Original Research Paper

Volume-7 | Issue-9 | September-2017 | ISSN - 2249-555X | IF : 4.894 | IC Value : 79.96

Physiology

INTER-RELATIONSHIP OF ARM SPAN,HEIGHT AND ARM-SPAN TO HEIGHT RATIO IN NORMAL CENTRAL INDIAN CHILDREN AGED 5-15 YEARS

Sachin Pawar	MD (Physiology), Associate Professor, Dept. of Physiology, Mahatma Gandhi Institute of Medical Sciences, Sevagram
NV Mishra	MD (Physiology), Professor and Head, Dept. of Physiology, GMC, Nagpur-Corresponding Author
VD Tajne	MD (Physiology), Associate Professor, Dept. of Physiology, GMC,Nagpur
MT Jivtode	MD (Physiology), Associate Professor, Dept. of Physiology, GMC,Nagpur

ABSTRACT Arm span and height correlation varies according to different ethnic group. It is therefore important to study this relationship in native population. Arm span to height correlation is needed to predict height in subjects in whom height cannot be reliably measured due to structural defects. Therefore, it is reasonable to study the arm span and height relationship in school children of age group 5 – 15 years in central India. Cross sectional study was conducted on 200 school children of 5-15 years. Their anthropometric and pulmonary parameters were recorded. Arm span and standing height were having significant positive correlation with FVC, FEV1, PEFR ($P < 0.01$) . Similarly, arm span was found to have significant correlation with standing height both in male and female ($r=0.98$). Arm span to height ratio is having significant correlation ($P < 0.01$) with age. In conclusion, arm span is having significant positive relationship with height and arm span to height ratio with age.

KEYWORDS : arm span, height, pulmonary function test, armspan to height ratio

INTRODUCTION

It is generally accepted that standing height is having strongest correlation with pulmonary function test (PFT).[1] However in subjects having spinal deformity, extreme debility, muscular dystrophy, neuro-muscular weakness, structural defect or any other condition which results in significant shortening, height no longer can be considered as the consistent measurement to predict normal lung volumes. In such cases, greater importance is given to that measurement which would predict what height would have been, had there been no spinal deformity or to that measurement which is strongly correlated with PFT but remain unaffected by spinal deformity and that measurement is arm span.

The earliest documented observation that man can be drawn in square and in circle was made by Roman architect Vitruvius, thereby indicating similar magnitude of arm span and height. Until 19th Century, this arm span - height equality was largely artistic and philosophical concept , but this equality was found to be infrequent with arm span often being greater than height. British Sculptor Bonomi first designed instrument to measure height and breadth of a man.[2]

Arm span and height correlation varies according to different race and ethnic group.[3] It is therefore important to study this relationship in native population. The relationship between height and arm span is important in the diagnosis of disorders of connective tissue such as Marfan's syndrome. Arm span to height correlation is needed to predict height in subjects in whom height cannot be reliably measured due to structural defects. Among various body parameters suggested for predicting body height, arm span is found to be most reliable and consistant.(4) Therefore, the present study was undertaken to study the arm span and height relationship in school children of age group 5 – 15 years in central India as well as to observe arm span to height ratio in male and female.

MATERIALS AND METHODS:

A total of 200 subjects (99 males and 101 females) aged 5-15 years studying in primary, middle and high-school were recruited in this cross- sectional study after getting ethics approval from the Institutional Ethics committee. Study was carried out at Navyug Primary School and Pt. Bachharaj Secondary School, Nagpur. Children with past or present history of respiratory disease, cardio-respiratory illness, thoracic cage disorder, chest or upper limb deformity, allergic illness were excluded from this study. Study subjects were divided into 11 groups with an age difference of one year viz.5, 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 years. Anthropometric parameters included in this study were standing and arm span in cm. Study was done in a group of five children in morning hours 10 AM to 12 Noon to avoid diurnal variations. Standing height was measured against the wall inscribed measuring scale to the nearest completed centimeter. Age was calculated from date of birth recorded in school register. Arm span was measured as the distance between the tips of both middle fingers of horizontally abducted and maximally outstretched hands with subjects standing and facing the wall. Lung functions were measured with MIR-SPIROLAB II. The techniques were demonstrated to each child and they were made three efforts while standing and wearing a nose clip with an interval of five minutes between two consecutive maneuvers and the best of three was recorded. Single expiratory maneuver gave the Spirometric parameters required for study: FVC, FEV1¬ and PEFR.

Statistical Analysis:

Results were expressed as Mean ± SD. P-values less than 0.01 were judged statistically significant. Pearson's correlation coefficient(r) is calculated between dependent and independent variables and their significance is tested by using Student's t-test. Statistical analysis of data was performed using one way analysis of variance (ANOVA). SPSS (Statistical Package for Social Sciences) version 10.0 was used for calculations.

RESULTS:

The age and gender wise distribution of subjects is shown in table 1. Statistical profile of anthropometric and pulmonary parameters is depicted in table 2. Arm span as well as standing height were found to have significant positive correlation with all three pulmonary parameters namely FVC, FEV1 and PEFR ($P < 0.01$) [table 3]. Similarly, arm span was found to have strong and significant correlation with standing height both in male and female ($r=0.98$) (Table 4). Arm span to height ratio is having significant correlation ($P < 0.01$) with age, females ($r = 0.47$) having better correlation than males ($r =0.30$) (Table 5). Arm span to height ratio obtained in this study is depicted in table 6.

Table 1: Age and gender wise distribution of subjects

Age(in years)	No. of subjects		
	Male	Female	Total
5	4	8	12
6	11	9	20
7	8	10	18
8	11	10	21
9	7	7	14
10	10	9	19

11	5	8	13
12	16	12	28
13	9	11	20
14	14	13	27
15	4	4	8
Total	99	101	200

Table 2: Statistical profile of anthropometric and pulmonary parameters.

Age in years (no. of subjects)	Standing Height(cm)	Arm Span (Cm)	Arm Span to Height ratio	FVC(L)	FEV1(L)	PEFR(L/s)
5(8)	112.37±1.49	107.62±5.86	0.98±0.04	0.80±0.17	0.74±0.08	2.37±0.48
6(9)	114.83±4.10	113.72±4.74	0.99±0.01	0.99±0.17	0.96±0.15	2.53±0.49
7(10)	117.81±5.71	118.85±6.22	1.00±0.01	1.04±0.13	1.00±0.13	2.58±0.60
8(10)	127.10±5.63	129.25±5.38	1.01±0.02	1.38±0.18	1.33±0.17	3.28±0.67
9(7)	131.50±6.98	133.64±6.68	1.01±0.01	1.45±0.32	1.34±0.26	3.01±0.84
10(9)	134.44±7.13	137.77±9.46	1.02±0.01	1.67±0.29	1.55±0.21	4.00±0.45
11(8)	137.50±6.96	139.18±5.63	1.02±0.02	1.71±0.29	1.60±0.21	4.18±0.61
12(12)	147.25±6.25	152.00±7.31	1.03±0.02	2.07±0.28	1.94±0.25	4.85±0.50
13(11)	150.00±10.70	154.86±12.33	1.02±0.03	2.46±0.48	2.29±0.44	5.68±1.08
14(13)	156.19±5.36	162.53±8.07	1.04±0.02	2.65±0.33	2.46±0.29	5.80±0.50
15(4)	157.50±5.91	161.25±8.30	1.02±0.02	2.61±0.22	2.52±0.12	6.18±0.91

***Values are Mean ±SD**

Table 3: Relationship of FVC, FEV1 and PEFR to standing height and arm span.

Anthropometric Parameter	Sex	FVC		FEV1		PEFR	
		r	p-value	r	p-value	r	p-value
Standing Height	Whole Group	0.92	p<0.01*	0.94	p<0.01*	0.90	p<0.01*
	Male	0.91	p<0.01*	0.95	p<0.01*	0.90	p<0.01*
	Female	0.93	p<0.01*	0.94	p<0.01*	0.89	p<0.01*
Arm Span	Whole Group	0.91	p<0.01*	0.94	p<0.01*	0.89	p<0.01*
	Male	0.91	p<0.01*	0.95	p<0.01*	0.90	p<0.01*
	Female	0.92	p<0.01*	0.93	p<0.01*	0.88	p<0.01*

r is the Pearson's Correlation Coefficient. p-value is calculated by using Student's t-test for correlation at 1% level of significance.* - Significant at 1% level of significance i.e. p<0.01

Table 4. Relationship of Arm Span to Height

Anthropometric Parameter	Sex	Height	
		r	p-value
Arm Span	Whole Group	0.98	p<0.01*
	Male	0.98	p<0.01*
	Female	0.98	p<0.01*

Table 5. Relationship of Age to Arm Span: height ratio

Anthropometric Parameter	Sex	Age	
		r	p-value
Arm Span: Height Ratio	Whole Group	0.39	p<0.01*
	Male	0.30	p<0.01*
	Female	0.47	p<0.01*

Table 6. Arm span: height ratio in study subjects

Arm span: height ratio	Sex	Mean± SD	Range	SEM
	Whole group	1.019 ± 0.02	0.88-1.11	0.001
	Male	1.02 ± 0.02	0.96-1.09	0.002
	Female	1.01 ± 0.02	0.88-1.11	0.002

DISCUSSION:

Arm span has been proposed as a surrogate for standing height in prediction of lung volume in subjects who are unable to stand or who have skeletal deformity. The absolute difference between arm span and height is usually very small, therefore arm span may be directly substituted for height in prediction equations [5,1,6,7,8]. Hepper et al[1] found predicted vital capacity based on height and arm span almost identical. Application of correction factor to estimate height from arm span has been a practice since long in conditions where actual height is difficult to measure[6]. The disadvantage of this method of evaluation of height from arm span is that, relation between arm span and height is not well established [9] and also arm span to height ratio varies with age and sex[1]; especially in younger age group(<20 years).[9]Body height is generally used in prediction formulae for spirometric values since it is best anthropometric parameter correlated strongly with spirometric parameters. The most promising method for predicting normal spirometric values seem to be arm span method[1,10]. Arm span method requires the determination of the relationship between arm span and body height.

Our observation are in agreement with the studies by Hibbert ME et al[6] who found strong correlation between height and arm span in both male and female. (r =0.98 and 0.97 respectively). They proposed no adjustment factor to evaluate height from arm span. Johnson BE et al[10] also observed significant correlation between height and arm span in normal person (r =0.43 in female and 0.96 in male in 11-15 years age group), but they proposed adjustment factor of 1.03 for both sexes to estimate height from arm span. Similar were the findings by Hepper NGG et al[1], Aggarwal AN et al[5,2] and Godfrey S et al[11] who found close correlation between arm span and height in both male and female. However, arm span to height correlation varies according to various ethnic groups and races as depicted by various studies[3,12,13]. The absolute difference between height and arm span in any individual is usually small[5]. This may be the probable reason, arm span is having strong correlation with height and PFT. In present study, we observed that arm span measurements were slightly greater than height in 72.5%, less than height in 21% and equal to height in 6.5% of study subjects. Our results are co-existent with the observations made by Aggarwal AN et al[5] who found that arm span exceeded height in 79.82% less than height in 16.22% and equal to height in 3.95% of their study subjects. Johnson BE et al[10] also observed arm span to be greater than height. Similar was the observation by Aggarwal AN et al[2] who reported arm span being greater than height in 82.6% subjects. Thus equality between arm span and height is not well defined, therefore it is necessary to take arm span to height ratio to estimate height from arm span. Arm span to height ratio obtained in this study are in close agreement with the previously recorded figures in various studies.[5,1,6,9] Different results in mean value of arm span to height ratio might be because of racial difference.

Our observation is in accordance with the observation by Linderholm H et al(9) who found linear positive correlation of arm span to height ratio with age (r =0.45 for male and female). They also found that arm span to height ratio differed between sexes. So significant sex and age difference in arm span to height ratio was observed. Similarly, Hibbert ME et al[6] found slight but definite correlation of arm span to height ratio with age. However, our observation is in contrast to the observations by Johnson BE et al[10] who found arm span to height ratio was independent of both age and sex and Hepper NGG et al[1] who observed arm span to height ratio independent of age but they mentioned influence of sex on the ratio which found to be greater in males. Our findings are comparable with those of Aggarwal AN et al[5] who observed arm span to height ratio almost same in both sexes. Aggarwal AN et al[2] reported that height to arm span ratio (not arm span to height ratio) not significantly correlated with age and concluded that age not being major predictor for estimation of height from arm span. This observation goes against our finding.

Various workers[1,10,9,6,5] have found that normal pulmonary function parameters can be predicted from arm span in subjects with spinal deformity, structural defect and shortening or other condition in which observed height is not the normal height, by substituting arm span for height either directly or by converting arm span to estimated normal

height and thereby predicting normal lung volumes. The arm span method is having advantage of convenience and easy applicability but is disadvantageous on account of not well defined relationship between arm span and height. Various studies[1,6] have indicated that normal individual have only a small difference between height and arm span measurement. Aggarwal AN et al[5] proposed that arm span is reasonable surrogate for height in population in whom established norms for correlation between height and arm span are not available. Hence, further studies are suggested in this respect and to establish individual population based regression equation to predict lung volume and flow rates.

CONCLUSION:

Arm span has the significant positive correlation with standing height both in male and female. Arm span to height ratio is having significant correlation with age.

REFERENCES:

1. Hepper NGG, Black LF, Fowler WS. Relationship of lung volume to height and arm span in normal subjects and in patients with spinal deformity. Am Rev Respir Dis 1965;91:356-362.
2. Aggarwal AN, Gupta D, Ezekiel LM, Jindal SK. Statistical estimation of height from arm span in North Indian subjects. Indian J Physiol Pharmacol 2000;44(3):329-334.
3. Parker JM, Dillard TA, Phillips YY. Arm span – height relationship in patients referred for spirometry. Am J Respir Crit Care Med 1996 ;154(2 pt 1):533-536.
4. Mohanty SP, Babu SS, Nair NS. The use of arm span as predictor of height: A study of south Indian women. J Orthop Surg 2001;9(1): 19-23.
5. Aggarwal AN, Gupta D, Jindal SK. Interpreting spirometric data: Impact of substitution of arm span for standing height in adult from North India. Chest 1999;115 (2):557-562.
6. Hibbert ME, Lanigan A, Raven J, Phelan PD. Relation of arm span to height and the prediction of lung function. Thorax 1988;43:657-659.
7. Leech JA, Dulberg C, Kellie S. Relationship of lung function to severity of osteoporosis in women. Am Rev Respir Dis 1990;141: 68-71.
8. Allen SC. The relation between height, arm span and forced expiratory volume in elderly women. Age ageing 1989;18:113-116.
9. Linderholm H, Lindgren U. Prediction of spirometric values in patients with scoliosis. Acta Orthop Scand 1978;49:469-474.
10. Johnson BE, Westgate HD. Method of predicting vital capacity in patients with thoracic scoliosis. The Journal of Bone and Joint surgery 1970-Oct;52-A (7):1433-1439.
11. Godfrey S, Kamburoff PL, Nairn JR. Spirometry , lung volume and airway resistance in normal children aged 5-18 years. Br J Dis Chest 1970;64:15-24.
12. Reeves SL, Verakmin C, Henry CJ. The relationship between arm span measurement and height with special reference to gender and ethnicity. Eur J Clin Nutr 1996;50:398-400.
13. Steele MF, Mattox JW. Correlation of arm span and height in young women of two races. Ann Hum Biol 1987;14:445-447.