Skeletal and Sexual Maturation and Growth in Tokyo Girls: Longitudinal Observations

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For the study of adolescent growth observation of data obtained from longitudinal surveys is indispensable, but in practice it is almost impossible because this type of study demands enormous patience of both research workers and subject children.

In the field of biological anthropology in Japan two important longitudinal growth study projects have been carried out. One was a study of mixed Japanese-American children born of Japanese women and occupation soldiers just after the Second World War. The semi-longitudinally analyzed results have been reported up to the present. The other is the study of twins surveyed from 1974 through 1991, of which the results are now being analyzed.

For the study of skeletal maturation, some cross-sectional studies based upon the Tanner-Whitehouse method must be

mentioned. The TW1 system, assessing morphological changes of bones appearing in the left hand and wrist on X-ray film, was applied first in Japan in 1968 and 1969 to Tokyo children aged 6 to 18 (Ashizawa, 1970). They were found to present one to one-and-a-half years advanced skeletal maturation over the British children's standard.

With the TW2 method, *i.e.*, revised TW1 rating system, children in Okinawa, Sapporo, Nagasaki, Amami-Oshima, and Nomozaki were assessed in the 1970s and 1980s (Kimura, 1977 a, b; Takai and Akiyoshi, 1983; Takai, *et al.*, 1984; Takai, 1990). Of these, the last one was longitudinally surveyed, but the results were reported semi-longitudinally.

Recently, radiation exposure regulations have become increasingly strict, and it has become almost impossible to survey skeletal maturation in healthy children. On the other hand, and contradictorily, data on normal healthy children's growth and maturation are being demanded by physicians according to the growing importance of treatment of short-stature children resulting from various conditions such as chromosomal aberrations, endocrinological abnormalities, and so on.

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Materials

The subject girls were selected from the data set of Eto and Ashizawa (1992). In this data set, TW2 X-ray observations conducted for more than 10 years from 1969 on 65 girls are provided with stature, body weight, and chest circumference. The subject girls were pupils in a group of private schools operated by a Buddhist temple whose families lived on the west side of Tokyo and were of an average socio-economic level in the capital. All of the girls were born between 1963 and 1966.

Comparing contemporary standard growth curves of Tokyo girls, which were published by the Ministry of Education, Science, and Culture in Japan, no statistical difference is observed between our subject group and the standard group in stature, chest circumference and body weight.

Among these 65 subjects, 44 were selected for this study because of their correctly recorded menarcheal date. Two girls did not show any peak in their weight or chest circumference velocity curves, so that we excluded them from this study of adolescent growth, thus reducing the subject number to 42.

Methods

(1) Growth data

To annually measured stature, body weight, and chest circumference growth curves of each girl the smoothing spline curve was applied. Smoothing spline velocity curves of these measurements were obtained as well for each individual girl with the age, size intensity, and size at the peak.

(2) Skeletal maturation

Skeletal maturation was assessed according to the TW2 rating system. To the RUS, Carpal, and 20-Bone skeletal maturity score curves and the annual velocity score curves of

Table 1. Means and standard deviations of menarcheal age, age at peak velocity, size intensity and size at the peak, and size at menarche of stature, body weight and chest circumference

	N	Means	SD
Menarcheal age (years)	42	12.36	0.98
Age at PHV (years)	42	11.06	0.93
PHV (cm)	42	7.76	1.20
Stature at PHV (cm)	42	141.62	6.42
Stature at menarche (cm)	42	150.26	6.39
Age at PWV (years)	42	11.79	1.32
PWV (kg)	42	6.47	1.82
Weight at PWV (kg)	42	38.97	6.81
Weight at menarche (kg)	42	41.75	6.77
Age at PCV (years)	42	11.81	1.19
PCV (cm)	42	5.44	1.30
Chest circumference at PCV (cm)	42	71.19	5.05
Chest circumference at menarche (cm)	42	73.60	5.53

each girl, the smoothing spline curve was applied. Age, score intensity, and score at the peak were obtained.

(3) Menarcheal age

The diary method was utilized. Specifically, at the beginning of this study, the mothers were asked in advance to record the date of menarche of their daughters at such time it should occur. The date was accurately recorded for the 44 girls, so that it was possible to record the correct menarcheal age.

Results

Table 1 presents the means and standard deviations of menarcheal age, age at peak velocity, size intensity and size at the peak, and size at menarche of stature, body weight and chest circumference.

Table 2 shows the means and standard deviations of age at peak score velocity, score intensity and score at the peak, and score at menarche of RUS, Carpal, and 20-Bone maturity scores.

We were able to summarize the order of the ages of peak velocity of three measure-

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ments, those of the three bone maturity scores, and menarcheal age. Menarche occurs at 12 years and 3 or 4 months of age (age 12.36). This is almost the same as the mean menarcheal age of Tokyo girls (12.3 years) but slightly precocious for Japan (12.5 years) as estimated from the *status quo* data of 1987 (Hinobayashi, 1990). RUS-score-peak-velocity appears closest to the menarcheal age, 11 years and 10 or 11 months; namely 4 or 5 months previous to menarche. Statural peak is attained 1 year and 3 months before menarche. Carpal-score-peak-velocity appears precociously, at age 9.

Table 2. Means and standard deviations of age at peak score velocity, score intensity and score at the peak, and score at menarche of RUS, Carpal and 20-Bone maturity scores

	N	Means	SD
Age at RUS-score-peak-velocity (years)	39	11.86	1.38
RUS-score-peak-velocity	39	128.2	23.3
Score at RUS-score-peak-velocity	39	702.3	119.0
RUS-score at menarche	42	752.0	77.2
Age at Carpal-score-peak-velocity (years)	33	9.02	1.26
Carpal-score-peak-velocity	33	118.3	34.9
Score at Carpal-score-peak-velocity	33	748.8	137.0
Carpal-score at menarche	42	987.3	15.4
Age at 20-Bone-score-peak velocity (years)	33	9.53	1.16
20-Bone-score-peak-velocity	33	118.6	25.0
Score at 20-Bone-score-peak-velocity	33	732.5	91.2
20-Bone-score at menarche	42	950.0	27.6

Table 3 presents statistically significant correlation coefficients concerning menarcheal age, stature, and RUS maturity score.

We can summarize these correlations as follows:

1) Girls experiencing an earlier menarcheal age show peak-height-velocity and RUS-score-peak-velocity with larger magnitude (intensity) at earlier ages, and are of a lower stature and smaller RUS-score at menarche.

2) Girls experiencing an earlier age at peak-height-velocity are of a lower stature at peak-height-velocity, but are of a larger magnitude (intensity) and earlier age at RUS-score-peak-velocity.

3) Girls having a larger peak-height-velocity show RUS-score-peak-velocity at an earlier age.

4) Girls having a taller stature at peak-height-velocity are of a taller stature at menarche.

5) Girls having a taller stature at menarche show a larger RUS-score at menarche.

6) Girls experiencing RUS-score-peak-velocity at an earlier age show a smaller score, but of a larger magnitude.

7) Girls having a larger RUS-score-peak-velocity show a smaller score at their peak velocity.

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Table 3. Statistically significant correlation coefficients concerning menarcheal age, stature, and RUS maturity score

	Menarcheal age	Age at PHV	PHV	Stature at PHV	Stature at menarche	Age at RUS-score peak	RUS-score p.velocity
Age at PHV	.687***						
PHV	-.354*	-.389*					
Stature at PHV		.414**					
Stature at menarche	.331*			.764***			
Age at RUS-score-peak	.350*	.508***	-.354*				
RUS-score-peak-velocity						-.333*	
Score at RUS-score-peak						.835***	
RUS-score at menarche		.561***			.360*		-.364*

* p < 0.05, ** p < 0.01, *** p < 0.001

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