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ORIGINAL ARTICLE

CO-RELATION OF SIX MINUTE WALK TEST WITH PULMONARY FUNCTION TESTS IN OBESE INDIVIDUALS ADMITTED FOR BARIATRIC SURGERY

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ABSTRACT: AIMS AND OBJECTIVES: To evaluate Pulmonary Function Tests and 6MWT in obese individuals and to correlate 6MWT with FEV1 and MMEF 75-25 and establish the individual significance in evaluating bariatric subjects. **MATERIAL AND METHOD:** Prospective observational study carried out on 50 obese patients referred to PFT Lab for pre-operative investigations (admitted for planned Bariatric Surgery) after the informed consent in Department of Respiratory Medicine, Sri Aurobindo Medical College and Post Graduate Institute, Indore (MP). Biometric data (age, sex, height and weight), Pulmonary Function Tests (PFT) and Six minute walk test (6MWT) data was collected. Exclusion criteria for study is those who were not willing, unable to perform PFT/6MWT acceptably, recent cardiac event, patients with osteoarthritis or neuromuscular disorder and patients with known pre-existing respiratory illness. **STATISTICAL ANALYSIS:** Statistical analysis was performed using Graphpad Quick Calcs: t test calculator software. The data were reported as mean ± standard deviation (SD). The absolute (6MWD) in meters was used. The correlation between 6MWD and the patient's pulmonary function test were evaluated by applying unpaired 't' test. 6MWT shows extremely significant correlation with FEV1and MMEF 75-25. **RESULT:** There is high correlation between 6MWT and PFT in obese individuals. All the patients above normal BMI have ventilatory defect which may be due to restriction imposed by abdominal wall and chemical mediators released by adipocytes. Predicted values are calculated by Udwadia Index. **CONCLUSION:** 6MWT is a good prognostic tool to study ventilatory mechanism in obese individuals.

KEYWORDS: PFT, 6MWT, BMI, FEV1, MMEF 75/25.

INTRODUCTION: Obesity is a worldwide disease of increasing prevalence, currently representing a major public health problem superimposed on ancient problems such as malnutrition and infectious-contagious diseases in emerging countries.[1,2] The health consequences of obesity range from a higher risk of premature death to severe chronic diseases that reduce the quality of life.[1]

Obesity is a chronic medical condition characterized by an excessive accumulation of fat on human body that causes a generalized increase in body mass. It is measured by using body mass index (BMI) which is a reflection of weight and height. Body mass index (BMI) is calculated as the weight in kilograms divided by the square of the height in meters (BMI = weight (kg) /height (m^2). The world Health Organization (WHO) classified obesity using BMI cut-off values of 25 and 30 kg/m^2 Body mass index (BMI) of 18 to 24.9 kg/m^2 is considered normal weight, a BMI of 25.0-29.9 kg/m^2 is considered overweight and a BMI of 30 kg/m^2 or higher is considered obesity.[3]

To investigate the effect of obesity on the respiratory system, most researchers use values of pulmonary function tests (PFT). The factors that usually affect the values of pulmonary function tests are age, gender, height, race or ethnic origin and possibly obesity. As the individual gets older age, the lung volumes and capacities become smaller and the lung volumes and capacities are larger in males than females.[4]

Out of the above stated factors affecting pulmonary function values, obesity is considered to be commonest and worst offender which alters relationship between lungs, chest wall and diaphragm leading to profound alterations in pulmonary function values which can be assessed by spirometry.[5]

Obesity may affect respiratory function in a number of ways. Carbon dioxide production increases as a function of body weight. Obese subjects consume approximately 25% more oxygen than non-obese subjects at rest,[6] and increased lung and respiratory system resistance due to the reduction of lung volume,[7-9] which can profoundly alter pulmonary function and diminish exercise capacity by its adverse effects on respiratory mechanics, resistance within the respiratory system, respiratory muscle function, lung volumes, energy cost of breathing, control of breathing and gas exchange.[10] Obesity is not a single disease in itself. It places patient at the risk of many diseases including hypertension, dyslipidemia, type II diabetes mellitus, coronary heart disease, cerebral stroke, gall bladder disease, osteoarthritis, some cancers, aspiration pneumonia, pulmonary thromboemblism, obstructive sleep apnoea, obesity hypoventilation syndrome and respiratory failure which are associated with substantial morbidity and increased mortality. Weight loss can reverse many of the alterations of pulmonary function produced by obesity.[11]

Excess weight may cause impaired pulmonary function, especially in morbid obesity.[12-14] It is interesting to study them by spirometry during the preoperative period of bariatric surgery in order to investigate the possibility of restrictive or obstructive pulmonary problems due to it. Obese patients commonly present respiratory symptoms such as dyspnea, explained in part by the fact that obese persons tend to breathe in a more rapid and shallow manner as an adaptation to the increase in total respiratory work and in the resistance caused by obesity. Several studies have shown that obese patients without co-morbidities present dyspnea even at rest and in the absence of other causes.[15]

Many literature reports emphasize the fact that morbidly obese patients have reduced expiratory reserve volume (ERV) and reduced al functional residual capacity (FRC), as well as restrictive respiratory behavior in many cases. [16, 17] In severely obese patients, ventilatory normality is reestablished after weight loss as a consequence of increased FRC, residual volume (RV), total lung capacity (TLC) and ERV.[18,19]

In obese people, the presence of adipose tissue around the rib cage and abdomen and in the visceral cavity loads the chest wall and reduces functional residual capacity (FRC). The reduction in FRC and in ERV is detectable, even at a modest increase in weight. However, obesity has little direct effect on airway caliber. Spirometric variables decrease in proportion to lung volumes, but are rarely below the normal range, even in the extremely obese, while reductions in expiratory flows and increases in airway resistance are largely normalized by adjusting for lung volumes. Nevertheless, the reduction in FRC has consequences for other aspects of lung function. A low FRC increases the risk of both expiratory flow limitation and airway closure. Marked reductions in expiratory reserve volume may lead to abnormalities in ventilation distribution, with closure of airways in the dependent zones of the lung and ventilation perfusion inequalities. Greater airway closure during tidal breathing is associated with lower arterial oxygen saturation in some individuals. Bronchoconstriction has the potential to enhance the effects of obesity on airway closure and thus on ventilation distribution. Thus obesity has effects on lung function that can reduce respiratory well-being, even in the absence of specific respiratory disease, and may also exaggerate the effects of existing airway disease.[20]

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Obese people are at increased risk of respiratory symptoms, such as breathlessness, particularly during exercise, even if they have no obvious respiratory illness.[21,22] Obesity has a clear potential to have a direct effect on respiratory well-being, since it increases oxygen consumption and carbon dioxide production, while at the same time it stiffens the respiratory system and increases the mechanical work needed for breathing.[20]

There are several modalities available for the objective evaluation of functional exercise capacity. Some provide a very complete assessment of all systems involved in exercise performance (high technology), whereas others provide basic information but are low technology and are simpler to perform. The modality used should be chosen based on the clinical question to be addressed and on available resources. The most popular clinical exercise tests in order of increasing complexity are stair climbing, a 6 Minute Walk Test (6MWT), a shuttle-walk test, detection of exercise-induced asthma, a cardiac stress test (e. g., Bruce protocol), and a cardiopulmonary exercise test.[23,24] Assessment of functional capacity has traditionally been done by merely asking patients the following: "How many flights of stairs can you climb or how many blocks can you walk?" However, patients vary in their recollection and may report overestimations or underestimations of their true functional capacity. Objective measurements are usually better than self-reports. In the early 1960s, Balke developed a simple test to evaluate the functional capacity by measuring the distance walked during a defined period of time.[25] A 12-minute field performance test was then developed to evaluate the level of physical fitness of healthy individuals.[26] The walking test was also adapted to assess disability in patients with chronic bronchitis.[27] In an attempt to accommodate patients with respiratory disease for whom walking 12 minutes was too exhausting, a 6-minute walk was found to perform as well as the 12-minute walk.[28] A recent review of functional walking tests concluded that "the 6MWT is easy to administer, better tolerated and more reflective of activities of daily living than the other walk tests".[29]

The 6MWT is a practical simple test that requires a 100-ft hallway but no exercise equipment or advanced training for technicians. Walking is an activity performed daily by all but the most severely impaired patients. This test measures the distance that a patient can quickly walk on a flat, hard surface in a period of 6 minutes (the 6MWD). It evaluates the global and integrated responses of all the systems involved during exercise, including the pulmonary and cardiovascular systems, systemic circulation, peripheral circulation, blood, neuromuscular units, and muscle metabolism. It does not provide specific information on the function of each of the different organs and systems involved in exercise or the mechanism of exercise limitation, as is possible with maximal cardiopulmonary exercise testing. The self-paced 6MWT assesses the submaximal level of functional capacity. Most patients do not achieve maximal exercise capacity during the 6MWT; instead, they choose their own intensity of exercise and are allowed to stop and rest during the test. However, because most activities of daily living are performed at sub-maximal levels of exertion, the 6MWD may better reflect the functional exercise level for daily physical activities.[30]

AIMS:

1. To evaluate Pulmonary Function Test of obese individuals.
2. To evaluate submaximal exercise capacity by doing 6MWT.
3. To correlate these values among each other.

ORIGINAL ARTICLE

OBJECTIVES:

1. To asses ventilatory status of above BMI individuals.
2. To correlate 6MWT, FEV1 and MMEF 75-25 among each other and establish the individual significance in evaluating bariatric subjects.

MATERIAL AND METHOD: Study is conducted in Department of Respiratory Medicine, Sri Aurobindo Medical College and Post Graduate Institute, Indore (MP).

Data Collection: Biometric data (age, sex, height, weight), Pulmonary Function Test and Six minute walk test of obese patients referred to PFT Lab for pre-operative investigation, admitted for planned Bariatric Surgery.

Study design: Prospective observational study.

Sample size: 50 obese patients.

Study subjects: Obese patients referred to PFT Lab for pre-operative investigations, admitted for planned Bariatric Surgery.

Informed Consent: consent for inclusion obtained from the patients in writing after explaining about the study and its utility.

Inclusion Criteria: Obese patients referred to PFT Lab for pre-operative investigations, admitted for planned Bariatric Surgery.

Exclusion Criteria:

- Patients not willing.
- Patients unable to perform PFT/6MWT acceptably.
- Patients with recent cardiac event.
- Patients with osteoarthritis or neuro-muscular disorder.
- Patients with known pre-existing respiratory illness.

Pulmonary Function Test (PFT): PFT has been performed on jaeger PFT machine with body box in Department of Respiratory Medicine of Sri Aurobindo Medical College and Post Graduate Institute, Indore MP by qualified PFT technician with assistance of physiologist and reported in consent with pulmonologist.

Indices includes:

Forced expiratory volume 1 (FEV1).
Maximum mid expiratory flow 75/25.

Six minute walk test (6MWT): At the time of test, the patient's heart rate, blood pressure and oxygen saturation were measured. Subjects were asked to walk at their own pace, along a 30 m long and straight red line on the floor of hospital hallway marked at intervals of one meter each. Each patient was instructed to walk as much distance as possible in 6 minutes. No encouragement was offered, but the patient was told standardized phrase to indicate the time remaining. The patient was allowed to stop if symptoms of significant distress occurred, like severe dyspnea, chest pain, dizziness, diaphoresis, or leg cramps. However, the patient was asked to resume walking as soon as possible, if he or she could. At the end of six minutes, the patient was asked to stop and a repeated measurement of blood pressure, heart rate, oxygen saturation by pulse oxymeter, were measured and the distance walked for 6 minutes was recorded. The patients were asked to be observed for a 10-15 minutes period after the test, to assess any possible complications. Patients who started to walk but did not complete the test, were included in the study.

Statistical Analysis: Statistical analysis was performed using Graphpad Quick Calcs: t test calculator software. The data were reported as mean ± standard deviation (SD). The absolute (6MWD) in meters was used. The correlation between 6MWD and the patient's pulmonary function test were evaluated by applying unpaired 't' test.

	All participants (n=50)	**Males (n=38)**	**Females (n=12)**
Age in years	46.34±9.0522	46.58±9.1286	45.58±9.1598
Height in centimeters	166.90±9.7839	170.32±8.2564	156.08±5.4013
Weight in kilograms	128.33±25.6251	135.65±23.4560	105.17±17.4399
BMI (Kg/m^2)	45.23±7.1133	45.85±7.5272	43.26±5.4089

Table 1: Biometric Data

	All participants (n=50)	**Males (n=38)**	**Females (n=12)**
Predicted FEV1	2.7268±0.4986	2.9510±0.3230	2.0167±0.1810
FEV1 (best effort)	2.4852±0.5823	2.6139±0.5745	2.0775±0.4016
Predicted MMEF 75-25	2.5834±0.4391	2.7292±0.3922	2.1217±0.1880
MMEF 75-25 (best effort)	2.1186±0.8206	2.4158±0.9509	2.3400±0.7346

Table 2: Spirometric Data

	All participants (n=50)	**Males (n=38)**	**Females (n=12)**
6MWT	360. 66±89. 55	368. 05±90. 25	337. 25±86. 86

Table 3: Six Minute Walk Test Data

		Standard error of difference	**'t' value**	**'p' value**	
6MWT 360.66±89.55	FEV1 2.4852±0.5823	12.665	28.2817	<.0001	Extremely Statically significant
	MMEF 75-25 2.1186±0.8206	12.665	28.3100	<.0001	Extremely Statically significant

Table 4: Unpaired 't' test

6MWT shows extremely significant correlation with FEV1and MMEF 75-25.

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RESULTS: There is high correlation between 6MWT and PFT in obese individuals. All the patients above normal BMI have ventilatory defect which may be due to restriction imposed by abdominal wall and chemical mediators released by adipocytes. Predicted values are calculated by Udwadia Index.

DISCUSSION: We perform a study on obese individuals presenting for bariatric surgery. We evaluated their ventilatory status by PFT and 6MWT. The data was collected over the period of one and a half years and analyzed using statistical principles. We compared our data with similar studies.

In the study done by Khandelwal M et al,[31] total 65 subjects were taken including 48 males and 17 females. in study done by Chen Hong et al,[32] total number of subjects was 150 including 123 males and 27 females. In our study there was total 50 subjects were taken, the total number is less because they were obese individuals admitted for planned Bariatric surgery which is quiet very expensive and everybody can't afford. Males far outnumbered female patients; possible reason for this may be due to socioeconomic reasons.

In the study done by Joey C. Eisenmann et al,[33] in 2007 on obese children with BMI 19.5±4 Kg/m^2, and by C. Guimarães et al,[34] on obese adults of BMI 49.7±8.2 Kg/m^2 both have shown decreased lung functions due to obesity and in this study BMI 45.227±7.1133 Kg/m^2 is also showing the same pattern.

The decreased pulmonary function in obese could be due to several mechanisms including respiratory or chest wall mechanics (work of breathing, compliance, elastic recoil), resistance within the respiratory system, respiratory muscle function, and airway structure or function.[35,36] Obesity may change airway function by increasing bronchial hyper-responsiveness.[36] An alternative explanation may be related to the inflammatory response shown in obese individuals. As suggested by Gilliland et al,[37] adipose tissue is a source of pro-inflammatory cytokines and chemokines, and their increase in the obese state may have the potential to enhance pulmonary inflammation.

Obesity also acts like a restrictive pulmonary disease in that it provides an external load on the chest wall.[37,38] Such a restrictive effect is characterized by decreases in both FVC and FEV1, with variable effects on FEV1%, and is shown with many types of external loads. This effect may provide a direct link with the decreases seen in pulmonary function that might even precede the previously mentioned airway effects.[39] Central obesity adversely affects pulmonary function in adults because stress on the chest wall and diaphragm is greater.[40] Morbid obesity is associated with pulmonary insufficiency, risk of aspiration pneumonia, pulmonary thromboembolism, and respiratory failure.[36]

The results of this study were consistent with previous findings in and these results have clinical and public health implications.

6MWT evaluates the integrated responses of all including the respiratory system, cardiovascular systems, blood, neuro-musculoskeletal system and muscle metabolism. The 6MWT is easy to administer, economic, better tolerated, and more reflective of activities of daily life. It may be widely used to evaluate the exercise tolerance in patients with heart or lung disease.[41]

6MWT is best used to determine the response the treatment in heart or lung disease.[42-52] The 6MWT has also been used as a one-time measure of functional status of patient.[53-56]

Correlation of Spirometry indices and 6MWT: The standard spirometry maneuver is a maximal forced exhalation (greatest effort possible) after a maximum deep inspiration (completely full lungs). Several indices can be derived from this blow.

Forced Expiratory Volume in One Second (FEV1): Present study demonstrate positive correlation between 6MWT and FEV1, This results were similar to other studies done by Hatem FS Al Ameri,[57] Naghshin R et al,[58] Mehta A et al,[59] and Khandelwal M et al.[31]

Maximum Mid Expiratory Flow rate 75-25 (MMEF 75-25): Has a wide range of normality, is less reproducible than FEV1. The present study also demonstrates positive correlation between 6MWT and MMEF 75-25 as seen in some previous studies.

The correlation of 6MWT and pulmonary function test, in patients with respiratory diseases, makes this test easy and a simple tool for assessing the disease status. We feel that this test is underutilized by clinicians. Test may be easily carried out in hospital settings with adequate space but may be difficult to be carried out in office practice due to time and space constraints.

PFT is the gold standard for the diagnosis of respiratory function at present. However, PFT is difficult to perform for some patients, especially for those patients with seriously impaired pulmonary function and severe dyspnoea. It is also a costly method with restricted availability. Long term monitoring of pulmonary function by PFT is also difficult. There is a good correlation between the 6MWT and spirometric parameters in obese patients. The 6MWT is also a simple, convenient, and effective exercise test which could be widely applied.[60-62] Equipment needed to implement the 6MWT, such as finger pulse oxymeter, sphygmomanometer, stopwatch, etc are all simple medical instruments. After a simple training, even non-medical people such as a family member could carry out the 6MWT, although caution is always needed.

CONCLUSION: 6MWT is a good prognostic tool to study ventilatory mechanism in obese individuals.

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ORIGINAL ARTICLE

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