GROWTH AND MATURITY STATUS OF ELITE BRITISH JUNIOR TENNIS PLAYERS

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Abstract

Purpose.

Growth and maturation impact the selection, development and progression of youth athletes. Individual differences in the growth and maturity may afford a performance advantage, clouding coaches and practitioners' perceptions regarding current ability and future potential. This may result in the exclusion of talented, yet less physically gifted athletes.

Methods.

Participants were 91 male (n=47) and female (n=44) elite British Junior tennis players 8-17 years of age (12.5±1.9 years). Height and body mass were measured and compared to growth charts; Hand-wrist radiographs were taken. Skeletal age was estimated with the Fels method and contrasted to chronological age.

Results.

Mean height and body mass of individual players ranged between the 50th and 90th centiles for age and sex. Females were advanced in skeletal age relative to chronological age (0.3-.89 yrs.) from eight years. Males were average to delayed in maturation from 8-12 years, but advanced in skeletal age from 14 to 16 years (0.75-1.23 yrs.).

Conclusions.

Individual differences in growth and maturation appear to contribute towards the selection of elite junior tennis players, with a bias towards males and females who are advanced in maturation, and comparatively tall and heavy for their age. This has important implications for talent identification and development.

Introduction

Studies of the growth and maturity characteristics of youth tennis players date to the 1980s and early 1990s are limited and by the selective nature of tennis may not generalize to adult samples. Three studies of male players (U.S., Italy, Finland) indicated mean heights that varied between the 25th percentiles and medians of U.S. reference values in late childhood and early adolescence, while mean body mass approximated the medians (Malina, 1994). In contrast, two studies from the former Czechoslovakia indicated taller heights and heavier body masses than the reference medians in players 12-13 years. Corresponding data in four studies of female tennis players (Australia, former Czechoslovakia), indicated mean heights above the reference medians, specifically during adolescence, but mean body mass near the reference medians (Malina, 1994). Trends from a mixed-longitudinal study of select Australian youth players followed in the 1980s were similar (Blanksby, 1994). Mean height and body mass of male players were consistently above the reference medians from 11 to 17 years of age, while those of females were initially below the reference but approximated the reference medians at 15 and 17 years of age.

Data for a mixed-longitudinal sample of elite U.K. tennis players spanning 1987-1992 (Training of Youth Athletes, TOYA) presented mean heights of males that were above U.K. reference medians at 10-12 years, were at the reference medians at 13-15 years, and approximated the 75th percentiles at 16-18 years; mean body masses were at the reference median from 10 through 15 years and above the reference from 16-18 years. Corresponding means heights of U.K. female players were slightly above the U.K reference medians from 10-12 years and then moved to approximate at the 75th percentile by 15 years and remained at this level; mean body masses of females were at the reference medians at 10 and 11 years, but then increased with age and approximated the 75th percentile by 14 years, and remained just below this level through 18 years of age (Baxter-Jones & Helms, 1996; Erlandson, Sherar, Mirwald, Maffulli, & Baxter-Jones, 2008). Data for more recent tennis studies are generally consistent with observations for the TOYA sample (Bass et al., 2002; Bergeron, McLeod, & Coyle, 2007; Ducher, Bass, Saxon, & Daly, 2011; Girard & Millet, 2009; Juzwiak, Amancio, Vitalle, Pinheiro, & Szejnfeld, 2008; Sánchez-Muñoz, Sanz, & Zabala, 2007). Overall, the data available for youth tennis players are consistent with the secular trend indicated for elite adult male players, though the magnitude of the trend is less.

Data on the maturity status of youth tennis players are very limited, especially at elite junior and senior level. Testicular volume of male players in the TOYA study approximated reference values for boys (Baxter-Jones, Helms, Maffulli, Baines-Preece, & Preece, 1995). Skeletal ages of nine Finnish players did not differ, on average, from chronological age at 11 years (Mero, Jaakkola, & Komi, 1989), while skeletal ages of 6 elite junior national Japanese players were, on average, in advance of chronological age from 12 to 14 years (Kanehisa, Kuno, Katsuta, & Fukunaga, 2006). Corresponding data for age at menarche are limited since samples include girls who have and have not attained menarche and are limited in chronological age ranged considered (Ducher et al., 2011). Mean ages at menarche of 13.2 and 13.3 years were reported for the sample of players in the TOYA study (Baxter-Jones, Helms, Baines-Preece, & Preece, 1994; Erlandson et al., 2008) suggesting later maturation than the norm at the time of collection (12.8 years) (Malina et al. 1991). Skeletal ages for 6 elite junior national Japanese female tennis players were, on average, advanced by one year relative to chronological ages from 12 to 14 years (Kanehisa et al., 2006). In contrast, skeletal ages of 14 elite female tennis players from the former Czechoslovakia were, on average, equivalent to their chronological ages at 14 and 17 years (Novotny, 1981).

Contemporary adult male and female tennis players generally present above average height and body mass (Burke, 2007; Kovacs, 2007; Reilly, 1990). Mean height of senior male elite players has increased steadily over the years, in contrast to the average population (Cole, 2000), with current male players are 9 cm taller than players 20 years ago (International Tennis Federation, 2013; Robson, 2011). The secular change in the heights of tennis players reflects the importance of size relative to service speed. Height accounts for as much as 50% of the variance in service speed (Vaverka & Cernosek, 2007), and an additional inch of racket length (i.e., height of service) increases first serve percentage by as much as 5% (Brody & Smith, 2001). With service speed of up to 263 km/hr. being recorded and taller players serving faster than their shorter counterparts (Association of Tennis Professionals, 2012; Vaverka & Cernosek, 2007), it is not surprising that tallness is an increasingly desirable attribute when identifying and selecting tennis players.

Size attained during childhood and adolescence is related, in part, to biological maturation (Malina, 2007). Individual differences in growth and maturation may directly and/or indirectly influence the selection, socialization (ie., developmental experiences and interactions) and/or persistence in sport as size advantages associated with advanced maturation may translate into performance advantages and also perceptions of coaches (Cumming, Eisenmann, Smoll, Smith, & Malina, 2005; Valente-dos-Santos et al., 2012). Within a given age group during late childhood and early adolescence, boys or girls advanced in biological maturation tend to be, on average, taller, heavier and carry greater mass-for-stature, than those who are later or delayed in maturation (Malina, 2007; Malina & Geithner, 2011).

This trend is most notable in male youth sports that require strength, speed, and power and in older and more elite samples (Malina, Ribeiro, Aroso, & Cumming, 2007). The latter reflects increases in selectivity or exclusivity of sport as youth pass through adolescence. Young female athletes tend to be ‘on time’ or slightly late in maturity, and possess stature and body mass that equals or exceeds age-specific medians (Baxter-Jones, Thompson, & Malina, 2002; Malina, 1994), though variation in size and maturity varies by sport. The degree to which variation in biological maturity status within a competitive age group contributes towards the selection and performance of junior tennis players remains unclear, especially at the elite level. (Baxter-Jones, Eisenmann, & Sherar, 2005; Van Den Berg, Coetzee, & Pienaar, 2006).

In light of the lack of evidence pertaining to the biological maturity of junior players at the elite level, the purpose of the study was to compare the growth and maturational status of elite junior tennis players against population norms. It is hypothesized that tennis players from both sexes will be above the 50th centile for stature and will display advanced maturation.

Methods

Participants

Participants included 91 elite male (n=47) and female (n=44) junior tennis players 8 through 17 years of age (12.5±1.9 years). The sample represented the top eight players in the Great Britain National rankings in their respective age groups (U10, U11, U12, U13, U14, U15, U16 and U18). It should be noted that players in an age category may be of the upper age limit. For example, a 10 year old could be competing in the U10 age group. In sample selection, a top eight player (n=41, males: 16, females: 25) was unable to attend the National Training Camp for assessment. In 16 cases (males: 6, females: 10) the next highest ranked player within the respective age group was invited to participate, while no additional player was invited in the remaining 20 cases. The males included 43 individuals self-identified as Caucasian, 2 as mixed race, 1 as black, and 1 as Indian. The females included 37 individuals self-identified as Caucasian, 4 as black, 2 as mixed race, and 1 as Indian.

Ethics

Ethical approval for the study was obtained from the Research Ethics Approval Committee for Health at the lead author's host University, with the approval from the Lawn Tennis Association. As the majority of participants were <16 years of age, written assent and consent was obtained from both participants and parents/guardians.

Procedures

Data were collected at a three-day camp at the National Training Centre in Roehampton, London. Participants arrived the day before assessment. In addition to the anthropometry, a radiograph of the left hand-wrist was taken for the purpose of assessing skeletal maturity status. The radiograph was taken by an onsite trained and certified technician.

Height was measured to the nearest 0.1cm using a calibrated Harpenden stadiometer fixed to a wall following standardized procedures (Malina, 1995). Participants stood barefoot, feet together and heels touching a metal plate attached to the wall. The participant took a deep breath just prior to the trained technician firmly placing the headboard of the stadiometer on the head. The measurement was then recorded. The mean difference in measurement between technicians was calculated. Associated standard deviations were -0.23 cm and 0.16 cm respectively, with a relative technical error of 0.12%. The intraclass correlation between assessments was excellent (ICC r=1.00).

Body mass was measured to the nearest 0.1kg using a calibrated Marsden Weighing Company DP2400 BMI Indicator scale. Wearing only a T-shirt and shorts, the participant stood barefoot on the scale with arms hanging loosely by the side and with body mass evenly distributed over both feet. The mean difference in replicate measurements between assessors and associated standard deviation was 0.0 kg (SD=.0) with a relative technical error of 0.10%. The Inter-investigator reliability was excellent (ICC r=1.00).

All 91 participants provided assent/consent for the hand-wrist radiograph for estimating biological maturity status. No players in the U18 age group consented to skeletal hand x-rays. The Fels method for estimating skeletal age (SA) was used (Roche, Chumlea, & Thissen, 1988). The Fels method was chosen on the basis that it employs a wider range of criteria to determine skeletal age and provides as standard error associated with each assessment, providing a greater degree of confidence regarding the predicted values (Malina et al., 2004).

Positioning of the hand-wrist for the radiograph was as follows. Participants placed the forearm, palm and fingers in contact with a cassette with the middle finger was positioned in line with the forearm. The fingers were splayed and fully extended. After bone-specific assessments and ratios were completed, the grades and ratios of each indicator in addition to chronological age (CA) (i.e., assessment date – birth date) and sex of the participant was entered into the Fels software program

(Felshw 1.0 Software) which computed the skeletal age and associated standard error (Roche et al., 1988).

All films were assessed by the same trained technician and also by an experienced independent assessor. The mean difference between assessors was -0.07 years, with a relative technical error of 1.4% and high intraclass correlation (r=.99, C.I. 95% = .99-1.00). Bland-Altman plots, which provide an estimate of bias and limit of agreement between assessors, indicated a slight positive, yet statistically significant, slope between assessors. The single outlier (>2 standard deviations) was a difference of -0.58 years at a mean skeletal age of 16.46 years.

Maturity status was expressed as the difference between skeletal age and chronological age (SA minus CA). The SA-CA difference was used to classify each player as late (SA younger than CA by >1.0 year), on time (average, SA within ±1.0 year of CA), or early (SA older than CA by >1,0 year) maturing (Malina, 2011).

Analysis

Descriptive statistics (means, standard deviations) were calculated for chronological age, height, body mass, skeletal age, and SA-CA. Height and body mass of individual players were also plotted relative to reference data for British youth (World Health Organization, 2013).

Results

Descriptive statistics for chronological age, height, body mass, skeletal age and SA-CA by sex and competitive age groups are summarized in Table 1. Table 2 details the distribution of elite male and female British tennis players by maturity status and age group and Table 3 details the CA, height and body mass by sex, competitive age group and maturity category. Height and body mass of Individual male tennis players and corresponding age group means are plotted relative to UK reference values (World Health Organization, 2013) in Figures 1-2. Heights and body masses of individual players range from the 25th to in excess of the 95th percentiles of the respective reference values. Mean heights fall between the 75th-90th centiles for the U10 and U12 groups, approximate the 90th centiles for the U14 group and the 75th centile for the U16 group (Figure 1). Mean body masses approximate the 75th centile for the U10 age group and fall between the 75th – 90th centiles for the other age groups (Figure 2).

Heights and body masses of individual female players and corresponding age group means are illustrated in Figures 3-4. Heights and body masses of individual players range from the 10th to in excess of the 95th percentiles of the respective reference values. Mean heights (Figure 3) and body masses (Figure 4) approximate at the 75th centile in the four competitive age groups.

Mean skeletal age of male U10 players is somewhat below mean chronological age, while mean skeletal age is similar to mean chronological age among male U12 players (Table 1). On the other hand, mean skeletal ages of U14 and U16 male players are in advance of the respective mean chronological ages.

Mean skeletal age of female players is in advance of mean chronological age in each of the four competitive age groups. Mean SA-CA differences vary by 0.30 and 0.89 years. Classifications of individual players as late, average (on time) or early in skeletal maturity status are summarized in Table 3. In the female sample, 29.5% were classified as advanced; 66% represented ‘on time’ and 4.5% were classified as late maturers. In the male sample, 32% were classified as advanced; 57% were ‘on time’ and 11% were late maturers.

The three contrasting maturity groups are present among U10 and U12 male players. No male players in the U14 and U16 groups are late in skeletal maturation, while equal numbers of male players in these competitive age groups are on time and advanced in skeletal maturation. In contrast, only two female players (U14) are late maturing. All others are on time or early.

A chi-square distribution analysis was performed to determine whether the three maturity groups were equally preferred in each age group of the male and female samples. In the female sample, the distributions of maturity was homogeneous, χ (6, N = 44) = 9.26, p = .16, with early maturing females dominant in all age groups. In the male sample, the three maturity groups were not equally distributed, χ (6, N = 47) = 14.07, p = .03, indicating an increased preference towards early maturing males in the older age groups (U14 and U16).

Discussion

This study described the growth and maturity characteristics of British elite junior male and female tennis players. Youth players of both sexes were, on average, taller and heavier compared to UK reference values. It should however be noted that some variation of the players height and body mass were apparent, with not all elite players exceptionally tall. Female players were, on average, advanced in skeletal maturation in each competitive age group, while male players were, on average, advanced in skeletal maturation only in the U14 and U16 age groups. These results suggest that individual differences in growth and maturity may contribute to the process of athlete identification and selection in elite junior tennis. The nature and magnitude of growth- and maturity-related variation to these processes of youth athlete development are not specifically known.

Although the youth tennis players presented, on average, greater height and body mass for age relative to UK reference values, the distributions of individual heights and body masses should be noted. The data suggested a reasonable degree of homogeneity in the distributions of height and body mass was apparent and, by inference, a high degree of selectivity. Only 12% of male and 9% of female players presented below average heights for age, while 15% of male and 14% of female players presented below average body mass for age (Figures 1 to 4). The small height and lower mass of the male players reflected those individuals who were late or on-time in maturation. In contrast, the number of females with below average body mass and height included a small percentage of individuals who were advanced in maturation.

Athlete selection and investment strategies that include or exclude youth on the basis of growth and maturity characteristics ensure that those who are most physically gifted for a given sport are identified and represented from an early age. The long-term benefit of such strategies has, however, been questioned, as they favor individuals on the basis of attributes that are highly variable and not fully realized until adulthood. Consequently, talented yet later maturing and/or relatively younger athletes may be overlooked or excluded. Ironically, such approaches may also disadvantage those individuals who are most physically gifted as youth. The pressure to succeed may encourage taller, heavier, or more mature players to play to their physical advantages at the expense of developing their technical, tactical or psychological skills. Additionally, more mature players may neglect to develop the physical attributes required at the senior elite level, as they already possess the physicality to cope with the demands placed on them at youth level. Similarly, coaches, parents, and/or scouts may form unrealistic expectations regarding their ability and future potential, falsely assuming that the physical advantages present in childhood/adolescence will be retained in adulthood. This explains why many talented young athletes fail to achieve their expectations as adults.

A maturity-related gradient with increasing chronological age is suggested in the skeletal age data for youth male athletes (Malina, 2011). The data for U10 and U12 tennis players suggested somewhat later maturation (Table 2). This contrasts, with observations on 9 youth tennis players in Finland who had presented skeletal age which was equivalent with chronological age (Mero et al., 1989). The advanced skeletal maturation noted among U14 and U16 players in the current study (Table 2) was consistent with trends in a longitudinal sample of 6 elite junior national Japanese players 11, 12, 13 and 14 years of age (Kanehisa et al., 2006).

The U10 and U12 players had, on average, heights and body masses that exceeded the reference medians although they were, respectively, slightly delayed and on time in skeletal maturation. Of note, the participants' final predicted heights exceeded the reference medians for adult males and females. Allowing for the relatively small sample sizes, this suggests that a predisposition for tallness independent of maturation status is an important predictor of tennis selection. That said, the advanced skeletal maturation of the U14 and U16 players was consistent with a size advantage in mid- and late-adolescent males. The under-representation of late and preponderance of on time and early maturing players in the older age groups is consistent with observations for male youth athletes in several sports including soccer, American football, swimming, athletics (track and field), (Malina, 2011). The athletic advantages of early maturation compared to age peers (i.e., greater size, strength, speed, and power) are most evident between 13 to 17 years; a period when males advanced in maturation are close to full maturity while late maturing males may still be in the initial stages of puberty (Malina et al., 2004). The greater proportion of early maturing males in the older age groups may also reflect age associated changes in the nature of the game (increased physicality), selection or exclusion by the coaching staff, talent identification protocols, individual selection, or a combination of these factors (Bailey et al., 2010; Malina et al., 2004).

The female tennis players in the current sample were, on average, advanced in skeletal maturation in all age groups (Table 2). This is consistent with trends in a longitudinal sample of 6 elite junior national Japanese players at 12, 13 and 14 years of age (Kanehisa et al., 2006), but contrasted observations for 14 elite players from the former Czechoslovakia who presented equivalent values for skeletal age and chronological age at 14 and 17 years of age (Novotny, 1981). However, only 2 players were classified as late maturing at 14 years of age. Classifications at 17 years are influenced by reduced variation in skeletal age as skeletal maturity is approached.

Allowing for the relatively small sample sizes, the trends in female players suggest that the size and athletic advantages associated with advanced skeletal maturity are apparent from an early age. These advantages (i.e., greater size and absolute strength) may counter potential performance disadvantages associated with pubertal gains in absolute and relative fat mass. Likewise, the regular physical activity associated with regular training in tennis reduce accumulations of fatness associated with early puberty in female tennis players, although body composition data for youth players are not extensive (Malina & Geithner, 2011). Estimated percentage fat predicted from skinfolds was 28% for elite adolescent players (15.9±0.6 years) and did not differ between high and low ranked players (Sánchez-Muñoz et al., 2007). Corresponding estimates for young adult female tennis players were variable but lower, 18% body fat based on skinfolds in two studies and 22% body fat based on densitometry (Malina, 2007).

The growth characteristics of the players in the current study (i.e. taller and heavier than average for their age) were consistent with those reported in previous research involving youth athletes (Malina, 2007; Malina & Geithner, 2011) and elite and sub-elite junior tennis players (Baxter-Jones et al., 2005; Erlandson et al., 2008; Sánchez-Muñoz et al., 2007). It should be noted, however, the mean values for height and body mass for the under 16 age groups in the current sample exceeded the equivalent values reported for male and female players of the same age competing in the 2005 and 2006 Junior Davis Cup tournaments (UK males +5.2cm & +3.3 Kg; UK females +1.8 cm & +1.3 Kg.) (Sánchez-Muñoz et al., 2007). The greater mean values for height and body mass observed in the current sample may reflect a number of factors, including a greater preference for selecting taller and heavier players in the UK system, self-selection based on the physical demands of the sport, a greater emphasis upon the development of muscle mass (in the case of body mass), and/or a secular trend towards the selection of taller and heavier players. These differences are worthy of further investigation, yet should be interpreted with caution due to the comparatively small sample sizes.

The findings in this study have several implications for tennis. First, the evidence suggests that elite junior tennis players are being identified and selected on the basis of their physical attributes with a preference for youth who present greater physical size, and/or advanced maturity. As noted, athlete selection and investment strategies that favor athletes on attributes not realized until adulthood risk including those who benefit as a result of their advanced maturity, while simultaneously excluding those who are equally, if not more, talented but delayed in maturation.

Accordingly, those involved in the development of young tennis players should consider how individual differences in size and maturity contribute to athlete selection, performance and development practices. For the purpose of evaluating talent and potential, researchers, alongside practitioners, may also develop fitness and performance standards that reflect individual differences in size and maturity and not simply CA. Separate standards could also be developed for athletes who succeed as adults, establishing profiles that more accurately represent the prerequisites for success at the professional level (Carling & Collins, 2014). Understanding that the physical advantages associated with early maturers are transient would allow coaches and physical trainers alike to focus on developing additional areas of their tennis game rather than relying on their physical prowess. This would arm these players with the skills necessary to make the transition to senior tennis rather than drop out once they are unable to match the skills of the late maturers as they catch up physically post puberty.

Limitations of the current study should be noted. First, the sample is small and limited to youth tennis players competing at the highest level in the United Kingdom. Consequently, these results should be interpreted with caution and may not generalize to players competing at different levels and/or from different countries. The cross sectional and descriptive nature of the study also implies that it is not possible to confirm any cause and effect associations between growth, maturation, and selection. Future research employing longitudinal or mixed longitudinal designs and including measures of physical, functional and psychosocial attributes are required in order to better understand how the processes of growth and maturation contribute athlete identification and selection in youth tennis and youth sports in general.

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Appendices

Table I

Means and standard deviations for chronological age (CA), height, body mass, skeletal ages (SA), and the difference between SA and CA (SA minus CA) by age groups of elite British female and male tennis players.

	Age Groups			
	U-10 n=10	U-12 n=17	U-14 n=12	U-16 n=5
Females	M (SD)	M (SD)	M (SD)	M (SD)
CA, yrs	9.81 (0.59)	11.79 (0.61)	14.11 (0.60)	15.67 (0.45)
Height, cm	141.72 (7.43)	156.05 (6.55)	163.96 (4.51)	166.26 (8.86)
Height Z-Score	.68	1.08	.62	.53
Body Mass, kg	33.17 (5.53)	44.54 (5.61)	57.00 (6.54)	61.26 (7.73)
Body Mass Z-Score	.24	.66	.76	.73
SA, yrs	10.59 (1.48)	12.18 (0.73)	14.40 (1.56)	16.56 (0.68)
SA-CA, yrs	0.78 (1.11)	0.39 (0.75)	0.30 (1.35)	0.89 (1.00)
Males	U-10 n=13	U-12 n=14	U-14 n=7	U16 n=13
	M (SD)	M (SD)	M (SD)	M (SD)
CA, yrs	10.48 (.26)	12.01 (.63)	13.49 (.32)	15.01 (.76)
Height, cm	146.15 (4.02)	153.40 (8.08)	170.77 (9.32)	175.92 (7.35)
Height Z-Score	.81	.70	1.50	.86
Body Mass, kg	36.15 (3.33)	43.69 (7.31)	56.34 (9.01)	64.73 (9.33)
Body Mass Z-Score	.53	.73	1.06	.85
SA, yrs	10.07 (1.09)	12.10 (1.17)	14.72 (0.91)	15.84 (1.28)
SA-CA, yrs	-0.41 (1.03)	0.09 (1.02)	1.23 (0.85)	0.75 (.99)

Z-Scores for height and body mass reflect mean values relative to age and sex specific norms

Table II

Distribution of elite male and female British tennis players by maturity status and age group.

	Age Group	Late	On-Time	Early	χ^2	P	Total
Males	U10	4	7	2			13
	U12	1	10	3			14
	U14	0	2	5	14.07	.03	7
	U16	0	8	5			13
	Total	5	27	15			47
Females	U10	0	5	5			10
	U12	0	14	3			17
	U14	2	6	4	9.26	.16	12
	U16	0	4	1			5
	Total	2	29	13			44

Table III

Descriptive statistics for height and body mass by maturity status and age groups in elite male and female British tennis players.

Age Group	Maturity Status	n	Male				n	Female			
			Height (cm) M (SD)	Height Z-Score	Body Mass (kg)	Body Mass		Height (cm) M (SD)	Height Z-Score	Body Mass (kg)	Body Mass
U10	Late	4	143.2 (3.0)	.35	35.6 (3.9)	.44	-	-	-	-	-
	On-Time	7	146.5 (3.5)	.86	35.8 (3.2)	.47	5	138.5 (5.2)	.48	30.60 (1.70)	.01
	Early	2	150.8 (4.0)	1.69	38.5 (3.9)	.95	5	144.9 (8.5)	.86	35.7 (.75)	.43
U12	Late	1	144.4	-.37	34.2	-.49	-	-	-	-	-
	On-Time	10	152.4 (8.3)	.49	43.0 (6.6)	.60	14	155.4 (6.4)	.99	43.9 (4.9)	.58
	Early	3	159.7 (3.6)	1.73	49.1 (7.9)	1.37	3	159.3 (7.8)	1.47	47.4 (9.1)	.92
U14	Late	-	-	-	-	-	2	164.0 (3.3)	-	57.7 (3.3)	-
	On-Time	2	160.5 (2.5)	.24	47.2 (7.9)	.14	6	165.6 (5.7)	.88	55.3 (7.9)	.57
	Early	5	174.9 (7.4)	2.01	60.0 (6.9)	1.37	4	161.6 (1.9)	.26	59.2 (6.1)	.98
U16	Late	-	-	-	-	-	-	-	-	-	-
	On-Time	8	176.3 (8.7)	.85	62.3 (10.7)	.60	4	163.2 (6.5)	.01	59.8 (8.1)	.54
	Early	5	175.4 (5.3)	.65	68.6 (5.5)	1.07	1	178.5	2.6	67.0	1.43

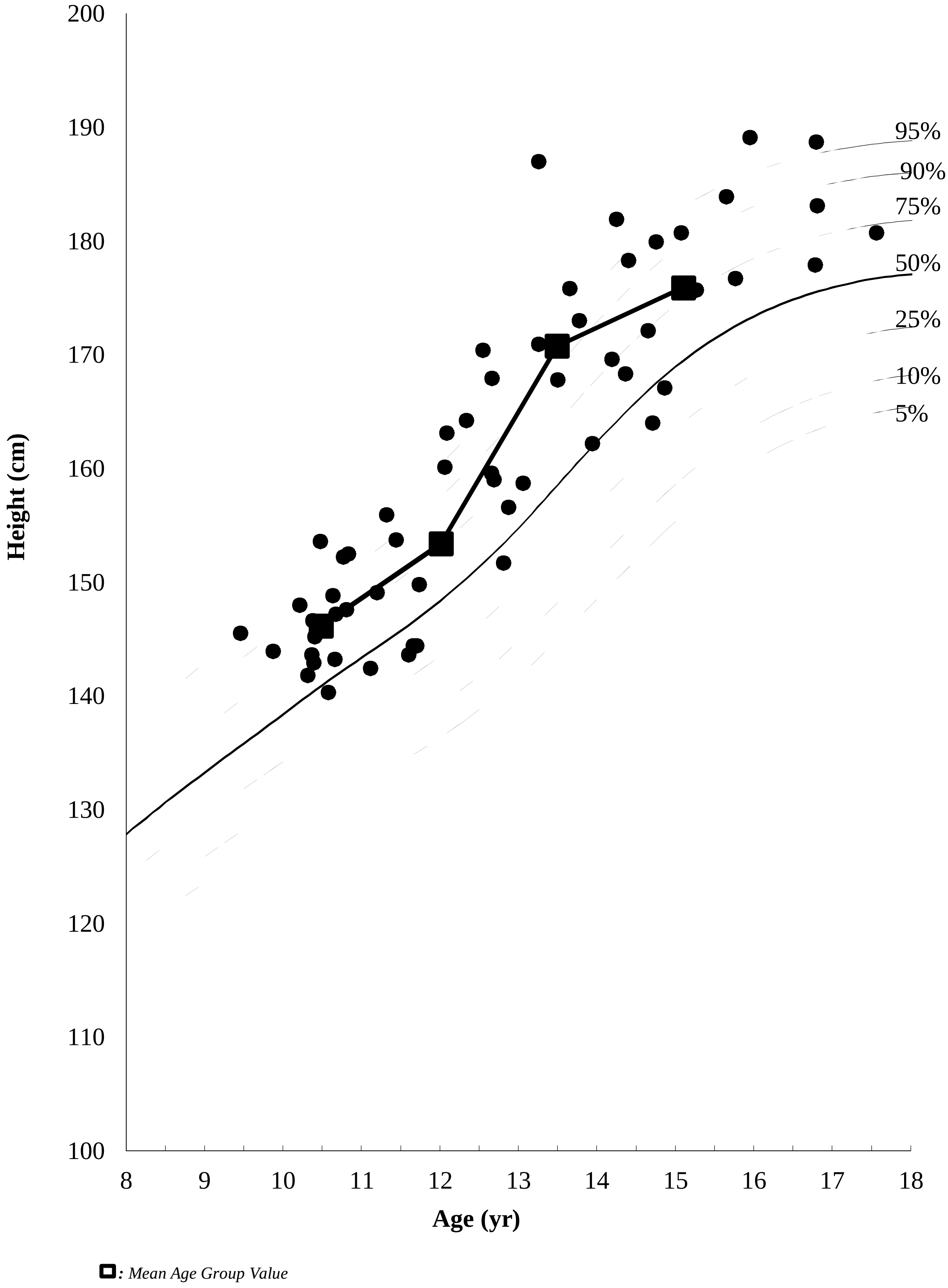


Figure 1. *UK Growth Charts depicting the distribution of UK elite male junior tennis players' heights relative to age*

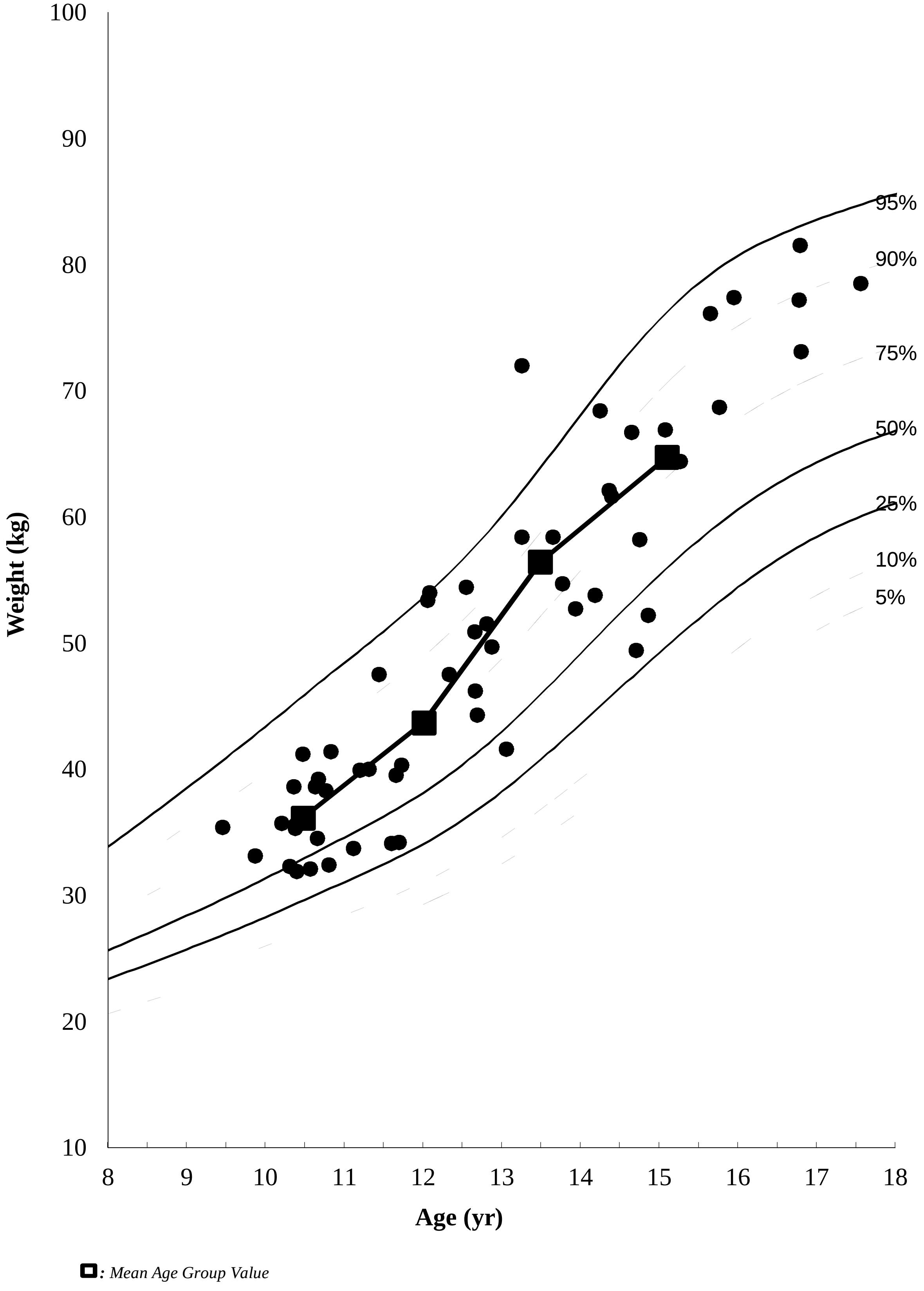


Figure 2. *UK Growth Charts depicting the distribution of UK elite male junior tennis players' weights relative to age*

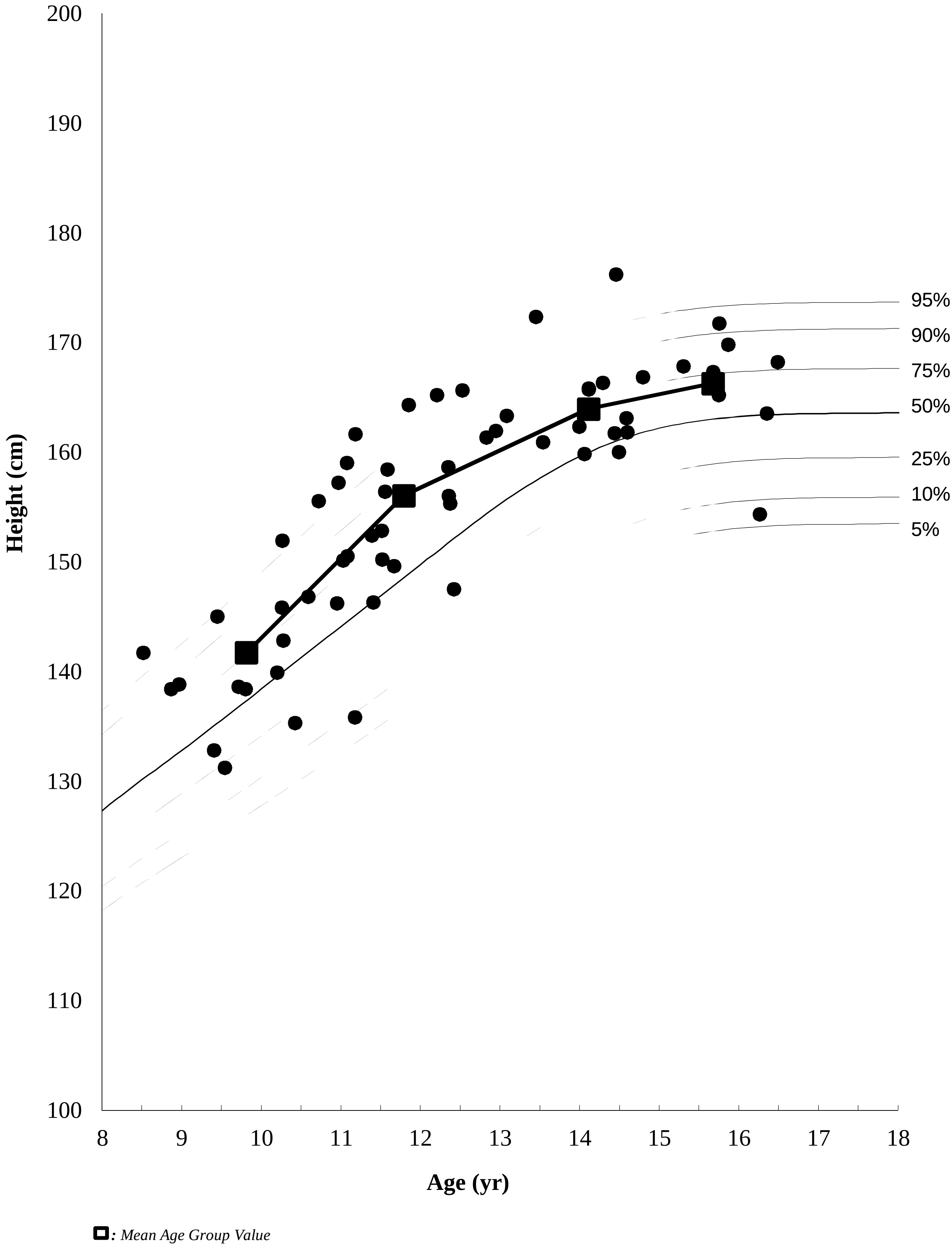
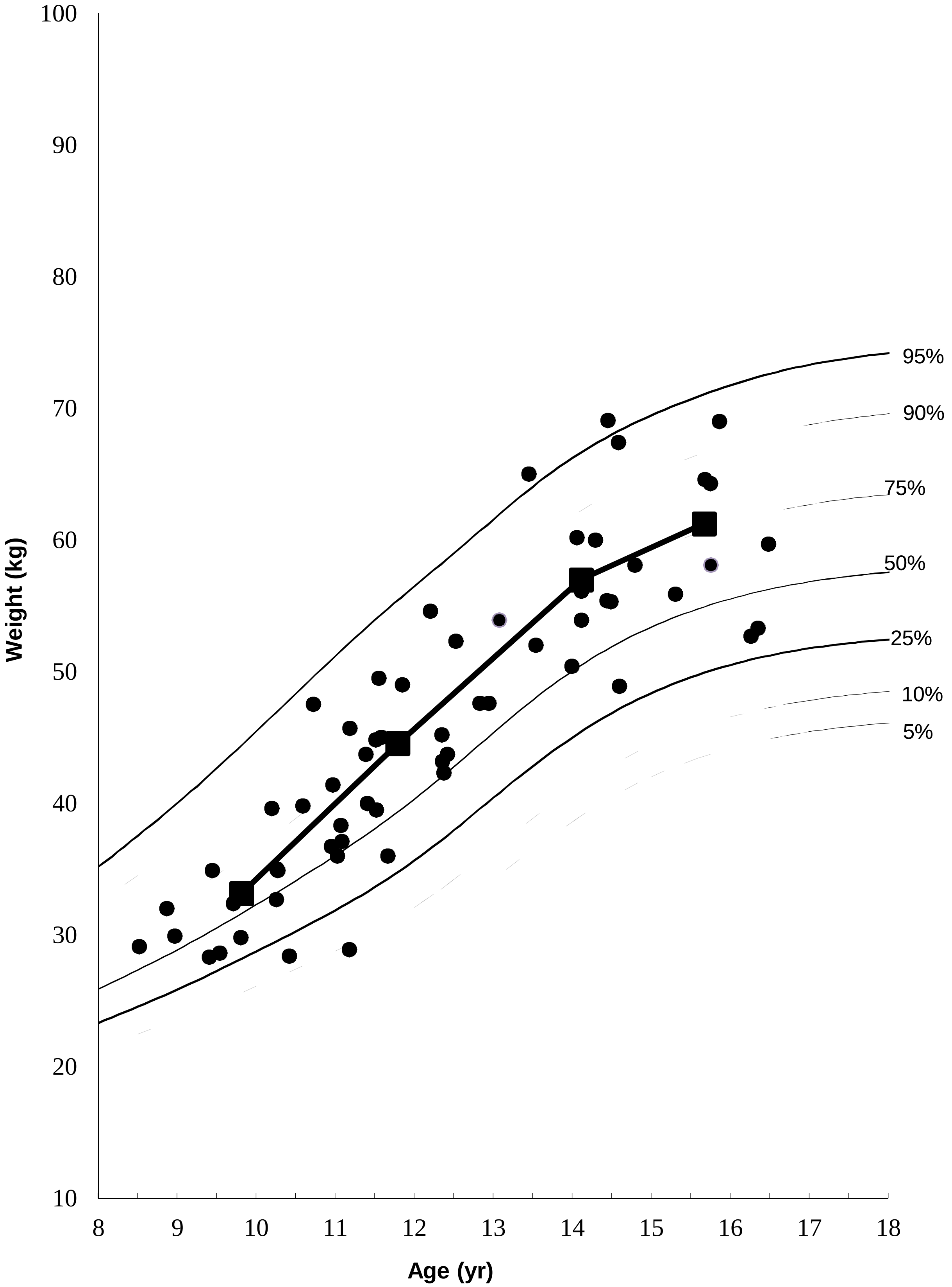


Figure 3. *UK Growth Charts depicting the distribution of UK elite female junior tennis players' heights relative to age*



: *Mean Age Group Value*

Figure 4. *UK Growth Charts depicting the distribution of UK elite female junior tennis players' weights relative to age*