Assessment of Pulmonary Functions in Obese Young Adults

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Abstract

Introduction: Obesity, especially, adolescent obesity is specially a matter of concern and the causes are manifold that includes lack of regular exercise, sedentary life style, over consumption of high caloric foods; genetic, endocrine and metabolic mechanisms and perinatal and early life factors. Pulmonary function testing is the most commonly performed lung function test and are considered to be the initial screening tool for pulmonary diseases. Medical students of M.B.B.S. course have a hectic schedule along with inappropriate diet and sedentary lifestyle of can cause them to gain weight. Since obesity in these young adults is associated with various pulmonary function alterations, it becomes necessary to assess the respiratory functions of these medical students.

Aim: To assess the pulmonary functions in obese young adults.

Objectives: To compare the effects of central obesity versus peripheral obesity on pulmonary functions as compared to the normal.

Settings: Department of Physiology Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Wardha and Department of Medicine, TNMC & BYL Nair Ch. Hospital, Mumbai Central, Mumbai.

Method: After taking informed written consent, anthropometric data was recorded from each participant. Obese medical students were divided into central and peripheral obese groups on the basis of waist hip ratio and waist circumference. On brief general and clinical examination, pulmonary function tests (FVC, FEV1 and FEV1/FVC ratio) of central obese, peripheral obese and healthy subjects were recorded using MIR Spirometer with Winspiro-Pro 4.4 software after one practice attempt and report was interpreted. Comparison of data among various study groups was done by using Chi square test and one way Analysis of Variance (ANOVA) – Tukey's post hoc test. The level of significance was set at 5%. The P-value <0.05 was considered as statistically significant.

Interventions: Not applicable.

Results: There was a statistically significant difference of mean values of FVC, FEV1 and FEV1/FVC % between normal and peripheral obese groups and between normal and central obese groups and also between peripheral obese and central obese groups.

Conclusion: This study shows that young obese adults have lower pulmonary function tests values as compared to normal individuals whereas the detrimental effect is more in the central obese than peripheral obesity. Hence early identification and initiation of preventive measures to prevent the deterioration of lung functions in susceptible young adults is crucial.

Keywords: *Medical students, central obese, peripheral obese, pulmonary function test, young adults.*

Introduction

Obesity is a medical condition in which excess body fat accumulates to the extent that it may have an adverse effect on the health leading to reduced life expectancy and increased health problems. Adolescent obesity is specially a matter of concern and the causes are manifold

that includes lack of regular exercise, sedentary life style, over consumption of high caloric foods; genetic, endocrine and metabolic mechanisms and perinatal and early life factors.[1,2] Co-morbidities of adolescent obesity encompass both short and long term health concerns and can cause various deleterious effects on the respiratory function.[3] Pulmonary function testing is a method of assessing lung function by measuring the volume of air that the subject is able to expire from the lungs after a maximal inspiration. It is the most commonly performed lung function test and are considered to be the initial screening tool for pulmonary diseases. The test can be performed at the bedside, in a physician's office or in the pulmonary laboratories. Students of M.B.B.S. course have a hectic schedule consisting of lectures, practicals and examinations due to which they get less time for exercise. Moreover inappropriate diet and sedentary lifestyle of medical students can cause them to gain weight. Since obesity is associated with various pulmonary alterations, it becomes necessary to assess the respiratory functions of these obese young adults. The current study looks into the association of pulmonary function tests with body fat distribution in normal weight and obese students in the age group of 18-25 years.

Aim: To assess the pulmonary functions in obese young adults.

Objectives: To compare the effects of central obesity versus peripheral obesity on pulmonary functions as compared to the normal.

Materials and method: The study was conducted in the Department of Physiology in collaboration with Department of medicine in a tertiary care hospital in city of Mumbai. The Ethics Committee of the hospital and institution approved the protocol employed for the study. All tests are standardized and have been used in medicine department of institute for assessing pulmonary functions in patients.

80 Male and Female medical students having age between 18 and 25 years and BMI between 25 and 29.9 kg/m^2 as per Asian standards were included in study group. (4) 40 physically healthy male and female medical students, without any symptoms, having age between 18 and 25 years and BMI between 18.5 and 24.9 kg/m^2 as per Asian standards were included in control group. [4] Medical students of age less than 18 years & greater than 25 years, with BMI less than 18.5 & more than 29.9 Kg/m^2, with acute or chronic respiratory diseases taking treatment for the same, having other comorbidities, pregnant females, were excluded from the study after a detailed history and a detailed physical examination of the subjects to exclude the respiratory diseases. Weighing machine, stadiometer, non-elastic measuring tape, Lloyds hand held body composition monitor, MIR Spirometer with Winspiro-Pro 4.4 software. (P.F.T. machine) [5], nose clip and disposable mouthpiece were used for the data collection.

All cases and controls were selected according to the inclusion and exclusion criteria. Subjects were instructed to not to have food or drinks 2 hours prior to the test, not to smoke before coming for pulmonary function tests (PFT) examination. Subjects were instructed to have sufficient hydration and light meal in the previous night and Light breakfast in the morning and also to report acute respiratory episodes

On arriving, Cases and controls were explained in detail about the procedure to be performed in their vernacular language to their satisfaction. A brief explanation regarding the purpose of study and the tests to be performed was given to the subjects. The subjects were registered and their information recorded. Written informed consent was obtained. Anthropometric measurements like body weight, height, waist circumference, hip circumference, body mass index, waist-to-hip ratio, total Body fat percentage were taken.

The subjects were divided into normal non obese subjects (control) and obese subjects (cases) based on body mass index (BMI) values.[4,6]. Subjects having BMI between 18.5 to 23 Kg/m^2 were normal subjects (control) and 25 and 29.9 kg/m^2 were obese subjects (cases). The subjects who fell under obese category were divided into central obese and peripheral obese using waist circumference and waist to hip ratio (WHR). Females with waist circumference $\geq$80 cm and WHR $\geq$ 0.8 were centrally obese subjects and those with waist circumference $\leq$ 80 cm and WHR $\leq$ 0.8 were peripherally obese. Males with waist circumference $\geq$ 90 cm and WHR $\geq$ 0.95 were centrally obese subjects and those with waist circumference $\leq$ 90 cm and WHR $\leq$ 0.95 were peripherally obese.[7,8,9]

Pulmonary function tests were performed with subject in sitting position with legs uncrossed. A nose clip was put on his/her nose. The subject was asked to perform tidal breathing through mouth and after that

to execute forceful expiration as fast as possible at the end of a deep, full expiration. One practice attempt was given.[10]

Forced vital capacity (FVC), Forced expiratory volume at the first second (FEV_1) and FEV1 / FVC ratio were assessed in cases and controls, calculated and analyzed on MIR Spirometer with Winspiro-Pro 4.4 software. MIR Spirometer was calibrated every morning.

Statistical analysis: The data entry was done in Microsoft – EXCEL programme and the results were tabulated and statistically analyzed by Statistical Package for the Social Sciences (SPSS) version 20.0 software. Descriptive statistic (mean and standard deviation) was used for numerical data. Comparison of data among various study groups was done by using Chi square test and one way Analysis of Variance (ANOVA) – Tukey's post hoc test. The level of significance was set at 5%. The P-value <0.05 was considered as statistically significant.

Results

The percentage distribution of males and females in the study and control group was statistically non-significant and hence we concluded that the three groups were comparable. (Table No. 1)

On applying ANOVA – Tukey's Post-hoc test, the groups it was observed that the mean values of Age were statistically not significant and hence the groups are comparable. (Table No. 2).

But It was observed that there was a statistically significant difference of mean values of BMI between groups were statistically insignificant, thus indicating proper selection of the groups. (Table No.3)

On applying ANOVA - Post-hoc Tukey test to groups it was observed that there was a statistically significant difference of mean values of **FVC** between normal and peripheral obese groups (P value - 1.926E-03) and between normal and central obese (P value - 1.876E-08) and also between peripheral obese and central obese (P value - 0.0146).Thus groups were statistically significant. (Table No. 4)

It was observed that there was a statistically significant difference of mean values of **FEV1** between normal and peripheral obese central obese (P value - 7.201E-08) and between normal and central obese (P value - 5.100E-09) and also between peripheral obese and central obese (P value - 0.0014) were statistically significant. (Table No.5)

Also It was observed that there was a statistically significant difference of mean values of **FEV1/FVC %** between normal and peripheral obese (P value - 4.619E-04) and between normal and central obese (P value - 5.100E-09) and also between peripheral obese and central obese (P value - 5.1003E-09) were statistically significant. (Table No. 6).

Table 1 - Distribution of study groups as per sex

Sex		Group			Total
		Normal	Central Obese	Peripheral Obese	
Females	Count	20	20	20	60
	Percent	50.0%	50.0%	50.0%	50.0%
Males	Count	20	20	20	60
	Percent	50.0%	50.0%	50.0%	50.0%
Total	Count	40	40	40	120
	Percent	100.0%	100.0%	100.0%	100.0%
Chi Square Test		P value		Association	
Pearson Chi-Square test.		1.000		Not significant	

Table 2 - Comparison of Age (Years).

Parameter	**Normal**			**Central Obese**			**Statistical Parameters**	
Age (Years)	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	20.63	1.444	20.0	20.55	1.449	20.00	0.971	Not significant
	Normal			Peripheral Obese			Statistical Parameters	
	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	20.63	1.444	20.0	20.98	1.459	21.0	0.529	Not Significant
	Central Obese			Peripheral Obese			Statistical Parameters	
	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	20.55	1.449	20.00	20.98	1.459	21.0	0.3924	Not Significant

Table 3 - Comparison of BMI (Kg/m^2)

Parameter	**Normal**			**Central Obese**			**Statistical Parameters**	
BMI (Kg/M^2)	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	20.72	1.768	20.0	26.55	1.339	26.00	5.100E-09	Significant
	Normal			Peripheral Obese			Statistical Parameters	
	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	20.72	1.768	20.0	26.95	1.131	27.0	5.1003E-09	Significant
	Central Obese			Peripheral Obese			Statistical Parameters	
	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	26.55	1.339	26.00	26.95	1.131	27.0	0.4296	Not Significant

Table 4 - Comparison of FVC (Litres)

Parameter	**Normal**			**Central Obese**			**Statistical Parameters**	
FVC (Litres)	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	3.08	0.572	3.00	2.35	0.483	2.00	1.876E-08	Significant
	Normal			Peripheral Obese			Statistical Parameters	
	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	3.08	0.572	3.00	2.68	0.474	3.0	1.926E-03	Significant
	Central Obese			Peripheral Obese			Statistical Parameters	
	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	2.68	0.474	3.0	2.35	0.483	2.00	0.0146	Significant

Table 5 - Comparison of FEV1 (Litres)

Parameter	**Normal**			**Central Obese**			**Statistical Parameters**	
FEV1 (Litres)	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	3.00	0.641	3.00	2.00	0.000	2.00	5.100E-09	Significant
	Normal			Peripheral Obese			Statistical Parameters	
	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	3.00	0.641	3.00	2.38	0.490	2.0	7.201E-08	Significant
	Central Obese			Peripheral Obese			Statistical Parameters	
	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	2.38	0.490	2.0	2.00	0.000	2.00	0.0014	Significant

Table 6 - Comparison of FEV1/FVC (Percentage)

Parameter	Normal			Central Obese			Statistical Parameters	
FEV1/FVC Percentage	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	95.75	4.081	96.0	83.05	3.809	84.0	5.100E-09	Significant
	Normal			Peripheral Obese			Statistical Parameters	
	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	95.75	4.081	96.0	92.63	2.696	93.0	4.619E-04	Significant
	Central Obese			Peripheral Obese			Statistical Parameters	
	Mean	SD	Median	Mean	SD	Median	P- value	Significance
	92.63	2.696	93.0	83.05	3.809	84.0	5.1003E-09	Significant

Discussion

The fat content of the human body exhibits the most striking variations in the state of nutrition varying along the emaciation-obesity continuum than perhaps any other body constituents. This study sheds light on the effect of pattern of fat distribution (depending on WC and WHR) on some pulmonary functions in obese young adults.

A. Effect of central obesity on FVC FEV1 and FEV1/FVC ratio: Following mechanisms can be responsible for the decrease in **FVC FEV1 and FEV1/FVC ratio** seen in central obesity.

1. Physical compression of lungs and alveoli due to fat deposition in mediastinum, around the heart, pleural space and above the diaphragm.
2. Fat deposition in the abdomen raises the diaphragm due to increased intra-abdominal pressure and reduces the functional residual capacity.
3. Thoracic kyphosis and lumbar hyperlordosis in central obesity reduces chest wall compliance.
4. Airway inflammation and reduced lung volume by lateral compression causing the narrowing of the airway increasing the respiratory resistance. Closure of the dependent airway may result in small areas of atelectasis ultimately leads to decreased lung compliance.
5. Excessive mechanical load of deposited fat in the respiratory and non-respiratory muscles imposes great burden on inspiratory muscles and overstretching of the diaphragm and decreased skeletal muscle glycogen synthesis results in the decreased isokinetic respiratory muscle strength and endurance.
6. Increased blood flow due to increased metabolic demands by the muscles and the lungs results in increased pulmonary blood pressure. This leads to decreased lung volume and airway inflammation thereby narrowing the airway. Also airway caliber of these obese persons is reduced possibly by remodeling of the airway. These together probably result in reduction in FVC, FEV1and FEV1/FVC ratio in central obese individuals.

B. Effect of peripheral obesity on FVC FEV1 and FEV1/FVC ratio:

1. Interleukin 6 act as myokine in muscle and released in response to increased cost of breathing in obese person. Interleukin 8 is produced by airway smooth muscle cells. It induces chemotaxis for neutrophils and other granulocytes. It increases the oxidative stress and inflammatory and autoimmune processes affecting the lung functions.
2. TNF α induces inflammation and proteolysis. This results in decreased strength of smooth muscles and decreased elasticity of airway and, in turn, increased airway resistance and impaired lung functions.
3. Adiponectin, an anti-inflammatory substance, is exclusively secreted from adipose tissue in the bloodstream. A decreased level of adiponectin results in adipose tissue formation thereby increasing the secretion of pro-inflammatory substances.

4. Also adipokines, either directly or indirectly, adipokines affect inflammation of small airway resulting in premature closure of the inflamed and edematous small airways and result in reduction in FVC, FEV1and FEV1/FVC ratio in peripheral obese subjects.

Studies are available on Metabolic healthy Obesity, Pulmonary Artery Hypertension in young adults and related problems among medical students.

Conclusions

This study shows that young obese adults have lower pulmonary function tests values as compared to normal individuals whereas the detrimental effect is more in the central obese than peripheral obesity. Hence early identification of the subjects who are at risk and the risk factors leading to excessive weight gain is important to initiate preventive measures to prevent the deterioration of lung functions in susceptible young adults. Further studies are needed in this regards.

Ethical Clearance: Taken from institutional ethics committee.

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Conflict of Interest: Nil.

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