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Age and Maturity Related Differences in Motor Coordination among Male Elite Youth Soccer Players

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Age and Maturity Related Differences in Motor Coordination among Male Elite Youth Soccer Players

Abstract

This study investigated differences in generic and soccer-specific motor coordination as well as speed and agility depending on age and maturity in elite youth soccer players (U10-U15, N=619). Measurements included body height, body weight and sitting height to estimate age at peak height velocity (APHV); three Körperkoordinationstest für Kinder subtests (i.e. jumping sideways (JS), moving sideways (MS), balancing backwards (BB)) to assess generic motor coordination; the UGent dribbling test for soccer-specific motor coordination; a 5m/30m sprint and T-test for speed and agility, respectively. Age-specific z-scores of the predicted APHV identified players as earlier, on time or later maturing. (M)ANOVA analyses showed significant age by maturity interaction effects for the speed and agility test cluster, revealing maturity related differences in U14 ($p=0.04$) and U15 players ($p=0.013$). Next to an overall higher performance with age for all test clusters ($p<0.001$, η^2 0.080-0.468), earlier maturing players outperformed their later maturing peers in 5m/30m sprinting ($p<0.01$). The opposite was seen for JS ($p=0.03$) and BB ($p=0.011$). So, players' maturity status should be taken into account to adequately value performance in talent identification. Also, the focus on characteristics that appear to be minimally biased by an earlier maturational timing (i.e. motor coordination) should be increased.

Introduction

Soccer is one of the most popular sports worldwide with 4% of the world population being actively involved, including 21.5 million youth players under the age of 18 years (Kunz, 2007). A lot of these youth players strive to attain a professional career in soccer. Further, professional soccer clubs carefully invest in their own youth academies trying to provide optimal conditions and specialised training to accelerate the developmental process of talented young players (Williams and Reilly, 2000). This substantial investment emphasises the need for reliable talent identification and development programmes that are able to detect and support potentially talented young players (Pearson, Naughton, & Torode, 2006; Vaeyens, Lenoir, Williams, & Philippaerts, 2008).

Especially at elite level, playing soccer requires a range of technical and tactical skills as well as physical performance characteristics such as highly developed speed and agility (Hulse et al., 2013; Reilly, Bangsbo, & Franks, 2000; Svensson and Drust, 2005). Many of these physical performance characteristics show the greatest improvement during the adolescent growth spurt (Pearson, et al., 2006; Philippaerts et al., 2006). Because of their advanced anthropometric and physical profile (i.e. being taller, faster and more powerful) (Figueiredo, Coelho, Cumming, & Malina, 2010; Meylan, Cronin, Oliver, & Hughes, 2010), early maturing soccer players are more often selected for youth academy enrolment as well as regional or national team play than their late maturing peers (Malina et al., 2000; Meylan, et al., 2010). However, some evidence suggests that late maturing players catch up on physical performance (Beunen et al., 1997; Meylan, et al., 2010), and then have a higher chance to reach a professional level than early and on time maturing boys playing in an elite level youth academy (Ostojic et al., 2014). Due to the difficulty of predicting adult performance during (early) adolescence, the use of dynamic talent identification programmes (e.g. taking age and maturity status into account) evolving with the changing individual player characteristics is recommended (Malina, Ribeiro, Aroso, & Cumming, 2007; Vaeyens, et al., 2008).

Motor coordination is another player characteristic used in talent identification. It can be described as multiple body effectors (i.e. muscles, joints and limbs) optimally working together to achieve goal-directed human movement in the most efficient way (Diedrichsen, Shadmehr, & Ivry, 2010). Generic motor coordination serves as the basis to acquire more specialized sport-specific motor coordination skills (Hulteen et al., 2015; Malina, Eisenmann, Cumming, Ribeiro, & Aroso, 2004) and has previously been related to future success in sports. Generic motor coordination encompasses skills that are not specifically practiced (Vandorpe et al., 2012). Therefore, the assessment of players' performance on generic motor coordination tests seems to be more useful to discover their real aptitude or potential to pick up new technical skills (Deprez, Fransen, Lenoir, Philippaerts, & Vaeyens, 2014; Pion, Fransen, et al., 2015; Vandorpe, et al., 2012). Soccer-specific motor coordination skills, on the other hand, can be influenced by training history in elite youth soccer players (Valente-dos-Santos et al., 2012), but these skills are of primary interest for practitioners in the field and of importance in the current practice of talent identification. Moreover, unlike physical performance characteristics, generic motor coordination and soccer-specific technical skills appear to be less influenced by maturational timing, showing no difference in performance between early and late maturing elite-level players (Gouvea et al., 2016; Vandendriessche et al., 2012). Previous research demonstrated that maturity status only explained 8.1% of the variability in generic motor coordination in pubertal boys between 11 and 14 years (Freitas et al., 2016), whereas physical performance was highly influenced by a difference in maturational timing among national team players aged 15 and 16 years (Vandendriessche, et al., 2012).

To date, there are few data available on generic and soccer-specific motor coordination as well as physical performance characteristics in relation to age and maturity status in youth elite level soccer players up to 14 years of age (Deprez, et al., 2014; Vandendriessche, et al., 2012). Furthermore, the few studies cover only small age ranges or consist of relatively small sample sizes mostly derived from a small number of youth academies (Deprez, et al., 2014; Vandendriessche, et al., 2012). Puberty is known to be an important period in terms of development of physical performance and generic motor coordination due to the pronounced changes in body proportions related to the sudden increase in length of the body and its limbs around the growth spurt (Quatman-Yates, Quatman, Meszaros, Paterno, & Hewett, 2012; Visser, Geuze, & Kalverboer, 1998). Therefore, the aim of this study was to investigate age and maturity status related differences in some commonly used talent identification characteristics (i.e. generic motor coordination, soccer-specific motor coordination and speed and agility) in a large sample of Belgian male elite youth soccer players in the under 10 (U10) to under 15 (U15) age categories.

Methods

Participants

A total of 619 elite-level male youth soccer players with an average weekly training volume of 273.25 ± 49.62 minutes were recruited from 6 different youth academies, each of which being associated with a Belgian Premier League professional soccer club. All at the time of testing non-injured players from the U10-U15 age categories of the elite level teams were eligible for participation in this study. The players as well as their parent(s) or legal caretaker(s) were fully informed about the study and child assent as well as parental written informed consent were obtained. The study protocol was approved by the medical ethical committee of the University Hospital of Brussels (B.U.N. 143201628616).

Measurements

Both anthropometric and field test data were collected at the site of the included youth academies by the first author and trained study assistants at the start of the 2016-2017 season. The entire test battery was performed on the same day with a 10-minute cardiovascular warm-up between the anthropometric measurements and the performance tests. The total duration of the warm-up, anthropometric measurements and the performance tests was approximately 45 minutes per player.

Anthropometry and maturity status.

Body height (Seca 213 Portable Stadiometer, Seca, Germany) and sitting height (Harpenden sitting height table, Holtain, UK) were measured to the nearest 0.1 cm according to previously described procedures (Lohman, 1988). Players' leg length was calculated as the difference between their recorded body height and sitting height. Body weight was determined barefoot to the nearest 0.1 kg using a digital scale (Tanita BC-420SMA, Tanita, Japan). An adjustment of 0.2 kg has been made to account for the clothing weight (i.e. shorts and a T-shirt) of players during assessment.

An estimation of the years from peak height velocity (PHV), which is an indicator for the adolescent growth spurt, was made using an equation for boys by Mirwald and colleagues (2002). This equation is based on the abovementioned anthropometric measures body height, sitting height and body weight in combination with the players' exact chronological age. The approximation of the age at PHV (APHV) based on the prediction equation used, is often lower in younger children who are not yet in their adolescent growth spurt and higher in older participants who already passed their adolescent growth spurt (Malina and Koziel, 2014). To counter this potential age-dependent over- and underestimation of APHV, age-specific z-scores were used in the present study to classify players according to their maturity status. The predicted APHV was used to calculate z-scores within each specific age category (U10-U15, N = 6). Based on these age-specific z-scores of the predicted APHV, players were then classified as 'earlier' ($z < -1$), 'on time' ($-1 \leq z \leq 1$) or 'later' ($z > 1$) maturing (Malina, Dompier, Powell, Barron, & Moore, 2007).

Generic motor coordination.

Generic motor coordination was determined using the three subtest short version of the Körperkoordinationstest für Kinder (KTK) (Kiphard, 1974, 2007): (1) jumping sideways (JS), number of jumps over a wooden slat in 15 seconds; (2) moving sideways (MS), number of displacements on wooden boards for 20 seconds (s); (3) balancing backwards (BB), number of steps on 3 different wooden beams of decreasing width. The fourth test, hopping for height (HH) over a foam obstacle of increasing height, was removed from the original test battery due to the increased risk of ankle sprain (Deprez, et al., 2014; Pion, Segers, et al., 2015). Moreover, previous research has shown a substantial agreement ($r = 0.98$, $p < 0.001$ (Vandorpe et al., 2011); $r = 0.97$, $p < 0.001$ (Novak et al., 2017)) between the overall generic motor coordination score based on the four item KTK test battery and the three subtests short version. The short version is thus also considered a valid measure for generic motor coordination (Novak, et al., 2017; Vandorpe, et al., 2011). All three KTK subtests were conducted under standardised conditions according to the methods described by Kiphard and Schilling (1974, 2007).

Soccer-specific motor coordination.

Soccer-specific motor coordination was tested using the Ghent University (UGent) dribbling test as previously described by Vandendriessche et al. (2012). This test has a good reliability, shown by an intra-class correlation coefficient of 0.81 (Vandendriessche, et al., 2012).The players completed a circuit set out by cones with four left and four right turns at different angles. The distance between the cones ranged between 1 and 2.2 meters (Vandendriessche, et al., 2012). The UGent dribbling test was performed as fast as possible in two conditions: the first attempt without the ball (i.e. familiarisation with the circuit), and the second attempt with the ball. The test was performed on artificial turf wearing soccer shoes, using the official competition ball size (i.e. size 4 for U10-U14 and size 5 for U15). The time of both attempts was measured to the nearest 0.01 seconds with a handheld stopwatch, but only the latter attempt (i.e. with the ball) was retained for analysis.

Speed and agility.

The players performed four maximal sprints of 30 meters (m) on artificial turf wearing soccer shoes, with 25 seconds of recovery in between. Fastest split times at 5 m and 30 m were used to evaluate starting speed and sprinting ability, respectively. This test was previously found to be highly reliable with a coefficient of variation of 1.8 (Wragg, Maxwell, & Doust, 2000). Agility was assessed by the T-test (Vandendriessche, et al., 2012), which was also performed on artificial turf. In this test, players run 5 m straight, turn 90°, run 5 m before the next 180° turn, run 10 m towards the second 180° turn, then run 5 m before a final 90° turn to ultimately finish at the initial starting point. The T-test was executed twice: first with all turns performed left, and then with all turns performed right. The second condition was performed when the player considered himself recovered. A modified version of this test was previously found highly reliable, with an intra-class correlation coefficient greater than 0.9 (Sassi et al., 2009). Time to accomplish both speed and agility tests was registered to the nearest 0.001 seconds (MicroGate Racetime2, Microgate, Italy).

Statistical analyses

Descriptive statistics for all outcome measures as a function of age category and maturity status are presented as mean ± standard deviation (SD). Due to the hierarchical data structure (i.e. players within teams within youth academies), the variance in scores of individual field tests within the three abovementioned test clusters (i.e. generic motor coordination, soccer-specific motor coordination, speed and agility) explained by the different youth academies (N=6), was examined by mixed model analyses including youth academy as a random factor. Differences in test performance according to age category and/or maturity status were investigated within each test cluster by multivariate analyses of variance (MANOVA) or univariate analysis of variance (ANOVA) where appropriate. In case of a significant age category by maturity status interaction effect, subsequent (M)ANOVA analyses split by age category (N=6) were executed to identify maturity related differences within each of those separate age categories and combined with a Bonferroni correction for multiple comparisons. Eta squared values (η^2) of the (M)ANOVA test results were calculated to obtain effect sizes, with values higher than 0.01 considered a small effect, higher than 0.06 a medium effect and higher than 0.14 considered a large effect (Cohen, 1988). All tests were conducted in SPSS 24.0 software (IBM corp., Amork, NY) with statistical significance level set at $p < 0.05$.

Results

Descriptive statistics for anthropometric characteristics of the 619 elite level soccer players of the U10 to U15 age categories (11.71 ± 1.67 years) are presented in ***Table 1***. Average predicted APHV ranged from 12.99 years (U10) to 14.03 years (U14). Due to the maturity status categorisation based on normally distributed age-specific z-scores, 70.2% of the players were categorised as 'on time', 14.9% as 'earlier', and 14.9% as 'later' maturing both in the total sample and within each specific age category.

Mixed model analyses revealed that the different youth academies accounted for 0 to 14% of the explained variance in test scores within the three clusters (i.e. generic motor coordination, soccer-specific motor coordination, speed and agility), but the set significance level was not reached for any of those test clusters ($p > 0.05$). Therefore, the random factor youth academy was not included in further analyses.

(M)ANOVA results of main and interaction effects as well as effect sizes (η^2) for the three test clusters are displayed in ***Table 2***. A significant age by maturity interaction effect was found for the speed and agility test cluster as well as for the individual sprint and the T-test scores. Split by age category, significant maturity related differences were only found in the U14 (multivariate $F = 2.074$, $p = 0.04$, $\eta^2 = 0.041$) and U15 (multivariate $F = 2.52$, $p = 0.013$, $\eta^2 = 0.061$) age categories, with the earlier maturing players outperforming their later maturing peers for all individual test scores within this particular test cluster (N = 4) (***Table 3***).

The main effect of age was significant for all three test clusters and all nine individual field tests ($p < 0.001$, η^2 ranging from 0.08 to 0.468). Independent of players' maturity status, a gradual improvement in performance with increasing age was seen (***Table 4***). Post-hoc analyses in the generic motor coordination test cluster displayed significant differences between successive age categories from U11 to U14 (p-value range: < 0.001 to 0.039), with the older players reaching better performance. The BB subtest did not show a significant difference between any successive age categories, although U15 players scored significantly higher than U10 players ($p < 0.001$). Results for soccer-specific motor coordination did only differ between U11-U12 and U13-U14, with the older players performing significantly better than their younger peers (p-values < 0.001 and 0.021 respectively). On the 30 m sprint test, post-hoc analyses showed higher performance in older players ($p < 0.001$). The 5 m sprint and T-tests were performed better by older players over all successive age categories, except for U12-U13 ($p > 0.33$).

The main effect of maturity was observed in the generic motor coordination as well as in the speed and agility test cluster, but not for soccer-specific motor coordination. Post-hoc analyses revealed that, regardless of age category, the later maturing players showed significantly higher test scores on JS ($p = 0.041$) and BB ($p = 0.011$) than their earlier maturing peers. In the speed and agility test cluster, however, faster sprint times on 5 m and 30 m ($p < 0.01$) were observed for the earlier maturing players compared to their later maturing peers (***Table 5***).

Discussion

The present study examined age and maturity status related differences in possible talent identification characteristics (i.e. generic motor coordination, soccer-specific motor coordination and speed and agility) in a large sample of youth elite level soccer players (U10 to U15 age categories) from six different Belgian youth academies. The main findings include that the speed and agility test cluster showed a significant age by maturity interaction effect as well as a significant main effect for both age and maturity, although effect sizes were small for the interaction and maturity effect. In addition, generic motor coordination shows a significant main effect for age and maturity, whereas in soccer-specific motor coordination only a significant main effect for age was revealed.

The age-dependent effect of maturity in the speed and agility test cluster was only present in the U14 and U15 age categories. These are the age categories in which the adolescent growth spurt is likely to occur (average age: 13.8 ± 1.0 years) (Philippaerts, et al., 2006; Sherar, Mirwald, Baxter-Jones, & Thomis, 2005). The earlier maturing players in these age categories presumably already passed their APHV, in contrast to the later maturing players who most likely have not yet reached their PHV. The large increase in strength and speed around the time of PHV could explain the maturity effects observed in the U14 and U15 age categories favouring the earlier maturing soccer players (Beunen and Malina, 1988; Philippaerts, et al., 2006).

The gradual increase with age in physical performance characteristics (i.e. strength, speed and endurance) as described by Philippaerts et al. (2006) as well as in skill acquisition through a large number of yearly training hours (Figueiredo, Coelho e Silva, & Malina, 2011) can explain the observed difference in speed and agility, generic and soccer-specific motor coordination between successive age categories in the present study. Moreover, the yearly selections traditionally made by the youth academies, with only the best players being retained, probably further reinforce the significant differences found in both physical performance, generic and soccer-specific motor coordination between successive age categories.

Age related improvements in generic motor coordination were not similar in all KTK subtests. While MS and JS gradually increased with increasing age, age related differences were much less pronounced in the BB subtest. Differences in the BB subtest only emerged over several age categories (e.g. between the two extreme age categories included in this study (i.e. U10 and U15 ($p<0.001$)), favouring the older players. The small differences assuming a slow evolution of the balance skill, are in accordance with the differences seen in a large sample (N=1228) of normally developing German children tested in 1974 (Kiphard, 1974, 2007). It is likely that the increase in body length in teenagers – implying a higher position of the centre of mass – interferes with performance on a task like the BB. Moreover, longitudinal data suggest that there is only limited improvement in BB subtest score between the ages of 12 and 23 (Ahnert and Schneider, 2007). No difference in the JS and MS subtest scores was observed between the U14 and U15 age categories in this study. These findings are in accordance with previous literature showing only a gradual increase in JS score after the age of 12 and only a small changes in MS score (Ahnert and Schneider, 2007; Deprez et al., 2015). The lack of difference between the U14 and U15 age categories on all generic motor coordination tests, might point out the existence of the hypothetical “motor awkwardness” during the adolescent growth spurt, representing a period of temporary motor coordinative instability (Beunen and Malina, 1988; Davies and Rose, 2000). However, longitudinal data are needed to provide a clear view on the evolution of motor coordination around the adolescent growth spurt.

In contrast to previous studies within the field of youth soccer (Figueiredo, et al., 2011; Vandendriessche, et al., 2012), this study found a significant effect of maturity in the generic motor coordination test cluster. However, our study was conducted in players around the APHV (aged 9 to 14 years), so the results possibly display the direct effect of the adolescent growth spurt that differs in timing between players. The later maturing players were found to outperform their earlier maturing peers on two of the three KTK subtests (JS and BB). In spite of the significance of these findings, the effect sizes are small ($\eta^2 = 0.012$ for both tests), indicating that the impact of maturity status on generic motor coordination is limited. Moreover, in contrast to speed and agility, this limited effect of maturity status on generic motor coordination is stable over the pubertal development. The significant interaction effect in the speed and agility test cluster, revealing more pronounced maturity related differences in the U14 and U15 age categories, was not present for generic motor coordination. From this point of view, it is recommended to include generic motor coordination in talent identification test batteries due to its robustness against pubertal developmental influences. One might argue that the soccer specific coordination is not affected by maturity at all (***Table 5***). Possibly, the (small) impact of maturity is overpowered by the extensive amount of training on dribbling skills in elite youth players.

The significant effect of maturity status on generic motor coordination as demonstrated by the present study could also result from the age-dependent method chosen to categorise the players by their maturity status. An equation was used to estimate the maturity offset based on anthropometric data in order to determine the APHV (Mirwald, et al., 2002). A large difference in average predicted APHV between the different U10-U15 age categories was found to be present in this study. This large difference indicates the limitation of the predicted APHV: systematic errors in the predicted of the APHV, especially for individuals further removed from their APHV (Malina and Koziel, 2014; Mills, Baker, Pacey, Wollin, & Drew, 2017). Despite the limitations of the use of prediction equations for APHV, it is a practical solution compared to more accurate but also more invasive and expensive methods such as X-ray and DXA (Mills, et al., 2017; Romann and Fuchslocher, 2016). Furthermore, the use of age-specific z-scores of APHV to classify players by maturity status further enables professionals in the field to categorise and compare their own players based on an easy field method (Meylan, et al., 2010).

A major strength of the present study is its large sample size of elite level youth players from six different youth academies. A second strength is the coverage of a wide range of age categories around the adolescent growth spurt (N = 6, U10-U15), as compared to previous work evaluating the effect of maturity status on a smaller sample of players after the APHV (Vandendriessche, et al., 2012). However, a limitation of the generalisability of the results of this study, is that all participating youth academies belonged to one single country. Another limitation of the study is that the field tests used, were partly performed outdoors and test conditions were not controlled for wind and temperature. Nonetheless, test sessions were only performed in dry conditions. As the results of the present study are cross-sectional, future research should focus on mapping the longitudinal evolution of physical and motor coordination skills – both generic and soccer-specific – to determine the predictability of talent in late adolescence and adulthood by the determinants studied from a young age onwards.

In conclusion, this study emphasizes that the pubertal period is a critical time frame for skill acquisition and development of performance in youth elite soccer players, as significant differences between several successive age categories were observed in all test clusters. Speed and agility, which are physical performance characteristics often used in talent identification, appear to be more biased by the maturational timing in favour of the earlier maturing players, especially around the APHV. This bias seems to be present for generic motor coordination also, but only to a limited extent and in favour of the later maturing players. Soccer-specific motor coordination appears not to be influenced by maturity status. These findings suggests that physical performance characteristics should be less emphasised in the talent identification process around the APHV, while both generic and soccer-specific motor coordination should be considered in this period. This could help to equalise the chances for earlier, on time, and especially later maturing players to get selected and being provided with the necessary opportunities to attain a professional career in soccer.

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Table 1. Descriptive statistics of anthropometric characteristics (mean ± SD) according to age category and maturity status.

	U10	**U11**	**U12**	**U13**	**U14**	**U15**
	n = 91	n = 114	n = 117	n = 103	n = 104	n = 90
Early maturing						
n	14	19	17	13	16	13
Age (y)	9.25 ± 0.26	10.21 ± 0.33	11.17 ± 0.31	12.43 ± 0.38	13.42 ± 0.31	14.23 ± 0.30
Height (cm)	145.02 ± 4.19	147.4 ± 4.35	152.84 ± 3.58	165.52 ± 5.14	170.66 ± 4.56	176.18 ± 3.67
Sitting height (cm)	76.22 ± 1.86	77.39 ± 2.05	80.18 ± 1.82	85.45 ± 2.42	89.63 ± 2.14	92.25 ± 1.12
Weight (kg)	36.32 ± 4.58	37.08 ± 3.3	41.49 ± 2.74	51.73 ± 5.94	56.80 ± 5.15	64.06 ± 5.97
Predicted APHV (y)	12.47 ± 0.17	12.88 ± 0.11	13.11 ± 0.19	13.09 ± 0.30	13.05 ± 0.29	13.05 ± 0.17
On time						
n	65	74	85	78	71	62
Age (y)	9.38 ± 0.24	10.34 ± 0.26	11.32 ± 0.27	12.33 ± 0.27	14.70 ± 12.29	14.31 ± 0.27
Height (cm)	136.33 ± 4.59	141.12 ± 4.96	146.15 ± 3.75	151.70 ± 5.40	158.79 ± 7.06	168.35 ± 6.09
Sitting height (cm)	71.70 ± 2.08	73.72 ± 1.78	75.80 ± 1.64	78.06 ±2.21	81.39 ± 2.94	86.74 ± 2.80
Weight (kg)	29.79 ± 2.97	32.92 ± 3.00	35.49 ± 3.50	39.86 ± 5.15	45.13 ± 6.06	56.87 ± 7.05
Predicted APHV (y)	13.02 ± 0.15	13.36 ± 0.18	13.69 ± 0.18	13.97 ± 0.25	14.05 ± 0.35	13.84 ± 0.33
Late maturing						
n	12	21	15	12	17	15
Age (y)	9.45 ± 0.23	10.44 ± 0.24	11.50 ± 0.16	12.47 ± 0.17	13.36 ± 0.23	14.36 ± 0.27
Height (cm)	128.55 ± 4.24	134.83 ± 4.17	141.08 ± 2.35	144.02 ± 4.89	147.04 ± 5.07	158.29 ± 6.20
Sitting height (cm)	67.68 ± 1.68	69.79 ± 1.87	72.38 ± 1.17	73.38 ± 1.97	75.38 ± 1.50	80.73 ± 2.75
Weight (kg)	26.61 ± 2.18	28.49 ± 1.68	32.99 ± 2.04	34.43 ± 4.62	35.77 ± 2.96	43.85 ± 4.13
Predicted APHV (y)	13.43 ± 0.16	13.83 ± 0.11	14.16 ± 0.11	14.63 ± 0.20	14.91 ± 0.14	14.74 ± 0.26

SD: standard deviation, APHV: age at peak height velocity

Table 2. Results of (M)ANOVA analyses examining the difference in performance according to age category and/or maturity status per test cluster.

	MANOVA age*maturity [F (p)]	**η^2**	**MANOVA age [F (p)]**	**η^2**	**MANOVA maturity [F (p)]**	**η^2**
Generic motor coordination	*0.641 (0.934)*	*0.011*	*24.917 (<0.001)**	*0.128*	*2.811 (0.010)**	*0.009*
Jumping sideways (# jumps)			73.578 (<0.001)*	0.282	3.737 (0.024)*	0.012
Moving sideways (# displacements)			55.883 (<0.001)*	0.246	0.307 (0.736)	0.001
Balancing backwards (# steps)			12.968 (<0.001)*	0.080	3.906 (0.021)*	0.012
Soccer-specific motor coordination						
Dribbling test with ball (s)	0.830 (0.600)	0.011	32.476 (<0.001)*	0.225	0.627 (0.534)	0.002
Speed and agility	*1.835 (0.001)**	*0.031*	*32.285 (<0.001)**	*0.166*	*2.345 (0.017)**	*0.008*
Best time sprint 5m (s)	2.339 (0.010)*	0.028	72.147 (<0.001)*	0.253	6.978 (0.001)*	0.017
Best time sprint 30m (s)	2.416 (0.008)*	0.021	163.384 (<0.001)*	0.468	7.252 (0.001)*	0.013
T-test left (s)	2.215 (0.016)*	0.028	64.701 (<0.001)*	0.242	0.577 (0.562)	0.001
T-test right (s)	2.382 (0.009)*	0.028	79.025 (<0.001)*	0.282	1.103 (0.332)	0.003

#: number of, F (p) - values in italics: multivariate F statistics. *: indicates significant results.
In case of non-significant multivariate test results, univariate test results were not shown.

Table 3. Descriptive statistics of the speed and agility test cluster (mean ± SD) according to age category and maturity status.

	U10 n = 91	**U11** n = 114	**U12** n = 117	**U13** n = 103	**U14** n = 104	**U15** n = 90
Earlier						
n	14	19	17	13	16	13
Sprint 5m (s)	1.24 ± 0.06	1.24 ± 0.08	1.18 ± 0.07	1.12 ± 0.10	1.08 ± 0.08	1.03 ± 0.08
Sprint 30m (s)	5.57 ± 0.28	5.32 ± 0.26	5.14 ± 0.18	4.83 ± 0.40	4.56 ± 0.25	4.41 ± 0.20
T-test left (s)	9.36 ± 0.58	8.88 ± 0.40	8.91 ± 0.38	8.67 ± 0.41	8.27 ± 0.25	8.07 ± 0.25
T-test right (s)	9.34 ± 0.41	8.96 ± 0.41	9.02 ± 0.43	8.69 ± 0.48	8.34 ± 0.23	8.09 ± 0.30
On time						
n	65	74	85	78	71	62
Sprint 5m (s)	1.28 ± 0.09	1.23 ± 0.08	1.20 ± 0.09	1.17 ± 0.07	1.12 ± 0.08	1.07 ± 0.08
Sprint 30m (s)	5.52 ± 0.34	5.34 ± 0.29	5.17 ± 0.25	5.06 ± 0.25	4.82 ± 0.27	4.54 ± 0.25
T-test left (s)	9.22 ± 0.48	9.01 ± 0.37	8.72 ± 0.40	8.80 ± 0.46	8.50 ± 0.43	8.18 ± 0.29
T-test right (s)	9.35 ± 0.56	9.07 ± 0.37	8.77 ± 0.39	8.85 ± 0.35	8.60 ± 0.42	8.24 ± 0.25
Later						
n	12	21	15	12	17	15
Sprint 5m (s)	1.27 ± 0.07	1.23 ± 0.08	1.18 ± 0.05	1.15 ± 0.03	1.15 ± 0.08	1.16 ± 0.09
Sprint 30m (s)	5.54 ± 0.28	5.37 ± 0.25	5.18 ± 0.19	4.91 ± 0.17	4.90 ± 0.27	4.79 ± 0.26
T-test left (s)	9.15 ± 0.35	9.02 ± 0.43	8.69 ± 0.37	8.67 ± 0.32	8.66 ± 0.30	8.34 ± 0.29
T-test right (s)	9.23 ± 0.41	9.08 ± 0.42	8.73 ± 0.40	8.69 ± 0.34	8.68 ± 0.33	8.40 ± 0.28

SD: standard deviation

Table 4. Descriptive statistics of the three test clusters (mean ± SD) according to age category.

	U10 n = 91	**U11** n = 114	**U12** n = 117	**U13** n = 103	**U14** n = 104	**U15** n = 90
Generic motor coordination						
Jumping sideways (# jumps)	81.18 ± 9.11	84.47 ± 8.65*	90.21 ± 8.19*	94.88 ± 10.37*	97.67 ± 9.33	101.17 ± 9.19
Moving sideways (# displacements)	50.05 ± 7.18	51.46 ± 6.53*	56.17 ± 6.46*	60.91 ± 9.47*	64.68 ± 9.42	63.78 ± 11.54
Balancing backwards (# steps)	50.48 ± 9.72	52.20 ± 9.67	53.03 ± 10.54	56.96 ± 10.18	58.98 ± 9.56	58.67 ± 10.14
Soccer-specific motor coordination						
Dribbling test with ball (s)	22.47 ± 2.21	21.78 ± 2.03*	20.68 ± 2.04	20.16 ± 1.77*	19.40 ± 1.38	18.86 ± 1.50
Speed and agility						
Sprint time 5m (s)	1.25 ± 0.09*	1.23 ± 0.08*	1.19 ± 0.08	1.17 ± 0.07*	1.12 ± 0.08*	1.08 ± 0.09
Sprint time 30m (s)	5.53 ± 0.32*	5.34 ± 0.41*	5.17 ± 0.23*	5.02 ± 0.27*	4.79 ± 0.28*	4.56 ± 0.26
T-test left (s)	9.24 ± 0.47*	8.93 ± 0.48*	8.75 ± 0.40	8.77 ± 0.44*	8.49 ± 0.40*	8.19 ± 0.29
T-test right (s)	9.33 ± 0.51*	9.05 ± 0.38*	8.80 ± 0.41	8.81 ± 0.37*	8.58 ± 0.40*	8.24 ± 0.27

SD: standard deviation, #: number of, *: significantly different from the consecutive age category

Table 5. Descriptive statistics of the three test clusters (mean ± SD) according to maturity status.

	Earlier n = 92	**On time** n = 435	**Later** n = 92
Generic motor coordination			
Jumping sideways (# jumps)	$88.29 \pm 13.02^{a,b}$	91.89 ± 11.15^{a}	91.83 ± 11.16^{b}
Moving sideways (# displacements)	56.92 ± 9.83	57.89 ± 10.21	57.33 ± 10.47
Balancing backwards (# steps)	52.86 ± 10.53^{b}	54.93 ± 10.22	57.12 ± 11.45^{b}
Soccer-specific motor coordination			
Dribbling test with ball (s)	20.69 ± 2.22	20.41 ± 2.01	20.36 ± 2.24
Speed and agility			
Sprint time 5m (s)	$1.15 \pm 0.11^{a,b}$	1.18 ± 0.10^{a}	1.19 ± 0.08^{b}
Sprint time 30m (s)	$5.00 \pm 0.48^{a,b}$	5.09 ± 0.41^{a}	5.13 ± 0.36^{b}
T-test left (s)	8.71 ± 0.56	8.75 ± 0.52	8.71 ± 0.50
T-test right (s)	8.77 ± 0.55	8.82 ± 0.52	8.82 ± 0.45

SD: standard deviation, #: number of, ^{a}: significant difference between earlier and on time maturing players, ^{b}: significant difference between earlier and later maturing players