Excelling at youth level in competitive track and field athletics is not a prerequisite for later success

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Abstract

Enhancing our understanding of athlete development would be valuable for coaches, parents and administrators to set realistic performance expectations and to advance youth sport policy. To this end, a database of track and field performances was examined. Records of 134,313 performances by athletes aged between 12 and 35 years in sprinting, throwing, jumping and middle distance events were analysed. Results revealed that a minority (Male, 9%; Female, 13%) of top 20 ranked senior athletes were also ranked in the top 20 at Under 13 (U13). These results were supported by the finding that a minority of athletes retained their top 20 ranking at subsequent age grades (36.3% U13-U15; 23% U13-U17; 13% U13-U20; 43.3% U15-U17; 22.1% U15-U20; 41.8% U17-U20). By U20, less than 30% of athletes who had been ranked in the top 20 at U13 were still listed on the national rankings. Examining a broader sample of athletes revealed weak to moderate correlations between performances at different age grades until at least Under 17-Under 20. These findings reinforce the message that excelling at youth level in competitive athletics is not a prerequisite for senior success.

Keywords: early specialisation, youth success, youth sport, adolescent athlete

Introduction

Promising young athletes are routinely selected to talent development programmes such as specialised sport schools or club academies (van Rens, Elling, & Reijgersberg, 2015; Vaeyens, Güllich, Warr, & Philippaerts, 2009). Within sports that are measured in centimetres, grams, or seconds (termed CGS sports; e.g., track and field athletics), such selection is often on the basis of current performance levels (Andronikos, Elumaro, Westbury, & Martindale, 2015; Boccia et al., 2017). However, performances at youth level are thought to be relatively independent of long term potential due to the highly complex and nonlinear nature of athlete development (Abbott, Button, Pepping, & Collins, 2005; Abbott & Collins, 2002; Baker, Schorer, & Wattie, 2017). That said, there is a paucity of research tracking changes in performance over the development of young athletes (Boccia et al., 2017; Costa, Marinho, Bragada, Silva, & Barbosa, 2011). Enhancing our understanding of changes in performance across development would be valuable for coaches, parents and administrators to set realistic performance expectations and to advance youth sport policy (Shibli & Barrett, 2011; Tønnessen, Svendsen, Olsen, Guttormsen & Haugen, 2015).

Previous research has investigated the relationship between youth and adult success in a range of sports (Barreiros, Côté, & Fonseca, 2014; Durandt, Parker, Masimla, & Lambert, 2011; Güllich & Emrich, 2006; Moesch, Elbe, Hauge, & Wikman, 2011; Sokolavas, 2006). For example, Barreiros et al. (2014) found that only one third of athletes who had competed internationally at pre-junior level (≤16 years) in soccer, swimming, volleyball or judo also competed at senior level. Focusing on different age grades within youth sport, Durandt et al. (2011) found that the majority (76%) of players who competed at the national level at the Under 13 Craven Week rugby tournament in South Africa did not compete at the Under 18 tournament in subsequent years. Within track and field athletics specifically, Shibli and Barrett

(2011) examined a sample of 513 athletes ranked in the top 20 in the United Kingdom at Under 15; only 12% of these athletes retained this status at the Under 20 age grade. Boccia et al. (2017) examined the performances of Italian athletes from the age of 12 to career termination based on records from a national database. Only 0-5% of eventual top level (top 4%) senior long and high jumpers were considered top level when they were 12-13 years of age. The percentage of eventual top level senior athletes considered top level at 16 years of age ranged from 10% (male long jumpers) to 59% (female high jumpers). Taken together, these studies clearly illustrate that youth success is not a prerequisite for senior success.

While a number of studies have identified that the developmental trajectory of elite athletes is nonlinear and highly variable (Abbott et al., 2005; Gulbin, Weissensteiner, Oldenziel, & Gagné, 2013; Huxley, O'Connor, and Larkin, 2017), there is a lack of research quantifying changes in athletic performance across age groups (Boccia et al., 2017; Costa et al., 2011). Costa et al. (2011) tracked the performance progression of swimmers from 12 to 18 years. Pearson correlation coefficients between performances at age 12 and age 18 were generally low, ranging from -0.62 to 0.31. Correlations between performances at different ages were typically strong for consecutive years (e.g., age 12 v age 13). However, correlations between performances two and three years apart were much lower until approximately 16 years of age, at which point strong correlations emerged and were interpreted as evidence of performances stabilising. Within track and field athletics, Boccia et al. (2017) found a similar pattern of correlations in the performances of Italian long and high jumpers. These studies suggest that the performances of youth athletes may be expected to show high variation before the age of 16 years, although caution is urged in generalizing this finding to other athletic disciplines which are underpinned by different physiological processes which develop at different rates through adolescence (Lloyd & Oliver, 2012; Malina, Bouchard, & Bar-Or, 2004).

Limited research has investigated sex differences in the developmental trajectories of track and field athletes. In an analysis of the 100 all-time best Norwegian athletes at each age from 11 to 18, Tønnessen et al. (2015) found that male and female athletes performed almost equally up to the age of 12, but that the rate of development in males was higher than that of females from that age onwards. However, as the all-time best athletes were analysed at each age grade, the development of individuals was not assessed. Boccia et al. (2017) tracked athlete across age grades, and found that top senior female long and high jumpers were more likely to have attained success at younger ages than their male counterparts, however their results are restricted to these jumping events.

Understanding the manner in which athletic performances change through youth sport is important for coaches, parents, and sport scientists working in talent development to set realistic performance expectations and to design effective talent pathways. The Power of 10 (www.thepowerof10.info) is a publically accessible database which collates performances from youth and senior track and field competitions in the United Kingdom. Such statistics databases provide a wealth of information which can be used to study athlete development (Brazo-Sayavera, Martínez-Valencia, Müller, Andronikos, & Martindale 2017; Boccia et al., 2017; Saavedra-García, Gutierrez-Aguilar, Sa-Marques, & Fernandez-Romero, 2016). Specifically, we explored the relationship between youth and adult success by conducting a retrospective analysis of when top ranked senior athletes were first ranked in the top 20 for an age grade. As retrospective and prospective approaches have produced differing perspectives on the importance of youth success (Hollings & Hume, 2010), we subsequently examined the proportion of athletes who had been ranked in the top 20 at youth level who (a) retained a national ranking, and (b) retained a top 20 ranking in subsequent age categories. Finally, we examined changes in performance across development for a broader sample of athletes by correlating performances across age categories for all athletes for whom data was available.

Method

Data was acquired from a publicly-available website, www.powerof10.info, which hosts information on athlete track and field performances and rankings within the United Kingdom. All data used in this study is reported anonymously. Institutional ethical approval was obtained for the project.

Retrospective Analysis

A retrospective analysis was undertaken to investigate the relationship between junior and senior success. All senior athletes ranked in the top 20 of the senior age category for each of eleven events (100m, 200m, 400m, 800m, 1500m, sprint hurdles, long jump, high jump, shot put, javelin and discus) at the end of the 2014-15 track and field season were identified. Senior athletes were defined as those who were too old to compete in the Under 20 category. Events longer than 1500m and the 400m hurdles were not considered as Under 13 (U13) athletes do not compete in these events, while neither pole vault nor hammer were considered due to the specialist facilities required to train for these events. The top 20 ranking criterion was chosen as this represented athletes who could reasonably be expected to make national semi-finals. Furthermore, as the top 20 has previously been used in the analysis of athlete progression and retention within UK athletics populations (Morris & Nevill, 2006; Shibli & Barrett, 2011), using this category facilitated comparison with previous research.

A profile of each athlete is available on www.powerof10.info, including performances and rankings at each age grade. These profiles were examined for each athlete’s ranking at each age grade. The top ranking for each athlete at each age grade was identified, irrespective of event (i.e., if a future top long jumper was first nationally ranked in the 100m at Under 13

(U13), then he/she was listed as being nationally ranked at U13). Athletes for whom no information was available at an age grade, whether through not competing or not performing well enough to be ranked, were noted as “unlisted”. Where an athlete was ranked in the top 20 in multiple events (e.g., long jump and high jump), the highest ranking was used with all duplicate records removed. The final sample was comprised of 184 senior men and 151 senior women.

Prospective Analysis

All participants who appeared on the Power of 10 database in one of nine events (100m, 800m, 1500m, sprint hurdles, long jump, high jump, shot put, discus, javelin) between 2005 and 2015 were identified. These events were chosen as they represent the core athletic disciplines (sprint/hurdle, run, jump, throw). Due to the need to accurately identify athletes across age categories, records without dates of birth were also excluded. Birthdates were available for 67% of U13s, 69% of U15s, 79% of U17s, and 89% of U20 athletes.

Within the United Kingdom, youth athletes are organized within two- (U13, U15, U17) or three-year (U20) age bands. Each athlete was only counted once per age category; the analysis was therefore restricted to those athletes who were in the final year of each age category. Due to various factors such as injury or school exams, it is possible that an athlete may not achieve their best performance within their final year in an age grade. As such, the performance (and ranking) identified for each athlete at each age grade was the best performance that he/she had achieved across all years within the age grade. This process resulted in 134,313 records being identified. These records were sorted into categories based on age grade (i.e., U13, U15, U17, U20), event, and sex. Senior athletes were not considered due to the relatively low numbers of senior athletes who could be traced back to junior ranks.

To perform a prospective analysis, all athletes who were ranked within the top 20 at U13 were first identified. Only athletes who were old enough to have completed their time at the higher age group were analysed (i.e., as data was available up to 2015, records from U13 athletes active in the years 2005-2008 were examined to compare performances at U13 and U20, whereas to compare performances at U13 and U15, records from the years 2005-2013 were examined). The percentages of athletes who were ranked in the top 20 at U13 and who (i) were still ranked on the Power of 10 database at subsequent age grades, and (ii) who maintained their top 20 ranking at subsequent age grades, were calculated. This process was then repeated for athletes ranked in the top 20 at U15 (tracked at U17 and U20) and at U17 (tracked at U20).

Inter-relationships between performances at different age grades

To analyse the relationship between performances at different age grades, the 134,313 records were processed using customised Microsoft Excel spreadsheets. These spreadsheets matched individual records between two categories (e.g., Girls U13 long jump and Girls U15 long jump) on the basis of name and date of birth. The number of athletes who were shared between categories ranged from 27 (male javelin U13-U20) to 1285 (male 100m U15-U17), with a mean of 392 athletes per comparison.

Data Analysis

Descriptive statistics are presented on the age at which senior athletes were first ranked within the top 20. To analyse whether top ranked senior male and female athletes differed in the age at which they first achieved top 20 ranking, χ^2 Goodness of Fit tests were applied. Cramer's V provided a measure of effect size, with values of 0.1, 0.3 and 0.5 indicating small, medium and large effect sizes, respectively (Cohen, 1992). To analyse whether top 20 ranked juvenile male and female athletes differed in the proportion that retained a top 20 ranking, retained a ranking outside of the top 20, or were no longer listed on the national rankings, χ^2 Goodness of Fit tests were again applied.

Pearson correlation coefficients were calculated to determine the relationship between performances in the different age categories. This statistical procedure has previously been applied to the longitudinal analysis of long and high jumpers (Boccia et al., 2017) and swimmers (Costa et al., 2011). When repeated measures are correlated, relatively higher correlation values may be expected due to covariates such as diet and training (Fallowfield, Hale, & Wilkinson, 2005). Consequently, values of ±0.2-0.5 were classified as weak correlations, values of ±0.5-0.7 were classified as moderate correlations, and values of ±0.7-1.0 were classified as strong to very strong correlations (Fallowfield et al., 2005), approximately representing ≥5%, ≥25% and ≥50% shared variance respectively. Fisher's r to Z transformation was used to test whether the correlation coefficients from male and female samples differed (Field, 2009).

Results

Retrospective Analysis

Figure 1 illustrates the percentage of top 20 ranked male and female senior athletes who were first ranked in the top 20 at each age grade. For both male and female athletes, the majority of participants were unlisted at the U13 age grade, and even at U15 level, 60% of men and 49% of women were still not listed on the database. By U17, the majority of top ranked senior athletes were not only listed, but 48% of men and 58% of women were ranked within the top 20 for that age grade. The proportion of male and female athletes did not differ at U13 $\chi^2 = 1.58$, $V = 0.06$, $p = 0.21$, or U20 $\chi^2 = 1.30$, $V = 0.08$, $p = 0.25$. However, significant differences with a small effect size emerged at both U15 $\chi^2 = 4.64$, $V = 0.11$, $p = 0.03$, U17 $\chi^2 = 6.89$, $V = 0.14$, $p = 0.008$. Inspection of Figure 1 suggests that these differences are due to relatively more males than being unlisted at both U15 and U17, and relatively more females than males being ranked in the top 20 at both U15 and U17.

Prospective Analysis

The percentage of athletes who were ranked in the top 20 at one age grade, and who (1) retained a national ranking, and (2) retained a top 20 ranking in subsequent age categories, is summarised in Figure 2 and presented in additional detail in Table 1. It is clear that there is a high turnover in the number of athletes who are ranked on the Power of 10 database, with the highest proportion of athletes retained between adjacent age categories. Similarly, the proportion of athletes who retained their top 20 ranking across age groups was lowest between U13 and U20. Even between the two oldest age groups, on average only 41.8% of top 20 ranked U17 athletes were still ranked in the top 20 at U20 (range 32.6-50.0%).

Further inspection of Table 1 reveals that males and females show similar rates of retention within the Power of 10 database, and retention of top 20 rankings. When data from the different events was pooled, χ^2 Goodness of Fit tests revealed statistically significant differences between the sexes in the proportion of athletes with no ranking, ranked outside of the top 20, and ranked within the top 20. The comparison between males and females in the transition from U13 to U15 showed a small effect: $\chi^2 = 32.80$, $V = 0.11$, $p < 0.001$, due to a relatively higher number of males having no ranking at U15. While the remaining comparisons showed statistically significant differences between the sexes, examination of the effect size in these cases suggested that this result was due to the sample size rather than a genuine effect: U13 to U17, $\chi^2 = 6.30$, $V = 0.06$, $p = 0.012$; U13 to U20, $\chi^2 = 7.93$, $V = 0.08$, $p = 0.005$; U15-U17, $\chi^2 = 3.90$, $V = 0.04$, $p = 0.048$; U15 to U20, $\chi^2 = 10.8$, $V = 0.08$, $p = 0.001$; U17 to U20, $\chi^2 = 16.7$, $V = 0.09$, $p < 0.001$.

Table 1.

Retention of top 20 ranked youth athletes in subsequent age grades by age and sex.

Sex	Event	U13-U15			U13-U17			U13-U20			U15-U17			U15-U20			U17-U20		
		N	%Com	%RTR	N	%Com	%RTR	N	%Com	%RTR	N	%Com	%RTR	N	%Com	%RTR	N	%Com	%RTR
Male	100m	146	76.0%	26.0%	115	43.5%	13.0%	65	18.5%	3.1%	192	74.5%	31.8%	124	33.1%	9.7%	138	67.4%	32.6%
	Hurdles	146	80.1%	31.5%	113	47.8%	16.8%	56	26.8%	12.5%	153	68.0%	39.9%	100	34.0%	22.0%	105	49.5%	39.0%
	800m	156	79.5%	33.3%	128	51.6%	21.9%	75	41.3%	9.3%	161	80.1%	39.1%	106	51.9%	17.9%	131	76.3%	38.9%
	1500m	160	78.1%	28.8%	128	66.4%	21.9%	75	38.7%	9.3%	164	79.9%	37.8%	114	48.2%	17.5%	130	70.0%	41.5%
	HJ	180	74.4%	29.4%	138	46.4%	20.3%	79	30.4%	13.9%	185	70.8%	39.5%	131	41.2%	16.8%	144	54.2%	40.3%
	LJ	153	56.2%	26.8%	118	33.9%	17.8%	70	20.0%	11.4%	136	68.4%	39.0%	82	42.7%	23.2%	120	69.2%	45.8%
	Discus	137	80.3%	39.4%	108	60.2%	23.1%	65	33.8%	16.9%	149	77.9%	49.7%	103	52.4%	28.2%	121	71.9%	49.6%
	Shot	132	76.5%	37.9%	102	50.0%	26.5%	57	29.8%	15.8%	149	75.8%	48.3%	100	42.0%	27.0%	116	58.6%	42.2%
	Javelin	132	72.0%	42.4%	104	51.9%	30.8%	58	17.2%	6.9%	151	74.2%	49.0%	102	30.4%	17.6%	109	56.0%	39.4%
Female	100m	157	83.4%	33.1%	120	58.3%	25.0%	66	36.4%	21.2%	155	70.3%	36.8%	97	41.2%	26.8%	98	69.4%	50.0%
	Hurdles	146	85.6%	38.4%	111	43.2%	20.7%	55	21.8%	10.9%	140	74.3%	45.7%	86	40.7%	25.6%	95	54.7%	38.9%
	800m	156	84.1%	38.2%	127	56.7%	23.6%	72	34.7%	16.7%	141	78.0%	46.1%	95	48.4%	23.2%	110	60.9%	43.6%
	1500m	149	84.8%	40.4%	124	55.6%	25.8%	70	28.6%	12.9%	132	78.0%	47.7%	89	42.7%	25.8%	102	59.8%	39.2%
	HJ	192	83.5%	36.6%	147	57.1%	25.2%	87	19.5%	11.5%	157	78.3%	42.7%	107	33.6%	21.5%	111	44.1%	36.0%
	LJ	163	83.4%	35.6%	124	55.6%	21.0%	70	24.3%	10.0%	144	72.9%	42.4%	99	35.4%	17.2%	106	58.5%	42.5%
	Discus	143	80.7%	41.4%	115	57.4%	29.6%	65	29.2%	15.4%	131	81.7%	57.3%	86	47.7%	33.7%	102	61.8%	50.0%
	Shot	36	86.1%	41.7%	34	70.6%	23.5%	72	29.2%	20.8%	*	*	*	*	*	*	*	*	*
	Javelin	29	93.1%	51.7%	40	55.0%	27.5%	60	31.7%	15.0%	*	*	*	*	*	*	*	*	*

Note: N refers to the total number of athletes in the sample who were ranked in the top 20 at the younger age grade. %Com refers to the percentage of athletes who were still competing at a high enough standard to be ranked in their final year at the older age grade. %RTR refers to the percentage of athletes who retained their top 20 ranking in the older age grade. U = Under. HJ = high jump. LJ = long jump. *Due to a change in weight during the period of investigation, no data was available for these events.

Inter-relationships between performances at different age grades

Pearson correlation coefficients describing the inter-relationships between performances at different age grades are presented in Table 2. Correlations between performances at U13 and all subsequent age grades were weak to moderate for both males and females. Correlations between adjacent age grades (i.e., U13-U15; U15-U17; U17-U20) tended to be larger than correlations between non-adjacent age grades. The strongest correlations were evident for throwing events. Strong correlations between performances at U17 and U20 existed for most events, especially in the throwing events.

Fourteen of the 54 comparisons (nine events x six age groups) showed a significant difference ($p < 0.05$) in the strength of the correlation coefficient between male and female samples. In all 14 cases, correlations were stronger within the female samples (significant differences are highlighted by shaded cells within Table 2).

Table 2.

Pearson correlation coefficients indicating the relationship between performances at various age grades by event and by sex

Sex	Event	U13-U15		U13-U17		U13-U20		U15-U17		U15-U20		U17-U20	
		N	r [95% CI]	N	r [95% CI]	N	r [95% CI]	N	r [95% CI]	N	r [95% CI]	N	r [95% CI]
Male	100m	955	0.53 [0.48, 0.58]	387	0.42 [0.33, 0.50]	66	-0.04 [-0.28, 0.20]	1285	0.57 [0.53, 0.61]	278	0.35 [0.24, 0.45]	616	0.62 [0.57, 0.66]
	Hurdles	516	0.56 [0.50, 0.62]	195	0.39 [0.26, 0.50]	39	0.20 [-0.13, 0.48]	506	0.68 [0.63, 0.72]	109	0.49 [0.34, 0.62]	175	0.65 [0.55, 0.72]
	800m	1103	0.55 [0.50, 0.59]	471	0.43 [0.35, 0.50]	114	0.11 [-0.07, 0.29]	1169	0.63 [0.60, 0.67]	341	0.42 [0.33, 0.50]	662	0.66 [0.61, 0.70]
	1500m	1063	0.56 [0.51, 0.60]	490	0.39 [0.31, 0.46]	101	0.18 [-0.02, 0.36]	1115	0.63 [0.59, 0.66]	330	0.38 [0.28, 0.47]	637	0.65 [0.61, 0.70]
	High Jump	668	0.57 [0.52, 0.62]	243	0.45 [0.34, 0.55]	51	0.08 [-0.20, 0.34]	654	0.63 [0.58, 0.67]	184	0.33 [0.19, 0.45]	303	0.74 [0.68, 0.79]
	Long Jump	698	0.55 [0.49, 0.60]	298	0.45 [0.36, 0.54]	65	0.34 [0.11, 0.54]	574	0.69 [0.64, 0.73]	121	0.46 [0.30, 0.59]	363	0.70 [0.65, 0.75]
	Discus	407	0.65 [0.59, 0.71]	168	0.52 [0.40, 0.63]	40	0.51 [0.24, 0.71]	518	0.72 [0.67, 0.75]	150	0.57 [0.45, 0.67]	288	0.83 [0.79, 0.86]
	Shot	497	0.69 [0.64, 0.73]	205	0.56 [0.45, 0.64]	40	0.25 [-0.06, 0.52]	567	0.75 [0.71, 0.78]	165	0.53 [0.42, 0.64]	273	0.82 [0.77, 0.85]
	Javelin	408	0.63 [0.57, 0.69]	166	0.59 [0.48, 0.68]	27	0.38 [0.00, 0.66]	418	0.78 [0.74, 0.81]	106	0.64 [0.51, 0.74]	245	0.81 [0.76, 0.85]
Female	100m	1151	0.56 [0.52, 0.60]	370	0.44 [0.35, 0.52]	56	0.43 [0.19, 0.62]	889	0.64 [0.60, 0.68]	194	0.62 [0.53, 0.70]	298	0.73 [0.67, 0.78]
	Hurdles	1049	0.59 [0.55, 0.63]	310	0.36 [0.26, 0.46]	47	0.14 [-0.15, 0.41]	646	0.67 [0.63, 0.71]	120	0.42 [0.25, 0.55]	183	0.70 [0.61, 0.76]
	800m	1226	0.60 [0.57, 0.64]	462	0.46 [0.38, 0.53]	101	0.41 [0.23, 0.56]	846	0.69 [0.65, 0.72]	194	0.51 [0.39, 0.60]	293	0.77 [0.72, 0.81]
	1500m	810	0.64 [0.60, 0.68]	294	0.48 [0.39, 0.57]	59	0.62 [0.43, 0.76]	763	0.72 [0.69, 0.76]	208	0.56 [0.46, 0.65]	289	0.66 [0.59, 0.72]
	High Jump	912	0.57 [0.52, 0.61]	337	0.39 [0.30, 0.48]	36	0.46 [0.15, 0.68]	679	0.69 [0.65, 0.73]	125	0.55 [0.42, 0.66]	184	0.78 [0.71, 0.83]
	Long Jump	1200	0.58 [0.54, 0.61]	405	0.36 [0.27, 0.44]	81	0.13 [-0.09, 0.34]	798	0.69 [0.65, 0.72]	205	0.47 [0.36, 0.57]	276	0.76 [0.70, 0.80]
	Discus	466	0.67 [0.61, 0.71]	169	0.64 [0.54, 0.72]	35	0.45 [0.13, 0.68]	447	0.81 [0.78, 0.84]	129	0.65 [0.54, 0.74]	194	0.85 [0.81, 0.89]
	Shot	294	0.69 [0.63, 0.75]	141	0.43 [0.29, 0.56]	60	0.44 [0.21, 0.62]	*	*	*	*	*	*
	Javelin	189	0.74 [0.66, 0.80]	71	0.55 [0.37, 0.70]	37	0.38 [0.07, 0.63]	*	*	*	*	*	*

Note: values in square brackets indicate 95% confidence intervals ([Lower Limit, Upper Limit]); * indicates that no data is available for this comparison due to a change in the rules governing the weight of implements. Shaded cells indicate where significant differences between male and female samples were identified at $p < 0.05$.

Figure 3 further illustrates the typical relationships between performances at different age groups, using female 800m runners as an exemplar. Considerable variability is evident in the performances, even in comparisons where the correlations are strong. For example, athletes who progressed to run under 2 minutes 10 seconds (the qualifying time for the 2017 European U20 Championships 800m) as an U20 had run between 2 minutes 18 seconds and 2 minutes 36 seconds as U13s (*M* = 2 minutes 27 seconds, SD = 5.9 seconds), between 2 minutes 7 seconds and 2 minutes 28 seconds as U15s (*M* = 2 minutes 16 seconds, SD = 4.4 seconds), and between 2 minutes 3 seconds and 2 minutes 23 seconds as U17s (*M* = 2 minutes 11 seconds, SD = 4.0 seconds).

Discussion

The results of this study extend previous research by demonstrating that the prediction of adult and U20 performance from early youth performances is problematic across a wide range of disciplines, and across multiple age categories. Analyses of the age at which top 20 ranked senior athletes first achieved a top 20 ranking as a junior, of the percentage of top 20 ranked athletes retaining their top 20 ranking across different age grades, and of the correlations between performances at different age grades, all clearly indicated that performances at the lowest age grade of youth athletics (U13) have a weak relationship with performance at U20 or senior levels. This finding is consistent with previous research in a range of sports (e.g., Barreiros et al., 2014; Moesch et al., 2011; Sokolavas, 2006), including track and field athletics (Boccia et al., 2017; Huxley et al., 2017; Shibli & Barrett, 2011).

While the majority of senior athletes were not listed on the national rankings at U13, it is not clear whether this result is due to the limited number of performances held on the national database when these senior athletes were competing as juniors, or due to these athletes not competing in athletics at that point. For example, in 2005, 136 U13 male athletes were ranked in the 100m. In 2015, 750 athletes were ranked in the equivalent category. Consequently, caution is required in interpreting the differences between the “unlisted” and “ranked outside the top 20” categories. Limited information is available on the age of first athletic competition, but Boccia et al.’s (2017) finding that the average age of entry into competition for Italian long and high jumpers was between 14 and 16 years of age is consistent with our results. Furthermore, the age at which an athlete experienced their initial competition is likely to be less important than the nature of their initial exposure to athletics; that is, the extent to which the athlete engaged in deliberate play or deliberate practice, and whether the athlete specialised in track and field or was engaged in a range of sports (Côté & Vierimaa, 2014; MacPhail, Gorely, & Kirk, 2003; Shibli & Barrett, 2011). Nevertheless, the finding that the majority of seniors were not top ranked as U13 athletes reinforces the message that *excelling* at the youngest level of competitive athletics is not a prerequisite for senior success.

This conclusion is reinforced when examining the percentage of athletes who retained a top 20 ranking across age grades (Figure 2). At all age grades, only a minority of athletes retained their top 20 ranking. This finding is consistent with that of Shibli and Barrett (2011), who tracked 513 athletes ranked in the top 20 in 2005 through to 2010, and found that only 12% of athletes retained a top 20 ranking. In the present study, 22.1% of top 20 ranked U15 athletes were found to have retained their top 20 ranking. The difference between the two figures may be due to the greater sample size in the current study (N = 1621 for the U15-U20 comparison), or the wider range of years over which athletes were tracked (2005-2015). The present study extends Shibli and Barrett’s (2011) findings, by illustrating that the high turnover in top ranked performers begins at U13, and is relatively consistent across events. The high turnover is potentially not just related to holding a top ranking, as the results revealed that a large proportion of athletes were no longer listed on the national rankings 4-6 years later on.

Again, the results are consistent with Shibli and Barrett's (2011) comparison of the U15 to U20 transition (44% still competing relative to 42% in the current study).

Examining the inter-correlations between performances at different age grades reveals that the performance variability of top ranked athletes is also evident for the broader athletic population. A strong relationship between performances at different age grades does not emerge until at least U17-U20. Although there are slight differences between the absolute values for the correlations in Italian long and high jumpers (Boccia et al. 2017) and those reported by the present study, the general pattern of results is consistent across the two studies on athletics, and that of Costa et al. (2011) in swimming. The magnitude of the correlations, particularly between performances at U13 and U20, emphasise that the range of performances from which high achieving athletes may develop is very broad. In the girls 800m example, the top 256 ranked U13 girls from the 2016-17 season would be identified as performing at a level from which, historically, performers capable of qualifying for the European championships have developed. Especially when considered in light of previous research which has found that peak athletic performance is not achieved until the mid-twenties for explosive power/sprint events, or even later for endurance events (Allen & Hopkins, 2015; Shibli & Barrett, 2011), these findings reinforce the need to delay selection for development squads until late adolescence where possible (Abbott et al., 2005; Andronikos et al., 2015).

Correlations between performances were highest for the throwing events, particularly during late adolescence. This result suggests that greater confidence may be had in the selection of talented female throwers during late adolescence, as there is no difference in the weight of implements thrown by U20 and senior women. In contrast, the discus and shot thrown by senior men are heavier than those thrown by U20 men. Consequently, further tracking of athlete performances through senior level is required before firm conclusions can be drawn regarding selections of male athletes.

While there were no differences between males and females on the majority of measures, a number of potentially important differences emerged. Top ranked senior female athletes were more likely to have been top ranked at U15 and U17 than their male counterparts. Secondly, correlations across age grades for several events tended to be higher in females than in males. These findings are likely due to females maturing earlier than males (Cumming, Standage, Gillison, & Malina, 2008; Malina et al., 2004). Despite these sex differences, it is important to note that approximately half of top ranked senior female athletes were still unranked at U15, while the correlations, despite being larger than those for males, were still not strong until U17-U20. Therefore, there does not appear to be any reason to vary selection policies between male and female athletes until at least late adolescence.

There are a number of limitations with this study. Primarily, the database did not contain sufficient data to trace athletes from youth levels through to the finish of their senior career. A greater depth of historical data would allow more accurate conclusions to be drawn regarding the relationship between youth and adult success. Secondly, as performances below a certain standard were not recorded, the correlation coefficients calculated may underestimate the actual value due to restricted range (Howell, 2012). However, the consistency of findings from the age of initial top 20 ranking, and the percentage of athletes who retained their top 20 ranking across age grades, support the pattern of results from the correlation coefficients. Finally, when an athlete is not listed on the national database, it is not clear whether that athlete has dropped out of the sport, or is simply no longer competing at a high enough level to be ranked. Consequently, no conclusions can be drawn regarding dropout from this data.

This study has presented a picture of youth athletics in the United Kingdom. Future research should examine the extent to which key stakeholders are aware of this picture, and what strategies they are implementing to provide an optimal youth sport experience (Bergeron et al., 2015). While much previous research has focused on coaches' knowledge (Fiander, Jones, & Parker, 2013; Lewis, Morgan, & Cooper, 2015; Andronikos et al., 2015), research should also consider the knowledge and strategies implemented by parents (Elliott, Drummond, & Knight, 2017; Harwood & Knight, 2016; Knight, Dorsch, Osai, Haderlie, & Sellars, 2016). Misunderstandings of youth development are likely to lead to problems in relation to early specialisation such as dropout (Crane & Temple, 2015; Fraser-Thomas, Côté, & Deakin, 2008) and injury (Hall, Foss, Hewett, & Myer, 2015; Wilhelm, Choi, & Deitch, 2017). Consequently, it is vital that any misunderstandings regarding high performance in juvenile competitions be addressed.

In conclusion, analyses of a range of different variables indicate that performances at the lowest grade of youth athletics (U13) have a weak relationship with performance at U20 or senior levels. Consequently, administrators, coaches and parents need to consider what structures are implemented at the level of national organization, club and practice session to ensure an optimal youth development experience.

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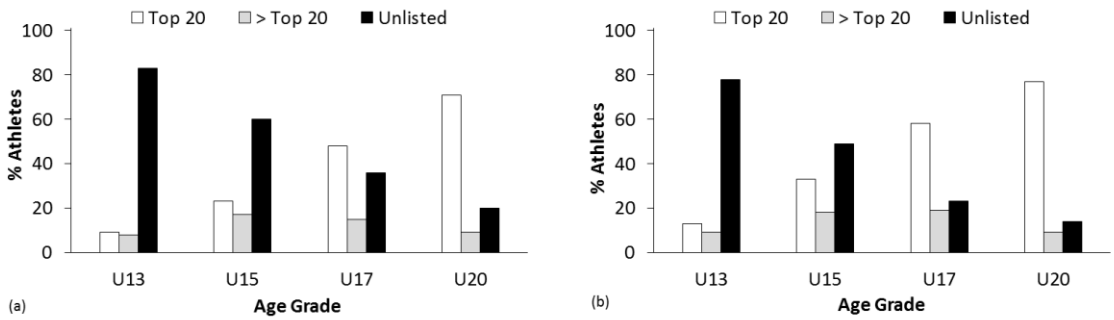

Figure 1. The percentage of top 20 ranked (a) senior male, and (b) senior female athletes at the end of the 2014-15 track and field season who were ranked in the top 20 at each age grade. U = Under.

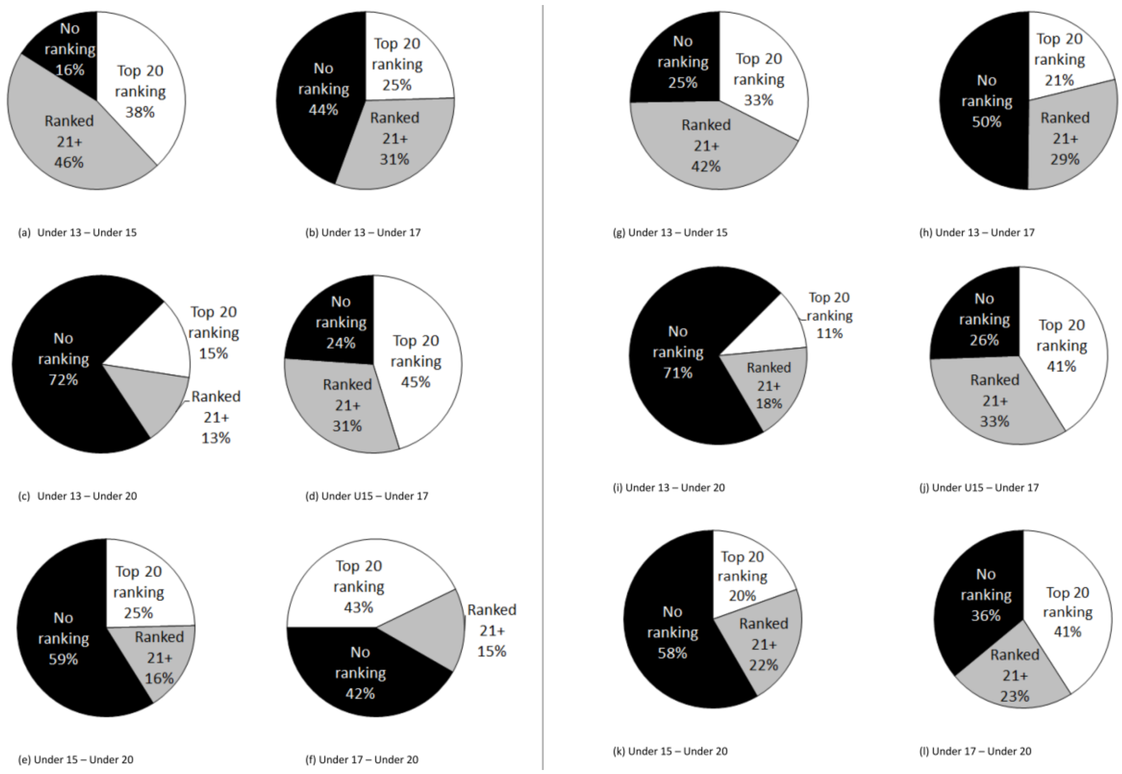

Figure 2. The proportion of top 20 ranked female (a to f) and male (g to l) athletes at the lower grade who retained their top 20 ranking (white portion), retained a national ranking outside the top 20 (grey ranking), or no longer appeared on the rankings (black portion).

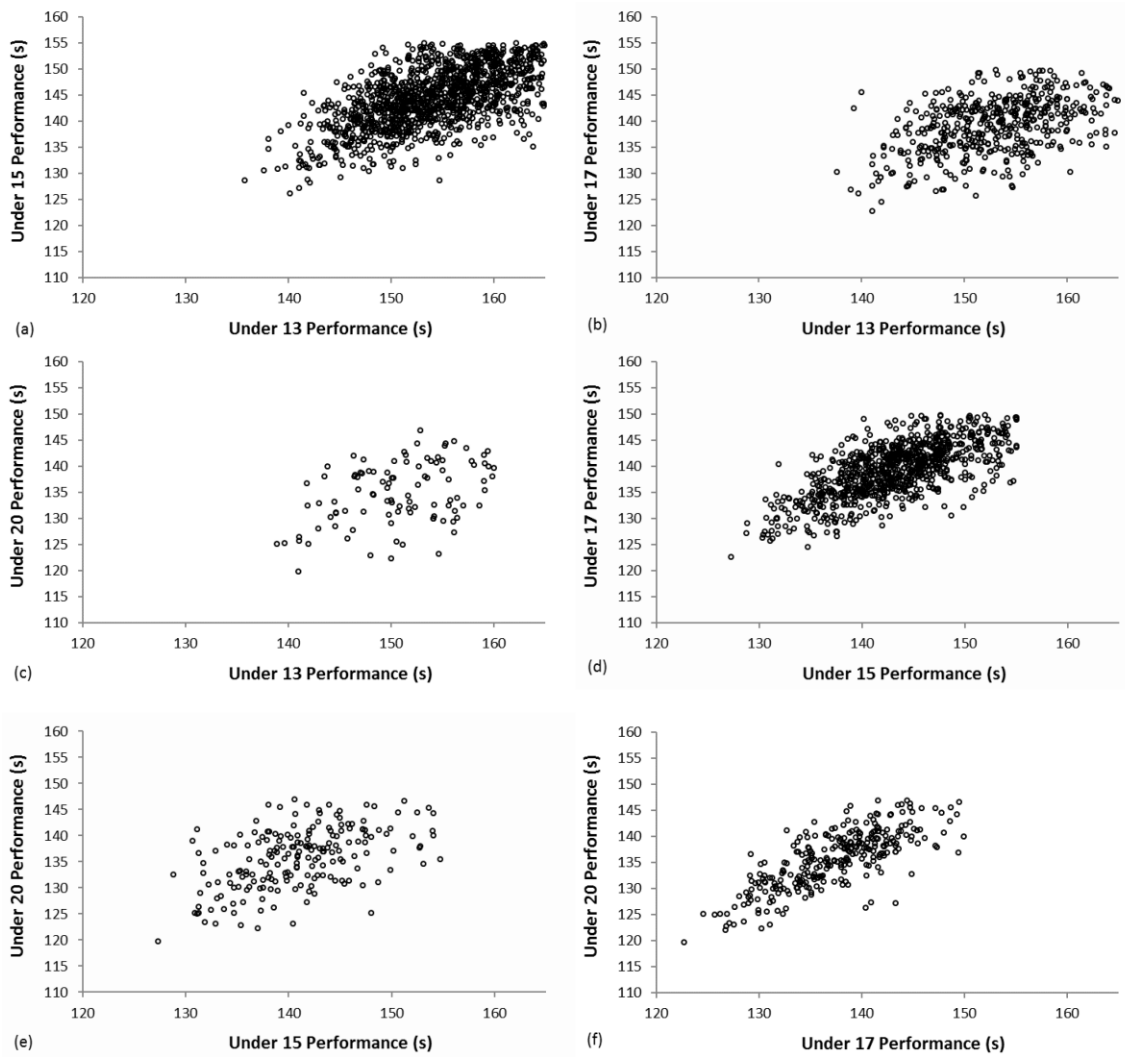

Figure 3. Illustration of the relationships between performances at various age groups for female 800m runners; (a) Under 13 relative to Under 15, (b) Under 13 relative to Under 17, (c) Under 13 relative to Under 20, (d) Under 15 relative to Under 17, (e) Under 15 relative to Under 20, (f) Under 17 relative to Under 20.