Stature Estimation in Egyptian Primary School Children from Giza Governorate

Howaida Saeed Mohammed[1], Nadia Abd El Monem Kotb[1], Usama Mohamed El Barrany[1], Mai Moustafa Magdi[1], Maha AbdeLrahman Mowafy[2]

[1]*Forensic Medicine and Clinical Toxicology,* [2]*Family Medicine, Faculty of Medicine, Cairo University, Cairo, Egypt.*

Abstract

Stature is one of the used parameters for identification in forensic anthropology. This study aimed to develop a formula to estimate the stature of children using anthropometric measurements. Ten anthropometric measurements were measured for 350 students randomly selected from two primary schools. The arm span exceeds height at old ages and the majority of measurements were higher in girls. A strong correlation was found for stature and majority of measurements.

Keywords: *Stature, Estimation, Egyptian, Primary school, Children, Giza.*

Background

Anthropometry is the scientific study of a variety of methods to estimate the measurements of the human body and skeleton. Stature is a measure of biological development and is determined by a combination of genetic and environmental factors.[1]

Stature expresses a lot of features of humans and is an inherent characteristic; therefore, its estimation is essential for identifying and clarifying the unknown livings and the human remains.[2]

Stature estimation resulted from measuring segments and bones in different parts of the human body, precisely upper and lower extremities, has a long history to be mentioned.[3], using humerus length are nearly limited and the majority of these studies were undertaken on adults.[4]

Material & Methods

The current study was conducted on 350 Egyptian healthy children aged 6 to <13 years were recruited randomly from two primary schools in Giza governorate, then children were divided into 7 groups according to age each group was 50 children (25 boys and 25 girls). Children who were non- Egyptian, below or above the age and had fractures, deformities or previous surgical operations were excluded from the study. A written consent was taken from The Ministry of Education and head masters of the schools. Measurements were taken by the same person from the right side of the child. The birth data (day, month, and year) of students were taken from their school records.

· **Body Weight (kg)** was measured using Secca weight scale; the subjects were instructed to stand over the scale bare feeted with light clothing and weight recorded to nearest 0.01 kilogram.

· **Standing height:** Subjects were in standing barefoot position; with straight back. The head was in the Frankfurt horizontal plane and then the head vertex was contacted to firm and the number was recorded approximated to the nearest 0.1 cm.[5]

· **Sitting height:** was measured by using portable Holtain anthropometer. The child was sitting erect on a desk with her/his legs hanged free and knee flexed at 90º and fixed to the edge of the desk.. The mean of three measurements was calculated and approximated to the nearest 0.1 cm.[6]

Corresponding auther:
Mai Moustafa Magdi, Lecturer of Forensic Medicine and Clinical Toxicology,
Dr.maimagdi_83@kasralainy.edu.eg
Address: Kasralainy, Faculty of Medicine, Cairo University, Cairo, Egypt.

· **Maximum head Length:** measured using the sliding caliper from the glabella (the most prominent point above the root of the nose on the frontal bone, between the eyebrows) to the opisthocranion (the most prominent part of the occiput) and the measures approximated to the nearest 0.1 cm.[7]

· **Head Circumference:** Head circumference was measured using a plastic tape, placed over the eyebrows and passed around the head, and over the very posterior protuberance of the occiput.[8]

· **Arm Span:** measured from the left middle fingertip to the right middle fingertip using a calibrated steel tape. It was approximated to the nearest 0.1 cm.[9]

· **Upper arm Length:** The distance between acromion end of clavicle and olecranon process by a sliding caliper.[10]

· **Forearm Length:** measured in arm flex position from the tip of olecranon to the point between radius and ulnar tuberosity.[11]

· **Lower Limb Length:** calculated by subtracting the sitting height from the stature.[12]

· **Leg Length:** Measurement is taken from medial articulation of the knee joint to the most distal point of medial malleolus.[13]

The statistical package SPSS version 24 used for data coding and entering. Unpaired t test used to Compare between groups and Chi square ($\chi2$) test was used for comparing categorical data but when the expected frequency is less than 5 the exact test was used. For Correlation between quantitative variables the Pearson correlation coefficient was performed. To detect factors affecting stature and age, linear regression was performed. There was a statistical significance when the Probability (P) values equal or less than 0.5.

Findings

The arm span length was shorter than height in both boys and girls at ages 6 – 9 years old. The mean of the majority of measurements was higher in girls at ages 6 & 9 years old, while at ages 7 & 8 years it was higher in boys **(Table 1)**.

The arm span length was shorter than height in girls but exceeds in boys at 10 years, while exceeds the height at ages 11 & 12 years. There was increasing mean in the majority of measures in girls than boys **(Table 2)**.

A significant correlation between stature and all measurements was found **(Table 3)**. In addition, linear regression analysis revealed that stature can be estimated in boys and girls **(Tables 4 and 5)**.

Table (1): Anthropometric dimensions among 6 – 9 years old children

	6 years (n= 50)		7 years (n= 50)		8 years (n= 50)		9 years (n= 50)	
	Boys	**Girls**	**boys**	**girls**	**boys**	**girls**	**boys**	**Girls**
	mean± SD	mean± SD	mean± SD	mean± SD	mean± SD	mean± SD	mean± SD	mean± SD
Age	6.51±.30	6.44±.29	7.44±.31	7.37±.23	8.50±.29	8.41±.32	9.42±.30	9.45±.29
Height	122.04±3.86	123.12±4.47	127.64±4.37	125.36±4.29	132.32±4.66	130.44±4.60	139.32±5.44	139.60±5.43
Weight	22.06±2.48	24.65±6.75	25.31±4.14	25.95±6.88	27.24±4.04	27.54±6.30	36.42±9.90	36.38±7.14
AS	119.80±4.07	120.08±5.51	125.44±5.52	122.52±5.39	130.52±5.15	128.56±5.82	139.08±7.15	139.16±7.31
UAL	24.26±1.01	24.41±1.07	25.80±1.42	24.92±1.30*	26.89±1.27	26.00±1.17*	28.74±1.83	28.76±1.32
FAL	18.55±.65	17.88±1.06*	18.80±.94	18.00±.78*	19.66±1.26	19.07±1.09	21.13±1.58	21.22±1.38

Cont... **Table (1): Anthropometric dimensions among 6 – 9 years old children**

LLL	59.72± 3.14	60.56± 2.89	62.28± 2.79	60.80± 2.94	64.72± 3.53	64.20± 3.12	69.08± 3.72	70.80± 3.25
LL	26.00± 1.22	26.20± 1.58	27.00± 1.12	27.24± 1.42	28.84± 1.49	28.96± 1.72	30.76± 2.20	32.08± 2.16*
MHL	16.76± .46	16.26± .66*	16.61± .67	15.85±. 60**	16.97±. 62	15.94±. 40**	17.05±. 73	16.56±. 55*
HC	51.00± 1.19	49.56± 1.83*	51.12± 1.33	49.84± 1.89*	51.72± 1.77	50.04± 1.10**	52.76± 1.56	51.24± 1.27**

* significant

** highly significant

Arm Span (AS), Forearm Length (FAL), Head Circumference (HC), Leg Length (LL), Lower Limb Length (LLL), Maximum head Length (MHL), Upper arm Length (UAL),

Table (2): Anthropometric dimensions among 10 – 12 years old children.

	10 years (n= 50)		11 years (n= 50)		12years (n= 50)	
	boys	Girls	boys	girls	Boys	Girls
	mean±SD	mean±SD	mean±SD	mean±SD	mean±SD	mean±SD
Age	10.45±.26	10.44±.31	11.41±.26	11.50±.26	12.50±.31	12.48±.28
Height	141.04±6.51	141.88±6.46	147.32±7.49	150.20±5.27	151.80±5.48	153.64±5.31
Weight	34.86±9.66	34.64±5.04	43.27±12.68	41.76±7.46	44.28±11.18	51.68±12.10*
AS	141.76±7.76	141.44±7.19	147.44±9.31	151.76±6.08	153.00±7.78	155.96±8.02
UAL	28.96±1.63	29.04±1.83	31.33±3.06	31.61±1.64	32.27±2.45	33.01±2.36
FAL	21.06±1.26	21.15±1.27	22.60±1.79	22.88±.99	23.19±1.47	23.68±1.32
LLL	69.60±4.20	71.56±4.98	73.76±4.42	76.00±3.54	77.52±3.62	77.32±3.88
LL	32.00±2.25	32.20±2.12	33.56±2.53	34.76±1.54*	35.44±2.08	35.12±2.20
MHL	16.65±.73	16.73±.55	17.23±.59	17.04±.41	17.07±.39	16.98±.64
HC	51.84±2.03	51.48±1.29	53.16±1.52	52.44±1.53	52.80±1.29	53.08±1.68

Table (3): The correlation between stature and measurements in boys and girls.

Measurements	Boys		Girls	
	Pearson's correlation	P - value	Pearson's correlation	P - value
AS	0.974	< 0.001	0.978	< 0.001
UAL	0.941	< 0.001	0.952	< 0.001
FAL	0.927	< 0.001	0.959	< 0.001
LLL	0.950	< 0.001	0.959	< 0.001
LL	0.958	< 0.001	0.959	< 0.001
MHL	0.273	< 0.001	0.619	< 0.001
HC	0.559	< 0.001	0.708	< 0.001

Table (4): Linear regression coefficients for stature estimation in boys.

	Regression Equation	Unstandardized Coefficients		Standardized Coefficients	t	P value	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)		12.119	4.496		2.696	0.008	3.245	20.994
Age	Stature=12.119+0.489* arm span+0.573* lower limb+0.431* age+0.295* head circumference.	0.431	0.138	0.077	3.123	0.002	0.159	0.704
AS		0.489	0.032	0.565	15.429	< 0.001	0.426	0.551
LLL		0.573	0.052	0.350	10.970	< 0.001	0.470	0.676
HC		0.295	0.103	0.045	2.867	0.005	0.092	0.498

Table (5): Linear regression coefficients for stature estimation in girls.

	Regression Equation	Unstandardized Coefficients		Standardized Coefficients	t	P value	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)		19.872	4.461		4.454	< 0.001	11.065	28.679
Age	Stature=19.872+0.379* arm span+0.500* lower limb+0.679* age+0.384* leg length+0.261* head circumference	0.679	0.149	0.115	4.553	< 0.001	0.384	0.973
AS		0.379	0.041	0.451	9.224	< 0.001	0.298	0.460
LLL		0.500	0.062	0.302	8.117	< 0.001	0.378	0.621
LL		0.384	0.139	0.118	2.772	0.006	0.111	0.657
HC		0.261	0.106	0.042	2.462	0.015	0.052	0.470

Discussion

In the current study, girls were taller than boys at ages 6 and 9 up to 12 years and heavier than boys at ages 6 – 8 and 11- 12 years, while at ages 9 - 10 years the boys were heavier than girls. This is agreeing with **Reyes et al. & Tee et al.**[14, 15] This is can be illustrated by the fact that the growth at age (10 – 13 years) of puberty in girls is earlier than boys then boy's puberty growth occur after age of 12 years old.

In this study, the mean arm span values were shorter than the height and longer in boys at younger ages, while exceeds height and longer in girls at older ages. This is may be related to the rapid growth at age of puberty and this is in agreement with **Zhu et al., Zverev and Chisi.& Grimberg and Lifshitz**[18, 16, 17]However, disagree with **Zverev and Chisi.,** who found that the mean arm span values exceeded height in all age groups of boys and in older girls.[16]

In this study the arm length was higher in girls at ages 6, 9 &12, while at ages 7- 8 and 10 - 11 years it was higher in boys. These results are in agreement with **Zhu et al. & Karakas et al.**[18, 19]

The mean forearm length values were higher in girls than boys in older ages and this agree with **Karakas et al. & Zhu et al.**[19, 18]

The mean lower limb length was higher in girls at ages 6, 9, 10, 11 years, while in boys it was higher at ages 7,8, 12 years. Agree with **Reyes et al. and Malina et al.**[14, 20]

The leg length was longer in girls in all ages except age 12 years. This result is in agreement with **Malina et al. & Zhu et al.**[20, 18] However, **Karakas et al.** found that the leg lengths of girls were longer than boys at ages 8, 10 & 11 years.[19]

The head length was higher in boys in all ages except age 10 years and this agree with **Hansi and Ashish** with values less than our study.[21]and this may be related to genetic, environmental factors like dietary habits, vitamin deficiencies and ethnic variability. In accordance **Chowdavarapu et al.** found in their study that the mean value of head length was higher in girls.[22]

The mean head circumference was greater for boys at ages 6 - >12 years. These results agree with **Neyzi et al.**[23] However, disagree with **Batterjee et al,** who found that, it was higher in girls at ages 8 – 12 years old.[24]

These differences could be ascribed to the surrounding environmental, nutritional and genetic factors.

In the current study arm span, length of the upper arm, forearm, lower limb and leg showed a strong positive correlation for stature. These agree with **Mishra et al. & Zhu et al.**[25, 18]

Mishra et al. Conducted regression equations using arm span.[25]and **Smith** using humerus, femur & tibia.[26]

Conclusion

The girls exceeded boys in the majority of measurements. Arm span exceeds height in older ages in both boys and girls, while head length and circumferences were higher in boys. The majority of these measurements are useful for estimating stature using multiple regression equations. Further studies should be conducted on large numbers and different regions.

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