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Physical Profiles of Female Academy Netball Players by Position

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Physical Profiles of Female Academy Netball Players by Position

Brief Running Head: Female Netball Position Characteristics

Research conducted at the University of Salford

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1

2 **ABSTRACT**

3 The purpose of this study was to evaluate the height, body mass and physical characteristics of female

4 academy netball players by position (centers, defenders and shooters). Data were collected on 43

5 regional academy players during the preseason period and comprised of height and body mass, and

6 physical characteristics (single-leg hop [SLH], squat jump [SJ], countermovement jump [CMJ], 5- and 10-m

7 sprint, 505 and cardiorespiratory fitness). Defenders and shooters demonstrated significantly ($p = < 0.05$;

8 $d \geq 1.1$) greater body mass compared to centers. Defenders demonstrated significantly ($p = < 0.05$; $d =$

9 1.6) greater height compared to centers, however no significant differences were noted between centers

10 and shooters ($p = 0.19$; $d = 0.7$) and defenders and shooters ($p = 0.70$; $d = 0.5$). Centers performed better

11 during the SLH left leg ($p = 0.01$; $d = 1.0$), SJ ($p = 0.03$; $d = 1.1$), CMJ ($p = 0.01$; $d = 1.4$), 5 m ($p = 0.04$; $d \geq$

12 -0.9) and 10 m sprint ($p = 0.01$; $d = -1.2$), 505 left ($p \leq 0.03$; $d \geq 1.0$), 505 right ($p \leq 0.03$; $d = 1.3$), and

13 cardiorespiratory fitness ($p = 0.01$; $d \geq 1.2$), compared to other positions. No other significant differences

14 were observed. These findings demonstrate that height, body mass and physical characteristics differ

15 between positions in female netball players, and provide normative data for English academy netball

16 players. Strength and conditioning coaches should consider the specific demands on individual positions

17 when training female netball players.

18 **KEYWORDS:** fitness testing; netball; youth athletes; sprint; countermovement jump

19

20 **INTRODUCTION**

21 Success in netball is highly dependent on physical fitness characteristics including strength, power, speed,

22 and agility (35). To perform consistently throughout the 60-minute game, and recover effectively

23 between bouts of high-intensity exercise, netball players must also display a high level of aerobic fitness.

24 This has been highlighted in previous work (4, 34), with heart rates reported between 75-85% of the

25 maximum heart rate during match play. Furthermore, match-play analysis reveals center-court players

26   (center [C], wing attack [WA], wing defense [WD]) cover more distance (8) and accumulate greater player

27   loads (6, 11, 44), compared to defenders (goal keeper [GK], goal defense [GD]) and shooters (goal attack

28   [GA], goal shooter [GS]). These differences are likely due to the differing roles of the positions combined

29   with positional restrictions during play relating to which areas of the court individual players can play in.

30   Netball players must successfully complete multiple high-intensity short-duration sprints, cutting and

31   pivot maneuvers, and up to 60 jump landings per game (12, 15), all requiring high levels of concentric and

32   eccentric force production (27). The literature provides normative data for sprinting speed (35, 37, 39),

33   change of direction speed (CODS) (1, 37, 39), vertical jump (24, 35, 37, 39), maximum strength (35, 37),

34   and a range of other factors including anthropometric and aerobic capacity measurements (35, 39).

35   However, very little is known about the physical profiles (height and body mass, and physical

36   characteristics) across netball playing positions. Physical profiling of netball players by position would

37   assist coaches and practitioners to prescribe appropriate training programmes in line with the position-

38   specific demands shown to exist during training and competition.

39   In academy athletes, mean sprint times for 5- and 10 m range from 1.10 and 1.88 s, respectively, for

40   English academy netball players (37, 39), to 1.25 and 2.07 s, respectively, for Australian academy netball

41   players (35). Average vertical jump performances demonstrate great variation, ranging from 0.34 to 0.41

42   m for squat jump (SJ) and 0.35 to 0.46 m for countermovement jump (CMJ) height (35, 39). Recently,

43   Thomas et al. (37) reported isometric mid-thigh pull strength (30.70 ± 5.26 N·kg⁻¹) in academy netball

44   players. The authors reported that stronger athletes also demonstrated significantly faster 5 m (stronger:

45   1.08 ± 0.06 s; weaker: 1.15 ± 0.05 s), 10 m (stronger: 1.91 ± 0.06 s; weaker: 1.99 ± 0.06 s) sprint times

46   than weaker athletes. Furthermore, stronger athletes demonstrated significantly faster 505 L (stronger:

47   2.44 ± 0.08 s; weaker: 2.55 ± 0.11 s) and 505 R (stronger: 2.41 ± 0.08 s; weaker: 2.54 ± 0.07 s) CODS times

48   than weaker athletes. Moreover, stronger athletes produced significantly greater jump heights in the SJ

49   (stronger: 0.41 ± 0.06 m; weaker: 0.36 ± 0.04 m) and the CMJ (stronger: 0.42 ± 0.05 m; weaker: 0.37 ±

50   0.04 m). These findings highlight the importance of maximum strength in female netball athletes. This

51   result may be explained by the fact that peak ground reaction forces and impulse are strong

52   determinants of sprint, CODS, and vertical jump performances (20, 36, 40-42). **Furthermore, greater**

53 **levels of maximum strength may improve an athlete's ability to hold static and dynamic positions, such**

54 **as jumping and landing (27), sprinting (23) and CODS (31, 32), providing a greater acceleration,**

55 **acceptance of higher eccentric forces, thus preparing athletes for the movement demands and injury**

56 **risks associated with the sport.**

57 Most of the existing literature focuses on the physical demands of netball match-play (4, 6, 8, 11-15,

58 44) and physical characteristics (24, 37, 39). There are currently no normative data available in the

59 published literature regarding position-specific physical characteristics in female netball players. The

60 aim of this study was to determine differences in height and body mass, and physical characteristics

61 between positions (centers, defenders and shooters) of female netball players using a netball-

62 specific testing battery. It was hypothesized that there would be clear differences in height and body

63 mass, and the physical characteristics of the different position groups. Specifically, centers would

64 demonstrate superior hop, SJ, CMJ, sprint, CODS, and cardiorespiratory fitness performances than

65 both defenders and shooters. It was further hypothesized that both defenders and shooters would

66 exhibit greater height and body mass values, compared to centers.

67 **METHODS**

68 **Experimental Approach to the Problem**

69 **A cross-sectional observational design** of a regional female netball academy in the United Kingdom was

70 conducted using field tests specific to the sport. Athletes were assessed on height and body mass, and a

71 range of physical characteristics (single-leg hop [SLH], SJ, CMJ, 5- and 10 m sprint, 505 CODS and 30-15

72 intermittent fitness test [30-15$_{IFT}$]). Players were defined into positions by the academy coaching staff,

73 thus allowing comparisons between female academy netball players per their position. The positions

74 were classified as: centers (*n* = 15; C, WA, WD), defenders (*n* = 15; GK, GD) and shooters (*n* = 13; GA, GS).

75 **Subjects**

76 Female academy netball players (*n* = 43; age = 15.51 ± 1.49 years; height = 1.74 ± 0.06 m; body mass =

77 66.56 ± 8.15 kg) participated in this study. A power analysis determined that with 43 subjects, the study is

78   adequately powered for a between factors analysis with multiple groups, to detect differences with an

79   alpha of 0.05 and 80% power (G*Power version 3.1.9.2. Universität Kiel, Germany) (10). All players were

80   fully informed of the requirements of the investigation and provided appropriate consent to participate,

81   with consent from the parent or guardian of all players under the age of 18. The investigation was also

82   approved by the institutional review board.

83   **Procedures**

84   Testing was conducted in the preseason (October 2015), at the end of a 4-week general preparation

85   mesocycle. All athletes rested the day before testing and were asked to attend testing in a fed and

86   hydrated state, similar to their normal practices before training. All participants were familiar with the

87   tests performed in this study as part of their normal training and monitoring regime. On arrival, all

88   participants had their height (Stadiometer; Seca, Birmingham, United Kingdom) and body mass assessed

89   (Seca Digital Scales, Model 707) while in bare feet, measured to the nearest 0.1 kg and 0.1 cm,

90   respectively. Testing order was as follows: SLH, SJ, CMJ, sprint, CODS and 30-15$_{IFT}$. Before the start of

91   testing, athletes were instructed to perform a standardized warm-up, as directed by the investigator (39).

92   Furthermore, standardized progressive warm-ups were applied before all tests to control potential

93   variables and improve the reliability of all tests. All testing was performed indoors on a hardwood netball

94   court.

95   **Hop Testing**

96   A 6-m long, 15-cm-wide line was marked on the floor, along the middle of which was a standard tape

97   measure, perpendicular to the starting line. The SLH test began with participants placing the toes of both

98   feet on the back of the start line, before balancing on the leg to be tested. Participants had to "stick" the

99   landing for the trial to be counted. If the subject did not do this, the trial was disregarded and another

100   was attempted. In accordance with previous research (28), participants performed 3 warm-up trials on

101   each leg. Participants performed a simultaneous arm swing and crouch, then hopped as far forward as

102   possible, taking off from one leg, before landing on the same leg. Three maximal trials were recorded on

103   each leg, with one minute of rest between trials. Intraclass correlation coefficient (ICC) and coefficient of

104   variation (CV) for hops were as follows: SLH left leg (ICC = 0.89; CV = 3%) and SLH right leg (ICC = 0.91; CV

105   = 3%). The best performance of each leg was used for further analysis.

Vertical Jump Testing

107   Vertical jump height data were collected using a portable jump mat (Just Jump; Probiotics, Huntsville, AL,

108   USA), as previously described by Thomas et al. (37). Vertical jump tests began with the SJ condition. On

109   stepping onto the jump mat, athletes were instructed to get in the "ready position," which consisted of

110   the subject having their hands-on hips and assuming a self-selected squat depth. Once in position, a

111   countdown of "3, 2, 1 Jump" was given. A three second hold of the bottom position was used to

112   eliminate the involvement of the stretch-shorten cycle. If players failed to adhere to the strict protocol

113   and either performed a countermovement or moved their hands off their hips, the trial was repeated

114   after an additional one-minute rest. For the CMJ, athletes were instructed to perform a rapid eccentric

115   phase, immediately followed by a rapid concentric phase with the intention to jump as high as possible.

116   Countermovement jumps were performed with the hand on the hips, and countermovement depth of

117   the eccentric phase was self-selected by the athletes to maximize CMJ height. For both SJ and CMJ,

118   athletes performed three trials, with one minute of rest between trials. Alternate jump height was

119   calculated from flight time $(1/8 \ [g \times t^2])$ (where g = the acceleration due to gravity and t = air time), and

120   subsequently corrected per the formula by McMahon et al. (26). The ICC and CV for vertical jump

121   performances were as follows: SJ (ICC = 0.94; CV = 3%) and CMJ (ICC = 0.92; CV = 2%). The best

122   performance from each of the three trials was used for further analysis.

123

Sprint Testing

125   The 10 m sprint test was administered as a test of acceleration and sprint ability. All athletes performed

126   three trials, with two minutes rest between trials, using "Brower photocell timing Gates" (model number

127   BRO001; Brower, Draper, UT, USA) setup at 0-, 5-, and 10 m. Timing gates were placed at the

128   approximate hip height for all athletes as previously recommended (43), to ensure that only one body

129   part, such as the lower torso, breaks the beam. Athletes started 0.5 m behind the first gate, to prevent

130   any early triggering of the initial start gate, from a two-point staggered start. The ICC and CV for sprint

131   performances were as follows: 5 m (ICC = 0.60; CV = 4%) and 10 m (ICC = 0.75; CV = 2%). The best

132   performance of the three trials was used for further analysis.

133   **Change of Direction Speed Testing**

134   Change of direction speed was assessed utilising a 505 test. Athletes started 0.5 m behind the photocell

135   gates, to prevent any early triggering of the initial start gate, from a two-point staggered start. Timing

136   gates were again placed at the approximate hip height for all athletes. Athletes were instructed to sprint

137   to a line marked 15 m from the start line, placing either left or right foot on the line, depending on the

138   trial, turn 180° and sprint back 5 m through the finish (16). If the subject changed direction before hitting

139   the turning line, or turned off the incorrect foot, the trial was disregarded and the subject completed

140   another trial after the rest period. All athletes performed three trials, with a two-minute rest between

141   trials. The ICC and CV for 505 performances were as follows: left leg (ICC = 0.60; CV = 2%) and right leg

142   (ICC = 0.69; CV = 2%). The best performance from each of the three trials was used for further analysis.

143   **30-15 Intermittent Fitness Test**

144   The 30-15$_{IFT}$ was performed to assess cardiorespiratory fitness as previously described (17). Players were

145   instructed to complete as many 'stages' as possible, and the test ended when a player could no longer

146   maintain the imposed running speed or when they were unable to reach a 3-m zone around each line at

147   the moment of the audio signal on three consecutive occasions. If players were unable to complete the

148   stage, then their score was recorded as the stage that they last completed successfully, and the running

149   velocity recorded as their maximal intermittent running velocity (V_{IFT}).

150   **STATISTICAL ANALYSES**

151   **Data are presented as either mean ± SD or mean with 90% confidence intervals (90% CI) where**

152   **specified.** Normality of data was assessed by Shapiro–Wilk statistic, and homogeneity of variance was

153   verified with Levene's test. A series of one-way analysis of variance were conducted to analyse

154   differences in physical characteristics between positions. Where significant differences were found,

155   Bonferroni post hoc analyses were completed to detect differences between positions. The magnitude of

156   differences between position groups was also expressed as standardized mean difference [Cohen' d,

157   effect sizes, (ES)] (5), and based on the scale by Hopkins (19). All statistical analyses were completed

158   using SPSS (version 23, IBM, New York, NY, USA). An *a priori* alpha level of $p \leq 0.05$ was used as the

159   criterion for statistical significance.

160   **RESULTS**

161   The mean ± *SD* values for height and body mass, SLH, SJ, CMJ, sprint, CODS, and cardiorespiratory fitness

162   of female academy netball players by position can be found in Table 1. The table presents overall effects

163   and ES between positions.

164   ** INSERT TABLE 1 AROUND HERE **

165   There were no significant differences ($p > 0.05$; $d = -0.1$ to 0.3) in age between the groups (Table 1). One-

166   way analysis of variance revealed differences in height, post-hoc analysis that defenders were

167   significantly taller ($p = 0.01$; $d = 1.6$) compared to centers. Trivial-to-moderate, yet non-significant

168   differences were found between the heights of centers and shooters ($p = 0.19$; $d = -0.7$) and defenders

169   and shooters ($p = 0.70$; $d = 0.5$). Body mass was significantly different with defenders significantly heavier

170   than shooters ($p = 0.02$; $d = 1.1$) and shooters heavier than centers ($p = 0.03$; $d = 1.1$), whereas small non-

171   significant differences were found between defenders and shooters ($p = 0.78$; $d = 0.4$).

172   With regards to SLH L performances, centers scored significantly higher compared to shooters ($p = 0.01$; d

173   = 1.0), whereas small, yet non-significant differences were found between centers and defenders ($p =$

174   0.26; $d = 0.9$) and defenders and shooters ($p = 0.35$; $d = 0.5$). No significant differences ($p > 0.05$) were

175   identified for SLH R performances with small-to-moderate effects identified between positions ($d = 0.2$ to

176   0.7).

177   Significant moderate differences were found for SJ height, with centers jumping higher than defenders (p

178   = 0.03; $d = 1.1$), whereas small-to-moderate, yet non-significant differences were found between both

179   the centers and shooters ($p = 0.06$; $d = 0.8$) and defenders and shooters ($p = 0.99$; $d = -0.2$).

180   Countermovement jump height was significantly greater for the centers compared to defenders (p = 0.01;

181   d = 1.4), whereas trivial and moderate non-significant differences were observed between the defenders

182   and shooters (p = 0.44; d = −0.2) and centers and shooters (p = 0.12; d = 0.8).

183   Five metre sprint performances were significantly faster in the centers than the shooters (p = 0.04; d =

184   −1.0) and defenders than the shooters (p = 0.04; d = −0.9), whereas trivial and non-significant differences

185   were found between centers and defenders (p = 0.96; d = 0.1). Ten metre sprint performances were

186   significantly faster in the centers than the shooters (p = 0.01; d = −1.2), whereas small and moderate non-

187   significant differences were identified between defenders and shooters (p = 0.91; d = −0.4) and centers

188   and defenders (p = 0.14; d = −0.7).

189   Centers were significantly faster, during the 505 L compared to both the defenders (p = 0.03; d = −1.0)

190   and shooters (p = 0.01; d = −1.2), whereas trivial non-significant differences were found between

191   defenders and shooters (p = 0.99; d = −0.2). Similarly, centers demonstrated significantly faster 505 R

192   performances than both the defenders (p = 0.01; d = −1.3) and shooters (p = 0.03; d = −1.3), whereas

193   small non-significant differences were found between defenders and shooters (p = 0.83; d = 0.2).

194   Maximal intermittent running velocity was significantly greater in the centers to that of both the

195   defenders (p = 0.01; d = 1.4) and shooters (d = 1.2), whereas trivial non-significant differences were

196   observed between the defenders and shooters (p = 0.83; d = 0.1).

197   **DISCUSSION**

198   The aim of this study was to evaluate the height and body mass, and physical characteristics between

199   position groups in female academy netball players, using a complete field testing battery specific to the

200   sport. The results of this study indicate that differences in height and body mass, and physical

201   characteristics (SLH, SJ, CMJ, sprint, CODS, and cardiorespiratory fitness) exist between position groups in

202   female academy netball players. **The current findings add to a growing body of literature on the physical**

203   **characteristics of female netball players, and will serve as a basis for future studies, with the findings**

204   **used to establish normative values for monitoring and assessment of academy level netball players.**

205   The results of the current study indicate height was greater in defenders compared to centers. This

206   supports the hypothesis and consistent with previous findings (33) whereby differences were identified

207   between positions for height in male soccer players. Differences in height are likely explained by the

208   positional demands of the sport. Netball squads are relatively heterogeneous in physical stature,

209   whereby tallness is routinely accepted as selection criteria for defenders and shooters in netball.

210   Surprisingly, there was no difference in height when comparing centers to shooters. This finding may

211   partly be explained by 1) **while tallness may be seen to be a desirable characteristic, it may not be**

212   **essential for success in netball for shooters compared to defenders**, or 2) **players in the current study**

213   **were pre-elite youth athletes (15.51 ± 1.49 years old)** and may have been at different stages away from

214   their peak height velocity (21). Further studies, which take natural development (maturation) into

215   account, will need to be undertaken. Defenders and shooters were significantly heavier than center

216   players, while there were no significant differences in body mass between defenders and shooters. These

217   findings are similar to those previously reported (33), whereby goalkeepers demonstrated heavier body

218   mass compared to outfield players in elite male soccer players.

219   In this study, center players demonstrated superior SLH L performances compared to shooters. These

220   findings may be explained by the fact that center players perform a greater percentage of hop landings

221   during matches, therefore center players may be better prepared to performing hop techniques due to

222   their playing position and individual fitness characteristics (15). However, in the current study, no

223   differences were observed between position groups for SLH R. **While it is difficult to explain this result,**

224   **positional and/or training related factors may, in part, play a more significant role than first thought.**

225   For example, athletes may have a more "**preferred**" side when hopping, which may differ within- and

226   between-positions, thus masking any differences in SLH R performances between positions. Indeed,

227   Hewit et al. (18) found that between-limb asymmetries are task and variable dependent, and magnified

228   when data is analysed at an individual level.

229   The current study found that center players demonstrated significantly greater SJ and CMJ heights

230   compared to defenders, yet non-significant differences were found between both the centers and

231   shooters and defenders and shooters. However, it is argued that non-significant results do not necessarily

232   imply the nonexistence of a worthwhile differences in vertical jump performances. From our findings,

233   there is evidently a trend of increased SJ and CMJ height between centers and shooters (d = 0.8). **The**

234   **players in the current study appeared to have similar SJ (0.37-0.41 m) and CMJ (0.37-0.42 m) heights**

235   **when compared to other female netball players (37, 39).** The findings of this study may partly be

236   explained by the fact that centers are found to perform more jumps and perform more frequent multi-

237   directional movements during play (13, 14), requiring high levels of force production, like the SJ and CMJ.

238   Furthermore, centers were found to have significantly lighter body mass' than defenders, thus having less

239   inertia to overcome. Given acceleration is inversely proportional to its mass, centers may have applied a

240   greater concentric impulse, causing greater acceleration which could have attributed to greater jump

241   heights (25); however, these variables were not assessed in this study. A further study with more focus

242   on the force-time characteristics during vertical jumping in female netball players is therefore suggested.

243   Professional netball players have been reported to execute a change in activity pattern on average every

244   6 seconds (8, 13). However, positional and court restrictions prevent players from achieving a maximal

245   velocity. Therefore, the ability to change velocity to evade a defender, or when reacting to an attacker,

246   plays an important role in netball performance (13, 14). The results from this study showed that centers

247   demonstrated significantly faster 5- and 10 m sprint performances when compared to shooters.

248   Additionally, defenders produced significantly faster 5 m sprint performances compared to the shooters.

249   **These findings are similar to those by Lockie et al. (22) whereby midfielders demonstrated fastest 5 m**

250   **sprint times compared to other positions in female soccer players. The data from this study reveal**

251   **subjects from this cohort were faster over 5- and 10-m when compared to Australian academy netball**

252   **players (35), and similar to English academy players (37, 39). It can thus be suggested that players of**

253   **the present study could be classified pre-elite youth players, as far as their short sprint performance is**

254   **considered.**

255   The findings of this study reveal centers demonstrated faster 505 CODS performances compared to both

256   defenders and shooters for both left and right legs. This result may be explained by the fact that centers

257   perform a greater number of sprints and multi-directional movements during play (8), **therefore the 505**

258 **test may be related to the movements frequently performed by center court players compared to**

259 **other positions. Additionally, t is unknown whether these differences would still exist if a different**

260 **CODS test was utilised within this study (modified 505, t-test).** There are, however, other possible

261 explanations. The centers ability to decelerate a lower body mass more effectively may provide the

262 explanation for superior CODS performances; however, their ability to decelerate was not assessed.

263 Recent work by Dos'Santos et al. (9) suggests faster CODS performances to be strongly associated with

264 shorter ground contact times, greater horizontal propulsive forces, and greater horizontal braking forces.

265 Because there was no difference in 10 m sprint times between centers and defenders, sprint ability

266 cannot account for the differences in CODS performance in these positions. Conversely, because there

267 was a difference in 10 m sprint times between centers and shooters, differences in CODS performances

268 may be attributed to sprint ability (29). Lastly, given center players have the least number of court

269 restrictions, perform more frequent multidirectional movements, and change activity every 2.8 seconds,

270 it is likely differences in CODS performances are determined by both playing position and an individual's

271 fitness. **When considering the overall data, these results are similar to those obtained in academy**

272 **netball players (37, 39) and faster when compared to club netball players (1). The ability to change**

273 **velocity or direction to evade a defender or when reacting to an attacker plays an important role in**

274 **netball performance, and thus should be developed accordingly across all playing positions.**

275 Maximal intermittent running velocity was found to be significantly higher in centers than both defenders

276 and shooters, yet non-significant differences were found between defenders and shooters. Based on the

277 ES, the differences that existed were sizeable. **The V_{IFT} scores in current study are similar to those**

278 **reported in male and female handball (3), male and female soccer (7, 38) and rugby league (30),**

279 **illustrating that high levels of cardiorespiratory fitness are required for academy netball competition,**

280 **despite the positional restrictions placed upon players. Furthermore, the V_{IFT} attained by players in the**

281 **current study would be similar to values reported in sub-elite netball players (2).** The findings of the

282 current study confirm the conclusions of previous studies (4, 6, 8, 11, 44), that center players require high

283 levels of cardiorespiratory fitness as they cover greater distances, spend higher proportions of match

284 time being active, perform more sprints, and change direction more frequently than defenders and

285 shooters. These findings may help us to understand the importance of cardiorespiratory fitness for center

286 court netball players. Further research should be undertaken to investigate the influence of common

287 netball training-related activities on the cardiorespiratory fitness of female netball players.

288 Some limitations exist in the current study. This study did not examine the influence of physical

289 maturation on physical capabilities in netball players. Research has shown that physical capabilities

290 develop in a nonlinear fashion as a result of growth and maturation, which may have affected the

291 findings in the current study. Secondly, sprint and CODS tests were performed on a hardwood netball

292 court, making direct comparisons to tests performed in laboratories difficult. However, this surface is

293 common to netball training and competition, thus ensuring sprint and CODS tests were performed in an

294 ecologically valid manner.

295 **PRACTICAL APPLICATIONS**

296 The findings of this study indicate that centers exhibit different physical characteristics compared to

297 defenders and shooters. **Specifically, center court players demonstrated superior performances in**

298 **vertical jump, sprint acceleration, CODS and cardiorespiratory fitness when compared to other playing**

299 **positions.** These differences could be attributed to both playing position and an individual's fitness. **Such**

300 **information regarding the physical characteristics of academy pre-elite youth netball players may be**

301 **used by coaches and practitioners to individualize training programs to meet the sport-specific playing**

302 **position requirements. Indeed, center court players may need to complete more position-specific**

303 **training to ensure they meeting the demands of the playing position.** Further research should identify

304 the importance of maximum strength in female netball players so that more specific training

305 recommendations can be provided with regards to this capacity.

306

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Table 1. Age, height, body mass and physical characteristics of academy netball players by playing position.*

	Centres (*n* = 15)			Defenders (*n* = 15)			Shooters (*n* = 13)			Centres vs. Defenders Cohen's *d*	Centres vs. Shooters Cohen's *d*	Defenders vs. Shooters Cohen's *d*
Age (years)	15.73	±	1.44	15.53	±	1.64	15.23	±	1.42	−0.1 (−0.5 to 0.7)	0.3 (−0.3 to 1.0)	0.2 (−0.4 to 0.8)
Height (m)	1.70	±	0.04	1.77	±	0.05†	1.74	±	0.07	−1.6 (−2.2 to −0.9)	−0.7 (−1.3 to −0.1)	0.5 (−0.1 to 1.1)
Body Mass (kg)	61.80	±	4.63	70.60	±	10.45†	67.38	±	5.50†	1.1 (−1.7 to −0.5)	1.1 (−1.7 to −0.4)	0.4 (−0.3 to 1.0)
SLH L (m)	1.85	±	0.14	1.75	±	0.09	1.66	±	0.22†	0.9 (0.2 to 1.5)	1.0 (0.4 to 1.7)	0.5 (−0.1 to 1.2)
SLH R (m)	1.83	±	0.15	1.74	±	0.13	1.71	±	0.19	0.6 (0.1 to 1.2)	0.7 (0.1 to 1.3)	0.2 (−0.4 to 0.8)
SJ (m)	0.41	±	0.05	0.36	±	0.04†	0.37	±	0.05	1.1 (0.5 to 1.8)	0.8 (0.1 to 1.4)	−0.2 (−0.8 to 0.4)
CMJ (m)	0.42	±	0.04	0.37	±	0.03†	0.38	±	0.06	1.4 (0.8 to 2.1)	0.8 (0.1 to 1.4)	−0.2 (−0.8 to 0.4)
5 m (s)	1.12	±	0.06	1.11	±	0.09	1.18	±	0.05†‡	0.1 (−0.5 to 0.7)	−1.0 (−1.7 to −0.4)	−0.9 (−1.6 to −0.3)
10 m (s)	1.92	±	0.06	1.97	±	0.08	2.00	±	0.07†	−0.7 (−1.3 to −0.1)	−1.2 (−1.9 to −0.5)	−0.4 (−1.0 to 0.2)
505 L (s)	2.44	±	0.11	2.54	±	0.10†	2.56	±	0.09†	−1.0 (−1.6 to −0.3)	−1.2 (−1.8 to −0.5)	−0.2 (−0.8 to 0.4)
505 R (s)	2.41	±	0.06	2.52	±	0.10†	2.50	±	0.07†	−1.3 (−2.0 to −0.7)	−1.3 (−2.0 to −0.7)	0.2 (−0.4 to 0.8)
30-15$_{IFT}$ (km·h⁻¹)	18.50	±	1.31	16.87	±	0.97†	16.88	±	1.23†	1.4 (0.7 to 2.1)	1.2 (0.6 to 1.9)	0.1 (−0.6 to 0.6)

*Data are presented as mean ± *SD* and Cohen's d effect size (90% confidence intervals).

L = left leg; R = right leg; SLH = single-leg hop; SJ = squat jump; CMJ = countermovement jump; 30-15$_{IFT}$ = 30-15 intermittent fitness test.

†Significantly different from centres (p ≤ 0.05).

‡Significantly different from defenders (p ≤ 0.05).