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Original Research Article

An Observational Study to Assess the Association between Age and BMI with Peak Expiratory Flow Rate in Children Aged 10-15 Years

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Abstract

Aim: The aim of the present study was to assess the correlation of age and BMI with peak expiratory flow rate in children aged 10-15 years.

Methods: The present study was conducted in the Department of Pediatrics, JLNMCH, Bhagalpur , Bihar, India for 12 months and 200 children were included in the study.

Results: Around 54% of the children were Male and 46% of them were female. Majority of the children 24.5% were 13yrs, followed by 20.5% were 12yrs, 18.5% were 11yrs, 14.5% were 14yrs, 12.5% were 10yrs and only 9.5% were 15yrs. Majority of the children 75% had normal BMI, followed by 12% were underweight, 9.5% were overweight and only 3.5% were obese. Majority of the children 26% had PEFR 250-280, followed by 21% had PEFR 311-340, 17% had PEFR 281-310, 14% had PEFR 341-370, 14% had PEFR 200-249 and only 8% had PEFR 371-400. There was a positive correlation between PEFR and age with r value 0.423 and this correlation was statistically significant. PEFR and Female age had more positive correlation than Male age. There was a positive correlation between PEFR and weight with r value 0.652 and this correlation was statistically significant. PEFR and Female weight had more positive correlation than Male weight. There was a positive correlation between PEFR and Height with r value 0.509 and this correlation was statistically significant. PEFR and Male Height had more positive correlation than Female Height. There was a positive correlation between PEFR and BMI with r value 0.471 and this correlation was statistically significant. PEFR and female BMI had more positive correlation than Male BMI.

Conclusion: The study emphasised maintenance of normal BMI in children and adolescents in order to prevent future risk of obstructive respiratory diseases. Prevention of malnutrition by dietary counselling, school health programmes, early detection of malnutrition by regular growth monitoring, health supplements and Obesity prevention by regular exercises and appropriate diet is important in maintaining normal PEFR.

Keywords: BMI, respiratory distress, asthma, malnutrition

Introduction

Definition of PEFR is as the maximum or peak flow rate which is attained during a forceful expiratory effort (after taking a deep inspiration). It is the measurement of airflow through the bronchial tree and gives an idea about bronchial tone. Pulmonary functions are normally determined by respiratory muscle strength, the thoracic cavity's compliance, airway resistance, and the lung's elastic recoil. [1] Pulmonary functions may usually vary according to the physical characteristics including age, height, and body weight. [2]

Obesity is now categorized as a "disease" condition by the World Health Organization (WHO). The WHO has recommended the use of BMI as the simplest form of defining obesity. [3] Obesity is a chronic medical condition, characterized by an excessive fat accumulation in human body, and cause a general increase in body mass. [4] Obesity is usually calculated by BMI, which is weight in kg divided by height in square meter. [4] PEFR decreases with high BMI in elderly age group. The association of high BMI with low PEFR may indicate that obesity is an important risk factor for lung function and reduced airflow. [5]

Gender differences in airway behavior and clinical manifestations of airway disease have also been reported. The latter are attributed to biological and socio-cultural factors, such as body size, sex hormones, sex hormone receptors, and intracellular signaling pathways. [6,7] Ethnicity has also been shown to have an impact on lung function variation, with white populations having higher Forced Vital Capacity and Forced Expiratory Volume in 1 s (FEV1), and black Americans having smaller lung volumes. [7] Additionally, increased weight decreases lung volume and capacities, this is due to increasing resistance to outflow of air through the airways. PEFR is positively correlated with height and inversely correlated with weight. Obesity is linked to decreased PFTs due to its restrictive effect on the lung and chest wall. [8,9] Notably, studies have reported a significant increase in PEFR with age in children, with boys having higher values than girls. The relationship between age and PEFR in children is complex and may be influenced by sex, ethnicity, physical activity levels, and the method used to measure PEFR. [10,11]

The aim of the present study was to assess the correlation of age and BMI with peak expiratory flow rate in children aged 10-15 years.

Materials and Methods

The present study was conducted in the Department of Pediatrics JLNMCH, Bhagalpur , Bihar, India for 12 months and 200 children were included in the study.

Inclusion Criteria

- School going children in the age group of 10 to 15 years.

Exclusion Criteria

- Bronchial asthma.
- Acute or chronic respiratory tract infection (at least 3 months before examination).
- Acute or chronic cardiac disease.
- Any systemic illness.
- History of allergy.
- Structural deformity of the thoracic cage.
- Substance abuse (e.g.: smoking)

Methodology

All tests were carried out with prior permission from the head of the schools and informed consent from children's parents in local language. For each child detailed history and physical examination was done and all anthropometric parameters were measured and entered as per the proforma. Following examination, each child was subjected to measurement of peak expiratory flow rate according to the steps given below.

Before recording the procedure was demonstrated to each child. The following steps were followed with the wright's Mini Peak Flow Meter.

1. Set the cursor to zero. Do not touch the cursor when breathing out.

2. Stand up and hold the peak flow meter horizontally in front of the mouth.

3. Take a deep breath in and close the lips firmly around the mouth piece, making sure there is no air leak around the lips.

4. Breathe out as hard and as fast as possible.

5. Note the number indicated by the cursor.

6. Return the cursor to zero and repeat this sequence twice more, thus obtaining three readings.

The highest or best reading of all three measurements was the peak expiratory flow rate at that time.

Anthropometry

1. Weight: Child's weight was taken with minimal clothes using electronic scale.

2. Height: Height was measured using standard stadiometer.

3. BMI: With the obtained weight and height, BMI was calculated with the formula - wt. (kg)/ [ht (m)2] and compared with IAP charts.

Statistical Analysis: Data was entered into Microsoft excel data sheet and was analysed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Continuous data was represented as mean and standard deviation. Independent t test was used as test of significance to identify the mean difference between two quantitative variables. ANOVA was used as test of significance to identify the mean difference between more than two quantitative variables. Correlations were performed with Pearson Correlation coefficient.

Results

Table 1: Distribution based on Gender and Age

Gender	Frequency	Percentage
Female	92	46.0
Male	108	54.0
Age (in yrs)		
10yrs.	25	12.5
11yrs	37	18.5
12 yrs.	41	20.5
13 yrs.	49	24.5

14 yrs.	29	14.5
15 yrs.	19	9.5
Total	200	100.0

Around 54% of the children were Male and 46% of them were female. Majority of the children 24.5% were 13yrs, followed by 20.5% were 12yrs, 18.5% were 11yrs, 14.5% were 14yrs, 12.5% were 10yrs and only 9.5% were 15yrs.

Table 2: Distribution of children according to Body Mass Index

BMI	Frequency	Percentage
Under Weight	24	12.0
Normal	150	75.0
Over Weight	19	9.5
Obese	7	3.5
Total	200	100.0

Majority of the children 75% had normal BMI, followed by 12% were underweight, 9.5% were overweight and only 3.5% were obese.

Table 3: Distribution of children according to PEFR

PEFR	Frequency	Percentage
200-249	28	14.0
250-280	52	26.0
281-310	34	17.0
311-340	42	21.0
341-370	28	14.0
371-400	16	8.0
Total	200	100.0

Majority of the children 26% had PEFR 250-280, followed by 21% had PEFR 311-340, 17% had PEFR 281-310, 14% had PEFR 341-370, 14% had PEFR 200-249 and only 8% had PEFR 371-400.

Table 4: Correlation of PEFR with Age, weight, height, BMI

Variable	r and p value	Male	Female	Overall
PEFR/age	Pearson Correlation (r value)	0.381	0.468	0.423
	P value	<0.001	<0.001	<0.001
PEFR/weight	Pearson Correlation (r value)	0.610	0.708	0.652
	P value	<0.001	<0.001	<0.001
PEFR/height	Pearson Correlation (r value)	0.543	0.449	0.509
	P value	<0.001	<0.001	<0.001
PEFR/BMI	Pearson Correlation (r value)	0.442	0.513	0.471
	P value	<0.001	<0.001	<0.001

There was a positive correlation between PEFR and age with r value 0.423 and this correlation was statistically significant. PEFR and Female age had more positive correlation than Male age. There was a positive correlation between PEFR and weight with r value 0.652 and this correlation was statistically significant. PEFR and Female weight had more positive correlation than Male weight. There was a positive correlation between PEFR and Height with r value 0.509 and this correlation was statistically significant. PEFR and Male Height had more positive correlation than Female Height. There was a positive correlation between PEFR and BMI with r value 0.471 and this correlation was statistically significant. PEFR and female BMI had more positive correlation than Male BMI.

Discussion

Lung function tests have evolved from tools for physiological study to clinical investigations in assessing respiratory status. They have become a part of routine health examination in respiratory, occupational, sports medicine and public health screening. [12] Tests have been designated to indicate the extent of narrowing of airways, which can lead to breathing issues, decreased oxygen consumption, and an increased risk of respiratory infections. A simple but important test used to measure lung function is the Pulmonary function test (PFT). [13]

Around 54% of the children were Male and 46% of them were female. Majority of the children 24.5% were 13yrs, followed by 20.5% were 12yrs, 18.5% were 11yrs, 14.5% were 14yrs, 12.5% were 10yrs and only 9.5% were 15yrs. Majority of the children 75% had normal BMI, followed by 12% were underweight, 9.5% were overweight and only 3.5% were obese. Majority of the children 26% had PEFR 250-280, followed by 21% had PEFR 311-340, 17% had PEFR 281-310, 14% had PEFR 341-370, 14% had PEFR 200-249 and only 8% had PEFR 371-400. In the obese patient, the tidal volume (TV) and FRC are decreased due to changes in elastic properties of the chest wall. Retractile forces of the lung parenchyma on the airways are reduced at low lung volume. At low FRC, the airway smooth muscle may be unloaded with a paradoxical increased shortness in response to normal parasympathetic tone or to other bronchial-constricting agents. [14] Thus, it has been hypothesized that in obese patients, breathing at low TV does not allow the normal stretching of airway smooth muscle during breathing, which causes the detachment of actin – myosin cross bridge of the airway smooth muscle. The bigger the TV, the greater the ensuing bronchial dilation. [15] This fact, known as "deep inhalation effect," allows restoration of the dilation of the airways in normal conditions. This protective effect is reduced in obese individuals in comparison to lean subjects. Therefore, the net result of airway narrowing occurs in obese subjects. [16,17]

There was a positive correlation between PEFR and age with r value 0.423 and this correlation was statistically significant. PEFR and Female age had more positive correlation than Male age. There was a positive correlation between PEFR and weight with r value 0.652 and this correlation was statistically significant. PEFR and Female weight had more positive correlation than Male weight. There was a positive correlation between PEFR and Height with r value 0.509 and this correlation was statistically significant. PEFR and Male Height had more positive correlation than Female Height. There was a positive correlation between PEFR and BMI with r value 0.471 and this correlation was statistically significant. PEFR and female BMI had more positive correlation than Male BMI.

Conclusion

The study emphasised maintenance of normal BMI in children and adolescents in order to prevent future risk of obstructive respiratory diseases. Prevention of malnutrition by dietary counselling, school health programmes, early detection of malnutrition by regular growth monitoring, health supplements and Obesity prevention by regular exercises and appropriate diet is important in maintaining normal PEFR.

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