

# PRACTICAL PHYSIOLOGY

## 435's team

I

## SPIROMETRY

Respiratory block.

(( اللهم إني أسألك فهم النبيين ، وحفظ  
الملائكة المقربين ، وأن تجعل لساني  
عامراً بذكرك ، وقلباً بخشيتك ، وبدني  
بطاعتك فأنت حسبي ونعم الوكيل ))

- Very important
- Extra information
- Terms

# Objectives



- Use a spirometer and determine lung volumes and capacities.
- Define and provide values for the various lung volumes and capacities.
- Recognize the physiological and some pathological factors that modify lung volumes and capacities.

# Spirometry



## What is spirometry?

The spirometry is a pulmonary function test that measures lung **VOLUMES** and **CAPACITIES**.

To determine the cause of shortness of breath.

To rule out any kind of obstructive or restrictive diseases.

**Why do we use a spirometry test?**

To diagnose and monitor lung problems.

To monitor how well medications for lung problems are working.

# Simple spirometer

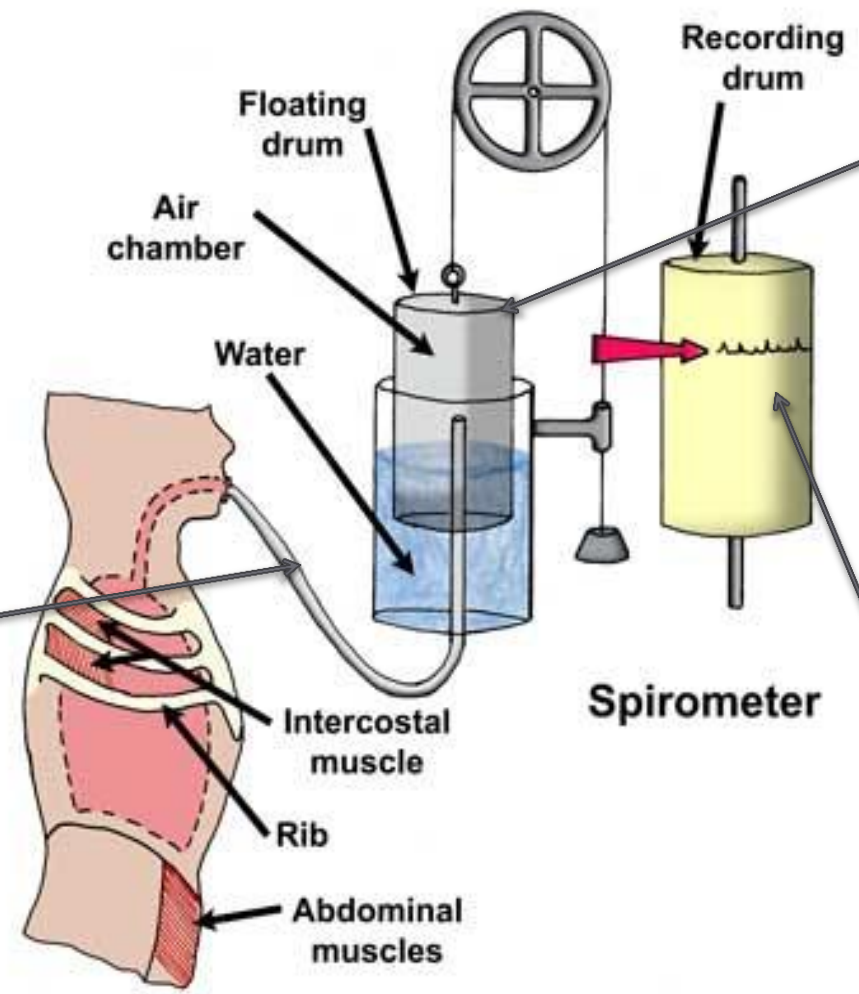


1-Drum inverted over a chamber of water with the drum counterbalanced by a weight.

3-a tube connects the mouth with the gas chamber.

2-in the drum is air of oxygen.

4-When one breathes in and out of the chamber, the drum rises and falls and an appropriate recording is made on a moving paper.



**Spirometer:** is an instrument for measuring the air capacity of the lung.  
**Spirometry:** is the process.  
**Spirogram:** مخطط التنفس

# Method of using spirometry.



1-insert a sterilized mouthpiece.

2-close the nose with the nose clip.

3-take a normal breath through the mouthpiece for a short time then take a deep inspiration to fill the lungs completely, then breathe normally for a short time.

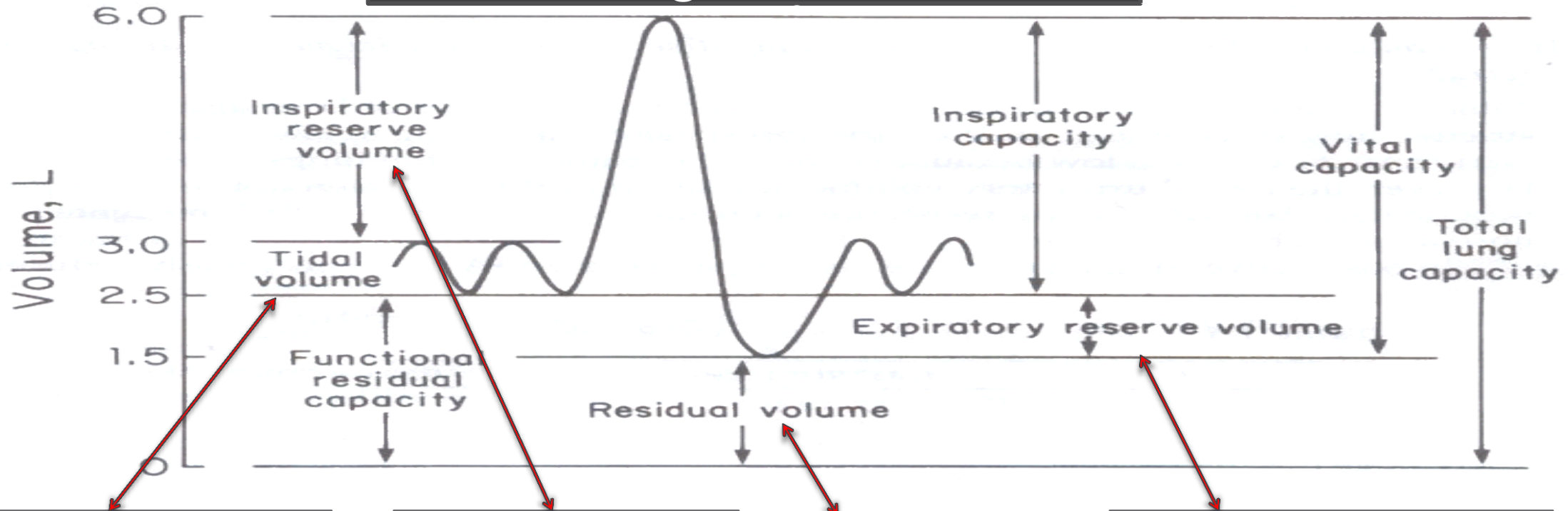
4-expire, forcibly as completely as possible, then breathe normally for a short time.

5-take a deep forceful inspiration and immediately expire forcibly and as completely as possible, then breathe normally.

6-the **spirogram** is recorded on a moving drum.

The air in the lungs can be subdivided on this diagram into **4 volumes** and **4 capacities**:

## Lung volumes:



### Tidal volume:

The amount of air that moves into the lungs with each inspiration (**or** the amount the moves out with each expiration) = **500 ml.**

### Inspiratory reserve volume:

The **extra** volume of air that can be inspired above the normal tidal volume = **3000ml.**

### Residual volume:

The air left in the lungs **after the most forceful expiration** = **1200ml.**

### Expiratory reserve volume:

The volume expelled by an active expiratory effort after passive expiration (**after the end of a normal tidal expiration**) = **1100ml.**

# Lung capacities:



## The inspiratory capacity :

$$IC = TV + IRV$$

(tidal volume of inspiration + inspiratory reserve volume)

$$500 + 3000 = 3500 \text{ ml}$$

The amount of air a person can breathe beginning at the normal expiratory level and distending the lungs to the maximum amount

$$= 3500 \text{ ml}$$

## The functional residual capacity :

$$FRC = ERV + RV$$

(expiratory reserved volume + Residual volume)

$$1100 + 1200 = 2300 \text{ ml}$$

The amount of air that remains in the lungs at the end of normal expiration

$$= 2300 \text{ ml}$$

## The vital capacity:

$$VC = IRV + TV + ERV$$

(inspiratory reserve volume + tidal volume + expiratory reserved volume)

$$3000 + 500 + 1100 = 4600$$

ml

The maximum amount of air a person can expel after maximal inspiration

$$= 4600 \text{ ml}$$

## The total lung capacity: TLC =

$$VC + RV$$

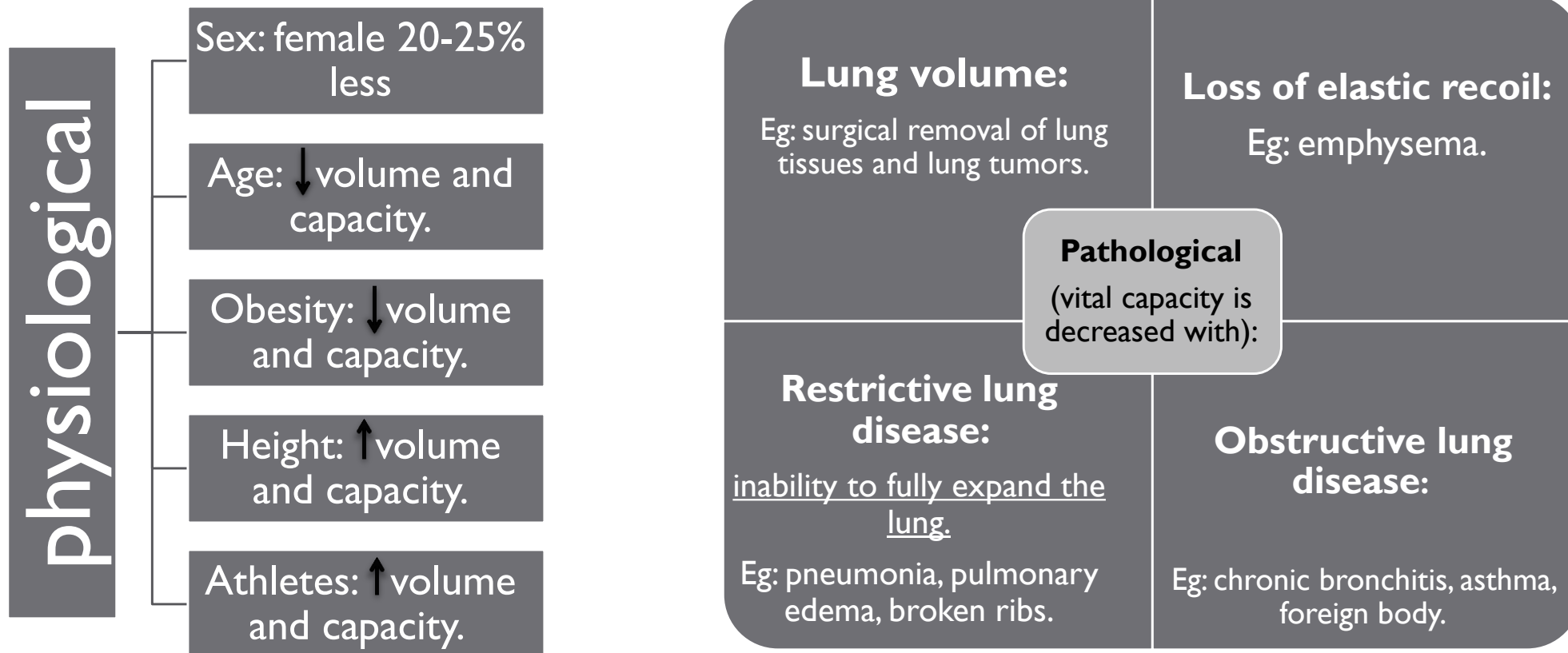
(vital capacity + Residual volume)

$$4600 + 1200 = 5800 \text{ ml}$$

The max volume to which the lungs can be expanded with the greatest possible inspiratory effort

$$= 5800 \text{ ml}$$

# Physiological and pathological factors influencing lung volumes and capacities:





Video

[Spirometry basics](#)

Quiz

[Test yourself](#)

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# DYNAMIC SPIROMETRY

Respiratory block.

## objectives

- To test pulmonary function.
- e.g. Forced vital capacity (FVC),
- measurements including FEV<sub>1</sub>
- and flow volume curve.

**Push yourself  
because no one  
else is going to do  
it for you.**

- ▶ Very important
- ▶ Extra information
- ▶ Terms

# Dynamic Spirometry



1

It provide an objective measurement of lung function.

2

It analyzes volume and velocity of expired air.

## Importance of spirometry

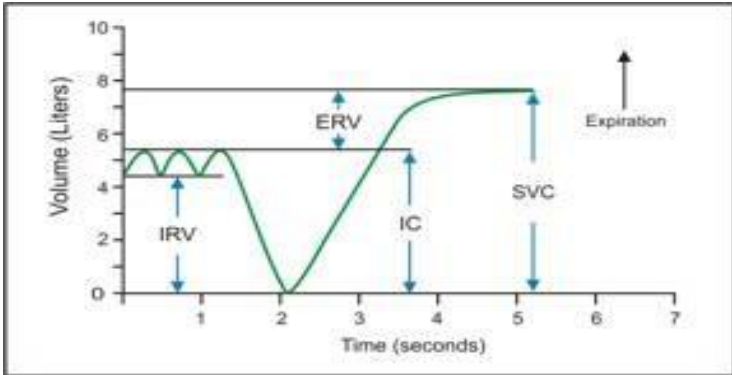
- access physical fitness.
- diagnosis of lung diseases (obstructive or restrictive).
- follow disease progression.

# Types of tests

## Static test

Performed **without** regard to time.

**Relaxed vital capacity:** maximum volume of air expired **during relaxed** expiration after a maximal inspiration.



## Dynamic test

In dynamic test 2 curves can be obtained.  
See next slides.

Performed at forcible and maximum effort against **time**.

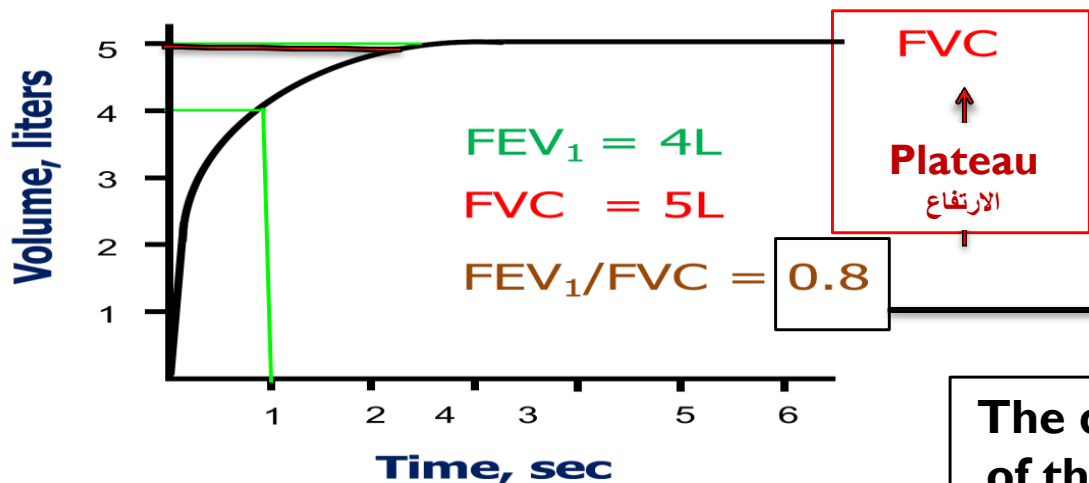
**Forced vital capacity (FVC):** the max volume of air that can be **forcibly** and **rapidly** exhaled following a max inspiration.

Measure the **rate** at which the lung changes volume during forced breathing.

# Two types of curves can be obtained

## I- Forced expiratory curve:

A plot of exhaled volume against time:



**FEV1 % or ratio = ( FEV1/FVC)\* 100**

- Fraction of the vital capacity expired during the 1<sup>st</sup> second of a forced expiration (**normal 70%-80%**)

(Normal)

The duration of the test is about 6 seconds.

Forced expired curve helps to know:

Obstructive lung disease.

Restrictive lung disease.

Mechanism:

The subject takes a maximal inspiration and then exhales as rapidly as forcibly and as maximally as possible.

**Forced Expiratory volume in one second (FEV1):** the volume of air exhaled in the 1<sup>st</sup> second of forceful expiration starting from full inspiration .

# Results interpretation

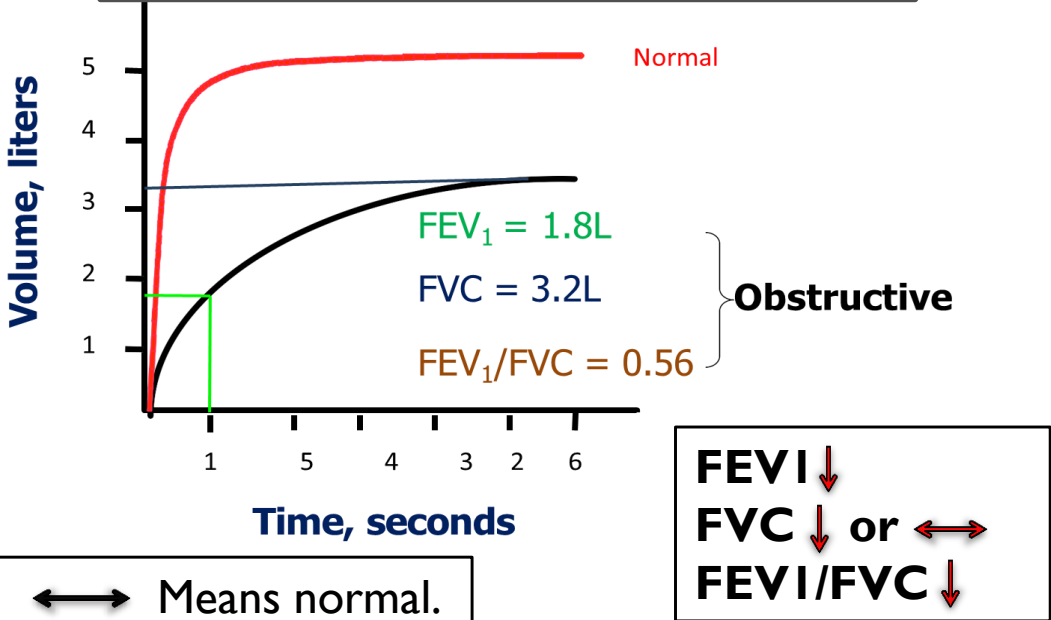
Results are reported as absolute values (litre) ,and as percentages of predicted values based on age, height, sex, ethnicity

**Normal:** Both FVC and FEV1  $\geq 75\%$  of predicted.  
 If one or both parameters is < 75% predicted, calculate FEV1 ratio:

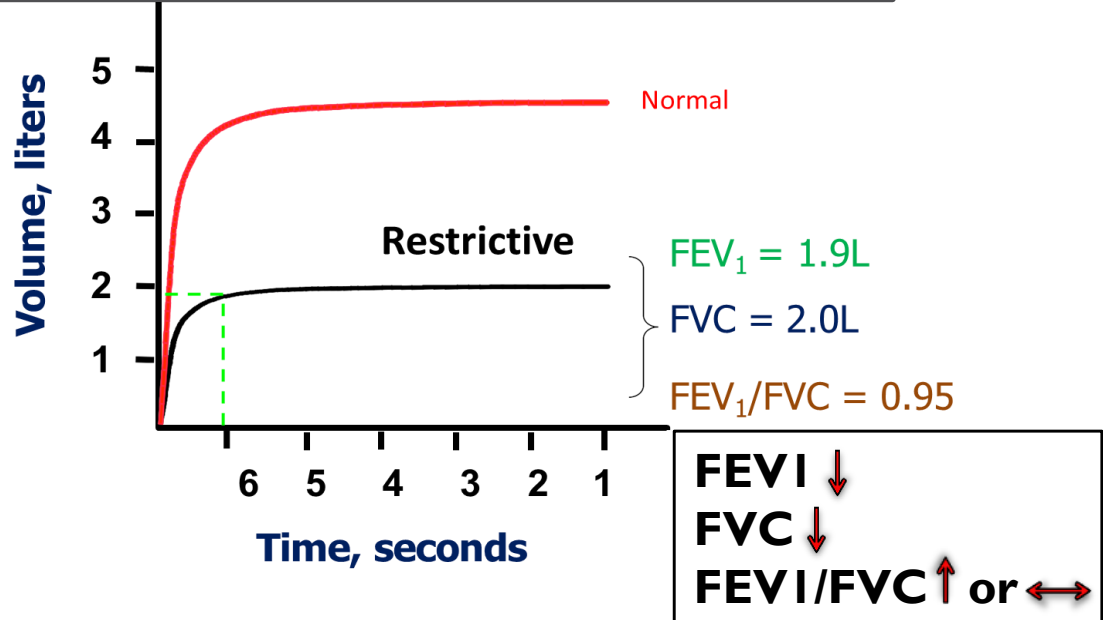
- FEV1%  $\geq 80\%$  **Restrictive.**
- FEV1%  $< 70\%$  **Obstructive.**

الطبيعي تكون نسبة ال FEV1 و ال FVC أكبر من ٧٥% بس اذا كان واحد فيهم او كلهم أقل من ٧٥% نشوف النسبة بينهم (FEV1 ratio) اذا كانت أكبر من الطبيعي يعني ريستريكتف واذا كانت أصغر يعني أوبستراكتف.

## Obstructive lung disease

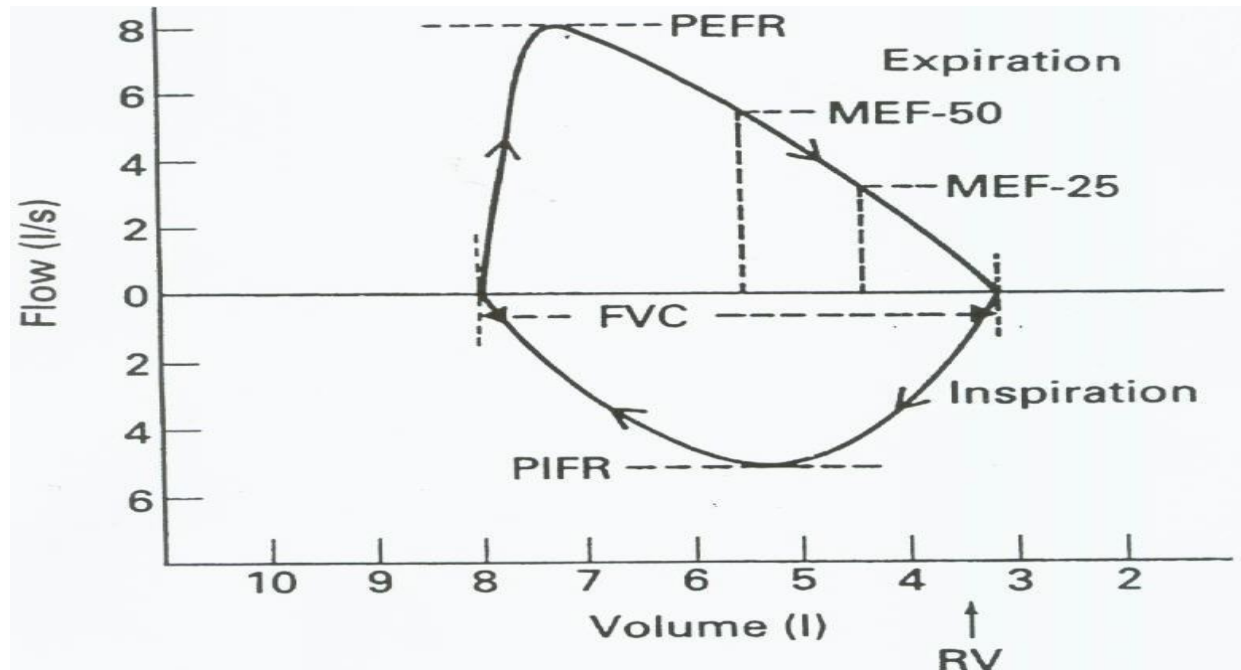


## Restrictive lung disease



# 2-Flow volume loop (Curve)

This measures expiration & inspiration **flow** as a function of exhaled volume rather than against time.



**FVC** measured over the X-axis

Breathes normally (tidal volume)

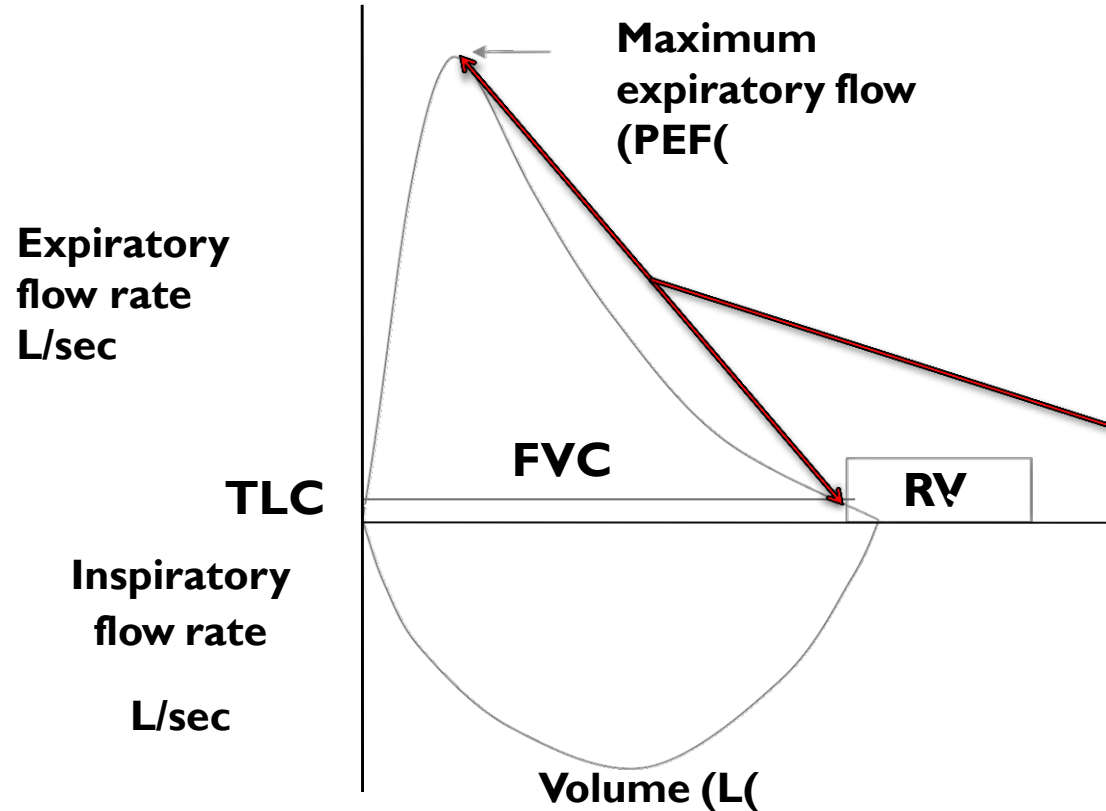
Maximum inspiration

Exhales fast!

Rapid maximum inspiration.

- **Peak expiratory flow rate (PEFR):** is a person's maximum speed of expiration, normally = **6-12 L/sec**
- **Peak inspiratory flow rate (PIFR):** max flow speed achieved during forceful inspiratory effort = **6 L/sec**
- **Maximal Expiratory Flow at 50% (MEF50):** max expiratory flow at **50%** of **FVC**, normally = **4-6 L/sec**

# Flow volume loop and flow limitation

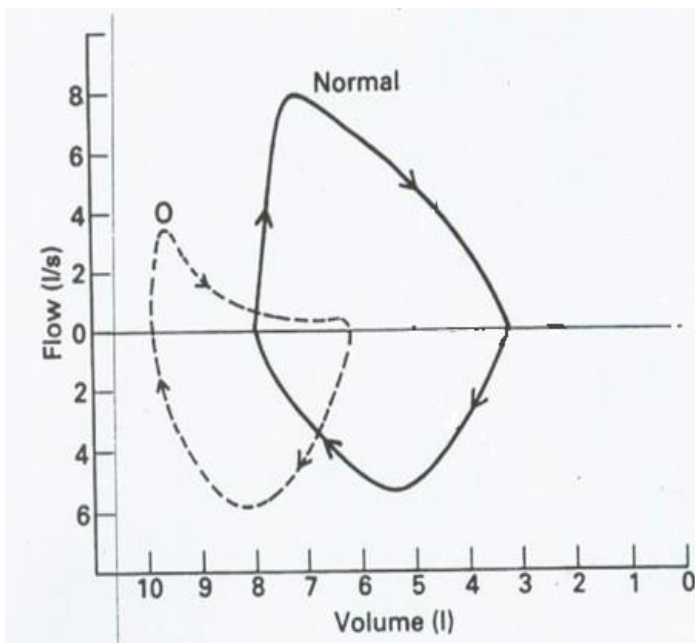


- The **inspiratory** and the **1<sup>st</sup> early flow rates of the expiratory** curve: (flows generated near the TLC) are **effort (muscle) dependent**
- The greater one can raise pleural pressure (the harder one forces the air out), the greater the resulting air flow
- At low lung Volume, as RV is approached, after a certain pleural pressure ( $P_{ip}$ ) is reached, flow rate is **effort independent** (it depends on the size of the bronchi)
- Harder effort generates higher  $P_{ip}$  but no greater airflow, this is because the positive  $P_{ip}$  that tends to collapse the airway exceeds the airway pressure that tends to keep the airways open: the airways narrow, preventing any further increase in airflow despite greater effort.

**Residual volume, total lung capacity and The functional residual capacity CANNOT** be measured by simple spirometry ( as they include residual volume )

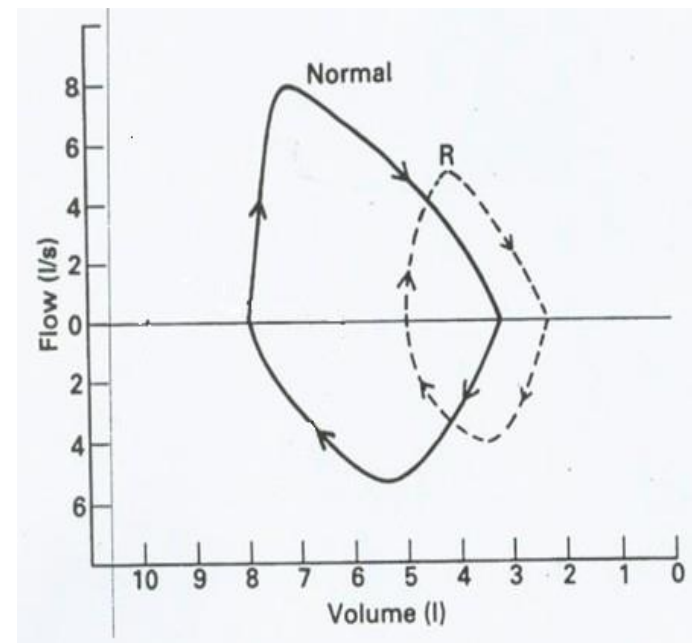


# OBSTRUCTIVE LUNG DISEASE



- ↑ Air way resistance.
- ↓ **PEFR** and ↓ **MEF50**
- Effort independent part of the curve is  
**CONCAVE.** (important)
- Inspiratory loop is normal.

# RESTRICTIVE LUNG DISEASE



- ↓ **Lung Compliance**
- ↓ **All Flow parameters.**
- **Miniature loop** لوب مصغر (elliptical  
بيضاوي الشكل).

## Video

**DON'T** forget to check the questions file. It's so **IMPORTANT.**

Obstructive Vs Restrictive Lung Diseases:  
<https://www.youtube.com/watch?v=JOFfuTi-Cko>

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(( اللهم إني استودعتك علمي  
هذا أمانة عندك على أن ترده إليّ  
وقت حاجتي إليه ))

# THANK YOU FOR CHECKING OUR WORK

For any correction, suggestion or any useful information,  
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