Formation of Norms for Body Development Index in the Assessment of Developmental Age

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ABSTRACT

The present study, conducted on 130 male children belonging to two age groups viz. 11 & 12 years, explores new avenues for anthoropologists, sports scientists and physical trainers to find out the developmental age of children (below 20 years), just by taking five anthropometric measurements. These measurements for male children (separate for female) are body height (cm), body weight(kg), biacrorniale and biliospinale breadths(cm) and forearm circumference (cm.) The Body Development Index (B.D.I) of the child is obtained by using the formula given by Wutscherk (1982). The obtained value of B.D.I. is referred to the table to find out the developmental ages of the child.

The developmental ages estimated for 11 and 12 years children of the present study show significant differences, that means, children of both these age categories are slow in their physical maturity. In the present study, hand wrist x-rays of children were also taken and assessment of development age by Tanner et al (1975) has also been made. A high level of correlation was observed between both these methods and there by claiming the stand for use of B.D.I. method to assess one's developmental age. By making use of these methods i.e. Tw2 20-bone age method and B.D.I. method, the norms for assessment of developmental age for Indian children were made.

INTRODUCTION

Age generally refers to be the chronological age or calendar age of an individual, however, in sports, it is important to know the developmental age of an aspiring athlete. The developmental age refers to the status of one's growth and maturity with reference to the physical processes, the emotional make up and motor behaviour etc. The developmental stages of one's maturity usually have set pattern of growth and development having variations in the rate from one child to another. The growth process is a phasic phenomenon having specific periods of progress in the normal children and these phases of growth are related to developmental ages more often. Growth of a child is fast during his early childhood, but it becomes steady till the initiation of adolescence then follows the period of fast growth, which is termed as adolescent growth period. After adolescent period, growth slows down and reaches a gradual halt. As proved scientifically, the various patterns of growth have direct relationship with one's level of strength, his/her physical performance. This means that when growth is at its peak, especially during the adolescent, physical performance capacities of a normal healthy individual is also at its peak. Because of this, it is suggested that to achieve excellence in

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sports the best period is the period of adolescence, during which if regular and systematic sports training is given to the children then desired performance at the later stages can be achieved. To excel in sports, one aspect which should also be kept in the mind is the developmental age of sporting children. But however, in India competitions are held on the basis of 'Chronological Age'.

In India not only the competitions but the participation in sports is also generally age based. Most of the sports federations arrange the competition by making age categories viz. sub junior, junior and seniors. Though the idea of age based competitions was to motivate and select the talent at early age but, this aim has never been achieved, as participation of the elder children in the lower age categories has always selected seniors in the junior competitions. It is expected that those who excel at early age might do so because they develop into full growth adults. But, such expectations are quite less because of the better performance of seniors as junior leaves no further avenues for improvement in the technical and tactical aspects of sports. Practically also, it has been found in India that the adolescent champions are not the champions of senior level.

Thus, for the betterment of sports in India emphasis should be given to the competitions, which are based on equals of maturity. It is true that there are also well known maturity associated variations in body size, shape and composition. The early maturing boys and girls are generally heavier and taller and have more muscle mass, bone mass and lean body mass than the late maturing boys and girls (Singh, 1992). So, the question arises why not to select such boys and girls for imparting training and making them perfect athletes for their choice of sports? This can be done after examining scientifically, the suitability of the sport and maturity status of the child to know his/her developmental age.

In the present study, an attempt has been made to find out developmental age through anthropometric method (i.e. from body measurements) as well as through hand wrist x-rays.

METHODOLOGY

For the present study, data were collected on 130 male children belonging to age groups 11 and 12 years, from different schools of Ropar and Hoshiarpur districts of Punjab. Left hand-wrist x-ray were taken according to the technique given by Tanner et al (1975) whereas for anthropometric measurements, standard techniques of weiner & Lourie (1969) were followed. Body Development Index has been calculated according to the formula given by Wutscherls (1982) as follows :

$$\text{B.D.I} = \frac{\text{Middle Breadth} \times \text{Forearm Circumference (corrected)}}{\text{Body Heighth (cm)} \times 10}$$

$$\text{Middle Breadth} = \frac{\text{Biaromiale Breadth} + \text{Biliospinale Breadth}}{2}$$

$$\text{Forearm circumference (corrected)} = 2 \times \text{Forearm circumference (given)} - \text{R.I. (correction value)}$$

$$\text{R.I. (Rohrer Index)} = \frac{\text{Bodywt : (kg)}}{\text{BodyHt : (M)}^3} \times 10$$

To find out the correction value for forearm circumference, the obtained R.I. Value has been referred to Table 1. Biological age is assessed by B.D.I. value by referring Table 2 given by Wutscherka (1973).

To assess developmental age through skeletal age method, hand-wrist x-rays of same children were also taken and their developmental age has been assessed by Tanner's TW_2—20 bone age method (1975).

RESULTS & DISCUSSION

Table 3 shows skeletal age (i.e. TW_2—20 bone age RUS age, carpal age) of the children of two age groups of 11 and 12 years. The children of 11 years have been reported to have 10.00 + 1.434 years as TW_2—20 bone age, 10.54 + 1.897 years as RUS age and 9.63 + 1.279 years as carpal age. These figures shows that the children having the chronological age of 11 years are biologically slower in their developmental maturity. The 12 years old children have shown their TW_2-20 bone age as 10.47+ 1.482 years, RUS age as 11.13+2.043 years and carpal age as 10.08+1.253 years. This data also depict that Indian children showing mean chronological age as 12 years are biologically slower in their development maturity.

Table 4 shows mean value of test of significance employed between the children of chronological ages of 11 and 12 years, respectively, with developmental ages (TW_2-20 bone age, RUS age and carpal age separately) Almost highly significant differences have been found between chronological ages and developmental ages of the children. This means that children having chronological ages as 11 and 12 years are remarkably different in their developmental maturity. But, the difference for skeletal ages of both the age groups were found to be statistically non-significant (Table 3).

Table 6 shows mean values of developmental ages of the children of two selected age groups viz 11 and 12 years calculated through Body Development Index method. The children of 11 years have shown developmental age as 10.18+1.862 years whereas children of 12 years have shown developmental age 10.69 + 2.039 years. These figures also show that children at chronological ages of 11 and 12 years are slow in their developmental ages.

Table 7 and 8 show mean values of test of significance between children at chronological ages 11 and 12 years, respectively, with their developmental ages. The most pertinent finding as evident from Table 6 is that the developmental ages calculated through hand-wrist x-rays by using Tanner et al method (1975) and that predicted by Body Development Index method (BDI) are almost same (Table 3 & 6).

Table 9 to 11 show high level of correlation between developmental ages predicted through TW_2 method and through B.B.I method. By seeing these results it can be stated that the B.D.I. method to assess one's development age is authentic and can be relied upon.

The present study holds it importance from another angle too. The study in hand provides norms for Body Development Index for Indian children. Table 12 provides the BDI norms for Indian children for two age groups. This means if a child is measured for five anthropometic measurements and then if his calculated BDI value (by using formula mentioned in methodology portion) is 0.66 then his developmental age would be 10 years. If child's BDI value is assessed as 0.69 then his

developmental age would be 11 years.

Table 13 show means values of five anthropometric measurements of children at ages 11 and 12 years. This Table can be useful to refer to the values of various measurements at these two particular age groups.

Thus, the present study opens avenues for anthropologists working in India to evaluate child's developmental age at any time by just taking five anthropometric measurements. Therefore the present method of assessing child's developmental age through BDI is an easy, economical and useful method for all those who are interested to know the maturity status of their children.

Table-1 Mean Values of Rohrer Index with Correction Figures

Rohrer Index	Forearm Circum-ference (Correction)	Rohrer Index	Forearm Circum-ference (Correction)
0.90	+3.7	1.07	+ 1.0
0.91	+3.5	1.08	+0.8
0.92	+3.4	1.09	+0.6
0.93	+3.2	1.10	+0.5
0.94	+3.1	1.11	+0.3
0.95	+2.9	1.12	+0.2
0.96	+2.7	1.13	+0.0
0.97	+2.6	1.14	+0.2
0.98	+2.4	1.15	-0.3
0.99	+2.3	1.16	-0.5
1.00	+2.1	1.17	-0.6
1.01	+1.9	1.18	-0.8
1.02	+18	1.19	-1.00
1.03	+1.6	1.20	-1.1
1.04	+1.5	1.21	-1.3
1.05	+1.3	1.22	-1.5
1.06	+1.1	1.23	-1.6
1.23	-1.6	1.36	-3.7
1.24	-1.8	1.37	-3.8
1.25	-1.9	1.38	-4.0
1.26	-2.1	1.39	-4.2
1.27	-2.3	1.40	-4.3
1.28	-2.4	1.41	-4.5
1.29	-2.6	1.42	-4.7
1.30	-2.7	1.43	-4.8
1.31	-2.9	1.44	-5.0
1.32	-3.2	1.45	-5.1
1.33	-3.2	1.46	-5.3
1.34	-3.4	1,47	-5.5
1.35	-3.5	1.48	-5.6
		1.49	-5.8
		1.50	-5.9

Table-2: Mean Values of Body Development Index of G.D.R. Children (Wutscherk, 1973)

Age in Years	Boys	Girls
4	0.52	0.52
5	0.55	0.57
6	0.57	0.61
7	0.59	0.64
8	0.62	0.67
9	0.65	0.70
10	0.67	0.73
11	0.69	0.75
12	0.70	0.75
13	0.72	0.79
14	0.80	0.84
15	0.83	0.87
16	0.84	0.88
17	0.86	0.91
18	0.90	0.97
Adult	1.00	0.97

Table-3 : Mean Values of TW AGE, RUS Age and Carpal Age among Male Children of two Age Groups (By Tanner et al, 1975

Parameters	Age Groups				t-values (11 vs 12 yrs.)
	11 Years (n=69)		12 Years (n=61)		
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	
TW, Age	10.00	1.434	10.47	1.482	$1\text{-}780_{(NS)}$
RUS Age	10.54	1.897	11.13	2.043	$1\text{-}657_{(NS)}$
Carpal Age	9.63	1.279	10.08	1.253	$1\text{-}956_{(NS)}$

Table-4: Values of test of Significance between Chronological Age and Developmental Age (TW_2-20 Bone Age, RUS Age and Carpal Age)

Chronological age (in yrs.)	Developmental age			t-value
	TW_2-20 bone Age	RUS Age	Carpal Age	
11	10.00 ±1.434			5.9849 (s)
11		10.54 ±1.897		2.174 (s)
11			9.36 ±1.279	10.863 (s)

Table-5: Values of test of Significance between Chronological Age and Developmental Age (TW_2-20 Bone Age, RUS Age and Carpal age)

Chronological age (in yrs.)	Developmental age			t-value
	TW_2-20 bone Age	RUS Age	Carpal Age	
12	10.47 ±1.482			7.134 (s)
12		11.13 ±2.043		2.939 (s)
12			10.08 ±1.253	10.5269 (s)

Table-6: Mean values of BDI and Developmental age by BDI among Male Children of two age groups.

Parameters	Age Groups				t-value
	11 Years (n=69)		12 Years (n=51)		
	$\bar{X}$	S.D	$\bar{X}$	S.D	
B.D.I. value	0.66	0.040	0.69	.063	3.33 (s)
Developmental Age by B.D.I.	10.18	1.862	10.69	2.039	1.445 (NS)

Table-7: Values of test of significance between chronological age and developmental age (B.D.I.)

Chronological age (In years)	Chronological age In years	t-test
11	10.18	3.8319 (s)

Significant at 1% level

Table-8: Values of test of significance between chronological age and developmental age (B.D.I.)

Chronological age (In years)	Chronological age	t-test
12	11.978	4.472 (s)

Table-9: Mean values of Co-efficient of Correlation between Developmental Ages calculated through B.D.I. Method of Wutscherk (1982) and of TW_2 Method of Tanner et al (1975) TW_2-20 Bone Age

Parameters	Age Groups			
	11 Years (n=69)		12 Years (n=61)	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Developmental age assessed by BDI method Wutscherk (1982) (a)	10.18	1.862	10.69	2.039
Developmental age assessed by TW_2 method, TW_2-20 bone Tanner et. al (1975) (b)	10.00	1.434	10.47	1.482
Co-efficient of correlation Between (a) & (b)	0.809.91		0.700440	

Table-10: Mean Values of Co-efficient of Correlation between Developmental Ages calculated through B.D.I. Method of Wutscherk (1982) and of TW_2 Method of Tanner et al (1975) TW_2-20 Bone Age

Parameters	Age Groups			
	11 Years (n=69)		12 Years (n=61)	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Developmental age assessed by BDI method Wutscherk (1982) (a)	10.18	1.862	10.69	2.039
Developmental age assessed by TW_2 method-RUS Age Tanner et. al (1975) (b)	10.54	1.897	11.13	2.043
Co-efficient of correlation Between (a) & (b)	0.7198448		0.68666534	

Table-11: Mean Values of Co-efficient of Correlation between Developmental Ages calculated through B.D.I. Method of wutscherk (1982) and of TW_2 Method of Tanner et al (1975) TW_2-20 Bone Age

Parameters	Age Groups			
	11 Years (n=69)		12 Years (n=51)	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Developmental age assessed by BDI method Wutscherk (1982) (a)	10.18	1.862	10.69	2.039
Developmental age assessed by TW_2 method, Carpal Age Tanner et. al (1975) (b)	9.63	1.279	10.08	1.253
Co-efficient of correlation Between (a) & (b)	0.745544194		0.668114815	

Table-12: Norms for BDI to depict Developmental Age.

BDI value	Developmental age in Years
.66	10
.69	11

Table-13: Mean Values of various body measurements of Male Children of two Age Groups.

Measurements	Groups Based on Decimal Age				t-values (11 vs 12 yrs)
	11 Years (n=69)		12 Years (n=51)		
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	
Body Height (cm)	137.97	7.276	140.54	7.287	1.944
Body Weight (Kg)	30.406	5.359	31.871	6.187	1.399
Forearm circumference (cm)	19.430	1.479	19.541	1.353	0.430
Biacromiale-Breadth (cm)	29.753	1.686	30.337	1.785	3.121
Biliospinale-Breadth (cm)	18.313	1.181	18.616	1.549	1.226

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