

SKELETAL MATURATION OF GIRLS PARTICIPATING IN SPORTS

¹Kaur, G., ¹Sidhu, L. S., ²Sidhu, Maninder S. and ³Singh, J.

¹Department of Human Biology, Punjabi University, Patiala, India,
²Govt. Medical College, Patiala, India

³Department of Sports Anthropometry, Faculty of Sports Sciences, SAI, Netaji Subhas National Institute of Sports, India

Abstract: The present study has been conducted on 145 sports girls and 137 controls, belonging to Punjab State ranging in age from 12 to 16 years. The radiographs of left hand and wrist were taken and analysed using TW₂ method. The data were collected from September 1992 to September 1993. The results indicate that both sports girls and controls possess significantly greater skeletal ages than their chronological ages, but do not differ in their maturity status except at 15 years of age.

Keywords: Skeletal Maturity; TW₂ Bone Age; RUS Bone Age; Percentile.

Introduction

The assessment of skeletal maturity is currently used in clinical diagnosis and in monitoring endocrinological and growth disorders of children. The estimate of skeletal maturity can also be used in predicting the adult height of children during school years. The knowledge obtained from this type of study can be utilised in sports counselling. Only few studies are available on children participating in sports (Kato and Ishiko 1966, Cerny 1969, Malina 1986, Kotulan et al. 1980, Novotny 1981). In India such type of research studies are limited. Singh (1992) conducted study on sports and non sports boys of Punjab ranging in age from 11 to 19 years and found that sports boys are advanced in their skeletal maturity status as compared to their counterparts. But data on Indian female players are still lacking. Keeping this in view, the present study has been conducted on sports girls and non-sports girls of Punjab.

Objectives

The objectives of the study are as follows:

1. To provide the standards of skeletal maturity in girls from 12 to 16 years of age.
2. To elicit the differences in maturity status of sports girls and controls.
3. To present the range of variation for each bone of the hand and wrist.

Material and Methods

The data for the present cross-sectional study were collected on 145 sports girls and 137 controls ranging in age from 11.5 to 16.5 years during September 1992 to September 1993 from various schools/institutions of Punjab. The data on sports girls were also collected during Punjab state championship held at Pologrounds, Patiala, from

17th to 20th September, 1992. The data on controls were collected from Government Senior Secondary School, Pheel Khana, Patiala. The girls who regularly played games and participated atleast in district level competitions were included in the study, however, most of them have either participated in state or national level of school competitions. The players belonging to various games like Kabaddi, Kho-Kho, Hockey, Athletics, Swimming, Gymnastics, Basketball, Handball, Volleyball, Football, Judo and Archery were included in the study.

Since the chronological age plays an important role in the study so the date of birth of each girl was recorded carefully and then matched with the school register. Chronological age was calculated by using decimal calendar given by Tanner et al (1969).

The girls were then grouped into various age groups of one year duration. For example, all the girls having age between 11.5 and 12.499 placed in age group of 12 years and other groups are also made in this manner. The radiographs of left hand and wrist were taken following standard techniques given in TW₂ method (Tanner et al. 1975). In order to protect the children from radiation hazards, lead aprons were provided. Skeletal age (TW₂ 20 bone and RUS bone age) were assessed following TW₂ method. Percentiles were made according to the equations given by Youden (1951). Student's "t" test was applied to see whether the differences between two groups were significant or not.

Results

The results are presented as follows:

Normal age variation in maturity stages of bones of hand and wrist. Table 1 gives the age range of maturity stages of hand and wrist which are described as follows:

Table 1: Age range of skeletal maturity stages of various bones of hand and wrist in sports girls and controls

Bone	Maturity Stages							
	Sports Girls				Controls			
	F	G	H	I	F	G	H	I
Radius	-	12-15	12-16	13-16	-	12-14	12-15	13-16
Ulna	12-13	12-16	12-16	-	-	12-14	12-16	-
Metacarpal-1	12-14	12-15	12-16	12-16	12-13	12-15	12-15	12-16
Metacarpal-3	12-14	12-15	12-16	12-16	12-13	12-15	12-15	12-16
Metacarpal-3	12-14	12-15	12-16	12-16	12-13	12-15	12-15	12-16
Proximal Phlanax-1	12-15	12-14	12-16	12-16	12-14	12-15	12-15	12-16
Proximal Phlanax-3	12-15	12-15	12-16	12-16	12-14	12-15	12-15	12-16
Proximal Phlanax-5	12-15	12-15	12-16	12-16	12-14	12-15	12-15	12-16
Middle Phlanax-3	12-15	12-15	12-16	12-16	12-14	12-15	12-14	12-16
Middle Phlanax-5	12-15	12-15	12-16	12-16	12-14	12-15	12-14	12-16
Distal Phlanax-1	12-15	12-14	12-16	12-16	12-14	12-15	12-14	12-16
Distal Phlanax-3	12-15	12-14	12-16	12-16	12-14	12-15	12-14	12-16
Distal Phlanax-5	12-15	12-14	12-16	12-16	12-14	12-15	12-14	12-16

Radius. F stage of radius is absent in both sports girls and controls. G stage can be seen from 12 to 15 years in sports girls and 12 to 14 years in controls. Radius can be seen in H stage from 12 to 16 years in sports girls whereas in controls this stage disappears after 15 years of age. I stage appears at the age of 13 years in both sports girls and controls.

Ulna. F stage of ulna can be observed at 12 and 13 years in sports girls whereas it is absent in controls. Ulna bone can be seen at G stage from 12 to 16 years in sports girls whereas it is observed only upto 14 years in control girls.

Metacarpal -1st, 3rd and 5th. F and G stages of metacarpal 1, 3 and 5 can be seen from 12 to 14, 12 to 15 years in sports girls and 12 to 13 and 12 to 15 years, respectively in control girls. H stage of all the three metacarpals can be seen from 12 to 16 years in sports girls, whereas in control is present only up to 15 years.

Proximal Phalanx 1st, 3rd and 5th. F stage of these bones can be seen from 12 to 15 years in sports girls and 12 to 14 years in controls. H stage ranges from 12 to 16 years in sports girls whereas it disappears at 15 years in controls. I stage lasts for 16 years in both these group of girls.

Middle Phalanx 3rd and 5th. F stage of middle phalanges can be seen in sports girls from 12 to 15 years and in controls from 12 to 14 years of age H stage ranges from 12 to 16 years in sports girls whereas in controls it lasts up to 15 years of age.

Distal Phalanx 1st, 3rd, and 5th. F stage of distal phalanges ranges from 12 to 15 years in sports girls and 12 to 14 years in controls. Similarly H stage ranges from 12 to 16 years in sports girls whereas it disappears at 15 years in control girls.

Chronological age Vs skeletal age of sports girls. Table 2 shows that sports girls possess, significantly greater skeletal ages (20 bone age and RUS bone age) than their chronological ages from 12 to 14 years of age. Maximum difference of 1.03 years has been observed between chronological age and 20 bone age at 12 years of age and minimum difference (0.34 years) has been found at 15 years of age, showing thereby that differences go on decreasing with increasing age.

Table 2: Comparison between chronological age (C.A.) and skeletal age (S.A.) of sports girls

N	C.A. (yrs)		TW ₂ 20 Bone Age (yrs)		RUS AGE (yrs)		t-value	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	C.A. Vs TW ₂	C.A. Vs RUS
31	11.92	0.34	12.95	0.98	13.08	1.34	5.42*	4.69*
25	12.98	0.28	13.63	1.03	14.06	1.22	2.98*	4.36*
40	14.03	0.27	14.61	1.15	14.97	1.07	3.14*	5.38*
26	14.93	0.26	15.27	1.05	15.41	0.93	1.65	0.67
23	15.92	0.28	15.67	0.67	15.79	0.45	1.64	1.20

* Significant at 5% level

Chronological age Vs skeletal age of control girls. It has been observed from Table 3 that controls possess significantly greater skeletal ages than their chronological ages from 12 to 15 years of age. At the age of 12 years, a maximum difference of 0.92 years has been found between chronological age and 20 bone age and at the age of 15 years a

minimum difference of 0.53 years has been noticed. All the control girls have achieved their adult maturity status by 16 years of age.

Table 3: Comparison between chronological age (C.A.) and skeletal age (S.A.) of control girls

N	C.A. (yrs)		TW ₂ 20 Bone Age (yrs)		RUS AGE (yrs)		t-value	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	C.A. Vs TW ₂	C.A. Vs RUS
24	11.98	0.28	12.90	0.85	13.09	1.18	5.10*	4.48*
25	12.92	0.23	13.80	1.18	14.14	1.22	3.66*	4.82*
28	13.90	0.26	14.43	1.10	14.76	1.09	2.47*	4.21*
35	14.92	0.27	15.82	0.60	15.88	0.44	8.35*	11.90*
25	15.98	0.18	Adult	-	Adult	-	-	-

* Significant at 5% level

Comparison of maturity status of sports girls and controls. Table 4 gives the comparison of maturity status of sports girls and controls. It has been noticed from Table that sports girls do not differ significantly in their maturity status from controls till 14 years of age. However, at the age of 15 years, controls possess significantly greater skeletal ages as compared to sports girls. At the age of 16 years, all the control girls have achieved their full maturity status, but some sports girls are still on their path towards maturity.

Table 4: Comparison between chronological age (C.A.) and skeletal age of sports and control girls

N	Sports girls						Control girls						
	C.A. (yrs)		TW ₂ 20 Bone Age (yrs)		RUS (yrs)		C.A. (yrs)		TW ₂ 20 Bone Age (yrs)		RUS (yrs)		
Mean	SD	Mean	SD	Mean	SD	N	Mean	SD	Mean	SD	Mean	SD	
31	11.92	0.34	12.95	0.98	13.08	1.34	24	11.98	0.28	12.90	0.85	13.09	1.18
25	12.98	0.28	13.63	1.03	14.06	1.22	25	12.92	0.23	13.80	1.18	14.14	1.22
40	14.03	0.27	14.61	1.15	14.97	1.07	28	13.90	0.26	14.43	1.10	14.76	1.09
26	14.93	0.26	15.27	1.05	15.41	0.93	35	14.92	0.27	15.82	0.60	15.88	0.44
23	15.92	0.28	15.67	0.67	15.79	0.45	25	15.98	0.18	Adult	-	Adult	-

t-value	
TW ₂ Vs TW ₂	RUS Vs RUS
0.20	0.01
0.76	0.23
0.65	0.80
2.45*	2.43*
-	-

* Significant at 5% level

Percentiles for skeletal maturity. Table 5, Fig 1 illustrates that the maximum 20 bone score is reached at 13 years by 90% early maturing girls and at 15 years by 25%

late maturing sports girls. In case of controls, the maximum maturity score was reached at 13 years by 90% early maturing girls and at 15 years by 75% late maturing girls. Table 6, Fig. 2 shows that adult RUS maturity score is found at 14 years in 90% early maturing sports girls and at 16 years in 3% late maturing sports girls. At the age of 14 years, 90% early maturing control girls have adult RUS maturity score.

Table 5: Percentiles of TW₂ score in sports girls and controls from 13 to 16 years of age

Percentiles	Age in years							
	13		14		15		16	
	Sports Girls	Control Girls	Sports Girls	Control Girls	Sport Girls	Control Girls	Sport Girls	Control Girls
3	911	912	945	940	957	987	987	A
10	928	929	957	953	957	990	991	A
25	945	946	970	966	970	994	993	A
50	964	966	983	981	991	998	997	A
75	983	986	997	995	A	A	A	A
90	A	A	A	A	A	A	A	A
97	A	A	A	A	A	A	A	A

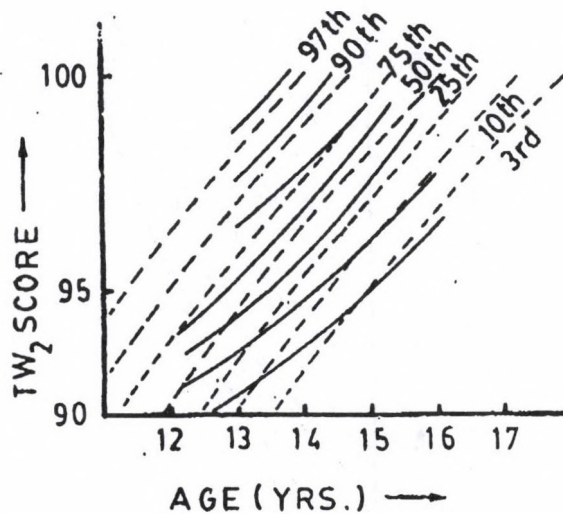


Fig. 1: 20-bone (TW₂) skeletal maturity score of sports girls (—) compared with British standards (-----)

Table 6: Percentiles of RUS score in sports girls and controls from 13 to 16 years of age

Percentiles	Age in years							
	13		14		15		16	
	Sports Girls	Control Girls	Sports Girls	Control Girls	Sport Girls	Control Girls	Sport Girls	Control Girls
3	552	560	677	645	756	909	893	A
10	629	637	745	717	814	934	920	A
25	706	714	814	789	873	959	947	A
50	794	802	892	873	940	987	979	A
75	882	890	971	956	A	A	A	A
90	969	967	A	A	A	A	A	A
97	A	A	A	A	A	A	A	A

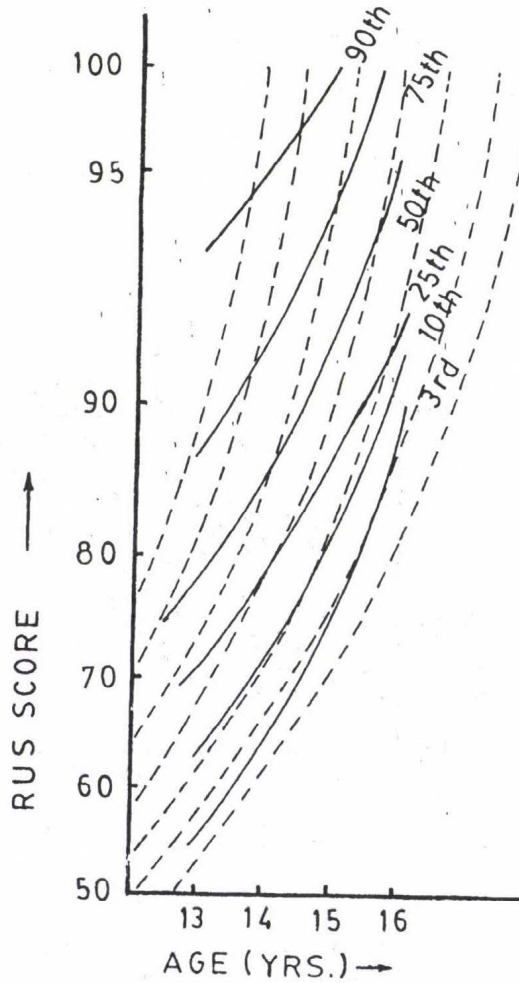


Fig. 2: RUS skeletal maturity score of sports girls (—) compared with British standards (-----)

Discussion

The results indicate that both sports girls and controls possess significantly greater skeletal ages than their chronological ages from 12 to 14 years. Differences are narrowed down with increasing age and become negligible at 15 and 16 years of age. This may be due to the fact that skeletal age is fixed up by 16 years of age whereas chronological age goes on increasing. When TW_2 score of sports girls are plotted on British standards, then we found that at 3rd and 10th percentile, our sports girls are ahead in skeletal maturity status than British at 13 and 14 years of age, match at 15 years and slow down thereafter. Whereas at other percentiles our sports girls are ahead in skeletal maturity status than British girls at all ages. This may be due to trends of earlier maturation present in human population popularly known as secular growth shift, as the data on British population were collected during the fifties. Tanner et al (1983) have stated about the skeletal maturation standards of 1950s that "It would in principle be desirable to update them now." It can, indeed, be expected that there has been a trend towards earlier maturation in the biological maturity status over the last 28 years (Roche 1979). Our results indicate that sports girls do not differ from controls in their maturity status from 12 to 14 years of age. Thus, from the results it can be concluded that there is no effect of exercise on the skeletal maturation of individuals. Similar results have also been reported by Cerny 1969, Malina 1986, Kotulan et al. 1980, Novotny 1981. At the upper age groups i.e. at 15 and 16 years of age, most of the sports girls have attained adult maturity status, only few have yet to attain. Due to this, nothing can be said about their average maturity status. Further more, as cross-sectional data are taken, it is difficult to understand the actual maturity status of girls of 15 and 16 years of age. Moreover, India is a country where incentives are related with sports performance. Although the great care was taken to obtain the actual age of individuals, but there may be chance of under age participation. Due to these limitations we can suggest that in future longitudinal studies should be undertaken if one would have to enquire about the effect of physical activity on skeletal maturation.

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Mailing address: G. Kaur
Department of Human Biology
Punjabi University
Patiala 147 002
India