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RESEARCH ARTICLE

ASSESSMENT OF PULMONARY FUNCTION TEST PROFILE AMONG SCHOOL- GOING CHILDREN IN REFERENCE TO ANTHROPOMETRIC PROFILE: A PROSPECTIVE OBSERVATIONAL STUDY

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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 conducted with the children in upright sitting position utilizing the Digital RMS-MED spirometers subsequent to obtaining informed written consent from their parents. Strict protocols were implemented to guarantee for accuracy and standardization throughout testing process.

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.

Body mass index (BMI), Respiratory health, Respiratory function.

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Introduction:-

Spirometry is a vital and invaluable tool for monitoring the advancement and guiding treatment strategies of respiratory disease. 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 commonly utilized assessments for children over six years old. Pulmonary Function Test parameters help recognizing and monitoring of both obstructive and restrictive respiratory diseases. Pulmonary function tests play 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 myriad of parameters including anthropometric, geographic, genetic, ethnic, racial, socioeconomic, life-style and technical factors. The dimensions and silhouette of ribcage, strength of respiratory muscle and development of lung parenchymal tissue vary according to diverse genetic, racial, ethnic and geographic factors in children.[4]

Spirometry is user friendly, uncomplicated, non-invasive, painless and effort-dependent method to assess 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 352 boys 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 assessed measured at the nipples level, precisely midpoint of inhalation and exhalation.
- 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 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 derived by dividing the circumference of waist by that of circumference of hip.

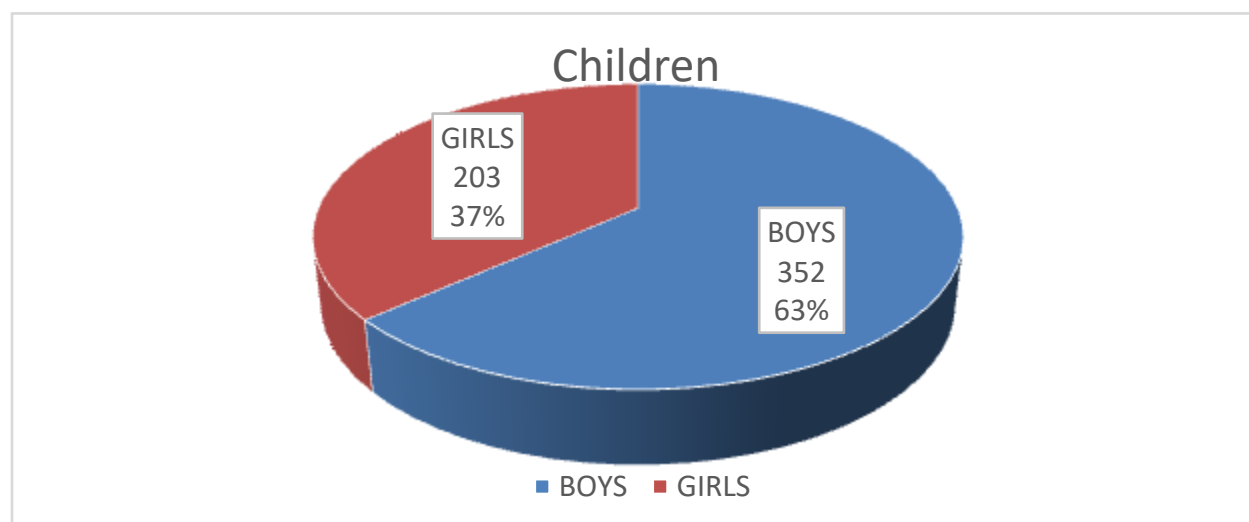
Pulmonary Function Test (PFT): Spirometry was conducted in accordance with American Thoracic Society (ATS) guidelines utilizing a Digital RMS-MED spirometer. All PFT profile assessment took place in a privatized and soundless room setting with the child seated in an upright position. Dynamic lung volumes and capacities were measured. The pulmonary function parameters assessed comprised Forced Expiratory Volume in one second (FEV₁), Forced Vital Capacity (FVC), the FEV₁/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. Continuous variables were noted as mean \pm 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 \pm SD)	Girls (Mean \pm SD)
1.	Age	12.5 \pm 2.7	12.5 \pm 2.8
2.	Weight	41.41 \pm 10.3	39.73 \pm 9.8
3.	Height	139.93 \pm 15.2	139.55 \pm 13.5
4.	BMI	22.05 \pm 7.3	21.08 \pm 7.1
5.	Head Circumference	52.15 \pm 1.6	52.10. \pm 1.5
6.	Chest Circumference	67.93 \pm 6.0	68. 23 \pm 5.5
7.	Mid Upper Arm Circumference	20 .2 \pm 2.3	20.8 \pm 2.1
8.	Waist Circumference	69.65 \pm 5.7	59.54 \pm 5.2
9.	Hip Circumference	75.0 \pm 6.3	70.01 \pm 6.0
10.	W/H ratio	0.87 \pm 0.05	0.87 \pm 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/m²) compared to girls (21.08 kg/m²), 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 69.79 cm and Hip Circumference at 75.01 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 \pm SD	BOYS (n)	Mean \pm SD
FEV1 (L)	203	1.95 \pm 0.4	352	2.35 \pm 0.5
FVC (L)	203	2.10 \pm 0.5	352	2.55 \pm 0.5
FEV1/FVC (%)	203	92.5 \pm 4.0	352	91.2 \pm 4.3
PEFR (L/Min)	203	270 \pm 60	352	310 \pm 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 FEV₁, FVC, and PEFR are significantly different between boys and girls, while the FEV₁/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 profile

Anthropometric profile	FEV ₁ (r/p)	FVC (r/p)	FEV ₁ /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 Circumference	0.30/0.010 S	0.32/0.008 NS	-0.05/0.30 NS	0.35/0.005 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, FEV₁, and PEFR.

Harmonious with earlier disquisition by Shaikh. et al. (2019)) and Escaldelaiet 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 FEV₁ 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, FEV₁, 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 benchmarks in boys were significantly advanced and elevated in comparison 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 FOR 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

ETHICAL APPROVAL: The study was approved by the Institutional Ethics Committee and consent has to be obtained from school authorities.

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