

RESEARCH ARTICLE

A comparative study of impact of obesity on maximum voluntary ventilation in young adult women

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ABSTRACT

Background: Obesity has become a global epidemic. The prevalence and severity of obesity in young adult females are dramatically increasing worldwide. Along with other organs, respiratory system is also compromised. Obesity is likely the cause of pulmonary function decline which is linked to early morbidity and mortality. The maximum voluntary ventilation (MVV) test evaluates the respiratory endurance and is influenced by the respiratory muscle strength, the lung and chest compliance, and the control of breathing and airway resistance. In the case of obese individuals, this variable is reduced mainly by mechanical injury to the respiratory muscles, caused in particular by the excessive weight on the thorax. Hence, this study was done to know the impact of obesity on MVV in adult females. **Aims and Objectives:** The purpose of this study was to compare the pulmonary function test (PFT) parameter in obese adult females and non-obese adult female patient and to evaluate the impact of obesity on MVV. **Materials and Methods:** PFTs of 50 normal, healthy, non-obese females and 50 healthy but obese females, age group 18-30 years of Hubli city were determined and were compared. Criteria for obesity in our study taken were according to the WHO criteria of body mass index. The PFT was carried out with computerized Spirometer Eazy on-PC model. MVV parameter was used as a measure of lung function. **Results:** In our study, obese females had MVV (liters) of 58 ± 12.2 , whereas corresponding values in controls was 87 ± 66 . There was statistically highly significant difference between two groups ($P < 0.01$). There was statistically significant lower MVV in the obese group than the non-obese group ($P < 0.01$). **Conclusion:** In our study, MVV was significantly reduced in obese females compared to non-obese female. These data demonstrate MVV of obese adult females were significantly reduced when compared to the normal weight counterparts. Obesity had a significant impact on MVV parameter.

KEY WORDS: Obesity; Adult Women; Pulmonary Function Test; Maximum Voluntary Ventilation

INTRODUCTION

Obesity is a chronic disease characterized by excessive body fat which causes damage to the individual's health

and is associated with co-morbidities such as diabetes and hypertension and vascular dysfunction. Obesity can cause various deleterious effects on respiratory function such as alterations in respiratory mechanics, decrease in respiratory muscle strength and endurance, decrease in pulmonary gas exchange, lower control of breathing, limitations in pulmonary function tests (PFTs) and exercise capacity and impair health and quality of life.^[1] Obesity may affect several body systems and therefore, lead to higher morbidity and mortality rates in the population. Of all those affected, the respiratory system derives special attention because obesity promotes important change in its mechanics,

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intolerance to exercise, gas exchanges, control of respiration pattern and the strength and endurance of respiratory muscle.^[8] Major respiratory complications of obesity include a heightened demand for ventilation, elevated work of breathing, respiratory muscle insufficiency, and diminished respiratory compliance. Respiratory function is determined by interaction of lungs, chest wall, and muscles. Obesity reduces chest wall compliance, respiratory muscle function and peripheral airway size.^[6] Obesity is likely the cause of pulmonary function decline.^[5] The MVV test evaluates the respiratory endurance and is influenced by the respiratory muscle strength, the lung and chest compliance, and the control of breathing and airway resistance. In the case of obese individuals, this variable is reduced mainly by mechanical injury to the respiratory muscles, caused in particular by the excessive weight on the thorax.^[1]

MATERIALS AND METHODS

This study was conducted in the Department of Physiology, KIMS, Hubli. Data are collected from 50 non-obese adult women of 18-30 years body mass index (BMI) 30 kg/m² and 50 obese adult women of 18-30 years BMI 30 kg/m² and above, selected randomly from general population satisfying the inclusion and the exclusion criteria. The evaluation of pulmonary function was performed by spirometry using an Eazy on-PC model, computerized Spirometer (NDD Medizintechnik AG), Zurich. The study and the control group were selected based on inclusion and exclusion criteria.

Inclusion Criteria

- Age 18-30 year
- Individuals falling within the range of normal and obese BMI
- Healthy individuals
- Sedentary
- Non-smokers.

Exclusion Criteria

- Smokers
- Those who have physical deformities of chest wall
- Patient showing obstructive or restrictive alterations in the PFTs
- Obstructive sleep apnea syndrome
- Patients with noticeable weight gain over preceding 3 months.

The protocol of the study was approved by the Institutional Ethical Committee. The procedure was explained to the patients and the importance of the test was also briefed to the patients. Then, the selected group of patients was categorized into non-obese and obese based on the chart provided by the WHO for BMI (kg/m²).

<18.5	Underweight
18.5-24.99	Normal weight
25-29.99	Overweight
30 and above	Obese

Anthropometric Parameters

- Height: Standing height was measured in centimeters nearest to 1 cm with a measuring tape attached over a wall. While measuring the height, the patient removed their shoes and the patient stands with his heels together, stretching upward to full extent their back is as straight as possible with relaxed abdomen
- Weight: It was measured in kilograms on an empty bladder, empty stomach on a standardized digital weighing machine to the nearest 0.1 kg; while measuring the weight, the patient removed their shoes and wore least possible clothing
- BMI: Was calculated based on the Quetelets index,

$$\text{BMI} = \text{Weight (in kg)} / \text{height}^2 \text{ (in m)}$$

The patient who had BMI <30 kg/m² were considered as non- obese. The patients, with a BMI 30 kg/m² and above, were considered as obese.

Spirolyser

The evaluation of pulmonary function was performed by Spirometry using an Easy on-PC model, Computerized spirometer (NDD Medzintechnik AG CH-8005) Zurich, Switzerland. It plugs directly into the USB port of a PC. It works on ultrasonic Doppler principle. The directly evaluated parameters were lung volumes, capacities, and flow through the procedures of maximum voluntary ventilation (MVV) performed at least three times each, according to the standards of the American Thoracic society with the volunteers in the sitting position. Results were expressed as absolute values and as a percentage of the reference predicted values. The MVV was expressed in L/min and as a percentage of the reference predicted values.

RESULTS

The data obtained was tabulated, analyzed and expressed as mean±standard deviation to assess anthropometric and MVV parameter in the 2 groups. To compare the level of MVV

Table 1: MVV in obese females and controls

	Number of patients	MVV
Obese	50	58.5±12.2
Controls	50	87.6±20.3
P value		<0.01 (HS)

HS: Highly significant, MVV: Maximum voluntary ventilation

parameter between the two groups, the unpaired Student's *t*-test was applied, and statistical significance was indicated by $P < 0.05$. The obese females had MVV (litres) of 58 ± 12.2 , whereas corresponding values in controls was 87 ± 66 . There were statistically highly significant differences between two groups ($P < 0.01$). There was statistically significant lower MVV in the obese group than the non-obese group ($P < 0.01$).

DISCUSSION

Obesity has become a global epidemic. The prevalence and severity of obesity in young adult females are dramatically increasing worldwide. Along with other organs, respiratory system is also compromised. Obesity is likely the cause of pulmonary function decline which is linked to early morbidity and mortality. The changes in the lung function in obesity are caused by extra adipose tissue in the chest wall and abdominal cavity, compressing the thoracic cage, diaphragm and lungs, resulting in decrease in lung volumes.^[1] The MVV test evaluates the respiratory endurance and is influenced by the respiratory muscle strength, the lung and chest compliance, and the control of breathing and airway resistance. In the case of obese individuals, this variable is reduced mainly by mechanical injury to the respiratory muscles, caused in particular by the excessive weight on the thorax.^[1] In this study, obese females had MVV 58.58 ± 12.2 , whereas correspondent non-obese had MVV 87.66 ± 20.3 , obese females had lower MVV compared to non-obese females. This was statistically highly significant ($P < 0.01$).

This study is concordance with the study done by Paralikar *et al.* which showed a significant decrease in the MVV in the obese group. MVV depends on the movement of air into and out of the lungs during continued maximal effort throughout a preset interval. The MVV is a simple, informative test that provides an overall assessment of the effort, co-ordination, and flow-resistive properties of the respiratory system. As a result of air trapping, inspiratory muscles are placed at a mechanical disadvantage leading to lower inspiratory pressure and flow, and reduced respiratory muscle strength, causing low MVV. Alternatively, in some obese patients, diaphragmatic muscle weakness due to a variety of causes could lead to a decreased MVV. In addition, a decreased MVV may reflect extrinsic mechanical compression on the lung and the thorax.^[3]

Costa *et al.* have found reduction in the MVV in their study. The MVV test evaluates the respiratory endurance and is influenced by the respiratory muscle strength, the lung and chest compliance, and the control of breathing and airway resistance. In the case of obese individuals, this variable is reduced mainly by mechanical injury to the respiratory muscles, caused in particular by the excessive weight on the thorax.^[1]

Ladosky *et al.* in their study by comparing a group of obese and non-obese patients have found reduction in the MVV, they also suggested that the reduction of the endogenous retrovirus may be a consequence of air trapping caused by obesity and leading to a reduction in the MVV.^[6]

CONCLUSION

A comparative study of MVV test in young obese adult women in and around Hubli was conducted in the Department of Physiology, KIMS, Hubli. This type of study is entirely new to this geographical area, and this study intends to find the alteration in the PFT parameter in young adult obese females as compared with the normal weight individuals, particularly in this part of the country. This study showed that MVV values were significantly reduced in obese females compared to non-obese females. Hence, in this study, PFT parameter MVV showed statistically significant inverse relation with obesity. This indicates that obesity alters pulmonary functions which may give rise to long-term complications which are associated with early mortality and morbidity.

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