Effect Of Body Fat Percentage On Maximum Ventilatory Volume (MVV) In Young Adults Of Indian Population

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Abstract: Background: Obesity impairs quality of life by causing various hazardous effects on respiratory functions of an individual along with other medical complications. The objective of the study was to evaluate effect of body fat percentage on MVV in young adults of Indian population. Method: 120 students of 18-25 years age group who had no lung disease were recruited. Their age, sex, height, weight was recorded. Students with BMI 18.5- 24.9 kg/m^2 constituted control group and students with BMI 25.0 -29.9kg/m^2 constituted study group. Skinfold thickness was calculated using 4-site method (biceps, triceps, subscapular and suprailiac) with the help of Skinfold Caliper. Body fat percentage was calculated by using Durnin and Womersley method. MVV was recorded by computerised spirometry. The statistical analysis was done using appropriate tests. Result: The study group presented with lower values of MVV than control group. Moreover MVV was having strong negative correlation with body fat percentage. Conclusion: The effect of body fat percentage on MVV indicates that obesity affects pulmonary mechanics of an individual.

Key Words: Body fat percentage, Durnin and Womersley method, Maximum Ventilatory Volume (MVV)

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Introduction: In the present era of modernization and globalization, developing countries like India is facing obesity as important health problem. Besides the genetic predisposition, adoption of sedentary lifestyle, lack of regular physical exercise, excessive intake of junk foods, stress of competitive world has made the environment conducive to the development of obesity[1]. Most popular index to compare body composition of people and to categorize them as obese and non-obese is the Body mass index(BMI). Although BMI is the major index in evaluating obesity but direct measurement of body fat and its distribution is more important[2]. Moreover the effects of obesity on ventilatory parameters may depend on both the distribution and size of excess adipose tissue[3].The deleterious effects of obesity on pulmonary functions led to various complications.

MVV is also known as maximum breathing capacity (MBC). It indicates the maximal volume of gas that can be breathed per minute by maximal voluntary effort. MVV is an important measure of respiratory muscles strength and endurance. The current study looks into the association of body fat percentage with MVV in normal weight and overweight M.B.B.S. students. So that the subjects who are at high risk can be identified. This will help to plan and execute preventive measures to prevent negative effects on health and quality of life. Overall the study depicts effect of obesity on pulmonary mechanics of an individual.

Materials and Method: The present study was undertaken in young adults of 18 - 25 years medical undergraduate students from a well known tertiary hospital Mumbai. The proforma and plan of the study were submitted to the local Ethics Committee and were approved before undertaking this study. The plan and purpose of study were explained to students. Then every student signed informed consent. 120 medical undergraduate students of age 18-25 years including both males and females participated in this study. All students were normal without any symptoms. Participants with known history of any respiratory disease, heart disease or major surgery done, any neuromuscular disorder or skeletal muscle abnormalities were excluded.

The study was conducted using equipments: weighing machine, measuring tape, Skinfold

Caliper and computerized PFT machine. Age (years), sex and anthropometric parameters (height (cm) and weight (kg) were noted. Weight was measured using a weighing machine whose least count was 0.5 kg. Height was measured using a measuring scale whose least count was 0.1cm. BMI was then calculated using Quetlet's index as: BMI = weight (kg) / Height (metre) [2]

Participants were classified depending upon BMI as:
Control group: 18.5 – 24.9 kg/m^2 and
Study group: 25.0 – 29.9 kg/m^2

In both groups each constituted 60 students having 30 males and 30 females in that individual group. Skinfold measurement method was most widely used body composition testing method for assessing percent body fat. Skinfold parameters measured were biceps (mm), triceps (mm), subscapular (mm) and suprailiac (mm). All these parameters were measured using skinfold caliper (make Anand Agencies) whose least count is 0.1mm. Skinfold caliper is a device which measures skinfold thickness with underlying layer of fat. All measurements were taken on right side of body while standing erect. The participants were instructed to keep shoulder and arm muscles relaxed during the test. All measurements were done on healthy, undamaged, uninfected dry skin. The skinfolds were picked up between the thumb and index finger of left hand and lifted up.

The caliper was held in right hand and pressure plates were applied perpendicularly 1 cm above the fingers holding the skinfold tightly and allowing the pressure of the caliper alone to be applied to the skinfold. The reading was taken 2 seconds after the caliper application in mm. The grip was maintained throughout the measurement. Minimum of three measurements were taken at each site with atleast 2 min interval to allow the tissue to restore to its uncompressed form.

Midpoint between tip of acromion process and tip of olecranon process keeping elbow in extended and relaxed position was identified using a measuring tape. At this midpoint vertical fold was raised on anterior aspect of arm for biceps skinfold. For triceps skinfold procedure is same except fold was raised on posterior aspect of arm. Subscapular skinfold measurement was taken on the oblique fold just below the bottom tip of scapula.

Suprailiac skinfold measurement was taken on slightly oblique fold just above the crest of ileum in the midaxillary line just towards front from side of waist. The average of three readings at a particular site represented the accepted value for that site. The sum of accepted values at all four sites represented the final skinfold score which was entered into a table given by Durnin and Womersley for calculating body fat percent [4].

The evaluation of maximum ventilatory volume was performed by computerized PFT machine manufactured by MEDGRAFICS (CPFS/D USB Med Graphics preVent ™ Pneumotach). The participant was asked to sit comfortably in a chair. Each participant had been explained about the test in detail. They were also shown how to perform the test with sufficient trials. For recording maximum voluntary ventilation (MVV), the participant was asked to inhale and exhale deeply and rapidly as possible for 15 seconds and then calculated for one minute. Three efforts were done and the best effort was taken into consideration according to standard norms[5]. The readings for MVV were expressed as L/min.

Result: The results for MVV and Body Fat Percentage were tabulated. The data entry was done in MS-EXCEL programme and analysis was done by SPSS-IS statistical software version 19.0 for windows. For statistical analysis, the data were submitted to 'unpaired t 'test. So that comparison of MVV in study and control group was obtained. Compared data was expressed as Mean ± SD. Statistical significance was indicated by 'P' value < 0.05. For finding correlation between body fat percentage and MVV, Pearson's correlation test was applied.

Table 1: Study variables in comparison between study and Control groups

Parameter	Male		Female	
	Control	Study	Control	Study
Age(years)	19.80±1.79	20.17±1.90	19.37±1.00	19.43±1.30
Height(cm)	170±7.43	163±8.44	159±6.95	158±5.07
Weight(kg)	61.60±6.71	70.72±8.41	53.30±6.65	66.40±5.31
BMI(kg/m^2)	22.52±1.95	26.52±1.09	22.02±1.89	26.18±0.74

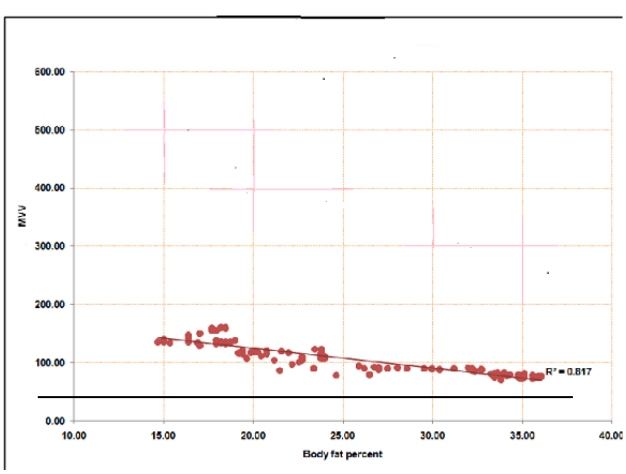
Table 2: Comparison of skinfoldthickness(4-sites in mm),Body Fat% and MVV between control & study groups

Parameter	Male		Female	
	Control	Study	Control	Study
Biceps	9.77±1.17	11.30±2.00	13.10±2.09	19.53±1.50
Triceps	11.23±1.55	15.50±2.10	14.30±2.29	21.60±1.60
Subscapular	11.20±1.32	15.57±2.50	16.37±4.41	23.17±2.20
Suprailiac	12.30±1.84	17.30±2.58	17.37±4.60	24.67±3.47
Body fat%	17.43±1.21	21.42±1.70	29.08±3.03	34.40±3.05
MVV (L/min)	143±10.52	113±6.77	88±2.66	77±3.01

Table 3: Correlation of Body Fat %with MVV in males and females

Body fat percentage		PFT-MVV
Female (60)	Pearson Correlation	-0.702
	Sig. (2-tailed)	3.99E-10
Male (60)	Pearson Correlation	-0.707
	Sig. (2-tailed)	2.63E-10

Fig 1: Scatter Diagram showing correlation of body fat% with MVV



Discussion: Quantitative distribution of body mass provides the initial framework for the description of man's nutritional status[6].The fat content of the human body influences morbidity and mortality of individuals. MVV test evaluates the respiratory endurance. The impaired respiratory muscle function has been possibly related to fatty deposits, overstretched diaphragm, decreased isokinetic skeletal muscle endurance[7,8,9,10,11,12,13]. Apart from strength of the respiratory muscles, factors that affect MVV are respiratory compliance and the airway resistance. Obesity is characterized by combination of effects on lung and chest wall compliance[14,15].Lung compliance is decreased due to reduced distensibility of extrapulmonary structures, increased pulmonary blood volume, closure of dependent airways and increased alveolar surface tension[14,15,16].The increased adiposity around ribs, diaphragm and abdomen leading to limited movement of ribs as well as decreased total thoracic and pulmonary volume pulling chest wall below its testing level cause reduction in chest wall compliance[17]. Also decreased respiratory compliance, intrinsic structural changes, thickening of airway wall combinely contribute to airflow limitation resulting in lower MVV in obesity[10, 18]. Obesity is associated with adipokines causing systemic inflammation that result in the impaired lung function[19, 20, 21, 22, 23].

Conclusion: The findings of study indicate that measure of body fat percentage affects dynamic lung volumes which are evidenced by changes in MVV in overweight adults. But these changes were not significantly causing obstructive or restrictive disorder in overweight adults. Thus obesity affects pulmonary mechanics of an individual. Limitation of study is measurement of inspiratory and expiratory pressures at different lung volumes. Although many studies regarding effect of obesity on pulmonary functions have been done from time to time, still we have not succeeded in bringing about curative measures. So the main importance now lies in identifying subjects at risk as means of preventive measures.

References:

1. Saxena Yogesh, Purwar Brijesh, Upmanyu Rashi. Adiposity: Determinant of peak expiratory flow rate in young Indian adult males. The Indian Journal of Chest Diseases & Allied Sciences 2011; 53: 29-33.
2. Ceylan, Emel MD, Comlecki, Abdurrahman MD, Akkoclu,Atila MD, Ceylan,Cengiz MD, Itil,Oya MD, Ergor, Gul MD, Yesil, Sena MD. The effects of body fat distribution on pulmonary function tests in overweight and obese. Southern Medical Journal 2009; 102(1):30-35
3. Carmelamaiolo,MD,EhabI.Mohamed,PHD,Angela AndreoliMD etc Is altered body fat distribution responsible for reduced pulmonary function in obese type 2 diabetic women Diabetes care 2001;24:961-962.
4. Durnin JV and Womersley. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. Br. J. nutri 1974; 32(1):77-97.
5. Miller M, Crapo R, Hankinson J, BrusascoV, Burgos F, Casaburi R, Coates A, Enlight P, Vander, Griten CPM, Gustafsson, Jensen R, Jonhson DC, MacIntyre N, McKay R, Navajas D, Pederson OF, Pellegrino R, Viegi G, Wanger J. ATS/ERS Task force: standardization of lung function-standardization of Spirometry. European Respiratory Journal 2005; 26(2):319-338.
6. Brozak J and Keys A. The evaluation of leanness-fatness in man: norms and interrelationships. Food and agricultural organization of the United Nations, Dietary Surveys, 1949:194-206.
7. Fadell EJ, Richman AD, Ward WW, Hendon JR.Fatty infiltration of respiratory muscles in Pickwickian syndrome. N Engl J Med. 1962; 266(26):861–863.
8. Lennmarken C, Sandstedt S, Von Schenck H, Larsson J. Skeletal muscle function and metabolism in obese women. J Parenteral Nutr. 1986; 10(6):583–587.
9. Newham DJ, Harrison RA, Tomkins AM, Clark CG. The strength, contractile properties and radiological density of skeletal muscle before and 1 year after gastroplasty. Clin Sci (Lond) 1988; 74(1):79–83.
10. Sood Akshay. Altered Resting and Exercise Respiratory Physiology in obesity. Cli Chest Med 2009; 30(3): 445-vii.
11. Sharp JT, Druz WS, Kondragunta VR. Diaphragmatic responses to body position changes in obese patients with obstructive sleep apnea. Am Rev Respir Dis. 1986; 133(1):32–37.
12. Damsbo P, Vaag A, Hother-Nielsen O, Beck-Nielsen H. Reduced glycogen synthase activity in skeletal muscle from obese patients with and without type 2 (non-insulin-dependent) diabetes mellitus. Diabetologia. 1991; 34(4):239–245.
13. Krotkiewski M, Grimby G, Holm G, Szczepanik J. Increased muscle dynamic endurance associated with weight reduction on a very-low-calorie diet. Am J Clin Nutr. 1990; 51(3):321–330.
14. Naimark A, Cherniack RM. Compliance of the respiratory system and its components in health and obesity. J Appl Physiol 1960; 15:377-382.
15. Salome CM, King GG, Berend N. Physiology of obesity and effects on lung function. J Appl Physiol 2010; 108:206-211.
16. Hedenstierna G, Santesson J. Breathing mechanics, dead space and gas exchange in the extremely obese, breathing spontaneously and during aneasthesia with

intermittent positive pressure ventilation. Acta Aneasthesiol Scand 1976; 20:284-294.
17. Pelosi P, Croci M , Ravagnan I , Tredici S, Pedoto A, Lissoni A, Gattinoni L. The effects of body mass on lung volumes, respiratory mechanics and gas exchange during general anesthesia. Anesth Analg 1998; 87:654-660.
18. Zerah H,Harf A, Perlemuter L, Lorino H, Lorino AM, Atlan G. Effects of obesity on respiratory resistance. CHEST 1993; 103:1470-1476.
19. Cancello R, Tounian A, Poitou C, Clement K. Adiposity signals, genetic and body weight regulation in humans. Diabetes Metab. 2004; 30(3):215–227.
20. Steffes MW, Gross MD, Schreiner PJ. Serum adiponectin in young adults--interactions with central adiposity, circulating levels of glucose, and insulin resistance: the CARDIA study. Ann Epidemiol. 2004; 14(7):492–498.
21. Fredberg J, Inouye D, Mijailovich M, Butter J. Perturbed equilibrium of myosin binding in airway smooth muscle and its implications in bronchospasm. Am J Respir Crit Care Med 1999; 159:959-967.
22. Thyagarajan B, Jacobs DR, Apostol GG, Smith LJ, Lewis CE, Williams OD. Plasma fibrinogen and lung function: the CARDIA Study. Int J Epidemiol. 2006; 35(4):1001–1008.
23. Thyagarajan B, Smith LJ, Barr RG. Association of Circulating Adhesion Molecules with Lung Function: The CARDIA Study. Chest. 2009 Feb 18.

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