# Determination of Skeletal Age in Children Aged 8 -18 Years

Pages with reference to book, From 104 To 106

A. Haleem Shaikh ( Department of Radiology, Peoples Medical College and Hospital, Nawabshah. )
Ranyo, M. Rikhasor,A. Majeed Qureshi ( Department of Anatomy, Chandka Medical College, Larkana. )

**Abstract**

Skeletal age determination exercise was performed by Greulich- Pyle method in 402 normal children (219 males and 183 females) aged 8-18 years during 1993-94 at Chandka Medical College, Larkana. On the average, the males were 1 year and the females were 0.5 years retarded from 8-15 years and from 8-13 years respectively. This retardation during childhood might be due to malnutrition, ill health or other environmental factors. However, males after 15 years and females after 13 yeats (round about puberty and afterwards) were found advanced in their skeletal age indicating earlier maturity in our children as compared to western children (JPMA 48: 104, 1998).

## Introduction

The estimation of skeletal age has become increasingly common as a mean of biological age. Biological development however, varies from population to, population and also depends on sex and race.

Previously height. weight and chronological age have been ascribed greatest significance in evaluating biological age. The first assessments of skeletal maturation employed a radiograph of the hand and the degree of maturation was indexed by the time of development of ossification centres and epiphysial-diaphysial fusion. Todd[1] developed a method for skeletal age based on the appearance of the joint surfaces. their size relationship and their shape in the metaphvsial-epiphysial regions and other centres of ossification. As have others[2,3] subsequently. Todd found pronounced regularity in skeletal development in various regions of the body and published an atlas of standards for the left hand and wrist. Greulich-Pyle[4] atlas is a further development and improvement of Todd's atlas. Subsequently Tanner— Whitehouse[3] 'score method" appeared, in which 20 representative bones of the hand and wrist arc given points for maturity; skeletal age is calculated from the sum of these points.

The two last mentioned methods are those which are mostly employed internationally (Greulich-Pyle and Tanner-Whitehouse). The Tanner-Whitehouse system is more laborious but is much more reliable[6]. According to Roche et al[7], Greulich-Pyle system is simple and easier to use for the prediction of skeletal age.

Skeletal age is a useful diagnostic tool provided correct standards are used and the limitations of accuracy arc recognised. In growth disturbances and in endocrine disease, skeletal age is of great importance. It is also used as an indicator in hormone treatment. Having these clinical as well as medico-legal importance this cross sectional study was carried out at Larkana to provide an idea for establishing an average skeletal age for our children in relation to chronological age. It is a continuity ofourprevious paper[8].

## Material and Method

The material consisted of radiographs of the left hand and wrist of 402 children (219 males and 183 females) aged 8-18 years. All the children were apparently nonnal and belonged to an average middle class in their socio-economic status. The children were collected mainly from Larkana city but some

cases collected at Lahore and Nawabshah were also included, The real date of birth of every child was obtained from parents on special request and the X-ray was taken on or within 0.1 year of the child's buth day. All the children were divided into 11 age groups as shown in Table I.

Table I. Distribution of cases in various chronological age groups.

| Age group (in years) | No. of male cases | No. of female cases |
|---|---|---|
| 8 | 18 | 20 |
| 9 | 19 | 17 |
| 10 | 17 | 18 |
| 11 | 21 | 21 |
| 12 | 20 | 18 |
| 13 | 20 | 20 |
| 14 | 21 | 17 |
| 15 | 25 | 20 |
| 16 | 19 | 16 |
| 17 | 22 | 10 |
| 18 | 17 | 6 |
| Total | 219 | 183 |

Skeletal age was determined on the basis of Greulich-Pyle atlas. Each radiographic film was compared with standard plates of Greulich-Pvle atlas. The age of the standard plate with which the radiograph of present research nearly coincided, was recorded as the skeletal age (SA) of that radiograph. In this way skeletal age was determined for all the radiographs individually. After that, mean skeletal age (x) for each chronological age group was obtained by applying the following statistical method.

Where X= mean SA, X= sum of all individual values and N= number of values in each age group. SD= standard deviation and -(Xl X)= difference between each value and mean value.

Those children who were 3 years (or more than 3 years) retarded or advanced in their skeletal age were excluded from this study.

**Results**

Table II. Mean skeletal age (X) with standard deviation (S.D) in relation to chronological age (C.A) of males.

| C.A. (in years) | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S.A (X) | 7 | 7.9 | 9.1 | 9.9 | 11.2 | 12.1 | 13.6 | 14.8 | 16.1 | 17.6 | 18.8 |
| S.D. | .52 | .45 | .68 | .63 | .91 | .90 | .67 | .72 | .73 | .75 | .53 |

Table III. Mean skeletal age (X) with standard deviation (S.D) in relation to chronological age (C.A) of females.

| C.A. (in years) | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S.A (X) | 7.4 | 8.3 | 9.5 | 10.9 | 11.9 | 12.8 | 14.3 | 15.8 | 17.1 | 18.4 | 19.2 |
| S.D. | .48 | .72 | .67 | .68 | .61 | .45 | .54 | .40 | .36 | .47 | .5 |

The results are shown in Table 11 and Table III for male and female children respectively.
The mean skeletal age in male children showed 0.2 to 1.1 year retardation upto age of 15 years while it showed 0.1 to 0.8 years advanced skeletal age after 15-18 years. The mean skeletal age in female children showed 0.2 to 0.7 year Greulich-Pyle atlas. The retardation was seen upto 13 yea"s in females and upto 15 years in males. Tthcse figures are at or near the puberty period of each sex. However, after puberty, skeletal age was found advanced in both sexes. This may indicate that catch-up of retarded skeletal age during childhood was achieved (reached) near puberty and then showed gradual advancement till complete maturity. However, for catch-up a longitudinal study will be more reliable. The retardation during childhood was generally found in all the bones of the hand but it was particularly more marked in the carpal bones. This might be due to either malnutrition or ill health which are more prevalent in our children8, or it might be due to the fact that American children froni whom the Greulich- Pyle atlas was prepared had matured under the highest socio- economic and cultural conditions and this may explain the 1/2 - I year retardation of our children who retardation upto the age of 13 years while it showed 0.3 to 1.4 years advanced skeletal age after 13 to 18 years.
The retardation of skeletal age during childhood was found generally in all the bones of the hand but it was particularly more in the carpal bones of both sexes. Five children (3 males and 2 females) aged 8-13 years were retarded by 3 years and four children (2 males and 2 females) were advanced by more than 2 years in their skeletal age in the present study. It was also found that majority of the children showed complete fusion (maturity) of all the epiphyses of hand and wrist bones at the age of 18 years in males and 16 years in females.

**Discussion**

The present study showed skeletal age retardation from 8-15 years in male children and from 8-13 years in female children. On the average, the males were about 1 year and females about 0.5 year retarded as compared to the belonged to average middle class in their socio-economic status. Anderson[9] also found Danish children retarded on the basis of Greulich-Pyle atlas, males 5.9 months, females 5.2 months. Using the T.W method, on the other hand they were advanced by 2.3 months. Various studies[10-13] have shown similar deviations, depending on race and on geographical regions.

East Africans of Bantu origin have been found to be slightly retarded as early as their first year to show maximum retardation at the age of 10 (by 1/2-2 years). Even at the age of 17, the difference had not been completely eliminated[14]. The ossification sequence however, was the same as in Caucasian or as in our children[15]. It has therefore, been suggested that separate standards should be available for children of different races and different regions.

**References**


1. Todd, T.W. Atlas of skeletal maturation. Part 1. Hand. London; Kimpton, 1937 (cited in Mathiasen, 1973);
2. Acheson, R.M. A method of assessing skeletal maturity from radiographs. J. Anat., 1 954;88:498-508.
3. Mathiasen, MS. Determination of bone age and recording or minor skeletal hand anomalies in normal children. Dan, Med. Bull. 197320:80-85.
4. Greulich, W.W. and Pyle, SI. Radiographic atlas of skeletal development of the hand and wrist. 2nd ed., Stanford, California. Stanford, University Press, 1959, p.256.
5. Tanner, J.M., Whitehouse. RH., Marshal, WA. et al. Assessment of skeletal maturity and prediction of adult height. London, Academic Press, 1975.
6. Buckler, JJvLH. How to make the most of hone ages. Arch. Dis. Child., 1983:58:761-63.
7. Roche, A F.. Eyman, S.L. and Davila, G,H A comparison between Greuli-Pyle and Tanner-Whitehouse assessment of skeletal maturity. Radiology, 1971 ;98:273-80.
8. Rikhasor, R.M., Qureshi, AM, and Shaikh, A.H. 1)etermination of skeletal age in children from 1-7 years. Pak. Med. 2., 1994;1625-26, 38-40
9. Anderson, E. Skeletal development as a measure of biol:gical development. Pediatrics, 1987:77 (Suppl): 73-4.
10. Canals, ML Valenzuela, C.Y. and Vergara, S.P Skeletal maturity of children aged 6-19 years. wrist and hand. Rev Chil, Pediatr.. 1988:59:1 02-5.
11. Vignolo, M., Milani, S., Dibattista, E. et a!. Modified Greulich. Pyle, Tanner-Whitehouse and Rochee-Wainer-Thissen (knee) methods for skeletal age assessment in a group of Italian children arid adolescents. Eur. J. Pediatr., 1990; 149:314-7.
12.. Arpenter, CT. and Laster, E.l, Skeletal age determination in Young children. Analysis of three regions of the hand-wrist film. J. Pediatr. Orthop., l993;1376-9.
13. National Institute of Health, National Nutrition survey 1985-87 report. Islamabad, Nutrition Division, National Institute of Health, Government of Pakistan, 1988, pp. 6-34
14. Mecakay, D.H. Skeletal maturation in the hand: Study of development in East African Children, Trans. R. Soc. Trop. \\ d Hyg., 1952;46:135.50.
15. Rikhasor, R.M. and Sajida, A. Time of appearance of ossification centers of the hand andwrist. Pak. 2. Med. Res., 1992;31 :132-8.