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ESTIMATION OF STATURE USING PERCUTANEOUS LENGTH OF RADIUS, ULNA AND TIBIA AMONG LODHAS AND MUNDAS OF DISTRICT MIDNAPORE, WEST BENGAL

ABSTRACT — The present study aims at estimation of stature using percutaneous lengths of radius, ulna and tibia bones of the living populations of district Midnapore, West Bengal, i.e. the Lodhas and the Mundas. The study is based on a sample of 199 Lodhas (123 males and 76 females) and 199 Mundas (110 males and 89 females) in the age range of 18 to 40 years. Stature and Percutaneous lengths of radius, ulna and tibia have been recorded for each subject to compute the respective Multiplication Factor (M. F.) for these three long bones in the form of a ratio by dividing the stature by respective bone length and then computing the average for each bone, sex wise.

The Multiplication factors, thus, derived for the three bone lengths have been checked for their reliability on a set of measurements on ten individuals, belonging separately to the four groups. The average difference in actual and estimated stature works out to be 1.57 cm (ulnar length), 2.93 cm (radial length) and 2.74 cm (tibial length) among Lodha males while the Lodha females exhibit an average difference of 2.47 cm, 4.24 cm and 4.76 cm respectively for ulna, radius and tibia.

The Munda males and females, in comparison to Lodhas do not exhibit much difference in the actual and estimated stature. The average difference comes out to be 0.91 cm (ulna), 1.22 cm (radius) and 3.07 cm (tibia) for males and 1.22 cm (ulna), 2.40 cm (radius) and 3.25 cm (tibia) for females.

On the basis of the average stature the error in estimated stature among Munda males and females is around 2 percent while among Lodha males it is around 2 percent and little above 3 percent among Lodha females. It may, thus be stated that these M. Fs could safely be used to predict the Stature for both the sexes of Munda and Lodha groups using one or more bone lengths depending upon their availability.

KEY WORDS: Lodhas — Mundas — Percutaneous Length — Radius — Ulna — Tibia — Multiplication Factor — Stature Estimation.

Various studies done on the remains of human skeleton have devised ways of estimating stature of living individuals from the skeletal remains. Attention has been primarily given to the long bones. On its basis regression equations relating the length of one or more of these long bones to stature have been computed (Telkka, 1950). Along with the regression equation method, some studies have described the length of a bone as a ratio to stature (Pan, 1925; Nat, 1931; Siddiqui and Shah, 1944).

But Trotter and Gleser (1952; 1958) regression formulae are the most commonly used method for reconstruction of adult stature in United States. These formulae are simple modifications of the nineteenth century work of Pearson (1899).

The regression formulae of this or another type have a restricted scope as they are mainly devised for a particular population. Inter-population comparisons and computation of stature from these regression formulae are simply not possible. Every

formula has a particular utility: it is applicable for a population rather than inter-population studies. From this, it follows that new formulae should be computed.

Skeletal material of every population in a country is, however, not available. In its absence, obviously new regression equations cannot be formulated. Therefore in each country, we will have equations only of those populations whose skeletal remains are available. What about those which remain unrepresented in terms of skeletal remains? An alternative to this is to obtain measurements of certain living populations and by using Nat's (1931) method-multiplication factor (M.F.) — we can relate the proportion of long bones to stature. These multiplication factors would also be helpful in stature reconstruction from skeletal remains of the concerned population. In addition to Nat (1931) other studies of Singh and Sohal (1952), Allbrook (1961), Athwale (1963), Zorab et al. (1964) and Joshi et al. (1964, 1965) have also reported regression formulae for reconstruction of stature from one or two long bone lengths of different living population groups.

In this study, we formulate the multiplication factors (as suggested by Nat, 1931) on the basis of the length of three long bones, viz. radius, ulna and tibia of two population groups of district Midnapore, West Bengal, the Mundas and the Lodhas.

MATERIAL AND METHODS

Results of the present study are based on the measurements of 199 Mundas (110 males and 89 females) and 199 Lodhas (123 males and 76 females), of district Midnapore, West Bengal, in the age range of 18 to 40 years. On each subject stature and percutaneous lengths of radius, ulna and tibia were obtained following the standard measurement technique, detailed as under:

Stature: Subject stands erect in the standard standing position, with head oriented in eye-ear plane. Using the anthropometer, measure the distance between standing surface and the highest point on the head in mid-sagittal plane.

Length of Radius: The left forearm was flexed and semipronated with the hand in natural position. Using the sliding caliper (beam compass) measure the distance from the radial head to the tip of the styloid process palpable at the wrist-thumb joint.

Length of Ulna: The left forearm was flexed and semipronated with hand in natural position. Using the sliding caliper (beam compass) measure the distance from the tip of the olecranon process to the distal margin of the ulnar head, palpable on the dorsum of the wrist.

Length of Tibia: The subject sat with left knee placed in semi-flexed position and the left foot partly inverted to relax the soft tissues and render bony landmarks prominent. Using beam compass, measure the length of tibia from the medial condyle (as it becomes palpable and diverges anteriorly from the articulating femoral condyle) to the tip of the medial malleolus (Sphyrion).

The multiplication factors (M.F.) for the three long bones under study have been computed as a proportion of the long bone to stature in the form of a ratio by dividing the stature by respective bone length and then computing the average for each bone, sex wise.

RESULTS AND DISCUSSION

Analysis of data, on two tribal groups of district Midnapore, West Bengal, i.e. the Mundas and the Lodhas, reveal that Lodha males and females are comparatively taller than the Munda males and females. Following results have been obtained for both the groups with regard to stature and the percutaneous length of the three long bones, i.e. radius, ulna and tibia:

Stature (in centimetres):

1. Munda males (n = 110) — Average : 156.19; Range : 131.50 — 170.00
2. Munda Females (n = 89) — Average : 148.64; Range : 124.00 — 158.40
3. Lodha males (n = 123) — Average : 158.01; Range : 141.10 — 173.50
4. Lodha Females (n = 76) — Average : 149.55; Range : 136.70 — 164.50

Radial Length (in centimetres):

1. Munda males — Average: 24.60, Range: 19.50 — 27.60 — Multiplication Factor = 6.35 ± 1.80 ,
2. Munda females — Average: 22.85, Range: 19.40 — 24.70 — Multiplication Factor = 6.50 ± 1.13
3. Lodha males — Average: 24.68, Range: 20.80 — 27.80 — Multiplication Factor = 6.40 ± 0.24
4. Lodha females — Average: 22.56, Range: 21.00 — 25.70 — Multiplication Factor = 6.53 ± 2.54

Due to the differential proportion of radial length among Mundas (males and females) and Lodhas (males and females), the multiplication factor, thus, obtained exhibits slightly higher values for Lodha males and females in comparison to the Munda males and females, Females of both the groups express higher M.F. value than the males.

Ulnar Length (in centimetres):

1. Munda males — Average: 26.16, Range: 20.30 — 29.10 — Multiplication Factor = 5.97 ± 0.18
2. Munda females — Average: 24.45, Range: 21.40 — 27.50 — Multiplication Factor = 6.08 ± 0.22
3. Lodha males — Average: 26.27, Range: 22.10 — 29.80 — Multiplication Factor = 6.01 ± 0.45
4. Lodha females — Average: 24.21, Range: 20.70 — 29.70 — Multiplication Factor = 6.18 ± 0.41

The values of the Multiplication Factors derived as a ratio between ulnar length and stature reveal a similar trend as observed in case of the Multiplication Factors computed for radial length for the two tribal groups. Females, once again, exhibit a higher M.F. value than the males of both groups.

Tibial Length (in centimetres):

1. Munda males — Average: 37.44, Range: 25.40 — 41.50 — Multiplication Factor: 4.17 ± 0.24
2. Munda females — Average: 35.39, Range: 25.00 — 40.00 — Multiplication Factor: 4.19 ± 0.22
3. Lodha males — Average: 37.35, Range: 26.50 — 41.40 — Multiplication Factor: 4.23 ± 0.60
4. Lodha females — Average: 35.43, Range: 31.60 — 39.80 — Multiplication Factor: 4.27 ± 0.50

TABLE 1. Multiplication Factors for Different Indian Populations

S. No.	Population/Author	Multiplication Factors		
		Radius	Ulna	Tibia
1.	Bengali Hindus — Pan, 1924	6.70	6.00	4.40
2.	U. P. Indians — Nat, 1931	6.90	6.30	4.48
3.	Punjabis, Lahore — Siddiqui and Shah, 1944	6.50	6.00	4.20
4.	Punjabis, Amritsar — Singh and Sohal, 1952	6.43	5.93	4.18
5.	Munda Males — Present Study	6.35	5.97	4.17
6.	Munda Females — Present Study	6.50	6.08	4.19
7.	Lodha Males — Present Study	6.40	6.01	4.23
8.	Lodha Females — Present Study	6.63	6.18	4.27

TABLE 2. Difference between the actual and estimated Stature using Multiplication Factor among Lodha Males and Females

Sl. No.	Actual stature	Length of Ulna	Estimated Stature	Error	Length of Radius	Estimated Stature	Error	Length of Tibia	Estimated Stature	Error
LODHA MALES										
1.	158.0	26.4	158.7	0.7	25.1	160.6	2.6	36.5	154.4	3.6
2.	163.5	27.3	164.1	0.6	25.5	163.2	0.3	38.6	163.3	0.2
3.	154.7	25.0	150.2	4.5	23.2	148.5	6.2	35.7	151.0	3.7
4.	169.4	27.9	167.7	1.7	26.0	166.4	3.0	40.5	171.3	1.9
5.	149.3	24.1	144.8	0.5	22.5	144.0	5.3	36.0	152.3	3.0
6.	166.8	27.3	164.1	2.7	26.3	168.3	1.5	39.2	165.8	1.0
7.	158.1	26.5	159.3	1.2	25.5	163.2	5.1	38.7	163.7	5.6
8.	157.2	25.7	154.5	2.7	24.4	156.2	1.0	36.8	155.7	1.5
9.	147.6	24.7	148.4	0.8	23.4	149.7	2.1	33.9	143.4	4.2
10.	159.0	26.4	158.7	0.3	24.5	156.8	2.2	38.2	161.7	2.7
LODHA FEMALES										
1.	149.0	23.7	146.5	2.5	21.5	142.5	6.5	34.7	148.2	0.8
2.	138.1	22.9	141.5	3.4	22.0	145.9	7.8	33.3	142.2	4.1
3.	157.0	26.5	163.8	6.8	24.3	161.1	4.1	35.4	151.2	5.8
4.	153.1	24.7	152.6	0.5	22.3	147.8	5.3	37.1	158.4	5.3
5.	144.6	23.5	145.2	0.6	22.0	145.9	1.3	35.6	152.0	7.4
6.	151.5	24.3	150.2	1.3	23.1	153.1	1.6	36.8	157.1	5.6
7.	136.7	21.7	134.1	2.6	21.0	139.2	2.5	31.6	134.9	1.8
8.	149.2	23.8	147.1	2.1	22.9	151.8	2.6	36.2	154.6	5.4
9.	156.6	25.2	155.7	1.1	24.6	163.1	6.5	38.2	163.1	6.5
10.	160.0	26.5	163.8	3.8	24.8	164.2	4.2	38.4	164.9	4.9

In case of bone length average it is observed that the Munda males have slightly longer tibia than the Lodha males, while among females the Lodhas have longer tibia than the Mundas. The M.F. thus derived as a ratio between the tibial length and stature, once again, reveal greater M. F. values for females than the males for both groups as observed in case of radius and ulna bones.

Table 1 lists the M.F. values reported by different researchers on Indian skeletal material along with the M.F. values for the Mundas and Lodhas of the present study based on the percutaneous length of radius, ulna and tibia. The highest M.F. value for radius is reported by Nat (1931) on skeletal material of U.P. Indians while the Munda males (present study) exhibit the least value. The highest M.F. value is reported by Singh and Sohal (1952) on skeletal material of Punjabis of Amritsar while the Munda males (present study) once again express the least value. The M.F. values of tibia exhibit a similar situation as observed in case of radius.

It has been noted that the M.F. values based on the skeletal material are invariably greater than the ones based on the percutaneous lengths of the radius, ulna and tibia, excepting a few instances where the situation is reverse. This variation is probably due to the dry and wet (living) condition of the concerned bone.

The reliability of the Multiplication Factors computed for Mundas (males and females) and Lodhas (males and females) for the three percutaneous bone lengths has been checked on a set of measurements on ten individuals, each belonging to the

TABLE 3. Difference between the actual and estimated stature using Multiplication factor among Munda Males and Females

Sl. No.	Actual Stature	Ulnar Length	Estimated Stature	Error	Radial Length	Estimated Stature	Error	Length of Tibia	Estimated Stature	Error
MUNDA MALES										
1.	145.4	24.8	148.1	2.7	24.0	152.4	7.0	36.0	150.1	4.7
2.	162.9	27.4	163.6	0.7	26.2	166.4	3.5	38.3	159.7	3.2
3.	154.1	25.8	154.0	0.1	25.1	159.4	5.3	38.8	161.8	7.7
4.	163.8	27.4	163.6	0.2	25.9	164.5	0.7	39.8	165.9	2.1
5.	147.3	24.6	146.9	0.4	23.0	146.1	1.2	35.4	147.7	0.4
6.	148.8	25.3	151.0	2.2	23.5	149.2	0.4	35.9	149.7	0.9
7.	160.5	26.7	159.4	1.1	25.8	163.8	3.3	37.8	157.6	2.9
8.	165.6	27.8	165.9	0.3	25.6	162.6	3.0	38.7	161.4	4.2
9.	165.2	27.7	165.4	0.2	25.9	164.5	0.7	39.0	162.6	2.6
10.	157.6	26.6	158.8	1.2	25.6	162.6	5.0	36.7	153.0	4.6
MUNDA FEMALES										
1.	149.5	24.5	148.9	0.6	22.9	148.8	0.7	36.0	150.8	1.3
2.	155.6	25.1	152.6	3.0	24.2	157.3	1.7	36.5	152.9	2.7
3.	136.5	22.4	136.2	0.3	19.4	126.1	10.4	31.2	130.7	5.8
4.	138.5	23.3	141.7	3.2	21.5	139.7	1.2	32.9	137.8	0.7
5.	150.6	24.6	149.6	1.0	23.3	151.4	0.8	34.8	145.8	4.8
6.	158.5	26.0	158.1	0.4	24.7	160.5	2.0	38.9	162.9	4.4
7.	144.9	24.1	146.5	1.6	22.2	144.3	0.6	36.1	151.2	6.3
8.	134.0	22.2	134.9	0.9	21.3	138.4	4.4	32.7	137.0	3.0
9.	152.8	25.1	152.6	0.2	23.4	152.1	0.7	36.3	152.1	0.7
10.	151.0	25.0	152.0	1.0	23.0	149.5	1.5	36.7	153.8	2.8

four groups. The difference between the actual stature and the estimated one, using the M.F. is listed in Tables 2 and 3 respectively for Lodhas and Mundas.

The average difference in stature among Lodha males (Table 2) obtained for the three bone lengths comes out to be 1.57 cm, 2.93 cm and 2.74 m respectively for ulnar length, radial length and tibial length. The female Lodhas on the other hand express slightly greater differences amounting to 2.47 cm for ulna, 4.24 cm for radius and 4.76 cm for tibia (Table 2).

Similarly, the Munda males and females do not exhibit much variation in the difference between the actual and estimated stature. The average difference works out to be 0.91 cm (ulna), 1.22 cm (radius) and 3.07 cm (tibia) among males while the females exhibit 1.22 cm, 2.40 cm and 3.25 cm respectively for ulna, radius and tibia (Table 3). The differences between the actual and estimated stature are more or less of similar intensity among these tribal groups excepting Lodha females.

It is clear from the above observations that in estimating stature of an individual using a single bone the difference is in no case beyond the 4.76 cm. Considering other sources of error it may be stated here that stature, from a single bone measurement, can be estimated within an accuracy of 5.0 cm for Lodha females, within 3.0 to 3.5 cm accuracy for Lodha males, Munda males and females respectively. The average height of Munda males

being 156 cm and 148.64 cm for females, the error in estimated stature for Mundas is around 2 per cent. While in case of Lodhas the males have an average stature of 158.01 cm and females 149.55 cm, the error in estimated stature comes out to be around 2 per cent for males and little above 3 per cent for females. This explains that these multiplication factors could safely be used for estimating stature, using one or more than one bone lengths depending upon the availability for both the sexes of Munda and Lodha groups.

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