



Pulmonary Function Tests

Interpretation · Ratio first, then volumes, then transfer factor

USE Z-SCORES
not % predicted

READ IT IN THIS ORDER *three steps, and the sequence prevents most errors*

1 · IS THERE OBSTRUCTION?

Look at the **FEV₁/FVC ratio**. Below the **lower limit of normal (LLN)** defines obstruction. Use the LLN rather than a fixed 0.70, which **over-diagnoses obstruction in the elderly** and under-diagnoses it in the young.

2 · IS THERE RESTRICTION?

Only total lung capacity can confirm restriction, and TLC requires body plethysmography or gas dilution. **A low FVC on spirometry alone suggests but does not prove restriction** — it is also produced by air trapping, poor effort, or neuromuscular weakness.

3 · WHAT IS THE DLCO?

The transfer factor separates causes with identical spirometry. **Correct for hemoglobin** — anemia falsely lowers it and polycythemia falsely raises it — and remember it is also raised by **alveolar hemorrhage** and by left-to-right shunt.

THE 2022 INTERPRETATION UPDATE *two changes that alter who gets labelled abnormal*

Change	What it means
Race-neutral reference equations	The GLI 2022 race-neutral equations are now recommended by ATS and ERS, replacing race-specific equations. Applying them reclassified a large proportion of patients as having normal physiology or less severe impairment, and increased the proportion of Black individuals identified with restrictive impairment from roughly 27% to 38%. The change matters for disability assessment, transplant listing and eligibility thresholds.
Z-scores, not per cent predicted	Severity should be graded by z-score rather than per cent predicted or fixed cut-offs. A z-score expresses how many standard deviations a value sits from the predicted mean for that age, height and sex — so the LLN corresponds to a z-score of -1.645 , the 5th percentile.
Why it matters	Per cent predicted misleads at the extremes of age and height, systematically over-calling abnormality in older and shorter patients. Z-scores apply one consistent statistical threshold across the whole population.

MATCH THE PATTERN TO THE DISEASE *spirometry plus DLCO usually names it*

Pattern	Numbers	Typical causes
Obstructive, low DLCO	FEV ₁ /FVC ↓, TLC normal or ↑, DLCO ↓	Emphysema — alveolar destruction reduces the surface for transfer.
Obstructive, normal DLCO	FEV ₁ /FVC ↓, DLCO normal	Asthma and chronic bronchitis. Asthma also shows bronchodilator reversibility .
Restrictive, low DLCO	TLC ↓ , ratio normal or ↑, DLCO ↓	Interstitial lung disease — the parenchyma itself is diseased.
Restrictive, normal DLCO	TLC ↓ , DLCO normal	Extrapulmonary restriction — obesity, chest wall disease, kyphoscoliosis, neuromuscular weakness , pleural disease. The lungs are normal; something limits their expansion.
Isolated low DLCO	Spirometry and volumes normal	Pulmonary vascular disease — consider pulmonary hypertension or chronic thromboembolic disease. Also early ILD and anemia.

TECHNICAL POINTS THAT CHANGE INTERPRETATION *check these before believing the numbers*

QUALITY FIRST

Look at the flow-volume loop before the numbers. Poor effort, early termination, cough and leaks all invalidate the study. **Flattening of the inspiratory limb** suggests extrathoracic upper airway obstruction, and flattening of both limbs suggests a fixed lesion — findings you will miss entirely if you only read the table.

BRONCHODILATOR RESPONSE & NEUROMUSCULAR

Significant reversibility supports asthma, but **its absence does not exclude it** — test on a symptomatic day or consider bronchial challenge. For suspected **neuromuscular weakness**, request **supine as well as erect FVC**: a fall of more than about 20% lying flat suggests **diaphragmatic weakness**, and add maximal inspiratory and expiratory pressures.

GRADING SEVERITY AND JUDGING CHANGE *what counts as worse*

Question	Answer
How severe is it?	Grade by z-score of the relevant index — FEV ₁ for obstruction. The further below -1.645, the more severe. This replaces the older per-cent-predicted bands, which behaved inconsistently across age and height.
Has it genuinely changed?	Compare against within-subject variability , not the predicted value. Small fluctuations between tests are expected; a relative FVC decline of ≥ 10% or DLCO decline of ≥ 15% over a year are the thresholds used to define progression in fibrotic lung disease.
Is the test valid?	Check acceptability and repeatability criteria before interpreting. An unacceptable maneuver produces numbers that look authoritative and mean nothing — the commonest cause of a spuriously "restrictive" report is submaximal effort.
Mixed pattern?	Reduced ratio AND reduced TLC indicates genuine combined obstruction and restriction — but confirm with lung volumes, since severe air trapping alone reduces FVC and mimics restriction on spirometry.

THE ADJUNCTIVE TESTS *what to add when spirometry is not the answer*

FUNCTIONAL & PROVOCATION

Six-minute walk test — distance plus **desaturation**, which identifies ambulatory oxygen needs and tracks ILD and pulmonary hypertension. **Cardiopulmonary exercise testing** to separate cardiac from respiratory from deconditioning causes of breathlessness. **Bronchial challenge** (methacholine or mannitol) where asthma is suspected but spirometry is normal — **a negative challenge has a high negative predictive value**.

SPECIALISED MEASURES

Maximal inspiratory and expiratory pressures and **supine FVC** for neuromuscular disease. **F_{en}O** as a marker of type 2 airway inflammation in asthma. **Arterial or capillary blood gases** where hypercapnia is possible — spirometry says nothing about ventilation adequacy, and a normal FEV₁ does not exclude respiratory failure in neuromuscular or chest wall disease.

PEARLS & PITFALLS

- Do not use a fixed FEV₁/FVC of 0.70. Use the LLN, or you will over-diagnose COPD in older patients and miss it in younger ones.
- Spirometry cannot diagnose restriction. A low FVC needs lung volumes before you call it restrictive.
- Correct DLCO for hemoglobin. An uncorrected value in an anemic patient looks like parenchymal disease.
- Race-neutral GLI equations are the current standard and materially change who is labelled impaired.
- Look at the loop. Upper airway obstruction and poor-quality studies are visible only in the shape of the curve.
- An isolated low DLCO with normal spirometry should prompt thought of pulmonary vascular disease, not reassurance.

References: ERS/ATS technical standard on interpretive strategies for routine lung function tests (Eur Respir J, 2022) · ATS statement on a race-neutral approach to the interpretation of lung function measurements · Global Lung Function Initiative 2022 reference equations.

Educational aid; verify against local laboratory reference standards and patient factors.

