South African Journal for Research in Sport, Physical Education and Recreation, 2025, 47(1): 52 – 66.
ISBN: 0379-9069

A POSITIONAL COMPARISON OF ANTHROPOMETRIC AND PHYSICAL PARAMETERS AMONG YOUTH NETBALL PLAYERS DURING THE PRESEASON

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ABSTRACT

Netball is an intermittent court-based sport that requires athletes to perform numerous tasks demanding refined physical attributes. The aim of the study was to compare the anthropometric and physical performance metrics across the various playing positions in netball players. A cohort of 150 female netball players (age: 18.8±1.39 years; height: 161.5±7.56 cm; body mass: 56.4±9.24 kg) volunteered for participation. All participants completed a barrage of physical performance tests: anaerobic and aerobic capacities, planned agility, sprint, flexibility, and lower limb and upper body power tests. All data were assessed using Kruskal–Wallis test with pairwise comparisons ($p<0.05$). Body height ($p<0.001$), mass ($p<0.001$) and composition (body fat percentage) ($p<0.001$) were significantly different across various playing positions. No statistical differences for aerobic ($p=0.069$), or anaerobic ($p=0.273$) capacities, and planned agility tests ($p=0.156$) were noted between playing positions. However, positional differences in sprint times ($p<0.001$), flexibility ($p<0.001$) and jump heights ($p=0.009$) were noted. The study reported differences in anthropometric and physical parameters across the different playing positions, which may have influenced the in-game positional demands and helped determine the key attributes required for each netball position player should have to perform.

***Keywords**:* Age-group athletes; Court-based sport; Physical fitness; Position-specific.

INTRODUCTION

Netball is a popular court-based team sport, and is played by seven players a side. Each game is divided into four quarters of 15 minutes. The aim of netball is to score more goals, by shooting a ball through a 3.05-m high hoop. The game requires players to have a combination of physical fitness, technical skill, and team strategy to compete at various levels (Davidson *et al*., 2008; Simpson *et al*., 2019). A unique aspect of netball is the process of landing, planting, and pivoting, as players cannot move once foot-ground contact is made following catching the ball (Hopper *et al*., 2017). Additionally, playing positions are restricted to certain court areas. Consequently, players are frequently involved in changes of directions, rapid accelerations and decelerations, jumps, and landings, resulting in a high-intensity intermittent sport (Thomas *et al*., 2017; Shaw *et al*., 2020; Whitehead *et al*., 2021). These playing demands vary depending on the player position, competition level, and opposition (Simpson *et al*., 2019; Whitehead *et al*., 2021).

A netball team comprises the following positions: goal keepers (GK), goal defence (GD), wing defence (WD), centre (C), wing attack (WA), goal shooter (GS), and goal attack (GA) (Thomas *et al*., 2017). These playing positions differ in terms of their movements, rate of work, and technical skills performed during matches (Davidson *et al*., 2008; Fox *et al*., 2013). Centre-court players (C, WA, WD) perform multidirectional movements more often than circle-based players (GD, GA, GK, GS). Additionally, elite age-group centre-court players can cover up to two kilometres more per game than other playing positions (Shaw *et al*., 2020).

While each position has specific physical match demands, overall refined physiological performance is essential for success in netball. Due to its intermittent nature (Thomas *et al*., 2017; Shaw *et al*., 2020), the physical demand of netball requires players to have refined aerobic and anaerobic systems. Specifically, anaerobic demand will increase during the short bouts of acceleration, jumping and changes of directions, while the aerobic demand can provide sustained energy production during active recovery and moderate to high-intensity periods (Barrett *et al*., 2017). Overall, a refined aerobic capacity, and the interplay with anaerobic metabolism, is likely beneficial for players to maintain a higher intensity throughout game periods. Similarly, muscular power is a vital component in netball as players are required to effectively execute jumps, accelerations, changes of directions and throwing (Thomas *et al*., 2017; Simpson *et al*., 2019; McKenzie *et al*., 2020; Hogarth *et al*., 2021b). Indeed, muscular power has been reported as a discriminating factor in player ability, performance and success (McKenzie *et al*., 2020).

Numerous studies have investigated the role of anthropometric parameters in differentiating players across positions (Thomas *et al*., 2017; Simpson *et al*., 2019; McKenzie *et al*., 2020; Whitehead *et al*., 2021). Specifically, players positioned closer to the goals (GSs and GKs) tend to display distinct height-related advantages influencing their efficacy in shooting and defensive strategies (Davidson *et al*., 2008; Thomas *et al*., 2017; Simpson *et al*., 2019; Whitehead *et al*., 2021).

In addition to anthropometric variations, the physical demands of netball positions significantly contribute to player specialisation. The high-intensity intermittent nature of the netball game requires an examination of physical and physiological attributes such as agility, speed, strength and endurance across positions (Thomas *et al*., 2017; Simpson *et al*., 2019; McKenzie *et al*., 2020; Hogarth *et al*., 2021b). Centre-court players, who are responsible for linking the defensive and attacking ends, tend to exhibit superior running speed and agility, and aerobic endurance, whereas defenders may demonstrate heightened strength and running acceleration to deter opponents' advances (Davidson *et al*., 2008; Simpson *et al*., 2019; Shaw *et al*., 2020; Whitehead *et al*., 2021).

Purpose of research

Understanding the influence of anthropometric and physical attributes across netball positions is imperative for player selection, training programme development and injury prevention. Additionally, with the increased level of professionalism in netball, it has now become essential to evaluate and monitor physical and performance attributes of players, as these indices have the potential to be used as a tool for talent identification (McKenzie *et al*., 2020). Therefore, the aim of this study was to compare the physical and physiological performance of youth netball players by playing position.

METHODOLOGY

Participants

A cohort of 150 South African female provincial netball players (age: 18.8±1.39 years; height: 161.5±7.56 cm; body mass: 56.4±9.24 kg) volunteered for participation in this study. The sample comprised of GKs (n=20), GDs (n=20), WDs (n=15), C (n=31), WAs (n=22), GAs (n=25) and GSs (n=17). All participants provided signed informed consent prior to participation and ethical clearance was granted by the faculty research ethics committee (REC-1666-2022).

Procedures

The procedures for testing were conducted in alignment with the National Strength and Conditioning Association (Haff, 2016). The test battery was conducted over 2 days per group of 25 players. The first day consisted of anthropometric assessments (height, body mass, flexibility and skinfold measurements), followed by physical assessment (upper and lower body power, agility, sprint speed). All procedures allowed participants 30 minutes' rest between tests. On day two, anaerobic and aerobic capacity tests were conducted separated by a 90-minute rest interval. On both days, a 10-minute warm-up consisting of constant submaximal jogging (eight lengths of the court) followed by lower extremity dynamically active stretching (walking lunges and sumo squats) was led by the main researcher.

Body composition

Body height and mass were measured using a standardised Seca 213 stadiometer (Germany) and Seca Robusta 813 scale (Germany), respectively. Skinfold thickness was measured using a Harpenden skinfold calliper (United Kingdom) at seven sites on the right side of the body: triceps, subscapular, chest, midaxillary, suprailiac, abdominal and thigh skinfold (Elsey *et al*., 2021). The Jackson and Pollock (1980) seven-site skinfold equation was used for calculating the body fat percentage (BF%).

Flexibility

The modified sit-and-reach test was used to assess the flexibility of the lower back and hamstring muscles. This was done by using a portable sit-and-reach box with a measuring scale above it. The players had to sit and place the soles of the foot against the box and bring the trunk forward with both arms extended and the hands one-on-top-of-the-other and reach as far as possible (Venter *et al*., 2005).

Upper body power

The 2-kg medicine ball throw test required the participants to sit on the ground with their back against the wall and both legs extended. The participants were instructed to throw the ball as far as they could from chest height. The distance between the participant and landing position of the ball was measured. Participants were permitted three trials with the best throw recorded (Stewart *et al*., 2011).

Leg power

The jump height of each of the players was measured using the Swift Yardstick (Australia). The players were instructed to jump vertically as high as possible using a countermovement jump and touch the highest vane they could reach. The jump height was recorded as the difference between jump reach and standing reach heights. Participants were afforded three attempts, with the greatest jump height being recorded (Venter *et al*., 2005).

Planned agility

The commonly used netball planned agility test proposed in Tanner and Gore (2012) was utilised, requiring two timing light gates (Fusion Sport, Smart Speed, Australia) for precise measurements. The test involved completing a predetermined course of cones, comprising three left and two right 90-degree turns. Players began in a crouched position with one foot on the start line, weaving through the cones following a specific sequence. If cones were touched or moved, the trial was restarted. Prior to the three test trials, players had a warm-up trial at 50% maximum effort to familiarise themselves with the course. During the test trials, players exerted maximum effort to complete the course as quickly as possible. The time to complete the course was measured in seconds. Participants completed three attempts, with the lowest time being recorded. A rest period of at least 5 minutes was afforded between each attempt.

Sprint tests

Sprint test times were measured, using a series of Fusion Sport Smart Speed (Australia) timing gates as the time taken to complete 5-metre and 20-metre sprints, respectively. The player began with the front toe touching the start line at the 0-metre mark with the heel of the back foot elevated. The player was then instructed to place all body mass on the front foot with the shoulders and hips placed in a crouched ready position (Venter *et al*., 2005; Tanner & Gore, 2012). The players then had to sprint as quickly as possible through the finishing gate and begin their deceleration only once they passed the cones placed 4 metres behind the last gate. Participants attempted three sprint trials, with the shortest total time being recorded.

Anaerobic fitness

Anaerobic fitness was measured using the 250-metre shuttle run test (Coopoo & McNaughton 2012) which required 25- by 10-metre sprint shuttles without rest, covering an accumulative distance of 250 metres. A single 10-metre shuttle was followed by a 180-degree turn, requiring the participant's fingers to be grounded over the line, for a valid shuttle recording. The test was conducted at maximum effort for the duration. Timing lights (Fusion Sport Smart Speed, Australia) were used to record the total time taken to complete the 25 shuttles, to the nearest 0.01 seconds (Fleishman, 1964; Coopoo & McNaughton 2012).

Aerobic fitness

An indication of aerobic capacity was obtained using yo-yo intermittent recovery test 1 as conducted by Bangsbo, Iaia and Krustrup (2018). A distance of 20 metres was created using 16 cones on either end to form the start and 180-degree turn lines for the shuttle. A prerecorded audio signal was used to indicate the start and stop of each running phase. The audio recording progressively increases the required running speeds by reducing the times between signals. Participants were to run back and forth following audio signals until they can no longer keep up (athlete fails to reach the start line on two consecutive occasions) or voluntarily stop due to fatigue. The test score is the total distance covered in metres (completed shuttles multiplied by 20 metres) and maximal oxygen consumption (VO_{2max}) was calculated as [distance covered × 0.0084] +36.4 (Bangsbo *et al*., 2008).

Statistical analysis

All data distributions were tested for normality using a Shapiro–Wilk test. The dataset did not show normal distributions and is presented as medians and interquartile ranges. Kruskal–Wallis tests were computed for possible differences across the groups for each parameter tested. Post-hoc tests (pairwise comparisons) were performed to identify where the differences occurred in the one-way ANOVA with $p<0.05$. All statistical data were computed in the Statistical Package for Social Sciences (SPSS 27, IBM).

RESULTS

Anthropometrical and physical performance data are reported in Table 1. Body height and mass were significantly different across various playing positions ($p<0.001$). Specifically, WAs were shorter than GKs ($p= 0.002$), GDs ($p= 0.026$) and Cs ($p=0.016$). WDs were taller than GSs and Cs ($p=0.004$). Additionally, GKs were taller than Cs ($p<0.0001$). Regarding body mass, GKs ($p=0.005$) and WDs ($p=0.02$) were heavier than WAs. Similarly, GKs ($p=0.03$) and GSs ($p=0.02$) were heavier than Cs. Additionally, WAs were lighter than GSs ($p=0.003$). With regard to BF%, significant positional differences ($p<0.001$) were noted between GDs and WDs ($p=0.046$), and GDs and GKs ($p=0.016$). Generally, the WDs and GKs had higher BF% than GDs.

No physical performance differences were noted (Table 2) between playing position for yo-yo intermittent recovery test level 1 ($p=0.069$), distance covered ($p=0.067$), calculated VO_{2max} ($p=0.067$), anaerobic capacity (250-metre shuttle run) ($p=0.273$) and planned agility tests ($p=0.156$). However, sprint times over 5- and 20 metres were different across playing positions. Specifically, over 5-metre sprints, GDs ($p=0.005$) and Cs ($p=0.003$) were faster than GSs. Over a distance of 20 metres, GSs were the slowest positional group compared with GDs ($p<0.0001$) and Cs ($p<0.0001$). Similarly, GKs were slower over 20 metres than GDs ($p=0.03$).

Table 1. **COMPARISONS OF ANTHROPOMETRIC MEASUREMENTS FOR 150 NETBALL PLAYERS BY POSITION**

		Combined (n=150)	**Goal keeper (n=20)**	**Goal defence (n=20)**	**Wing defence (n=15)**	**Centre (n=31)**	**Wing attack (n=22)**	**Goal attack (n=25)**	**Goal shooter (n=17)**	***p*-value**
Age (years)	Median (IQR)	18.0 (1.0)	18.0 (1.0)	19.0 (2.0)	20.0 (4.0)	18.0 (0.0)$^{GS;WA}$	18.0 (1.0)	18.0 (2.0)	18.0 (0.5)	<0.001
	Mean±SD	19.17±1.72	18.65±1.09	19.15±1.31	20.2±2.14	18.23±0.62	18.55±0.86	19.12±1.81	18.35±0.79	
Height (cm)	Median (IQR)	161.0 (9.85)	163.7 (11.3)^{WA}	162.9 (8.5)^{WA}	167.4 (8.8)^{GS}	156.0 (6.5)$^{GS;WA;GK}$	155.8 (12.8)	162.5 (5.6)	163.5 (12.4)	<0.001
	Mean±SD	161.33±7.04	165.94±6.61	163.79±5.56	162.35±5.27	156.62±5.06	158.17±11.86	162.06±5.17	164.92±6.93	
Body mass (kg)	Median (IQR)	54.95 (13.13)	58.5 (18.7)^{WA}	55.75 (8.42)	57.1 (19.5)^{WA}	51.6 (11.2)^{GK,GS}	50.4 (8.15)^{GS}	57.4 (14.9)	61.0 (13.2)	<0.001
	Mean±SD	56.44±9.79	62.43±12.55	55.42±5.78	61.65±10.4	52.08±7.36	50.76±5.96	56.7±8.34	61.25±7.89	
Body fat (%)	Median (IQR)	23.5 (4.0)	25.0 (5.7)^{GD}	22.5 (6.5)	25.6 (6.7)^{GD}	22.6 (3.2)	22.3 (3.0)	23.5 (4.7)	24.8 (2.7)	<0.001
	Mean±SD	24.34±4.77	26.84±6.85	21.6±3.37	25.51±4.78	22.63±2.99	22.56±3.62	23.84±3.84	24.71±1.91	

Kruskal–Wallis, superscripts indicate differences between groups (post-hoc $p<0.05$).
IQR=interquartile range SD=standard deviation

Table 2. **COMPARISONS OF PHYSICAL PERFORMANCE DATA FOR 150 NETBALL PLAYERS BY POSITION**

		Combined (n=150)	Goalkeeper (n=20)	Goal defence (n=20)	Wing defence (n=15)	Centre (n=31)	Wing attack (n=22)	Goal attack (n=25)	Goal shooter (n=17)	p-value
250-m shuttle test (s)	Median (IQR)	84.25 (15.53)	90.9 (11.0)	70.0 (10.4)	87.0 (14.0)	87.6 (21.0)	84.9 (31.8)	83.0 (19.0)	83.0 (12.2)	0.273
	Mean±SD	87.96±14.27	91.28±8.09	80.55±7.99	85.8±11.45	89.44±15.06	91.75±28.03	86.42±11.51	85.55±11.75	
Yo-yo intermittent test (level)	Median (IQR)	13.1 (1.10)	12.3 (0.97)	13.3 (0.30)	13.1 (1.00)	13.1 (0.90)	13.2 (1.30)	12.3 (1.15)	12.3 (1.55)	0.069
	Mean±SD	12.79±0.92	12.57±0.64	13.2±0.97	12.81±0.8	12.87±0.66	12.87±1.03	12.59±1.08	12.8±0.87	
Yo-yo total distance (m)	Median (IQR)	2720 (360)	2480 (310)	2800 (120)	2720 (320)	2720 (320)	2760 (440)	2480 (380)	2480 (500)	0.067
	Mean±SD	2637.31±278.44	2558±208.24	2764±307.08	2629.33±256.33	2655.48±217.05	2658.18±336.19	2563.2±344.46	2632.94±279.73	
Calculated VO_{2max} (ml/kg/min)	Median (IQR)	59.25 (3.02)	57.23 (2.60)	59.92 (1.01)	59.25 (2.69)	59.25 (2.69)	59.58 (3.70)	57.23 (3.19)	57.23 (4.20)	0.067
	Mean±SD	58.55±2.34	57.89±1.75	59.62±2.58	58.49±2.15	58.71±1.82	58.73±2.82	57.93±2.89	58.52±2.35	
Planned agility (s)	Median (IQR)	9.54 (1.25)	9.66 (1.03)	9.67 (1.10)	10.08(1.19)	9.71 (1.16)	8.89 (1.47)	9.45 (1.46)	9.48 (1.75)	0.156
	Mean±SD	9.6±1.22	9.76±0.69	9.48±1.54	9.72±0.8	9.89±0.89	9.05±1.02	9.29±1.63	9.68±1.04	
5-m sprint time (s)	Median (IQR)	1.18 (0.13)	1.19 (0.14)	1.12 (0.09)^{GS}	1.24 (0.23)	1.14 (0.08)^{GS}	1.21 (0.08)	1.18 (0.19)	1.28 (0.23)	<0.001
	Mean±SD	1.2 ± 0.11	1.19 ± 0.08	1.14 ± 0.1	1.24 ± 0.13	1.15 ± 0.07	1.19 ± 0.08	1.18 ± 0.13	1.28 ± 0.12	
20-m sprint time (s)	Median (IQR)	3.59 (0.3)	3.61 (0.40)	3.43 (0.22)^{GS,GK}	3.52 (0.56)	3.42 (0.25)^{GS}	3.62 (0.14)	3.62 (0.21)	3.81 (0.29)	<0.001
	Mean±SD	3.62±0.31	3.7±0.28	3.45±0.23	3.66±0.31	3.52±0.2	3.54±0.3	3.61±0.26	3.88±0.36	

Table 2. **COMPARISONS OF PHYSICAL PERFORMANCE DATA FOR 150 NETBALL PLAYERS BY POSITION**

		Combined (n=150)	Goalkeeper (n=20)	Goal defence (n=20)	Wing defence (n=15)	Centre (n=31)	Wing attack (n=22)	Goal attack (n=25)	Goal shooter (n=17)	p-value
Sit-and-reach (cm)	Median (IQR)	36.00 (10.00)	40.0 (8.1)^{GS}	40.0 (14.7)	37.0 (7.0)	37.0 (6.0)	32.0 (18.5)^{GS}	36.0 (8.0)	30.0 (13.0)	<0.001
	Mean±SD	34.8±8.04	37.93±5.9	35.48±8.08	37.15±6.33	36.6±5.03	28.96±10.98	36.04±7.61	29.2±8.67	
Jump height (cm)	Median (IQR)	36.00 (10.25)	31.0 (9.8)^{C,GD}	42.0 (13.7)	38.0 (8.0)	40.0 (13.0)	35.5 (7.0)	36.0 (9.5)	32.0 (9.0)	0.009
	Mean±SD	35.25±7.67	32.4±5.79	38.55±10.59	38.4±4.76	38.81±7.4	36.41±6.79	36.44±8.18	33.18±5.05	
Medicine ball throw (cm)	Median (IQR)	390.00 (110.0)	410 (64)	390 (122)	360 (185)	369 (120)	390 (112)	394 (70)	370 (123)	0.104
	Mean±SD	369.93±70.57	400.95±69.66	368.4±65.4	331.67±91.39	351.03±68.77	384.09±61.21	379.64±66.2	358.24±86.62	

Kruskal–Wallis, superscripts indicate differences between groups (post-hoc p<0.05)
IQR=interquartile range SD=standard deviation.

With the sit-and-reach test, there were significant differences noted ($p<0.001$) with GKs having better flexibility compared with GSs ($p=0.017$) and WAs ($p=0.020$). Jump height was significantly different across the playing positions ($p=0.009$). GKs attained lower jump heights compared with Cs ($p=0.019$) and GDs ($p=0.018$). Lastly, no significant differences were noted in the medicine ball throw ($p=0.104$).

DISCUSSION

The aim of this study was to assess the physical fitness parameters across playing positions in a group of youth netball players. Anthropometric differences in height, mass and BF% were observed. In terms of physical performances, differences were found between the positions in sprint times, flexibility, and jump height.

The body height and mass of the current sample was slightly lower than previous reported studies (Venter *et al*., 2005; Ferreira & Spamer, 2010; Thomas *et al*., 2019; Graham *et al*., 2020; Sinclair *et al*., 2020). The discrepancy between studies can be based on population demographics, as regional differences may be apparent. Physically, the body height and mass differences showed that playing positions closest to goal post, such as GDs, GSs and GKs, were taller than Cs and WAs. The height differences between playing positions reported in this study are supported by Thomas *et al*. (2017), Sinclair *et al*. (2020) and Graham *et al*. (2020). Overall, it could be advantageous to have taller players in areas where goal shooting and defending occur, as it could improve the chances of scoring or intercepting shots. Shorter and more dynamic players may be beneficial in the mid-court. Indeed, these selective traits seem to be apparent in the current data and those previously described (Thomas *et al*., 2017; Graham *et al*., 2020; Sinclair *et al*., 2020). In terms of mass, the heaviest players were those closest to the goals. This is likely due to the height differences (Graham *et al*., 2020) – as height increases, so too would body mass. Indeed, significant mass differences were noted between GKs, WDs and WAs, and similarly between GKs, GSs and Cs. Overall, the more dynamic territorial positions (WAs and Cs) were the lightest playing positions. Slighter body heights and masses may be advantageous for these dynamic positions (Thomas *et al*., 2019). Regarding body composition, the current sample reported a median BF% of 23.5%, lower than other comparable samples (Ferreira & Spamer, 2010; Sinclair *et al*., 2020). Playing position differences were noted between GKs and GDs, and WDs and GDs. It is likely that higher BF% present in defence positions may serve as a performance trait, where physical presence may be beneficial. Additionally, the transition from amateur to professions status has allowed for more frequent and intense training and competition (Whitehead *et al*., 2021), from which annual anthropometrical improvements have been reported (Simpson *et al*., 2019). Indicating that frequent training can lead to a loss of body fat (Hogarth *et al*., 2021a). However, data suggest that a higher BF% may serve as a potential protective mechanism against contact injuries (Sinclair *et al*., 2021). This may be partly due to players with higher BF% having as a greater physical presence and larger capacities to deal with physical collisions (Sinclair *et al*., 2021).

In the current study, sit-and-reach test was used to determine the lower back and leg flexibility of players. The findings of the sit-and-reach test (36 cm) are comparable with those reported by Venter *et al*., 2005 (38.8±7.2 cm). In terms of positional differences, GKs were more flexible than GSs and WAs. While these differences are presented, they should be interpreted with caution, as the sit-and-reach test does not provide a complete picture of flexibility, nor does it reflect the locomotive demands of netball. Rather, the sit-and-reach test would report hamstring and lower back range of motion, which can be a marker of general flexibility (Koen *et al*., 2003).

Upper body muscular strength and power indices have been reported to be closely related ($r>0.78$) to a chest throw (Cronin *et al*., 2004). As such, in the present study, upper body power was measured using a medicine ball throw. The median throw distances were 394 cm with is in line with previously reported data (320–370 cm) (Hackett *et al*., 2018). However, the current results reported no significant differences in upper body power across all playing positions ($p=0.104$). It is likely that upper body strength and power indices are similar across all netball playing positions as an intrinsic requirement for the sport. That is, all players are required to have a refined level of upper body strength and power to pass effectively and accurately during training and matches (Bock-Jonathan *et al*., 2007).

In a sport such as netball, where jumping and landing are essential components, it was anticipated that jump related metrics would be refined. However, the median jump height attained by the sample was 36 cm, substantially lower than data reported, which ranges between 37–52 cm (Venter *et al*., 2005; Terblanche *et al*., 2009; Venter *et al*., 2017; Thomas *et al*., 2019; Graham *et al*., 2020; Sinclair *et al*., 2020). Lower jump height values could indicate reduced muscular power and generally lower muscle mass. The sample presented in the current study reported lower body masses and similar levels of body fat. As such, their composition may be skewed towards non-contractile tissues which would not aid in performance. Additionally, the lower jump heights might be indicative of training experience and the level of competition of the sample (Simpson *et al*., 2019; Sinclair *et al*., 2020). Only the data reported by Ferreira and Spamer (2010) (33.74±1.23 cm) and Terblanche and Venter (2009) (37–39 cm) were comparable. However, the protocol completed by Ferreira and Spamer (2010) was not reported. Within the current sample, there were jump height differences between the playing positions ($p=0.009$). Specifically, GKs attained lower jump heights compared with Cs ($p=0.019$) and GDs ($p=0.018$). These differences are supported by Thomas *et al.* (2019), who reported jump height differences between defenders and centres. Similarly, Graham *et al.* (2020) reported jump height differences between shooters and defenders and shooters and mid-court players using magnitude-based inferences. From these data, it would appear that more dynamic positions are likely to attain greater jump heights than largely static attacking and defending positions.

Median planned agility time for the sample was 9.54 s (1.25 s) with no differences reported across the playing positions ($p=0.156$). Published norms taken from the Australian Institute for Sport (2010) indicated mean times of 9.05s±0.26s and 8.92±0.34 s for U19 academy development players and open national team players, respectively. Although, these players are considered to be classified at a higher level than the current sample, the overall performance would infer a satisfactory representation of the provincial players in this study. Additionally, factors involved in agility performance such as acceleration and deceleration assisted by the change of direction of movement and limb power production may not be the only factors at play (Horička *et al*., 2014). For instance, perceptual components are determined by complex reactions to changeable stimuli. Therefore, adequate perceptual judgement in the sharpness of turns and depth perception of the cones that mark the turns is seen to be a contributor to overall agility and may be the reason for the relatively fast agility times of the sample (Horička *et al*., 2014).

Median sprint times of 1.18 s (0.13 s) and 3.59 s (0.3 s) were noted for the 5- and 20-metre distances, respectively. Sprint times over 5 metres were similar to those reported by Terblanche *et al*. (2009), Thomas *et al*. (2019) and Graham *et al*. (2020) (1.11–1.22 s), but slower than Venter *et al*. (2017) (1.05 s). Over 20 metres, the current sample performed similar to the sample (3.47–3.56 s) reported by Terblanche and Venter (2009) but slightly worse than Graham *et al*., (2020) who reported a range of 3.41–3.52 s. Sprint times over 5- and 20 metres were different across playing positions. Specifically, over 5-metre sprints, GDs and Cs were faster than GSs. In support of these differences, Thomas *et al*. (2019) reported sprint time differences between shooters and centre-court players and shooters and defenders. Over a distance of 20 metres, GSs were the slowest positional group compared with GDs and Cs. Similarly, GKs were slower over 20 metres than GDs. In support, Graham and colleagues (2020) reported territory-based sprint differences between shooters and mid-court players.

Netball is characterised by frequent high-intensity movements of explosive power and lower limb control (Thomas *et al*., 2017; Shaw *et al*., 2020). To accommodate these movements, players are required to have refined anaerobic and aerobic systems. In the current study, no significant differences were noted between playing positions over the 250-metre shuttle run (p=0.273). Overall, it is likely that players experience similar adaptations from general team fitness and periodisation models. In terms of the sport, netball players are required to be both aerobically and anaerobically fit regardless of playing position. Moreover, the synergy between metabolic systems would promote recovery during periods of intermittent high intensity. Overall, the aerobic capacity of the current sample was acceptable with a median level of 13.1 (accumulated distance: 2720 metres and calculated VO_{2max}: 59.25 ml/kg/min). These values are lower than reported values for age group players in South Africa (Sinclair *et al*., 2020). Importantly, based on the data presented by Sinclair and colleagues (2020), it is noted that aerobic capacity increases with age and training experience. Therefore, the lower numbers presented in the current study could be due to the inexperience noted in our sample. Notwithstanding the differences between the studies, the current data (p=0.069) and that presented by Sinclair *et al*. (2020) (p=0.230) did not report any significant differences between playing positions. It is likely that all players in a netball squad, irrespective of playing position, will have comparable aerobic capacities as fitness training regimes would be similar. However, if players are grouped into territorial positions, based on game movements, a meaningful difference is noticed (Graham *et al*., 2020). Using magnitude-based inferences, Graham and colleagues (2020), reported differences between middle and shooter players, and defender and shooter players. Based on the movement demands, it seems that mid-court and defender players cover more distance during games (Thomas *et al*., 2017; Shaw *et al*., 2020; Whitehead *et al*., 2021).

Performance in netball is not limited to anthropometrical and physical variables, as the game is reliant on technical and tactical skills (Bock-Jonathan *et al*., 2007; McKenzie *et al*., 2020; Whitehead *et al*., 2021). While body height seems to be important, overall technical performance from individuals and team coherence are likely to be vital in team success. As such, players may be selected due to their technical and tactical abilities regardless of their anthropometrics and physical performance. Although selection can be independent of these variables, taller players are preferred in positions closer to the goal posts, and shorter, more dynamic players are selected in mid-court positions (Thomas *et al*., 2019; Graham *et al*., 2020; McKenzie *et al*., 2020; Sinclair *et al*., 2020; Whitehead *et al*., 2021). These positional differences are likely to provide advantages during matches, where centre-court players can dynamically position themselves to compete for ball possession while goal attackers and defenders have the height advantage to shoot for or block goal attempts.

Practical application

Practically, the findings of this study could aid coaches in player selection and training optimisation and tracking. Specifically, this study helps coaches identify physical attributes (height) for different positions during selection processes. In addition, coaches should tailor training programmes that target specific physical capacities (strength, power) needed for each position and monitor these metrics over time.

CONCLUSION

Overall, the current study provides a holistic view of physical performance indices for age-group netball players. The study highlights differences in anthropometrics and physical capacities across the various playing positions. From the data it is noted that players may be selected for positions based on their physical height and their physical performance may be refined through training and positional demands. Future studies are required to elucidate more refined physical metrics that are sensitive to change, such as the rate of force development for muscular strength and power (Hogarth *et al*., 2021b). Similarly, the effects of regular structured training on these parameters would need to be monitored over seasonal and career periods (Simpson *et al*., 2019; Hogarth *et al*., 2021a).

Conflict of interest

The authors declare no conflict of interest.

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