Assessment of Pulmonary Function Test Profile among school-going children in reference to Anthropometric profile : A Prospective Observational Study

ABSTRACT

BACKGROUND: Protection of pediatric population by performing Pulmonary Function Test (PFT) is a primary concern. Lung function assessment is a crucial diagnostic and monitoring tool for a variety of pediatric respiratory conditions. Therefore, it is imperative to encourage primary care physicians and pediatricians to make implement of spirometry in the management of pediatric respiratory disorders.

AIMS and OBJECTIVE: Given the rising concern of respiratory parameters according to Age, Weight, Height and Body Mass Index (BMI) , Head Circumference (HdC), Chest Circumference (CC), Upper Mid Arm circumference (UMAC), Waist Circumference (WC), Hip Circumference (HC), and Waist–Hip Ratio (WHR) among children. This study aims to investigate respiratory health by comparing Pulmonary Function Test (PFT) parameters with anthropometric parameters in children.

MATERIAL and METHODS:

This prospective observational study was conducted among 555 normal healthy school children (352 boys and 203 girls) aged 8 to 17 years studying from grades V to X standard. Anthropometric measurements including Height, Weight, Body Mass Index (BMI), Head Circumference (HdC), Chest Circumference (CC), Upper Mid Arm circumference (UMAC), Waist Circumference (WC), Hip Circumference (HC), and Waist–Hip Ratio (WHR) were systematically recorded. Pulmonary Function Test (PFT) were performed with the children seated upright using a the Digital RMS-MED spirometer following informed written consent from parents. Strict protocols ensured precision and standardization during testing.

RESULTS: Pulmonary Function Test Profile were found to be statistically significant in our study group. In both boys and girls, PFT values exhibits strong positive correlation with age, and height, weight, Chest Circumference (CC), Upper Mid Arm circumference (UMAC), Waist Circumference (WC), Hip Circumference (HC), which was found to be statistically significant ($P < 0.05$).

CONCLUSION: In summary, Pulmonary Function Testing serves as a vital diagnostic tool in pediatric care. Spirometry must be a reliable and practical method to ensure accurate assessment. Regular reappraisal of the acquired skills of the pediatricians and technicians is the key for ensuring quality.

Keywords: Children, Pulmonary Function Tests (PFT), Spirometry Anthropometric parameters Body mass index (BMI), Respiratory health, Respiratory function.

INTRODUCTION-:

Spirometry is essential and useful instrument for tracking progression of respiratory diseases. Pulmonary Function Test parameters provide an objective measure of lung health in children. Childhood respiratory disease is a common ailment of morbidity and mortality worldwide. [1] In present time, Pulmonary Function tests can be performed in children to elderly age group person. Spirometry and peak expiratory flow rate (PEFR) are the most frequently used tests in children more than six years of age. Pulmonary Function Test parameters help recognizing and monitoring of both obstructive and restrictive respiratory diseases. Pulmonary function tests plays a vital role in the monitoring of management of respiratory problems.[2]

Lung volume, capacities and airway size increase in growing children. Important aspect is that PFTs are carried out in a child-friendly clinical setting with expertise hand of technicians, as there are specific challenges with learning difficulties are encountered while testing younger children. A degree of compliance and experience is required for successfully performing the Pulmonary Function testing.[3]

The development of respiratory function and growth of physical parameters has to be synchronized in children. Therefore, Pulmonary Function Test are equally important for the complete assessment of respiratory system and as well as physical development in children. The prevalence of pulmonary diseases especially bronchial asthma in children is increasing worldwide and for this challenge prediction of pulmonary function need to be established in children. PFTs are influenced by various parameters like anthropometric, geographic, genetic, ethnic, racial, socioeconomic, life-style and technical factors. The size and shape of ribcage, strength of respiratory muscle and development of lung parenchymal tissue fluctuate according to different genetic, racial, ethnic and geographic variations in children.[4]

Spirometry is simple to use, non-invasive, painless and effort-dependent method to quantity lung function (LF). In spirometry, lung dimensions and airflows are determined and displayed in a spirogram in form of graph to evaluate lung debility and impairment, diagnosing and monitoring respiratory disease.[5]. Most important determinants of Pulmonary Function Test are age, Height, Sex circumferences of the mid-upper arm, chest (CC), waist (WC), Hip (HC), BMI, and waist–hip ratio (WHR). [6]. Although body weight or related adiposity measures are also indicators of body size, their relation with measurement of Pulmonary Function Test Profile is unpredictable, predominantly in children. Overall, the Pulmonary Function is positively related with weight but has not strong relationship., if weight exceeded from normal range. [7]. Hence, Present study was undertaken to find out the correlation between anthropometric profile and Pulmonary Function Test Profile in children.

METHODS: -

Study Type and Study Design- This is an observational type of prospective and cross-sectional study in design.

Study Site -This study was done in 5 different school of Jaipur city in association with in department of Physiology, JK LONE Hospital and Respiratory Medicine SMS Medical College Jaipur.

Study Population-Children between the age group of 8-17 years.

Inclusion criteria- Inclusion criteria were children age group between 8 to 17 years.

Exclusion criteria -Exclusion criteria were cardiorespiratory diseases; thoracic cage disorders; children with H/O bronchial asthma, COPD or allergic diseases; children on treatment of respiratory tract infections.

Sample Size-A total of 555 children 352boys and 203 girls in the age group of 8-17 years from different 5 schools in to consideration.

Sampling Technique: 580 children were randomly selected and given to the questionnaire, out of which 555 children’s parents consented for the study with no respiratory or cardiovascular illness for the past 3 months prior to the study were finally appointed in the study after approval from institutional ethics Committee with No-3019MC/EC/2017.

Anthropometric Measurements: Anthropometric data—including Age, Sex, Weight, Height, Body Mass Index (BMI), Head Circumference (HdC), Chest Circumference (CC), Upper Mid-Arm Circumference (UMAC), Waist Circumference (WC), Hip Circumference (HC), and Waist–Hip Ratio (WHR)—were recorded following the guidelines outlined in the World Health Organization (WHO) Training Course on Child Growth Assessment.

- **Weight** was measured using an electronic weighing scale. Expected weights were referenced at specific ages: approximately 15 kg at 3 years, 18 kg at 5 years, 21 kg at 7 years, and 30 kg at 10 years. Typically, children gain about 3 kg annually until the onset of puberty.
- **Height** was measured with a stadiometer, ensuring the child stood erect without footwear.
- **Head Circumference (HdC)** was measured using a non-stretchable measuring tape placed around the head from the occipital protuberance to the supraorbital ridge.
- **Chest Circumference (CC)** was measured at the level of the nipples, midway between inspiration and expiration.
- **Upper Mid-Arm Circumference (UMAC)** was computed by means of marking the middle point between the pointed end of the acromion process and the olecranon of the ulna at the left arm.
- **Waist Circumference (WC)** was measured on the midpoint between the lower most rib and the iliac crest along side the mid-axillary line, use of a non-elastic tape on the give up of regular expiration. Two readings have been taken, and obtained mean was recorded.
- **Hip Circumference (HC)** was measured on the broadest part of the hips (between the greater trochanters and lower hindquarters) with the kids standing upright and legs together. Thin clothing was ensured, and note down the mean of two readings.

- **Waist–Hip Ratio (WHR)** was determined by calculating the waist circumference divided by hip circumference.

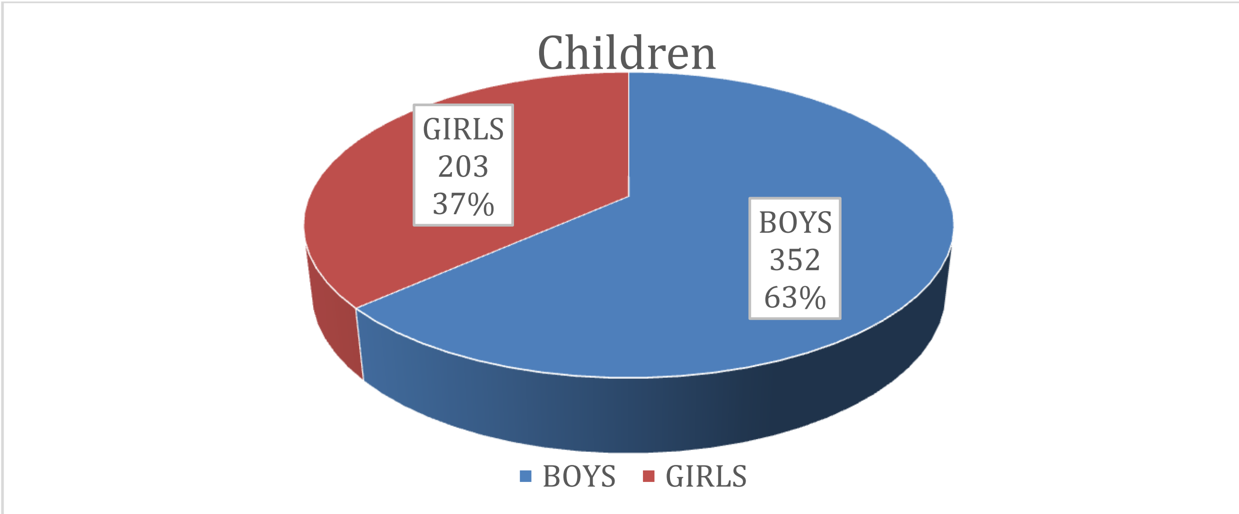
Pulmonary Function Test (PFT): Spirometry was conducted in accordance with American Thoracic Society (ATS) guidelines utilizing a Digital RMS-MED spirometer. All PFT profile assessment took place in a privatized and soundless room setting with the child seated in an upright position. Dynamic lung volumes and capacities were measured. The pulmonary function parameters assessed comprised Forced Expiratory Volume in one second (FEV_1), Forced Vital Capacity (FVC), the FEV_1/FVC ratio, and Peak Expiratory Flow Rate (PEFR).

Statistical Analysis: Mean and standard deviation were computed for all anthropometric and spirometric variables according to gender. All statistical analyses were performed using SPSS

(version 26.0) (IBM SPSS Statistics, version 26.0. Continues variables were noted as mean ± standard deviation (SD). The mean for Age, Height, Weight, BMI, Head Circumference (HC), Chest Circumference (CC) Upper mid arm circumference, Waist circumference, Hip circumference, W/H ratio, FEV1, FVC, FEV1/FVC, PEFR were calculated separately for boys and girls. The independent t-test was applied to determine differences in measurements between two groups and Pearson correlation coefficient (r) was used to measure strength and significance ($p <0.05$) between anthropometric parameters and Pulmonary Function Test (PFT) in children.

RESULTS:

Distribution of children according to gender



This Pie chart depicts a total of **555 children** were assessed, consisting of **203 girls** and **352 boys**.

TABLE 1: Anthropometric parameters in children according to gender (Boys and girls)

Sr. no.	Parameters	Boys (Mean ±SD)	Girls (Mean ±SD)
1.	Age	12.5±2.7	12.5±2.8
2.	Weight	41.41 ±10.3	39.73 ±9.8
3.	Height	139.93 ±15.2	139.55 ±13.5
4.	BMI	22.05 ± 7.3	21.08 ±7.1
5.	Head Circumference	52.15±1.6	52.10. ± 1.5
6.	Chest Circumference	67.93 ±6.0	68. 23 ±5.5
7.	Mid Upper Arm Circumference	20 .2 ±2.3	20.8±2.1
8.	Waist Circumference	69.65±5.7	59.54± 5.2
9.	Hip Circumference	75.0±6.3	70.01±6.0
10.	W/H ratio	0.87±0.05	0.87±0.04

Table No. 1 shows Mean age was similar between boys and girls, around **12.5 years**, with a **standard deviation (SD)** of nearly 3 years, indicating a balanced distribution across the 8 - 17-year range. **Boys** had a slightly higher mean height (**139.93 cm**) than **girls** (**139.55 cm**), with variability (SD) of 13–15 cm in both groups. Mean weight in boys was in more (**41.41 kg**) than girls (**39.73 kg**), with SDs around 10 kg. The Mean **BMI** was higher in boys (**22.05 kg/m^2**) compared to girls (**21.08 kg/m^2**), though both showed considerable variability (**SD +7**), reflecting diverse body compositions in this age group. Both genders had very similar **Head Circumferences** (**52.15 cm**), indicating no major sex-based differences in this parameter. **Chest Circumference** was nearly equal as well, with **girls (68.23 cm)** slightly ahead of **boys (67.93 cm)**. MUAC was almost the same between boys and girls **20 cm**), a useful indicator for body composition. Waist and Hip Circumference were also closely matched. Boys had a Waist circumference of about **59.79 cm** and Hip Circumference at **69.65 cm**, while girls had **59.54 cm** Waist Circumference and **70.01 cm** Hip Circumference. Waist Hip Ratio (WHR) values were identical (**0.87**) in both groups, suggesting no significant gender difference in fat distribution patterns at this age range

Table No. 2 Distribution of Pulmonary Function Test profile in children according to gender (Boys and Girls)

PFT Profile	GIRLS (n)	Mean ± SD	BOYS (n)	Mean ± SD
FEV1 (L)	**203**	**1.95 ± 0.4**	**352**	**2.35 ± 0.5**
FVC (L)	**203**	**2.10 ± 0.5**	**352**	**2.55 ± 0.5**

FEV1/FVC (%)	**203**	**92.5 ± 4.0**	**352**	**91.2 ± 4.3**
PEFR (L/Min)	**203**	**270 ± 60**	**352**	**310 ± 65**

Table No. 2 Depicts Pulmonary Function Test Profile FEV1 and FVC are higher in boys as compared to girls. FEV1/FVC ratio remains relatively stable between genders and is used clinically to detect obstructive or restrictive patterns. **PEFR** shows a wider range of variability and is influenced heavily by effort and technique. p-values indicate that **FEV_1, FVC, and PEFR** are **significantly different** between boys and girls, while the **FEV_1/FVC ratio** is **not significantly different** in gender distribution.

Table No.3 Distribution of Pearson Correlation Coefficient with significance level between Anthropometric profile and Pulmonary Function Test

Anthropometric profile	**FEV1 (r/p)**	**FVC (r/p)**	**FEVI/FVC (r/p)**	**PEFR (r/p)**
Age	**0.68/0.0001 HS**	**0.65/0.0001 HS**	**-0.15/0.07 NS**	**0.70/0.0001 HS**
Weight	**0.60/0.0001 HS**	**0.62/0.0001 HS**	**-0.12/0.08 NS**	**0.65/0.0001 HS**
Height	**0.75/0.0001 HS**	**0.72/0.0001 HS**	**-0.10/0.11 NS**	**0.78/0.0001 HS**
BMI	**0.40/0.004 S**	**0.42/0.003 S**	**-0.18/0.04 S**	**0.45/0.002 S**
Head	**0.30/0.010**	**0.32/0.008**	**-0.05/0.30**	**0.35/0.005**

Circumference	**S**	**NS**	**NS**	**S**
Chest Circumference	**0.58/0.0001 HS**	**0.60/0.0001 HS**	**-0.10/0.09 NS**	**0.63/0.0001 HS**
Mid Upper Arm Circumference	**0.55/0.0001 HS**	**0.52/0.000 HS**	**-0.13/0.06 NS**	**0.57/0.0001 HS**
Waist Circumference	**0.42/0.0002 S**	**0.45/0.001 S**	**-0.20/0.02 NS**	**0.48/0.001 S**
Hip Circumference	**0.46/0.001 S**	**0.48/0.001 S**	**-0.14/0.05 NS**	**0.50/0.0001 HS**
W/H ratio	**0.20/0.045 NS**	**0.22/0.037 NS**	**-0.25/0.018 NS**	**0.25/0.020 NS**

S: Significant HS: Highly Significant NS: Non-Significant

Table No. 3 Depicts **Height vs PEFR (r = 0.78)**: Strong positive correlation → As height increases, PEFR increases. **Age vs FEV1 (r = 0.68)**: Moderate-to-strong positive correlation → Older children tend to have better FEV1. **Weight vs FVC (r = 0.62)**: Moderate positive correlation → Heavier children generally have higher FVC. Means Pulmonary function tends to improve with growth-related parameters (age, height, weight). **BMI vs FEV1/FVC ratio (r = -0.18)**: Weak negative correlation → As BMI increases, FEV1/FVC ratio slightly decreases, but may not be significant. **Height vs FEV1/FVC ratio (r = -0.10)**: Very weak or no correlation. **Strong predictors** of PFT values (r ≥ 0.6) often include: Age Height, Weight, Chest Circumference, MUAC. **W/HR** may show weaker associations compared to absolute body size measures.

DISCUSSION

The present study aimed to evaluate anthropometric parameters and Pulmonary Function Test (PFT) values in children, and to compare the findings with those reported in similar studies. Our results demonstrate a significant correlation between anthropometric measures—such as Age Height, Weight, BMI, Chest Circumference (CC), Waist Circumference (WC), Hip Circumference (HC) and Pulmonary Function Test (PFT) Profile including FVC, FEV_1, and PEFR.

Harmonious with earlier disquisition by Shaikh. et al. (2019)) and Escaldelai et al. (2023), our study confirms that height is the most significant predictor of Pulmonary Function Test in children. In our study sample, both FVC and FEV_1 showed a strong positive correlation with height ($p < 0.01$), which aligns with the findings of Oloyede et al. (2013) and Olanrewaju (1991) who reported the significant positive relationship between lung volume and height. According to Raju et al (2003) Age, Height, Weight, and Chest Circumference were the best predictors for FEV1, FVC and PEFR presented significant association with lung functions. Doctor et al (2010) gaining importance of anthropometric profile in our study and reported that "Variables such as FVC, FEV_1, and PEFR exhibit a strong positive correlation with height, age, and body surface area in both males and females. Study of Budhiraja et al (2010) results confirm our study finding that age, weight and height have positively correlated with Pulmonary Function Test Profile (PFT) boys and girls both. Pulmonary Function standards in boys were significantly higher as compared to girls. "Peak Expiratory Flow Rate (PEFR) has gained significant prominence and is now widely utilized as a key method for assessing both obstructive and restrictive pulmonary disorders." Gunasekaran (2021) reported in study on PEFR as boys had higher PEFR value than girls of the same age group.

Overall, our findings underscore the interplay between growth parameters and Pulmonary Function and advocate for regular assessment of PFTs in Pediatric health evaluations, especially in children with abnormal anthropometric profiles.

CONCLUSION

Height emerges as the most robust predictor of Pulmonary Function among school-aged children. While **BMI** exerts a moderate association with lung function. Effect of BMI is comparatively less substantial than that of height. Pulmonary Function Test parameters showed progressive improvement with physical growth, emphasizing the critical roles of adequate **nutrition** and regular **physical activity** in respiratory health**.** Timely assessment of Pulmonary Functions is vital for the **early identification of children predisposed to respiratory complications.**

CONTRIBUTION OF SOCIETY

1. Early Disease Detection -Enables timely identification of respiratory conditions such as asthma, allowing for early intervention and management.

2. Public Health Impact

Provides critical data to support evidence-based policymaking for child health.

3. Lifestyle & Environmental Assessment

Analyses the influence of factors like air pollution, nutrition, and physical activity on lung health.

4. Health Awareness

Empowers parents, educators, and schools to promote healthy lung habits in children through informed decision-making.

5. Research & Innovation

Facilitates advanced studies in pediatric respiratory health, fostering innovation and improved healthcare outcomes.

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CONFLICT OF INTEREST: None declared

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