National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

Effect of obesity on pulmonary function test in adolescent boys

Ranjana Shingne[1], Akshay Berad[2], Balaji Ghugare[3]

[1]Department of Physiology, Dr. Ulhas Patil Medical College, Jalgaon (Kh), Maharashtra, India, [2]Department of Physiology, Rajiv Gandhi Institute of Medical Sciences, Adilabad, Telangana, India, [3]Department of Physiology, GMERS Medical College, Vadodara, Gujarat, India

Correspondence to: Akshay Berad, E-mail: akshay_berad@rediffmail.com

Received: April 01, 2020; **Accepted:** April 22, 2020

ABSTRACT

Background: Obesity is an emerging problem, especially among adolescents due to their lifestyle changes related to the low level of physical activity and high-calorie diet. Excess adipose tissue is often associated with respiratory abnormalities such as a reduction in lung volumes, capacities, and expiratory flow rates. Hence, there is a need to find the pulmonary functions test values among obese adolescents and create awareness of the drawbacks of obesity as this is the high-risk period for the onset of obesity which predicts body mass index in adulthood. **Aims and Objectives:** The aims of the study were to study the effect of obesity on pulmonary function test (PFT) values in adolescent boys. **Material and Methods:** PFT was done on 10 obese and 10 nonobese adolescent boys of the age group 12–17 years from Dr. Ulas Patil English Medium School, Bhusawal. Forced vital capacity (FVC), forced expiratory volume at 1st s (FEV_1), (FEV_1/FVC) ratio, and maximum voluntary ventilation (MVV) were taken as parameters for study. **Results:** FVC, FEV_1, FEV_1/FVC, and MVV are reduced in obese subjects as compared to nonobese boys and it is statistically highly significant. **Conclusion:** Results of the study conclude that obesity affects the pulmonary functions and obese adolescents have significantly lower pulmonary functions.

KEY WORDS: Obesity; Adolescents; Pulmonary Function Test; Boys

INTRODUCTION

Body weight depends on the balance between caloric intake and utilization of calories. Obesity results when the former exceeds the latter.[1] Obesity may be defined as an abnormal growth of the adipose tissue due to an enlargement of fat cell size (hypertrophic obesity) or an increase in fat cell number (hyperplasic obesity) or a combination of both.[2] Obesity is a state of excess adipose tissue mass. Excess accumulation of body fat is the consequence of environmental and genetic factors, social factors, and economic conditions also represent important influences. The recent increase in obesity can be attributed to a combination of excess caloric intake and decreasing physical activity. Poorly understood reasons for increased food assimilation due to dietary composition have also been postulated as having sleep deprivation and unfavorable gut flora. The susceptibility to obesity is polygenic in nature. The prevalence of obesity has increased dramatically over the past 3 decades. In the United States in 2008, 34% of adults age >20 were obese (body mass index [BMI] >30), and another 34% were overweight (BMI 25–30). Most alarming is the same trend among children, where 17% between ages 2 and 19 were obese, and another 18% were overweight. This has led to an epidemic of type 2 diabetes in children, a condition almost never seen until recently. These trends to increased obesity are not limited to Western societies but are occurring worldwide.[3] Close to 30 million overweight children are living in developing countries and 10 million in developed countries. The prevalence of overweight and obesity in Indian children is around 20% posing a

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2020.10.04098202022042020	

significant risk of lifestyle disease in the future. A convenient and reliable indicator of body fat is the BMI, which is body weight (in kg) divided by the square of height (in m). As a method of measuring body fat is cumbersome and expensive, several clinical and anthropometric parameters are used as a marker of obesity. BMI is the most widely used parameter to define obesity. Children with a BMI more than 85th percentile for age are considered overweight, while those more than 95th percentile for age are obese. BMI is a good indicator of body fat but is unreliable in short muscular individuals. For industrialized countries, it has been suggested that an increase in body weight primarily caused by a reduced level of physical activity. In children, obesity correlates with some degree with time spent watching television and sleep deprivation. Childhood obesity also contributed by family history, high socioeconomic strata, emotional stress, and psychological causes such as depression, anxiety, loneliness, and certain drugs such as corticosteroids, B-adrenergic blockers, and genetic syndromes such as Prader–Willi syndrome and Laurence-Moon-Biedl syndrome. Nowadays, television and print media are playing an important role in producing obesity by a heavy advertisement of fast food outlets of energy-dense micronutrients poor food and beverages (eat – least category). Endocrine complications are the most important adverse effect of childhood obesity. The most common is insulin resistance which leads to the development of Type II diabetes mellitus, metabolic syndrome, and non-alcoholic fatty liver disease, dyslipidemia, hypertension, and atherosclerosis. Obese children are at risk of respiratory distress and bronchial asthma. Obesity predisposes to the development of obstructive sleep apnea and hypoventilation syndrome. Milder forms are associated with snoring, irritability, hyperactivity, and daytime somnolence. Management of childhood obesity is challenging with major impetus on lifestyle measures. Diet, activity, and behavioral measures are the main part of therapy. Decrease junk food consumption, avoid watching television while eating, increase physical activity, increase fruit consumption, screen time (watching television, computer, and mobile devices) is restricted, and increase in routine activities like household chores walking to school should be encouraged. Moreover, drug therapy and surgery are reserved for morbid cases. Overweight and obesity are the fifth leading risk of global deaths. Prevention of obesity should begin in early childhood as adult obesity is harder to treat than childhood. A child whose energy requirement is 2000 kcal/day and who consumes 100 kcal/day extra then weight gain will be 5 kg/year. Hence, a fruitful approach will be to identify those children are at risk of obesity and find a way of preventing it. The most important goal of the present study is to find out the impact of obesity on pulmonary functions of adolescent boys. As childhood obesity is associated with restrictive lung disease (decreased respiratory movements due to chest wall obesity) as well as obstructive airway disease (airway fat deposition).[4]

MATERIALS AND METHODS

Study Group

A total of 10 obese adolescents and ten nonobese served as the control group was selected.

Study Design

This was a cross-sectional study.

Sampling Method

Simple random sampling was used.

Methodology

A 10 obese adolescent boys of the age group 12–17 years, and 10 nonobese adolescent boys of the age group 12–17 years. From Dr. Ulhas Patil English Medium School, Bhusawal were selected for the study group.

The study was conducted in January 2019. Ethical committee permission for this study was taken from the Institutional Ethics Committee. Informed consent was taken from all subjects. Personal and medical details were collected through a questionnaire. Anthropometric data:

Height, weight, and BMI were calculated.

1. Height – Standing height was measured in centimeters nearest to 1 cm with a measuring tape attached over a wall. While measuring the height, the subject removed their shoes and stand with their heels together such a way that back of the heels touching to the wall
2. Weight – Weight was measured in kilograms in an empty bladder and empty stomach on a standardized weighing machine (SEKA NORA)
3. BMI – BMI was calculated.

BMI =Weight (in kg)/Height 2 (in m)

Boys having BMI greater than the 95th percentile for age were classified as obese.[5] A total of 10 healthy obese boys were identified. Similar 10 nonobese healthy boys having BMI <85th percentile for age and sex were taken as controls. All subjects were explained about the procedures to be undertaken and pulmonary function test (PFT) was done in a sitting position at room temperature using a spirometer (RMS HELIOS 401). Forced vital capacity (FVC), forced expiratory volume at 1st s (FEV_1), (FEV_1/FVC) ratio, and maximum voluntary ventilation (MVV) were taken as PFTs parameters for study.

Inclusion Criteria

Healthy obese adolescent boys selected after through history taking and clinical examination.

Exclusion Criteria

The following criteria were excluded from the study.

1. History of chewing tobacco and smoking
2. Subjects with acute or chronic respiratory disease
3. History of cardiovascular, endocrine disorders, and liver disease
4. Neuromuscular disorders, musculoskeletal disorders, and chest deformity
5. H/o drug administration drugs, e.g. corticosteroids and B-adrenergic blockers.

Statistical Analysis

Data were tabulated and statistically analyzed. Mean and standard deviation was calculated. The student *t*-test has been used to compare the significance of the difference of PFT values in obese and control subjects.

RESULTS

Age and BMI of obese and control subjects were compared. The average BMI of the obese group was 30.77 ± 0.5 kg/m^2 and of control group's was 21.14 ± 1.48 kg/m^2. The average age of the obese and control groups was 14.72 ± 1.42 and 16.5 ± 1.2 years [Table 1]. Table 2 shows that FVC, FEV$_1$, FEV$_1$/FVC, and MVV are less in obese subjects as compared to the control subjects group and it is statistically highly significant.

DISCUSSION

The mean BMI of the obese boys was 30.77 ± 0.5 kg/m^2 compared to the non-obese 21.14 ± 1.48 kg/m^2. The mean age of the obese and nonobese boys was 14.72 ± 1.42 and 16.5 ± 1.2 years. The present study showed that FVC, FEV$_1$, MVV, and FEV$_1$/FVC% were decreased in the obese subjects as compared to the control subjects and it is statistically highly significant. Obesity was the cause of pulmonary function decline. Pulmonary function depends on the movement of lungs, thoracic wall, muscles, and diaphragm. Since obesity decent of the diaphragm into the abdominal cavity is restricted due to the deposition of fat, this restriction of movement is the major reason for lung dysfunction. This fat deposition also restricts the rib cage movement which in turn decreases the compliance and elastic recoiling of the lungs. The abdominal fat deposition also leads to redistribution of blood flow to the thoracic compartment which results in reduced vital capacity. Airflow resistance is also increased due to the deposition of fat which is another reason for the decline in pulmonary functions.

Table 1: Age and BMI of non-obese and obese boys

Parameters	Nonobese boys *n*=10 (Mean±SD)	Obese boys n=10 (Mean±SD)
Age (years)	16.5±1.2	14.72±1.42
BMI (kg/m^2)	21.14±1.48	30.77±0.5

BMI: Body mass index

Table 2: Comparison of PFT values between non-obese and obese boys

PFT parameters	Nonobese boys (Mean±SD)	Obese boys (Mean±SD)	"*P*"-value
FVC (In L)	3.51±0.73	2.67±0.38	0.004**
FEV$_1$ (In L/S)	3.45±0.73	2.18±0.38	0.003**
FEV$_1$/FVC (%)	98.22±2.48	84.90±10.61	0.001**
MVV (In L/Min)	147.55±30.74	89.90±18.23	0.0007**

**Highly significant, SD: Standard deviation. PFT: Pulmonary function test, FVC: Forced vital capacity, FEV$_1$: Forced expiratory volume at 1st s, MVV: Maximum voluntary ventilation

The extra amount of fat in the abdominal cavity and in the chest wall compresses the diaphragm and thoracic cage which leads to a decrease in lung compliance and elastic recoil of lungs.[6,7] In our study FEV, FVC was found to be less in obese boys as compared to nonobese boys; similar, results were reported in the study done by Ulger *et al*.[8] A study conducted by Spathopoulos *et al*. reported a decline in FVC, FEV$_1$, and FEV$_1$/FVC ratio values in obese and overweight boys.[9] Tantisira *et al*. observed that as BMI increases, there is a fall in FEV$_1$/FVC ratio.[10] A study done by Bruno *et al*. concluded that FEV, FVC, FEV$_1$/FVC values were decreased as the BMI increases.[11]

There are limitations in this present study. The sample size is very small. Further studies should include more subjects. Girls of the same age group should also be included. In this study, a particular class of obesity not mentioned.

CONCLUSION

It can be concluded that an increase in BMI leads to a decrease in FEV$_1$, FVC, and FEV$_1$/FVC values. This shows that obesity in adolescent boys affects pulmonary functions. This age is important to detect pulmonary dysfunction so that control measures can be taken to decrease obesity in adolescents and prevent future adulthood obesity. Children should be encouraged for playing more outdoor games, adequate sleep at least 8–9 h/day. Should take care to avoid high-calorie diet, junk food consumption, and reduce screen hours such as TV hours, mobile games, and video games. Parents should spend time with kids and support them emotionally.

REFERENCES

1. Barrett KE, Brooks H, Boitano S, Barman S. Digestion, absorption and nutritional principles In: Ganong's Review of Medical Physiology. 23rd ed., Ch. 27. New York: McGraw-Hill Education; 2009. p. 276.
2. Park K. Textbook of Preventive and Social Medicine. 22nd ed.

Jabalpur: M/s Banarsidas Bhanot Publishers; 2005. p. 397-401.
3. Longo L, Fauci S, Kasper D, Hauser S, Jameson J. Harrison's Principles of Internal Medicine. 18th ed. New York: The McGrew-Hill, Health Professions Division; 2011. p. 1134-7.
4. Pau V, Bagga AK. Ghai Essential Paediatrics. 9th ed. Kerala: CBS Publishers and Distributors; 2018. p. 524-8.
5. Cole TJ, Bellini MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: International survey. BMJ 2000;320:1240-3.
6. Koenig SM. Pulmonary complications of obesity. Am J Med Sci 2001;321:249-79.
7. Jubber AS. Respiratory complications of obesity. Int J Clin Pract 2004;58:573-80.
8. Ulger Z, Demir E, Tanac R, Goksen D, Gulen F, Darcan S, *et al*. The effect of childhood obesity on respiratory function tests and airway hyperresponsiveness. Turk J Pediatr 2006;48:43-50.
9. Spathopoulos D, Paraskakis E, Trypsianis G, Tsalkidis A, Arvanitidou V, Emporiadou M, *et al*. The effect of obesity on pulmonary lung function of school aged children in Greece. Pediatr Pulmonol 2009;44:273-80.
10. Tantisira KG, Litanjua AA, Weiss ST, Fuhlbrigge AL. Association of body mass with pulmonary function in the childhood asthma management program (CAMP). Thorax 2003;58:1036-41.
11. Bruno A, Pace E, Cibella F, Chanez P. Body mass index and comorbidities in adult severe asthmatics. Biomed Res Int 2014;2014:607192.

How to cite this article: Shingne R, Berad A, Ghugare B. Effect of obesity on pulmonary function test in adolescent boys. Natl J Physiol Pharm Pharmacol 2020;10(07):543-546.

Source of Support: Nil, **Conflicts of Interest:** None declared.