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**Differentiating technical skill and motor abilities in selected and non-selected 3-5 year old team-sports players**

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**Abstract**

This study examined the difference in 22 3-5 year old boys selected to an advanced or non-advanced group on an English community-based professional club training program. Time to complete 15m linear sprint and 15m zig-zag agility tests, with and without a ball, were used to assess the children’s technical skill and motor ability. Age and body mass of both groups were the same, whereas height was greater and BMI was lower in the selected group (p<0.01). Linear sprint times without and with the ball were 3.98 ± 0.35 and 4.44 ± 0.36 s, respectively for the selected and corresponding times were 4.64 ± 1.04 and 11.2 ± 5.37 s for the non-selected (p <0.01, ES 0.8, 1.8). Similar results were found when a change of movement was included, both with and without the ball. A model of selection indicated that performance in an agility test with the ball and height had the greatest discriminatory power and explained 95.5% of between group variance. Selected players performed significantly better in tests when ball control was required. These findings suggest that technical proficiency and physical differences may influence team selection in three to five year old children.

*Keywords: youth development, football, training, sprinting, agility*

**1. Introduction**

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Differences in physical and performance characteristics between elite, semi-elite and non-elite levels are well documented in adults or adolescents participating in individual (Ooh, Žvan, & Burnik, 2012) and team sports (Bracko, 2001; Elferink­Gemser, Kannekens, Lyons, Tromp, & Visscher, 2010; Freeston, Ferdinands, & Rooney, 2007; Gissis et al., 2006). Elite performers are associated with possessing superior speed, agility, jump height, throwing velocity and accuracy than their non-elite counterparts. Objective measures of performance are very difficult to obtain in soccer compared to individual sports due to its multifactorial nature (Meylan, Cronin, Oliver, & Hughes, 2010; Vaeyens et al., 2006). However, physical and physiological profiling including measures such as sprint speed, agility, leg power, strength, endurance and ball dribbling can discriminate between elite and non-elite youth players and predict future success in soccer players (Gissis et al., 2006; Meylan et al., 2010).

Interestingly, the factors influencing whether players are elite, sub-elite or non-elite change based on players age, with speed and soccer technique having the greatest discriminatory ability in U13 and U14 players, whereas aerobic endurance is more important in U15 and U16 players (Vaeyens et al., 2006). Thus, long term athletic development is a dynamic process in which the tests chosen must factor in the individual’s stage of development (Vaeyens et al., 2006). Selection of youth players is an important but challenging task for staff in football academies as decisions can be highly subjective and distinguishing between current ability and future potential is difficult, particularly at periods of rapid developmental change (Unnithan, White, Georgiou, Iga, & Drust, 2012; Vaeyens, Lenoir, Williams, & Philippaerts, 2008). It is proposed that greater use of game specific protocols or match analysis to identify ability may be more successful than traditional testing protocols (Gabbett, Jenkins, & Abernethy, 2009; Unnithan et al., 2012; Waldron & Murphy, 2013). Waldron and Murphy (2013) performed traditional fitness tests alongside competitive match analysis and found that elite U14 players covered greater distances, performed at higher intensities, completed more successful ball retention, whilst also running and dribbling at a higher pace. It is of note that, despite measuring many match related parameters, 10m sprint time was the most useful variable for distinguishing between elite and sub-elite players (Waldron & Murphy, 2013). However it is not known if sprint speed, agility and dribbling ability can be used in the identification of elite players in those under 12.

There is little research on the development of sprint speed and agility in the 3-5 age group. Previous research in older age groups (7–18 years olds) has demonstrated that linear speed increases annually and at 12 years old for boys is approximately 75% of that of corresponding 18 year olds (Papaiakovou et al., 2009). Isokinetic concentric and eccentric strength also progressively develop between the ages of 6- 12, but ranges between 40-50% of an equivalent 18 year old, indicating that sprint speed develops earlier than lower body strength (Bassa, Kotzamanidis, Patikas, & Paraschos, 2001). Whilst linear sprinting is seen more as a closed skill (Yanci, Reina, Los Arcos, & Camara, 2013), the addition of cones and a ball to be controlled change this towards a more open, match-related skill (Sheppard & Young, 2006), providing the dual tasks of controlling the ball and running (Meckel, Geva, & Eliakim, 2012).

The aim of the study was to assess the technical skill and motor abilities of a cohort of young children attending a soccer coaching program and to identify if physical characteristics, speed, agility and dribbling ability discriminate between those selected and those not selected for more advanced training.

**2. Methodology**

**2.1. Participants’ physical characteristics**

The parents of 35 children, aged between three and five years, who attended a Little Dribblers session were contacted to invite their children to participate in the study. 25 accepted this offer and were provided with study information. Subsequently three children failed to attend further sessions and were removed from the study. A total of 22 boys were included in the study. Each parent provided full informed consent and ethical approval for the study was obtained from the University of Sunderland Research Ethics Committee.

**2.2. Training Programme**

The Little Dribblers program is run by a professional football club’s foundation, for children aged under five. The sessions utilise story book coaching sessions, where a coach uses a story to engage players into completing the tasks at their own pace. From these sessions squad players are selected for further, more advanced training. The main aim of the advanced session is generate as many touches of the ball as possible in training drills and small sided games, with a focus on ball control, rather than passing and running. Players are selected for the advanced squad by a two-step process. An individual Sunderland Association Football Club (SAFC) coach identifies players based on their ball control and speed of dribbling during small sided games in regular sessions, and they are subsequently observed by the head coach of the advanced squad for final selection. It is unclear whether the selection process identified players who are actually more technically adept as the decision by the head coach is subjective.

**2.3. Procedure**

Participant testing was completed during regular Little Dribblers sessions at the SAFC Foundation of Light. Each child performed the tests individually and testing was independent of the club selection process, with the tests being performed solely for the purpose of this study and the information not shared with coaches prior to selection. Participants were removed for testing after at least 10 minutes of the session to ensure they had received an adequate warm-up. Body mass and height was recorded to the nearest 0.1 kg and 0.5 cm, using a Seca 761 scale and Seca 213 stadiometer respectively (Seca UK, Birmingham, UK). Each child completed two sprint tests and two agility tests and timings were assessed using two sets of Smartspeed light gates to an accuracy of 0.01s (Fusion Sport, Coopers Plains, QLD, Australia) at a height of 0.4 m. Initially participants were verbally instructed to sprint maximally over 15m. For all tests, participants commenced movement in a static, standing position immediately behind the timing gates. Following this, they were then instructed to dribble a Nike Technique football (size 4; Nike Inc., Beaverton, OR) over 15m, again as quickly as possible. If the participant lost control of the ball, the trial was cancelled and repeated. The sprint tests were repeated two further times with a two minute rest between each trial to prevent fatigue. Following a further five minute rest period the participant performed the agility tests. Marker cones (height 6 cm, diameter 20 cm) were placed between the light-gates at 4, 8 and 12 metres along the centre line of the 15m track. The participant was instructed to sprint as fast as possible down the track, weaving between the cones without touching them. This was repeated with the participant instructed to dribble the ball through the cones as fast as possible. As in previous testing, if the participant lost control of the ball or if a cone was missed or hit, the trial was cancelled and repeated. The agility tests were repeated twice more with a two minute rest between each trial.

**2.4. Statistical analysis**

Means and standard deviations for each test were calculated for the whole group, selected group and non-selected group. Coefficient of variation (CV) for test performance was calculated as the standard deviation divided by the mean and multiplied by 100%. Results were tested for normality using a Shapiro-Wilk test. Independent samples t-tests were subsequently ran using SPSS (IBM SPSS Statistics, IBM Co., Armonk, NY) to determine if differences existed between the selected and non-selected groups, with significance *a priori* set at p=0.05. Effect sizes were calculated to measure the magnitude of mean differences between the groups following the process outlined by Hopkins, Marshall, Batterham, and Hanin (2009) and the strength of relationships were calculated as trivial (<0.2), small (0.2-0.6), moderate (0.6-1.2), large (1.2-2.0), very large (>2.0). A step-wise linear discriminatory function analysis using selection as the dependent variable was performed in order to assess the predictive power of the parameters to determine whether players would be selected or not.

**3. Results**

Of the 22 children who participated in the study, seven were subsequently selected to the advanced training group, with the remaining deemed non-advanced by the head coach. Differences in age and body mass between selected and non-selected players were small or trivial but selected players had significantly greater height and hence reduced Body Mass Index (BMI) (Table 1; ES = 1.41, 1.49, respectively, p<0.01). Those in the selected group completed the 15m sprint marginally faster than those in the non-selected group, but the differences were of a moderate magnitude (Table 2; p =0.01; ES = 0.84). The selected group was faster by a large magnitude when completing the 15m sprint with the ball and the test of agility, with or without the ball, when compared to the non-selected group (all p<0.05). There was a significant correlation between 15m linear speed and 15m agility both with (p<0.01; R2=0.67) and without the ball (p<0.01; R2=0.59). The skill index, defined as the ratio of time taken during the agility test without the ball to with the ball (Mirkov, Nedeljkovic, Kukolj, Ugarkovic, & Jaric, 2008), was 0.63 ± 0.08 for the selected group and 0.37 ± 0.13 for the non-selected group (ES: 2.33, p<0.005). The results of the stepwise discriminant function analysis indicated that the parameters ‘skill index’ and ‘height’ alone had sufficient predictive power to be included in the analysis and could classify players as selected and non-selected correctly in 95.5% of cases (P<0.001). All selected players were correctly classified, whereas one non-selected individual was misclassified as being in the selected group.

**Table 1. Participant descriptive data (mean ± sd).**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Age** | **Height (m)** | **Mass (kg)** | **BMI** |  |
| **Non-Selected** | 4.1 | ± 0.7 | 0.98 | ± 0.05\*\* | 17.5 | ± 0.5 | 18.3 | ± 1.6\*\* |
| **Selected** | 4.1 | ± 0.7 | 1.05 | ± 0.05 | 17.7 | ± 0.5 | 16.2 | ± 1.2 |

\*\* Denotes significantly different from selected (p<0.01)

**Table 2. Mean ± SD time to complete sprint and agility tests (s) and associated test effect size values.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **15m sprint without ball (s)** | **15m sprint with ball (s)** | **15m agility without ball (s)** | **15m agility with ball (s)** |
| **Overall** | 4.43 ± 0.92 | 9.04 ± 5.44 | 5.30 ± 1.30 | 14.26 ± 7.94 |
| **Non-Selected** | 4.64 ± 1.04 | 11.19 ± 5.37 | 5.74 ± 1.36 | 17.62 ± 7.50 |
| **Selected** | 3.98 ± 0.35 | 4.44 ± 0.36\*\*\* | 4.37 ± 0.28\* | 7.06 ± 0.84\*\*\* |
| **Cohen *d*** | 0.84 | 1.78 | 1.39 | 1.98 |

Significantly different from non-selected (\* denotes p<0.05, \*\*\* denotes p<0.005)

**4. Discussion**

The aim of the study was to identify if the technical skill and motor ability of three to five year old children, subsequently selected to an advanced training group, are superior to their non-selected peers. Significantly greater speeds over a 15m linear sprint with ball, 15m agility with- and without the ball were found in the selected compared to the non-selected group. The results indicate that it is possible to differentiate between the ability of very young children through basic sprint and agility tests. Both technical ability (ball control) and physical characteristics (height), have a greater influence than linear speed or body mass on talent identification of player at this age level.

To the best of our knowledge, no previous studies have examined differences in sport-specific testing of footballers younger than ten years old. The results of the present study support findings undertaken in older children, adolescents and adults (Bradley et al., 2013; Gissis et al., 2006; Waldron & Murphy, 2013). In the present study, average linear sprint speed of the non-selected over 15 m was 3.2 ± 0.7 m.s-1, which was the same as previously found in a sample of 4.4 year olds over 25m (3.2 ± 0.5 m.s-1; (Gabel, Obeid, Nguyen, Proudfoot, & Timmons, 2011)). In contrast, the selected boys sprint speed in the present study (3.8 ± 0.3 m.s-1) was greater than that same sample of 4.4 year olds just over a year later (3.6 ± 0.3 m.s-1 at 5.6 years; (Gabel et al., 2011)), and similar to previous findings in untrained 7 year old boys over a 10m distance (3.8 ± 0.2 m.s-1 (Papaiakovou et al, 2009)) and a mixed group of 6.4 year old boy and girls over 15m (3.7 ± 0.3 m.s-1 (Yanci et al., 2013)). Collectively, these results appear to indicate that the sprinting speed of the selected boys was equivalent to a year greater than their non-selected counterparts, which would seem remarkable at such an early stage of development. However, the greater height of the selected boys would indicate longer leg length and could partially explain their superior sprint speed, though the overall correlation between sprint speed and height was non-existent in the current study (p=0.54; R2 =0.02). In addition, the average height of the selected boys in the present study was 9 and 18 cm lower than previous older age cohorts with similar sprint speed (Gabel et al., 2011; Yanci et al., 2013, respectively).

There were greater within group variability in the non-selected group for every test result. For example, CV values for 15m sprints, both linear speed and agility were 8.8 and 6.3% in the selected group and 22.4 and 23.7% in the non-selected group. The correlation between linear speed and agility, both with, and without the ball was higher than in previous studies (Sheppard & Young, 2006), which may be explained by the relative simplicity of the agility test used in the present study. The linear speed and agility of the non-selected group was 11 and 21% slower than the selected group, respectively, whereas the differences in speed when the ball was involved were of a far greater magnitude (52- 53% lower). The selected group demonstrated a superior and more consistent skill index, defined as the ratio between zigzag running without and with the ball (Mirkov et al., 2008). Dribbling the ball resulted in a decrement in both speed and agility, but had a greater influence on agility, as the locomotive task of running was made more challenging by requiring participants to maneuver around the cones (Meckel et al., 2012). The additional demand of moving with the ball resulted in a 10 and 37% decrease in the selected group for sprint speed and agility, respectively, whereas the equivalent decreases were 52 and 63% for the non-selected group. These results would indicate that the dual task of dribbling the ball and running had little effect on relative speed in the selected group over a simple, linear track, whereas it moderately reduced performance when the running task was more complex as found previously in 13 year old soccer players (Meckel et al., 2012). In contrast, the dual task of both dribbling the ball and running caused greater decrement in the non-selected group over both simple and more advanced test tracks. Previous findings from adult rugby league players indicate that dual-task, but not single-task testing of technical ability could discriminate between selected and non-selected players (Gabbet, Jenkins & Abernethy, 2011). Good spatial and temporal accuracy is required to complete tasks such as dribbling or ball striking. There are age related speed-accuracy trade-offs during interception tasks, with 7-8 year old children displaying poorer performance than older children and young adults and these decrements were associated with poorer prediction of target trajectories (Rothenberg-Cunningham & Newell, 2013). Both age (U16, U20 and senior) and skill levels (low, intermediate and high) can influence anticipatory skills of rugby league players which it was suggested were achieved through accumulated sport-specific experience (Gabbett & Abernethy, 2013). In the present study it is likely that the selected group were more capable of anticipating the movement adjustments required when moving at maximal speed with control of the ball.

Previous exposure to football specific training, even in players under the age of three years, may explain the superior technical skill found in selected group in the current study. The Little Dribblers program includes an 18-36 month-old class that focuses on simple games involving either running with or without the ball. Children then progressed into the 3-5 years group which is designed to develop balance, agility and co-ordination. Favazza, Siperstein, Zeisel, Odom, Sideris, & Moskowitz (2013) applied motor-skill based teaching models over a two month period to young children with developmental delays and autism aged between 3-5 years. They found that the children randomly assigned to motor skill training showed advances of seven to eight months development compared to three to four months advances in a control group (Favazza et al. 2013). Retrospective studies in senior Australian Football League (AFL) players have indicated that greater, early exposure to structured activities and deliberate play in other team sports was associated with superior sport-related perceptual and decision making skills as adults (Berry, Abernethy, & Cote, 2008). As little as six training sessions over three weeks using traditional games such as ‘tag’, have been demonstrated to increase agility in a modified T Design Test in 6 year olds by 9%, but had no effect on 5 or 15m linear speed (Yanci et al., 2013). Yanci et al. (2013) found that linear speed was best improved by using specified drills as part of the training sessions, but had less influence on agility. Kannekens, Elferink-Gemser, and Visscher (2009) proposed that high quality training, coaching and game experience starting at a young age are key factors in creating world class football players. Although the participants in the present study were very young and were unlikely to be involved in structured training for a significant length of time, no data on previous training and deliberate play was collected, which is a common study limitation (Vaeyens et al., 2006). Further research into this area should include an assessment of previous soccer related and non-soccer related training to determine the level of influence of these factors on skill and ability in this age group. According to Fitts and Posner’s model of stages of motor learning (1967), less attention is required once a skill becomes more automatic. Dual task testing can be used to test how automatic a skill has become as training in one task, for example controlling the ball, can reduce the interference when performing the dual tasks in the present study (controlling the ball and running). It cannot be determined from the present study whether decrements in speed resulted from participants switching attentional focus from each task, for example sacrificing ball control at the cost of running or vice versa as there was no separation of them into primary and secondary tasks.

The age of the selected and non-selected groups did not differ and thus a relative chronological age effect due to advanced physical maturation and anthropometric differences between players born at different stages of a single year (Cobley, Baker, Wattie, & McKenna, 2009) is unlikely to explain the differing results. However, the selected individuals were taller than their non-selected counterparts and had a lower BMI. Height was the only physical parameter included in the stepwise model to predict selection or non-selection. It cannot be assumed that greater stature indicates that the selected group members were more physically mature as there are many confounding factors such as future adult height (Meylan et al., 2010). When their weight was presented relative to their height (BMI), the selected group had lower values, potentially indicating lower adiposity. In contrast to height and weight (Gissis et al., 2006; Vaeyens et al., 2006), adiposity has been shown to discriminate between elite, sub-elite and non-elite under 13, 14, 15 and 16 players (Vaeyens et al., 2006). A parameter such as height would be easily apparent to an assessor and may explain why taller players were more likely to be selected than those of lesser stature. The selection process in the present study and in team sports such as soccer is highly subjective, primarily relying on the coach’s knowledge, expertise and their predetermined image of the attributes required of a successful player (Meylan et al., 2010). Since selection can be subject to error or inconsistency (Unnithan et al., 2012), it could be argued that another set of coaches could have selected a different group of players and hence identified different test attributes. However, analysis of the results showed a clear differentiation of performance between the selected and non-selected groups, indicating that the selection process was relatively robust, possibly facilitated by the early age of the participants in the present study.

Basic field tests utilising repeated sprints and zig-zag running with and without the ball (Mirkov et al., 2008), and more sport specific ones involving passing shooting and dribbling (Ali et al., 2007; Russell, Benton, & Kingsley, 2010) have been found to be reliable and valid tests of ability in young adult soccer players. Previous research using discriminatory function analysis has indicated that a combination of fitness testing and match-related parameters could correctly classify 100% of ‘elite’ and ‘sub-elite’ U14 year old players (Waldron & Murphy, 2013). Due to the scope of the current study and the age of the participants, implementation of more advanced test protocols designed for adults would have been inappropriate as the physical and mental demand would be beyond the capacities of the participants. This was evident through an initial pilot trial of the Nike Arrow Head Agility test (SPARQ, Nike Inc., Beaverton, OR) and the T-Test agility examination (Semenick, 1990). Due to the complex organisation of the track and systems used, the children became confused and were unsure which direction was required after each turn. Thus, the simplified tests of speed and agility implemented in the present study contained elements of adult tests, such as linear speed, agility and ball control. These were sufficiently simple that that the children were able to complete them but were also able to discriminate between two levels of ability, classifying correctly 95.5% of players for selection or non-selection according to the discriminant function analysis performed.

There are other factors other than speed, agility ball control and physical characteristics that contribute to footballing ability that were not considered due to the age of the participants in the present study. Testing could include physiological testing such as capacity for aerobic or repeated sprint exercise, which reflect the intermittent, energetic demands of match-play (Bradley et al., 2011). In addition, more sport-specific assessments, such as shot power or pass accuracy or an age-adapted Hoff dribbling track (Hoff, Wisløff, Engen, Kemi, & Helgerud, 2002), could be a better indicator of overall physical and technical performance. Performance in competitive games was not considered as a situation for assessment (Waldron & Murphy, 2013), as the children are not expected to play in such games unless selected for the advanced group. Factors such as tactical awareness can distinguish abilities in older age groups in team sports (Kannekens et al., 2009), but are not assessable in children at this age.

Additional longitudinal studies following children through age group football training up to academy or professional level would further help understand player development and the efficacy of talent identification processes and if it is appropriate to stream children at such an early age. Indeed, early specialisation has been identified by the International Olympic Committee consensus statement on youth athletic development as an increasingly prevalent challenge to their health, well­being and performance (Bergeron et al., 2015). There is significant debate of the costs and benefits of early specialisation in terms of skill acquisition (Anderson & Mayo 2015). Early specialisation appears to occur more frequently in soccer compared to other team-sports within Europe, potentially due to its popularity, the infrastructure available through professionalised academies and the financial rewards associated with success. A sample of 328 elite U16 soccer players from academies in Brazil, England, France, Ghana, Mexico, Portugal and Sweden indicated that on average they started playing at five, undertook supervised training at seven and were competing in leagues at nine years old and had accumulated an average of 4553 hours of soccer activity by the age of 16 (Ford et al., 2012). Their overall developmental profile indicated early specialisation and early engagement rather than early diversification (Ford et al., 2012). However, a large scale study of over 1500 German national squad athletes in Olympic sports found that early specialisation and little involvement in other sports predicted success at 14 years of age, but did not reliably predict adult success (Gullich & Emrich, 2014). Their data did not indicate that early specialisation was associated with senior world class success in any of the categories of sports investigated, including game sports, but rather that late specialisation and involvement in other sports was better associated with adult success (Gullich & Emrich, 2014). Thus, those selected for advanced soccer training in the present study at such and early stage of their maturation should be encouraged to continue participation in other sports to benefit their overall motor skill development (Anderson & Mayo 2015).

**4.1. Conclusions**

The current study identified that three to five year old children subjectively selected by coaches for an advanced group possess superior speed, agility and ball control compared to non-selected children matched for chronological age on a community-based football club program. Both technical ability through ball control when completing the tasks and height were the primary factors that differentiated between the two groups.

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