A CROSS-SECTIONAL ANALYTICAL STUDY ON THE ASSOCIATION OF BODY MASS INDEX (BMI) TO DYNAMIC LUNG VOLUMES- ASSESSED BY DIGITAL SPIROMETER IN A TERTIARY CARE HOSPITAL

Dissertation Submitted to

THE TAMILNADU DR.M.G.R MEDICAL UNIVERSITY

in partial fulfillment of the regulations

for the award of the degree of

M.D.BRANCH – I

(GENERAL MEDICINE)

GOVT. CHENGALPATTU MEDICAL COLLEGE & HOSPITAL

THE TAMILNADU DR.M.G.R MEDICAL UNIVERSITY

CHENNAI, TAMILNADU

APRIL – 2016

CERTIFICATE

This is to certify that the dissertation titled **" A CROSS-SECTIONAL ANALYTICAL STUDY ON THE ASSOCIATION OF BODY MASS INDEX (BMI) TO DYNAMIC LUNG VOLUMES-ASSESSED BY DIGITAL SPIROMETER IN A TERTIARY CARE HOSPITAL**" is the bonafide work of **Dr. M.VASANTHA KUMAR** in partial fulfillment of the requirements for **M.D.BRANCH–I (GENERAL MEDICINE)** examination of **THE TAMILNADU DR.M.G.R MEDICAL UNIVERSITY** to be held in April 2016. The period of study was from June 2014 to August 2015.

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **"A CROSS-SECTIONAL ANALYTICAL STUDY ON THE ASSOCIATION OF BODY MASS INDEX (BMI) TO DYNAMIC LUNG VOLUMES- ASSESSED BY DIGITAL SPIROMETER IN A TERTIARY CARE HOSPITAL**" is a bonafide and genuine research work carried out by me at **GOVT. CHENGALPATTU MEDICAL COLLEGE AND HOSPITAL** from June 2014 to Auust 2015 under the guidance and supervision of **Dr.M.ANUSUYA M.D**, Professor, Department of General Medicine, Chengalpattu Medical College, Chengalpattu – 603 001.

Date :

Place : Chengalpattu

Signature of the Candidate

Dr. M.VASANTHA KUMAR

INSTITUTIONAL ETHICS COMMITTEE

CHENGALPATTU MEDICAL COLLEGE , CHENGALPATTU

APPROVAL OF ETHICAL COMMITTEE

To

Dr.M.Vasantha Kumar,
MD General Medicine
(2nd Year),
Chengalpattu Medical College,
Chengalpattu

Dear Dr.

The Institutional Ethical Committee of Chengalpattu Medical College reviewed and discussed your application to conduct the clinical / dissertation work entitled

A CROSS - SECTIONAL ANALYTICAL STUDY ON THE ASSOCIATION OF BODY MASS INDEX (BMI) TO DYNAMIC LUNG VOLUMES ASSESSED BY DIGITAL SPIROMETER IN A TERTIARY CARE HOSPITAL

ON 11.06.2014

The following documents reviewed

1. Trial protocol, dated _______version no
2. Patient information sheet and informed consent form in English and / or vernacular language.
3. Investigators Brochure, dated _____________version
4. Principal Investigators current CV
5. Investigators undertaking

The following members of the Ethics committee were present at the meeting held on

Date 11.06.2014 Time 11.30 Noon Place Chengalpattu Medical College

Approved__________________Chairman Ethics Committee

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Name of each member with designation:-

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1. Dr.R.Muthuselvan MD.,
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2. Dr.C.Srinivasan MD.,
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Biological Scientist

3. Dr.K.Baskaran MD.,
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5. Member from Nongovernmental Voluntary Organisation : Mr.P.Durairaj

6. Philosopher : Mr.K.S.Ramprasad

7. Lawyer : Lr. I. M. Karimala Basha

8. Layperson : Mr.Dilli

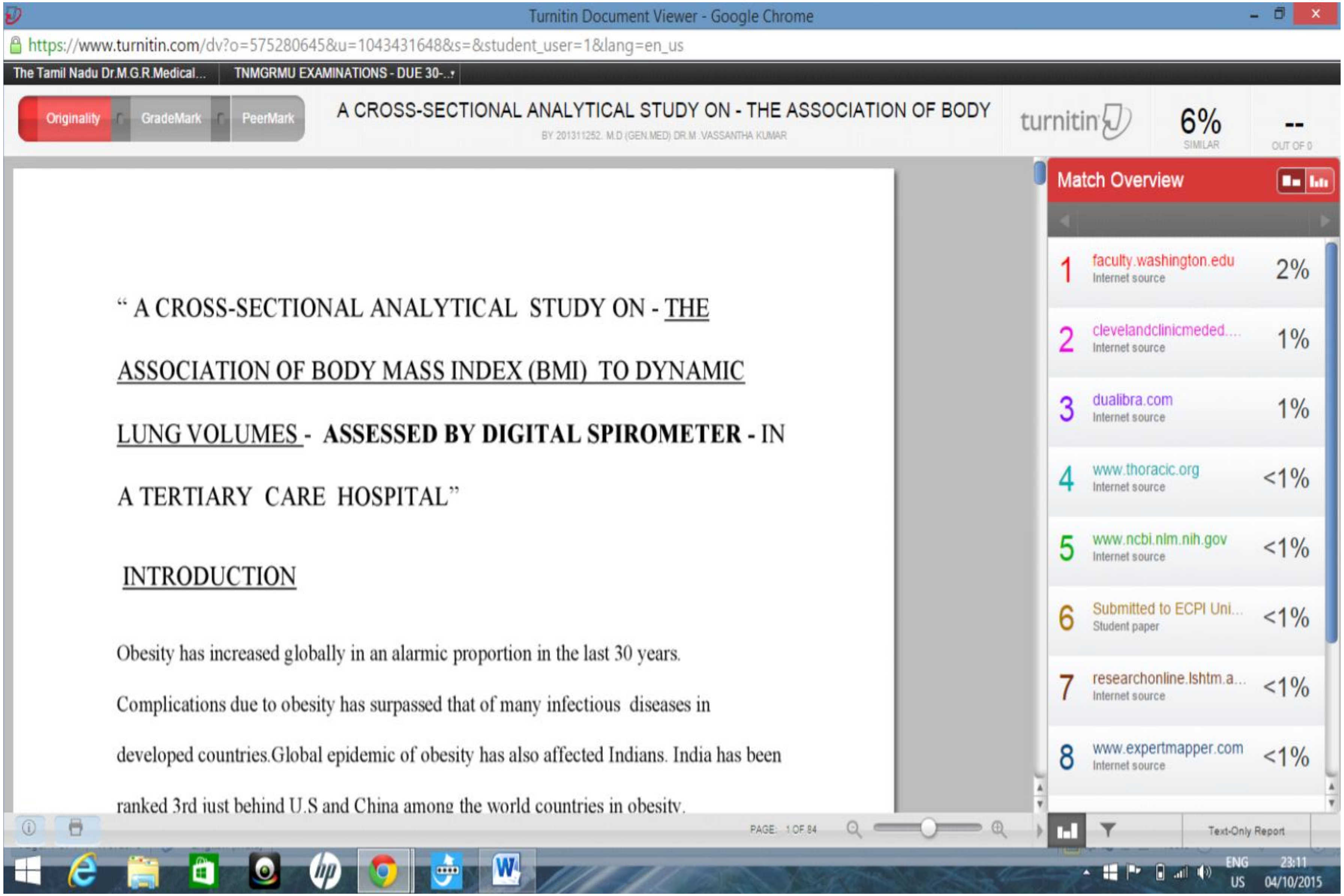
We approve the clinical trial to be conducted in its presented form

The Institutional Ethics Committee expects to be informed about the progress of the study and any SAE occurring in the course of the study, any changes in protocol and patient information / informed consent and asks to provide copy of final report.

Yours sincerely

11/6/14

Member secretary, Ethics Committee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INTRODUCTION

Obesity has increased globally in an alarmic proportion in the last 30 years. Complications due to obesity has surpassed that of many infectious diseases in developed countries.Global epidemic of obesity has also affected Indians. India has been ranked 3rd just behind U.S and China among the world countries in obesity.

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Last but not least, I am grateful to all those patients who were the subjects for this study, without whose co-operation this work would not have been possible.

I bow my head in respect before God Almighty.

Date: Signature of the Candidate

Place : Chengalpattu **Dr. M.VASANTHA KUMAR**

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LIST OF ABBREVIATIONS USED

%	Percentage
BMI	Body Mass Index
FVC	Forced Vital Capacity
FEV1	Forced Expiratory Volume in 1 Second
PCOS	Polycystic Ovarian Syndrome
CHF	Congestive Heart Failure
WHO	World Health Organisation
PFT	Pulmonary Function Test
VC	Vital Capacity
IC	Inspiratory Capacity
IRV	Inspiratory Reserve Volume
ERV	Expiratory Reserve Volume
RV	Residual Volume
FRC	Functional Residual Capacity
FEF	Functional Expiratory Flow
PEFR	Peak Expiratory Flow Rate
BTPS	Body Temperature and Pressure of Gas
FEV6	Forced Expiratory Volume in 6 Second
COPD	Chronic Obstructive Pulmonary Disease
MMEF	Maximal Mid-Expiratory Flow
FEV3	Forced Expiratory Volume in 3 Second
NAFLD	Non-Alcoholic Fatty Liver Disease
NASH	Non-Alcoholic Steato Hepatitis
BD	Bronchodilator

INTRODUCTION

Obesity has increased globally in an alarmic proportion in the last 30 years [1]. Complications due to obesity has surpassed that of many infectious diseases in developed countries. Global epidemic of obesity has also affected Indians[2]. India has been ranked 3rd in the list of top 10 countries with highest number of obese people just behind U.S and China.

Obesity carries significant risk for the development of Hypertension, Diabetes mellitus, Heart diseases, Stroke and some Cancers[3] .Obesity adversely affects Respiratory system also[4].

Obesity causes reduction of Lung compliance leading to decrease in lung volumes producing mostly a restrictive type of ventilatory defect. Compression of thoracic cage by excessive fat and increased pooling of blood in pulmonary vasculature mainly contribute towards reduction in respiratory compliance. Deposition of fat in diaphragm causes mechanical obstruction to the descent of diaphragm there by causing increased work of breathing and metabolic demand there by producing breathing difficulty

WHO recommends BMI for defining obesity. BMI has been reported to be negatively associated with values for dynamic lung volumes including forced vital capacity (FVC) and forced expiratory volume in first second (FEV1) [5]

Association between BMI and pulmonary function has been previously examined but not much studies are available in India. Therefore, the present study is conducted to measure the relationship between BMI and lung volumes in a sample of local population of 15 to 60 yrs age group of apparently healthy individuals attending Master Health Check Up OP and attenders of in-patients of wards of general medicine department, Govt. Chengalpattu Medical College, Chengalpattu.

AIM OF STUDY

AIM AND OBJECTIVES OF THE STUDY :

1. To measure the association of body mass index (BMI) to dynamic lung volumes assessed by Digital Spirometer

2. Comparing the study with similar studies done already in other reputed centres

REVIEW OF LITERATURE

OBESITY

Introduction

In a world where food supplies are intermittent, the ability to store energy in excess of what is required for immediate use is essential for survival.

Fat cells, residing within widely distributed adipose tissue depots, are adapted to store excess energy efficiently as triglyceride. When needed, these fat cells release stored energy as free fatty acids for use at other sites. This physiologic system,mediated through endocrine and neural pathways, permits humans to survive starvation for as long as several months.

However, in the presence of nutritional abundance and a sedentary lifestyle, and influenced importantly by genetic endowment, this system increases adipose energy stores and obesity develops which produces adverse health consequences.

Historical aspects

The word Obesity is derived from the Latin word obesitas, which means "stout, fat, or plump". Obesity has been known since ancient times. Ancient Greek medicine describes obesity as a medical disorder and the Ancient Egyptians also saw it in the same way[6]. Hippocrates mentioned about obesity that "Corpulence is not only a disease itself, but the harbinger of others".

The Ancient great Indian surgeon Sushruta (6th century BC) also mentioned about obesity and related obesity to diabetes and heart disorders[7]. He recommended physical work to help cure it and its side effects.

Definition:

"Obesity is a medical condition in which excess body fat accumulates to the extent that it may have an adverse effect on health".

Measurement

The most widely used method to gauge obesity is the *body mass index* (BMI), which is equal to weight/height^2 (in kg/m^2) **.** Other approaches to quantifying obesity include anthropometry (skinfold thickness), densitometry (underwater weighing), CT or MRI, and electrical impedance[8, 28]. BMI is closely related to both percentage body fat and total body fat[9].

Prevalence

In U.S more than 20 % of population is obese. In India about 11% of population is obese and about 5% are morbidly obese.In urban schools more than 15% school children are obese. According to a study published in the noted journal Lancet, India is just behind US and China in this global hazard list of top 10 countries with highest number of obese[10]. people. Unhealthy, processed food has become much more accessible following India's continued integration in global food markets.

This, combined with rising middle class incomes, is increasing the average caloric intake per individual among the middle class and above income households.

Physiologic Regulation of Energy Balance:

Substantial evidence suggests that body weight is regulated by both endocrine and neural components that ultimately influence the energy intake and expenditure.This complex regulatory system is necessary because even small imbalances between energy intake and expenditure will ultimately have large effects on body weight.For example, a 0.3% positive imbalance over 30 years would result in a 9-kg (20-lb) weight gain.

This regulation of energy balance cannot be monitored simply by calorie-counting in relation to physical activity. Rather, body weight regulation or dysregulation depends on a complex interplay of hormonal and neural signals.

Alterations in stable weight by forced overfeeding or food deprivation induce physiologic changes that resist these perturbations:

- with weight loss, appetite increases and energy expenditure falls;
- with overfeeding, appetite falls and energy expenditure increases.

This latter compensatory mechanism frequently fails, however, permitting obesity to develop when food is abundant and physical activity is limited. A major regulator of these adaptive responses is the adipocyte-derived hormone leptin, which acts through brain circuits (predominantly in the hypothalamus) to influence appetite, energy expenditure, and neuroendocrine function .

Syndromes associated with Obesity

A number of syndromes has been reported to be associated with obesity[11].Some of these are given below

- Prader-Willi syndrome
- Laurence-Moon-Biedl syndrome
- Cushing's syndrome
- Hypothyroidism.
- Insulinoma
- Craniopharyngioma and other disorders involving the hypothalamus

Pathologic Consequences of Obesity

Obesity has major adverse effects on health. Obesity and overweight together are the second leading cause of preventable death in the United States. Mortality rates rise as obesity increases, particularly when obesity is associated with increased intraabdominal fat[12].

Obesity is associated with an increase in mortality:

- 50–100% increased risk of death from all causes compared to normal-weight individuals, mostly due to cardiovascular causes[13].

- Life expectancy of a moderately obese individual could be shortened by 2–5 years, and
- A 20- to 30-year-old male with a BMI >45 may lose 13 years of life[27].

Insulin resistance and type 2 diabetes mellitus

Hyperinsulinemia and insulin resistance are pervasive features of obesity, increasing with weight gain and diminishing with weight loss Obesity is a major risk factor for diabetes, and as many as 80% of patients with type 2 diabetes mellitus are obese[14]. Weight loss and exercise, even of modest degree, increase insulin sensitivity and often improve glucose control in diabetes.

Reproductive disorders

Disorders that affect the reproductive axis are associated with obesity in both men and women. Male hypogonadism is associated with increased adipose tissue, often distributed in a pattern more typical of females. In men whose weight is >160% ideal body weight (IBW), plasma testosterone and sex hormone–binding globulin (SHBG) are often reduced, and estrogen levels are increased .Gynecomastia may be seen.

Obesity has long been associated with menstrual abnormalities in women, particularly in women with upper body obesity[15,16]. Most obese women with oligomenorrhea have the polycystic ovarian syndrome (PCOS), with its associated anovulation and ovarian hyperandrogenism; 40% of women with PCOS are obese. In obese women with PCOS, weight loss or treatment with insulin-sensitizing drugs often restores normal menses.

The increased conversion of androstenedione to estrogen, which occurs to a greater degree in women with lower body obesity, may contribute to the increased incidence of uterine cancer in postmenopausal women with obesity.

Cardiovascular disease

Obesity is an independent risk factor for the incidence of cardiovascular disease including Hypertension coronary disease, stroke, and congestive heart failure (CHF) in men and women[17].

With the additional effects of hypertension and glucose intolerance associated with obesity are included, the adverse impact of obesity is even more evident. The effect of obesity on cardiovascular mortality in women may be seen at BMIs as low as 25. Obesity, especially abdominal obesity, is associated with an atherogenic lipid profile.

Hepatobiliary disease

Obesity is frequently associated with the common disorder nonalcoholic fatty liver disease (NAFLD). This hepatic fatty infiltration of NAFLD can progress in a subset to inflammatory nonalcoholic steatohepatitis (NASH) and more rarely to cirrhosis and hepatocellular carcinoma[18].

Steatosis has been noted to improve following weight loss, secondary to diet or bariatric surgery[19].

Cancer

Obesity in males is associated with many cancers, including cancer of the esophagus, colon, rectum, pancreas, liver, and prostate[20].

Obesity in females is associated with higher mortality from cancer of the gallbladder, bile ducts, breasts, endometrium, cervix, and ovaries.

Some of the latter may be due to increased rates of conversion of androstenedione to estrone in adipose tissue of obese individuals. Other possible mechanistic links are other hormones whose levels are linked to nutritional state, including insulin, leptin, adiponectin, and IGF-1.

It has been estimated that obesity accounts for 14% of cancer deaths in men and 20% in women in the United States.

Bone and joint

Obesity is associated with an increased risk of osteoarthritis and gout[21]

Cutaneous disease

The skin problems associated with obesity is

- Acanthosis nigricans, manifested by darkening and thickening of the skinfolds on the neck, elbows, and dorsal interphalangeal spaces. Acanthosis reflects the severity of underlying insulin resistance and diminishes with weight loss.

- Friability of skin may be increased, especially in skinfolds, enhancing the risk of fungal and yeast infections.
- Finally, venous stasis is increased in the obese.

Pulmonary disease

Obesity may be associated with a number of pulmonary abnormalities[22,23,24]. These include

- Reduced chest wall compliance
- Increased work of breathing
- Increased minute ventilation due to increased metabolic rate
- Decreased functional residual capacity and expiratory reserve volume .
- Severe obesity may be associated with obstructive sleep apnea and the obesity hypoventilation syndrome"

Weight loss (10–20 kg) can bring substantial improvement, as can major weight loss following gastric bypass or restrictive surgery. Continuous positive airway pressure has been used with some success.

Other Problems Of Obesity

Apart from the direct health problem , obesity leads to many other problems including disadvantages in employment and increased business costs there by affecting the economy of all levels of society from individuals, to corporations, and also to the government.

BMI classification:

WHO classification[25]:

1.Under weight = BMI : <18.5 kg/m2

2.Normal = BMI :18.5 to 24.9 kg/m2

3 .Overweight = BMI :25 to 29.9 kg/m2

4. Obese Class 1 = BMI :30 to 34.9 kg/m2

5.Obese class 2 = BMI :35 TO 39 kg/2

6.Obese class 3 = BMI :> 40

In Asian Countries:

Some Asian countries including India have a higher proportion of total body fat and are at a greater risk of obesity related co-morbidities even at BMI cut-off point which are considered low risk for individuals in other countries[26].

Hence Asian countries propose stricter criteria for public health action.

1. Less than 18·5 kg/m2 - underweight

2. 18·5–23 kg/m2- increasing but acceptable risk

3. 23–27·5 kg/m2 - increased risk

4. 27·5 kg/m2 or higher - high risk

World Health Organization (WHO) recommends use of Body Mass Index (BMI) for defining obesity. BMI is the simplest and most widely used index of adiposity. The validity of BMI in predicting body fatness is well-established in different age, gender and racial groups.

BMI has been used to predict disease like Hypertension, Stroke, Coronary heart disease (CHD), Type-2 diabetes mellitus (T2DM) , and some Cancers.BMI has also been proposed as an overall indicator of mortality as well .

To summarise the World Health Organization (WHO) has described obesity as one of the most neglected public health problems, because it affects every region of the world. It has predicted that overweight and obesity may soon replace more traditional public health problems such as under nutrition and infectious diseases as the most significant cause of poor health[29]. Obesity is a public health problem and policy problem because of its prevalence, costs, and health effects on the people .

Obesity has reached epidemic proportions in India in this 21st century, with morbid obesity affecting 5% of the country's population. Obesity in children and adolescents is gradually becoming a major public health problem in India .

According to a study published in the noted journal Lancet, India is just behind US and China in this global list of top 10 countries with highest number of obese population. Unhealthy, processed food has become easily available following India's economic liberalisation. This, combined with rising middle class income groups and Sedantary life style changes contribute to the rapidly rising level of Obesity in India. Unless we take concrete steps to reduce obesity at this stage we will have to face the catastropic effects of obesity in the future[30]

PULMONARY FUNCTION TESTS (PFT)

PFT is a general term used to indicate a battery of Pulmonary functions. PFT include simple screening spirometry, formal lung volume measurement, diffusing capacity for carbon monoxide, and arterial blood gases[31].

Pulmonary function tests permit accurate, reproducible assessment of the functional state of the respiratory system and allow quantification of the severity of disease, thereby enabling early detection as well as assessment of the natural history and the response to therapy With the great advances in pulmonary physiology and medical instrumentation that have occurred during the past 40 years, pulmonary function testing has come to assume a central place in the practice of pulmonary medicine Testing equipment, patient testing maneuvers and techniques have been widely standardized throughout the world by the efforts of professional societies. Widely accepted norms and parameters have been established[32]. Of all these tests the most commonly used lung function screening study is Spirometry.

Spirometry:

Spirometry is a physiological test that measures how an individual inhales or exhales volumes of air as a function of time.

Spirometer was invented by John hutchinson

Spirometry is an important screening test of general respiratory health in the same way that blood pressure gives important information about general cardiovascular health. However, on its own, spirometry does not provide clinicians an aetiological diagnosis directly.

Spirometry should be the clinician's first option, with other studies being reserved for specific indications. Most of the people can easily perform spirometry when trained by an appropriate technician or other health care provider. This test can be done in the hospital inpatient setting, ambulatory setting, physician's office or in emergency department.

There are two types of Lung Function studies. They are the measurement of Static Lung functions and Dynamic Lung functions.

- Static Lung Function Tests measures purely volume based tests like Vital capacity (VC), Inspiratory Capacity (IC), Inspiratory Reserve Volume (IRV), Expiratory Reserve Volume (ERV), Residual Volume (RV) and Functional Residual Capacity(FRC).

- Dynamic Lung Function Tests measures Flow and Time based parameters like Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second(FEV1),Forced Expiratory Flow (FEF 25 -75%), and Peak Expiratory Flow Rate(PEFR).

Static Lung Volumes like Residual Volume , Functional Residual Capacity and Total Lung Capacity can be measured by

- Nitrogen washout technique
- Helium dilution method
- Body plethysmography

Dynamic Lung Functions like FVC, FEV1, FEF25-75 and PEFR can be easily measured by simple digital Spirometers.Spirometer can not measure – FRC, RV and TLC

Indications:

There are several reasons for performing spirometry[33]:

It can be used for diagnosing diseses monitoring respiratory signs and symptoms, for preoperative risk assessment, and as a tool in research and epidemiologic studies.

The following are some of the indications :

1. In any potentially hazardous occupation, individual workers should be monitored periodically by spirometry to detect and quantitative evidence of pulmonary problems.

2. Spirometry appears to be the best method to identify smokers at risk of developing severe chronic airflow obstruction.

3. Spirometry can indicate the statistical risk of specific surgical procedures for a group of patients..

4. Many government agencies (e.g., the Social Security Administration) require results of spirometry to quantitate impairment in patients who claim disability caused by chronic bronchitis or emphysema, as well as pneumoconioses, pulmonary fibrosis, and other pulmonary disorders.

5. Spirometric results, including peak flow rates, are extremely useful in assessing the effectiveness of treatment in asthmatic patients. These simple tests are equally valuable for quantitating the effects of treatment in patients with other forms of chronic airflow obstruction, as well as many forms of restrictive disorders.

6. Spirometry can be very sensitive to evaluate progression of disease, especially if baseline values, or results obtained early in the course of the illness, are available for comparison. This is because the variation in the range of normal is so large that changes in serial tests are much more sensitive than a single value for detecting abnormal function.

7. Spirometry is an excellent screening test for detection of chronic airflow obstruction but may also be useful in detecting restrictive disorders.

8. Spirometry should be part of the baseline clinical evaluation in all adult patients. If this baseline test is abnormal or if the patient has certain risk factors, the test should be repeated regularly (every 1 to 5 years)

9. Spirometry is used to assess patients as part of a rehabilitation program Medical and Industrial setup.

10.. In Public health it is useful in

- Epidemiological surveys
- Comparison of health status of people living in different environments

- Validation of subjective complaints in occupational or environmental settings

- Derivation of reference equations

Contraindications[34]:

- Recent Myocardial Infarction within 1 month or Unstable angina
- Recent eye surgery
- Active hemoptysis
- Pneumothorax
- Thoracic , abdominal and cerebral aneurysms

Spirometer:

 

A spirometer, is an instrument which directly measures the volume of air that is displaced or which measures airflow by a flow-sensing device, such as a pneumotachometer or a tube containing a fixed resistance to flow.

Most clinical pulmonary function testing laboratories now a days use a microprocessor-driven pneumotachometer to measure air flow directly and then to mathematically derive volumes.

Types of Spirometers:

Volume type

- Bellows
- Rolling seal
- Water
- Dry

Flow Sensing (Pneumotachometer)

- Fleisch
- Hot-wire
- Screen
- Turbine

Spirometer Quality control:

The American Thoracic Society has taken great effort to standardize and publish detailed recommendations regarding use of spirometry and lung volumes. These guidelines are inclusive of the selection of equipment, important technical considerations and standardization between laboratories for the procedures[35].

The following table summarizes equipment quality control as the recommendations given by the American Thoracic Society[36].

Spirometer Quality Control Summary:

Test	Minimum Interval	Action
Volume	Daily	3-L syringe check
Leak	Daily	3 cm H_2O constant pressure for 1 min
Linearity	Quarterly Weekly (flow spirometers)	1-L increments with a calibrating syringe measured over the entire volume range (flow spirometers simulate several different flow ranges)
Time	Quarterly	Mechanical recorder check with stopwatch
Software	New versions	Log installation date and perform test using known subject

Spirometer performance standard

The summary of the suggested performance standards for an office spirometer[37] is given below.

Performance Standards for a Spirometer

1. A volume spirometer should:

Accumulate volume for greater than 30 sec

Accommodate volumes of up to 7 L

Be accurate to within 3% or 50 mL of a test volume

2. A flow-sensing spirometer should:

Be able to measure flows up to 12 L/sec

Be accurate to within 5% or 0.2 L/sec

3. Both need:

Regular maintenance

Routine checks of accuracy of the spirometer and the computer

Spirogram:

A spirogram is a graphic representation of bulk air movement which is depicted as a volume-time tracing or as a flow-volume tracing.

Values generated from a simple spirogram provides the important graphic and numeric datas regarding the mechanics of the lungs, including airflow (Forced Expiratory Volume in 1 second (FEV_1) along with other timed volumes) and exhaled lung volume Forced Vital Capacity (FVC)

The measurement is expressed in liters for volumes or in liters per second for flows and is corrected for body temperature and pressure of gas (BTPS) that is saturated with water vapor.

Acceptability and Reproducibility Criteria for Spirograms:

The American Thoracic Society standardization guidelines for acceptability and reproducibility criteria are given below[38].

A well-trained PFT technician usually coaches the patient through the session until the demonstrated reproducibility of key parameters suggests the results represent the best possible measure of lung function at that time.

A. Acceptability Criteria

1. Free from :

- Artifacts
- Cough or glottis closure during the first second of exhalation
- Early termination or cutoff
- Variable effort
- Leak
- Obstructed mouthpiece

2. **Good start**

- Extrapolated volume is <5% of FVC or 0.15 L, whichever is greater *or*
- Time to PEF is <120 ms (optional until further information is available)

3. **Satisfactory exhalation**

- 6 sec of exhalation and/or a plateau in the volume-time curve *or*
- Reasonable duration or a plateau in the volume-time curve *or*
- The subject cannot or should not continue to exhale

B. Repeatability Criteria

After three acceptable spirograms have been obtained, apply the following tests.

- Are the two largest FVCs within 0.2 L of each other?
- Are the two largest FEV_1s within 0.2 L of each other?

If both of these criteria are met, the test session may be concluded.

If both of these criteria are not met, continue testing until:

- Both of the criteria are met with analysis of additional acceptable spirograms or

- A total of eight tests have been performed or
- Save a minimum of three best maneuvers

Procedures for recording forced vital capacity:

- Check the spirometer calibration
- Explain the test
- Prepare the subject
- Ask about smoking, recent illness, medication use, etc.
- Measure weight and height without shoes
- Wash hands

Instruct and demonstrate the test to the subject

- to include Correct posture with head slightly elevated
- Inhale rapidly and completely
- Position of the mouthpiece (open circuit)
- Exhale with maximal force

Perform manoeuvre (closed circuit method)

- Have subject assume the correct posture
- Attach nose clip, place mouthpiece in mouth and close lips around the mouthpiece
- Inhale completely and rapidly with a pause of ,1 s at TLC

- Exhale maximally until no more air can be expelled while maintaining an upright posture
- Repeat instructions as necessary, coaching vigorously
- Repeat for a minimum of three manoeuvres; no more than eight are usually required
- Check test repeatability and perform more manoeuvres as necessary

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- Check test repeatability and perform more manoeuvres as necessary

QUALITY OF THE DATAS:

The quality of the datas are assessed by two graphs called the

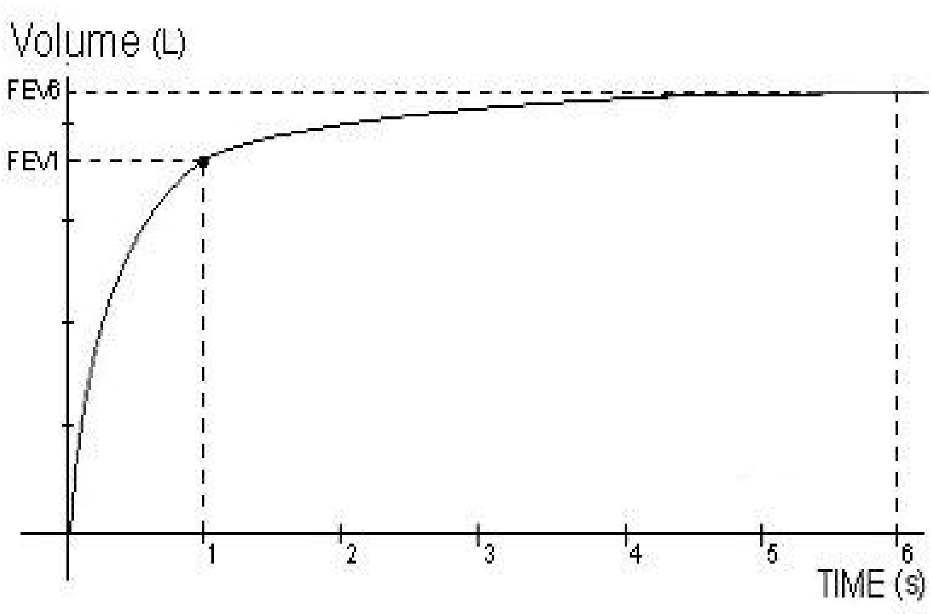
- **Volume-Time Tracing** and
- **Flow-Volume Loop**

The Volume-Time is most useful in assessing whether the end of test criteria have been met whereas The flow-volume loop is most valuable in evaluating the start-of-test criteria[39]

These graphs ascertain :

- the technical adequacy of a procedure
- the quality of the data
- the anatomic location of airflow obstruction

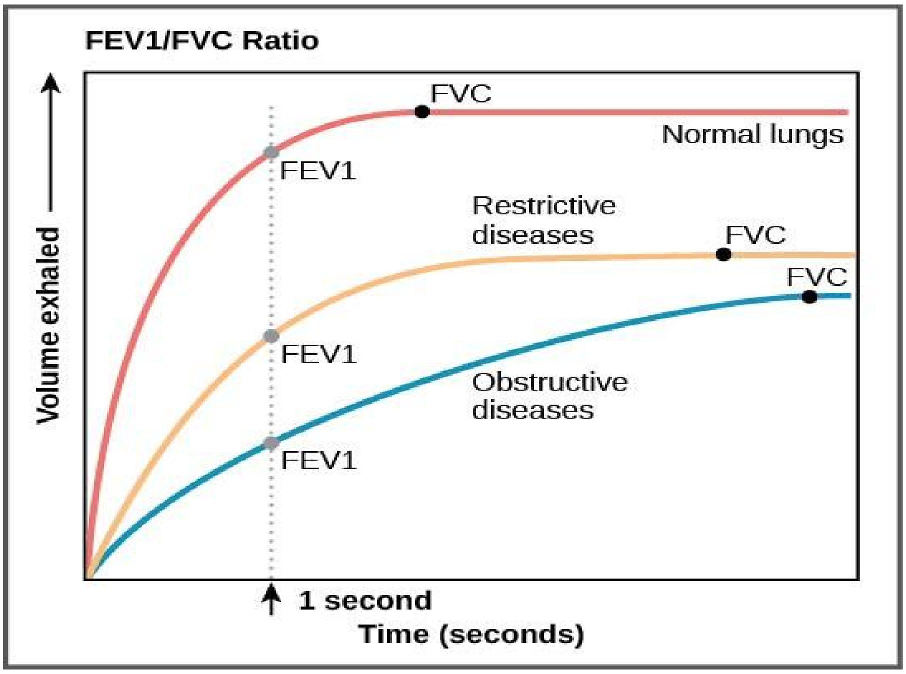
Volume-Time curve:



Volume-Time Graph

In Volume-Time graph X- axis is represented by Time in seconds and Y – axis is represented by Volume in litres. FEV1-Forced Expiratory Volume in 1 second is the volume expired in the first second of the FVC test and is a very important parameter in spirometry.This parameter is measured from Volume-Time graph.

In the following graph the morphology of Volume-Time graph seen in normal sujects ,patients with Obstructive lung disease and and in Restrictive lung diseases are given[40]

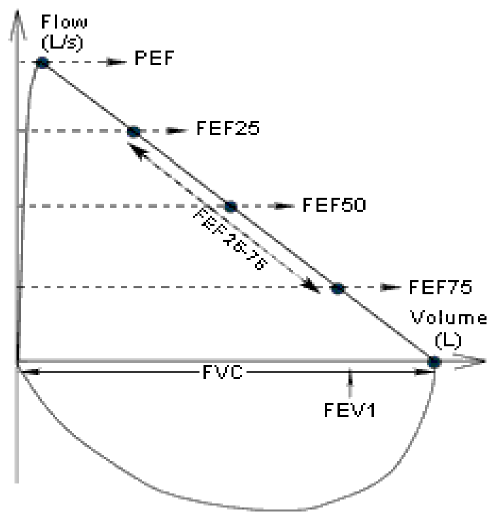


A healthy patient can expire about 80% of all the air out of his lungs in the first second during the FVC maneuver. A patient with Obstruction of the upper airways takes longer time to expire all the air from his lungs.The Volume expelled air in 1 second will be less in Obstructive Lung diseases and there by causes a decreased FEV1/FVC ratio.

A FEV1% that is too high is suggestive for a Restriction of the pulmonary volume.

After 6 seconds a second parameter can obtained- FEV6. This can been used as an alternative for FVC. FEV1/FEV6 can than be used in stead of FEV1/FVC[42].

Flow-Volume loop :



Flow-Volume Loop

The flow-volume loop is the most important graph in spirometry.This flow-volume loop is most valuable in evaluating the start of test criteria[43].

A Flow-Volume loop begins at the intersection of the X-axis (volume) and Y-axis (flow) At the start of the test both flow and volume are equal to zero. Directly after this starting point the curve rapidly mounts to a peak. This is the Peak Expiratory Flow. If the test is performed correctly, this PEF is attained within the first 150 milliseconds of the test.

It is important to note that as there is no time axis on the flow-volume loop , one can not interpret time intervals. A healthy patient expires between 70 and 90% of the FVC in the first second of the test. This means that it takes roughly about 5 seconds for him to expire the last 10 to 30 % of the FVC. The point where the FEV1 is reached is shown on the curve as an illustration.

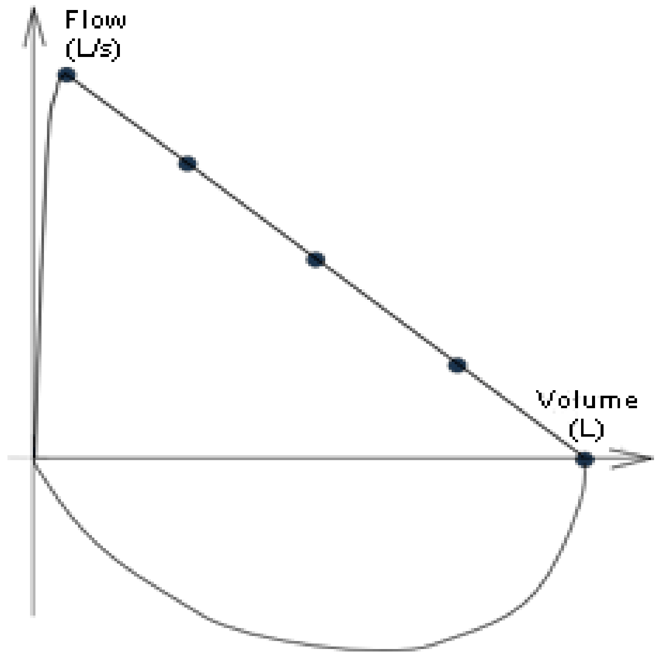
When the flow reaches zero, the FVC is reached . This is the Forced Vital Capacity and the patient has blown out as much air as he can.

After this the patient makes a complete and forced inspiration to obtain a closed flow-volume loop but the test can be interpreted without this as well[44].

The morphology of the flow-volume loop

The morphology of the flow-volume loop is very important. For the trained eyes the flow-volume loop tells immediately if the test was well done . From the shape of the flow-volume loop one can easily find the location of airflow limitation, such as the large upper airways or smaller distal airways[45].

A. Normal flow-volume loop:



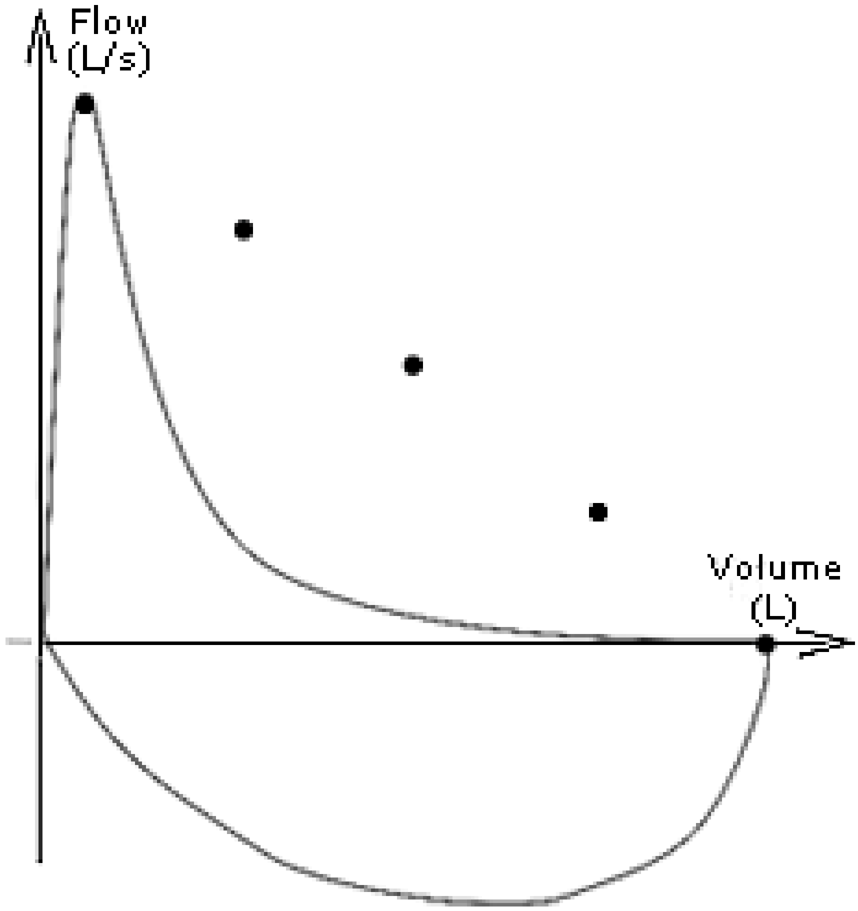
Normal Flow-Volume Loop

The normal Flow-Volume loop begins on the X-axis – also called Volume axis at the start of the test where both flow and volume are equal to zero. After a starting point this curve rapidly mounts to reach a a peak which is called Peak Expiratory Flow[46].

After the Peak Expiratory Flow, the curve descends and the flow decreases as more air is expired. A normal, Flow Volume loop descends in a straight or a convex line from top (PEF) to bottom (FVC).

The forced inspiration that follows the forced expiration has roughly the same morphology, but the PIF (Peak Inspiratory Flow) is not as distinct as PEF.

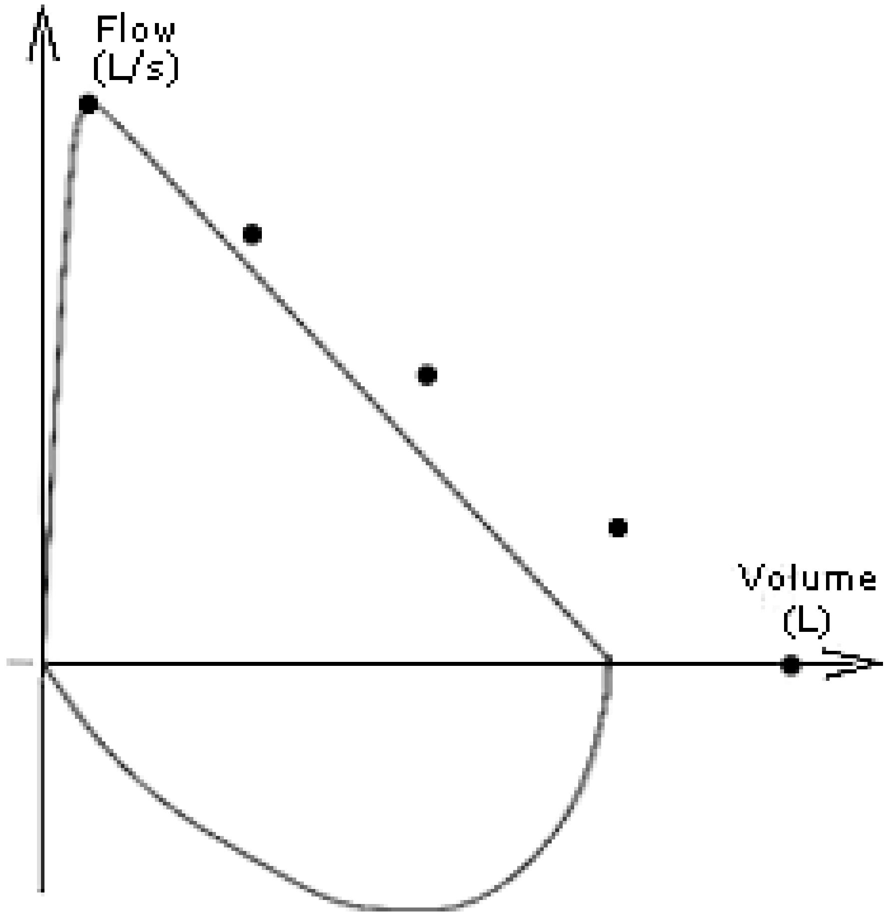
B. Obstructive Lung Disease:



Flow-Volume Loop in Obstructive Lung Disease

If the flow-volume loop is concave as seen in the above picture a bronchial obstruction can be suspected (Diseases like COPD or Bronchial Asthma) [47].

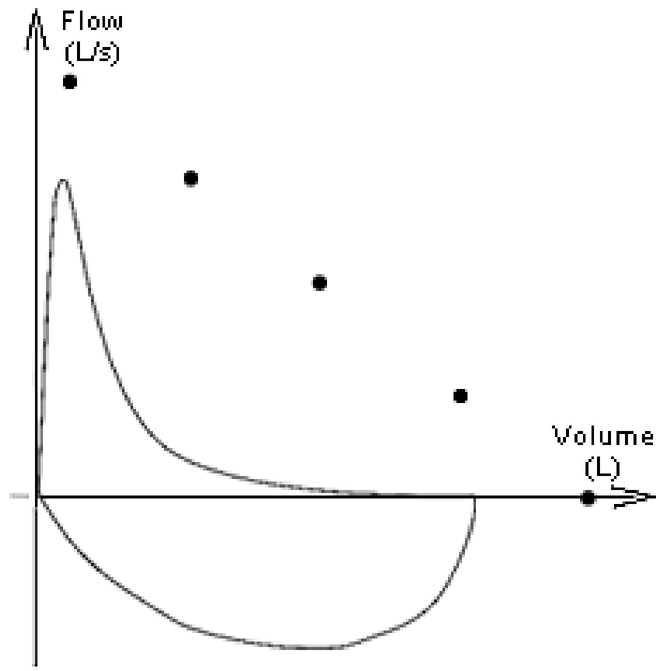
C. Restricive disorders:



Flow-volume Loop in restriction lung disease

The airways are normal hence the flow volume loop will be normal in shape. The curve will descend in a straight line from the PEF to the X-axis. The total lung volume is low, which results in a low FVC. PEF can be normal or low.

D. Mixed Lung Disease:



Flow-Volume Loop of Mixed Lung diseases

Some times patients will show signs of both obstructive and restrictive lung disease. The flow-volume loop will have the characteristics of both diseases.

Parameters of Spirometry:

Results of the Spirometry are usually given in both absolute values(litres, litres per second) and " percent predicted"—the test result as a percent of the "predicted values" for the patients of similar characteristics (height, age, sex, and sometimes race and weight). The following parameters are derived from the Spirometry[48] :

1. Forced Vital Capacity:

Forced vital capacity (FVC) is the volume of air that can forcibly be exhaled out after full inspiration, measured in liters.

FVC is the most basic paramrter in spirometry tests.The results obtained are compared to the predicted values that are calculated from his age, size, weight, sex and ethnic group[49].

FVC is usually decreased in diseases that cause the lungs to be smaller. In other words a decreased VC reflects limitation in chest excursion.Such processes are seen in Restrictive lung diseases[50].

Examples:

- Disorders of the lung parenchyma such as Pulmonary fibrosis
- Disorders of the bellows including Kyphoscoliosis,
- Neuromuscular disease,
- Pleural effusion

However, a reduction in FVC may not always be due to reduced total volumes .It is not a reliable indicator of total lung capacity or restriction, especially in the setting of airflow obstruction[51].

Examples:

- Bronchial Asthma
- COPD

2. **Forced Expiratory Volume in 1 Second FEV1:**

FEV1 is the volume of air that can forcibly be exhaled in one second, after full inspiration. The FEV_1 is the most widely used parameter to measure the mechanical properties of the lungs. The results of the test are compared to the predicted values that are calculated from his age, size, weight, sex and ethnic group[52].

In normal persons, the FEV_1 accounts for the greatest part of the exhaled volume from a spirometric maneuver and it reflects mechanical properties of the airways of both large and the medium size[53].

In a normal flow-volume loop, the FEV_1 occurs at about 75% to 85% of the FVC[54]. This parameter is reduced in obstructive and restrictive disorders.

- In Obstructive Lung diseases FEV_1 is reduced disproportionately to the FVC, thereby reducing the FEV_1/FVC ratio below the lower limit of normal.This indicates airflow limitation.

- In Restrictive Lung diseases FEV_1, FVC and total lung capacity are all reduced and the FEV_1/FVC ratio is normal or even elevated.

3. Additional Tests

A variety of parameters selectively reflect small airways. These include measures of flow from a spirogram, such as MMEF- the maximal mid expiratory flow or FEF_{25-75} - the forced expiratory flow at 25% to 75% of vital capacity[55]

The FEF_{25-75} is the slope of the spirogram between the 25th and the 75th percentiles of an FVC maneuver. Normal values and lower limits of normal for the FEF_{25-75}% have been published. A new parameter to assess small airways function - the FEV_3/FVC ratio, are proposed but this parameter is yet to be sufficiently validated[56].

Normality and predicted equations:

Studies conducted from healthy population indicate that the parameters of lung function, such as FEV_1 or FVC, are affected most significantly by height, age, gender, race, and weight[57].

Over the years, many regression equations have been generated by several investigators using different methodologies to study a variety of populations. The most commonly used standards are those of Morris and colleagues,- Crapo and colleagues, Knudson and colleagues and the National Health and Nutrition Examination Survey (NHANES II)[58]. These reference standards are based on a cohort of normal subjects of similar age, height, and race, with normal being defined as persons without a history of smoking or disease that can affect lung function.

Many approaches have been developed to determine the normal range of spirometry. The American Thoracic Society recommends using the concept of lower limit of normal by identifying the lowest 5% of a population, or patients that fall outside the limits of 1.645 standard deviations from the mean. This value may be calculated by multiplying 1.645 times the standard error of estimate (1.645 × SEE)[59].

Clinical interpretative strategies:

The respiratory diseases can be classified as obstructive or restrictive processes.

Obstructive disorders:

These are characterized by

- Airflow limitation
- Increased lung volumes with air trapping
- Normal or increased compliance (based on pressure volume profile)

Restrictive disorders

These are characterized by

- Reduced lung volumes and
- Increased overall stiffness of the lungs (with reduced compliance).

The summary the common obstructive and restrictive lung diseases[62] are given below.

Common Restrictive and Obstructive Lung Diseases

- **Common Obstructive Lung Diseases**
- Bronchial Asthma
- Chronic obstructive pulmonary disease which includes chronic bronchitis, emphysema and the overlap between them)
- Cystic fibrosis

Common Restrictive Lung Diseases

Interstitial Lung Diseases

- Idiopathic pulmonary fibrosis
- Interstitial pneumonitis
- Sarcoidosis
- Pneumoconiosis etc

Congestive heart failure

- Infectious inflammation (e.g., histoplasmosis, mycobacterium infection)
- Neuromuscular diseases
- Chest wall deformities like Kyphoscoliosis

Interpretation:

Generally, the measured values are compared with the lower limits of normal predicted values which are already calculted from the published studies and the results are interpreted as follows[60]:

Obstructive Lung diseases :

- The FEV_1 / FVC ratio is reduced below the lower limits of normal.

Restrictive Lung diseases :

- The FEV_1 / FVC ratio is normal but the FVC is reduced below lower limits of normal.

Mixed Abnormality:

- The FEV1 / FVC ratio is reduced below the lower limits of normal and
- The FVC is also reduced below lower limits of normal.

The assessment of severity of obstruction and restriction are given below which follows the American Thoracic Society's criteria for grading the severity of lung function abnormality[61].

Normal

- Both the VC and the FEV1/VC ratio are in the normal ranges

Severity of Obstruction Abnormality

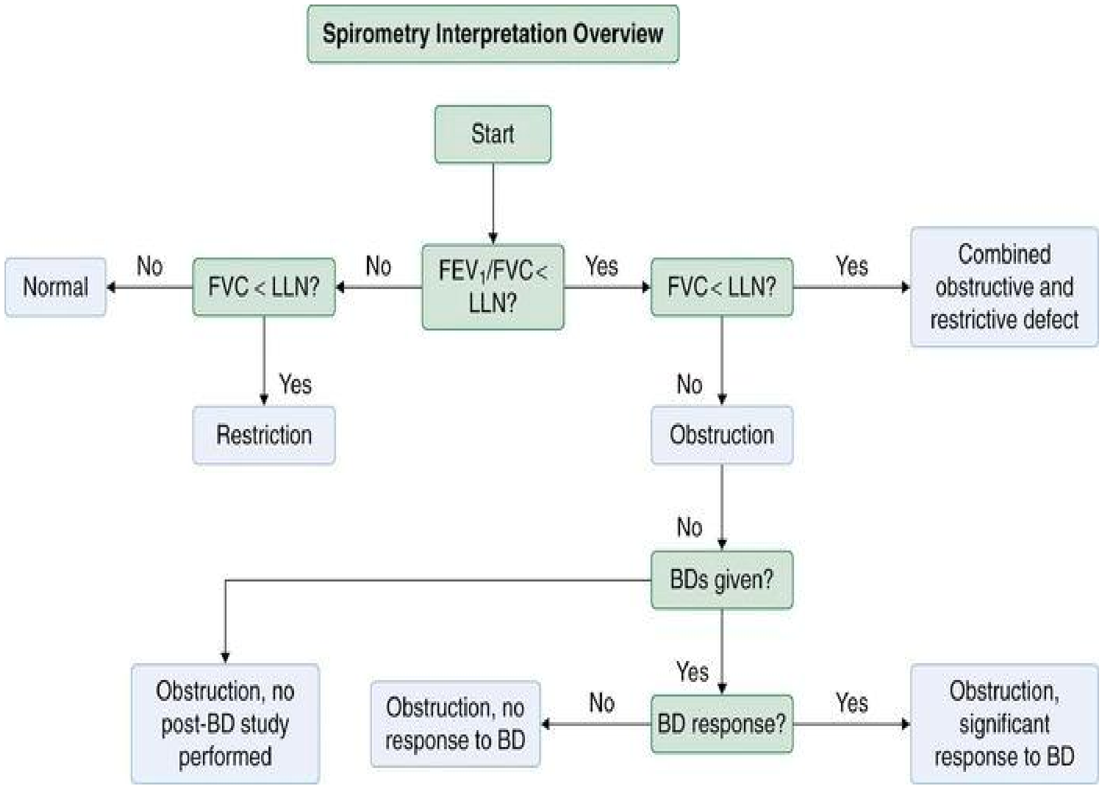
- May be a physiologic variant: Predicted FEV1 ≥100%
- Mild: Predicted FEV1 <100% and ≥70%
- Moderate: Predicted FEV1 <70% and ≥60%
- Moderately severe: Predicted FEV1 <60% and ≥50%
- Severe: Predicted FEV1 <50% and ≥34%
- Very severe: Predicted FEV1 <34

Severity of Restriction abnormality

- Mild: Predicted FVC < LLN but ≥70%
- Moderate: Predicted F VC <70% and ≥60%
- Moderately severe: Predicted FVC <60% and ≥50%
- Severe: Predicted FVC <50% and ≥34%
- Very severe: Predicted FVC <34

Flow chart- An approach to spirometry Interpretation:

A flow Chart on the approach to the interpretation of spirometry is given below[63].The explanation is already discussed in the previous pages.



MATERIALS AND METHODS

PLACE OF STUDY:

Chengalpattu Medical College Hospital, Chengalpattu.

DURATION OF STUDY :

15 months (June 2014 –August 2015)

POPULATION STUDIED :

300 (both males and females)

STUDY GROUP:

Above the age of 15 years of apparently healthy individuals attending Master Health Check Up OP and attenders of in-patients of wards of general medicine department, Govt. Chengalpattu Medical College, Chengalpattu.

INCLUSION CRITERIA:

All apparently healthy individuals of either gender above the age of 15 years of age .

EXCLUSION CRITERIA:

1. Smokers both Current and Ex-smokers and other tobacco users in any other form (chewing, snuffing or water pipe) were excluded from our study. (Ex-smoker is defined as someone who has smoked more than

100 cigarettes in his lifetime, does not currently smoke, but used to smoke daily previously)

2. Subjects with pre-existing pulmonary (e.g. tuberculosis, bronchial asthma, COPD etc.) disease. (By careful history taking and subjects with any chest symptoms like cough ,cold, Breathing difficulty, chest pain etc were excluded from the study)

3. Other systemic conditions (e.g. diabetes mellitus, hypertension, etc.) were also excluded.

- Blood pressure was checked for all the patients. Subjects with high Blood pressure or any past history of high BP were excluded.
- Random Blood sugar was checked for all subjects. Subjects with high blood sugar values of above 140 mgm% and past history of high blood sugsar were excluded from the study.

METHODS:

Proper approval for this study was obtained from Instituitional Ethical Committee of Chengalpattu Medical College. Written informed consent was obtained from each participant prior to inclusion in the study.

Anthropometric measurements have been done by standard techniques .To ensure correct measurement of height,subjects were asked to straighten their back and observer adjusted the head of the subject in Frankfort plane. Weight was measured by a electronic weighing scale. Subjects removed shoes before measurement of height and weight. BMI was calculated as kg/m2 from height and weight.

BMI was used as a measure of obesity and subjects were classified into five categories as follows :

1.Under weight = BMI : <18.5 kg/m*2*

2.Normal = BMI :18.5 to 24.9 kg/m2

3 .Overweight = BMI :25 to 29.9 kg/m2

4. Obese Class 1 = BMI :30 to 34.9 kg/m2

5.Obese class 2 = BMI :35 TO 39 kg/*2*

Dynamic lung functions were measured by spirometry.We used a flow measuring type digital spirometer (Spirolab III, Version 3.7, Rome, Italy). Measurements were done in accordance with the latest joint American and European guidelines which have replaced the older ATS and ERS guidelines respectively. All recordings were made between 09:00 AM and 12:00 PM to avoid any presumed diurnal variations.

Subjects were instructed regarding the correct way of blowing air into the spirometer and taking a deep breath before forceful expiration prior to the test. Spirometry of all subjects was done in proper sitting position for standardization and uniformity in interpretation of results. Nose clip was applied to all participants to avoid air leakage from nasal passages. A new disposable mouth-piece was attached to the spirometer before testing each participant. It was ensured that subjects sealed their lips tightly around the mouth-piece and blew out air as hard and fast as possible. The subject was actively encouraged during the procedure to breathe out as long as possible.

Tests were discarded and repeated if subjects coughed or blocked the meter with their tongue. Test was repeated for three recordings that met the acceptability and reproducibility criteria and the highest reading was reported. The procedure was abandoned if a participant was unable to produce an acceptable and repeatable spirogram after 8 attempts.

Dynamic lung volumes were assessed as

1. FVC (measured in litres) and FVC % reported as percentage of predicted values
2. FEV1 (measured in litres) and FEV1 % reported as percentage of predicted values and
3. Ratio of FEV1 to FVC (FEV1/FVC %).

Lung volumes were reported as percentage of predicted value as a linear variable possibly corrected for the effects of age and gender. FVC % and FEV1 % were calculated by the following equation :

- FVC % = measured FVC / reference value for FVC x 100
- FEV1 % = measured FEV1 / reference value for FEV1 x 100

ANALYSIS:

Analysis has been done by comparing the groups using t-test and ANOVA. Correlation is assessed by Pearson's r method

RESULTS AND ANALYSIS

There are 300 participants in this study.The information was collected prospectively. The demographic profile of the participants along with pulmonary function test were collected and entered in to MS Excel sheet and analyzed by using SPSS 16.0V. One way ANOVA and Chi sq test are used to find the significance among the Pulmonary functions at 5% level of significance.

Demograpic Profile:

Table 1 : Gender distribution of participants:

Sex	No.of participants	%
Male	244	81.3%
Female	56	18.7%
Total	300	100

This table shows that 300 people participated in our study. Out of these 244 are males constituting 81.3% of our study population.The remaining 56 are females thus constituting 18.7% of our study population.

Table : Age distribution of Participants

Age	No. of participants	%
10.-20	21	7%
21-30	62	20.7%
31-40	71	23.7%
41-50	86	28.7%
51-60	50	16.7%
61-70	8	2.7%
>70	2	0.7%
Total	300	100

People above the age of 10 years were selected for the study.This table shows that most of the participants are from 31 to 50 years age group.

Table 3 : BMI distribution of participants

BMI	**No.of participants**	**%**
Under weight	10	3.3 %
Normal	111	37 %
Over Weight	114	38 %
Class I Obesity	58	19.3 %
Class II Obesity	7	2.3 %
Total	300	100

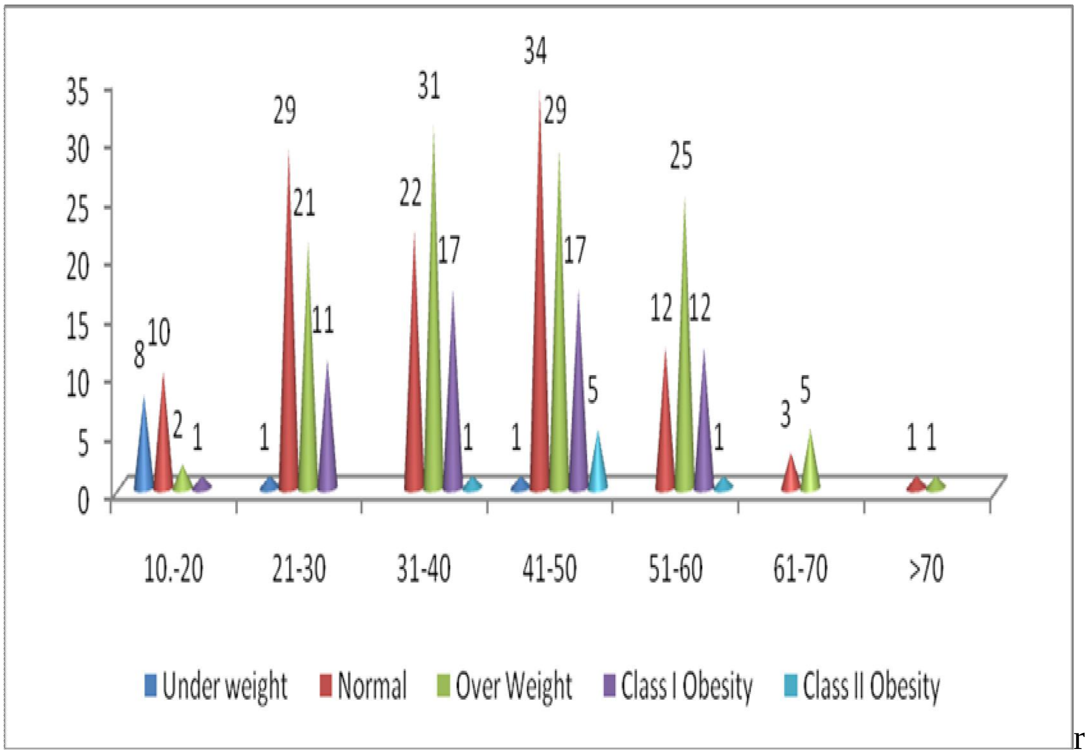
The Body mass index was classified by international BMI classification.Most of the people are either over weight or obese. The median BMI is over weight in our study area. Very few participants fall in class II and no one is in class III obese.

Table 4: Age Distribution over BMI

Age	Under weight	Normal	Over Weight	Class I Obesity	Class II Obesity	Total	Chi sq	p
10.-20	8 (80%)	10(9%)	2 (1.8%)	1 (1.7%)	0	21	10.9	**0.0001**
21-30	1 (10%)	29 (26.1%)	21 (18.4%)	11 (19%)	0	62		
31-40	0	22 (19.8%)	31 (27.2%)	17 (29.3%)	1 (14.3%)	71		
41-50	1 (10%)	34 (30.6%)	29 (25.4%)	17 (29.3%)	5 (71.4%)	86		
51-60	0	12 (10.8%)	25 (21.9%)	12 (20.7%)	1(14.3%)	50		
61-70	0	3 (2.7%)	5 (4.4%)	0	0	8		
>70	0	1 (0.9%)	1 (.9%)	0	0	2		
Total	10	111	114	58	7	300		

This study shows that 14% of people are overweight or obese in 11 - 20 years age group whereas it increased to 76% in 51 - 60 age groups respectively thus indicating that as age increases people tend to become overweight or obese . The association between the variables are found by chi sq = 10.9 with p = 0.0001 which is significant.

Graph1 : Age Distribution over BMI



r

This graph also shows that as age increases more and more people are becoming overweight or obese. The association between the variables are found by chi sq = 10.9 with p = 0.0001 which is significant.

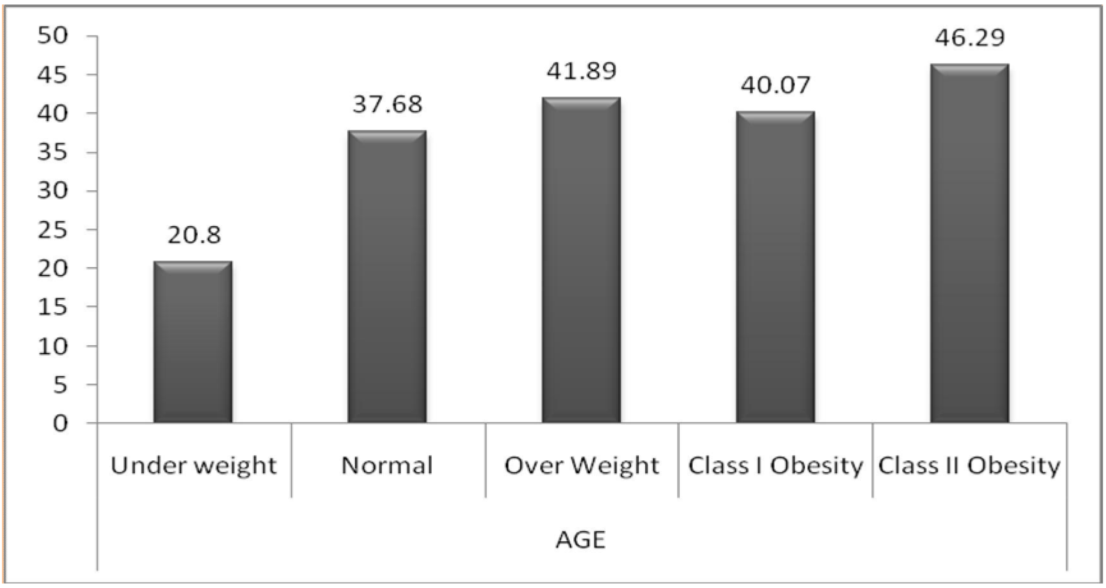
Table 5: Mean Age Distribution across BMI

AGE	No.	Mean Age	Std. Deviation	F	Sig.
Under weight	10	20.8	8.443	8.836	**0.0001**
Normal	111	37.68	12.669		
Over Weight	114	41.89	11.918		
Class I Obesity	58	40.07	10.052		
Class II Obesity	7	46.29	8.46		
Total	300	39.38	12.322		

This table shows that as age increases people tend to become overweight or obese. The Mean age of the underweight is 20.8 years and it increased to 46.29 years in Class II Obesity.

This classification found significance by one way ANOVA F = 8.836, P = 0.0001

Graph 2: Mean Value of Age across BMI



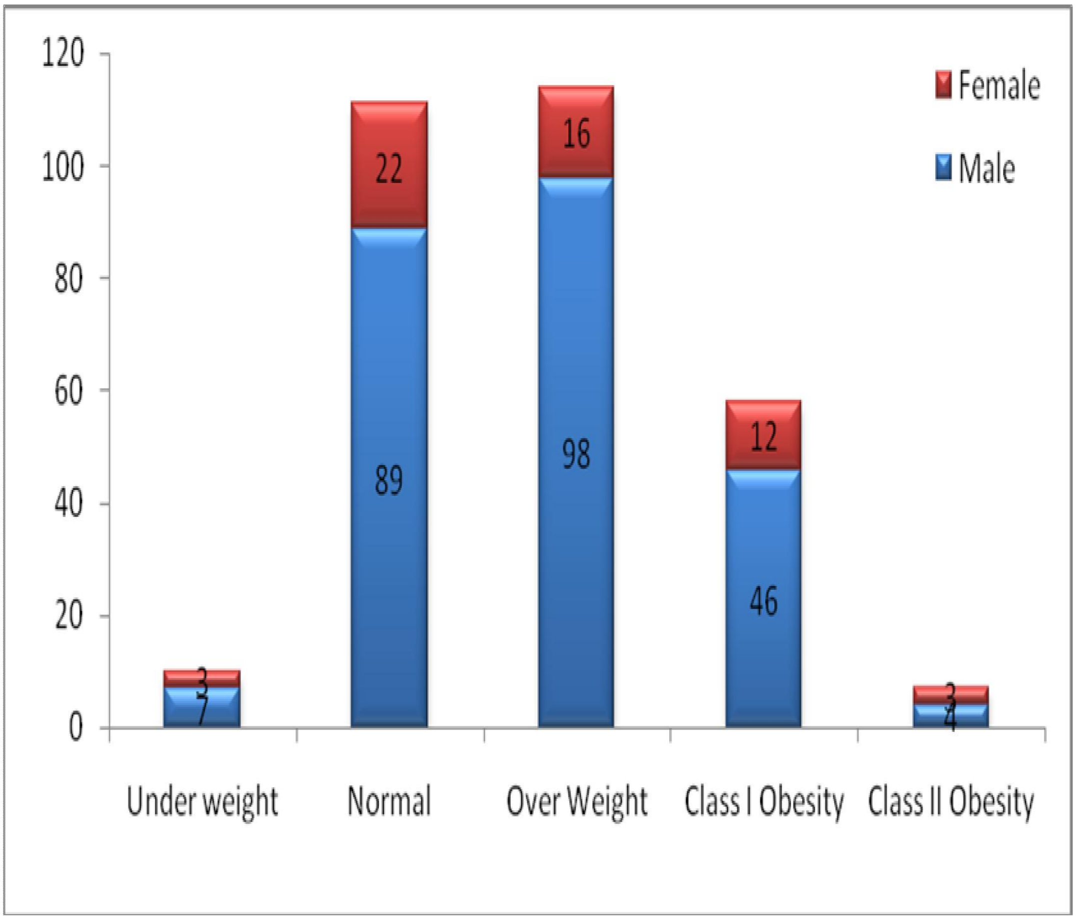
This graph describes the mean age of participants in each BMI category. The Mean age of the underweight is 20.8 years and it increased to 46.29 years in Class II Obesity. This classification found significance by one way ANOVA F = 8.836, P = 0.0001

Table 6: Sex distribution over BMI

Sex	Under weight	Normal	Over Weight	Class I Obesity	Class II Obesity	Total	Chi sq	p
Male	7 (70%)	89 (80.2%)	98 (86%)	46 (79.3%)	4 (57.1%)	244	5.4	0.2
Female	3 (30%)	22 (19.8%)	16 (14%)	12 (20.7%)	3 (42.9%)	56		
Total	10	111	114	58	7	300		

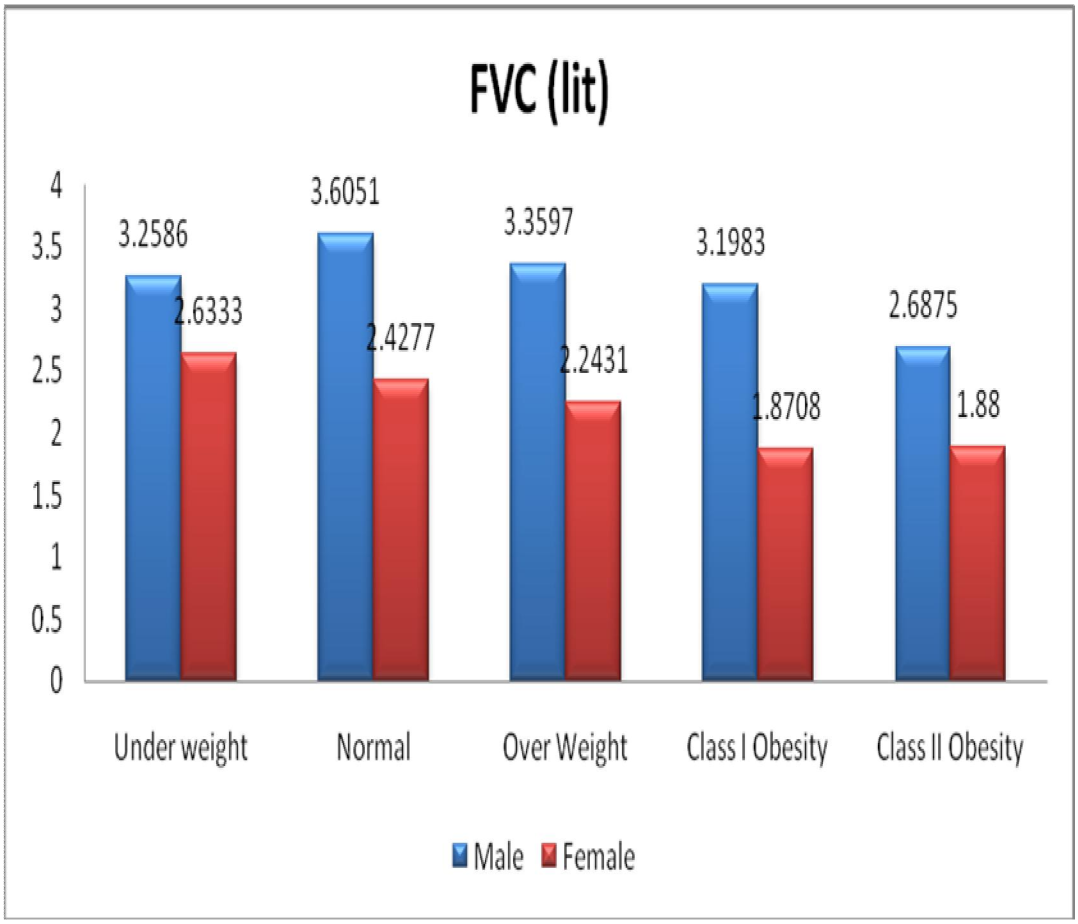
There is no significant difference in BMI between male and female participants. The chi sq value 5.4, p = 0.2

Graph 3: Sex Distribution



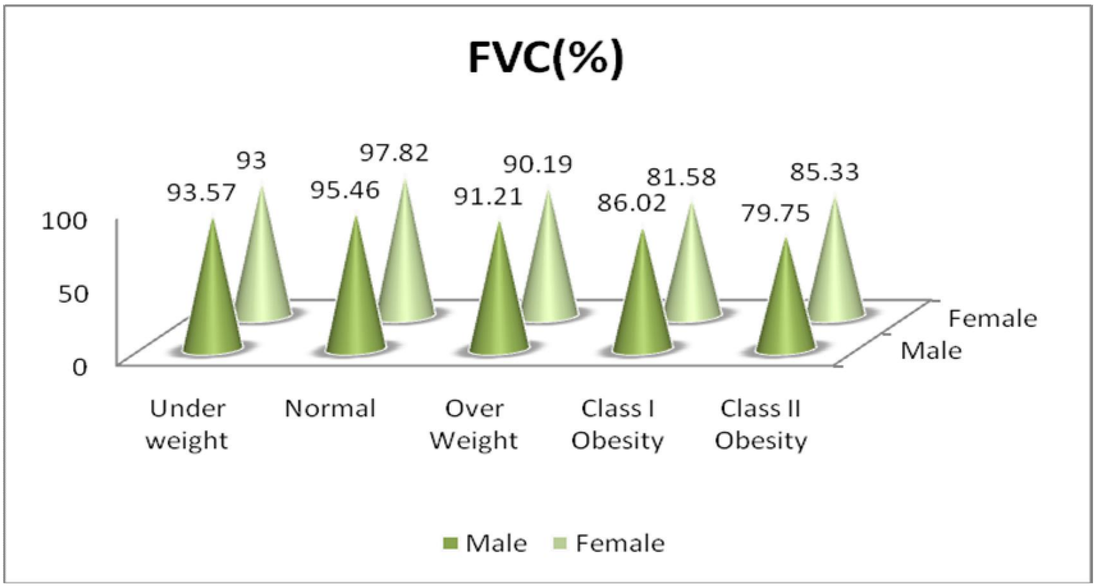
This Table shows that there is no significant difference in BMI between male and female participants. The chi sq value 5.4, p = 0.2

Graph 4 : Mean value of FVC in Litres across sex distribution

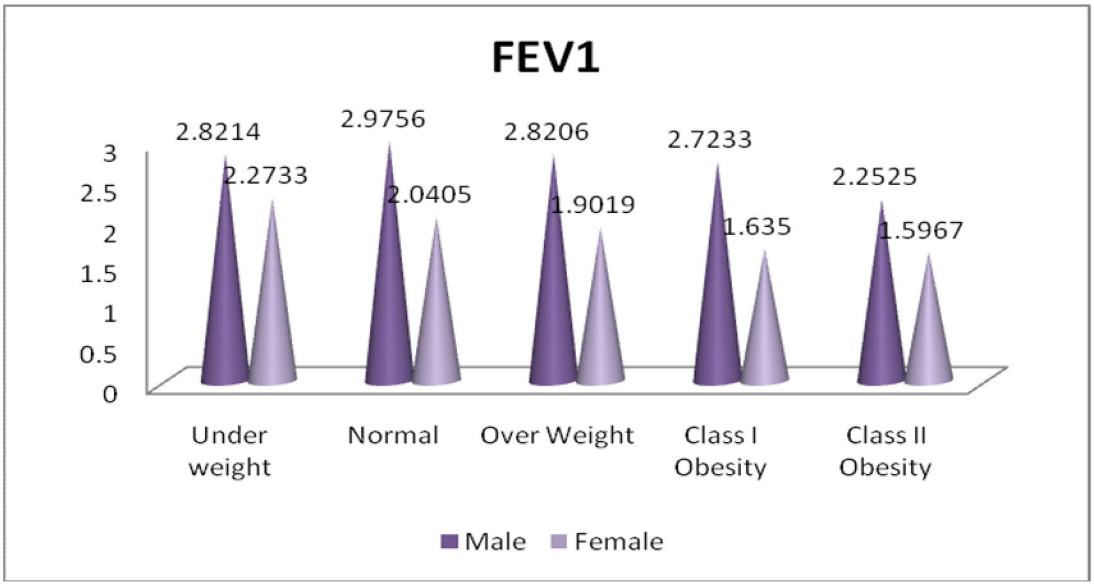


This graph shows that the absolute values of mean FVC is significantly high in Males in each BMI group.

Graph 5 : Mean value of FVC % across sex distribution

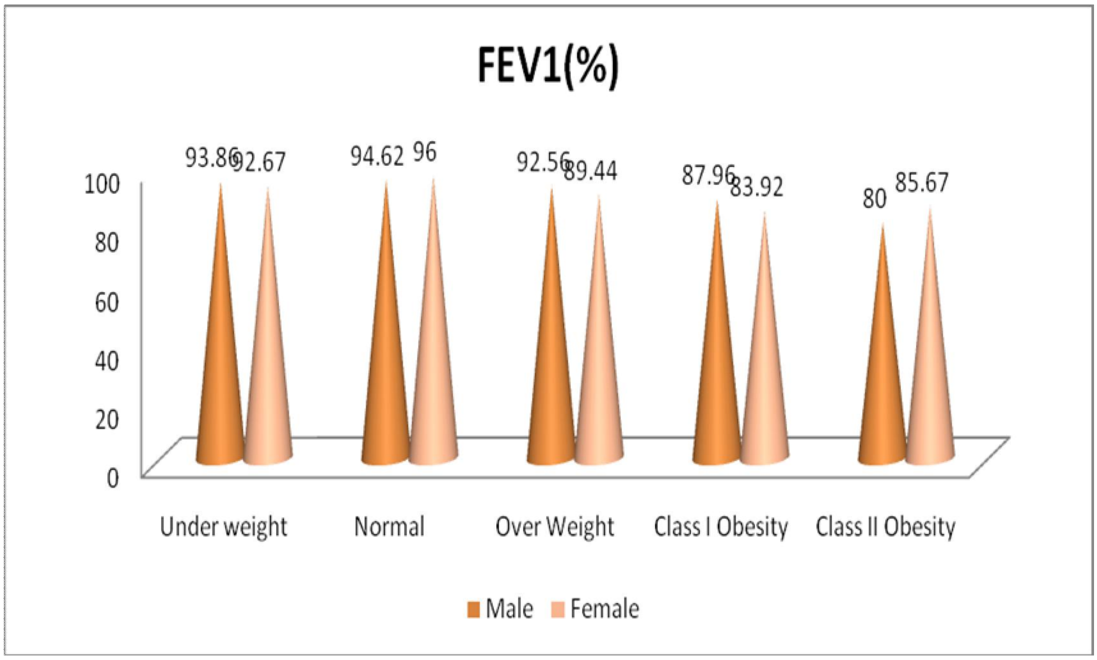


Graph 6 : Mean value of FEV1 in Litres across sex distribution



This graph shows that the absolute values of mean FEV1 is significantly high in Males in each BMI group

Graph 7 : Mean value of FEV1 % across sex distribution



Graph 8 : Mean value of FEV1 / FVC % across sex distribution

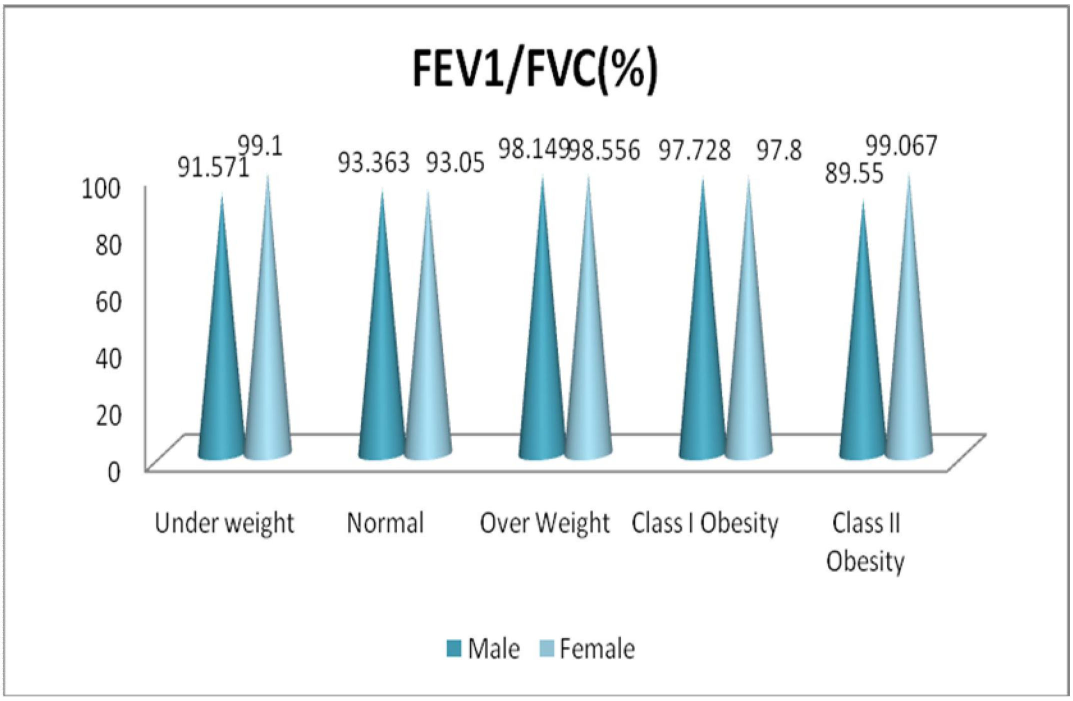
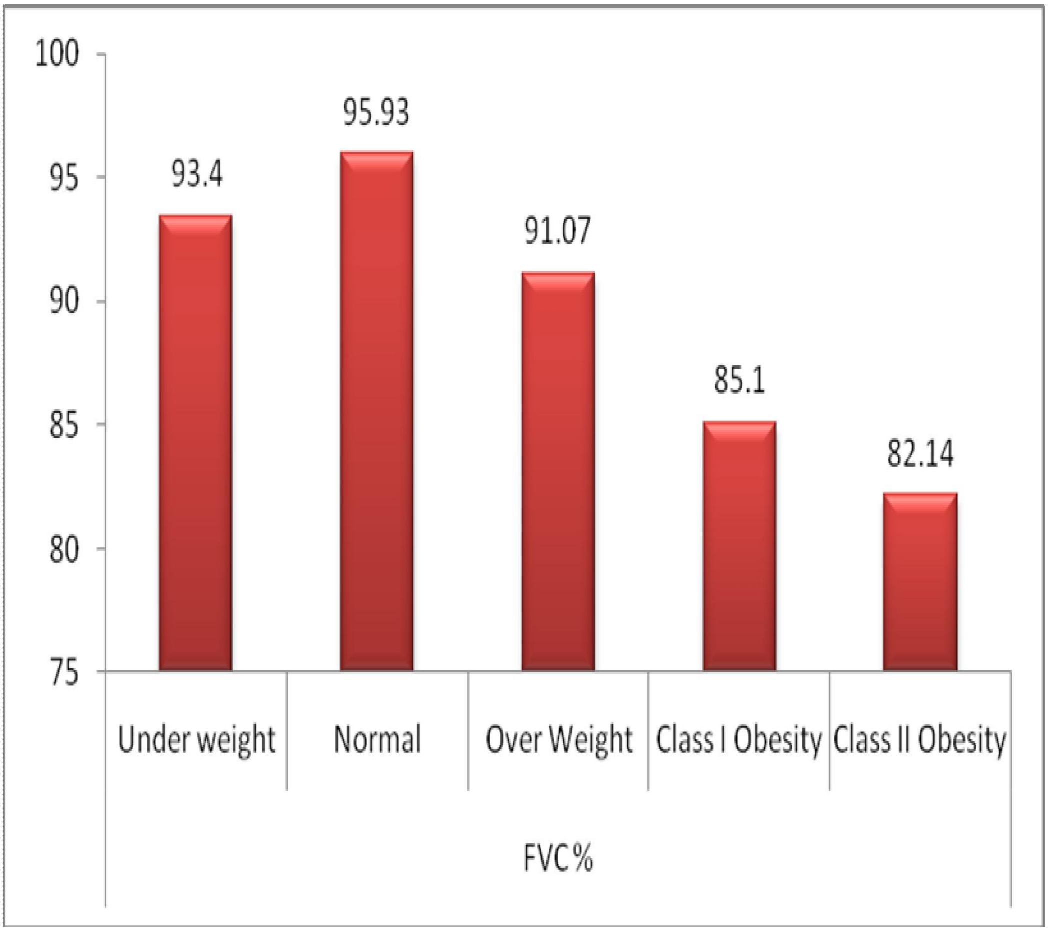


Table 7 : Mean Distribution of FVC (%) across BMI

FVC %	N	Mean	Std. Deviation	F	Sig.
Under weight	10	93.4	8.796	11.906	**0.0001**
Normal	111	95.93	10.031		
Over Weight	114	91.07	9.585		
Class I Obesity	58	85.1	12.02		
Class II Obesity	7	82.14	17.967		
Total	300	91.58	11.204		

This Table describes that the normal group mean value of FVC (%) ranges from 95.93 ± 10.03 and it is decreasing up to 10% to 12% when they become obese. Obese participants (BMI > 30 kg/m2) have significantly lower values of FVC% when compared to participants of normal BMI < 25 kg/m2 (Obese class I : 85.1 +_ 12 and Obese class II : 77.8 +_15.2 vs Normal: 95.9+_ 10). The significant difference calculated by using One Way ANOVA F = 11.9 with p = 0.0001.

Graph 9 : Bar diagram Mean Distribution of FVC (%) across BMI



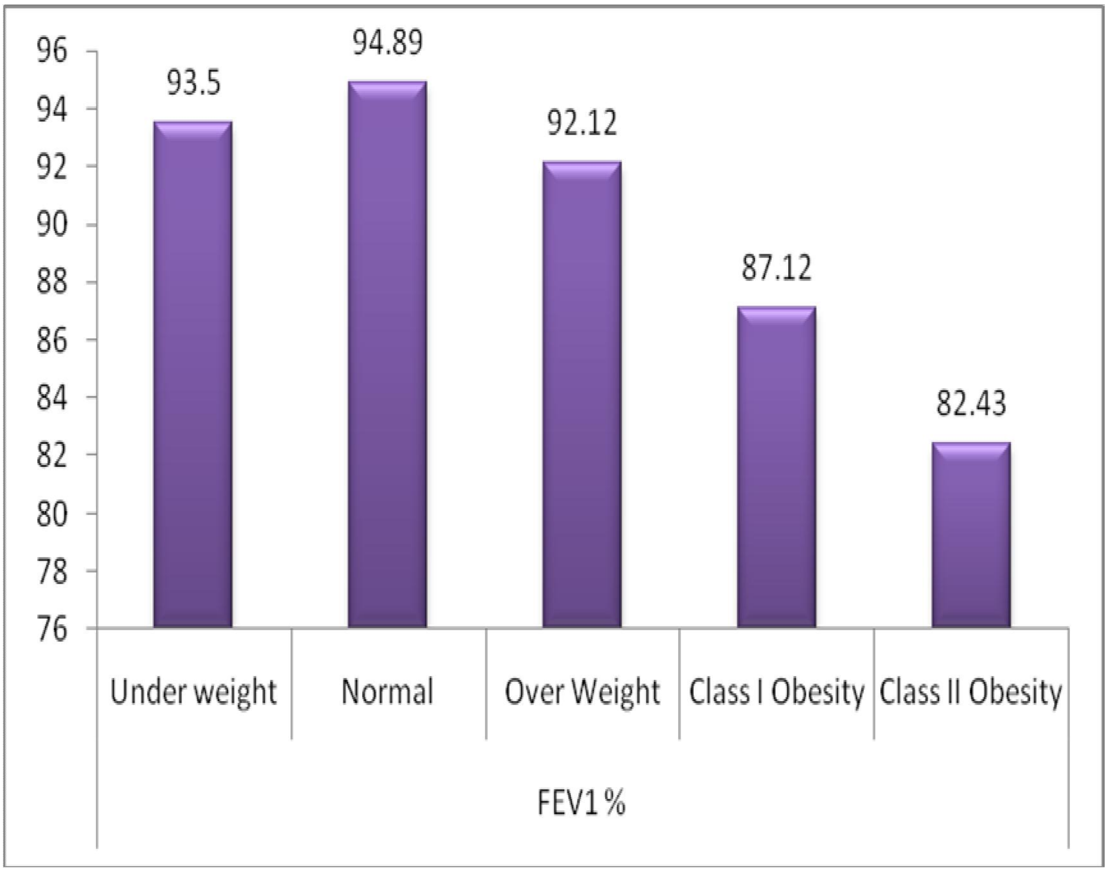
This graph describes that the normal group mean value of FVC (%) ranges from 95.93 ± 10.03 and it is decreasing up to 10% to 12% when they become obese. Obese participants (BMI > 30 kg/m2) have significantly lower values of FVC% when compared to participants of normal BMI < 25 kg/m2 (Obese class I : 85.1 +_ 12 and Obese class II : 77.8 +_15.2 vs Normal: 95.9+_ 10). The significant difference calculated by using One Way ANOVA F = 11.9 with p = 0.0001.

Table 8 : Mean Distribution of FEV1 (%) across BMI

FEV1 %	**N**	**Mean**	**Std. Deviation**	**F**	**Sig.**
Under weight	10	93.5	9.419	6.464	**0.0001**
Normal	111	94.89	10.891		
Over Weight	114	92.12	9.708		
Class I Obesity	58	87.12	11.792		
Class II Obesity	7	82.43	15.884		
Total	300	92	11.111		

This table describes that the normal group mean value of FEV1 (%) ranges from 94.89 ± 10.89 and it is decreasing up to 7% to 10% when they become obese. Obese participants (BMI > 30 kg/m2) have significantly lower values of FEV1% when compared to participants of normal BMI < 25 kg/m2 (Obese class I : 87.1 +_11.8 and Obese class II: 78.7 +_13.6 vs Normal: 94.9 +_10.9). The significant difference calculated by using One Way ANOVA F = 6.46 with p = 0.0001.

Graph 10 : Bar diagram Mean Distribution of FEV1 (%) across BMI



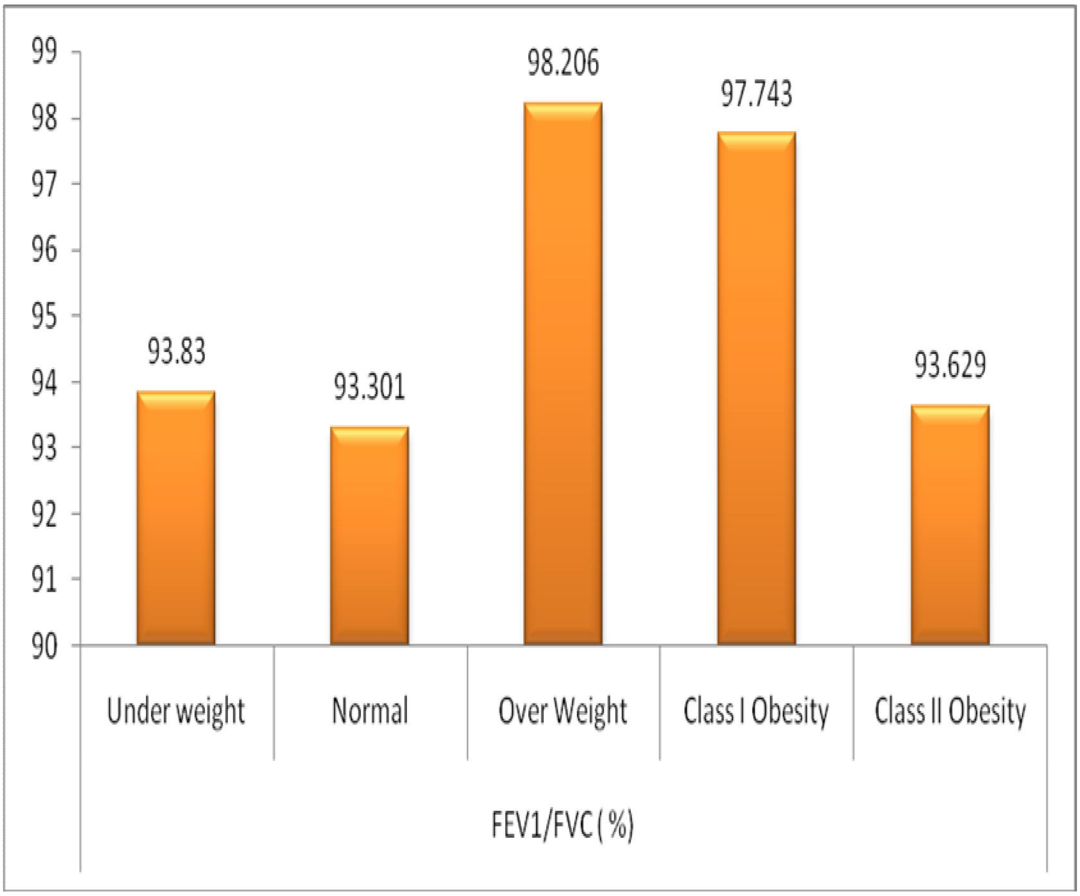
This graph describes that the normal group mean value of FEV1 (%) ranges from 94.89 ± 10.89 and it is decreasing up to 7% to 10% when they become obese. Obese participants (BMI > 30 kg/m2) have significantly lower values of FEV1% when compared to participants of normal BMI < 25 kg/m2 (Obese class I : 87.1 +_11.8 and Obese class II: 78.7 +_13.6 vs Normal: 94.9 +_10.9). The significant difference calculated by using One Way ANOVA F = 6.46 with p = 0.0001.

Table 9: Mean Distribution of FEV1/FVC (%) across BMI

FEV1/FVC (%)	N	Mean	Std. Deviation	F	Sig.
Under weight	10	93.83	12.4336	3.104	**0.016**
Normal	111	93.301	11.2256		
Over Weight	114	98.206	11.3803		
Class I Obesity	58	97.743	11.9203		
Class II Obesity	7	93.629	10.3019		
Total	300	96.049	11.6023		

This graph describes that the normal group mean value of FEV1/FVC (%) ranges from 93.3 ± 11.23 and it is increasing up to 4% to 5% when they become obese. The significant difference calculated by using One Way ANOVA F = 3.104 with p = 0.016.

Graph 11 : Bar Diagram Mean Distribution of FEV1/FVC (%) across BMI



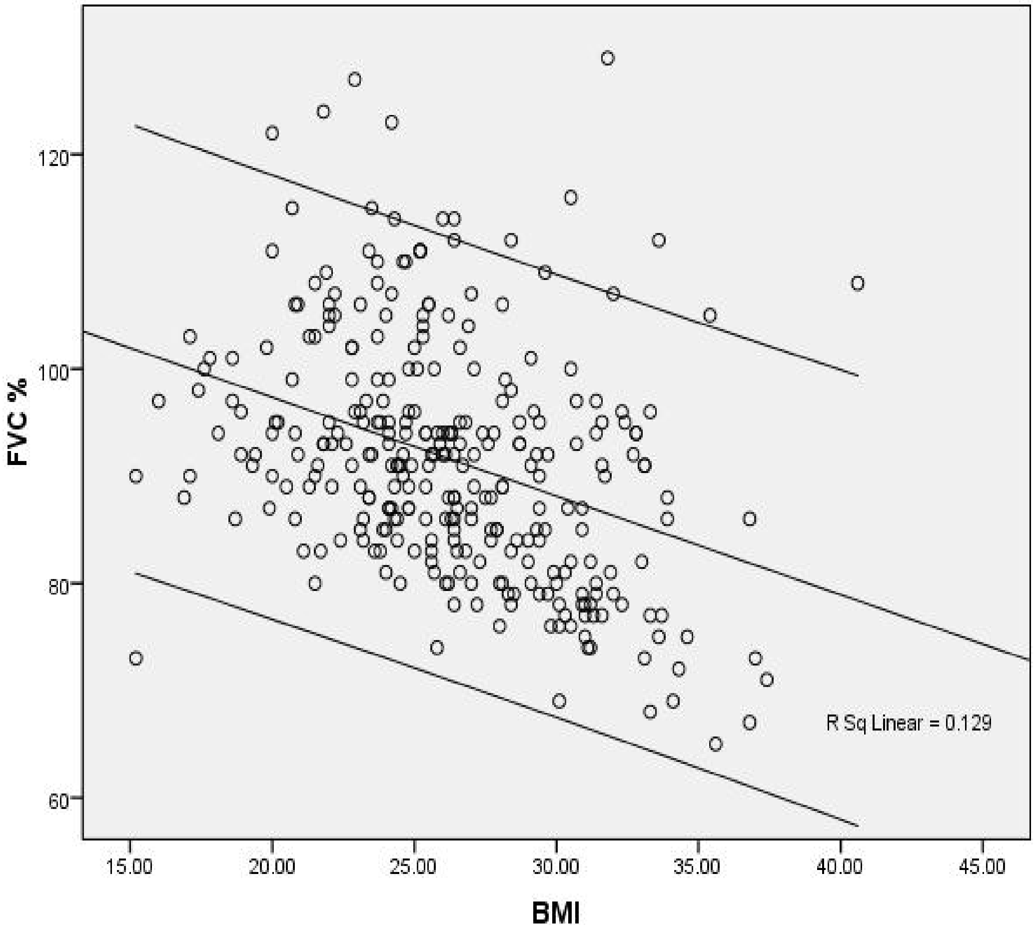
This graph describes that the normal group mean value of FEV1/FVC (%) ranges from 93.3 $\pm$ 11.23 and it is increasing up to 4% to 5% when they become obese. The significant difference calculated by using One Way ANOVA F = 3.104 with p = 0.016.

Table 10 : Correlation with BMI

BMI	Correlation	p value
Age	24.40%	**0.001**
FVC(%)	-36%	**0.001**
FEV1(%)	-25.30%	**0.001**
FEV1/FVC (%)	16.70%	**0.004**

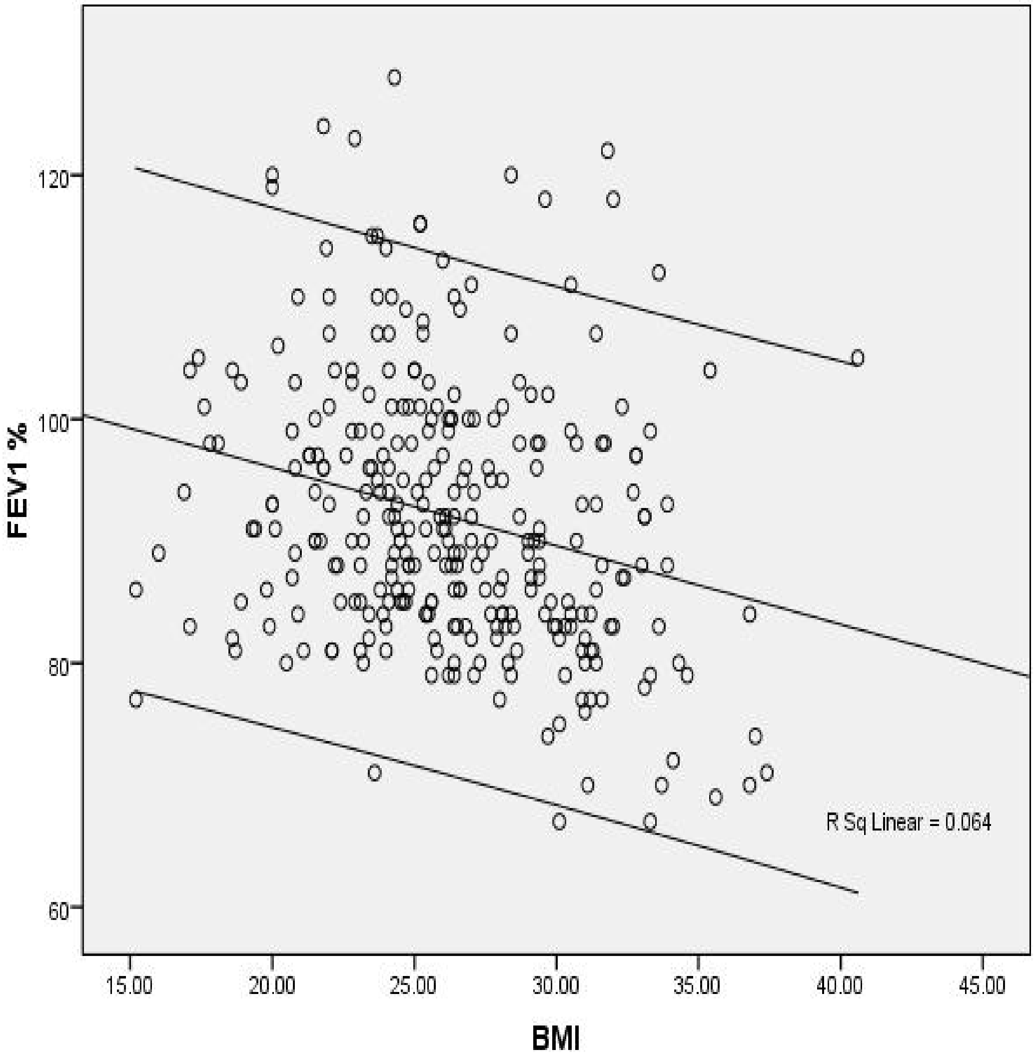
To find the relationship between two continuous variables pearson correlation coefficient are used at 5% level of significance. Table 10 shows that there is 24.4% positive correlation between age and BMI as age increases people are tend become obese,p = 0.001. there is 36% negative correlation between FVC (%) with BMI, That implies that as BMI increases the percentage of FVC tend to decrease, p = 0.001. same way there is 25.3% negative correlation between FEV1(%) with p = 0.001. but the ration of FEV1/FVC(%) were tend to increase as BMI increases there is 16.7% slight positive correlation explained in this study with p = 0.004.

Graph 12 : Scatter diagram of BMI with FVC(%)



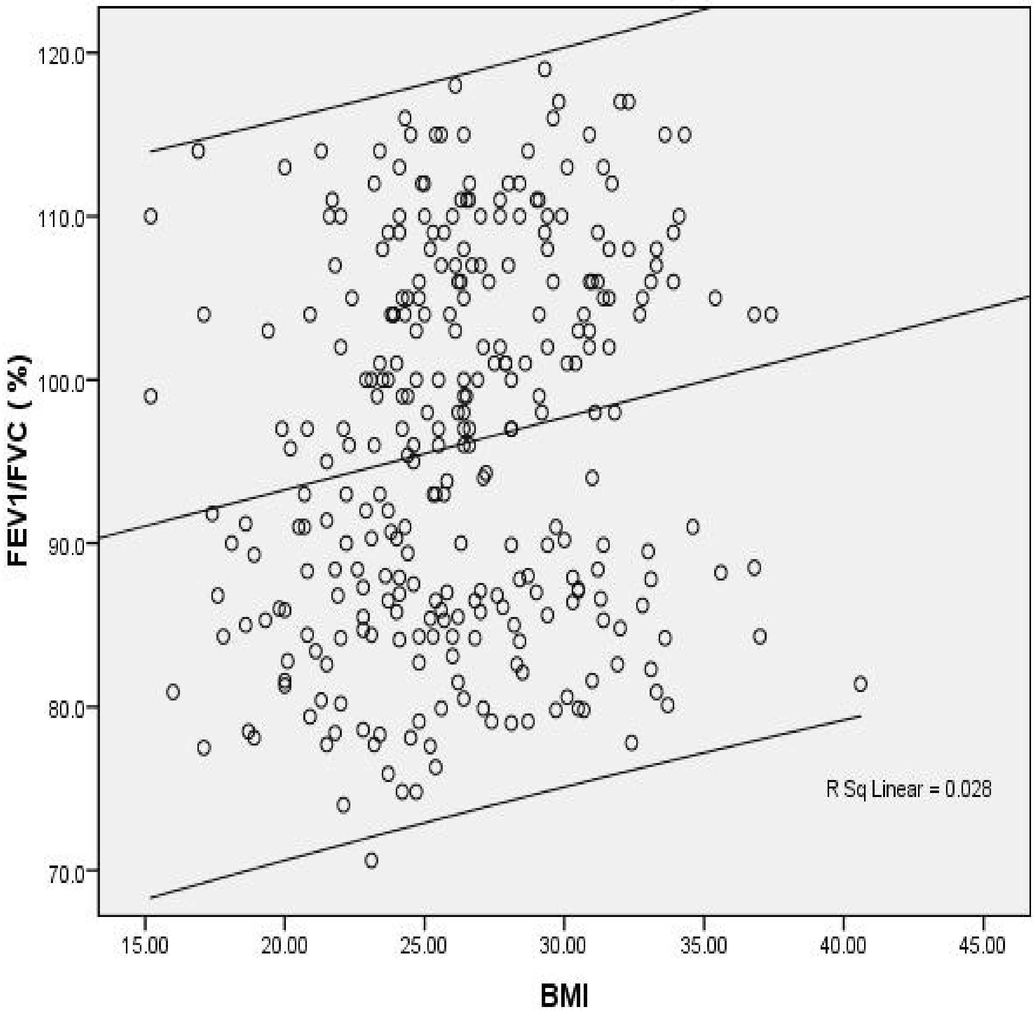
This graph explains that there is negative correlation with BMI and FVC (%). As BMI Increase FVC decrease. The line explains the linear relationship with 95% confidence interval.

Graph 13 : Scatter diagram of BMI with FEV1(%)



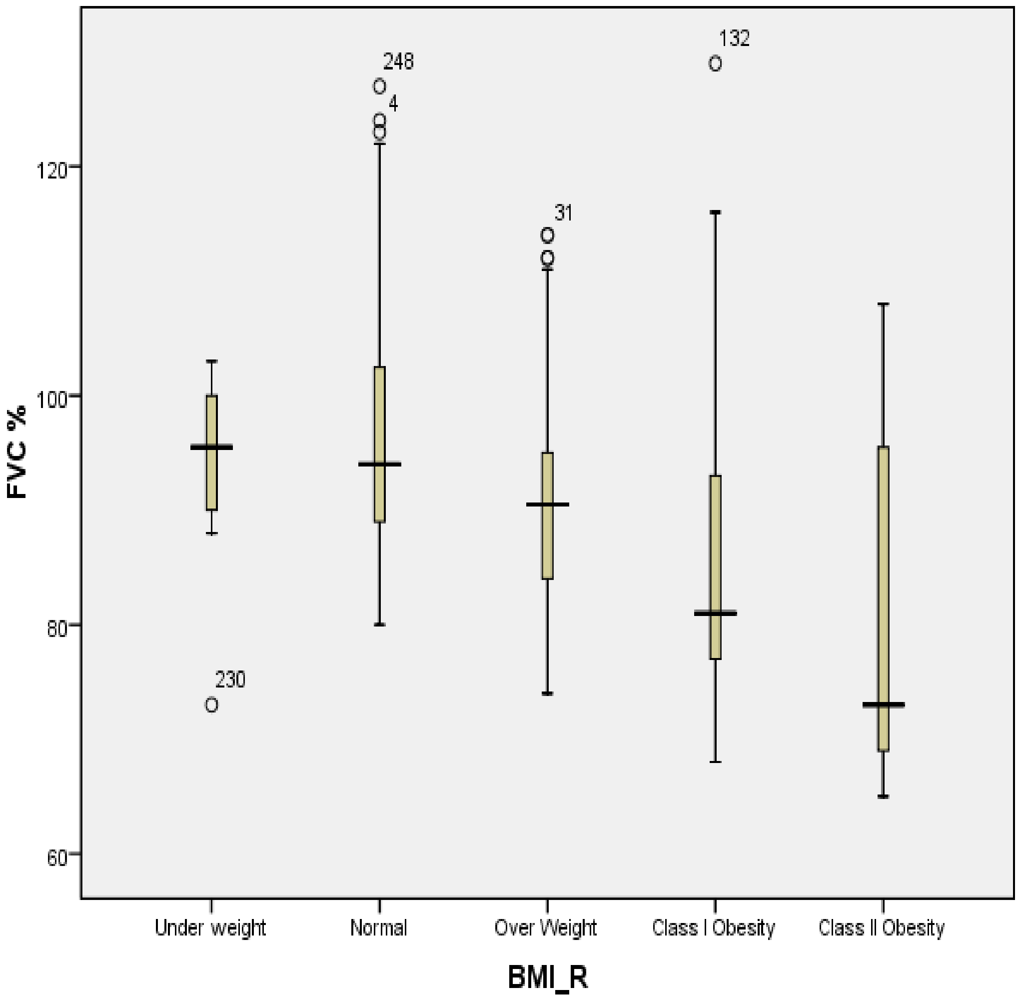
This graph explains that there is negative correlation with BMI and FEV1 (%). As BMI Increase FEV1 decrease. The line explains the linear relationship with 95% confidence interval.

Graph 14 : Scatter diagram of BMI with FEV1/FVC(%)



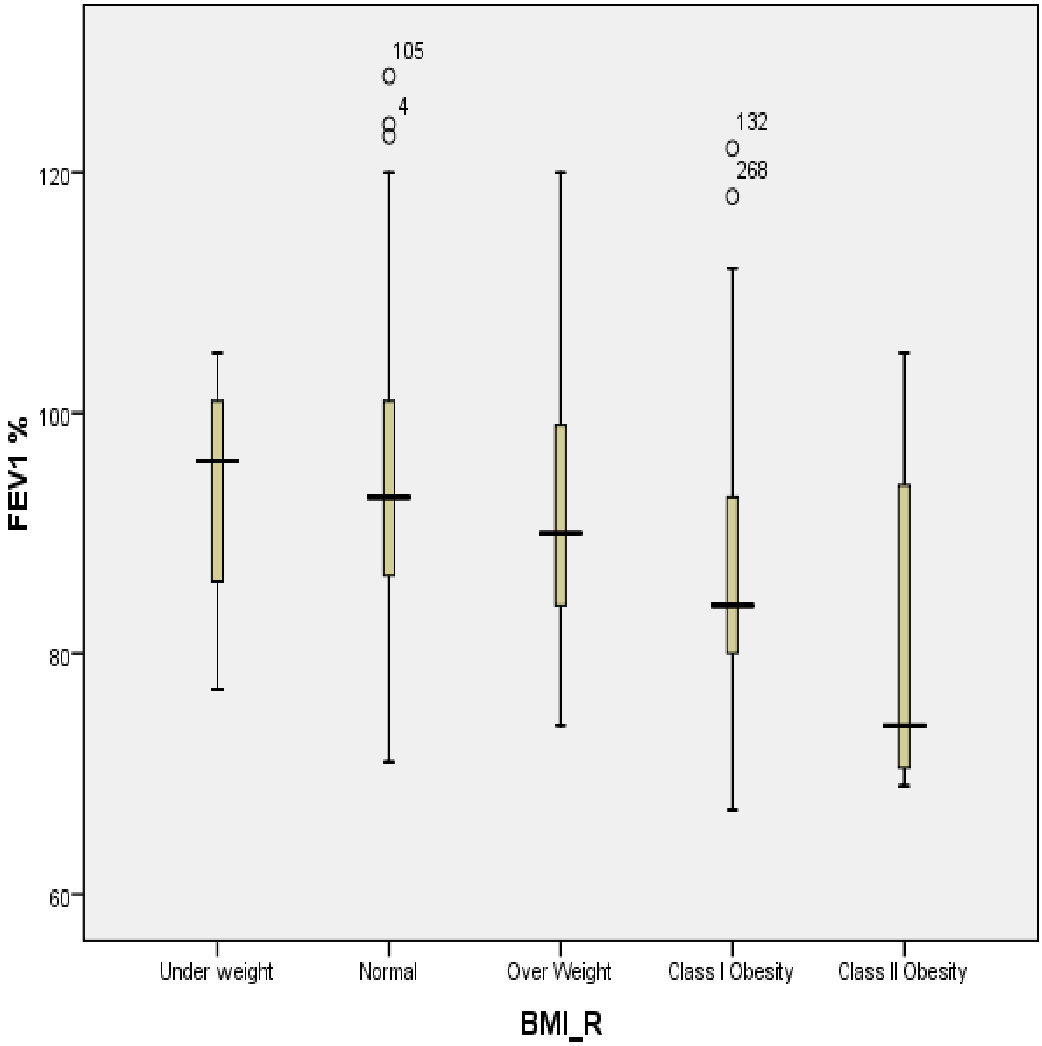
This graph explains that there is positive correlation with BMI and FEV1/FVC (%). As BMI Increase FEV1/FVC (%) increase. The line explains the linear relationship with 95% confidence interval

Graph 15 : Box plot of BMI classification with FVC(%)



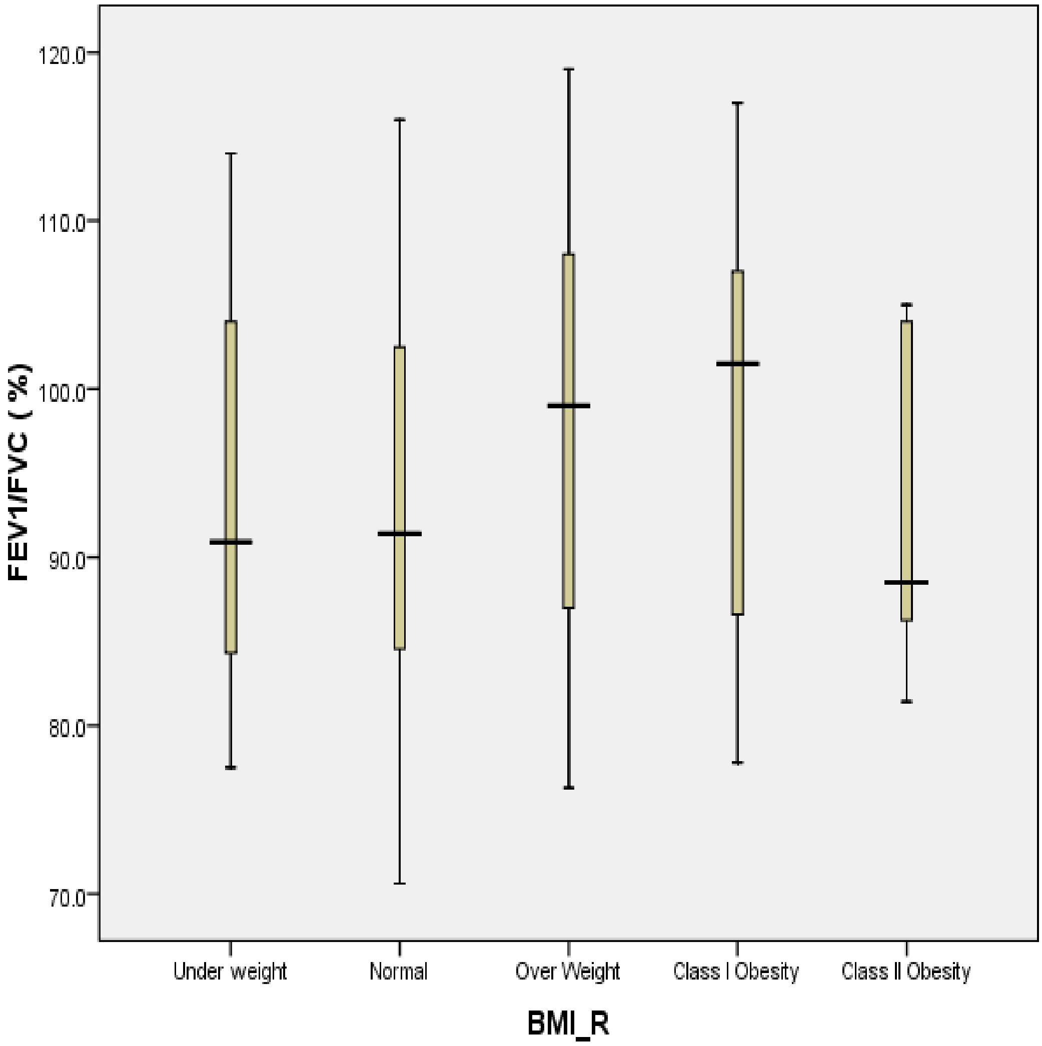
This graph explains the descriptive statistics for each BMI classification across FVC (%)

Graph 16 : Box plot of BMI classification with FEV1(%)



This graph explains the descriptive statistics for each BMI classification across FEV1 (%)

Graph 17 : Box plot of BMI classification with FEV1/FVC(%)



This graph explains the descriptive statistics for each BMI classification across FEV1/FVC (%)

DISCUSSION

1. Prevalence of Obesity:

In our study sample of 300, nearly 60% of the participants are either overweight or obese.This study shows that the problem of obesity in is increasing in India[66] .The results of the study conducted by C.S.Yajnik et al[67] on obesity in India and National Family Health Survey 2005-2006 showed that Obesity has reached epidemic proportion in India in this 21st century(A,B).Our study also shows similar results.This problem is due to the easy access to the unhealthy high caloric processed food , increase in the middle class group following globalisation and sedentary life style.

2. Age and BMI :

Our study shows that as age increases BMI also increases[68].In this study 14% of people are overweight or obese in 11 - 20 years age group whereas it increased to 51% and to 76% in 21 – 30 and 51 - 60 age groups respectively. Body weight increased with age . The increase in body weight and BMI with age has also been reported by Kapoor and Tyagi [69] and Tandon [70] in studies conducted in India.

Increase in body weight in middle age may be due to the accumulation of fat with age as these subjects have larger appetite leading to increased energy intake, fat-rich diet, and relatively less energy expenditure due to lesser involvement in physical activities due to other family and professional commitments.

3. BMI and Gender

Our study shows that there is no significant difference in distribution of BMI between male and female .This is in contrast to the earlier studies. Lovejoy et al[71] reported that Obesity prevalence is generally higher in women than in men, and there is also a sex difference in body fat distribution.The prevalence of overweight and obesity among men and women varies greatly within and between countries, and overall, more women are obese than men. These gender disparities in overweight and obesity are exacerbated among women in developing countries. Sex differences in obesity can be explained in part by the influence of gonadal steroids on body composition and appetite; however, behavioural, socio-cultural and chromosomal factors may also play a role.

In contrast to the above studies our study do not show significant difference in distribution of BMI among male and and female population.However the percentage females participated in our study is very less ,only 18.7%.Probably studies with bigger sample of females may show more light on these ststistics.

4. Dynamic Lung functions and BMI :

Our study reports the findings of strong inverse association between obesity and lung volumes and the details are as follows:

Our study shows clearly that **Obese participants have**

A. **Significantly lower values of FVC%** than participants of Normal BMI

B. **Significantly lower values of FEV1%** than participants of Normal BMI

C. Significantly **high ratio of FEV1/FVC (%)** than participants of Normal BMI.

The above findings of decrease in FVC % and FEV1 % in obese participants are consistent with those of some investigators who have shown that lung volumes are significantly lower among subjects in higher BMI groups.

These findings are comparable with the study conducted by Sohail Attaur-Rasool et al in Pakistan[72]. Moreover these results are consistent with results reported by Steele *et al.* [73]from proactive trial in British adults having family history of T2DM as well as by Morsi[82] who studied Saudi adults with varying degree of asthma and they reported negative correlation of BMI with FVC % and FEV1 % .8,21

Studying the same association, Al-Badr *et al*[74]. reported significant inverse association between BMI and both FVC% and FEV1% in obese subjects only.

However the presence of differences in Lung function among BMI categories in our study differ from some others studies. Costa *et al*[75] reported no significant difference of FVC%, FEV1% and FEV1/FVC among obese and non-obese females in Brazil. Chen *et al*[76] detected positive association of BMI with FVC and FEV1 in normal weight Canadians but negative association among overweight and obese subjects. Rasslan *et* al[77] found no significant correlation between pulmonary function and BMI among a sample of Brazilians. Moreover, Koziel *et al*[78] reported positive association of BMI with lung function among both males and females in Poland.

D. Our study shows that **gender** has **no effect on mean values of FVC% and FEV1%** .

This is is comparable with the earlier study done by Sohail Attaur-Rasool et al in Pakistani population

No gender differences of baseline pulmonary function found among these participants may be due to smaller sample size of females in our study and analysis of pulmonary function variables as percentage of predicted value.It is important to note that lung volumes reported as percentage of predicted value are a linear variable related to lung compliance. The proposed added advantage of using percent predicted values of lung function is a possible adjustment for the effects of age and gender on measured lung volumes in litres, which are affected by an individual's gender and age .

E. However our study shows that **the mean absolute value** of FVC in litr is significantly higher in Males .

This result is comparable with the results of the earlier studies done by Harik-Khan RI et al[79] and by Sohail Attaur-Rasool et[80] al in United Kingdom and Pakistan respectively. This gender difference in absolute raw values reported is likely to be attributed to the fact that men tend to have bigger lungs for same height when compared with females.Muscularity in men is another contributing factor to higher values of pulmonary function among men. Observing the same phenomenon, Osch-Balcom *et* ai[81] reported that raw values of FVC and FEV1 were higher in men.

Association of BMI with Lung function is very diverse and complicated as reported by various researchers across various populations. Thus the exact nature of difference of Lung functions among subjects of varius BMI groups and gender in different ethnic groups have been difficult to interpret. But our study clearly shows that **Obesity and Dynamic Lung Functions are inversely associated .**

CONCLUSION

Our study conducted in the sample of population who comprised of apparently healthy individuals of above the age of 15 years, attending Master Health Check Up Op and attenders of inpatients of wards of general medicine department,Govt. Chengalpattu Medical College, Chengalpattu reports the findings that increasing BMI is strongly associated with decreased lung volumes. Larger epidemiological studies in future may help further elucidate these relationships.

By understanding the correlation between the dynamic lung volumes and the BMI we would be able to predict the longevity of the Respiratory capacity of a person. Since human productivity and lung capacity are directly related and obesity is the core issue of many health problems , this study can throw light in formulating a public health policy in preventing obesity.

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PROFORMA

DEMOGRAPHIC DATA OF THE PATIENT:

Name: OP No:

Age: Case Serial No:

Sex:

Address:

Occupation:

HISTORY OF PRESENTING COMPLAINTS:

Cough/ Cold/ Wheezing

Difficulty In Breathing/ /Chest pain / Fever

Oliguria/Dysuria/Nocturia/Haematuria

Nausea/Vomiting/Diarrhoea

Bilateral Swelling Of Legs/ Facial Puffiness

PAST HISTORY:

H/o Diabetes mellitus

H/o Hypertension

H/o CAD

H/o TB/ COPD/ Bronchial asthma/ Allergic rhinitis

PERSONAL HISTORY:

H/o Smoking

H/o Alcohol consumption

FAMILY HISTORY:

H/O / Atopy/ Bronchial Asthma

GENERAL PHYSICAL EXAMINATION:

Built/ Nutrition

Pallor/ Cyanosis/ Clubbing

Pedal Oedema/ Generalised Lymphadenopathy

Skin/ Nails/ Mucous membrane

VITAL SIGNS:

PR-	Height- m2
BP-	Weight-kg
RR-	BMI- kg/ m2
JVP-	

RESPIRATORY SYSTEM:

Inspection

Palpation

Percussion

Auscultation

CVS/ ABDOMINAL/ NERVOUS SYSTEM EXAMINATION:

INVESTIGATIONS:

CBC

RFT

LFT

ECG

USG- ABDOMEN

SPIROMETRY

KEY TO MASTER CHART

Kg	Kilogram
Cm	Centimeter
BMI	Body Mass Index
FVC	Forced Vital Capacity
Lit	Litre
FEV1	Forced Expiratory Volume in 1 Second
%	Percentage

MASTER CHART

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGH T (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
1	SIDHARTH	52	M	88	163	33.1	2.94	91	2.42	92	82.3
2	YOGA GANDHI	47	M	72	169	25.2	4.03	111	3.44	116	85.4
3	SENTHAMIL	35	F	79	151	34.6	1.88	75	1.71	79	91
4	SUBRAMANIAN	72	M	60	166	21.8	3.33	124	2.61	124	78.4
5	RAGUNATHAN	59	M	70	172	23.7	3.48	99	2.64	95	75.9
6	ABDUL RAHIM	73	M	82	174	27.1	2.98	92	2.38	94	79.9
7	DEEPAK	23	M	72	169	25.2	4.59	111	3.56	101	77.6
8	KUMAR	55	M	60	154	25.3	2.81	104	2.37	107	84.3
9	MUNUSAMY	60	M	71	164	26.4	2.41	78	1.94	79	80.5
10	AMUDHA	38	F	48	145	22.8	2.02	91	1.71	90	84.7
11	VALRMATHI	40	F	38	143	18.6	2.04	97	1.86	104	91.2
12	RAJA	38	M	60	163	22.6	3.28	93	2.9	97	88.4
13	SARAVANAN	30	M	65	160	25.4	3.37	94	2.57	84	76.3
14	RAKESH	24	M	104	176	33.6	5.01	112	4.22	112	84.2
15	MARIMUTHU	36	M	85	162	32.4	3.34	95	2.6	87	77.8
16	PRABHU	33	M	82	173	27.4	3.92	94	3.1	89	79.1
17	THENNARASU	33	M	58	162	22.1	3.35	93	2.48	81	74
18	SUDHA	32	F	73	165	26.8	2.6	83	2.25	83	86.5
19	SRINIVASAN	28	M	70	174	23.1	4.56	106	3.22	88	70.6
20	MANOJ KUMAR	28	M	77	160	30	2.87	80	2.59	83	90.2
21	ERSHAD AHAMED	30	M	60	167	21.5	4.03	103	3.13	94	77.7
22	VASUDEVAN	42	M	100	157	40.6	3.39	108	2.76	105	81.4

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGHT (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
23	RAJAKUMARI	39	F	70	152	30.3	1.9	77	1.67	79	87.9
24	MURUGANANTAM	40	M	91	176	29.4	3.28	79	2.95	87	89.9
25	LINGESHWARAN	40	M	82	175	26.8	3.87	95	3.26	96	84.2
26	SARAVANAN	44	M	85	168	30.1	2.52	69	2.03	67	80.6
27	BALARAMAN	42	M	92	173	30.7	3.66	93	2.92	90	79.8
28	BALAMUGUNTHAN	40	M	85	173	28.4	3.31	83	2.78	84	84
29	ELUMALAI	52	M	90	168	31.9	2.81	81	2.32	83	82.6
30	GOVINDARAJAN	37	M	70	168	24.8	3.3	87	2.73	86	82.7
31	DHANRAJ	35	M	75	170	26	4.49	114	3.73	113	83.1
32	JAYAGOPAL	43	M	85	172	28.7	3.69	95	2.92	92	79.1
33	MARIYAPPAN	45	M	70	172	23.7	4.15	108	3.59	115	86.5
34	RAVIVARMAN	48	M	80	168	28.3	2.81	79	2.32	80	82.6
35	JAYAKUMAR	36	M	93	168	33	3.14	82	2.81	88	89.5
36	VELAVAN	35	M	78	178	24.6	3.93	90	3.44	95	87.5
37	JAYANTHI	32	F	71	158	28.4	2.22	78	1.95	79	87.8
38	NARAYANAN	41	M	62	170	21.5	3.45	90	2.85	90	82.6
39	SATHISH	19	M	95	174	31.4	3.47	79	2.96	80	85.3
40	THIYAGARAJAN	57	M	81	159	32	2.3	79	1.95	83	84.8
41	PONRAM	20	M	56	175	18.9	4.07	92	3.18	85	78.1
42	PUNITHA	60	F	78	148	35.6	1.19	65	1.05	69	88.2
43	RAJAPPAN	57	M	82	164	30.5	2.4	76	2.09	83	87.1
44	AKILA	36	F	58	155	24.1	2.51	95	2.18	96	86.9
45	MANIKANDAN	28	M	82	183	24.5	4.33	91	3.38	85	78.1
46	VIJAYA	26	F	62	164	23.1	3.08	96	2.78	99	90.3

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGHT (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
47	VINODHINI	20	F	40	150	17.8	2.74	101	2.31	98	84.3
48	GANESH	29	M	104	178	32.8	4.21	94	3.63	97	86.2
49	RAJARAMAN	45	M	90	165	33.1	2.55	73	2.24	78	87.8
50	LOKESH	23	M	65	162	24.8	3.63	96	2.87	88	79.1
51	SARITHA	37	F	59	168	20.9	2.87	92	2.28	84	79.4
52	RAMAJAYAM	40	M	62	160	24.2	4.12	123	3.08	110	74.8
53	HARIKRISHNAN	35	M	60	160	23.4	3.82	111	2.99	102	78.3
54	DHANDAPANI	32	M	104	168	36.8	2.62	67	2.32	70	88.5
55	RAJENDRAN	59	M	66	160	25.8	2.16	74	1.88	81	87
56	PUNITHA	38	F	60	152	26	2.3	92	1.94	91	84.3
57	KIRUBAKARAN	44	M	73	173	24.4	3.28	84	3.13	98	95.4
58	SATHISHKUMAR	44	M	66	166	24	3.71	105	3.35	114	90.3
59	DURAI RAJ	43	M	65	162	24.8	3.38	100	2.85	101	84.3
60	KISHOREKUMAR	20	M	47	161	18.1	3.5	94	3.15	98	90
61	VEERACHOLAN	40	M	83	165	30.5	4.17	116	3.33	111	79.9
62	SASIKALA DEVI	52	F	70	152	30.3	1.76	81	1.52	83	86.4
63	THANUPILLAI	63	M	50	155	20.8	2.22	86	1.96	96	88.3
64	SIVAKUMAR	17	M	45	161	17.4	3.3	98	3.03	105	91.8
65	KAVITHA JAYARAMAN	34	F	80	154	33.7	2.03	77	1.61	70	80.1
66	SARALA	43	F	58	145	27.6	1.97	93	1.71	96	86.8
67	VADIVEL	48	M	65	169	22.8	3.7	102	2.91	99	78.6
68	SRILAKSHMI GAYATHIRI	14	F	63	163	23.7	2.74	95	2.52	99	92
69	ARUL	42	M	60	173	20	3.7	94	3.02	93	81.6
70	VELU	63	M	73	160	28.5	2.24	79	1.84	83	82.1

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGH T (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
71	VISHNUVARDHAN	30	M	74	170	25.6	3.41	84	2.93	85	85.9
72	VIJAYA	57	F	61	155	25.4	1.93	89	1.67	91	86.5
73	JAYANTHI	50	F	51	145	24.3	1.66	86	1.51	92	91
74	SIVAPUSHPAM	51	F	43	140	21.9	1.89	109	1.64	114	86.8
75	AKASH	20	M	49	167	17.6	4.01	100	3.48	101	86.8
76	ISMOIL	21	M	87	167	31	3.01	75	2.83	82	94
77	KAREEM	42	M	82	167	29.4	3.47	95	2.97	98	85.6
78	MURUGAN	54	M	67	170	23.2	3.36	95	2.61	92	77.7
79	VASUDEVAN	41	M	51	165	18.7	3.07	86	2.41	81	78.5
80	VIJAY	17	M	65	148	29.7	2.13	79	1.7	74	79.8
81	SOLOMON	10	M	31	139	16	1.94	97	1.57	89	80.9
82	ELANGO	47	M	97	165	37	2.49	73	2.1	74	84.3
83	ARUNKUMAR SARAVANAN	27	M	95	187	27.2	3.87	78	3.65	88	94.3
84	SEKAR RAVICHANDRAN	53	M	73	167	26.2	3.17	94	2.71	99	85.5
85	KAVITHA	34	F	52	147	24.1	2.08	87	1.75	85	84.1
86	SHOBA	57	F	79	160	31	1.85	78	1.51	76	81.6
87	VENKATACHALAM	46	M	64	161	24.7	3.06	94	2.29	85	74.8
88	YUVARAJ	24	M	53	162	20.2	3.6	95	3.45	106	95.8
89	LAKSHMANAN	38	M	80	160	31.2	2.49	74	2.2	77	88.4
90	NARAYANAN	53	M	81	156	33.3	1.94	68	1.57	67	80.9
91	MUTHU.S	44	M	69	179	21.5	3.37	80	3.08	90	91.4
92	ANOOP	48	M	62	165	22.8	3.39	99	2.9	104	85.5
93	DINESH BHAGAI	47	M	57	161	22	3.38	105	2.71	101	80.2
94	MUTHUKRISHNAN	57	M	65	153	27.8	2.45	94	2.11	100	86.1

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGHT (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
95	PREMKAMAL	45	M	91	175	29.7	3.66	92	3.33	102	91
96	SHAJAHAN	35	M	60	173	20	3.7	90	3.18	93	85.9
97	SUGAVANESHWARAN	31	M	88	177	28.1	3.91	89	3.09	84	79
98	RAJASEELAN	31	M	89	178	28.1	3.57	80	3.21	87	89.9
99	GANAPATHI	70	M	72	165	26.4	2.18	112	1.65	102	98
100	DEERAN	23	M	90	170	31.1	1.81	74	1.46	70	98
101	VENKATESAN	56	M	72	165	26.4	2.85	88	2.37	92	108
102	SAKTHIVEL	42	M	105	182	31.7	3.93	90	3.51	98	112
103	ANANDANE	42	M	87	175	28.4	3.95	98	3.54	107	112
104	ANANDNAN	44	M	97	170	33.6	2.8	75	2.55	83	115
105	RAMANAJAM	56	M	67	166	24.3	3.74	114	3.36	128	116
106	VENGADASALABABY	38	M	68	168	24.1	3.73	99	3.39	107	113
107	PAJANY	45	M	75	168	26.6	3.37	93	2.56	86	96
108	TAMILARASAM	40	M	72	165	26.4	3.06	85	2.82	94	115
109	AYOTTIRAMANE	44	M	68	167	24.4	3.27	91	2.57	86	99
110	ULLAGANATHAN	54	M	76	172	25.7	3.33	92	2.8	96	109
111	KARTHIKEYAN	47	M	78	170	27	3.2	87	2.76	92	110
112	BABU	41	M	67	165	24.6	3.91	110	3	101	96
113	DEVARASSU	58	M	81	165	29.8	2.42	76	2.17	85	117
114	THANAGARASU	44	M	77	171	26.3	3.26	86	2.75	88	106
115	CHELLAPERUMAL	29	M	74	175	24.2	4.64	107	3.69	101	97
116	GANESAN	46	M	75	165	27.5	3.04	88	2.43	86	101
117	SUBBU	34	M	85	173	28.4	4.62	112	4.14	120	110
118	SASI KUMAR	37	M	74	167	26.5	3.12	83	2.78	88	111

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGHT (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
119	CHANDRASEKRAN	39	M	81	167	23.2	3.2	86	2.47	80	96
120	VARADARASU	57	M	64	166	23.2	2.74	84	2.36	90	112
121	VELU RAJ	34	M	71	169	24.9	3.56	91	3.23	98	112
122	RAMAMOORTHY	44	M	66	165	24.2	3.05	87	2.55	88	105
123	ASHARAF ALI	21	M	60	174	19.8	4.47	102	3.18	86	86
124	PANNEER	54	M	65	172	22	3.44	95	2.72	93	102
125	JOTHI	47	F	66	145	31.4	1.88	94	1.58	93	105
126	AMEENUDEEN	59	M	78	170	27	3.66	107	3.01	111	107
127	GUEDJENDIRAN	44	M	88	170	30.4	3.26	87	2.61	85	101
128	ASHOKAN	43	M	74	182	22.3	4.1	94	3.14	88	96
129	KUMAR	43	M	82	172	27.7	3.26	84	2.85	90	110
130	ANBUAZHALAN	43	M	90	175	29.4	3.49	87	3.01	91	108
131	LAKSHMAN	38	M	75	168	26.6	3.85	102	3.44	109	111
132	RITHOSH CHANDRA	38	M	94	172	31.8	5.13	129	4.03	122	98
133	MAHADEVAN	53	M	73	173	24.4	3.36	91	2.75	93	105
134	GANDHI	35	M	94	179	29.3	4.04	92	3.57	98	109
135	GOTHANDAPANI	47	M	86	172	29.1	3.03	80	2.65	86	111
136	SRINI VASAN	36	M	86	172	29.1	4.09	101	3.43	102	104
137	MAGESHWARAN	46	M	86	173	28.7	3.59	93	3.24	103	114
138	PALANISAMY	46	M	98	170	33.9	3.19	86	2.67	88	106
139	SHAZANA	45	M	80	173	26.7	3.54	91	3.01	95	107
140	VELMURUGAN	30	M	65	173	21.7	3.53	83	3.2	90	111
141	BALASUBRAMANI	28	M	61	175	19.9	3.8	87	3.03	83	97
142	BOOSHAAM	53	F	70	160	27.3	2	82	1.67	80	106

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGHT (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
143	KUMAR	55	M	60	154	25.3	2.83	105	2.38	108	109
144	MURUGAN	35	M	70	163	26.3	3.39	94	3.05	100	111
145	DEEP AKASH	21	M	71	174	23.5	4.57	115	3.95	115	100
146	SUGAVANESHWARAN	31	M	88	177	28.1	3.91	89	3.09	84	97
147	VEL MUTHU	20	M	60	166	21.8	3.72	93	3.29	96	107
148	JAYAKUMAR	62	M	78	173	26.1	2.78	80	2.49	91	118
149	SOORI	45	M	83	162	31.6	2.57	77	2.13	77	105
150	MANI M ALA	48	F	60	156	24.7	2.3	95	1.83	89	100
151	SARAVANA	30	M	65	160	25.4	3.37	94	2.57	84	93
152	RASATHI	43	F	45	163	16.9	2.46	88	2.26	94	114
153	KAPIL DEV	35	M	73	161	28.2	3.48	99	2.4	83	85
154	GANESH	29	M	104	178	32.8	4.21	94	3.63	97	105
155	SHANTHA	57	F	50	150	22.2	2.06	105	1.45	88	90
156	SIDDHARATH	52	M	88	163	33.1	2.94	91	2.42	92	106
157	YOVANGANDHI	47	M	72	169	25.2	4.03	111	3.44	116	108
158	ANAND RAJ	55	M	70	158	28	2.19	76	1.81	77	107
159	VELMURUGAN	34	M	83	164	30.9	2.9	78	2.43	77	103
160	LAKSHMAN	38	M	80	160	31.2	2.64	78	2.31	81	109
161	LAKSHMI	39	F	61	150	27.1	2.11	89	1.62	79	94
162	JAME SUBBRAMANIYAN	41	M	83	164	30.9	2.79	79	2.36	81	106
163	BRINDHA	18	F	38	158	15.2	2.7	90	2.25	86	99
164	MAGESHWARI	26	F	63	155	26.2	2.53	88	2.26	90	106
165	VALARMATHY	42	F	83	156	34.1	1.76	69	1.57	72	110
166	SELVAM	46	M	83	168	29.4	3.23	90	2.6	88	102

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGH T (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
167	SUBARAMANIYAN	42	M	65	165	23.9	3 .00	85	2.49	84	104
168	MARI MUTHU	49	M	63	172	21.3	3.31	89	2.95	97	114
169	ETHAYATULLA	31	M	80	170	27.7	3.46	85	2.87	84	102
170	VIJAYALAKSHMI	28	F	75	150	33.3	2.02	77	1.81	79	107
171	MOHAN	45	M	65	165	23.9	3.38	97	2.77	97	104
172	IYANARAPPAN	51	M	68	165	25	2.77	83	2.38	88	110
173	THARAMAI SELVI	48	F	85	155	35.4	2.49	105	2.1	104	105
174	MAGESHKUMAR	38	M	82	164	30.5	3.57	100	2.97	99	103
175	VENGATESN	37	M	79	165	29	3.08	84	2.75	90	111
176	THANADALVAN	53	M	91	176	29.4	3.24	84	2.76	90	110
177	SARAVANAN	43	M	95	176	30.7	3.96	97	3.27	98	104
178	SHAK	27	M	72	165	26.4	3.34	86	2.74	83	100
179	ANANDHAKUMAR	35	M	65	162	24.8	3.08	87	2.65	88	106
180	ZAHURDEEN	50	M	88	167	31.6	3.27	95	2.76	98	108
181	GUGAN	25	M	83	162	31.6	3.43	91	2.88	88	102
182	MUTHU	44	M	68	160	26.6	2.64	81	2.34	86	112
183	REVATHY	53	F	70	153	29.9	1.76	81	1.53	83	110
184	MOHAN	53	M	70	165	25.7	3.31	100	2.38	89	93
185	RAMANATHAN	43	M	77	177	24.6	3.81	92	2.88	85	95
186	SATHISH KUMAR	30	M	63	167	22	4.06	104	3.66	110	110
187	KANNAN	40	M	80	163	30.1	2.64	76	2.38	82	113
188	PRAKASH	27	M	100	175	32.7	4.04	92	3.47	94	104
189	GNANARAJ	18	M	78	172	26.4	4.28	114	3.99	110	99
190	MANIKANADAN	22	M	78	175	25.5	4.43	106	3.85	103	100

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGHT (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
191	RATHIKA	27	F	65	164	24.2	2.91	91	2.41	87	99
192	RAHAMANAN	37	M	68	159	26.9	3.51	104	2.54	100	100
193	SHANKAR	45	M	82	179	25.6	3.43	82	2.89	85	107
194	KARTHICKEYAN	51	M	74	163	27.9	2.74	85	2.16	82	101
195	PALANIAPPAN	48	M	68	165	25	3.29	96	2.9	104	112
196	MAHENDRAKUMAR	45	M	73	174	24.1	3.4	87	2.95	92	110
197	RAMALINGAM	44	M	79	168	28	2.91	80	2.59	86	112
198	MUNIRA	38	F	63	156	25.9	2.45	93	2.08	92	104
199	ELANGOVAN	48	M	74	168	26.2	3.75	105	2.9	100	98
200	PURUSOTHAMMAN	49	M	61	160	23.8	2.97	95	2.42	94	104
201	MANIKANDAN	25	M	82	165	30.1	3.05	78	2.55	75	101
202	ANADVAN	41	M	63	164	23.4	3.13	88	2.85	96	114
203	SENHIL	26	M	75	168	26.6	3.84	95	3.09	89	97
204	HARI	25	M	70	168	24.8	3.65	89	3.16	91	105
205	EGAMBARAM	53	M	78	172	26.4	3.08	84	2.33	80	97
206	PERIYAMMAL	35	F	52	145	24.7	2.5	110	2.13	109	103
207	RAJA	45	M	90	167	32.3	2.79	78	2.58	87	117
208	RAJA RATAHINAM	36	M	90	167	32.3	4.04	96	3.53	101	108
209	RAJENDRAN	51	M	70	175	22.9	3.68	96	2.64	85	92
210	VIJAYAKUMARI	51	F	65	145	30.9	1.64	85	1.5	93	115
211	ANBUSELVI	45	F	84	151	36.8	1.96	86	1.64	84	104
212	XAVIER HONESTRAJ	26	M	73	170	25.3	4.27	103	3.28	93	93
213	MURUGAIAN	47	M	78	173	26.1	3.28	86	2.76	88	107
214	THANGARASU	54	M	80	170	27.7	3.11	88	2.68	95	111

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGH T (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
215	BAIAMURAGAN	45	M	76	176	24.5	3.23	80	2.95	90	115
216	POVIARASAN	24	M	70	183	20.9	5.14	106	4.44	110	104
217	RAMALINGAM	44	M	95	169	33.3	3.55	96	3.03	99	108
218	RAMESH	45	M	70	172	23.7	3.96	103	3.43	110	109
219	KIRSHNAMURTHY	44	M	60	170	20.8	3.53	94	2.73	89	97
220	THIRUNAVUKARASU	42	M	67	166	24.3	3.2	89	2.65	89	104
221	DEVANATHAN	43	M	93	172	31.4	3.77	97	3.4	107	113
222	VEERAPPAN	57	M	63	157	25.6	2.58	92	2.28	100	115
223	MURALI	30	M	84	178	26.5	3.86	87	3.11	83	99
224	KANNAN	66	M	56	170	19.4	2.98	92	2.3	91	103
225	BAVITHRA	34	F	68	182	25.5	2.7	91	2.17	84	97
226	SENTHIL	32	M	76	163	28.6	3.09	84	2.54	81	101
227	RAVIKUMAR	43	M	77	166	27.9	3.04	85	2.45	83	101
228	THAIYAGU	31	M	74	177	23.6	3.64	83	2.6	71	88
229	SUKUMAR	59	M	73	177	23.3	3.66	97	2.78	94	99
230	ANANDARAJ	22	M	40	162	15.2	2.76	73	2.52	77	110
231	RAJALAKSHMI	68	F	55	151	24.1	1.65	93	1.37	94	109
232	JAYAKUMAR	62	M	78	173	26.1	3.21	92	2.52	92	103
233	SARASHWATHI	47	F	71	155	29.6	2.03	85	1.72	84	106
234	POONGKODI	31	F	57	156	23.4	2.58	92	1.99	82	93
235	DINESH	30	M	87	176	28.1	4.64	106	3.69	101	97
236	SUDHAKAR	33	M	70	166	25.4	3.27	86	3.05	95	115
237	RAMACHANDRAN	46	M	80	161	30.9	2.84	87	2.28	84	102
238	SHABANA	22	F	72	152	31,2	2.28	82	2.04	84	106

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGHT (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
239	BHUVANESHWARI	61	F	64	147	29.6	1.93	109	1.73	118	116
240	SUNDAR	55	M	83	169	29.1	3.15	91	2.41	87	99
241	RAJENDRAN	51	M	90	162	34.3	2.31	72	2.08	80	115
242	PRAVEENKUMAR	29	M	91	180	28.1	4.42	97	3.63	95	100
243	SENTHIL	38	M	99	171	33.9	3.46	88	3.03	93	109
244	MANIKKAVELU	45	M	72	165	26.4	3.07	88	2.54	89	105
245	DHAKSHAYINI	30	F	57	154	24	2.34	85	1.98	83	101
246	ROBERT	29	M	64	169	22.4	3.38	84	2.91	85	105
247	DASS	42	M	57	157	23.1	2.68	85	2.13	81	100
248	RAJESH	60	M	63	166	22.9	4.04	127	3.1	123	100
249	KAVITHA	36	F	65	177	20.7	3.47	99	2.65	87	93
250	GANAPATHY	19	M	45	162	17.1	3.26	103	2.87	104	104
251	KANNIYAMMAL	45	F	41	143	20	2.2	111	2	120	113
252	POONGODI	41	F	63	164	23.4	2.54	88	2.09	84	101
253	SARAVANAN	35	M	65	178	20.5	3.89	89	2.87	80	91
254	GAYATHRI	17	F	50	150	22.2	2.76	107	2.43	104	93
255	MAHABBAT	21	M	51	157	20.7	4.06	115	3.04	99	91
256	PRIYA	19	M	64	165	23.5	3.61	92	3.23	96	108
257	PENCHELLAIACH	50	M	97	161	37.4	2.25	71	1.83	71	104
258	AMLOPAVA MARY	52	F	65	158	26	2.19	94	1.91	97	110
259	TALEEM ALILAS	26	M	53	155	22.1	3.01	89	2.4	81	97
260	UJAL	23	M	64	172	21.6	3.9	91	3.54	97	110
261	BHARATH	21	M	62	170	21.5	4.53	108	3.57	100	95
262	SHANTU	24	M	80	174	26.4	4.02	92	3.19	86	96

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGH T (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
263	MUKESH	22	M	86	178	27.1	4.59	100	3.86	100	102
264	SUBHURADHA	29	M	50	164	18.6	3.8	101	2.65	82	85
265	MANI	28	M	59	152	25.5	2.88	106	2.32	99	96
266	CHAKRAGEUTAM	25	M	75	178	23.7	5.03	110	4.14	107	100
267	ARUN	29	M	80	179	25	4.63	102	3.96	104	104
268	DEVI	54	F	70	148	32	2.11	107	1.94	118	117
269	VANTHY	30	F	55	148	25.1	2.51	100	2.06	94	98
270	SARAVANAN	59	M	74	159	29.3	2.43	85	2.21	96	119
271	RADHIKA	32	F	71	156	29.2	2.66	96	2.16	90	98
272	MURALI	38	M	95	175	31	3.2	77	2.74	80	106
273	RAJARAJAN	32	M	95	174	31.4	3.38	80	3.04	86	89.9
274	VELMURUGN	20	M	60	166	21.8	3.72	93	3.29	96	88.4
275	MURUGAN	35	M	70	163	26.3	3.39	94	3.05	100	90
276	SHANMUGAM	44	M	80	172	27	3.3	86	2.83	90	85.8
277	MURUGAN	29	M	76	172	25.7	3.4	81	2.9	82	85.3
278	MURUGANPANDI	19	M	62	165	22.8	.4.00	102	3.49	103	87.3
279	SWAMINATHAN	57	M	72	173	24.1	3.39	94	2.98	104	87.9
280	GOPILAL	60	M	68	153	29	2.08	82	1.81	89	87
281	ANSARI	20	M	54	164	20.1	3.67	95	3.04	91	82.8
282	RANJIT	19	M	53	176	17.1	4.04	90	3.13	83	77.5
283	SHAKUL	18	M	60	168	21.3	4.19	103	3.37	97	80.4
284	MILANMALLIK	29	M	68	167	24.4	3.4	86	3.04	91	89.4
285	LAKSHMI	50	F	45	150	20	2.14	122	1.74	119	81.3
286	MAHIBULLA KHAN	22	M	55	`169	19.3	3.75	91	3.2	91	85.3

S. NO	NAME	AGE	SEX	WEIGHT (Kg)	HEIGHT (Cm)	BMI	FVC (Lit)	FVC %	FEV1 (Lit)	FEV1 %	FEV1/ FVC (%)
287	ADIKESAVAN	23	M	58	156	23.8	2.89	83	2.62	86	90.7
288	MAGESHWARI	56	F	64	143	31.3	1.34	77	1.16	81	86.6
289	BIMAN DASS	47	M	49	161	18.9	3.09	96	2.76	103	89.3
290	IBRAHIM	19	M	54	153	23.1	2.94	89	2.48	85	84.4
291	MUJUBUR	24	M	80	172	27	3.41	80	2.97	82	87.1
292	KRISHNAN	42	M	86	178	26.2	3.35	80	2.73	79	81.5
293	ARULKUMAR	27	M	67	167	24	3.23	81	2.77	81	85.8
294	SANMATHI	21	F	50	155	20.8	3.07	106	2.59	103	84.4
295	STALIN	30	M	56	163	21.1	3.07	83	2.56	81	83.4
296	BASKAR	33	M	75	171	25.6	3.38	83	2.7	79	79.9
297	MATHEW	40	M	78	165	28.7	3.34	93	2.94	98	88
298	SAKTHI VIJAYAN	39	M	65	172	22	4.19	106	3.53	107	84.2
299	KARTHIK	26	M	62	155	25.8	3.2	94	3.00	101	93.8
300	MUTHURAMAN	37	M	79	161	30.5	2.82	82	2.46	84	87.2