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Research Paper

Relation of Body Mass Index with Pulmonary Functions in Overweight Adolescent Boys: A Cross Sectional Study

Medical Science

KEYWORDS : PFT, Spirometry, BMI.

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ABSTRACT

Background: *Overweight and Obesity is rapidly increasing in India in all age groups. The present study assesses pulmonary functions in overweight adolescent boys.*

Aims: *To assess the dynamic lung functions in overweight adolescent boys*

Materials and Methods: *We cross-sectionally investigated the effect of increased body mass index (BMI) on pulmonary function in a sample of healthy children, aged 10–15years living in Dhanbad, Jharkhand. Standard anthropometric measurements weight (kg) and height (cm) were measured in all the children and BMI was calculated. Dynamic lung functions were measured in 30 overweight adolescent boys and an equal number of age-matched controls using spirometry.*

Results: *There was significant statistical relation between BMI and FEV1 (%), FEV1/FVC (%), PEF ($P < 0.05$).*

Conclusions: *There is significant relation between pulmonary function and BMI in overweight adolescent boys, particularly reduced FEV1 /FVC ratio.*

INTRODUCTION

Overweight and Obesity is an important public health problem. It is rapidly increasing in India in all age groups. The National Health and Nutrition Examination Survey, 2009-2010, found 32% of children, 2-19 yr old to be overweight or obese and 17% in the obese range. Among the various investigations available, pulmonary function test (PFT) is a one of the important tool for the assessment of pulmonary function. Lung function test (PFT) for lungs can be comparable to the electrocardiogram (ECG) for heart.[1] Predictive reference values are much important in clinical interpretation of these tests. Studies carried out in children had projected the equations for predicting different lung functions using anthropometric measures such as height, age and weight as independent variables in India[2-7] and in other countries. Obesity and overweight are associated with increase in body mass index.

Obesity is rapidly escalating in India in all age groups. School-based data indicate a prevalence rate between 5.6% and 24% in children and adolescents.[8-10] Impairment of pulmonary function is associated with both adolescent and adult obesity. Studies have revealed a significant reduction in forced vital capacity (FVC), forced expiratory volume in the 1st second (FEV1) and flow rates [peak expiratory flow rate (PEFR) in adolescent boys with high BMI. [11] However, studies investigating pulmonary functions in children with high BMI in India are few. Hence, the present study was aimed to investigate pulmonary function variables in the adolescent boys in Dhanbad city, Jharkhand and to know relation between body mass index (BMI) and pulmonary functions.

METHODOLOGY

The present study was conducted among normal healthy adolescent boys in the city who are attending our clinic regularly. The prior permission and written consent was obtained from the parents of the students involved in the study. The study was conducted among the adolescent boys (10-15 yrs). All boys were included in this age group except those having history of (h/o) fever last10 days, respiratory illness like symptoms in last10 days, acute or chronic respiratory diseases, history of cardiac or renal problems, anaemia like symptoms, history of any drug intake which can affect lung function, allergic history, history of deformity of chest or spine and any muscular weakness, significant family history of asthma, atopy, or other chronic lung diseases.

Details regarding purpose and objective of the study were explained to parents. Height and weight were measured in all the children in a standing position without shoes, using a stadiometer and an electronic digital scale: Body mass index (BMI) was calculated as per the following formula: body mass index = weight (kilograms)/height^2 (meter^2). BMI is an excellent proxy for more direct measurement of body fat. We are aware that BMI may not truly reflect adiposity, or give information on lean body mass. However, BMI is a simple epidemiological measure which is easily applied in large population studies, and it has recently demonstrated to correlate well to body fat mass in children and adolescents. Overweight (OW) and obese (O) children were defined following the gender- and age-specific cut-off points for overweight and obese by Cole et al[12]. A total of 30 boys with BMI $\geq$ 25 were included in the study while remaining boys were excluded due to exclusion criteria. An identical number of age-matched boys with BMI of < 25 were taken as controls.

The subjects were demonstrated the maneuvers of the pulmonary function tests. Computerized spirometry was carried out using MEDI:SPIRO (Maestros Mediline Systems Ltd., Navi Mumbai, India) observing the guidelines laid down by the American Thoracic Society and European Respiratory Society,[13] with the subject seated. Calibration of the spirometer was carried out daily using a 3-L calibration syringe as recommended by the American Thoracic Society. Each participant was told to take a deep breath and then blow into the mouth piece as hard and fast as she could. The same spirometer was used throughout the study and the tests were performed by the same technician. Data were collected and analysis was done with appropriate statistical test. Flow volume curve was plotted with the best of three acceptable maneuvers being taken as the final reading. The following pulmonary functions were recorded: Forced expiratory volume in one second (FEV1) , forced vital capacity (FVC)FVC, FEV1 / FVC (ratio of FEV1 and FVC), peak expiratory flow rate(PEFR), maximum mid-expiratory flow ($FEF_{25-75\%}$). Data was expressed as mean and standard deviation (SD). All P values less than 0.05 were considered statistically significant.

RESULTS

Table 1 compares the age and anthropometric variables of the overweight and control groups. The average BMI of the overweight group was 26.8 ± 3.98 kg/m^2 compared to the control group's 19.81 ± 1.32 kg/m^2. The average age of the overweight and control groups were 14.12 (± 0.83) and 13.8 (± 0.69) respectively.

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Table 1: Anth+ropometric data of the subjects (n=30)

Variables	Controls(n=30) Mean (±SD)	Overweight(n=30) Mean (±SD)
Age (Yrs)	13.86 (± 0.69)	14.12 (± 0.83)
Height (cm)	159.8 (±8.61)	161.8 (±6.64)
Weight (Kg)	50.08 (± 4.9)	69.46((±9.6) ***
BMI (Kg/m2)	19.81 (± 1.32)	26.8 (± 3.98) ***

**P < 0.01; ***P < 0.001

Table 2 compares the pulmonary function parameters of the overweight and control groups.FEV1 (% predicted) was significantly decreased in the overweight group (P < 0.01). FEV1 /FVC (both observed and percentage predicted) was also significantly less in the overweight group. Similarly PEFR is decreased in study group as compared to control group which is statistically significant. The other parameters, viz. FVC and flow rates like FEF25–75%, were not significantly different in the overweight and control groups.

Table 2: Respiratory parameters in study participants (n=30)

Parameters	Control Mean (±SD)	Overweight Mean (±SD)
FVC (Obs)	3.46 ± 0.49	3.59 ± 0.62
(FVC) (%)	104.9 ± 13.73	102.3 ± 13.68
FEV1 (Obs)	3.10 ± 0.42	2.98 ± 0.57
(FEV1) (%)	106.8 ± 12.38	94.26 ± 14.94**
FEV1/FVC (Obs)	89.6 ± 5.66	83.02±10.32***
FEV1/FVC (%)	101.87 ± 7.4	92.16 ± 11.24***
PEFR (Obs)	6.82 ± 1.43	6.86 ± 1.54
PEFR (%)	79.6±11.2	70.20±12.21*
FEF25–75% (Obs)	4.66 ± 1.35	3.46 ± 1.02
FEF25–75% (%)	123.9 ± 39.55	89 ± 24.58

* P value <0.05 statistically significant. **P < 0.01; ***P < 0.001

DISCUSSION

The predominant pulmonary function abnormality detected in the overweight subjects was a reduction in the FEV1 / FVC ratio. FEV1 and FEV1 /FVC were significantly decreased in the theses subjects. A decrease in the FEV1 / FVC was also observed by Inselman et al.[14] and Mallory et al. [15] However, no significant reduction was detected by Bossisio et al. [16] and Chaussain et al.[17] A reduction in the FEV1 /FVC ratio indicates airway narrowing, the severity of which is indicated by the absolute value of FEV1 . [18]

Similar negative correlation between BMI and pulmonary function was observed by Sri Nageswari et al. [19] in a group of obese children of mixed socioeconomic status from Punjab, India. They hypothesized that obesity is characterized by decrease in chest wall compliance due to increased amount of adipose tissue around the chest and abdomen, which decreases pulmonary functions in these children. Aundhakar et al. established a positive correlation between pulmonary function like FVC, MVV, PEFR and anthropometric parameters like age, height, weight, BSA, BMI etc.[20]

Raju et al. (2004) conducted a study to evaluate pulmonary function that developed prediction equations in Indian girls for height, weight, sitting height and chest circumference and body surface area. They concluded that variables like height, fat free mass and chest circumference or age have shown very strong predictability of FEV1, FVC and PEFR. Several researches have shown that parameters like FVC, FEV1, and PEFR etc. increase in accordance of age, height, body surface area etc. In present study we did not try to find out the prediction equation for the respiratory parameters in relation to age, height, weight, BMI etc.

According to the American College of Sports Medicine, due to increased weight on the chest wall and diaphragm obesity has mechanical effects on respiration. Being overweight also causes an increase in energy use as compared to a leaner person at the same workload, so in heavier people the respiratory muscles fatigue at lower intensities. These effects may contribute to the decreases in Functional Residual Capacity, Expiratory Reserve Volume and Total Lung Capacity. Our study also shows similar findings in overweight adolescent boys that high BMI leads to impact on respiratory function.

CONCLUSION

There is significant relation between pulmonary function and BMI in adolescent boys. As BMI increases, lung function tends to decrease as compared to those who have low BMI. This study unravels yet another health hazard associated with overweight and highlights the need to aggressively reduce weight at a younger age. We have shown that high BMI remains an important determinant of reduced spirometric parameters.

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