

Part 1: Anthropometrical assessment. One week prior to the start of Bloemfontein u/19 netball league the participating schools were visited to record the subjects' preferred playing position and anthropometric data (height, weight, body fat percentage, body mass index [BMI]), using the Heath and Carter anthropometrical assessment (Marfell-Jones *et al*., 2006).

Part 2: Collection of time-motion data. A commercially available GPS unit (Catapult OptimEye X4) and Polar T31 HR monitor and chest strap was used. Each device comprised a GPS component and a tri-axial accelerometer sampling at 10Hz and 100Hz, respectively. The GPS unit was fitted on the central upper back in a custom-made harness. Subjects received the HR monitor with chest strap and the GPS harness before putting on their netball attire. The GPS units were switched on and fitted into the harness when connecting to the GPS signal. The start- and end-time of each match was recorded. Data recorded by GPS during warm-up and between quarters were excluded.

Several studies have analysed the reliability and validity of different GPS devices in sport (Johnston *et al*., 2013; Muñoz-Lopez *et al*., 2017; Barr *et al*., 2019). It has also been reported that the updates in GPS firmware further improved the validity and inter-unit reliability of 5 and 10Hz GPS units (Johnston *et al*., 2013). Furthermore, the researcher scrutinised the data files of every player to ascertain that no faulty data collection occurred.

To determine the physical activity of the players, the Catapult OptimEye X4 accelerometer measures accelerations in the frontal, sagittal and transverse axes of movement (Gabbett *et al*., 2012). The following variables were recorded: heart rate response (maximum HR; mean HR); maximum velocity; total distance covered; distance covered in velocity bands; player load (PL) (total PL [determined according to Boyd *et al*. (2011)] and PL per metre). This

study made use of the velocity bands as defined by Dwyer *et al.* (2012): standing=0–0.1m/s; walking=0.2–1.7m/s; jogging=1.8–3.6m/s; running=3.7–5.3m/s; and sprinting=>5.4m/s.

Analysis of data

Physical profile and preferred position data were available for 42 subjects (Table 1). GPS data were recorded from 44 subjects in 16 matches during the u/19A Bloemfontein league and South African Top Schools Championship in Boksburg, Gauteng Province, during the 2017 netball season (data were recorded for both teams in nine matches, and for only one of the teams in the remainder). A "player quarter" was defined as the GPS data available for a given player during one quarter of a single match. One match provided data on 28 (4 x 7) player quarters for a given team. In total, 731 player quarters were recorded. To obtain comparable data for different players and playing positions, only data from players that participated in all four quarters during a given match in the same playing position were included for analysis (these four player quarters constitute 'player game"). In total, 140 player games (equivalent to 560 player quarters) were analysed (Table 1).

***Table 1*. NUMBER OF STUDY SUBJECTS (AND PLAYER GAMES) PER SCHOOL FOR PREFERRED PLAYING POSITION**

School	Preferred playing position							Total per school
	C	GA	GD	GK	GS	WA	WD	
A	1 (1)	2 (0)	1 (1)	1 (1)	1 (1)	1 (0)	1 (1)	8 (5)
B	1 (8)	1 (10)	0 (7)	2 (8)	1 (12)	2 (9)	1 (6)	8 (60)
C	2 (5)	0 (7)	0 (3)	1 (4)	1 (6)	1 (5)	1 (5)	6 (35)
D	1 (2)	1 (3)	1 (2)	0 (2)	0 (3)	1 (2)	0 (2)	4 (16)
E	1 (0)	1 (0)	1 (1)	1 (0)	1 (1)	2 (0)	0 (1)	7 (3)
F	1 (2)	2 (3)	1 (4)	2 (2)	1 (4)	1 (3)	1 (3)	9 (21)
Total per position	7 (18)	7 (23)	4 (18)	7 (17)	5 (27)	8 (19)	4 (18)	42 (140)

C = Center; GA = Goal Attack; GD = Goal Defence; GK = Goal Keeper; GS = Goal Shooter; WA = Wing Attack; WD = Wing Defence

Descriptive statistics for physical variables (weight, height, body fat percentage and BMI) were calculated by playing position. Similarly, descriptive statistics for each time-motion variable were calculated for 140 player games, by playing position. The data and descriptive statistics are graphically presented as box plots. In those plots, the boxes show the range between the first to the third quartile of the data; that is, the central 50% of the data, the mean is indicated by a "+" or "o" and the median by a horizontal line inside the box. The whiskers and "+" and "o" symbols drawn from the box indicate the full range of the data below the first and above the third quartile.

The time-motion variables were analysed using a linear mixed model with playing position as fixed effect, and the game, team, game x team interaction term, and player as random effects. Fitting of the random effects allowed for correlation between repeated observations from the same game, the same team, the same player across different games. Based on the linear mixed model, the mean values of variables for each position were estimated with standard errors (note that these estimates of mean values are model-based and usually differ slightly from the raw mean values of the data – simple averages – shown in the boxplots).

The pair-wise mean differences between playing positions were determined, together with associated p-values. Effect sizes were calculated by dividing the estimated mean differences between playing positions by the standard deviation (SD), where the SD was calculated as square root of the sum of player and residual variance components obtained from the mixed model analysis. SAS procedure MIXED (SAS Institute; Cary, NC, USA) was used to perform the mixed model analyses.

RESULTS

Physical profile of subjects

The weight, height (Figure 1), body fat percentage and BMI (Figure 2) of the players varied according to playing position.

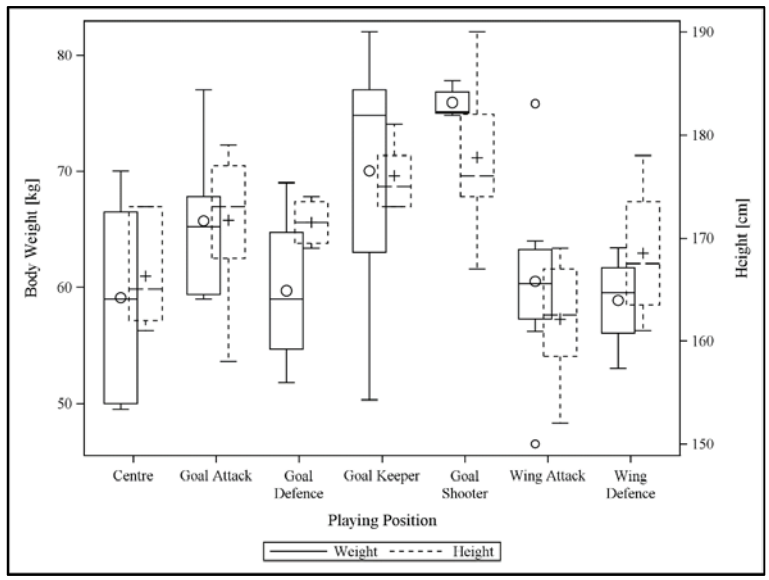

Figure 1. **BODY WEIGHT AND HEIGHT OF UNDER-19 FEMALE NETBALL PLAYERS** (n=42 players)

The GK (70.0kg) and GS (75.9kg) had a higher mean weight than the other positions. Similarly, the GK (176.0cm) and GS (177.8cm) were taller than the other players. The centre court players (C, WA, WD) were considerably shorter (mean height 166.3, 162.1 and 168.5cm, respectively) than the GA (171.7cm) and GD (171.5cm). The GD and WD had the lowest mean

body fat percentage. The relative distribution of BMI for the different positions correlated with the distribution of body fat percentage (Figure 2).

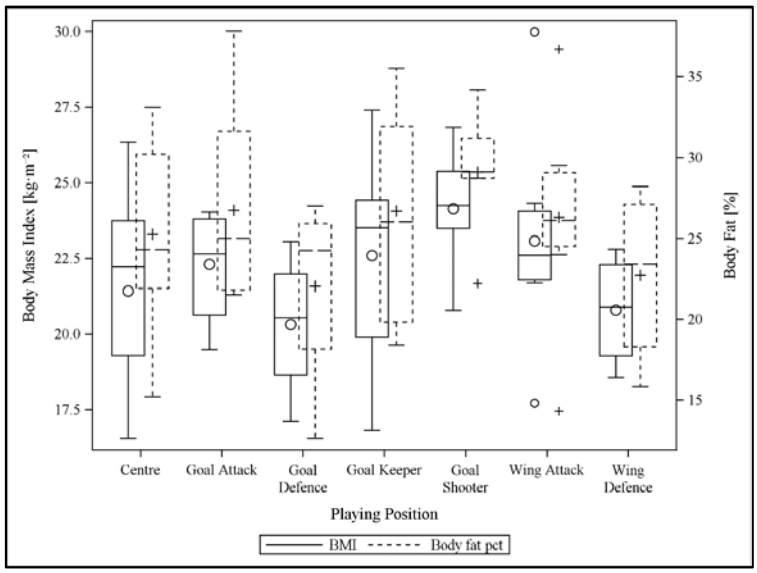

Figure 2. **BODY MASS INDEX (BMI) AND BODY FAT PERCENTAGE OF UNDER-19 FEMALE NETBALL PLAYERS** (n=42 players)

Heart rate (HR) response

The maximum HR of the GS was significantly lower than that of the other positions, with mean differences of 13–20b/min (effect sizes=1.28–1.96; SD=10.19b/min; all six pairwise p-values relative to the other playing positions ≤0.0020). Similarly, the mean HR of the GS was significantly lower than that of all other positions, except the GD (all five pairwise p-values ≤0.0138), with mean differences of 8–18b/min (effect sizes=0.63–1.41; SD=12.79 b/min). Although the maximum HR of the WD was significantly higher than that of the C (p=0.0498), the mean difference (6.5b/min) was not large (effect size=0.64). The C, GA and WA had the highest mean HR (Figure 3).

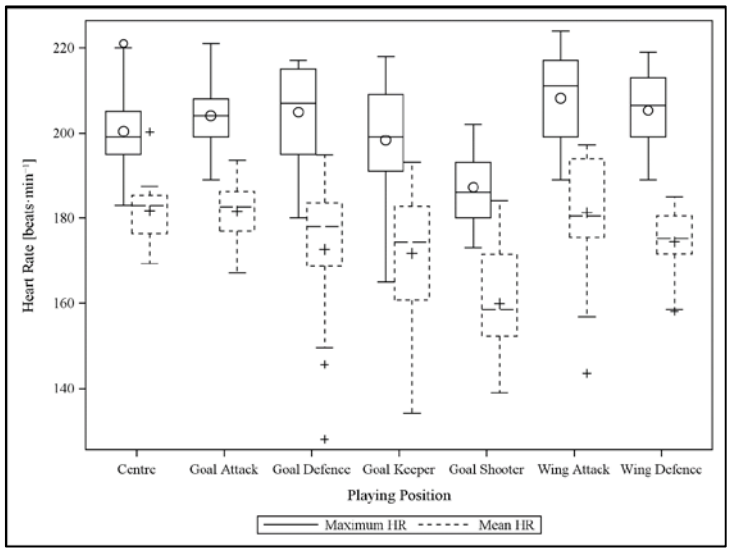

***Figure 3*. HEART RATE (HR) RESPONSE** (n=140 player games)

Maximum velocity

The GS and GK had lower maximum velocity than any other position (mean differences=0.50–1.10m/s; effect sizes=1.03–2.27; SD=0.48m/s), all ten pairwise p-values relative to the other five playing positions being ≤0.0101; Figure 4). The upper quartiles of the distribution of maximum velocity for these positions were approximately equal to or lower than the lower quartiles for the other positions. The IQR (inter-quartile range) of the other positions largely overlapped, suggesting no clear differences in the distribution of maximum velocity between the C, GA, GD, WA and WD. The C had the highest mean maximum velocity (5.22m/s), and the GS the lowest (4.11m/s). Overall, the mean maximum velocity of the participants was 4.79m/s.

Total distance covered

The GS and GK covered similar total distances (p=0.8244), although far lower than the other positions (all ten pairwise p-value being <0.0001 (Figure 4). The upper quartiles for the GS and GK were notably lower than the lower quartiles for all other positions, and the mean differences in total distance between the GS and GK versus the other positions were statistically significant. The mean differences between the GS and the C, WA, WD and GD were in the range 756.3–1475.9m (effect sizes=1.94–3.79; SD=389.3) and 795.6–1515.3m (effect sizes=2.04–3.89) between the GK and these positions. The C covered significantly more distance than all the other positions, with mean differences of 396.8–1515.3m (effect sizes=1.02–3.89) all six pairwise p-values ≤0.0013).

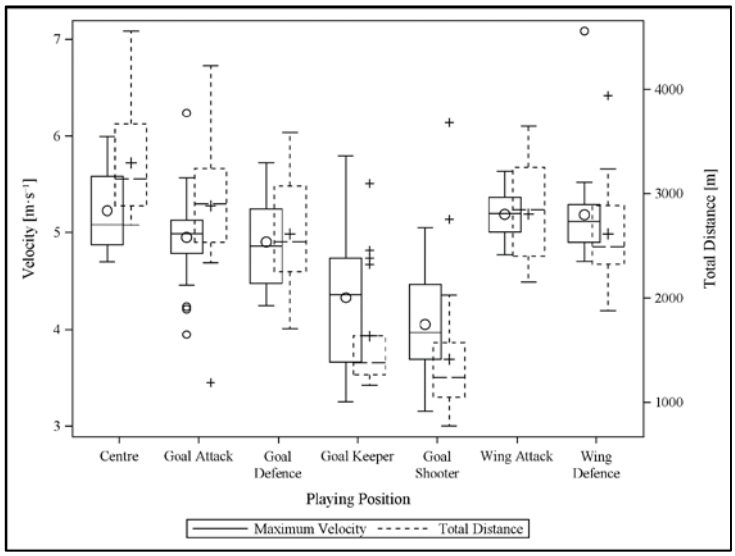

Figure 4. **MAXIMUM VELOCITY AND TOTAL DISTANCE COVERED**
(n=140 player games)

Distance covered in velocity bands

The distances covered by the various positions in different velocity bands varied notably (Figure 5, Figure 6). The lower quartiles of the distance covered in Velocity Band 1 (0–0.1m/s; standing) by the GS and GK were approximately equal to or higher than the upper quartiles for all the other positions (except the WD), suggesting that the GS and GK covered more distance in Velocity Band 1 than all the positions, except the WD. The mean distance covered by the GS in Velocity Band 1 was significantly higher than that of the C, GA, GD and WA (mean differences=10.17–14.24m; effect sizes=1.28–1.49; SD=7.94m; all four pairwise p-values ≤0.0035).

In Velocity Band 2 (0.2–1.7m/s; walking), the relative magnitudes of distances covered by the GS and GK versus the other positions were reversed. The GK and GS covered significantly less distance than all the other positions in Velocity Band 2, with mean differences of 143–363m (effect sizes=1.03–2.61; SD=138.9m) and all ten pairwise p-values ≤0.0113).

Figure 6 shows the differences between the playing positions in distance covered in Velocity Band 3 (1.8–3.6m/s; jogging) and Velocity Band 4 (3.7–5.3m/s; running). The mean distances covered by the GS and GK in Velocity Band 3 were significantly lower than for the other positions (mean differences=410.1–1031m; effect sizes=1.73–4.35; SD=237.1m; all ten pairwise p-values ≤0.0004). Similarly, distances covered by the GS and GK in Velocity Band 4 were significantly lower than for the other positions, except the difference between the GS and GD (mean differences=87.7–399.6m; effect sizes=0.99–4.52; SD=88.5 m; all nine pairwise P-values ≤ 0.0192). The C covered significantly more distance in both Velocity Band 3 (all six pairwise p-values <0.0001) and Velocity Band 4 (all six pairwise p-values <0.0001), with mean differences of 171.1–399.6m in Velocity Band 4 (effect sizes=1.93–4.52).

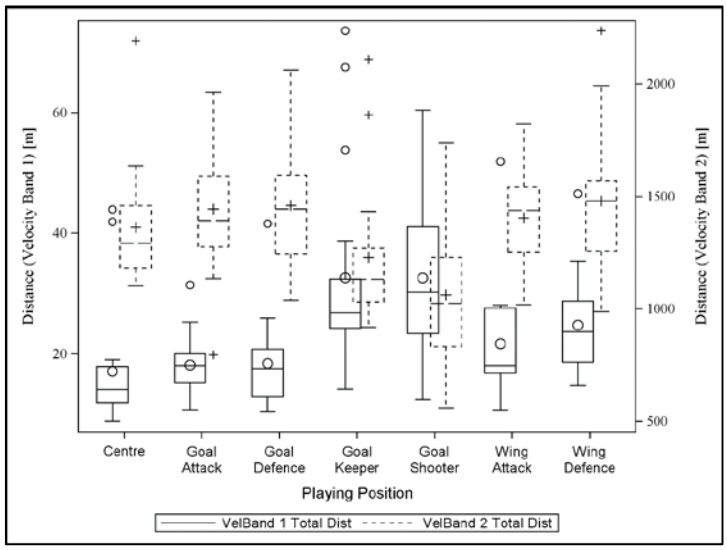

Figure 5. **DISTANCE COVERED IN VELOCITY BANDS 1 (STANDING) AND 2 (WALKING)** (n=140 player games)

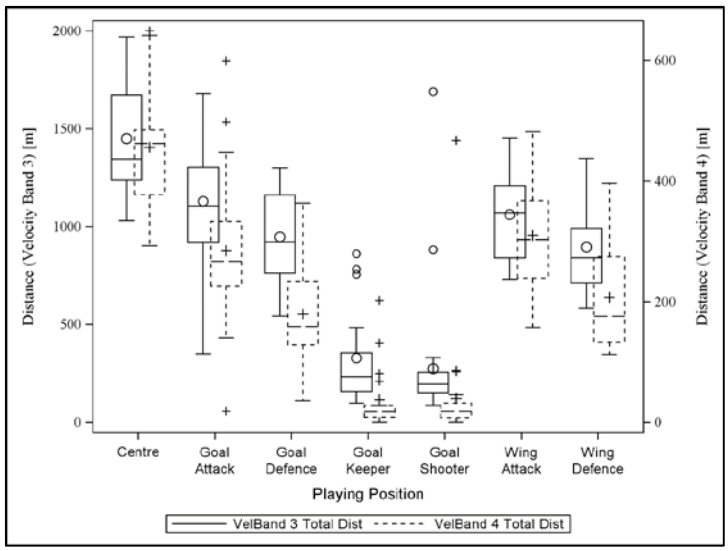

Figure 6. **DISTANCE COVERED IN VELOCITY BAND 3 (JOGGING) AND BAND 4 (RUNNING)** (n=140 player games)

Player load (PL)

The C (10.0AU/min) and WA (8.2AU/min) had a higher PL per minute than the other positions, which was the lowest for the GK (6.9AU/min) and GS (6.5AU/min) (Figure 7). The C had a significantly higher PL than all other positions (mean differences=1.86–3.56AU/min; effect sizes=1.29–2.47; SD=1.44AU/min; all six pairwise p-values <0.0001).

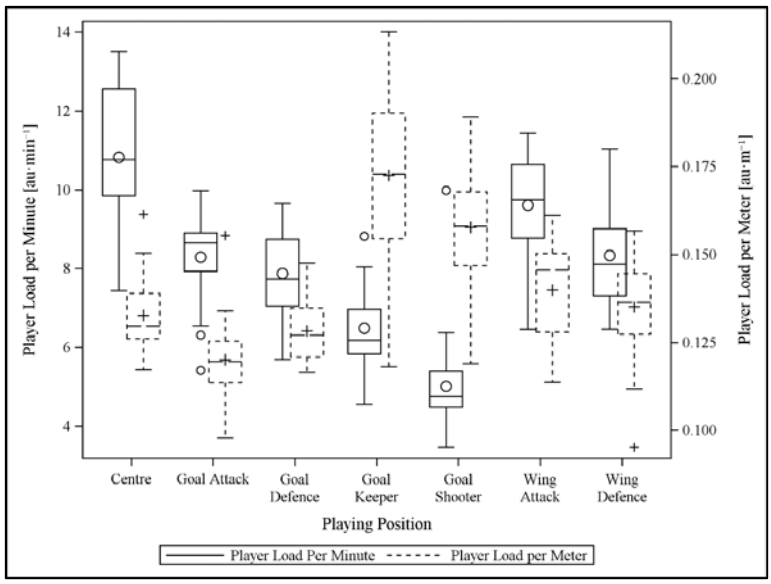

Figure 7. **PLAYER LOAD PER MINUTE AND PLAYER LOAD PER METRE** (n=140 player games)

The GS and GK had the highest PL per metre (AU/m) of all the positions, clearly because of the smaller distances covered by these players (see Figure 4), with significant mean differences from the other positions (mean differences=0.016–0.038AU/m; effect sizes=0.90–2.13; SD=0.018AU/m; all ten pairwise p-values ≤0.0272). Moreover, the GK had a significantly higher PL per metre than the GS (mean difference=0.019; effect size=1.07; p-value 0.0162).

DISCUSSION

This study, to our knowledge, is the first to investigate the physical characteristics of and physical demands on u/19 female netball players and statistically compare the differences between the playing positions.

The mean ***weight*** of u/19 female netball players in our study (64.3kg) was similar to a previously reported mean weight of 66kg (u/21; mean age 19.2 years) (Hopper, 1997). McCabe (2014) reported a notably higher mean weight (72.3kg) among older players (mean age 25.6±4.0 years). A mean weight of 68.8kg for 18–25-year-old netball players (Ferreira & Spamer, 2010; Thomas *et al*., 2016) and 67.8kg (mean age 22.6 years) (Cormack *et al*., 2014)

have been reported. A study involving female u/19 players found a mean weight of 69.8kg (Thomas *et al*., 2016), approximately 5.5 kg heavier than the players in the current study.

The mean ***height*** of the players in this study (170.1 cm) was lower than that of elite netball players (Hopper, 1997; Cormack *et al*., 2014; McCabe, 2014; Thomas *et al*., 2016). However, the younger age of the participants could explain the difference in mean height compared to the generally older subjects in other studies. The GS had the highest body fat percentage (29.1%) and BMI (24.1kg/m^2) in all the positions. Ferreira and Spamer (2010) reported a mean BMI of 22kg/m^2, similar to the overall BMI in this study.

Maximal HR values were similar to other intermittent sports, such as soccer, with HR ranging from 152–186b/min, (Krustrup *et al*., 2005) and basketball (91% HR_{max}) (Ben Abdelkrim *et al*., 2007). Soccer players performed at a mean of 86% of their maximum HR (Krustrup *et al*., 2005), similar to the netball players in the present study (87% HR_{max}). The results that was similar to previous research (Chandler *et al*., 2014; McCabe, 2014), showed that the GS performs at a significantly lower mean HR than any other position, except the GD. In contrast, the C and WA performed at a higher mean HR than the other positions. The C also presented with the highest mean maximum velocity, suggesting higher physical demand.

A previous study (Yong *et al*., 2015) on adolescent netball players reported that midcourt positions (WA, C, WD) covered a greater ***distance*** during match play compared to attacking positions (GS, GA). However, only one match comprising six 10-minute periods was investigated (Yong *et al*., 2015). The findings of the present study indicate that the GS and GK covered much lower mean total distances than the other positions, indicating lower physical demands on these players. The C covered significantly more distance during match play than any other position (mean differences of 397–1515m). Distances of 4210m covered by the GS, 4283m by the GK and 8000m by the C during match play have been reported (Davidson & Trewartha, 2008). In comparison, the mean total distances covered by the GS (1800.4m), GK (1761.1m) and C (3276.3m) in this study were substantially smaller. However, the participants in the study by Davidson and Trewartha (2008) were senior elite players playing Super League in England. Therefore, the age difference, level of participation, and duration of play could explain these differences. In u/19 netball, matches last 4 x 10 minutes, compared to 4 x 15 minutes in senior matches.

The current findings agree with previous research (Steele & Chad, 1991; Davidson & Trewartha, 2008) that the C covers significantly more ***distance jogging and running*** than the other positions. The GS and GK covered most distance in velocity bands 1 and 2 (standing and walking), and the least distance in velocity bands 3 and 4 (jogging and running). An unexpected finding was that all playing positions covered the largest distances in velocity band 2 (walking). The distance covered by the GS and GK in Velocity Band 2 constituted 68% and 74%, respectively, of the mean total distance covered by these players. The C, the least active of all positions in Velocity Band 2, covered 43% of the mean total distance in this velocity band. However, the C was the most active of all positions regarding distance covered in velocity bands 3 and 4, with a mean of 42% and 14%, respectively, of the mean total distance in these velocity bands. Of the total distance covered, the GS and GK covered the lowest distance in Velocity Band 3 (23% and 20%, respectively), and only 4% (GS) and 3% (GK) in Velocity Band 4.

The centre court positions (C, WA, WD) achieved higher total ***PLs*** than the other positions. They moved over a larger court area and covered greater distances, resulting in higher physical demands. The GS and GK presented with the lowest total PL, similar to previous research (Chandler *et al*., 2014; Fish & Greig, 2014; McCabe, 2014). The comparable

PL of the WA and WD confirms the link between physical demands and court restrictions applicable to these positions. The present results were similar to previous reports on the lower mean total PL of the GS and GK compared to the other positions (Chandler *et al*., 2014; McCabe, 2014). However, the GS and GK had a significantly higher PL per metre than any other position. This could be because these positions are restricted to one third of the court. Therefore, they cover smaller distances at lower velocities than, for example, the C. The C has been found to be the most physically demanding position (Chandler *et al*., 2014; Cormack *et al*., 2014; Fish & Greig, 2014; McCabe, 2014).

Overall, with regard to physical attributes of players and physical demands during match play, playing positions can be divided into three groups with similar attributes: GK and GS; WA, WD, GA and GD; and C. Compared to the other playing positions, the GK and GS tend to be heavier and taller, cover significantly smaller distances during match play at significantly lower maximum velocity, and have significantly lower player load. The C is allowed in a larger surface area that the GS and the GK, and therefore these positions are likely to cover a greater distance, reach greater velocities and present with a higher total PL, than the other positions during match play.

The main role of the centre court positions on attack is to create space and opportunity for the team to move the ball into the shooting circle where the GS and GA have an opportunity to attempt to score a goal. Therefore, the centre court positions, especially the C, need to cover the length of the court either in an attacking or defending capacity. Furthermore, the GS and the GK are only allowed in one third of the court with the main role of scoring a goal (in the case of the GS) or defending the GS (in the case of the GK). In order to create opportunities to receive the ball from teammates, the GS must either execute short, high intensity sprints to move away from the defender, or jump up high into the air to either receive the ball when thrown over the defending players or to try to catch the ball from a rebound.

The GK, on the other hand, must defend the GS. Therefore, the GK must attempt to move with the GS either in the frontal, sagittal or transverse plane. Similarly, the C covers significantly more total distance, significantly more distance in the highest velocity bands, and has significantly higher player load than the other positions. With regard to most physical demand measurements the WA, WD, GA and GD are placed intermediately, facing higher demands than the GK and GS, but lower demands than the C.

CONCLUSION AND PRACTICAL IMPLICATIONS

To optimise performance and construct appropriate conditioning programmes, players and coaches must understand aspects such as (i) player/load management; (ii) periodisation; (iii) recovery; (iv) session planning; and (iv) the role of strength and conditioning coaching (Thomas *et al*., 2016). The current findings emphasise the differences in physical demand between the playing positions in netball, and also the different type of load placed on the various positions. Coaches can apply the findings of this study to develop position-specific strength and conditioning programmes.

For example, programmes for the GK and GS should focus on developing speed and power in the vertical plane, in order for these players to beat opponents to the ball, or to successfully compete for a rebound after an unsuccessful shot at the goal. Programmes for midcourt players (C, WA, WD) should focus on frequent accelerations, short sprints, quick reaction time and jumps. These players should have high levels of anaerobic performance to accommodate the short recovery periods between high-intensity activities. To perform at high

intensity throughout the duration of the match, netball players should improve both aerobic and anaerobic endurance using high-intensity training modalities.

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Competing interests

The authors declare no financial or personal relations that may have inappropriately influenced them in writing the article.

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