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Original Article

# Analysis of Peak Expiratory Flow Rate and Spirometry in Obese and Nonobese Schoolchildren

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## Abstract

**Introduction:** Obesity is a health condition of the collection of fat on the human body leading to increased body mass index and other health issues and has various impacts on the respiratory system, which reduces the functional capacity of the lung. It is also known that obesity in childhood is a serious health issue, leading to overweight for children. Pulmonary function test is an essential component for evaluating lung functions that shows valuable procedures for diagnosing and managing respiratory diseases. **Materials and Methods:** This study was conducted on school children in the age group of 11–17-year-old obese and nonobese students. Lung function was measured using the spirometry and mini-Wright's peak expiratory flow (PEF) meter to identify differences among children. **Results:** A total of 245 healthy boys and girls, ranging from 11 to 17 years of age, were recruited for the study. There is no statistical difference between mean spirometric values of forced vital capacity (FVC), forced expiratory volume in the first (FEV1), FEV1/FVC %, FEF 25%–75% and PEF rate for obese groups in comparison with the nonobese control group. **Conclusion:** The current study found that females have lower lung function than males, which is significant statistically ($P < 0.03$) and to overcome respiratory illness.

**Keywords:** Obese, peak expiratory flow rate, school children, spirometry

## Introduction

Obesity is a health problem defined by an enormous collection of fat on the human body that results in increased body mass and is a miscellaneous disease leading to socio-psychological and health problems.[1] It has various negative effects on the respiratory and other systems, including decreased capacity for functional exercise.[2,3] It is the most significant health problem due to lack of physical exercise and poor diet; the current sedentary lifestyle is causing a slew of health problems.[4] Obesity in childhood is a serious health problem that affects children and adults leading to high cholesterol, high blood pressure and diabetes.[5-7] Although clinicians can usually detect airflow obstruction clinically, they are unable to assess the severity or reversibility of the obstruction.[8] As a result, pulmonary function tests (PFT) and sub-maximal exercise tests can aid in the diagnosis and management of a wide range of respiratory conditions, as well as the impact of morbidity and mortality on children, like weight gain or obesity.[9] Increased weight leads to impairment on lung function, small airway impairment, expiratory flow obstruction, decreased lung compliance, and respiratory muscle strength and gas exchange on PFT.[10-12] PFT are critical components for evaluating lung function and are a valuable tool for diagnosing and treating patients with respiratory ailments for evaluating adults and also children.[13] It detects the respiratory disease pattern and its severity.[14,15]

Furthermore, it is essential for tracking disease progression, treatment response, and determining disability.[16] Indian spirometric values vary from Western and other standards; even within the country, different regional and ethnicity have different test values.[17,18] Peak expiratory flow rate (PEFR) is a simple test for determining expiratory flow rate. The volume of air exhaled forcefully after a deep inhalation is

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known as the peak expiratory flow (PEF), where the flow reflects the respiratory muscle strength, the lung characteristics and airways.[19] PEF is particularly vulnerable to dynamic compression of extrapulmonary airways because their walls are not endorsed by traction from lung tissue while they are subject to pleural pressure. During childhood and adolescence, the body's mass grows in lockstep with skeletal growth. All such modifications have an impact on lung function and capacity.[20] PEFR is influenced by various factors such as age, sex, height, weight, body surface area, body mass index (BMI), and environmental and ethnic differences.[19] PEFR is patient dependent and reflects the status of large airways. Factors, such as anthropometric measurements, age, sex, malnutrition, and environmental effect, affect the peak expiratory rate in individuals.[21] During childhood and adolescence, the body's mass grows in lockstep with physical growth. The function and capacity of the lungs are affected by these changes,[20] and its value is highly correlated with conventional spirometry measurements of forced expiratory volume in the first (FEV1) second, and forced vital capacity (FVC). Its measurement is used to detect changes in airflow, asthma, chronic obstructive pulmonary disease, and exercise-induced bronchoconstriction in a noninvasive manner.[20,21] More specifically, we have done this study because of the novelty of this research; there were only a few studies that have addressed the reference of pulmonary function and PEFR in school children in South India. Due to the paucity of data, we have undertaken this study to assess and compare the spirometric parameters and PEFR of obese and nonobese school children between the age of 11–17 years in the Kanchipuram region, Tamil Nadu.

## Materials and Methods

The study was a case–control study, and a convenient sampling technique was used to select obese and nonobese participants. After obtaining ethical committee approval (309/IHEC/10-17) and receiving informed consent, a total of 245 participants in the age group of 11–17 years, both males and females, met the eligibility criteria included in the study. This study was conducted in Punjab Association Padma Adarsh Higher Secondary School, Vaniyanchavadi, Kanchipuram. The procedure and benefits of this study were explained to the children and their parents. The subjects were chosen based on inclusion and exclusion criteria after parent's informed consent. They were screened and their anthropometric parameters were measured. BMI of the students was plotted on the BMI-for-age chart developed by the World Health Organization[22] to categorize participants into obese and nonobese children. The participants performed spirometry, and test procedures were described verbally and demonstrated to the participants. All the tests were performed in computerized MEDSPIROR instrument, which uses pneumatic sensor as transducer and volume differential method for flow detection. We recorded FVC, FEV1, and forced expiratory flow (FEF) at the mid-portion of FVC (FEF 25–75). PEFR was measured by Wright's mini peak flow meter. The recording was done in a standing position. The subject was instructed to take deep inspiration and asked to blow out forcefully through the mouthpiece. Both spirometry and PEFR test maneuver were repeated thrice, and the best result was considered for the analysis. The frequency and percentages of qualitative data were presented and analyzed using an independent samples *t*-test.

**Table 1: Age and sex differences among obese and nonobese subjects**

| | Obese/nonobese (245) | |
|---|---|---|
| | Obese (101), *n* (%) | Nonobese (144), *n* (%) |
| Age | | |
| 11 | 27 (26.73) | 45 (31.25) |
| 12 | 38 (37.62) | 50 (34.72) |
| 13 | 27 (26.73) | 38 (26.39) |
| 14 | 9 (8.91) | 11 (7.64) |
| Sex | | |
| Male | 37 (36.63) | 66 (45.83) |
| Female | 64 (63.37) | 78 (54.17) |

## Results

All the collected data were entered into a Microsoft Excel spreadsheet before being transferred to IBM SPSS version 21 for analysis Chicago, IL, USA. Quantitative data were presented as mean and standard deviation and compared using Turkey's test, with a significance level of $P = 0.05$. The study enlisted the participation of 245 healthy boys and girls aged 11–17 year old [Table 1]. The subject's height, weight, and BMI were measured and recorded. The PEFR and spirometry were performed on the subjects, and their results were recorded, followed by a thorough explanation of the procedure. The subjects had a mean age of 12.13 ± 0.93 years, mean height of 147.04 ± 8.06 cm, mean weight of 38.7 ± 8.70 kg, mean BMI of 17.9 ± 3.00 kg/m$^2$ mean FEV1of 89 ± 16.49%, mean FVC of 88.2 ± 14.3%, mean FEV1/FVC of 99.39 ± 10.91%, mean FEF 25%–75% of 79.2 ± 22.9%, and mean PEFR 227.84 ± 53.91 (l/min) [Table 2]. There is no statistical difference between mean spirometric values FVC ($P = 0.53$), FEV1 (=0.796), FEV1/FVC% ($P = 0.41$), FEF 25%–75% ($P = 0.678$), and PEFR ($P = 0.187$) for obese groups in comparison with control group. Hence, this observation shows no significant difference in obese boys and obese girls group compared with gender. There is a significant difference in FEV1 and FEF 25%–75% in nonobese girls compared to gender [Table 3].

## Discussion

The BMI scale is a beneficial tool for classifying children's adiposity and body composition. It is likewise referred to as the Quetelet's index,[23] and is a beneficial tool for determining body fatness. Obesity is determined solely by BMI, and even if the lungs are healthy, increased respiratory effort and impaired

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**Table 2: Mean differences of pulmonary function test and peak expiratory flow rate parameters among male and female children**

| | *n* | $FEV_1$ | FVC | $FEV_1$/FVC | $FEF_{25\%-75\%}$ | PEFR (L/min) |
|---|---|---|---|---|---|---|
| Total number of subjects | 245 | 89±16.49 | 88.20±14.31 | 99.31±10.91 | 79.24±22.91 | 227.84±53.9 |
| Males | 101 | 88.70±17.02 | 88.20±14.90 | 99.39±12.22 | 79.24±23.11 | 227.84±54.71 |
| Females | 144 | 89.40±17.0 | 88.70±14.98 | 99.16±12.22 | 79.79±23.11 | 227.84±54.71 |

$FEV_1$: Forced expiratory volume in the 1 s, FVC: Forced vital capacity, FEF: Forced expiratory flow, PEFR: Peak expiratory flow rate

**Table 3: Correlation of pulmonary function test and peak expiratory flow rate among obese and nonobese subjects with sex**

| | Sex (mean±SD) | | Independent samples *t*-test | |
|---|---|---|---|---|
| | Male | Female | *t* | *P* |
| Obese | | | | |
| $FEV_1$% | 89.30±17.28 | 89.38±21.03 | −0.019 | 0.985 |
| FVC% | 87.78±14.81 | 91.94±17.22 | −1.228 | 0.223 |
| $FEV_1$/FVC% | 100.38±7.31 | 95.94±15.66 | 1.934 | 0.056 |

gas transport can impair respiratory function in obese people. Low- and high-BMI were connected to poor lung function, ensuing in airway narrowing and reduced lung recoil.[23] Spirometry is a useful clinical device in respiratory care, and its application necessitates a clear expertise among the subject, the technician, and the test's execution and interpretation. Despite the truth that this sort of study is done in different parts of the world, they have used numerous measures of adiposity to rule out the association among body differences in thoraco-abdominal configuration and pulmonary function;[24] gender differences in vital capacity can be explained by the smaller total number of alveoli (smaller surface area) and the smaller diameter of the airways when compared to the size of the lungs of women compared to men.[25] PEFR is determined by various factors, including airway resistance, maximal voluntary effort, and BMI.[26] In obesity, PEFR decreases due to fat deposition in the thoracic cage, and mechanical impact on the diaphragm, which can increase metabolic demands and breathing load. This study's result indicated a significant correlation in dynamic lung function in terms of FEV1% and FEF 25%–75% in nonobese girls compared with normal children. Lean boys had lower FVC ($P = 0.019$), FEV1 ($P = 0.048$), FEV3 ($P = 0.007$), PEFR ($P = 0.0002$), and FEF 25%–75% ($P = 0.003$) than normal boys, according to a study by Das *et al*. Overweight boys showed significant increased FEV1, FEF 25%–75% compared to normal boys. In normal and overweight boys, correlation coefficients for BMI and dynamic lung function test parameters were not statistically significant.[27] Our results showed no statistically significant difference in obese children compared with nonobese children. When we compared the dynamic lung function parameters of the obese group with the control group, we found that the values were not statistically significant. In nonobese groups, other parameters of FEV1 and FEF 25%–75% values increased, which is statistically significant ($P = 0.33$) in nonobese girls. The results of our study support the study by Saxena *et al*. in 2016 found that significant difference in FEV1% between normal and obese weights.[28] Data tested in independent sample *t*-test between BMI, lung function parameters in sex, FEV1 and FEF 25%–75% shows a positive correlation [Table 3]. Budhiraja *et al*.[29] also studied lung function, which shows a direct positive correlation with FEF 25%–75%. Our results show that FEV1 and FEF 25%–75% in nonobese girls are statistically significant compared to other children. These findings differ from those reported by Andrade *et al*., who found no significant correlation between sex and pulmonary function measures across the entire sample.

### Limitations

Our study has certain limitations, including evaluating lung function at only one time. A longitudinal research would be optimal to evaluate the changes in lung function in relation to body composition over time. In addition, a simple tool like the mini PEF meter may have intrinsic flaws, including packing, durability, and measuring limitations for lung function. For instance, the flow meter may have mechanical failures with repeated usage. Furthermore, this study's effectiveness would increase with larger sample size, and future researches should also investigate other lung function parameters.

## Conclusion

Obese patients show normal lung function when compared with nonobese patients. A wider application of this instrument, both by health-care professionals and patients, will help early diagnosis of respiratory ailments and improve the treatment quality in children. Lung function can be improved by keeping our bodies fit and healthy.

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### Conflicts of interest

There are no conflicts of interest

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