Title:

Influence of biological maturity on the match performance of 8 to 16 year old elite male youth soccer players

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Abstract

The aim of this study was to examine the influence of biological maturity on match performance in elite youth male soccer players. The participants were 80 Premier League Academy outfield players (8-16 years old). Biological maturity was determined by calculating estimated chronological age at peak height velocity. The U9 and U10 squads played 6-a-side and the U11-U16 squads played 11-a-side inter-academy matches. All matches were analyzed using a 1 Hz Global Positioning System (SPI elite, GPSport, Australia) with squad specific speed zones which were calculated based on 5 m flying sprint speed in the last 5 m of 10 m sprint test. In the U9/U10s, earl**ier** maturers were given a longer pitch time by coaches (~4 min per match, p = 0.029) and covered a greater total distance (~9%, ~400 m, p = 0.037) and a greater distance by walking (~13%, ~100 m, p = 0.024) and jogging (~12%, ~200 m, p = 0.014) during a match compared to lat**er** maturers. In the U13/U14s, earl**ier** maturers covered a greater distance per hour of a match by high speed running compared to lat**er** maturers (~25%, ~130 m, p = 0.028) and spent a longer percentage of time in high speed running during a match compared to lat**er** maturers (3.4% vs. 2.7%, p = 0.034). Thus, coaches should take care to provide all players with a similar pitch-time and should be aware in the talent identification and development process, particularly with the U13/U14 age group, that maturity can influence high speed match running performance.

Key words:

Association football, High speed running, Intermittent sport, Talent identification, young athletes.

INTRODUCTION

Biological maturity is a well known factor influencing body size in adolescent boys (17,30). In youth soccer, older and more mature players have been reported to gain advantages in the player selection process (3) and thus, players in some clubs (13-15 year old elite youth soccer players from three Portuguese soccer clubs) have been reported to be advanced in terms of their biological maturity (19).

There are several different methods to assess biological maturity. In youth soccer players, secondary sexual maturation, skeletal age, chronological age at peak height velocity (PHV) and testicular volume have been previously employed to determine biological maturity (2,3,8,12,15,19,21,25,27). However, there are limitations to the use of these methods to assess biological maturity in that, for example, secondary sexual maturation can only be used for adolescents and the measurement of testicular volume is not always acceptable to players, parents and clubs. Skeletal maturity is generally accepted as the best method (18), but it is costly and requires specialized equipment and the use of radiation can raise health, safety, moral and ethical issues. Moreover, determining the chronological age at which PHV requires a series of standing height measurements to be made over several years (17). As a result of the limitations of these approaches, a non-invasive method to determine biological maturity by calculating the estimated chronological age at PHV has become very widely used. The popularity of this method probably stems from the fact that it only requires the recording of chronological age, standing height, sitting height and body mass from a single session and can include participants with a chronological age range of 7 to 18 years (22). This non-invasive method has been recently updated and now only requires chronological age and sitting height as predictor variables for boys. Furthermore, the study reported a sufficient accuracy of the prediction of age at PHV as the accuracy was within ±1 year in 90% of the cases (23).

Previous research has examined the influence of biological maturity on the physical characteristics of youth male soccer players such as height and body mass. In 11-12 and 13-14 year old elite Portuguese soccer players, the players with advanced skeletal age were taller and there was a positive relationship between biological maturity and body mass in 11-12, 13-14 and 15-16 year olds (8,21). Similarly, more mature 13-15 year old elite Portuguese soccer players were taller when stage of pubic hair development (27) was employed to examine biological maturity and in 11-14 and 13-15 year olds, early maturing boys were significantly heavier than late maturing counterparts when biological maturity was determined by skeletal age and stage of pubic hair development, respectively (8,19).

In terms of physical performance, 13 -15 year old Portuguese elite soccer players with a higher stage of pubic hair development performed significantly better than players with a lower stage of pubic hair development in a 30 m sprint, standing vertical jumps and the Yo-Yo intermittent endurance test (19). Similarly, in 11-12 and 13-14 year old Portuguese players performance on the Yo-Yo intermittent endurance test and on the vertical jump tests respectively was better for more mature boys (8). Thus, the effect of biological maturity on the physical characteristics and physical performance of some groups of elite youth soccer players has been examined and more mature boys are taller, heavier and perform better on some endurance, sprint and jump tests. As biological maturity has been demonstrated to affect physical characteristics and physical performance, there is clear likelihood that biological maturity may influence actual match running performance.

Therefore, the aim of the present study was to examine the influence of biological maturity on the match running performance of 8 to 16 years old elite male youth soccer players. As it has been previously found that more biologically mature elite youth soccer players perform better on some endurance and sprint tests, it was hypothesized that the players with advanced biological maturity would cover a greater total distance and cover a greater distance at high running speeds than less mature boys during match play.

METHODS

Experimental approach

Players were recruited from an English Premier League Academy, which represents the highest standard of youth development in England with the purpose of furthering understanding of the impact of maturity on player development and talent identification at this level and to provide comparative data for other studies recruiting players at Club and Recreational levels.

Estimated chronological age at PHV was employed to determine the biological maturity of the players (23) and they were separated into earlier and later maturers based on the estimated chronological age at PHV. Match running performance of the U9 to U16 players was analyzed to investigate the distance covered during a match using 1 Hz GPS. The players took part in a 10 m sprint test with a 5 m split time and speed zones for each squad were calculated based on the result. The distances measured were categorized into five speed zones which were walking, jogging, low speed running, moderate speed running and high speed running. The match playing time, distances covered in each speed zone, the total distance covered and percentage of time spent in each speed zone during a match were compared between the earlier and later maturers in U9/U10, U11/U12, U13/U14 and U15/U16 to assess the influence of biological maturity.

The validity of 1 Hz GPS (1 Hz, SPI elite, GPSport, Australia) has been previously demonstrated in terms of distance covered and the distance covered at particular speeds (1,7, 16), while in terms of reliability the overall coefficient of variation within and between receivers was 2.6% and 2.8% (11).

Participants

The participants were 80 outfield white male players from one English Premier League Academy who played in under-9 (U9) to U16 age group squads (chronological age range: 8.4 - 16.2 yrs). For this study, squads were merged as follows: U9/U10 (standing height = 138.9 ± 5.6 cm (mean ± SD), body mass = 33.2 ± 4.4 kg), U11/U12 (151.7 ± 5.8 cm, 42.3 ± 5.9 kg), U13/U14 (167.1 ± 9.4 cm, 55.2 ± 9.6 kg) and U15/U16 (178.6 ± 6.2 cm, 67.6 ± 6.1 kg). The U9/U10, U11/U12 and U13/U14 squads had 3 training sessions a week and the U15/U16 squad had 4 training sessions a week. All squads played an average of one match per week during the season. Players were provided with a written and verbal explanation of the study including all tests and measurements to be taken. Each player signed an assent form and completed a health screen questionnaire prior to participation in the study. Players' parents, guardians or care-givers also signed a consent form prior to the start of the study. The study was approved by a University Ethical Committee.

Biological maturity

A cross-sectional design was employed to compare match running performance of earlier and later maturing academy players. The chronological age at PHV of the players was estimated using the equation: chronological age + maturity offset where maturity offset was – 8.128741 + (0.0070346 x (chronological age x sitting height)) (23). The equation was derived after calibrating the original equation created by Mirwald and colleagues (22) with 7 years longitudinal data of 79 boys (chronological age range = 8 to 21 years), and R^2 of actual and estimated chronological age at PHV was 0.906 and standard error of the estimates of maturity offset was 0.514 (23). Early maturers, average maturers and late maturers were defined as those players with an estimated chronological age at PHV of less than 13 years of age, 13-15 years of age and more than 15 years of age, respectively (26). However, because there were no late maturers in the Academy and only 19% of the players were early maturers, to enable performance comparison on the basis of maturity, half the boys in each playing squad (e.g., U10s) were designated as earlier and other half as later maturers on the basis of their estimated chronological age at PHV. Squads were then combined as described previously (e.g., U9/U10).

Match analysis

Soccer matches were analyzed using a 1 Hz Global Positioning System (GPS) (SPI Elite, GPSport, Australia). This system required players to wear a small backpack, which contained the device, and players wore this equipment throughout the match. The matches were played on flat grass pitches and the pitch dimensions and duration of the matches are shown in table 1. The U9/U10 group played 6-a-side matches and the U11/U12, U13/U14 and U15/U16 groups played 11-a-side matches. The matches were part of the regular series of inter-academy matches between Premier League Academies during a season. For a players' data to be included in the current study, a player needed to complete at least one half of a match on two occasions. The analysis described below was based on 3.6 ± 2.0 matches (mean ± SD; range: 2-13 matches) per player. Mean values from all matches played were calculated for each player. The GPS accessed a mean of 7.7 ± 1.4 satellites with a mean horizontal dilution of precision of 1.26 ± 0.29 throughout all the matches analyzed.

Sprint test

A 10 m sprint test with a split time at 5 m was conducted to obtain a "flying" 5 m sprint time at the start of the season in which the match analysis took place. The test was conducted indoors and the surface was a new generation synthetic sports turf. A photoelectric timing gate (Brower timing system, Utah, USA) was placed at 0, 5 and 10 m and, the time was recorded nearest to 0.01 s. The players sprinted from 1 m behind the first timing gate with their preferred foot front forward. No bouncing and backward movements were allowed just before initiating the sprint. Each player completed three sprints and the fastest sprint time was selected for the calculation of speed zones.

Match activities

Five speed zones specific to each squad were calculated utilizing the mean "flying" 5 m sprint speed for each age group. The five speed categories were calculated by splitting the speed of movement from 0.0 $m \cdot s^{-1}$, up to the speed equivalent to two standard deviations below the squad mean "flying" 5 m sprint speed, into 5 equal categories, and they were labelled as standing and walking, jogging, low speed running, moderate speed running and high speed running based on similar designations from earlier studies (6,9,10,13). Any running speeds recorded faster than the fastest speed zone were also categorized as high speed running (table 1). "Flying" 5 m sprint time from the 10 m sprint test was used for the speed zone calculations because sprint distances in association football are typically relatively short. For example, the average sprint distance of U15 elite Brazilian players was 8.6 m when stride length was used to estimate the distance covered by sprinting (24). The distances covered by the five locomotor categories were estimated using Team AMS software version 1.2 (GPSport, Australia). Mean playing time, match running distances in absolute terms and meters per hour, the percentage of time spent in each speed zone during a match were calculated. These speed zones are similar to the zones described in previous studies which reported on the match performance of U9-U16 youth soccer players (4,5,9,10,13).

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Statistical analysis

An independent sample t-test was employed to assess whether or not there were statistically significant differences between earlier and later maturing groups. Data were normally distributed as examined by a Shapiro-Wilk test and homogeneity of variance was confirmed using Levene's Test. The effect sizes (*d*) for these differences were also calculated as (mean A – mean B)/ (pooled SD) (29). Effect size values of 0.2, 0.5 and above 0.8 were considered to represent a small, moderate and large differences, respectively (29). Pearson's product moment correlation was employed to examine the relationships between variables. Results are presented as mean ± standard deviation (SD) and PASW 18.0 was used for all the statistical analyses. The level of statistical significance was set at $P < 0.05$.

RESULTS

In the U9/U10, U11/U12, U13/U14 and U15/U16 squads, the proportion of early maturers (estimated chronological age at PHV < 13 yrs) was 55, 8, 0 and 6%, respectively and the proportion of average maturers (estimated chronological age at PHV = 13-15 yrs) was 45, 92, 100 and 94%, respectively. No late maturers were found in any age groups. Thus, throughout the academy the proportion of early, average and late maturing players was 19, 81 and 0%, respectively.

In all groups, there was a 6 to 11 month difference in estimated chronological age at PHV between the earl**ier** and lat**er** maturers (p < 0.01 for all), but actual chronological age at the time of data collection was not different (table 2). In the U9/U10, earl**ier** maturers were given a longer pitch time by coaches (~6 min per match, p = 0.004) and covered a greater total distance (~13%, ~500 m, p = 0.009) and a greater distance by walking (~13%, ~100 m, p = 0.024) and jogging (~14%, ~200 m, p = 0.035) during a match compared to lat**er** maturers (table 2). Moreover, there were significant relationships between estimated chronological age at PHV and mean playing time (r = -0.63, p = 0.003), total distance (r = -0.57, p = 0.008), waking distance (r = -0.50, p = 0.026) and jogging distance (r = -0.55, p = 0.012) during a match in the U9/U10. In the U13/U14, earl**ier** maturers demonstrated a greater high speed running distance compared to lat**er** maturers in both absolute (~56%, ~200 m, p = 0.001, table 2) and relative (~44%, ~200 $m \cdot h^{-1}$, p = 0.002, table 3) terms, and spent a greater percentage of time in high speed running during a match compared to lat**er** maturers (3.5% vs. 2.5%, p = 0.003, table 3). In addition, The U13/U14 group demonstrated significant relationships between estimated chronological age at PHV and high speed running distance in both absolute (r = -0.69, p = 0.003) and relative (r = -0.57, p = 0.021) terms and percentage of time spent in high speed running (r = -0.57, p = 0.021).

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DISCUSSION

This study is the first to examine the influence of biological maturity on the match running performance of a wide age-range (8 to 16 years old) of elite youth soccer players. When estimated chronological age at PHV (23) was employed to assess biological maturity, earl**ier** maturers in the U9/U10 age group were given more pitch time by coaches and covered a significantly longer total distance during a match compared to lat**er** maturers. Moreover, in the U13/U14 age group, earl**ier** maturers covered a significantly longer distance per hour by high speed running and spent a significantly higher percentage of time undertaking high speed running during a match compared to lat**er** maturers.

In the present study, when estimated chronological age at PHV (23) was employed to assess biological maturity, no late maturing boys were found amongst the elite players in this academy with the proportion of early, average and late maturing players being 19, 81 and 0%, respectively. In 224 Canadian sedentary boys (more than 98% were white), 15.6% were early maturers, 69.7% were average maturers and 14.7% were late maturers (26). Hence, the players from the current study seem to have an advanced maturity status compared to Canadian sedentary boys. However, the proportion of early maturers was not as high as that reported for 13-15 year old Portuguese elite youth soccer players where the majority were considered to be of advanced biological maturity (19). This could be due to a difference in the player selection policy between the soccer clubs in England and Portugal. The fact that there were no late maturing boys in this English academy is a concerning finding suggesting that, in this club at least, it is not possible for late maturing boys to progress or perhaps even be selected for academy soccer despite an estimated 15% of the population falling into this group (26).

In the U9/U10 group, almost half of the players were early maturers whereas in older age groups there were 0 to 8% early maturers. This is possibly because the estimated chronological age at PHV methodology underestimates the actual chronological age at PHV in 9 and 10 years old boys (20). However, it could also be that young early maturing boys selected largely due to their advanced maturity, are subsequently released earlier by the club (3,19). Moreover, it has been shown that the formula for estimating chronological age at PHV overestimates the chronological age at PHV in 13 to 18 year old boys which may partly explain the small proportion of early maturers in the U11/U12, U13/U14 and U15/U16 groups of the current study (20,23).

Total match running distance from the current study was similar to that of previous studies which reported total match running distances of ~5000 to ~7000 $m \cdot h^{-1}$ during a match in elite youth soccer players from various countries (4-6,9,10,13,24). For the U9/U10 group of the current study, while there were no significant differences between earlier and later maturers in standardized total match running distance ($m \cdot h^{-1}$), earlier maturers were given a significantly longer playing time by coaches which may have resulted in earlier maturers covering ~13% (~500 m) longer total distance and more than 10% greater walking and jogging distances during a match compared to later maturers. Thus, the coaches seemed to favor the players with advanced maturity status and this finding is in line with a previous study which reported that older and more mature players gain advantages in the player selection process in elite youth soccer (3). Therefore, because earlier maturers are given more pitch time, they presumably have more opportunities to improve their match performance including their technical ability and tactical understanding perpetuating the advantage of the earlier maturers throughout the academy. Hence, coaches should take care to give all younger players a similar playing time on the pitch.

While the older (U13/U14) earlier and later maturing players in this academy were given a similar amount of playing time in matches, earlier maturers covered a greater distance than later maturers by high speed running in both absolute (~56%, ~200 m) and relative (~44%, ~200 m·h^{-1}) terms. Moreover, earlier maturers spent a higher percentage of time performing high speed running compared to later maturers (3.5% vs. 2.5%). Therefore, these results suggest that advanced biological maturity can result in an enhanced high-speed match running performance in the U13/U14 elite youth soccer players. Given that the estimated chronological age at PHV methodology overestimates the actual chronological age at PHV in the 13 and 14 year old boys, this finding possibly emerges in the U13/U14 group because it is in this age group that the variation in maturity status will be the greatest. Thus, in terms of talent identification and development in this age group, coaches should perhaps focus less on high speed match running performance and possibly focus more on other elements (e.g., technical elements and tactical understanding) particularly as specific skills have been reported to be the most discriminating factors between elite and non-elite U13/U14 soccer players (28). Alternatively, clubs and coaches need to ensure that maturity is taken into account in the talent identification and development process.

One previous study has also shown that maturity can affect progression in soccer, in that more mature U15 and U16 French National Institute of Football players were less likely to progress to gain a professional contract (15). In the present study, numbers were too small to examine retention and release statistically, but it is of interest in the U13/U14 age group of the current study that only 30% of earlier maturing players were retained for more than two forthcoming seasons (after the end of data collection for the present study) whereas 60% of later maturers were retained for more than two forthcoming seasons. These findings from the previous and present studies are possibly because players with advanced maturity status have a reduced margin for improvement compared to players who are behind in maturity status (28). Thus, possibly some players are selected for, or retained within, the academy or clubs between 13-16 years of age because they are advanced in terms of biological maturity, but these players may not have a high chance of gaining a professional contract (14). Further work is needed to examine the impact of maturity in youth soccer players on future progression in the game.

PRACTICAL APPLICATION

Biological maturity has been previously shown to influence physical characteristics and physical performance in adolescent male soccer players (8,19), but the effect of maturity on match running performance has not been previously examined. In the present study, using an inexpensive, easy and simple to use method (23), players with advanced biological maturity were shown to receive a greater playing time in the U9/U10 age group and in older age groups covered a greater distance at high speeds than less mature players in English Premier League Academy soccer players. However, these more mature players may not progress as well through the academy and on to professional football as they will be closer to their potential than less mature players, who if retained, may catch and overtake the earlier maturers at a later date (15). Thus, coaches need to be aware of the influence of biological maturity on playing time and high speed match running performance in elite youth soccer players and are encouraged to provide a similar playing time for all young players. Furthermore, particularly in the 13-14 year old age group, coaches might be best advised to focus more on technical elements and tactical understanding rather than match running performances or to take biological maturity into account in the talent identification, development and selection process.

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Tables

Table 1. The speed zones ($m \cdot s^{-1}$), pitch and penalty area dimensions (m) and match duration of the U11-U16 squads.

	U9	U10	U11	U12	U13	U14	U15 and U16
Standing and walking ($m \cdot s^{-1}$)	0.0 - 1.0	0.0 - 1.0	0.0 - 1.1	0.0 - 1.1	0.0 - 1.1	0.0 - 1.2	0.0 - 1.2
Jogging ($m \cdot s^{-1}$)	1.1 - 2.0	1.1 - 2.1	1.2 - 2.1	1.2 - 2.2	1.2 - 2.2	1.1 - 2.3	1.3 - 2.4
Low speed running ($m \cdot s^{-1}$)	2.1 - 3.1	2.2 - 3.1	2.2 - 3.2	2.3 - 3.2	2.3 - 3.3	2.4 - 3.5	2.5 - 3.7
Moderate speed running ($m \cdot s^{-1}$)	3.2 - 4.1	3.2 - 4.2	3.3 - 4.2	3.3 - 4.3	3.4 - 4.4	3.6 - 4.6	3.8 - 4.9
High speed running ($m \cdot s^{-1}$)	> 4.1	> 4.2	> 4.2	> 4.3	> 4.4	> 4.6	> 4.9
Pitch dimension (m)	44.8 x 26.0	44.8 x 26.0	78.7 x 54.1	78.7 x 54.1	88.0 x 64.2	100.8 x 68.2	100.8 x 68.2

Match duration	15 min x 4 or (20 min x 2 + 15 min x 2)	15 min x 4 or (20 min x 2 + 15 min x 2)	(20 min x 2 + 15 min x 2) or 25 min x 3	25 min x 3	25 min x 3	40 min x 2	40 min x 2

Table 2. Chronological age, estimated chronological age at PHV, match running distance (m) of earli**er** and lat**er** maturers from the U9/U10, U11/U12, U13/U14 and U15/U16 age groups.

		U9/U10			U11/U12			U13/U14			U15/U16		
		Earlier	Later	*d*	Earlier	Later	*d*	Earlier	Later	*d*	Earlier	Later	*d*
N		11	11		13	13		8	8		8	8	
Chronological age (years)	Mean	9.3	9.3	0.12	11.6	11.6	0.14	13.8	13.4	0.74	15.6	15.3	0.45
	SD	0.4	0.5		0.5	0.5		0.4	0.6		0.6	0.6	
Sitting height (cm)	Mean	75.0	72.4	0.73	81.3**	78.0	0.93	92.0**	83.9	3.75	96.9**	92.1	1.66
	SD	2.7	4.3		4.2	2.6		2.6	1.5		2.3	3.4	
Estimated chronological age at PHV (years)	Mean	12.6**	13.0	1.48	13.2**	13.5	1.86	13.2**	13.8	3.43	13.3**	13.8	2.04
	SD	0.3	0.3		0.2	0.2		0.2	0.2		0.2	0.3	
Mean playing time (min)	Mean	57.5**	51.4	1.39	59.5	60.5	0.10	58.4	54.0	0.59	71.3	73.9	0.26
	SD	4.2	4.6		9.8	9.9		8.4	6.3		11.8	7.9	
Distance (m) *Total*	Mean	4604**	4069	1.24	5613	5754	0.17	6167	5598	0.64	7967	8289	0.28
	SD	541	287		852	826		1120	559		1481	721	
Walking	Mean	990*	878	1.04	1040	1036	-0.02	977	897	0.75	1265	1240	0.10
	SD	94	119		154	227		133	72		304	174	

Jogging	Mean	1692*	1490	0.96	1684	1713	0.09	1820	1758	0.21	2558	2658	0.30
	SD	244	168		303	334		244	327		398	249	
Low speed	Mean	1214	1058	0.66	1508	1530	0.07	1715	1661	0.14	2253	2416	0.37
running	SD	294	162		370	264		500	245		573	254	
Moderate	Mean	509	467	0.33	869	912	0.25	1001	866	0.49	1251	1255	0.02
speed running	SD	143	105		184	147		360	155		352	130	
High speed	Mean	173	176	0.05	512	513	0.01	651**	417	1.99	639	719	0.43
running	SD	78	44		168	112		144	85		231	123	

Significantly different to later maturers at $*p < 0.05$ and $**p < 0.01$.

Table 3. Match running distance (m·h^{-1}) and time spent (%) in each speed zone in earli**er** and lat**er** maturers from the U9/U10, U11/U12, U13/U14 and U15/U16 age groups.

			U9/U10			U11/U12			U13/U14			U15/U16		
			Earlier	Later	*d*	Earlier	Later	*d*	Earlier	Later	*d*	Earlier	Later	*d*
N			11	11		13	13		8	8		8	8	
Distance (m·h^{-1})	*Total*	Mean	4800	4771	0.08	5682	5734	0.14	6314	6230	0.24	6698	6748	0.13
		SD	370	376		393	362		412	279		462	297	
	Standing and walking	Mean	1035	1022	0.17	1052	1023	-0.33	1013	1001	0.10	1060	1005	0.51
		SD	81	71		52	115		151	79		143	57	
	Jogging	Mean	1759	1743	0.10	1704	1707	0.01	1873	1941	0.43	2166	2162	0.02
		SD	169	157		180	225		125	184		176	109	
	Low speed running	Mean	1261	1246	0.06	1510	1523	0.07	1741	1863	0.36	1883	1970	0.33
		SD	270	225		199	167		344	322		326	178	
	Moderate speed running	Mean	531	554	0.15	883	916	0.21	1012	959	0.27	1050	1026	0.14
		SD	144	157		170	147		251	109		213	118	
	High speed	Mean	180	207	0.40	533	520	-0.07	671**	466	1.89	539	585	0.35

	running	SD	78	54		210	126		117	98		165	85	
	Standing and walking	Mean	44.9	45.3	0.11	44.4	43.5	-0.19	41.3	40.1	0.32	38.1	37.6	0.13
		SD	4.5	4.5		3.7	4.8		4.3	3.1		5.5	2.8	
	Jogging	Mean	34.7	34.1	0.23	30.0	30.2	0.06	30.9	32.4	0.45	34.7	34.5	0.11
		SD	2.5	2.8		3.1	3.3		2.5	4.1		2.9	1.4	
Percentage of time (%)	*Low speed running*	Mean	14.8	14.5	0.11	15.9	16.1	0.14	17.1	18.2	0.36	17.5	18.3	0.33
		SD	3.0	2.6		2.2	1.8		3.4	2.8		3.0	1.6	
	Moderate speed running	Mean	4.4	4.6	0.18	6.8	7.1	0.28	7.2	6.9	0.26	7.0	6.8	0.18
		SD	1.1	1.3		1.3	1.1		1.9	0.8		1.4	0.8	
	High speed running	Mean	1.2	1.3	0.32	3.0	3.0	0.05	3.5**	2.5	1.80	2.7	2.9	0.36
		SD	0.5	0.3		1.1	0.8		0.7	0.5		0.8	0.4	

Significantly different to later maturers at ** $p < 0.01$.