# Spirometry

**Table 1.** Indications for Spirometry

| |
|---|
| Diagnosis |
| To evaluate symptoms, signs, or abnormal laboratory test results |
| To measure the physiologic effect of disease or disorder |
| To screen individuals at risk of having pulmonary disease |
| To assess preoperative risk |
| To assess prognosis |
| Monitoring |
| To assess response to therapeutic intervention |
| To monitor disease progression |
| To monitor patients for exacerbations of disease and recovery from exacerbations |
| To monitor people for adverse effects of exposure to injurious agents |
| To watch for adverse reactions to drugs with known pulmonary toxicity |
| Disability/impairment evaluations |
| To assess patients as part of a rehabilitation program |
| To assess risks as part of an insurance evaluation |
| To assess individuals for legal reasons |
| Other |
| Research and clinical trials |
| Epidemiological surveys |
| Derivation of reference equations |
| Preemployment and lung health monitoring for at-risk occupations |
| To assess health status before beginning at-risk physical activities |

- Spirometry is used to measure forced expiratory flow rates and volumes. It is the most commonly used pulmonary function test and is useful in the evaluation of patients with respiratory symptoms (eg, dyspnea, cough, wheeze), and the monitoring of lung function in patients with lung disease, being treated with drugs that can affect lung function, or at risk of lung disease (eg, smoking, occupational exposures, family history).

- In the office setting, spirometry is typically used to detect, confirm, and monitor obstructive airway diseases (eg, asthma, chronic obstructive pulmonary disease [COPD]) and monitor known restrictive lung disease.
- In this setting, **the clinician must be knowledgeable about issues related to equipment, performance of the forced expiratory maneuver, and interpretation of the data to obtain reliable and clinically useful information.**

# EQUIPMENT

- Office spirometers should meet equipment specifications as described in international guidelines. The majority of spirometers manufactured since 1990 are accurate, although some flow-sensing office spirometers can produce falsely high results.
- To avoid cross-contamination between patients when using permanent flow sensors, it is preferable to employ single use disposable flow sensors that practically eliminate the risk of inhalational cross contamination. Disposable one-way mouthpieces may also be used; otherwise, patients should be

# QUALITY CONTROL

- Office spirometers should accurately measure the forced expiratory volume in one second (FEV1), forced expiratory volume in six seconds (FEV6), and forced vital capacity (FVC) and also provide quality checks and error messages. A survey of 17 spirometers used in primary care offices found only 1 of 17 met accuracy criteria; clearly manufacturers and practitioners need to be aware of potentially significant quality issues related to office spirometry [19].
- In addition to internal calibration performed by the device, daily calibration checks with a three liter syringe are recommended

# Holding bronchodilator medications

- In preparation for PFTs, bronchodilator medications are typically held so that bronchodilator response can be assessed after baseline spirometry. As examples, short-acting inhaled beta agonists (eg, albuterol, salbutamol) should not be used for four to six hours prior to testing [6].
- The short-acting muscarinic antagonist ipratropium should be held for 12 hours.
- Long-acting beta agonist bronchodilators (eg, salmeterol, formoterol) should be held for 24 hours prior to testing.
- The ultra-long-acting beta agonists (eg, indacaterol, olodaterol, vilanterol) should be held for 36 hours, and the long-acting muscarinic antagonists (also called anticholinergic agents) glycopyrrolate (glycopyrronium), tiotropium, aclidinium, and umeclidinium should be held for 36 to 48 hours.

# PROCEDURE

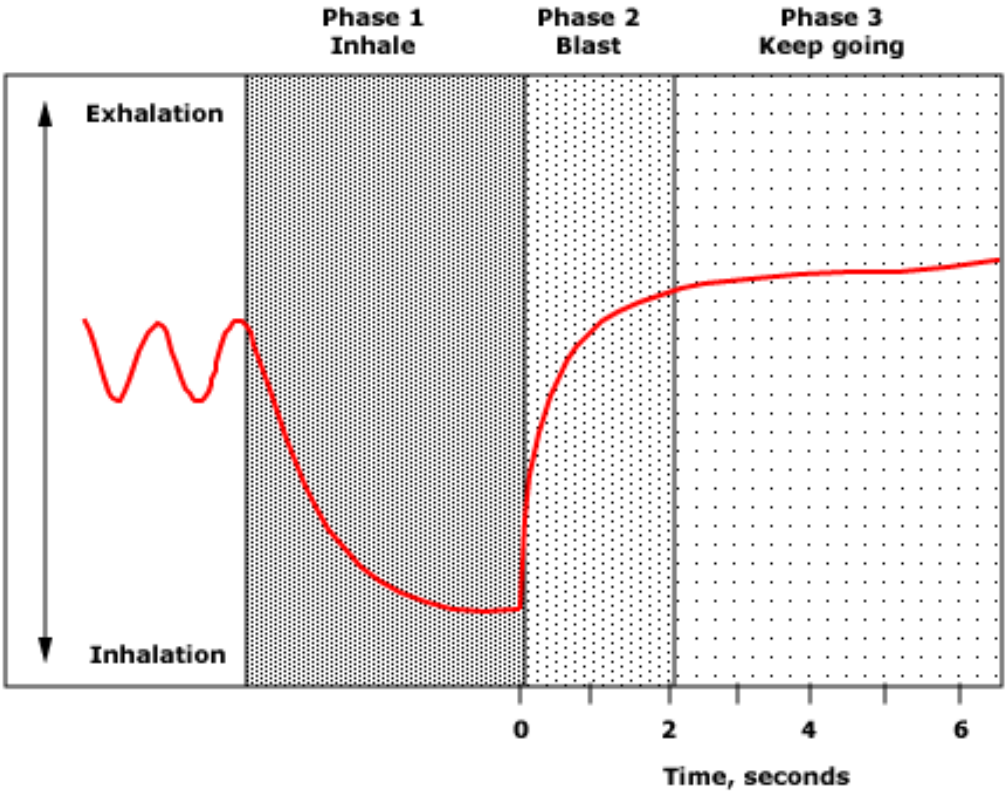
- Patients are usually seated during spirometry, unless otherwise noted. Nose clips or manual occlusion of the nares help to prevent air leakage through the nasal passages, although spirometry can be performed without nasal occlusion .The deep inhalation should occur before the mouthpiece is placed in the mouth. Immediately after the deep inhalation, the mouthpiece is placed just inside the mouth between the teeth. The lips should be sealed tightly around the mouthpiece to prevent air leakage during maximal forced exhalation. The patient should then be instructed to blast out the air without hesitation (within two seconds of reaching full inflation). **Exhalation should last until a**

# COACHING THE PATIENT

The most important task of the technician or person performing the test is to obtain maximal, reproducible efforts from the patient.

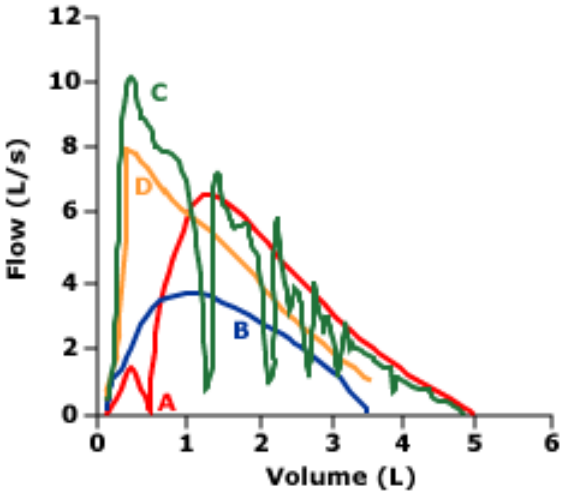
Even with the use of accurate instruments, office spirometry results may be misleading if the patient's efforts are submaximal. Unlike most other medical tests in which the patient remains passive, accurate spirometry results require significant exertion on the part of the patient.

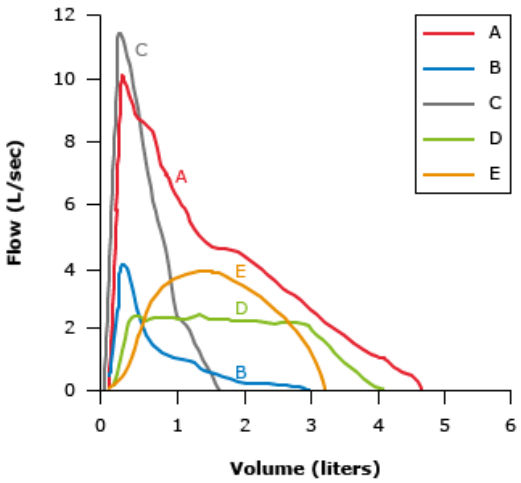
The technician must instruct and encourage the patient to perform the breathing maneuvers in three phases (figure 1):



# ADEQUACY OF TEST

- An adequate test usually requires three acceptable and repeatable forced vital capacity (FVC) maneuvers [10]. The clinician and technician must learn to recognize the patterns of acceptable and unacceptable efforts, since poorly performed maneuvers often mimic disease patterns. Detection of poorly performed maneuvers requires direct inspection of both flow-volume curves and volume-time spirograms (figure 2) [14,22].
- An acceptable maneuver requires a sharp peak in the flow curve and an expiratory duration that reaches a plateau of exhaled volume or 15 seconds, or greater than six seconds if measuring

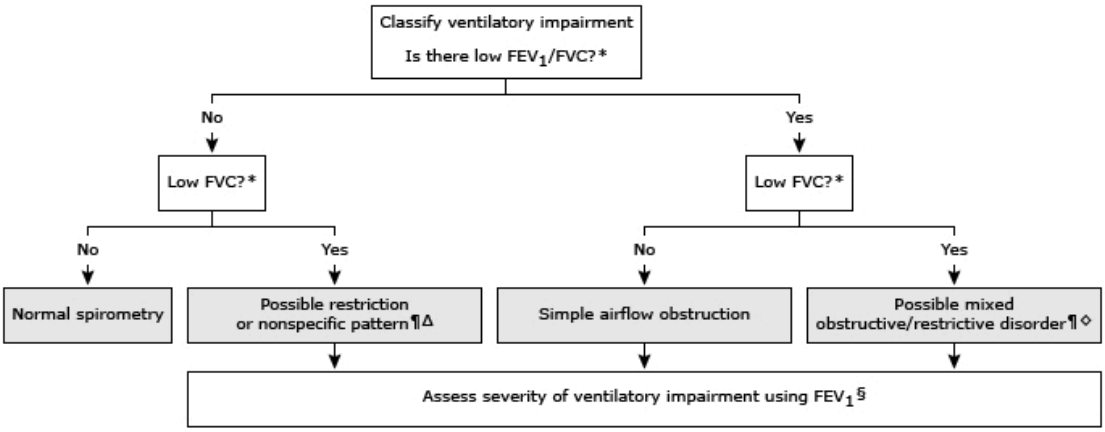


| Grade | Number of measurements | Repeatability: Age >6 years | Repeatability: Age ≤6 years* |
|---|---|---|---|
| A | ≥3 acceptable | Within 0.150 L | Within 0.100 L* |
| B | 2 acceptable | Within 0.150 L | Within 0.100 L* |
| C | ≥2 acceptable | Within 0.200 L | Within 0.150 L* |
| D | ≥2 acceptable | Within 0.250 L | Within 0.200 L* |
| E | ≥2 acceptable | >0.250 L | >0.200 L* |
| | **or** 1 acceptable | N/A | N/A |
| U | 0 acceptable **and** ≥1 usable | N/A | N/A |
| F | 0 acceptable and 0 usable | N/A | N/A |

# INTERPRETATION

- All tracings from the forced expiratory maneuvers should be examined for acceptability and repeatability, according to the criteria mentioned above. The study should then be classified as normal or abnormal, the latter showing an obstructive, a possible restrictive, or a possible mixed pattern. Lung volumes are necessary to confirm whether or not the patient has a restrictive deficit. The severity of the ventilatory impairment is then assessed, according to the algorithm




| FEV$_1$ (z-score) - preferred¥ | Ventilatory impairment severity |
|---|---|
| Less than −2.5 | Mild |
| −2.5 to −4.0 | Moderate |
| Less than −4.0 | Severe |

| FEV$_1$ (% predicted) if z-score not available¥ | Ventilatory impairment severity |
|---|---|
| More than 70% | Mild |
| 50 to 70% | Moderate |
| 35 to 50% | Severe |
| Less than 35% | Very severe |

# Forced vital capacity

- The forced vital capacity (FVC) (also known as the forced expiratory volume) is the maximal volume of air exhaled with a maximally forced effort from a position of full inspiration and is expressed in liters [10]. The highest FVC from the three acceptable forced expiratory maneuvers is used for interpretation [10].
- **The FVC may be reduced by suboptimal patient effort, airflow limitation, restriction (eg, from lung parenchymal, pleural, or thoracic cage disease), or a combination of these** (algorithm 1). In general, a low FVC needs further evaluation with full pulmonary function tests to determine whether lung restriction is present [24]

- Due to these potential problems with air trapping and incomplete exhalation, FVC is not used to grade restriction severity. We prefer to assess the severity of restrictive deficits by applying the z-score approach to **total lung capacity** measurements, when available.
- The slow vital capacity (SVC) is the maximal volume of air exhaled after a maximal inspiration, but without a forced effort. The SVC is rarely measured outside of hospital-based pulmonary function labs. For normal subjects, the slow and forced vital capacities are very close, whereas patients with airflow limitation tend to have a lower FVC than SVC.

# Forced expiratory volume in six seconds

- The forced expiratory volume in six seconds (FEV6) is sometimes used as a surrogate for FVC .
- The FEV6 has the advantage of being more reproducible than the FVC and less physically demanding for the patient.

# Forced expiratory volume in one second

- The forced expiratory volume in one second (FEV1) is the maximal volume of air exhaled in the first second of a forced exhalation that follows a full inspiration, expressed in liters [21]. The FEV1 reflects the average flow rate during the first second of the FVC maneuver. **The FEV1 is the most important spirometric variable for assessment of the severity of airflow obstruction.**
- The highest FEV1 from the three acceptable forced expiratory maneuvers is used for interpretation, even if it does not come from the maneuver with the highest FVC [10].
- In patients with asthma, the FEV1 typically declines with clinical

- As a rough guideline, the predicted FEV1 for a 50-year-old of average height is about 4 L for a male and 3 L for a female.
- When predicted values have not been calculated, patients with severe COPD generally have an FEV1 less than one liter, while those with moderate COPD have an FEV1 between 1 and 1.5 liters.
- Individuals with an FEV1 ≤75 percent of predicted are more likely to report dyspnea, wheezing, or cough, than those with an FEV1 >75 percent predicted.

# Ratio of FEV1/FVC

- The FEV1/FVC ratio is the fraction of the forced vital capacity that can be exhaled in the first second. It is the most important parameter for detecting airflow obstruction in diseases like asthma and COPD.
- However, once it has been determined that a patient has airways obstruction, the FEV1/FVC ratio is not useful for gauging severity of disease, since **the FVC often decreases with increasing obstruction due to air trapping or premature termination of exhalation**. The FEV1, not the FEV1/FVC ratio, should be used to monitor patients with asthma or COPD.
- The use of z-score <-1.645 or the fifth percentile LLN for FEV1/FVC

- If FEV1/FVC is low, but FEV1 is normal, this is still considered indicative of mild airflow obstruction. In some cases, a low FEV1/FVC in the presence of a normal FEV1 is classified as reflecting dysanapsis, or airways size being too small relative to lung volume size. While dysanapsis may be a physiologically normal variant, it has also been associated with COPD [37], bronchodilator responsiveness, and [38] severe asthma in children with obesity [39].
- If FEV1/FVC is normal, but FEV1 is low, this may represent restriction, which should be evaluated by lung volumes. When lung volumes are not available, this pattern has also been labeled "Preserved Ratio Impaired Spirometry", or PRISm. It is unclear if PRISm is a distinct phenotype of lung disease, but multiple studies have demonstrated that PRISm is associated with increased

# Other flow measures

- The transition from normal function to moderate airflow obstruction is generally gradual. Physiologists have searched for a test that is more sensitive than the FEV1 for detection of airflow obstruction in its early stages. None has proven to be as reliable as the index obtained by dividing the FEV1 by the FVC. The forced expiratory flow between 25 and 75 percent of the FVC (also known as FEF25-75 or maximal mid-expiratory flow rate) should not be used to detect "small airways disease" in adults, due to poor specificity and reproducibility.

# Flow-volume loops

- The flow-volume loop is a plot of inspiratory and expiratory flow (on the Y-axis) against volume (on the X-axis) during the performance of maximally forced inspiratory and expiratory maneuvers. Changes in the contour of the loop can detect upper airway obstruction.

# Post-bronchodilator spirometry

- In patients who have evidence of airflow limitation on baseline spirometry, and no prior diagnosis of asthma or COPD, post-bronchodilator spirometry may be useful. If post-bronchodilator spirometry is normal, COPD is less likely.
- Note, however, that a bronchodilator response alone does not distinguish asthma from COPD [48]. If the change in spirometry post-bronchodilator does not support a diagnosis of obstructive lung disease, referral for bronchial challenge testing (eg, with methacholine or exercise) may be helpful.

# LIMITATIONS

Abnormal spirometry results have little if any value in prompting smokers to quit [50-54]. All patients who smoke should be advised to stop smoking and provided smoking cessation assistance.

●In a patient with asthma, which is characterized by variability in clinical symptoms and airflow obstruction, normal airflow at the time of office visits does not exclude airflow obstruction at other times.

●Patients with early interstitial lung disease may have normal spirometry and need further testing of gas transfer with a diffusing capacity of the lungs for carbon monoxide (DLCO) and/or exercise oximetry to identify the cause of dyspnea [55].

●Misclassification may occur when spirometry is performed

- There are multiple barriers to performing in-office spirometry. One comprehensive survey identified multiple barriers **including lack of knowledge about how to interpret spirometry, lack of resources (equipment, personnel, skills, time), and lack of belief in importance of results.** Most of the barriers identified were also true for out-of-office (ie, hospital) spirometry, indicating that implementing spirometry in general faces many challenges.

# RISKS

- Spirometry is a low-risk procedure and has few side effects [14]. During the test, some patients may experience dizziness. The forced expiratory maneuver causes an increase in the pressure in the chest, abdomen, head, and eyes. In general, patients who have recently (eg, less than six weeks) had abdominal, intracranial, or eye surgery or a pneumothorax should not perform spirometry, although data are limited.
- **Spirometry requires exertion and should be avoided in patients with unstable angina or a recent myocardial infarction.**
- Rarely, performance of a forced expiratory maneuver will precipitate acute bronchoconstriction. This seems more likely to occur when a patient's asthma or COPD is poorly controlled. Treatment includes administering inhaled albuterol and supplemental oxygen

**Table 2.** Relative Contraindications for Spirometry

| |
|---|
| Due to increases in myocardial demand or changes in blood pressure |
| Acute myocardial infarction within 1 wk |
| Systemic hypotension or severe hypertension |
| Significant atrial/ventricular arrhythmia |
| Noncompensated heart failure |
| Uncontrolled pulmonary hypertension |
| Acute cor pulmonale |
| Clinically unstable pulmonary embolism |
| History of syncope related to forced expiration/cough |
| Due to increases in intracranial/intraocular pressure |
| Cerebral aneurysm |
| Brain surgery within 4 wk |
| Recent concussion with continuing symptoms |
| Eye surgery within 1 wk |
| Due to increases in sinus and middle ear pressures |
| Sinus surgery or middle ear surgery or infection within 1 wk |
| Due to increases in intrathoracic and intraabdominal pressure |
| Presence of pneumothorax |
| Thoracic surgery within 4 wk |
| Abdominal surgery within 4 wk |
| Late-term pregnancy |
| Infection control issues |
| Active or suspected transmissible respiratory or systemic infection, including tuberculosis |
| Physical conditions predisposing to transmission of infections, such as hemoptysis, significant secretions, or oral lesions or oral bleeding |

# MONITORING

Office spirometry is also useful for monitoring control of asthma The National Asthma Education and Prevention Program advises the following frequencies for spirometry testing when caring for patients with asthma:

- At the time of initial assessment
- After treatment is initiated and symptoms and peak flow have stabilized
- During periods of progressive or prolonged loss of asthma control
- At least every one to two years

For patients with chronic obstructive pulmonary disease (COPD), repeat

**Contraindications to bronchial challenge testing**

| |
|---|
| **Airflow limitation** |
| $FEV_1$ <60% predicted (adults or children) or <1.5 L (adults) |
| $FEV_1$ <75% predicted (adults or children) for exercise or eucapnic voluntary hyperpnoea challenge |
| **Spirometry quality** |
| Inability to perform acceptable and repeatable spirometry maneuvers throughout the test procedure |
| **Cardiovascular and other problems** |
| Myocardial infarction or stroke in last three months |
| Uncontrolled hypertension |
| Known aortic aneurysm |
| Recent eye surgery or intracranial pressure elevation risk |
| **General** |
| Inability to perform any of the testing maneuvers, such as inhaling the challenge agent consistently or exercising on treadmill or bicycle during an exercise challenge |

**Medications that may affect bronchoprovocation challenge test[1-3]**

| Medication | Minimum time to omit medication before challenge tests |
|---|---|
| **Inhaled bronchodilators** | |
| Albuterol | 8 hours |
| Levalbuterol | 8 hours |
| Terbutaline | 8 hours |
| Formoterol, salmeterol | 36 hours |
| Ultra long-acting beta agonists (eg, indacaterol, olodaterol, vilanterol) | 48 hours |
| Short-acting muscarinic antagonist (ipratropium) | 12 hours |
| Long-acting muscarinic antagonists (aclidinium, glycopyrrolate, tiotropium) | 72 hours |
| **Oral theophylline** | 24 hours |
| **Oral albuterol** | 12 to 24 hours |
| **Inhaled glucocorticoid (budesonide, fluticasone propionate)*** | 6 hours |
| **Inhaled glucocorticoid (long acting; fluticasone furoate, ciclesonide)** | 24 hours |
| **Oral glucocorticoid*** | 2 to 3 weeks |
| **Cromolyn sodium¶** | 4 hours |
| **Antihistamines (cetirizine, fexofenadine, loratadine)** | 72 hours△ |
| **Leukotriene modifiers** | |
| Montelukast◊ | 4 days |
| Zafirlukast | 4 days |

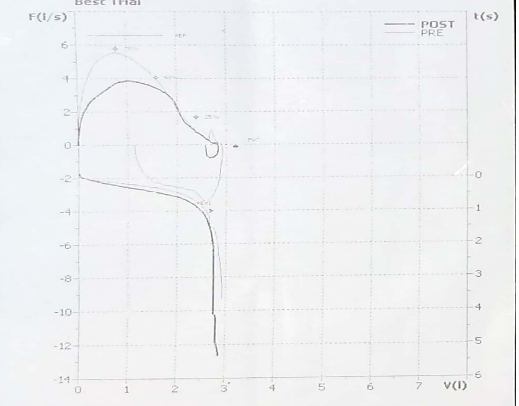
# Examples

Last Name: SHOKOOH FAR
First Name: SEDIGHEH
Company:
ID: 2649592303
User:
Height(cm): 165
Age: 47
Etnie: Caucasian

Date(mm-dd-yyyy): 05/29/2023
Gender: Female
Weight(Kg): 85.0
BMI(Kg/m^2): 31.2
Smoke: NO

Flowmeter calibration: 03/28/23
Gain Exp: 1033 Gain In: 1034 BTPS: 1.0854

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 2.94 | 3.20 | 92 | 2.88 | 98 |
| BestFEV1 | l | 2.57 | 2.74 | 94 | 2.51 | 98 |
| FVC | l | 2.94 | 3.20 | 92 | 2.88 | 98 |
| FEV1 | l | 2.57 | 2.74 | 94 | 2.51 | 98 |
| FEV1/FVC% | % | 87 | 80 | 109 | 87 | 100 |
| PEF | l/s | 5.56 | 6.55 | 85 | 3.88 | 70 |
| FEF25-75% | l/s | 3.54 | 3.38 | 104 | 3.23 | 91 |
| MEF75% | l/s | 5.56 | 5.74 | 97 | 3.61 | 65 |
| MEF50% | l/s | 4.39 | 4.03 | 109 | 3.65 | 83 |
| MEF25% | l/s | 1.51 | 1.67 | 91 | 1.53 | 101 |
| FET100% | s | 3.65 | | | 5.34 | 146 |
| VEXT | ml | 117 | | | 179 | 153 |

Predicted values: ERS93

Notes:

Signature: _____

COSMED
SHAHID BEHESHTI ANZALI
I-00041 Rome ITALY (www.cosmed.com)

Last Name: FAROKH ZAD
First Name: AZITA
Company:
ID: 2649245522
User:
Height(cm): 165
Age: 50
Etnie: Caucasian

Date(mm-dd-yyyy): 05/27/2023
Gender: Female
Weight(Kg): 90.0
BMI(Kg/m^2): 33.1
Smoke: NO

Flowmeter calibration: 03/28/23
Gain Exp: 1033 Gain In: 1034 BTPS: 1.0953

FORCED VITAL CAPACITY
Best Trial


| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 3.81 | 3.12 | 122 | 3.89 | 102 |
| BestFEV1 | l | 3.14 | 2.67 | 117 | 3.22 | 103 |
| FVC | l | 3.81 | 3.12 | 122 | 3.89 | 102 |
| FEV1 | l | 3.14 | 2.67 | 117 | 3.22 | 103 |
| FEV1/FVC% | % | 82 | 80 | 102 | 82 | 100 |
| PEF | l/s | 6.86 | 6.47 | 106 | 7.68 | 112 |
| FEF25-75% | l/s | 3.26 | 3.28 | 99 | 3.40 | 104 |
| MEF75% | l/s | 6.78 | 5.56 | 120 | 7.64 | 113 |
| MEF50% | l/s | 4.03 | 3.95 | 102 | 4.42 | 110 |
| MEF25% | l/s | 1.37 | 1.59 | 86 | 1.34 | 98 |
| FET100% | s | 4.11 | | | 4.07 | 99 |
| VEXT | ml | 88 | | | 87 | 99 |

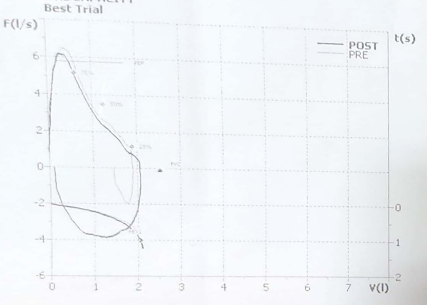
Predicted values: ERS93

COSMED
SHAHID BEHESHTI ANZALI
I-00041 Rome ITALY (www.cosmed.com)

Last Name: ZAFARI
First Name: ZOHREH
Company:
ID:
User: 2722206846 Date(mm-dd-yyyy): 05/29/2023
Height(cm): Gender: Female
Age: 160 Weight(Kg): 65.0
Etnie: 64 BMI(Kg/m^2): 25.4
Caucasian Smoke: NO

Flowmeter calibration: 03/28/23
Gain Exp: 1033 Gain In: 1034 BTPS: 1.0903

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 1.93 | 2.53 | 76 | 2.11 | 109 |
| BestFEV1 | l | | 2.12 | | 2.06 | |
| FVC | l | 1.93 | 2.53 | 76 | 2.11 | 109 |
| FEV1 | l | | 2.12 | | 2.06 | |
| FEV1/FVC% | % | | 77 | | 97 | |
| PEF | l/s | 6.50 | 5.77 | 113 | 6.26 | 96 |
| FEF25-75% | l/s | 3.52 | 2.74 | 129 | 2.87 | 81 |
| MEF75% | l/s | 6.46 | 5.15 | 125 | 5.71 | 88 |
| MEF50% | l/s | 3.76 | 3.48 | 108 | 2.98 | 79 |
| MEF25% | l/s | 2.33 | 1.19 | 196 | 1.66 | 71 |
| FET100% | s | 0.67 | | | 1.21 | 180 |
| VEXT | ml | 49 | | | 30 | 61 |

Predicted values: ERS93

Notes:

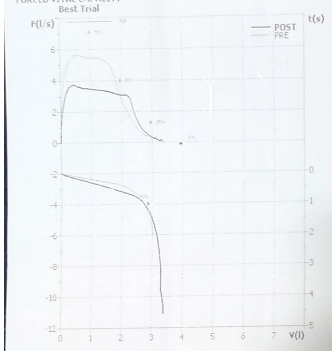
Signature: _____

COSMED
SHAHID BEHESHTI ANZALI
I-00041 Rome ITALY (www.cosmed.com)

Last Name: SAMADI
First Name: GHOLAM
Company:
ID: 2649801093 Date(mm-dd-yyyy): 05/29/2023
User: Gender: Male
Height(cm): 180 Weight(Kg): 85.0
Age: 80 BMI(Kg/m^2): 26.2
Etnie: Caucasian Smoke: NO

Flowmeter calibration: 03/28/23
Gain Exp: 1033 Gain In: 1034 BTPS: 1.0804

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 3.03 | 3.95 | 77 | 3.38 | 112 |
| BestFEV1 | l | 2.73 | 2.93 | 93 | 2.75 | 101 |
| FVC | l | 3.03 | 3.95 | 77 | 3.38 | 112 |
| FEV1 | l | 2.73 | 2.93 | 93 | 2.75 | 101 |
| FEV1/FVC% | % | 90 | 73 | 123 | 81 | 90 |
| PEF | l/s | 5.64 | 7.76 | 73 | 3.78 | 67 |
| FEF25-75% | l/s | 3.97 | 2.75 | 144 | 3.01 | 76 |
| MEF75% | l/s | 5.54 | 7.04 | 79 | 3.53 | 64 |
| MEF50% | l/s | 5.20 | 3.99 | 130 | 3.27 | 63 |
| MEF25% | l/s | 1.80 | 1.28 | 141 | 1.48 | 82 |
| FET100% | s | 2.06 | | | 4.53 | 220 |
| VEXT | ml | 58 | | | 64 | 110 |

Predicted values: ERS93

Notes:

Signature: _____

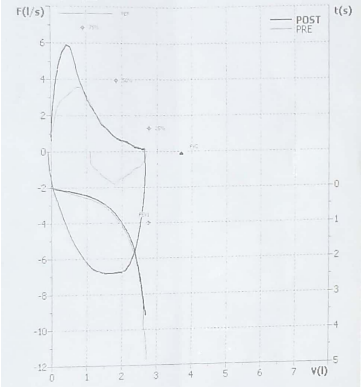
I-00041 Rome ITALY (www.cosmed.com)

Last Name: AZIZI
First Name: ALI ASGHAR
Company:
ID: 2649046260
User:
Height(cm):
Age:
Etnie: Caucasian

Date(mm-dd-yyyy): 05/29/2023
Gender: Male
Weight(Kg): 61.0
BMI(Kg/m^2): 27.4
Smoke: NO

Flowmeter calibration: 03/28/23
Gain Exp: 1033 Gain In: 1034 BTPS: 1.0903

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 2.72 | 3.69 | 73 | **2.68** | 99 |
| BestFEV1 | l | 1.96 | 2.82 | 69 | **2.01** | 103 |
| FVC | l | 2.72 | 3.69 | 73 | **2.68** | 99 |
| FEV1 | l | 1.96 | 2.82 | 69 | **2.01** | 103 |
| FEV1/FVC% | % | 72 | 74 | 97 | **74** | 103 |
| PEF | l/s | 3.60 | 7.61 | 47 | **5.94** | 165 |
| FEF25-75% | l/s | 1.45 | 2.94 | 49 | **1.50** | 104 |
| MEF75% | l/s | 3.44 | 6.83 | 50 | **5.06** | 147 |
| MEF50% | l/s | 1.90 | 3.94 | 48 | **1.89** | 100 |
| MEF25% | l/s | 0.62 | 1.28 | 48 | **0.62** | 101 |
| FET100% | s | 4.82 | | | **3.58** | 74 |
| VEXT | ml | 105 | | | **59** | 56 |

Predicted values: ERS93

Notes:

Signature:

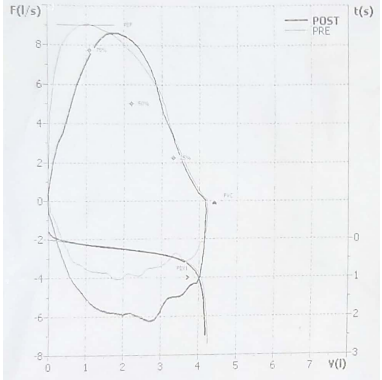
I-00041 Rome ITALY (www.cosmed.com)

Last Name: POREMAM
First Name: FAZEL
Company:
ID: 2620317177
User:
Height(cm): 165
Age: 29
Etnie: Caucasian

Date(mm-dd-yyyy): 05/31/2023
Gender: Male
Weight(Kg): 92.0
BMI(Kg/m^2): 33.8
Smoke: NO

Flowmeter calibration: 05/29/23
Gain Exp: 1040 Gain In: 1039 BTPS: 1.0953

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 4.26 | 4.41 | 96 | **4.20** | 99 |
| BestFEV1 | l | 4.05 | 3.76 | 107 | **3.99** | 99 |
| FVC | l | 4.26 | 4.41 | 96 | **4.20** | 99 |
| FEV1 | l | 4.05 | 3.76 | 107 | **3.99** | 99 |
| FEV1/FVC% | % | 94 | 82 | 115 | **95** | 101 |
| PEF | l/s | 9.11 | 9.03 | 101 | **8.65** | 95 |
| FEF25-75% | l/s | 7.19 | 4.65 | 154 | **7.23** | 100 |
| MEF75% | l/s | 9.08 | 7.70 | 118 | **7.34** | 81 |
| MEF50% | l/s | 7.83 | 5.01 | 156 | **8.33** | 106 |
| MEF25% | l/s | 4.03 | 2.21 | 182 | **4.03** | 100 |
| FET100% | s | 2.72 | | | **2.50** | 92 |
| VEXT | ml | 58 | | | **423** | 729 |

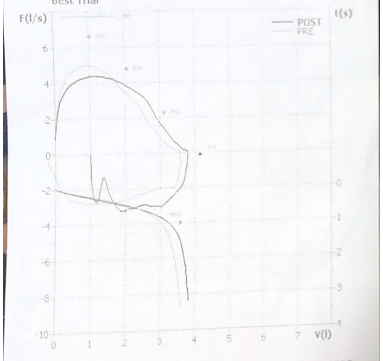
Predicted values: ERS93

**COSMED**
SHAHID BEHESHTI ANZALI
I-00041 Rome ITALY (www.cosmed.com)

Last Name: GHOJINVAN
First Name: NARJES
Company:
ID: 2640170341 Date(mm-dd-yyyy): 06/01/2023
User: Gender: Female
Height(cm): 175 Weight(Kg): 109.0
Age: 27 BMI(Kg/m^2): 35.6
Etnie: Caucasian Smoke: NO

Flowmeter calibration: 05/29/23
Gain Exp: 1040 Gain In: 1039 BTPS: 1.1098

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 3.60 | 4.16 | 86 | 3.82 | 106 |
| BestFEV1 | l | 3.05 | 3.64 | 84 | 3.27 | 107 |
| FVC | l | 3.60 | 4.16 | 86 | 3.82 | 106 |
| FEV1 | l | 3.05 | 3.64 | 84 | 3.27 | 107 |
| FEV1/FVC% | % | 84 | 84 | 100 | 85 | 101 |
| PEF | l/s | 5.01 | 7.70 | 65 | 4.41 | 88 |
| MEF25-75% | l/s | 3.45 | 4.19 | 82 | 3.70 | 107 |
| MEF75% | l/s | 5.00 | 6.56 | 76 | 4.36 | 87 |
| MEF50% | l/s | 3.97 | 4.77 | 83 | 4.01 | 101 |
| MEF25% | l/s | 1.69 | 2.27 | 74 | 2.24 | 133 |
| FET100% | s | 3.33 | | | 3.18 | 95 |
| VEXT | ml | 102 | | | 146 | 143 |

Predicted values: ERS93

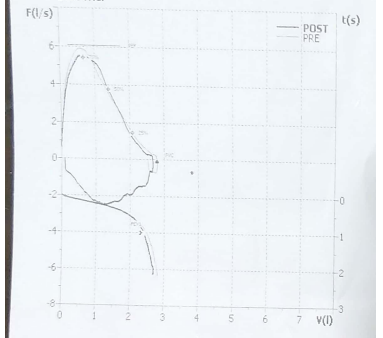
Notes:

**COSMED**
SHAHID BEHESHTI ANZALI
I-00041 Rome ITALY (www.cosmed.com)

Last Name: PASAND
First Name: FARZANEH
Company:
ID: 5709192953 Date(mm-dd-yyyy): 06/07/2023
User: Gender: Female
Height(cm): 160 Weight(Kg): 51.0
Age: 54 BMI(Kg/m^2): 19.9
Etnie: Caucasian Smoke: NO

Flowmeter calibration: 05/29/23
Gain Exp: 1040 Gain In: 1039 BTPS: 1.1146

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 2.83 | 2.79 | 101 | 2.70 | 96 |
| BestFEV1 | l | 2.48 | 2.37 | 104 | 2.40 | 97 |
| FVC | l | 2.83 | 2.79 | 101 | 2.70 | 96 |
| FEV1 | l | 2.48 | 2.37 | 104 | 2.40 | 97 |
| FEV1/FVC% | % | 87 | 79 | 110 | 88 | 101 |
| PEF | l/s | 5.94 | 6.07 | 98 | 5.61 | 94 |
| MEF25-75% | l/s | 3.07 | 3.08 | 99 | 3.24 | 106 |
| MEF75% | l/s | 5.84 | 5.40 | 108 | 5.56 | 96 |
| MEF50% | l/s | 3.56 | 3.73 | 96 | 3.90 | 109 |
| MEF25% | l/s | 1.42 | 1.44 | 99 | 1.42 | 100 |
| FET100% | s | 2.16 | | | 2.13 | 99 |
| VEXT | ml | 77 | | | 90 | 117 |

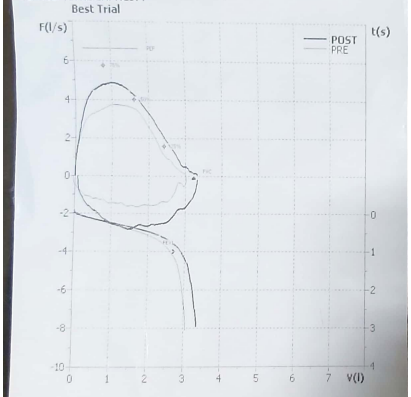
Predicted values: ERS93

**COSMED**
SHAHID BEHESHTI ANZALI
I-00041 Rome ITALY (www.cosmed.com)

| | | | |
|---|---|---|---|
| Last Name: | SAFAVI | | |
| First Name: | SEYEDEHKOKAB | | |
| Company: | | | |
| ID: | 5169509782 | Date(mm-dd-yyyy): | 06/12/2023 |
| User: | | Gender: | Female |
| Height(cm): | 170 | Weight(Kg): | 88.0 |
| Age: | 54 | BMI(Kg/m^2): | 30.4 |
| Etnie: | Caucasian | Smoke: | NO |

Flowmeter calibration: 05/29/23
Gain Exp: 1040 Gain In: 1039 BTPS: 1.1050

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 3.06 | 3.24 | 94 | 3.36 | 110 |
| BestFEV1 | l | 2.61 | 2.77 | 94 | 2.90 | 111 |
| FVC | l | 3.06 | 3.24 | 94 | 3.36 | 110 |
| FEV1 | l | 2.61 | 2.77 | 94 | 2.90 | 111 |
| FEV1/FVC% | % | 85 | 79 | 108 | 86 | 101 |
| PEF | l/s | 3.74 | 6.62 | 56 | 4.89 | 131 |
| FEF25-75% | l/s | 3.05 | 3.21 | 95 | 3.52 | 115 |
| MEF75% | l/s | 3.50 | 5.72 | 61 | 4.82 | 138 |
| MEF50% | l/s | 3.61 | 3.97 | 91 | 4.19 | 116 |
| MEF25% | l/s | 1.63 | 1.54 | 105 | 1.83 | 112 |
| FET100% | s | 3.05 | | | 2.94 | 97 |
| VEXT | ml | 136 | | | 119 | 88 |

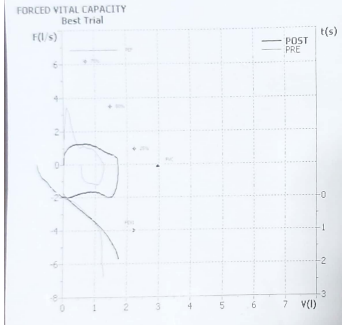
Predicted values: ER593

**COSMED**
SHAHID BEHESHTI ANZALI
I-00041 Rome ITALY (www.cosmed.com)

| | | | |
|---|---|---|---|
| Last Name: | FEYZI | | |
| First Name: | BYOK | | |
| Company: | | | |
| ID: | 1462005306 | Date(mm-dd-yyyy): | 06/10/2023 |
| User: | | Gender: | Male |
| Height(cm): | 160 | Weight(kg): | 53.0 |
| Age: | 73 | BMI(kg/m^2): | 20.7 |
| Etnie: | Caucasian | Smoke: | YES |

Flowmeter calibration: 05/29/23
Gain Exp: 1040 Gain In: 1039 BTPS: 1.0903

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 1.29 | 2.98 | 43 | 1.75 | 136 |
| BestFEV1 | l | 1.15 | 2.27 | 51 | 1.27 | 110 |
| FVC | l | 1.29 | 2.98 | 43 | 1.75 | 136 |
| FEV1 | l | 1.15 | 2.27 | 51 | 1.27 | 110 |
| FEV1/FVC% | % | 89 | 74 | 120 | 72 | 81 |
| PEF | l/s | 3.63 | 6.84 | 53 | 1.25 | 34 |
| FEF25-75% | l/s | 1.10 | 2.66 | 41 | 1.11 | 101 |
| MEF75% | l/s | 1.99 | 6.15 | 32 | 1.22 | 61 |
| MEF50% | l/s | 1.13 | 3.45 | 33 | 1.22 | 108 |
| MEF25% | l/s | 0.91 | 0.94 | 97 | 0.82 | 90 |
| FET100% | s | 2.37 | | | 1.05 | 78 |
| VEXT | ml | | | | 121 | |
| LungAge | Yrs | 105 | | | | |

Predicted values: ER593

Notes:

Signature:

# COSMED

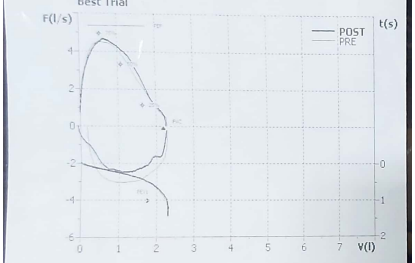
SHAHID BEHESHTI ANZALI
I-00041 Rome ITALY (www.cosmed.com)

Last Name: MAAROFZADEH
First Name: HAJAR
Company:
ID: 2679557042
User:
Height(cm): 152
Age: 63
Etnie: Caucasian

Date(mm-dd-yyyy): 06/10/2023
Gender: Female
Weight(Kg): 61.0
BMI(Kg/m^2): 26.4
Smoke: NO

Flowmeter calibration: 05/29/23
Gain Exp: 1040 Gain In: 1039 BTPS: 1.1001

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 2.33 | 2.21 | 106 | **2.31** | 99 |
| BestFEV1 | l | 2.25 | 1.83 | 123 | **2.27** | 101 |
| FVC | l | 2.33 | 2.21 | 106 | **2.31** | 99 |
| FEV1 | l | 2.25 | 1.83 | 123 | **2.27** | 101 |
| FEV1/FVC% | % | 96 | 77 | 125 | **98** | 102 |
| PEF | l/s | 4.51 | 5.36 | 84 | **4.70** | 104 |
| FEF25-75% | l/s | 3.29 | 2.68 | 123 | **3.61** | 110 |
| MEF75% | l/s | 4.50 | 4.92 | 91 | **4.58** | 102 |
| MEF50% | l/s | 3.72 | 3.31 | 112 | **4.07** | 109 |
| MEF25% | l/s | 1.95 | 1.13 | 172 | **2.19** | 112 |
| FET100% | s | 1.22 | | | **1.41** | 115 |
| VEXT | ml | 76 | | | **92** | 121 |

Predicted values: ERS93

Notes:

Signature:

# COSMED

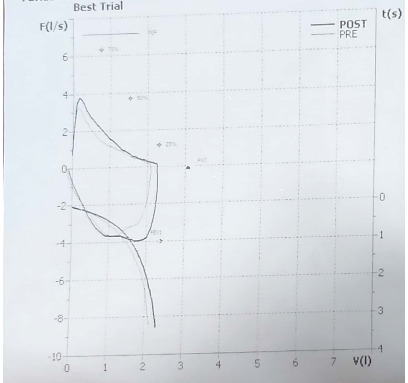
SHAHID BEHESHTI ANZALI
I-00041 Rome ITALY (www.cosmed.com)

Last Name: DERAGHSHANIFAR
First Name: REZA
Company:
ID: 2648822216
User:
Height(cm): 157
Age: 62
Etnie: Caucasian

Date(mm-dd-yyyy): 06/10/2023
Gender: Male
Weight(Kg): 52.0
BMI(Kg/m^2): 21.1
Smoke: YES

Flowmeter calibration: 05/29/23
Gain Exp: 1040 Gain In: 1039 BTPS: 1.0854

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 2.13 | 3.09 | 69 | **2.31** | 108 |
| BestFEV1 | l | 1.46 | 2.46 | 59 | **1.63** | 112 |
| FVC | l | 2.13 | 3.09 | 69 | **2.31** | 108 |
| FEV1 | l | 1.46 | 2.46 | 59 | **1.63** | 112 |
| FEV1/FVC% | % | 68 | 76 | 89 | **70** | 103 |
| PEF | l/s | 3.37 | 7.12 | 47 | **3.91** | 116 |
| FEF25-75% | l/s | 1.06 | 3.08 | 34 | **1.17** | 111 |
| MEF75% | l/s | 2.09 | 6.30 | 33 | **2.61** | 125 |
| MEF50% | l/s | 1.15 | 3.68 | 31 | **1.39** | 121 |
| MEF25% | l/s | 0.59 | 1.15 | 52 | **0.58** | 99 |
| FET100% | s | 3.22 | | | **3.27** | 101 |
| VEXT | ml | | | | **18** | |
| LungAge | Yrs | 92 | | | | |

Predicted values: ERS93

# COSMED

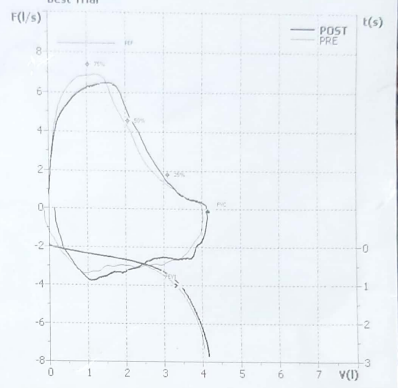
SHAHID BEHESHTI ANZALI
I-00041 Rome ITALY (www.cosmed.com)

Last Name: SADAT
First Name: SEYEDKARIM
Company:
ID: 2649705558
User:
Height(cm): 170
Age: 50
Etnie: Caucasian

Date(mm-dd-yyyy): 06/10/2023
Gender: Male
Weight(Kg): 70.0
BMI(Kg/m^2): 24.2
Smoke: NO

Flowmeter calibration: 05/29/23
Gain Exp: 1040 Gain In: 1039 BTPS: 1.0903

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 4.04 | 4.15 | 97 | **4.16** | 103 |
| BestFEV1 | l | 3.32 | 3.37 | 98 | **3.43** | 103 |
| FVC | l | 4.04 | 4.15 | 97 | **4.16** | 103 |
| FEV1 | l | 3.32 | 3.37 | 98 | **3.43** | 103 |
| FEV1/FVC% | % | 82 | 78 | 105 | **82** | 100 |
| PEF | l/s | 6.90 | 8.44 | 82 | **6.49** | 94 |
| FEF25-75% | l/s | 3.34 | 3.85 | 87 | **3.77** | 113 |
| MEF75% | l/s | 6.79 | 7.36 | 92 | **6.29** | 93 |
| MEF50% | l/s | 4.36 | 4.54 | 96 | **5.02** | 115 |
| MEF25% | l/s | 1.42 | 1.80 | 79 | **1.47** | 103 |
| FET100% | s | 2.64 | | | **2.86** | 108 |
| VEXT | ml | 118 | | | **177** | 150 |

Predicted values: ER593

# COSMED

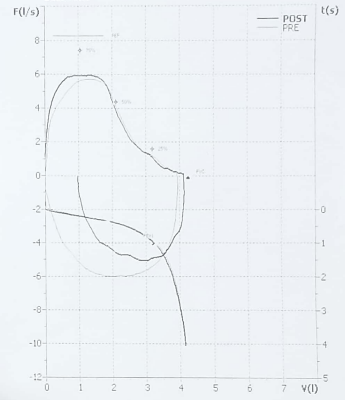
SHAHID BEHESHTI ANZALI
I-00041 Rome ITALY (www.cosmed.com)

Last Name: FALLAHGAR
First Name: AALA
Company:
ID: 2649508884
User:
Height(cm): 180
Age: 68
Etnie: Caucasian

Date(mm-dd-yyyy): 06/12/2023
Gender: Male
Weight(Kg): 71.0
BMI(Kg/m^2): 21.9
Smoke: YES

Flowmeter calibration: 05/29/23
Gain Exp: 1040 Gain In: 1039 BTPS: 1.0903

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 3.96 | 4.26 | 93 | **4.16** | 105 |
| BestFEV1 | l | 3.29 | 3.28 | 100 | **3.26** | 99 |
| FVC | l | 3.96 | 4.26 | 93 | **4.16** | 105 |
| FEV1 | l | 3.29 | 3.28 | 100 | **3.26** | 99 |
| FEV1/FVC% | % | 82 | 75 | 109 | **78** | 95 |
| PEF | l/s | 5.71 | 8.28 | 69 | **5.95** | 104 |
| FEF25-75% | l/s | 3.38 | 3.27 | 104 | **2.97** | 88 |
| MEF75% | l/s | 5.59 | 7.39 | 76 | **5.92** | 106 |
| MEF50% | l/s | 5.01 | 4.36 | 115 | **4.09** | 82 |
| MEF25% | l/s | 1.44 | 1.59 | 90 | **1.31** | 91 |
| FET100% | s | 2.55 | | | **4.03** | 158 |
| VEXT | ml | 199 | | | **117** | 59 |

Predicted values: ER593

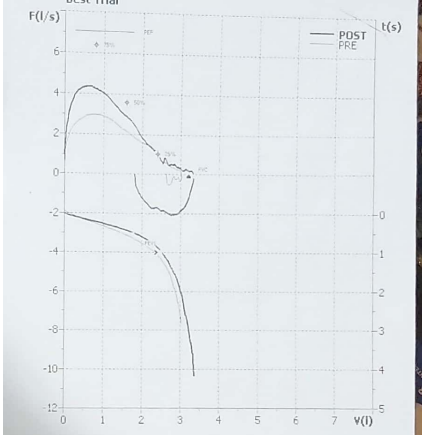
Rome ITALY (www.cosmed.com)

Last Name: SADRI
First Name: MAHMOOD
Company:
ID: 2593612673
User:
Height(cm): 165
Age: 75
Etnie: Caucasian

Date(mm-dd-yyyy): 06/12/2023
Gender: Male
Weight(Kg): 63.0
BMI(Kg/m^2): 23.1
Smoke: NO

Flowmeter calibration: 05/29/23
Gain Exp: 1040 Gain In: 1039 BTPS: 1.1050

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 3.04 | 3.21 | 95 | **3.38** | 111 |
| BestFEV1 | l | 2.35 | 2.43 | 96 | **2.54** | 108 |
| FVC | l | 3.04 | 3.21 | 95 | **3.38** | 111 |
| FEV1 | l | 2.33 | 2.43 | 96 | **2.54** | 109 |
| FEV1/FVC% | % | 76 | 74 | 103 | **75** | 99 |
| PEF | l/s | 2.98 | 7.06 | 42 | **4.40** | 148 |
| FEF25-75% | l/s | 2.12 | 2.68 | 79 | **2.12** | 100 |
| MEF75% | l/s | 2.98 | 6.36 | 47 | **4.25** | 142 |
| MEF50% | l/s | 2.28 | 3.58 | 63 | **2.79** | 123 |
| MEF25% | l/s | 1.38 | 1.02 | 135 | **0.74** | 53 |
| FET100% | s | 2.83 | | | **4.17** | 148 |
| VEXT | ml | 120 | | | **47** | 39 |

**Predicted values:** ERS93

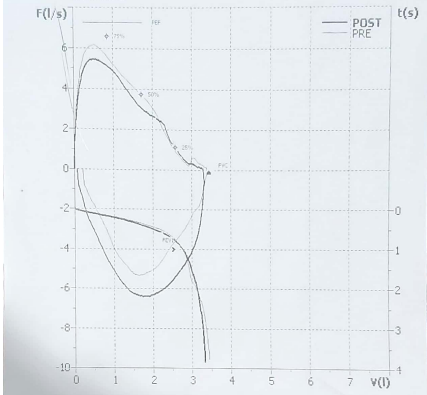
---

Last Name: HASAN ALI
First Name: MAHDI
Company:
ID: 0532739213
User:
Height(cm): 170
Age: 77
Etnie: Caucasian

Date(mm-dd-yyyy): 06/12/2023
Gender: Male
Weight(Kg): 53.0
BMI(Kg/m^2): 18.3
Smoke: NO

Flowmeter calibration: 05/29/23
Gain Exp: 1040 Gain In: 1039 BTPS: 1.0854

FORCED VITAL CAPACITY
Best Trial




| Parameter | UM | PRE | Pred | %Pred | POST | %PRE |
|---|---|---|---|---|---|---|
| BestFVC | l | 3.44 | 3.45 | 100 | **3.38** | 98 |
| BestFEV1 | l | 2.77 | 2.59 | 107 | **2.78** | 100 |
| FVC | l | 3.44 | 3.45 | 100 | **3.34** | 97 |
| FEV1 | l | 2.77 | 2.59 | 107 | **2.78** | 100 |
| FEV1/FVC% | % | 80 | 73 | 110 | **83** | 104 |
| PEF | l/s | 6.18 | 7.28 | 85 | **5.48** | 89 |
| FEF25-75% | l/s | 2.90 | 2.69 | 108 | **3.02** | 104 |
| MEF75% | l/s | 5.53 | 6.58 | 84 | **5.22** | 94 |
| MEF50% | l/s | 3.80 | 3.71 | 102 | **3.20** | 84 |
| MEF25% | l/s | 1.00 | 1.10 | 91 | **1.40** | 139 |
| FET100% | s | 3.74 | | | **3.83** | 102 |
| VEXT | ml | 37 | | | **49** | 132 |

**Predicted values:** ERS93