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Development of dribbling in talented youth soccer players aged 12–19 years: A longitudinal study

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Abstract

The aims of the current study were to assess the development and determine the underlying mechanisms of sprinting and dribbling needed to compete at the highest level in youth soccer. Talented soccer players aged 12–19 years ($n = 267$) were measured on a yearly basis in a longitudinal study over 7 years, resulting in 519 measurements. Two field tests, the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test, were assessed. Anthropometric characteristics, years of soccer experience, and duration of practice were recorded. The longitudinal data were analysed with multi-level modelling. Comparing the two tests at baseline, low correlations were observed (sprinting: $r = 0.49$; dribbling: $r = 0.22$), indicating that each test measures distinct qualities (acceleration vs. agility). Low-to-moderate correlations were found between dribbling and sprinting within each test (Shuttle Sprint and Dribble Test: $r = 0.54$; Slalom Sprint and Dribble Test: $r = 0.38$). Both dribbling and sprinting improved with age, especially from ages 12 to 14, but the tempo of development was different. From ages 14 to 16, sprinting improved rapidly in contrast to dribbling; this was especially evident on the Slalom Sprint and Dribble Test. In contrast, after age 16 dribbling improved considerably but sprinting hardly improved. Besides age, the factors that contribute to dribbling performance are lean body mass, hours of practice, and playing position.

Keywords: *Technical skill, expert athletes, speed, performance level, playing position*

Introduction

Comprehensive physiological, psychological, and tactical qualities are needed to become a professional soccer player (Bangsbo, 1994; Reilly, Williams, Nevill, & Franks, 2000b; Williams & Reilly, 2000). Another prerequisite for young soccer players to progress is that they possess a certain level of technical skills. Currently, there is no generally accepted standard test to measure technical qualities (Jaric, Ugarkovic, & Kukolj, 2001; Kukolj, Ugarkovic, & Jaric, 2003; Reilly et al., 2000b), thus it is unclear what level of technical skills is required to be among the best adolescent players. The principal technical skills are shooting, passing, ball control, and dribbling (Reilly & Holmes, 1983). Dribbling speed is considered critical to the outcome of the game, with elite soccer players performing 150–250 brief intense actions during a game (Mohr, Krustrup, & Bangsbo, 2003). Therefore, the ability to sprint and dribble at high speed is essential for performance in soccer. Previous research has indicated that the better players distinguish themselves by their running speed while dribbling the ball (Malina et al., 2005; Reilly et al., 2000b; Vaeyens et al., 2006).

Dribbling in soccer can be categorized into dribble actions while accelerating and dribble actions with quick changes of direction. Acceleration is of great importance, as soccer players only cover short distances (mean distance 10–20 m) at maximal effort (Cometti, Maffiuletti, Pousson, Chatard, & Maffulli, 2001; Reilly, Bangsbo, & Franks, 2000a; Spinks, Murphy, Spinks, & Lockie, 2007). Furthermore, many actions in soccer involve repeated short sprinting or dribbling with changes of direction (Bloomfield, 2007; Little & Williams, 2005; Sheppard & Young, 2006). This ability to change direction rapidly is called "agility". Acceleration and agility while sprinting have been identified as independent qualities (Little & Williams, 2005; Young, McDowell, & Scarlett, 2001). It is not yet clear whether dribbling while accelerating and

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dribbling while performing an agility task measure different components of the technical skill of dribbling, and what the exact relationship is between sprinting and dribbling over the same course. In the current study, therefore, we examined sprinting and dribbling in two soccer-specific field tests: the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test (Lemmink, Elferink-Gemser, & Visscher, 2004). The Shuttle Sprint and Dribble Test measures acceleration; sprinting and dribbling over short distances with quick changes of direction. The Slalom Sprint and Dribble Test measures slalom sprint and dribble performance, relevant for deceiving opponents. The Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test comprise several change-of-direction tasks (180° vs. 53.2°), both over 30 m.

Normative data for talented young soccer players can provide insight into the sport-specific skills necessary to be among the best national players in each age group. Although several researchers recommend applying a longitudinal design for profiling the development of sport-specific skills in talented players (Nieuwenhuis, Spamer, & van Rossum, 2002; Reilly et al., 2000b; Williams & Reilly, 2000), such research is scarce. A longitudinal design can determine the key changes in the sport-specific skill of dribbling that occur as a result of development and practice (Williams & Reilly, 2000).

Previous research has assessed the role of each playing position (Di Salvo et al., 2007; Mohr et al., 2003; Rienzi, Drust, Reilly, Carter, & Martin, 2000). One study (Mohr et al., 2003) reported that attackers and full-backs sprinted more than midfielders and defenders in professional soccer. Research on elite young Brazilian soccer players found that the fewest sprints were made by full-backs and the most sprints by attackers; also, attackers and offensive midfielders sprinted more with the ball than players from other positions (Pereira, Kirkendall, & Barros, 2007). Other research on young non-elite soccer players found that forwards were the fastest players in the 30-m straight and agility sprint, followed by midfielders (Gil, Gil, Ruiz, Irazusta, & Irazusta, 2007a). These results indicate that attackers are the best sprinters, although limited information is available regarding which position shows the best dribbling performance.

Longitudinal modelling can indicate which factors contribute to the development of dribbling performance in soccer. Previous cross-sectional research on talented youth soccer players has reported improvements on dribbling and sprinting tests with age (Gil, Ruiz, Irazusta, Gil, & Irazusta, 2007b; Kukolj et al., 2003; Rosch et al., 2000; Vanderford, Meyers, Skelly, Stewart, & Hamilton, 2004). It has also been shown that practice is a major feature for the development of soccer skills (Ericsson, Krampe, & Teschromer, 1993; Helsen, Hodges, Van Winckel, & Starkes, 2000; Helsen, Starkes, & Hodges, N. J., 1998). Previous research also showed height to be a significant factor for running speed in a group of talented soccer players (Malina, Eisenmann, Cumming, Ribeiro, & Aroso, 2004). Another contributor to performance in sports is lean body mass, which is related to body muscle percentage and body fat percentage. Various test batteries have revealed that athletes who perform better on change-of-direction sprint tests, also over short distances, tend to have a lower percent body fat (Gabbett, 2002; Meir, Newton, Curtis, Fardell, & Butler, 2001; Negrete & Brophy, 2000; Reilly et al., 2000a). As the hypothesis is that sprinting and dribbling (speed) are correlated to some extent, the variables that influence sprinting might also influence dribbling in talented youth soccer players.

The overall purpose of the current study was to gain more insight into the development and underlying mechanisms of an essential technical skill (i.e. dribbling) that is needed to compete at the highest level in youth soccer, and subsequently to be part of a select group following a developmental soccer programme. The first step towards accomplishing this goal was to establish the possible link between sprinting and dribbling as well as the possible connection between the two tests. Our hypothesis is that sprinting and dribbling on the same course are partly related, although the skill of dribbling is more complex than that of sprinting – therefore, the fastest sprinters are not expected always to be the fastest on the dribble. The second aim of this study was to investigate the development of sprinting and dribbling among talented youth soccer players aged 12–19 years. We believe that both sprinting and dribbling improve over the years and hypothesize that the greatest improvements will occur at younger ages. The third aim was to determine whether dribbling performance can be predicted by age, height, lean body mass, cumulative years of soccer experience, soccer practice, additional practice per week, and playing position. Earlier studies indicated that all these factors help to predict sprinting performance; we hypothesized that sprinting and dribbling are related, thus it is expected that the above factors can also predict dribbling performance.

Methods

Participants

Talented youth soccer players from two talent development programmes of premier league soccer clubs (i.e. soccer schools in the Netherlands) participated in this longitudinal study. From 2001 to 2008 measurements were taken annually, with the exception of 2004, resulting in seven measurement occasions. Only data for players who started at the soccer schools between 2001 and 2006 were used in the study. This resulted in 519 measurements with a total of 267 players. The players competed at the highest level, and represented the best 0.5% of soccer players in their age group (National Soccer Association, KNVB). Each year all measurements were taken during the competitive season; this resulted in well-trained players who followed a programme of intensive practice at their soccer school. Table I shows the number of players and number of measurements per age category.

Since goalkeepers' technical skills differ significantly from those of outfield players, data from goalkeepers was excluded from the current analysis. The outfield players were classified as defenders (central and external / full-backs and wing defenders), midfielders (central and external), and attackers (forwards). As there were overlaps in ages, it was possible to estimate a consecutive 8-year development pattern for ages 12–19 years. The age of the participants was recorded in months at the time of measurement to create standardized age groups. A 14-year-old player was defined as a player tested within the age range 13.50–14.49 years.

Procedures

All players were informed of the procedures of the study before providing their verbal consent to participate. The clubs and trainers gave permission for this study to go ahead, and the procedures were in accordance with the ethical standards of the Medical Faculty of the University of Groningen. The players completed the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test on an artificial grass soccer field at the same location on each measurement occasion. The measurements took place at the end of the competitive season, which varied from March to May. Ambient temperature, humidity, and wind conditions were documented; we did our best to match conditions across measurement occasions. Height, weight, and percentage body fat were measured. The latter was estimated by means of leg-to-leg bioelectrical impedance (BIA) analysis (Valhalla BIA, Valhalla, Inc., San Diego, CA) (Nunez et al., 1997). Lean body mass was calculated by subtracting the percentage of body fat from the total weight of the players. Date of birth, playing position, cumulative years of soccer experience, hours of soccer and additional practice were also recorded.

Table I. Number of players and number of measurements per age category.

		Number of measurements					
Age category	Age (mean ± *s*)	1	2	3	4	5	Total
12	12.03 ± 0.31	6	10	8	0	0	24
13	12.98 ± 0.26	2	23	17	4	1	47
14	13.98 ± 0.27	17	40	23	8	1	89
15	14.96 ± 0.27	22	37	32	8	0	99
16	16.01 ± 0.27	12	32	33	6	1	84
17	17.01 ± 0.27	12	38	28	5	1	84
18	17.96 ± 0.30	16	25	17	5	0	63
19	18.80 ± 0.30	6	11	7	4	1	29
Total measurements		93	216	165	40	5	519
Number of players		93	108	55	10	1	267

Shuttle Sprint and Dribble Test

The protocol for this test consisted of three maximal sprints of 30 m and three maximal sprints of 30 m while dribbling a soccer ball (Lemmink et al., 2004). Each 30-m sprint has three 180° turns (Figure 1). Sprints were measured by means of photocell gates (Eraton BV, Weert, Netherlands) placed 1.05 m above the ground (approximately at hip height). Shuttle sprint and dribble times were indicated by the time covered in the fastest of three sprints.

Slalom Sprint and Dribble Test

The protocol for this test consisted of a maximal slalom sprint and a maximal slalom sprint while dribbling a soccer ball (Lemmink et al., 2004). Twelve cones were placed in a zigzag pattern, and the participant had to slalom the 30-m course as fast as possible (Figure 2). Sprints were timed using a stopwatch.

Since both the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test were primarily developed for field hockey players (Lemmink et al., 2004), the psychometrics of these tests was

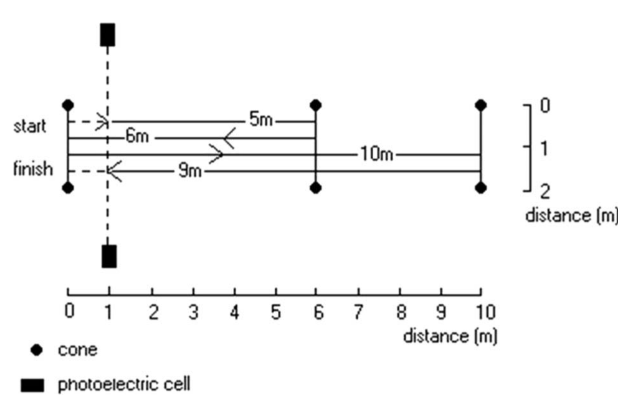

Figure 1. Course for the Shuttle Sprint and Dribble Test.

assessed for soccer players. The reliability of the Shuttle Sprint and Dribble Test was assessed during pilot testing of 19 youth soccer players aged 12–19 years (mean 15.4 years, $s = 1.9$), and the reliability of the Slalom Sprint and Dribble Test was tested in 18 players aged 12–19 years (mean 15.6 years, $s = 1.8$). Players were tested twice with 2 days between the first and second measurement. The results showed good relative as well as absolute test–retest reliability. The intra-class correlation (ICC) for the Shuttle sprint was 0.81 and absolute reliability 0.20 (95% CI: –0.12 to 0.52). For the Shuttle dribble, reliability (ICC) was 0.74 and absolute reliability –0.02 (95% CI: –0.37 to 0.34). For the Slalom sprint, the ICC was 0.79 and absolute reliability was 0.20 (95% CI: −0.02 to 0.42). Finally, for the Slalom dribble, the ICC was 0.71 and absolute reliability –0.26 (95% CI: –1.85 to 1.33).

Statistical analysis

Mean scores and standard deviations were calculated for the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test for each age group and playing position as well as for possible factors influencing technical performance on the tests

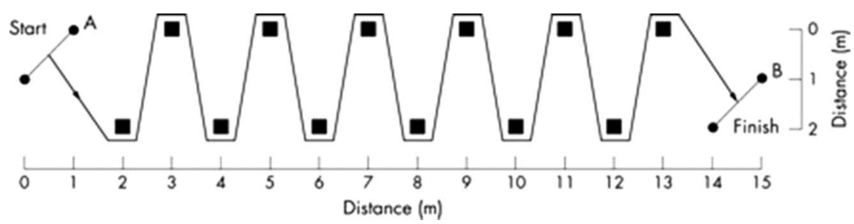

Figure 2. Course for the Slalom Sprint and Dribble Test.

Table II. Mean scores ($\pm s$) of talented soccer players on the Shuttle Sprint and Dribble Test and Slalom Sprint and Dribble Test, by age and playing position.

Age (years)		*n*	Shuttle sprint (s)	Shuttle dribble (s)	Slalom sprint (s)	Slalom dribble (s)
12	Defenders	5	8.56 ± 0.52	10.57 ± 0.48	15.10 ± 0.31	22.56 ± 1.42
	Midfielders	10	8.83 ± 0.34	10.33 ± 0.50	15.25 ± 1.14	23.64 ± 3.23
	Attackers	9	8.59 ± 0.27	10.38 ± 0.80	15.15 ± 0.58	22.49 ± 1.20
	Total	24	8.69 ± 0.37	10.40 ± 0.60	15.18 ± 0.80	22.98 ± 2.29
13	Defenders	17	8.53 ± 0.39	10.15 ± 0.41	14.73 ± 0.65	22.56 ± 1.92
	Midfielders	18	8.49 ± 0.29	10.00 ± 0.56	14.64 ± 0.65	21.22 ± 1.38
	Attackers	12	8.39 ± 0.31	9.88 ± 0.54	14.66 ± 0.82	22.18 ± 2.60
	Total	47	8.48 ± 0.33	10.03 ± 0.51	14.67 ± 0.68	21.84 ± 1.96
14	Defenders	32	8.39 ± 0.32	10.13 ± 0.52	14.41 ± 0.74	21.74 ± 1.46
	Midfielders	32	8.41 ± 0.38	9.83 ± 0.52	14.12 ± 0.64	21.19 ± 1.70
	Attackers	25	8.47 ± 0.36	10.13 ± 0.83	14.47 ± 0.91	21.67 ± 1.71
	Total	89	8.42 ± 0.35	10.02 ± 0.64	14.32 ± 0.77	21.52 ± 1.62
15	Defenders	34	8.20 ± 0.28	9.91 ± 0.46	14.18 ± 0.78	21.44 ± 1.74
	Midfielders	32	8.34 ± 0.33	9.83 ± 0.45	14.03 ± 0.74	20.91 ± 1.46
	Attackers	33	8.27 ± 0.36	9.80 ± 0.52	14.20 ± 0.73	21.84 ± 2.10
	Total	99	8.27 ± 0.32	9.85 ± 0.48	14.14 ± 0.75	21.40 ± 1.81
16	Defenders	32	8.09 ± 0.40	9.75 ± 0.54	14.14 ± 0.92	22.26 ± 2.19
	Midfielders	26	8.06 ± 0.42	9.62 ± 0.48	13.66 ± 0.82	20.46 ± 1.5
	Attackers	26	8.10 ± 0.30	9.53 ± 0.58	13.96 ± 0.83	21.42 ± 1.69
	Total	84	8.08 ± 0.37	9.64 ± 0.54	13.94 ± 0.87	21.44 ± 1.98
17	Defenders	31	7.97 ± 0.29	9.44 ± 0.35	13.78 ± 0.70	21.43 ± 1.79
	Midfielders	31	8.12 ± 0.31	9.52 ± 0.49	13.91 ± 0.69	20.28 ± 1.53
	Attackers	22	7.97 ± 0.29	9.53 ± 0.45	13.91 ± 0.96	20.70 ± 1.66
	Total	84	8.03 ± 0.30	9.49 ± 0.43	13.86 ± 0.76	20.81 ± 1.72
18	Defenders	23	8.00 ± 0.29	9.40 ± 0.56	13.79 ± 0.69	21.35 ± 1.85
	Midfielders	24	8.02 ± 0.21	9.46 ± 0.43	13.70 ± 0.82	20.11 ± 1.50
	Attackers	16	8.00 ± 0.27	9.49 ± 0.42	13.92 ± 0.68	20.87 ± 1.53
	Total	63	8.01 ± 0.26	9.45 ± 0.47	13.79 ± 0.73	20.76 ± 1.71
19	Defenders	6	7.97 ± 0.19	9.51 ± 0.41	13.10 ± 0.56	20.67 ± 1.63
	Midfielders	11	8.08 ± 0.29	9.48 ± 0.36	13.47 ± 0.52	20.11 ± 1.31
	Attackers	12	7.99 ± 0.31	9.53 ± 0.47	13.96 ± 1.18	20.79 ± 2.46
	Total	29	8.02 ± 0.28	9.51 ± 0.41	13.59 ± 0.90	20.51 ± 1.86

(height, lean body mass, cumulative years of soccer experience, soccer practice per week, and additional practice per week). On the players' first measurement, links between performances on the Shuttle Sprint and Dribble Test and Slalom Sprint and Dribble Test, and between sprinting and dribbling within one test, were established using Pearson's correlation coefficient (*r*).

Longitudinal changes in Shuttle Sprint and Dribble Test and Slalom Sprint and Dribble Test performance were investigated with multi-level models using the linear mixed-model procedure in SPSS version 14.0 (SPSS, Inc., 2005). Multi-level models can handle data that are not independent, as is the case in a longitudinal design. The advantage of multi-level models is that the number of measurements and the temporal spacing of measurements may vary between players, assuming that the missing data are random (Landau & Everitt, 2004; Peugh & Enders, 2005; SPSS, Inc., 2005). The first step in the multi-level analysis was to create prediction models of the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test that included age as an independent factor.

By means of the multi-level analyses, we were able to determine whether the performance changes across age groups significantly differ from each other. The second step created a multi-level model in which Level 1 was the repeated measures within individual players and Level 2 the differences between individual players. Possible predictors for the multi-level model are age, age^2, height (m), lean body mass (kg), cumulative years of soccer experience, soccer practice per week (hours), additional practice per week (hours), and playing position. Both age and age^2 were entered in the model to find the best model fit. The hypothesis was that dribbling performance increases most rapidly at a younger age. At older ages, the improvement per year is expected to be less marked, thus age^2 was also entered in the model, to indicate if the best model fit is linear or a quadratic curve.

The changes over time in the Shuttle Sprint and Dribble Test and Slalom Sprint and Dribble Test were modelled. Random intercepts and random slopes were considered, allowing a unique intercept for each individual player and properly accounting for correlations among repeated measures within individual players (Peugh & Enders, 2005) The model fit was evaluated by comparing Akaike's information criterion (deviance) of the empty model, the model without predicting variables, with the final model. An alpha of 0.05 was adopted for all tests of significance.

Results

Table II shows the players' performances on the Shuttle Sprint and Dribble Test and Slalom Sprint and Dribble Test by position and age group. Soccer players improved sprinting and dribbling performance with age. The descriptive results presented by age are illustrated in Table III. Height, lean body mass, and hours of soccer practice per week increased with age.

The correlations between the two field tests and between sprinting and dribbling within each test are shown in Table IV. According to the guidelines for correlations (Hinkle, Wiersma, & Jurs, 1979), the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test were weakly correlated, although the correlation for sprinting was stronger than that for dribbling. A moderate correlation between sprinting and dribbling was observed for the Shuttle Sprint and Dribble Test. The Slalom Sprint and Dribble Test showed a weak correlation between sprinting and dribbling.

Output estimates for the prediction models of the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test that included age as an independent factor (Level 1) are presented in Figures 3 and 4. Both tests show an improvement in sprinting and dribbling from ages 12 to 19 ($P < 0.001$).

Output estimates for the prediction models of the Shuttle dribble and Slalom dribble are displayed in Tables V and VI. The deviance shows that the model with the Level 1 parameters – age (as a continuous

Table III. Mean scores ($\pm s$) of talented soccer players for anthropometric variables, soccer experience, and practice hours, by age.

Age (years)	*n*	Height (m)	*n*	Weight (kg)	*n*	Body fat (%)	*n*	Lean body mass (kg)	*n*	Soccer experience (years)	*n*	Soccer practice per week (h)	*n*	Additional practice per week (h)
12	24	1.50 ± 0.08	24	38.55 ± 7.44	24	8.66 ± 3.16	24	35.09 ± 5.94	23	5.96 ± 1.20	24	5.75 ± 0.53	24	2.79 ± 2.98
13	43	1.58 ± 0.09	43	46.32 ± 9.60	43	8.09 ± 2.33	43	42.48 ± 8.44	45	7.14 ± 1.09	45	6.01 ± 0.81	44	3.20 ± 2.95
14	83	1.64 ± 0.08	82	50.73 ± 9.59	83	8.87 ± 4.46	81	46.82 ± 7.16	84	7.55 ± 1.56	84	6.32 ± 0.88	83	3.08 ± 2.74
15	95	1.71 ± 0.07	95	59.24 ± 7.90	94	8.72 ± 2.89	94	53.98 ± 7.02	94	7.99 ± 1.98	91	6.61 ± 1.02	89	2.79 ± 2.78
16	82	1.75 ± 0.07	82	65.21 ± 7.01	82	9.59 ± 3.51	82	58.91 ± 6.33	82	9.20 ± 1.77	80	7.67 ± 1.37	79	2.89 ± 3.29
17	83	1.76 ± 0.07	83	67.77 ± 7.62	83	8.42 ± 2.84	83	61.98 ± 6.56	76	9.92 ± 2.06	75	7.72 ± 1.38	74	1.96 ± 1.80
18	60	1.78 ± 0.07	60	71.37 ± 6.86	60	7.43 ± 2.90	60	66.00 ± 6.01	57	11.50 ± 1.61	56	8.53 ± 2.13	57	2.03 ± 2.26
19	28	1.78 ± 0.05	28	73.14 ± 6.85	28	9.19 ± 2.47	28	66.35 ± 5.62	25	12.10 ± 1.58	20	8.68 ± 2.68	19	3.13 ± 4.89

Table IV. Relationships between performances on the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test.

Relationship assessed	Pearson correlation (r)	P
Shuttle sprint and Slalom sprint	0.491	<0.001
Shuttle dribble and Slalom dribble	0.223	<0.001
Shuttle sprint and Shuttle dribble	0.542	<0.001
Slalom sprint and Slalom dribble	0.381	<0.001

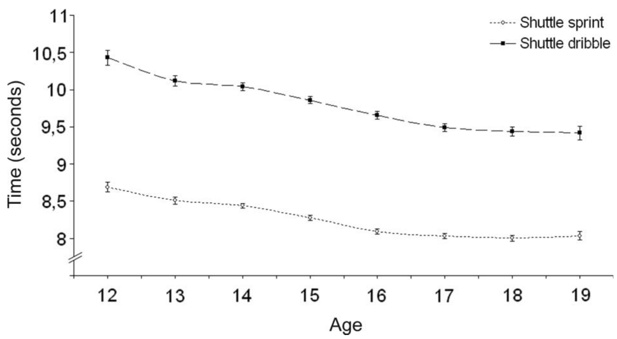

Figure 3. Estimated scores ($\pm$ 1 standard error) for the development of dribbling on the Shuttle Sprint and Dribble Test in talented soccer players. Significant differences, Shuttle sprint ($P < 0.05$): age 12 vs. ages 14–19, age 13 vs. ages 15–19, age 14 vs. ages 15–19, age 15 vs. ages 16–19. Significant differences, Shuttle dribble ($P < 0.05$): age 12 vs. ages 14–19, age 13 vs. ages 15–19, age 14 vs. ages 16–19, age 15 vs. ages 17–19.

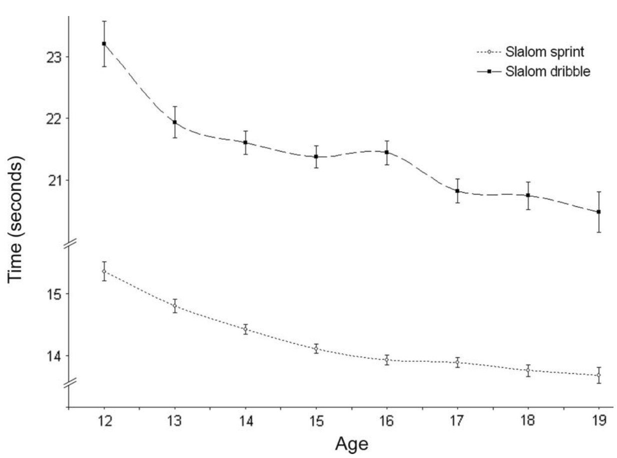

Figure 4. Estimated scores ($\pm$ 1 standard error) on the development of dribbling on the Slalom Sprint and Dribble Test in talented soccer players. Significant differences, Slalom sprint ($P < 0.05$): age 12 vs. ages 13–19, age 13 vs. ages 15–19, age 14 vs. ages 15–19. Significant differences, Slalom dribble ($P < 0.05$): age 12 vs. ages 14–19, age 13 vs. ages 17–19.

variable), lean body mass, and hours of total practice per week (soccer and additional hours) – significantly improves the model for Shuttle dribble ($P < 0.05$). The other Level 1 parameters (height and cumulative years of soccer experience) and the Level 2 parameter (playing position) do not create a stronger

Table V. Multi-level model for the Shuttle Dribble Test.

Fixed effects	Coefficient	Standard error	P
Intercept (constant)	11.99	0.23	<0.001
Age	-0.10	0.02	<0.001
Lean body mass	-0.01	0.00	<0.001
Total hours of practice per week	-0.02	0.01	0.030
Deviance	654.5		
Deviance, only age as factor	753.6		
Deviance from empty model	873.0		

model ($P > 0.05$). The best model for Shuttle dribble is expressed by the following equation: dribble performance on Shuttle dribble (in seconds) = 11.99 – 0.10 × age – 0.01 × lean body mass – 0.02 × hours of total practice per week. Hence the development of dribbling as measured with the Shuttle Sprint and Dribble Test can be predicted with the multi-level model. For instance, it is predicted that talented boys will improve 0.10 s every year independently of their training hours and increase in lean body mass. Total training hours accounts for 0.02 s per hour, for example boys who practise 10 h will improve another 0.20 s a year according to the multi-level model.

For the Slalom dribble, the Level 1 parameters of age (as a continuous variable) and hours of soccer practice per week create a significantly stronger model ($P < 0.05$). The Level 2 parameter, playing position, also improved the model significantly ($P < 0.05$). Midfielders' performance was significantly faster than that of attackers and defenders. The best model for defenders on the Slalom dribble is expressed by the following equation: dribble performance on Slalom dribble (in seconds) = 25.85 – 0.19 × age – 0.16 × hours soccer practice per week. For midfielders, the strongest model is the same model as for the defenders minus 0.80 s. The attackers' best predicted model is the defenders' model minus 0.22 s. The development of dribbling as measured with the Slalom Sprint and Dribble Test can also be predicted with the multi-level model. For instance, it is predicted that talented boys will improve 0.19 s each year independently of their training hours and improve 0.16 s per hour of soccer practice. This indicates that soccer practice accounts for a great proportion of the development of the improved Slalom dribble, taking into account the multiple hours of soccer practice a player experiences per week (Table IV).

Discussion

The results of this longitudinal study highlight the development of sprinting and dribbling in talented

Table VI. Multi-level model for the Slalom Dribble Test.

Fixed effects	Coefficient	Standard error	P
Intercept (constant)	25.85	0.73	<0.001
Age	−0.19	0.06	0.001
Hours soccer practice per week	−0.16	0.06	0.012
Defender	0	0	
Midfielder	−0.80	0.21	<0.001
Attacker	−0.22	0.21	0.304
Deviance	1914.4		
Deviance, only age as factor	2096.4		
Deviance from empty model	2130.3		

soccer players aged 12–19 years, as measured by two separate tests, the Shuttle Sprint and Dribble Test and Slalom Sprint and Dribble Test. We first examined the correlations between the two tests and the correlations within each test (i.e. between dribbling and sprinting). A low-to-moderate correlation (sprinting: $r = 0.49$; dribbling: $r = 0.22$) was found between the two tests, indicating that they are related, but also measure dissimilar qualities for sprinting and dribbling. The correlation between dribbling and sprinting showed low-to-moderate relationships (Shuttle Sprint and Dribble Test: $r = 0.54$; Slalom Sprint and Dribble Test: $r = 0.38$), indicating that high-speed players are not necessarily the best dribblers. We then examined the development of sprinting and dribbling in talented youth soccer players aged 12–19 years. The results showed improved development of sprinting and dribbling over the years, most marked from ages 12 to 14. However, the speed of development on the Slalom Sprint and Dribble Test is different for dribbling and sprinting: unlike dribbling, sprinting improves rapidly from ages 14 to 16. By contrast, after age 16 dribbling improves considerably but sprinting improves little. Finally, we examined factors predicting dribble performance. The factors that were found to contribute to dribble performance were advanced age, lean body mass, hours of practice, and playing position.

The first part of the study showed low-to-moderate correlations between the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test, illustrating that the two tests are correlated but measure distinct qualities. The Shuttle Sprint and Dribble Test measures primarily the acceleration of soccer players, because the players have to turn 180° three times, accelerating each time from zero velocity (Draper & Lancaster, 1985). The Slalom Sprint and Dribble Test measures the more soccer-specific action of deceiving an opponent by sprinting or dribbling with quick changes of direction (Reilly, 2005). Previous studies have reported low-to-moderate correlations between straight sprint tests and various changes-of-direction tests. A correlation of 0.47 has been reported for straight sprint compared with the Illinois agility test (Draper & Lancaster, 1985), and a correlation of 0.55 between the T-test and 40-yard straight sprint (Pauole, Madole, Garhammer, Lacourse, & Rozenek, 2000). These results are in line with the moderate correlation of the Shuttle sprint and the Slalom sprint ($r = 0.49$) in the present study. However, the correlations for dribbling are lower ($r = 0.22$) than for sprinting, indicating that the dribbling tasks are more distinct from each other, needing distinct technical skills for each test. In addition, within each separate test we assessed whether the best sprinters were also the technically most gifted players. The Shuttle Sprint and Dribble Test showed a moderate relationship between sprinting and dribbling ($r = 0.54$), indicating that some quick sprinters also showed good dribbling performance. The correlation on the Slalom Sprint and Dribble Test was low ($r = 0.38$), indicating that high-speed players are not necessarily the best dribblers. The Slalom Sprint and Dribble Test has a total of 12 relatively sharp changes of direction, compared with only three changes of direction in the Shuttle Sprint and Dribble Test. Execution of the multiple changes of direction while dribbling is more challenging than dribbling with only three changes of direction, and requires players to adopt a more sideways leaning posture to successfully change direction at high speed (Young et al., 2001).

The second part of the current study illustrated, by using the age model, the improvement in sprinting and dribbling from ages 12 to 19. This improvement is expected because high-intensity activities during match-play also increase with age for young players (Pereira et al., 2007). The changes for sprinting and dribbling were different, although both improved most rapidly at a younger age (12–14 years). The total percentage of predicted improvement for the Shuttle Sprint and Dribble Test from ages 12 to 19 was 7.5% on sprinting ($P < 0.001$) and 9.7% on dribbling ($P < 0.001$). The total percentage of predicted improvement for the Slalom Sprint and Dribble Test from ages 12 to 19 was 11.0% on sprinting ($P < 0.001$) and 11.8% on dribbling ($P < 0.001$). After age 14, players do not necessarily improve their dribbling in relation to their sprinting. Furthermore, quicker dribbling does not automatically indicate that sprinting speed is improved to the same extent. For example, from ages 14 to 16 the estimated progression of dribbling on the Slalom Sprint and Dribble Test (0.16 s) was small (0.7% improvement), whereas sprinting is estimated to improve (0.50 s) significantly (3.3% improvement). Peak height velocity, the maximum velocity in growth during adolescence, occurs in European boy soccer players around age 14 on average (Malina et al., 2004). This indicates that players improve their speed during and just after peak height but their technical skill on the Slalom Dribble test hardly improves. This phenomenon of temporary decline in performance or disruption of motor coordination is called "adolescent awkwardness" (Butterfield, Lehnhard, Lee, & Coladarci, 2004). The process of maturation does not occur at the same chronological age for all talented soccer players, possibly influencing the performance of individual players, since advanced biological maturity status is associated with slightly better technical performance (Malina et al., 2005). Comparable results were found in Olympic youth soccer athletes. Sprint performance on the T-test (sprinting with changes of direction) significantly improved from age 14 to age 15, but performance on a soccer skill test (including dribbling) did not improve significantly (Vanderford et al., 2004). In addition, the present study illustrated hardly any improvement from ages 16 to 19 on the Shuttle and Slalom Sprint (0.06 s and 0.25 s respectively), in contrast to the Shuttle and Slalom Dribble, which improved 0.24 s and 0.96 s. This demonstrates that no marked improvements in sprinting occurred after age 16, whereas a trend was seen for improvements in the technical skill of dribbling. The trend showed that the largest improvements in dribbling occurred at ages 16–17 in both tests. However, the Shuttle dribble and the Slalom dribble showed no significant improvement from ages 16 to 19, due to a large variation between the players.

The final part of the study investigated whether the development of dribbling can be predicted by a combination of factors. The results showed that age, lean body mass, and hours of total practice per week all contribute to Shuttle dribble performance. Significant contributors of the Slalom dribble were age, hours of soccer practice per week, and playing position. Although our results are in line with expectations, limited data are available on the development of talented youth soccer players. Several studies have reported that time spent in practice is a strong discriminator across levels of skill, with elite youth players spending much more time practising than sub-elite players (Helsen et al., 1998; Ward, Hodges, Williams, & Starkes, 2008). This is similar to the results of the current study, because dribble performance was found to increase with hours of practice. The current study illustrates that lean body mass can determine performance on the Shuttle dribble. Various test batteries have also revealed that athletes who perform better on change-of-direction sprinting tests tend to have a lower percent body fat (Gabbett, 2002; Meir et al., 2001; Reilly et al., 2000a), and therefore more lean body mass to contribute to speed. Hardly any information exists on dribble performance for various playing positions. However, match analyses of professional players show a trend for midfielders to dribble more than attackers, with defenders dribbling the ball least (Bloomfield, 2007). Previous research on elite young soccer players has also shown that attackers and offensive midfielders sprint more with the ball than players from other positions (Pereira et al., 2007). These match analyses results complement Slalom dribble performance in the present study, whereby midfielders performed the best, followed by attackers and defenders.

On the basis of the results obtained, a distinction can be made between the two tests: the Slalom dribble is a more soccer-specific test. Slalom dribble performance can only be predicted by soccer-specific practice, whereas the Shuttle dribble can also be affected by additional practice. Furthermore, Slalom dribble performance depends on playing position, whereas no significant differences for playing position were found for Shuttle dribble performance. Another difference between these tests is lean body mass, which positively predicts Shuttle dribble performance but not Slalom dribble performance. One could hypothesize that the Slalom dribble is more a test of coordination than the Shuttle dribble test. Previous research showed that greater lean body mass means more muscle mass, and most likely more strength, which has an influence on change-of-direction speed over short distances (Negrete & Brophy, 2000). This is in agreement with the current finding for the Shuttle dribble test, whereas Slalom dribble performance appeared to be affected by other factors.

One of the strengths of the current study is its use of a longitudinal design. Because of their surplus value, longitudinal designs are recommended in which players are monitored over a prolonged period of time (Nieuwenhuis et al., 2002; Reilly et al., 2000b; Williams & Reilly, 2000). Instead of comparing age groups in a cross-sectional fashion, the current study assessed the development of individual players, thus improving our understanding of the factors that contribute to performance development. The factor that influences dribbling performance most is more hours of practice per week, and in addition for the Shuttle dribble additional lean body mass. The multi-level models make it possible to compare the development of a talented young soccer player with the performance curves found, allowing trainers and coaches to assess an individual's performance relative to these curves. Applying the curves, trainers and coaches can determine if player X is performing above or below average for his age and which factors may be responsible. The curves indicate the desired development of talented youth soccer players. Hence, players should improve their sprinting and dribbling rapidly from ages 12 to 14, improve sprinting from ages 14 to 16, and from ages 16 to 19 an additional improvement in dribbling performance is needed to function at the highest level in youth soccer and to remain part of a talent development programme.

An additional strength of the present study is the use of statistical multi-level methods; the key advantage is that various measurements are allowed per player. A shortcoming of the current study was the average low numbers of measurements per player – on average 1.9 measurements per player were taken. Reasons for the low number are drop-out (poor performance), injuries, and no follow-up (testing stopped). The first reason could bias the results, but as such missing data were few (<15%), the impact will be small. Therefore, assuming that most missing data are random, we expect the current data to provide a good illustration of the development of dribbling in talented young soccer players. Another limitation in the current study is the recording of performance times in the Slalom Sprint and Dribble Test. In contrast with the Shuttle Sprint and Dribble Test, the performances were measured with a stopwatch instead of electronic measuring devices. Therefore, the measurement accuracy of the Slalom Sprint and Dribble Test might be less than that of the Shuttle Sprint and Dribble Test.

The present study investigated the development of sprinting and dribbling and the underlying mechanisms of dribbling among talented youth soccer players aged 12–19. Previous research has investigated sprinting, but the connection between sprinting and dribbling was not addressed. The current study found that there was a moderate relation between sprinting and dribbling on the same test. We also assessed a possible connection between the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test. Both tests showed low significant correlations, indicating some similarity between the tests, yet additionally indicating that the tests measure distinct qualities. The development of sprinting and dribbling showed most rapid improvements from ages 12 to 14. The results showed rapid improvements from ages 14 to 16 on sprinting, but dribbling hardly improved in that age span. However, dribbling appeared to improve further after age 16, while sprinting after that age hardly improved. Finally, factors found to contribute to an excellent performance in dribbling were advanced age, lean body mass (only for Shuttle dribble), and hours of (soccer and additional) practice. Furthermore, playing position distinguishes dribbling performance on the Slalom dribble test. To verify if there is a difference in development of talented young soccer players who ultimately reach professional status, these players are being followed until they reach elite status in adulthood.

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