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# Role of Ulnar Length and Arm Span for Prediction of Pulmonary Function Test in Late Adolescent

**Walulkar MS[1], Walulkar S [2], Sagdeo MM [3], Paikrao VM [4]**

Assistant Professor [1], Associate professor [2], Professor & HOD [3], Technician [4]
1,3- Dept. of Physiology, NKP Salve Institute of Medical Sciences & Research Centre, Nagpur
2,4- Dept of Anatomy, NKP Salve Institute of Medical Sciences & Research Centre, Nagpur

## Abstract

***Aims:*** *The present study is aimed to evaluate the role of ulnar length & arm span for prediction of pulmonary function test in late adolescent.* ***Material & Method:*** *This study was conducted on 253 medical students (112 males and 142 female) of N K P Salve Institute of medical sciences and research Centre Digdoh hills Nagpur. The subjects were apparently healthy and without physical deformity. The age of the subjects ranged from 18-20 years.* ***Result and observation:*** *Correlation of FVC and FEV1 are positive with weight, height, ulnar length and arm span while FVC and FEV1 are negatively correlated with age in males. FVC is positively correlated with all parameters except age while FEV1 is positively correlated with all parameters in females. Age is negatively correlated with FVC while other parameters are positively correlated in both male and female. FEV1 is positively correlated with all parameters in both male and female.* ***Conclusion:*** *Using ulna length to predict pulmonary function minimizes the inaccuracies introduced when measuring height or arm span.*

***Keywords****: Arm Span, Ulna, Pulmonary Function Test*

**Address for correspondence:** Dr. Madhavi S. Walulkar. Assistant Professor, Dept. of Physiology, NKP Salve institute of Medical Sciences & Research Centre, Nagpur. madhaviwalulkar@gmail.com, sanjaymwalulkar@gmail.com

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## Introduction

The interpretation of pulmonary function test is based on the comparison of data measured in an individual and predicted values derived from data obtained in healthy subjects. Most predictions equations use age, sex, standing height, ulnar length and arm span as independent variables. Ulnar length is not affected by age; it may be measured more accurately than other anthropometric measures and is highly reproducible. Arm span is the measure most widely studied in the field of pulmonary function testing and may be used to substitute for height directly or after adjustment by applying a fixed correction factor.

Pulmonary function changes throughout childhood and is related to height and age. Height has traditionally been used to predict normal values (1). When spinal deformity, weakness, or immobility is present, height measurement is difficult and inaccurate. Arm span has been used to estimate height, and prediction equations have been developed for healthy children in various populations (2). Precision of arm span measurements is limited by weakness and joint deformity that restrict the ability to actively extend the arms fully. Spinal deformity alters the position adopted during the measurement and reduces accuracy. It is common practice to predict height from a measurement of arm span obtained with a flexible tape measure that is run over the skin and around corners. This practice leads to significant error and has poor reproducibility. This study aimed to evaluate the role of ulnar length and arm span for prediction of pulmonary function test in late adolescent.

## Materials and Methods

This study was conducted on 253 healthy (and without physical deformity) medical students (112 males and 142 female) between the age group of 18-20 years of N K P Salve Institute of medical sciences and research center Digdoh hills Nagpur. Height was measured by Stadiometer, maintained in the Frankfort horizontal plane position. The ulna length was defined as the direct distance between the tip of the olecranon process and the styloid process while the elbow in full flexion. Ulna lengths were taken independently on right and left sides of each individual using a digital sliding caliper capable of measuring 0.01mm.

Arm span was measured on a wooden arm span stadiometer (3). The frame consisted of two vertical poles and a horizontal beam with measurements marked in millimeters. The frame sits neatly against the wall, and each pole is held stable by three wooden feet. Attached to the horizontal beam is a mobile vertical wooden plate that is positioned 80 to 200 cm above the floor. Students were measured while standing with their back against the wall, with their head, shoulders, buttocks, and heels touching the wall. The feet were vertically below the head, which was in the Frankfurt horizontal plane. The feet were together throughout their length. The arms were extended laterally so that the hands were at the same level from the floor as the shoulders. The palms faced forward. The middle finger of the right hand just touched the protruding right hand pole. The vertical plate was moved medially until it rested against the middle finger of the left hand. If the middle finger had been traumatically amputated or injured, this measurement was omitted.

Pulmonary Function Test recorded in one setting on the same day by Medspiror made in India. Three satisfactory efforts were recorded according to the norms given by American Thoracic Society. Statistical analysis was performed by the SPSS 20.0 software.

**Spirometry Measurement**

**Ulnar length Measurement**

## Results

Age is negatively correlated with FVC (pre) while weight, height, ulnar length and arm span are positively correlated with FVC(pre) in both male and female (Table- 1).From above table weight, height and ulnar length are found to be significant with 0.007, 0.005 and 0.041 significance respectively; where age and arm span are not significant (Table- 2).

Age, weight, height, ulnar length and arm span are positively correlated with FEV1 in both males and females (Table- 3).Table- 4 shows that constant and height are significant with significance of 0.001 and 0.005 respectively while age, ulnar length and arm span are not significant in both males and females for FEV1(pre). All values of age, weight, ulnar length and arm span are positively correlated in Pearson Correlation Coefficients analysis (Table- 5).

**Table-1: Descriptive Correlations in male and female for FVC (pre)**

| Correlations | | Age (years) | Weight (kg) | Height (cm) | Ulna length | Arm span |
|---|---|---|---|---|---|---|
| Pearson Correlation | FVC (pre) | -0.003 | 0.509 | 0.675 | 0.598 | 0.644 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Significance (1-tailed) | FVC (pre) | 0.484 | 0.000 | 0.000 | 0.000 | 0.000 |

**Table-2: Descriptive Coefficientsin male and Female for FVC (pre)**

| Coefficients[a] | | | | | | |
|---|---|---|---|---|---|---|
| **Model** | | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t value** | **Significance** |
| | | **B** | **Standard Error** | **Beta** | | |
| 1 | (Constant) | -4.021 | 1.051 | | -3.825 | 0.000 |
| | Age (years) | -0.024 | 0.047 | -0.024 | -0.520 | 0.604 |
| | Weight (kg) | 0.009 | 0.003 | 0.156 | 2.722 | 0.007 |
| | Height (cm) | 0.027 | 0.009 | 0.362 | 2.831 | 0.005 |
| | Ulna length | 0.050 | 0.029 | 0.132 | 1.750 | 0.041 |
| | Arm span | 0.007 | 0.007 | 0.128 | 1.070 | 0.286 |

a. Dependent Variable: FVC (pre)

**Table-3: Descriptive Correlations in male and female for FEV1 (pre)**

| **Correlations** | | **Age (years)** | **Weight (kg)** | **Height (cm)** | **Ulna length** | **Arm span** |
|---|---|---|---|---|---|---|
| Pearson Correlation | FEV1(pre) | 0.027 | 0.403 | 0.600 | 0.500 | 0.573 |
| Significance (1-tailed) | FEV1(pre) | 0.336 | 0.000 | 0.000 | 0.000 | 0.000 |

**Table-4: Descriptive Coefficientsin male and Female for FEV1 (pre)**

| Coefficients[a] | | | | | | |
|---|---|---|---|---|---|---|
| **Model** | | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t value** | **Significance** |
| | | **B** | **Std. Error** | **Beta** | | |
| 1 | (Constant) | -3.941 | 1.130 | | -3.487 | 0.001 |
| | (Constant) | 0.006 | 0.050 | 0.006 | 0.115 | 0.908 |
| | Age (years) | 0.004 | 0.004 | 0.071 | 1.110 | 0.268 |
| | Weight (kg) | 0.029 | 0.010 | 0.404 | 2.853 | 0.005 |
| | Height (cm) | 0.018 | 0.031 | 0.049 | 0.581 | 0.562 |
| | Arm span | 0.007 | 0.007 | 0.126 | 0.951 | 0.342 |

a. Dependent Variable: FEV1(pre)

**Table-5: Pearson Correlation Coefficientsfor Age, Wight, Height, Ulna length and Arm span**

| Age (Years) | Weight (kg) | Height (cm) | Ulna length | Arm span |
|---|---|---|---|---|
| $R^2$=0.027 | $R^2$=0.403 | $R^2$=0.600 | $R^2$=0.500 | $R^2$=0.573 |

## Discussion

Ulnar length and arms span were chosen because it is readily accessible even in wheelchair bound adolescent (children) and its measurement is unaffected by weakness or by joint or spinal deformity.

Ulnar length measurement with a Harpenden caliper is simple, requiring only superficial palpation. The technique can be taught to new staff in minutes. Some degree of inaccuracy would be expected when measuring the ulna with a tape measure, and it is not recommended. Several authors have previously documented the relationship between height and various body segments in their study populations (2, 4, 5). Particular attention has been paid to the upper limb (6,7) and arm span (3,7,8). In normal children, height prediction from upper limb measurement has high correlation coefficient. Predicted values of pulmonary function tests rely on accurate height measurement and, therefore, using ulna length to predict height could facilitate this (1).

Arm span measurement could also be affected by weakness or by joint or spinal deformity and was included only for comparison. Arm span is currently being used by most respiratory laboratories to predict PFT in childhood neuromuscular weakness and spinal deformity due to lack of a better alternative.

In this study, pulmonary function measurements were performed in the standing height and that are compared with by using arm span and ulnar length. Townsend (9) and Lalloo (10) have examined pulmonary function values obtained in the standing and sitting positions in adults. Lalloo and coworkers have found the FEV1 in the standing position to be approximately 5% greater than that in the sitting position in women but less than 5%in men.

Townsend (9) found the FEV1 and FVC to be 7% and 6% greater respectively in the standing position in men. The American Thoracic Society indicates that the FVC is longer in the sitting position in childhood but this has not been quantitated (6).

Height measurement is inaccurate in the presence of spinal deformed and when immobility is present. Measurement of pulmonary function is particularly important in monitoring progress and in preoperative pulmonary risk assessment. Spinal deformity causes restrictive pulmonary defects (11).

Arm span measurements may be performed but positioning for measurement is often limited by the deformity of spine, which may lead to an inequality of the level of the shoulder. This may makes the measurement and the PFT predicted from it less accurate.

Accurately predicted pulmonary function is important for monitoring disease progression, preoperative pulmonary risk assessment, guiding investigative pathways for sleep-disordered breathing, and instigation of respiratory supportive tools such as noninvasive ventilation and teaching techniques to assist mucociliary clearance.

## Conclusion

Measurement of pulmonary function is an important component of respiratory assessment in those with neuromuscular weakness or spinal deformity. Using ulna length to predict pulmonary function minimizes the inaccuracies introduced when measuring height or arm span. Its use will lead to more accurate prediction of pulmonary function in childhood neuromuscular weakness or spinal deformity.

***Conflict of Interest:*** *None declared*
***Source of Support:*** *Nil*
***Ethical Permission:*** *Obtained*

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