The effect of playing status, maturity status, and playing position on the development of match skills in elite youth football players aged 11-18 years: a mixed-longitudinal study

ORIGINAL ARTICLE

CHRIS SAWARD[1], JOHN G. MORRIS[1], MARY E. NEVILL[1], & CAROLINE SUNDERLAND[1]

[1]Sport, Health and Performance Enhancement (SHAPE) Research Group, Department of Sport Science, School of Science and Technology, Nottingham Trent University, UK.

Corresponding Author: Dr Chris Saward. Address: Nottingham Trent University, Clifton Lane, Nottingham, UK, NG11 8NS. Tel: +44(0)1159418418. Email: chris.saward@ntu.ac.uk

Running Head: *Match Skills in Elite Youth Football*

Abstract word count: 241

Main-body word count: 3972

Keywords: Talent, skill, youth, team sport, game analysis, modeling

Abstract

This mixed-longitudinal study examined the development of match skills in elite male youth footballers (aged 11-18 years), while considering the effect of playing status, maturity status, and playing position. Across two seasons, 126 elite male youth footballers were assessed in 1-10 competitive matches (401 player-matches). For each match, the on-the-ball actions of each player were recorded using a notation system. The match skills observed were frequencies of successful passes, on-target shots, dribbles, crosses, clearances, and tackles/blocks/interceptions. Multilevel Poisson analysis was used to model the development of players, with regard to each match skill. Modelling revealed significant ($p<0.05$) age-related changes in the frequency of several match skills. That is, dribbles increased, on-target shots, crosses and tackles/blocks/interceptions decreased, whereas changes in successful passes were position-specific. Players retained by an academy performed more dribbles compared to released players ($p<0.05$) (e.g., retained vs. released 18-year-old centre forward = 4.1 vs. 2.0 dribbles per hour), and retained defenders performed more tackles/blocks/interceptions than released defenders ($p<0.05$) (e.g., retained vs. released 18-year-old, on-time maturing centre back = 12.5 vs. 10.2 tackles/blocks/interceptions per hour). Moreover, compared to on-time maturing players, early maturing players performed more tackles/blocks/interceptions ($p<0.05$) (e.g., on-time vs. early maturing retained 18-year-old centre back = 12.5 vs. 15.2 tackles/blocks/interceptions per hour). Playing position affected all match skills ($p<0.05$). The developmental profiles of match skills presented here may support experts in identifying and developing talented footballers across a wide age range, while considering the influence of maturity status and playing position.

Keywords: Talent, skill, youth, team sport, game analysis, modelling

Highlights

- Multilevel Poisson modelling showed that match skills change with age in elite youth footballers aged 11-18 years, and that changes are affected by playing status, maturity status, and playing position.
- Players retained by an academy perform more dribbles compared to those released. Retained defenders perform more tackles/blocks/interceptions compared to released defenders. Thus, these match skills may be important in facilitating progression through an academy system.
- However, early maturing players perform more tackles/blocks/interceptions compared to on-time maturing players, suggesting that maturity status needs to be accounted for when considering defensive actions during talent identification and development processes.

Introduction

According to Baker, Cobley, Schorer, and Wattie (2017), talent identification refers to the process of identifying individuals who possess qualities that predict future attainment, and, talent development reflects the range of influences on the process of skill acquisition in a high performance sport setting. Talent identification and development research in football has tended to examine physical characteristics, and their development, as potential indicators of talent, however, an adequate grounding in game-specific skills is essential for progression to professional senior football (Unnithan, White, Georgiou, Iga, & Drust, 2012). Therefore, some researchers have assessed the skill characteristics of youth footballers using motor skill tests of dribbling, passing, and shooting, for example, with the purpose of contributing to the identification and development process (Figueiredo, Coelho e Silva, & Malina, 2011; Gouvea et al., 2016; Huijgen, Elferink-Gemser, Post, & Visscher, 2009, 2010; Vaeyens et al., 2006; Valente-dos-Santos et al., 2012). However, the tests employed to assess players' skills are more closed in nature than the open skills required in match-play and so may not reflect the requirement of actual competition where skills must be performed under pressure, in a constantly changing environment (Ali, 2011; Unnithan et al., 2012). Waldron and Worsfold (2010) proposed notational analysis as a more ecologically valid method for assessing the match skills of players from a talent identification and development perspective. Notational analysis involves objectively recording competitive performance so that key match skills can be quantified in a valid and consistent manner (Hughes & Franks, 2004). This method can also allow match skills such as tackling, blocking, and clearances to be assessed, which have generally been omitted from motor skill test research. Defensive skills are essential to performance in football (Almeida, Duarte, Volossovitch, & Ferreira, 2016), and, alongside offensive skills, should be assessed within match analysis research in order to provide a holistic view of players' match skills.

To examine whether match skills may be used for talent identification purposes, notational analysis studies have tended to compare young players of varying statuses (e.g., released from an academy vs. retained by an academy) on the basis of their match skills (Ré, Cattuzzo, Santos, & Monteiro, 2014; Varley et al., 2017; Waldron & Murphy, 2013; Waldron & Worsfold, 2010). For example, Waldron and Murphy (2013) showed that during match-play, compared to U14 centre of excellence standard footballers, U14 academy standard footballers completed more passes and made more tackles. At an older age, Varley et al. (2017) used a semi-automated notation system to examine the match skills of 380 U17 academy footballers during an international tournament. Results revealed that, compared to less successful teams in the tournament, more successful teams in the tournament, performed more shots, on-target shots, tackles, and had better first time pass accuracy. Thus, while match skills can distinguish between contrasting standards of youth footballers, there are inconsistencies between studies in the match skills that appear to be important. One possible explanation for these inconsistencies is that the players examined were of differing ages, which may reflect improving match skills and the changing nature of match-play at older ages (Almeida et al., 2016; Olthof, Frencken, & Lemmink, 2015). Assessing the development of elite youth footballers' match skills, across a wide age range, while considering playing status (i.e., released from an academy vs. retained by an academy), would provide a more comprehensive understanding of how match skills may influence progression through the various stages of an academy system.

Understanding how match skills change with age may therefore support dynamic talent identification procedures. It may also support practitioners in providing a suitable learning environment throughout players' development to improve match skills. However, to date, no studies have examined age-related changes in the skills of elite youth footballers in competitive match-play across a wide age range. Nevertheless, a recent study used a notation system to examine differences between U13 and U15 regional standard footballers in the defensive actions performed during small-sided games (Almeida et al., 2016). Results showed that compared to players aged U15, players aged U13 were more likely to regain possession through interceptions. Whether these findings extend to competitive match-play remains unclear. Furthermore, age-related changes in match skills may be complicated by maturational differences between players. Indeed, research has shown that maturity status influences motor skill test performance independent of age in youth footballers, and this may in turn affect match performance (Figueiredo et al., 2011; Malina et al., 2005; Vaeyens et al., 2006). However, the influence of maturity status on players' match skills as assessed by notational analysis has yet to be examined.

The match skill performance of professional footballers may be influenced by a series of factors, such as score-line, match location, and opposition quality (Liu, Gómez, Gonçalves, & Sampaio, 2016). However, the most consistent finding in senior professional football is that playing position influences match skill performance (Bradley, Lago-Peñas, Rey, & Gomez Diaz, 2013; Dellal, Wong, Moalla, & Chamari, 2010; Dellal et al., 2011; Liu et al., 2016). For instance, using a semi-automated video notation system, Dellal et al. (2010) examined the match skills of 3540 players from the French First League, in relation to playing position. They showed that compared to the other playing positions, midfielders performed the most successful passes and defenders won the highest percentage of ground and aerial duels. Whether the development of match skills in elite youth footballers is also position-specific remains unknown.

Clearly, there is requirement for a better understanding of how elite youth footballers' match skills develop with age, and how this development may differ based on footballers' playing status, maturity status, and playing position. Enhancing our knowledge of the development of match skills, and the influences on skill acquisition, has implications for talent identification and development in football and may help in the prediction of future attainment. Therefore, this mixed-longitudinal study examined the development of match skills in elite male youth footballers (aged 11-18 years), while considering the effect of playing status, maturity status, and playing position.

Methodology

Participants

A total of 126 elite male youth footballers aged 11-18 years, belonging to three professional English academies participated in the study. The U12, U13, and U14 age groups averaged three 90-minute training sessions a week, the U15-U16 age groups averaged four 90-minute training sessions a week, and the U17-U18 age groups averaged six 90-minute training sessions a week. Players participated in a competitive match once a week.

Ethical approval for the current study was obtained from the Ethical Advisory Committees at Nottingham Trent University and Loughborough University. Prior to taking part in the study, players and parents or guardians were provided with a written and verbal summary outlining the purpose, procedures involved, possible risks and benefits, and the voluntary and confidential nature of the research. Written assent was obtained from players and written consent was obtained from parents or guardians.

Design

Across two football seasons, 2010/11 to 2011/12, the match skills of 126 elite male youth footballers aged 11-18 years, were assessed in 1-10 competitive inter-academy matches (mean ± SD number of matches per player: 3.2 ± 2.4 matches), resulting in a mixed-longitudinal data set of 401 player-matches. The number of matches played per age group are displayed in Table 1. The match skills of each player-match were assessed using a notation system (MatchInsight, Prozone®, Leeds, UK). The match skills coded were frequencies of successful passes, on-target shots, dribbles, crosses, clearances, and tackles/blocks/interceptions (frequencies normalised to one hour of match-play). This design allowed the development of each match skill from age 11 to 18 years to be examined. The playing status of players was categorised as retained or released depending on whether they were signed to the academy on 1st Feb 2014, resulting in 66 players being categorised as retained and 60 players as released. Furthermore, the maturity status of players was estimated using a predictive equation (Moore et al., 2015), and the playing position for each player-match was recorded. This allowed the effect of playing status, maturity status, and playing position on match skill development to be considered.

Procedures

Maturity status. Somatic maturity estimates were made for 113 out of 126 players (13 players missed the assessment as they were absent due to injury/illness). A regression equation was used to estimate years from age at peak height velocity (APHV): Maturity offset= -8.128741 + (0.0070346 x (age x sitting height)) (Moore et al., 2015). Predicted APHV was calculated as chronological age minus maturity offset. Each player was then classified as early, average, or late maturing, based on predicted APHV, following the method outlined by Sherar, Mirwald, Baxter-Jones, and Thomis (2005). Players whose predicted APHV was between 13 and 15 years were classified as average maturing (n=98), players whose predicted APHV was <13 years were classified as early maturing (n=15), and players whose predicted APHV was >15 years were classified as late maturing (n=0). These classifications were chosen in-line with previous longitudinal growth data (e.g., Koziel & Malina 2018; Malina, Bouchard, & Bar-Or, 2004). That there were no late maturing players in this sample may reflect an academy's' bias towards selecting players advanced in biological maturity, but also that the regression equation used to estimate maturity status may underestimate APHV in late maturing boys (Koziel & Malina, 2018).

Match configuration. The matches analysed were part of the regular series of inter-academy matches between Premier League Academies during a season. All matches were 11-aside, but the configuration of matches varied depending on age group. The U12-U13 matches were formed of three or four periods, with total match duration between 75-80 minutes. For U14-U18 teams, matches were formed of two periods, with total match duration between 80-90 minutes. The playing position of each player was recorded for every match. Players were categorised as full back (FB) (n=74), centre back (CB) (n=75), centre midfielder (CM) (n=74), wide midfielder (WM) (n=74), or centre forward (CF) (n=62). Players who changed position mid-match were categorised as multi-positional (Multi) (n=42).

Match analysis. Matches were filmed with a single digital video camera (Canon Legria, FS306E) positioned on the half-way line at a height of 1.5 m. Videos were transferred to PC and on-the-ball actions of each player were recorded using a semi-automated computerised notational analysis system (Match Insight, Prozone®, Leeds, UK). This system allowed the following actions to be notated, based on the operational definitions provided by ProZone: successful pass (any attempt by a player to play the ball to a teammate where the ball reaches a teammate); on-target shot (any attempt at goal with any part of the body, except the head, that is going into the goal); dribble (any run with the ball that involves either, i., multiple touches with a directional change or ii., beating an opponent); crosses (any ball played from a wide area into the box with the aim of creating a goal scoring opportunity); clearance (a defensive touch undertaken by a player under pressure from the opposition or with no intended target); and tackle/block/interception (dispossession or attempted dispossession of an opponent by physical challenge or pressure when actual challenge/tackle is attempted, or, an opposing player, in close proximity, prevents the ball from reaching its intended target, or, possession gained where the previous event is made by a player from the opposition team).

Prior to commencing the main analysis, analysts underwent training using the notation system. This included reading, discussing and explaining the operational definitions of each on-the-ball action with the lead researcher. Furthermore, as suggested by O'Donoghue

(2007), precise operational definitions are required, but do not guarantee good reliability. Therefore, operational definitions were discussed while viewing example video sequences of elite youth football match-play in order to foster a shared understanding of action definitions, in the analysis context. Analysts then had at least 5 hours of practice using the system to notate elite youth football match-play footage prior to starting the main analysis. Inter-observer reliability was assessed by the principle analysts independently coding 40 minutes of a randomly selected match. One of the principle analysts independently coded the same randomly selected match 12 weeks later to assess intra-observer reliability. Cohen's Kappa was conducted to determine the strength of agreement between coders / observations on the selected on-the-ball actions. Overall, inter-observer (κ=0.86, $p<0.05$) and intra-observer reliability (κ=0.87, $p<0.05$) were very good. For inter-observer reliability, there was very good agreement between coders for successful passes (κ=0.87, $p<0.05$), on-target shots (κ=1.00, $p<0.05$), good agreement for crosses (κ=0.75, $p<0.05$), clearances (κ=0.74, $p<0.05$), and tackles/blocks/interceptions (κ=0.74, $p<0.05$), and moderate agreement for dribbles (κ=0.50, $p<0.05$). For intra-observer reliability, there was very good agreement between observations for successful passes (κ=0.91, $p<0.05$), on-target shots (κ=1.00, $p<0.05$), crosses (κ=0.89, $p<0.05$), dribbles (κ=0.89, $p<0.05$), and good agreement for clearances (κ=0.75, $p<0.05$) and tackles/blocks/interceptions (κ=0.79, $p<0.05$) (Altman, 1991).

Data Analysis

Multilevel Poisson models were fitted using MLwiN v3.00 (Bristol, U.K.) to examine the development of each match skill. Multilevel modelling was used due to the hierarchical structure of the data, i.e., repeated measures nested within players, nested within academies. A multilevel model is able to describe the underlying trends of a particular component in the population (fixed part) and also models the unexplained variation around the mean trend of that component (random part) (Twisk, 2003). The outcome variable for each multilevel model was the frequency of a match skill. A Poisson distribution is an appropriate distribution to use to model the frequency of a match skill because it is a count variable that is positively skewed and constrained to be non-negative (Nevill, Atkinson, Hughes, & Cooper, 2002). Multilevel Poisson models use a log-link function whereby the logarithms of the frequency of match skills are modelled. To transform models back to predicted frequencies of match skills, the inverse transformation of the natural logarithm must be used, via the exponential function (Rasbash, Steele, Browne, & Goldstein, 2017; Snijders & Bosker, 2012).

The following parameters were systematically added to a null model to observe their effect on explaining and partitioning variation in the development of players' match skill. Firstly, to investigate the variance in the level of a match skill between academies and between players, intercepts were allowed to vary randomly. The effect of age (centred at 15 years) on the match skill was then modelled. Quadratic age terms were then modelled. Subsequently, the effects of playing status, maturity status, playing position, and any two-way interactions between predictors, on the match skill were then modelled. Parameters were accepted or rejected based on their effects on the match skill, as indicated by Wald tests. Statistical significance was accepted at the 95% confidence level ($p<0.05$).

Results

Table 1 shows the match skills of the elite youth footballers, according to age group. For all models, there was no random variance between academies, and thus any random effects discussed henceforth relate to random variance between players. Table 2 shows the

Multilevel Poisson models for the development of match skills. All estimates in Table 2 are on the logarithmic scale and so need to be exponentiated to give predicted frequencies of match skills. For example, from Table 2, the model for frequency of crosses is: $\text{Log}(\pi_{ij}) = -2.182 + (-0.089*\text{Age centred at 15y}) + (0.044*\text{Age centred at 15y}^2) + (2.099*\text{FB}) + (1.253*\text{CM}) + (2.834*\text{WM}) + (2.147*\text{CF}) + (1.824*\text{Multi})$. For a 16.5-year-old WM, the exponential of the regression equation would predict: $\text{Exp}(-2.182 + (-0.089*1.5\text{y}) + (0.044*1.5\text{y}^2) + (2.834*1)) = 1.9$ crosses per hour of match-play. Figures 1-3 display the exponentiated model estimates for the development of each match skill.

Insert Table 1 & 2 here

Successful passes

The multilevel Poisson model for successful passes showed a significant effect of allowing the intercept to vary randomly between players (χ^2=28.7, 1df, p<0.05). The fixed part of the model predicted that age (χ^2=4.7, 1df, p<0.05), playing position (χ^2=35.5, 5df, p<0.05), and the interaction between age and playing position significantly affected the frequency of successful passes (χ^2=26.3, 5 df, p<0.05). The model predicted that in CB, FB, and CM the frequency of successful passes increased with age, whereas in WM, CF, and multi-positional players the frequency of successful passes decreased with age (see Figure 1a and b).

Insert Figure 1 here

On-target shots

There was no significant effect of allowing the intercept to vary randomly between players for the multilevel Poisson model for on-target shots. The fixed part of the model predicted that age (χ^2=7.6, 1df, p<0.05) and playing position (χ^2=55.6, 5df, p<0.05) significantly affected the frequency of on-target shots. The model predicted that the frequency of on-target shots decreased with age, and that CF performed the most (e.g., 18-year-old CF=0.6 on-target shots per hour), and defenders the fewest on-target shots (e.g., 18-year-old FB=0.03 on-target shots per hour) (see Figure 1c and d).

Crosses

The multilevel Poisson model for crosses showed a significant effect of allowing the intercept to vary randomly between players (χ^2=6.9, 1df, p<0.05). The fixed part of the model predicted that age (χ^2=4.6, 1df, p<0.05), age^2 (χ^2=3.9, 1df, p<0.05), and playing position (χ^2=113.7, 5df, p<0.05), significantly affected the frequency of crosses. The model predicted that the frequency of crosses decreased with age, until 16 years (see Figure 1e and f). Throughout development, WM performed the most crosses and CB the fewest (e.g., 18-year-old WM vs. CB = 2.2 vs. 0.1 crosses per hour).

Dribbles

The multilevel Poisson model for dribbles showed a significant effect of allowing the intercept to vary randomly between players (χ^2=17.8, 1df, p<0.05). The fixed part of the model predicted that age (χ^2=8.43, 1df, p<0.05), playing status (χ^2=17.0, 1df, p<0.05), and playing position (χ^2=50.2, 5df, p<0.05) significantly affected the frequency of dribbles. The model predicted that the frequency of dribbles increased with age, that retained players performed more dribbles versus released players (e.g., retained vs. released 18-year-old CF = 4.1 vs. 2.0 dribbles per hour), and that CF performed the most, and CB the fewest dribbles (e.g., CB vs. CF released 18-year-old performed 1.5 fewer dribbles per hour) (see Figure 2).

Insert Figure 2 here

Clearances

There was no significant effect of allowing the intercept to vary randomly between players for the multilevel Poisson model for clearances. The fixed part of the model predicted that playing position significantly affected the frequency of clearances (χ^2=330.0, 5df, p<0.05). There was no effect of age on the frequency of clearances. The model predicted that CB, FB, CM, WM, CF, and multi-positional players performed 4.0, 1.8, 0.9, 0.8, 0.4, and 0.9 clearances per hour, respectively.

Tackles/blocks/interceptions

The Poisson model for tackles/blocks/interceptions showed a significant effect of allowing the intercept to vary randomly between players (χ^2=12.1, 1df, p<0.05). The fixed part of the model predicted that age (χ^2=55.6, 1df, p<0.05), age^2 (χ^2=5.2, 1df, p<0.05), playing status (χ^2=5.4, 1df, p<0.05), maturity status (χ^2=8.4, 1df, p<0.05), playing position (χ^2=42.5, 5df, p<0.05), and the interaction between playing status and playing position (χ^2=11.8, 5df, p<0.05), significantly affected the frequency of tackles/blocks/interceptions. The model predicted that the frequency of tackles/blocks/interceptions decreased with age, and that early maturing players performed more tackles/blocks/interceptions compared to on-time maturing players (e.g., retained 18-year-old CB, on-time maturing vs. early maturing=12.5 vs. 15.2 tackles/blocks/interceptions per hour) (see Figure 3). Modelling also indicated that CB performed the most tackles/blocks/interceptions, and CF the fewest (e.g., CB vs. CF retained on-time maturing 18-year-old performed 7.6 more tackles/blocks/interceptions per hour). However, the model predicted different age-related changes in tackles/blocks/interceptions based on the interaction between playing status and playing position. That is, for CB, retained players performed more tackles/blocks/interceptions than released players (e.g., retained vs. released 18-year-old, on-time maturing CB performed 2.4 more tackles/blocks/interceptions per hour), whereas, for CF, retained players performed fewer tackles/blocks/interceptions than released players (e.g., retained vs. released 18-year-old, on-time maturing CF performed 0.5 fewer tackles/blocks/interceptions per hour).

Insert Figure 3 here

Discussion

This mixed-longitudinal study is the first to describe the development of match skills in elite youth footballers (aged 11-18 years), while considering the effect of playing status, maturity status, and playing position. The main findings of the present study were that: 1) with the exception of clearances, match skills changed with age; 2) throughout their development, compared to released players, retained players performed more dribbles and, for certain playing positions, more tackles/blocks/interceptions; 3) compared to on-time maturing players, early maturing players performed more tackles/blocks/interceptions throughout development, and; 4) playing position influenced the development of all match skills.

Age-related changes

The number of dribbles performed increased with age. Although the increase related to a relatively small number of dribbles per hour of match-play (see Figure 2), it was significant, and may suggest that players improve their ability to maintain control of the ball and beat opponents in match situations, as they grow and develop. This is a unique finding as this is the first study to examine age-related changes in the frequency of dribbles performed in competitive match-play in elite youth footballers. Nevertheless, consistent with the current findings in ecologically valid settings, motor skill test research also shows that dribbling performance on slalom and shuttle tests improve with age in talented players aged 12-18 years (Huijgen et al., 2009, 2010).

Previous motor skill test research has shown an improvement in passing skills with age in mixed-ability youth football players aged 11-17 years (Valente-dos-Santos et al., 2012; Vänttinen, Blomqvist, & Häkkinen, 2010). During match-play, the current study suggested that age-related improvements in the frequency of successful passes were position-specific. Unlike attackers (WM, CF), CB, FB, and CM increased their frequency of successful passes with age. The improvement of passing skill with age in CB and FB may possibly be because at older ages, defenders become more involved in initiating passing sequences. In support of this trend, elite senior defenders from top ranked teams in the Spanish Premier Division completed more passing-related actions compared to defenders from bottom ranked teams (Liu et al., 2016), suggesting enhanced involvement of defenders in play at higher performance standards. Relative to other positions, CM players performed a high frequency of successful passes at a younger age and increased the frequency of successful passes performed, as they got older. This suggests that performing successful passes is a key aspect of performance for this position that is improved throughout a player's development, possibly because a major role of the CM is to organise and develop the play within the core area of the pitch (Liu et al., 2016; Saward, Morris, Nevill, Nevill, & Sunderland, 2016).

The frequency of on-targets shots, crosses, and tackles/blocks/interceptions decreased with age in elite youth footballers. This is possibly due to an increasingly cautious approach to match-play at older ages, where there is less opportunity to cross and shoot, and a reduced requirement to perform overt defensive actions (Almeida et al., 2016; Olthof et al., 2015). However, research into the tactical aspects of match-play is required to examine this hypothesis. Furthermore, a range of other contextual variables may have influenced age-related changes in match skills, such as score-line, match location, and opposition quality (Liu et al., 2016), which were not considered in the current study.

Playing status

Throughout development, retained players performed more dribbles than released players did during match-play. This supports Huijgen et al. (2009) who showed that talented players aged 14-19 years who reached professional senior status performed better than those who reached amateur senior status on a repeated shuttle dribble test, and supports notational analysis research showing that elite U14 footballers performed more dribbles compared to sub-elite U14 footballers during match-play (Waldron & Worsfold, 2010). Despite the limitation of not assessing contextual variables, the current findings suggest that dribbling during match-play may be a key skill for progression in academy football, and may be a factor that practitioners are currently using to identify talented players.

Previous notational analysis research has shown that compared to their less successful counterparts, successful elite youth footballers perform more tackles during match-play at age U14 (Waldron & Murphy, 2013) and at age U17 (Varley et al., 2017). The current study extends previous work by showing that, across a wide age range, retained elite youth footballers only perform more tackles/blocks/interceptions compared to released elite youth footballers for certain playing positions, namely, defenders and multi-positional players. This possibly suggests that performing a high frequency of defensive actions may be a potential talent indicator for defenders.

Maturity status

That early maturing players performed more tackles/blocks/interceptions compared to on-time maturing players may suggest that performance of this skill during match-play could relate to advantages in size, strength, power, and speed associated with advanced maturity (Figueiredo et al., 2011; Malina et al., 2004, 2005; Towlson et al., 2017). As these advantages disappear in adulthood (Malina et al., 2004) it is recommended that the maturity status of players is accounted for when assessing defensive actions during match-play for talent identification purposes. However, there were no late maturing players in the current study. This may reflect the previously reported bias towards selecting boys advanced in biological maturity in elite youth sport (Malina et al., 2004). Alternatively, as recently suggested by Koziel and Malina (2018), it is possible that the predictive equation used to estimate maturity status may have underestimated APHV in late maturing boys. Regardless, it was only possible to examine differences between early and on-time maturing players in the present study, so the development of match skills in late maturing players remains unclear and warrants further investigation.

Playing position

The current results suggest that playing position affects the development of all match skills. Towlson et al. (2017) recently showed maturational and physical differences between playing positions in elite youth footballers aged 12-18 years, however, the current study is the first to show positional differences in match skills in a similar sample. Nevertheless, current results are in accordance with the notational analysis of senior professional football that show clear positional differences in players' match skills (Bradley et al., 2013; Dellal et al., 2010, 2011; Liu et al., 2016). Throughout development, CB performed the most clearances and tackles/blocks/interceptions. This is possibly due to their main purpose being to prevent goals being scored. Similarly, Dellal et al. (2010, 2011) showed that in the French, English, and Spanish top divisions, defenders won a higher percentage of air and ground duels compared to other positions. While FB showed similar development patterns to CB, they delivered a higher frequency of crosses. This may suggest that their wider position meant they were able to support attacking play more readily.

Results also possibly suggest that throughout development, a major responsibility of CM is to perform successful passes in order to develop play (Liu et al., 2016; Saward, Morris, Nevill, Nevill, & Sunderland, 2016), but also to perform tackles/blocks/interceptions, highlighting their defensive duties and requirement to try to win possession and control the middle of the pitch. Wide midfielders appeared to demonstrate a less defensive, and more attacking role than CM, as indicated by the lower frequency of tackles/blocks/interceptions and higher frequency of crosses and dribbles produced throughout development. Again, these trends are consistent with the match skill profiles of top ranked elite senior midfield players (data from Liu et al., 2016: tackles per match CM vs. WM = 2.7 ± 2.1 vs. 1.7 ± 1.7; crosses per match CM vs. WM = 1.8 ± 2.4 vs. 4.5 ± 4.4). Lastly, CF performed more dribbles and on-target shots compared to other positions, potentially highlighting their role in attempting to create and score goals (Liu et al., 2016). The current study is the first to show that highly specialised demands exist for each playing position in elite youth footballers as young as 11 years old.

Implications

An awareness of how match skills change with age in relation to playing status, maturity status, and playing position may support experts in identifying and developing talented players. That the frequency of dribbles performed during match-play increased with age and that retained players performed more dribbles than released players throughout development, may suggest that this match skill could be important for progression through a talent development programme. Thus, focusing on observing dribbling during matches may provide practitioners with some additional information regarding player potential. However, it is not suggested that players be selected or de-selected on this basis. Instead, during training, coaches could focus on developing players' dribbling technique and set up practice activities that replicate game-related conditions to encourage players to recognise situations where employing dribbling is appropriate.

For defenders, performing more tackles/blocks/interceptions during match-play may facilitate progression through a talent development programme. Again, during training it is potentially suggested that these skills could be encouraged when players adopt defensive positions within a particular practice activity. However, another key finding was that early maturing players performed more defensive actions than on-time maturing players during match-play and this needs to be accounted for during talent identification and development processes.

As early as U12 there appear to be position-specific skill requirements for match-play in elite youth football. However, it is not suggested that a player be assigned to a certain playing position at 11 years old and only taught match skills pertinent to this position, as this may prevent well-rounded skill development and transfer between positions at older ages (Towlson et al., 2017). Indeed, rotating young players around positions may allow players to learn the skill requirements of each position and become competent in all aspects of the game early in their careers, which may be beneficial for future performance. Nevertheless, the match skill profiles presented may allow coaches to manipulate training sessions to develop match skills pertinent to particular playing positions, at particular ages.

Limitations

The current study examined the development of match skills based on a mixed-longitudinal sample of elite youth footballers aged 11-18 years. This study design extends previous cross-sectional work examining age-related changes in match performance characteristics (e.g., Almeida et al. 2016). However, it is acknowledged that prospectively following players from aged 11 years to aged 18 years would have provided a better understanding of match skill development. Unfortunately, recruiting and tracking an elite sample over a seven-year period is expensive and suffers from the problem of participant dropout. Furthermore, previous research utilising mixed-longitudinal samples have tended to treat data independently (e.g., Vaeyens et al., 2006), even though repeated measurements of individuals are related. Conversely, the current study employs appropriate statistical techniques to analyse repeated measures data (Twisk, 2003). That said, it is also acknowledged that the extent of the repeated measures data collected is limited to 3.2 ± 2.4 matches per player. Future research should attempt to assess players' match skills across more matches and across a longer study period.

Another potential limitation of this study was the predictive equation used to estimate maturity status (Moore et al., 2015). Given the invasive nature of assessing maturity status via skeletal age and secondary sexual characteristics, the use of the non-invasive prediction equation was considered appropriate in the present context. However, recent evidence has suggested that the equation may underestimate APHV in late maturing boys (Koziel & Malina, 2018), potentially resulting there being no players classified as late maturing in the current study. Therefore, the development of match skills in late maturing players remains unclear and warrants further investigation.

Finally, the frequency of several match skills decreased with age, possibly due to improving tactical expertise at older ages. Future research should assess both tactical and skill elements of match-play to provide a more comprehensive understanding of the development of young players. Several other contextual variables, such as score-line, match location, and opposition quality also need to be considered to provide a clearer understanding of how they may influence young players' match skills.

Conclusion

Except for clearances, match skills change with age in elite youth footballers aged 11-18 years, and changes are affected by playing status, maturity status, and playing position. During match-play, performing more dribbles and, for defenders, performing more defensive actions may facilitate progression through an academy, and thus, these skills could be focused on and developed during training and matches. However, results also suggest that maturity status needs to be accounted for when considering defensive actions during talent identification and development processes. Age-related changes in match skills varied by position, and these profiles may allow coaches to refine training methods particular to certain playing positions at particular ages, whilst maintaining a flexible approach to positional allocation at an early age.

Acknowledgements

We would like to thank the academy staff for their support and the players for taking part in the study.

Disclosure statement

No potential conflicts of interest.

References

Ali, A. (2011). Measuring soccer skill performance: a review. *Scandinavian Journal of Medicine and Science in Sports, 21*, 170-183.

Almeida, C. H., Duarte, R., Volossovitch, A., & Ferreira, A. P. (2016). Scoring mode and age-related effects on youth soccer teams' defensive performance during small-sided games. *Journal of Sports Sciences*, *34*(14), 1355-1362.

Altman, D. G. (1991). *Practical Statistics for Medical Research*. London, Chapman & Hall.

Baker, J., Cobley, S., Schorer, J., & Wattie, N. (Eds.). (2017). *Routledge handbook of talent identification and development in sport*. Taylor & Francis.

Bradley, P. S., Lago-Peñas, C., Rey, E., & Gomez Diaz, A. (2013). The effect of high and low percentage ball possession on physical and technical profiles in English FA Premier League soccer matches. *Journal of Sports Sciences, 31*(12) 1261-1270.

Dellal, A., Chamari, K., Wong, D. P., Ahmaidi, S., Keller, D., Barros, R., ... Carling, C. (2011). Comparison of physical and technical performance in European soccer match-play: FA Premier League and La Liga. *European Journal of Sport Science*, *11*(1), 51-59.

Dellal, A., Wong, D. P., Moalla, W., & Chamari, K. (2010). Physical and technical activity of soccer players in the French First League-with special reference to their playing position. *International SportMed Journal*, *11*(2), 278-290.

Figueiredo, A. J., Coelho e Silva, M. J., & Malina, R. M. (2011). Predictors of functional capacity and skill in youth soccer players. *Scandinavian Journal of Medicine & Science in Sports, 21*(3), 446-454.

Gouvea, M., Cyrino, E. S., Ribeiro, A. S., da Silva, D. R., Ohara, D., Valente-dos-Santos, J., …, Ronque, E. (2016). Influence of skeletal maturity on size, function and sport-specific technical skills in youth soccer players. *International Journal of Sports Medicine*, *37*(6), 464-469.

Hughes, M., & Franks, I. M. (Eds.). (2004). *Notational analysis of sport: Systems for better coaching and performance in sport.* Psychology Press, N. Spon.

Huijgen, B. C., Elferink-Gemser, M. T., Post, W. J., & Visscher, C. (2009). Soccer skill development in professionals. *International Journal of Sports Medicine, 30,* 585-591.

Huijgen, B. C., Elferink-Gemser, M. T., Post, W. J., & Visscher, C. (2010). Development of dribbling in talented youth soccer players aged 12-19 years: A longitudinal study. *Journal of Sports Sciences, 28,* 689– 698.

Koziel, S. M., & Malina, R. M. (2018). Modified maturity offset prediction equations: validation in independent longitudinal samples of boys and girls. *Sports Medicine*, *48*(1), 221-236.

Liu, H., Gómez, M. A., Gonçalves, B., & Sampaio, J. (2016). Technical performance and match-to-match variation in elite football teams. *Journal of Sports Sciences*, *34*(6), 509-518.

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity*. Champaign Illinois, Human Kinetics.

Malina, R. M., Cumming, S. P., Kontos, A. P., Eisenmann, J. C., Ribeiro, B., & Aroso, J. (2005). Maturity-associated variation in sport-specific skills of youth soccer players aged 13–15 years. *Journal of Sports Sciences*, *23*(5), 515-522.

Moore, S. A., McKay, H. A., Macdonald, H., Nettlefold, L., Baxter-Jones, A. D., Cameron, N., & Brasher, P. M. (2015). Enhancing a somatic maturity prediction model. *Medicine and Science in Sports and Exercise*, *47*(8), 1755-64.

Nevill, A. M., Atkinson, G., Hughes, M. D., & Cooper, S. M. (2002). Statistical methods for analysing discrete and categorical data recorded in performance analysis. *Journal of Sports Sciences*, *20*(10), 829-844.

O'Donoghue, P. (2007). Reliability issues in performance analysis. *International Journal of Performance Analysis in Sport*, *7*(1), 35-48.

Olthof, S. B., Frencken, W. G., & Lemmink, K. A. (2015). The older, the wider: on-field tactical behavior of elite-standard youth soccer players in small-sided games. *Human Movement Science*, *41*, 92-102.

Rasbash, J., Steele, F., Browne, W. J., & Goldstein, H. (2017). *A User's Guide to MLwiN, v3.00*. Centre for Multilevel Modeling, University of Bristol.

Ré, A. H., Cattuzzo, T. M., Santos, F. M., & Monteiro, C. B. (2014). Anthropometric characteristics, field test scores and match-related technical performance in youth indoor soccer players with different playing status. *International Journal of Performance Analysis in Sport*, *14*(2), 482-492.

Saward, C., Morris, J. G., Nevill, M. E., Nevill, A. M., & Sunderland, C. (2016). Longitudinal development of match-running performance in elite male youth soccer players. *Scandinavian Journal of Medicine & Science in Sports, 26*(8), 933-942.

Snijders, T., & Bosker, R. (2012). *Multilevel Models: an introduction to basic and advanced multilevel modeling.* Thousand Oaks, CA, Sage Publications.

Sherar, L. B., Mirwald, R. L., Baxter-Jones, A. D., & Thomis, M. (2005). Prediction of adult height using maturity-based cumulative height velocity curves. *The Journal of Pediatrics*, *147*(4), 508-514.

Towlson, C., Cobley, S., Midgley, A. W., Garrett, A., Parkin, G., & Lovell, R. (2017). Relative age, maturation and physical biases on position allocation in elite-youth soccer. *International Journal of Sports Medicine*, *38*(03), 201-209.

Twisk, C. (2003). *Applied longitudinal data analysis for epidemiology: A practical guide*. Cambridge, Cambridge University Press.

Unnithan, V., White, J., Georgiou, A., Iga, J., & Drust, B. (2012). Talent identification in youth soccer. *Journal of Sports Sciences*, *30*(15), 1719-1726.

Vaeyens, R., Malina, R. M., Janssens, M., Van Renterghem, B., Bourgois, J., Vrijens, J., & Philippaerts, R. M. (2006). A multidisciplinary selection model for youth soccer: the Ghent Youth Soccer Project. *British Journal of Sports Medicine*, *40*(11), 928-934.

Valente-dos-Santos, J., Coelho-e-Silva, M. J., Simões, F., Figueiredo, A. J., Leite, N., Elferink-Gemser, M. T., ... Sherar, L. (2012). Modeling developmental changes in functional capacities and soccer-specific skills in male players aged 11-17 years. *Pediatric Exercise Science*, *24*(4), 603-621.

Vänttinen, T., Blomqvist, M., & Häkkinen, K. (2010). Development of body composition, hormone profile, physical fitness, general perceptual motor skills, soccer skills and on-the-ball performance in soccer-specific laboratory test among adolescent soccer players. *Journal of Sports Science & Medicine*, *9*(4), 547.

Varley, M. C., Gregson, W., McMillan, K., Bonanno, D., Stafford, K., Modonutti, M., & Di Salvo, V. (2017). Physical and technical performance of elite youth soccer players during international tournaments: influence of playing position and team success and opponent quality. *Science and Medicine in Football*, *1*(1), 18-29.

Waldron, M., & Murphy, A. (2013). A comparison of physical abilities and match performance characteristics among elite and subelite under-14 soccer players. *Pediatric Exercise Science*, *25*(3), 423-434.

Waldron, M., & Worsfold, P. (2010). Differences in the game specific skills of elite and sub-elite youth football players: Implications for talent identification. *International Journal of Performance Analysis in Sport*, *10*(1), 9-24.

Table 1. The frequency of match skills performed per hour of match-play in elite youth footballers, according to age group

Age Group	Matches (n)	Player-matches (n)	Successful passes	On-target shots	Dribbles	Crosses	Clearances	Tackles/ blocks/ interceptions
U12	3	14	11.3 ± 5.8	0.5 ± 1.1	0.5 ± 0.8	1.2 ± 1.8	1.7 ± 2.2	16.3 ± 7.9
U13	6	65	13.0 ± 6.7	0.6 ± 1.0	1.1 ± 2.5	1.3 ± 1.7	1.6 ± 1.7	14.9 ± 5.9
U14	5	65	13.2 ± 7.4	0.4 ± 0.8	1.4 ± 2.5	1.1 ± 1.6	1.6 ± 2.1	11.2 ± 5.1
U15	5	87	13.9 ± 6.8	0.2 ± 0.5	1.1 ± 1.7	0.9 ± 1.3	1.5 ± 2.0	10.4 ± 5.4
U16	10	73	14.3 ± 9.5	0.4 ± 0.6	1.5 ± 2.4	1.1 ± 1.1	1.3 ± 2.1	9.2 ± 5.2
U17	10	45	15.2 ± 6.8	0.2 ± 0.4	1.7 ± 2.6	0.6 ± 0.7	1.7 ± 2.2	10.2 ± 5.0
U18	10	46	14.5 ± 8.1	0.3 ± 0.6	2.4 ± 3.0	1.1 ± 1.4	1.4 ± 1.4	9.1 ± 5.3

Note. Data are presented as mean ± SD.

Table 2. Multilevel Poisson models for the development of match skills per hour of match-play

Parameter	Successful Passes Estimate (SE)	On-target Shots Estimate (SE)	Dribbles Estimate (SE)	Crosses Estimate (SE)	Clearances Estimate (SE)	[a]Tackles, blocks, interceptions Estimate (SE)
Fixed Effects						
Intercept	2.595 (0.057)	-2.066 (0.328)	-1.115 (0.236)	-2.182 (0.337)	1.390 (0.058)	2.485 (0.075)
Age	0.064 (0.029)	-0.146 (0.053)	0.136 (0.047)	-0.089 (0.042)	-	-0.104 (0.014)
Age^2	-	-	-	0.044 (0.022)	-	0.016 (0.007)
Playing Status	-	-	0.709 (0.172)	-	-	0.211 (0.091)
Maturity Status	-	-	-	-	-	0.194 (0.067)
FB	-0.003 (0.072)	-0.899 (0.612)	0.589 (0.251)	2.099 (0.351)	-0.804 (0.104)	-0.172 (0.089)
CM	0.119(0.074)	1.199 (0.376)	0.584 (0.261)	1.253 (0.380)	-1.550 (0.139)	0.031 (0.095)
WM	-0.231 (0.077)	1.201 (0.375)	1.179 (0.244)	2.834 (0.345)	-1.584 (0.140)	-0.296 (0.099)
CF	-0.195 (0.080)	1.938 (0.355)	1.400 (0.252)	2.147 (0.362)	-2.448 (0.223)	-0.657 (0.124)
Multi	0.001(0.083)	1.288 (0.394)	0.499 (0.286)	1.824 (0.373)	-1.465 (0.170)	-0.386 (0.116)
Age x FB	0.015 (0.036)	-	-	-	-	-
Age x CM	-0.050 (0.040)	-	-	-	-	-
Age x WM	-0.112 (0.042)	-	-	-	-	-
Age x CF	-0.188 (0.047)	-	-	-	-	-
Age x Multi	-0.085(0.046)	-	-	-	-	-
Retained x FB	-	-	-	-	-	-0.036 (0.124)
Retained x CM	-	-	-	-	-	-0.233 (0.127)
Retained x WM	-	-	-	-	-	-0.282 (0.134)
Retained x CF	-	-	-	-	-	-0.282 (0.157)
Retained x Multi	-	-	-	-	-	0.065 (0.144)
Random Effects						
Between-player variance	0.071 (0.013)	-	0.416 (0.099)	0.162 (0.063)	-	0.025 (0.007)

Note. All estimates are on the logarithmic scale. Data are normalised to one hour of match play. Age is centred at 15 y. FB=full back, CB=centre back, CM=centre midfielder, WM=wide midfielder, CF= centre forward, Multi= multi-positional. CB is the reference category for playing position. Released is the reference category for playing status. On-time maturity status is the reference category for maturity status. [a] 388 player-matches analysed due to missing maturity status data.

List of figures

Figure 1. Predicted development of the frequency of successful passes, on-target shots, and crosses per hour of match-play in elite youth footballers aged 11-18 years, for different playing positions. Left-hand panels show separate prediction lines for centre backs (CB), full backs (FB), and centre midfielders (CM). Right-hand panels show separate prediction lines for wide midfielders (WM), centre forwards (CF), and multi-positional players (Multi).

Figure 2. Predicted development of the frequency of dribbles per hour of match-play elite youth footballers aged 11-18 years, for (a) centre backs (CB), (b) full backs (FB), (c) centre midfielders (CM), (d) wide midfielders (WM), (e) centre forwards (CF), and (f) multi-positional players (Multi). Separate prediction lines for retained players and released players are shown within each playing position.

Figure 3. Predicted development of the frequency of tackles, blocks, and interceptions per hour of match-play in elite youth footballers aged 11-18 years, for (a) centre backs (CB), (b) full backs (FB), (c) centre midfielders (CM), (d) wide midfielders (WM), (e) centre forwards (CF), and (f) multi-positional players (Multi). Separate prediction lines for early maturing retained players, on-time maturing retained players, early maturing released players, and on-time maturing released players are shown within each playing position.