Joint statement from GOLD/GLI regarding the use of spirometry to define airflow obstruction and diagnose COPD

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Shareable abstract (@ERSpublications)
GOLD and GLI agree on many important issues regarding diagnosing COPD with spirometry, sharing concerns about under-use and agreeing that, in the appropriate clinical context, the fixed ratio can be used to identify COPD-related airflow obstruction https://bit.ly/4tB8cZt

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Introduction

COPD is one of the leading causes of morbidity and mortality worldwide [1]. Spirometry provides an objective measure of airflow obstruction that, in the appropriate clinical context, confirms the diagnosis of COPD. However, globally, access to spirometry is limited, the test is under-utilised, and many people are either misdiagnosed [2] or under-diagnosed [3, 4]. The intrathoracic airway obstruction that characterises COPD can be detected by finding expiratory flow limitation on spirometry. A reduced forced expiratory volume in 1 s (FEV_1) to forced vital capacity (FVC) ratio demonstrates flow limitation, but for more than 30 years there has been an unproductive debate about which threshold should be used to define airflow limitation and identify airway obstruction in patients with suspected COPD. In this viewpoint article, we focus on the use of spirometry use in routine clinical practice to confirm or exclude a diagnosis of COPD, and aim to propose a way forward to end the debate.

What is the debate?

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) recommends that a *fixed ratio*, defined as a post-bronchodilator FEV_1/FVC <0.7, is used to define COPD-related airflow obstruction and confirm the diagnosis in people with a medical history suggestive of COPD [5, 6]. Since the original 2001 GOLD report [7], the GOLD committee has regularly reviewed this recommendation [8] and has left it unchanged, as it is simple and independent of reference values [5].

Although the 2004 American Thoracic Society (ATS)/European Respiratory Society (ERS) recommendations on the diagnosis and treatment of patients with COPD also recommends using the fixed ratio [9], the ATS/ERS statements on spirometry and interpretive strategies for routine lung function tests, and the Global Lung Function Initiative (GLI) recommend using a defined *lower limit of normal* (LLN) value for the FEV_1/FVC ratio to define airflow obstruction [10]. The LLN is a threshold that is based on a lower boundary defined by the distribution of measurements taken from a healthy population. The LLN is typically set at the lower 5th percentile of reference populations with similar age, height and sex [11].

Neither threshold is intrinsically right or wrong. Each threshold for defining airflow obstruction evolved to solve different problems, and discordance between the criteria reflect fundamentally different goals. The threshold proposed by GOLD was intended to be a pragmatic approach for confirmation of the diagnosis of COPD in everyday practice. The threshold proposed by GLI intends to reflect the variability in lung function measures observed between individuals in populations. Both approaches have been criticised. The fixed ratio has the advantage of its simplicity; however, it ignores potential age-related lung function changes and may identify fewer younger and more older individuals as having airflow obstruction [12, 13]. The LLN considers age-related changes in lung function, reflecting loss of tissue elasticity, but crucially depends on the characteristics of the reference population and assumes the reference population is "healthy". Some individuals included in populations used to define "normal ranges" may have had undiagnosed or sub-clinical disease, leading to distortion of the LLN values. By considering age-related decline as physiologically normal, use of the LLN identifies more younger and fewer older individuals as having airflow obstruction. If used without reference to the presence of symptoms or exposure to risk factors for COPD, the LLN will falsely label some healthy younger individuals as having COPD.

There is increasing recognition of the importance of early detection in COPD and that COPD is a heterogeneous condition. The potential for the LLN to increase sensitivity in younger individuals with early COPD or at increased risk for COPD is especially relevant in this context. Detection of the condition earlier may allow for earlier intervention, but the potential for over-diagnosis of COPD by the LLN in younger people must also be considered [14–20]. In practice, both approaches are useful for confirming disease in people with respiratory symptoms and significant exposure history, and neither is perfect.

Studies have shown that older current and ex-smokers classified as obstructed using the fixed ratio but "normal" using the LLN (*i.e.* discordant results) have more respiratory symptoms, worse exercise tolerance, lower FEV_1 and FVC, lower gas transfer, more gas trapping, more structural abnormalities on computed tomography, an increased risk of exacerbations, COPD-related hospitalisations and death, and an increased prevalence of multi-morbidities, including cardiovascular disease [14, 15, 17, 21]. It appears, therefore, that using the fixed ratio can identify clinically relevant early disease in people at risk of COPD before overt obstruction is found by the LLN.

The divergent recommendations about spirometry interpretation have confused primary and secondary care clinicians, as well as pulmonologists. An unintended consequence, especially in primary care, has been the development of a perception that spirometry is a difficult test to perform and interpret, leading to under-use of spirometry to confirm the diagnosis of COPD [22, 23].

GLI and GOLD agree that the differences in recommendations about thresholds of "abnormality" are outweighed by shared concerns about the under-use of spirometry. The false dichotomy in applying thresholds and comparing these two approaches ignores the clinical context. In practice, only a small proportion of people are classified differently by the two approaches. The points of agreement are often overlooked and there is a widespread perception that there is strong disagreement between the organisations, with partisan views that one is right and one is wrong. This is far from the truth. GLI and GOLD share common goals and recently have worked closely together on these.

Spirometry is a key indicator of airflow obstruction, a hallmark feature of COPD

GOLD and GLI agree that COPD is characterised by airflow obstruction, and FEV_1/FVC measured by spirometry is currently the most appropriate objective biomarker of the airflow obstruction. GOLD and GLI agree that spirometry alone is not sufficient to make a diagnosis of COPD, and neither GOLD nor GLI recommend the diagnosis or labelling of patients with disease in the absence of a clinical history or based on a pulmonary function test result alone, and recognise the harms associated with diagnosing "disease" in a healthy individual.

Innovation may lead to the introduction of alternatives to spirometry and there may be ways of integrating complementary tests, such as oscillometry, CO_2 breath analysis, optoplethysmography or imaging techniques. Artificial intelligence (AI) may facilitate integration and may be more sensitive at detecting impairments, especially in the small airways or in patients with mixed patterns of restriction and obstruction [24]. However, these innovations may not be widely available and are unlikely to improve access to diagnostic testing.

Spirometry is under-utilised

Studies in many countries show that most people with a diagnostic label of COPD had not had spirometry performed [2, 22, 25–30]. Lack of access to spirometry, lack of confidence in interpreting the results, and

patient reluctance to attend and perform spirometry, have all been identified as barriers to its use [31, 32]. Education programmes can help overcome some of these [33] and AI may also help to improve spirometry quality in situations where confidence and understanding is poor.

Spirometry is a simple test to perform

GOLD and GLI agree that it is important to promote the message that spirometry is a simple and inexpensive test to perform. Spirometry is used in a number of contexts (diagnosis, disease management and research) and can be performed in various settings (primary care, community, occupational health, and secondary and tertiary hospitals). How spirometry is performed and used in each of these settings is different. Portable devices, improvements in software capabilities, ability to compare measured results with predicted values, including LLN, and real-time feedback have all helped to improve the simplicity and quality of testing. Hand-held devices with integrated instructions and feedback have fundamentally changed where and how the test can be performed. Interpretation may be further facilitated using AI approaches [34–37]. A recent randomised controlled trial in primary care found that AI-based decision support significantly improved clinicians' accuracy in diagnosing COPD [38].

Good quality testing is essential

GOLD and GLI agree that the differences between the two thresholds are irrelevant when the test quality is poor. Updated technical standards [39] and integrated algorithms (and in some cases AI) can help operators ensure good quality testing is performed in real time [24]. As a minimum, spirometry for confirming a diagnosis of COPD requires an individual to exhale forcefully, starting from a total lung capacity to achieve a plateau in expiratory flow and the manoeuvre must be free from artefacts. Effective coaching/encouragement is essential to ensure technically acceptable measures are collected. Modern spirometers can implement warning messages when these criteria are not met, simplifying and facilitating better testing.

The technical requirements for ruling out COPD are less rigorous than those for precise determination of lung volumes, and provided the core technical standards have been met, a more pragmatic approach may be acceptable in this setting. GOLD and GLI agree that if the FEV_1, FVC and FEV_1/FVC ratio are normal (however this might be determined) the results cannot occur because of a poorly performed manoeuvre, and COPD as currently defined can be excluded [5, 6]. If the FEV_1, FVC and FEV_1/FVC ratio are normal and there is a very high clinical suspicion of COPD, post-bronchodilator spirometry may occasionally reveal an FVC volume response and unmask obstruction. In the context of significant medical history and symptoms, a borderline value does not definitively confirm or rule out COPD. Respiratory symptoms are not normal and should be investigated until an underlying cause can be identified and treated.

There is a need for a minimum training level to be met in order to conduct good quality spirometry, but GOLD and GLI do not consider that advanced academic qualifications are required.

There is a degree of uncertainty

GOLD and GLI agree that COPD is a heterogenous disease and spirometry measures are prone to measurement errors and biological variability; both of these contribute to uncertainty when interpreting results. The results of biological measurements used as diagnostic tests cannot always be empirically categorised as "normal" or "abnormal". There are inevitably challenges with definitions that rely on thresholds of dysfunction, as biological dysfunction is a continuum and there is no value-free method for determining the boundary between what is abnormal and what is a result of biological variation [40, 41]. Thresholds lack empirical justification and can be subject to revision [42].

Much of the data used to discuss the rates of over- or under-diagnosis using either the fixed ratio or LLN is derived from healthy populations, not from populations with a high pre-test probability of COPD. In research cohorts of current and ex-smokers over 40 years of age, or patients with respiratory symptoms referred for investigation, the proportions with discordant results ranged from 8% to 18% [14, 15, 17, 21]. Like all physiological measurements, the FEV_1/FVC ratio shows intrinsic biological variability [43–45] and, in most cases, discordant values will fall within areas of uncertainty regarding interpretation (figure 1). For example, a ratio of 0.65 in a patient aged 80 years is above the LLN (~0.6) and below the fixed ratio of 0.7, but lies within the range of values where GOLD discourages making a firm diagnosis and recommends either further investigations or repeat testing at an interval. Furthermore, although the z-score used to identify the 5% LLN is fixed at −1.645, there is inevitably uncertainty in the population mean and standard deviation estimate which introduces an uncertainty interval around the estimated LLN, although a confidence interval for the LLN is not usually quoted. In most cases this uncertainty interval will overlap with that of the fixed ratio. Unavoidable variation exists in the measurement itself as, at their

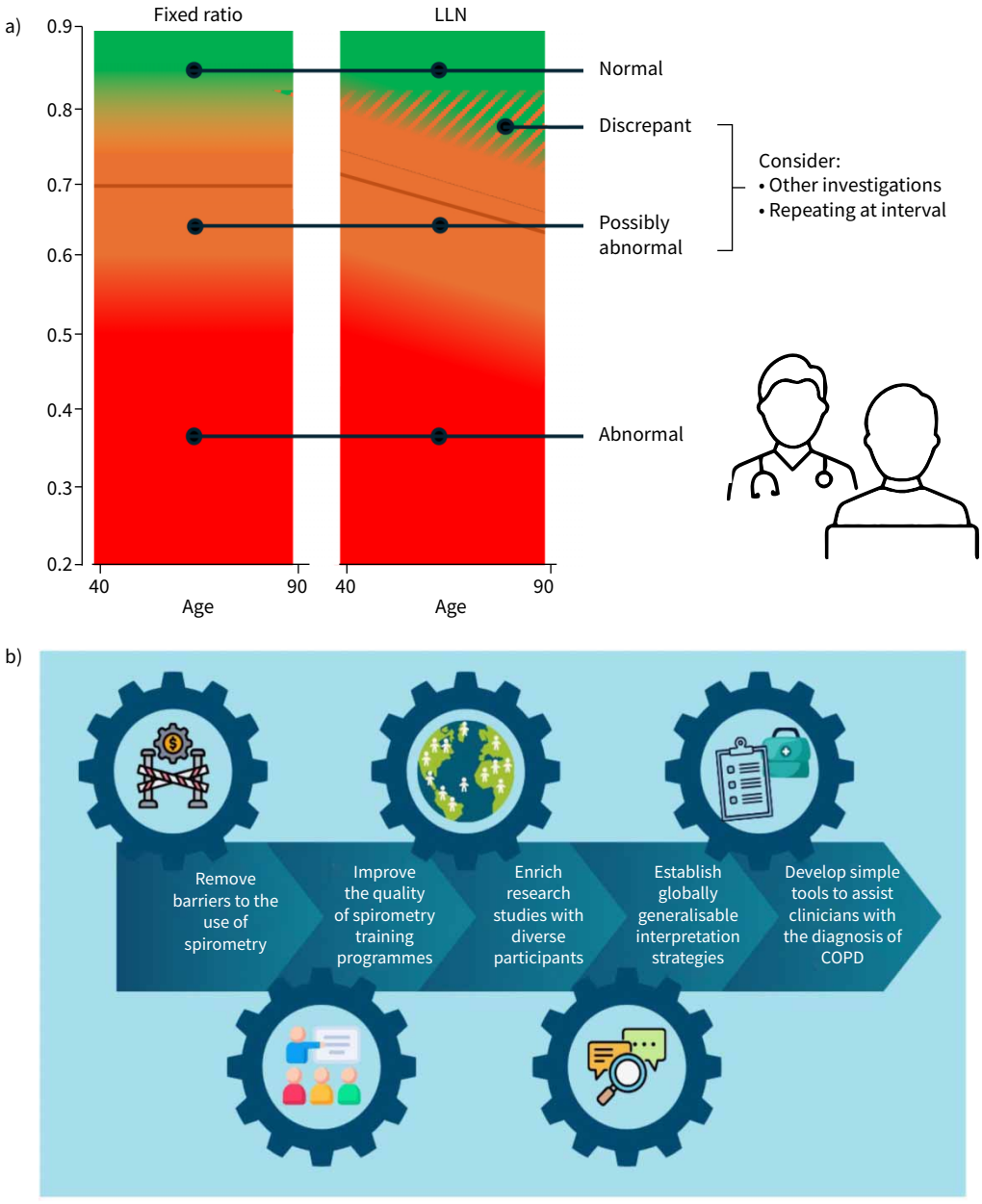

FIGURE 1 a) Interpretation of forced expiratory volume in 1 s (FEV_1) to forced vital capacity (FVC) ratio in a patient suspected of having COPD. b) Steps needed to improve the use of spirometry to confirm a diagnosis of COPD. LLN: lower limit of normal.

best, spirometers may show up to 5% variation in repeated test results [39]. In practice, therefore, it makes little difference whether the fixed ratio or LLN is used. Where there is a discrepancy, or more commonly where the result lies between 0.6 and 0.8, further investigations or repeat measurements should be performed to confirm or exclude a diagnosis of COPD (figure 1a).

When a spirometry result does not confirm airflow obstruction in a patient with symptoms and suggestive medical history, additional testing should be used to confirm a diagnosis. This could include measurement of the FEV_1/slow vital capacity (SVC). It is evident that neither the fixed ratio nor LLN adequately capture the heterogenous nature of COPD, or the many factors that affect lung growth and development across the life course. It is also important to note that the FEV_1/FVC ratio is also dependent on factors that can affect the numerator and denominator independently (*e.g.* obesity causing a relative reduction in FVC), resulting in an apparent normalisation of the ratio.

Bronchodilator response criteria

GOLD and GLI agree that there is widespread confusion between the terms bronchodilator response and bronchodilator reversibility. "Bronchodilator reversibility" refers to the improvement of an "abnormal" FEV_1/FVC ratio into the "healthy" range (either above 0.7 FEV_1/FVC or above the LLN for FEV_1/FVC) after a bronchodilator agent has been administered. Reversibility is often confused with "bronchodilator response", which represents the magnitude of change in FEV_1 or FVC observed after a bronchodilator is administered, whether it returns values back to normal or not. Many patients with COPD show a change in FEV_1 and/or FVC in response to bronchodilators [46, 47], but this does not constitute bronchodilator reversibility if FEV_1/FVC remains below the diagnostic threshold. Initially GOLD recommended using post-bronchodilator ratio values in its clinical definition because it was thought that post-bronchodilator values were more reproducible and could exclude asthma [6]. It is now clear that pre-bronchodilator values are also reproducible [48] and obstruction found only on post-bronchodilator measurements is uncommon [49].

Classification of severity of airflow obstruction

GOLD recommends classification of severity based on percent of predicted values for FEV_1, while ATS/ERS recommend using age, height and sex standardized z-scores. z-scores appear more strongly associated with patient symptoms (*e.g.* dyspnoea [50]) and risk of hospitalisation [51], but both approaches were inferior to an absolute measure of FEV_1 when mortality was the outcome [52]. Disease severity does not always correlate with the severity of airflow obstruction and ultimately both the GOLD and ATS/ERS thresholds are arbitrary. Severity should ultimately be defined based on patient-reported outcomes reflecting their ability to function, or clinical outcomes, such as survival.

GOLD and GLI agree that race-based reference values previously used can lead to underestimation of severity of airflow obstruction and normalise disparities in lung health [36]. GOLD agrees that the race-neutral equations published by GLI in 2022 (GLI-Global equations) [36] are the most appropriate currently [53]. Both GOLD and GLI acknowledge that questions remain about the global validity of these equations as they are based on a weighted average of racial and ethnic categories, and were derived from a population that did not include participants from many countries or global regions [54–56]. Currently, no satisfactory method has been found to account for anthropometric differences in chest dimensions [57]. Sitting height has been suggested as a proxy, but the same early life factors that affect lung growth affect body proportions [36]. There is an urgent need for interpretation strategies that incorporate anthropometric variation in chest dimensions that can be used globally and equitably.

Conclusions

GOLD and GLI agree on many issues (box 1). A common goal for both organisations is to reduce barriers to the use of spirometry and make it more available and utilised worldwide (figure 1b). Early recognition of the signs and symptoms of COPD, together with a simple, accurate and consistently used diagnostic

BOX 1 Key points of agreement between the Global Initiative for Chronic Obstructive Lung Disease (GOLD) and Global Lung Function Initiative (GLI)

Differences in recommendations about thresholds of "abnormality" are outweighed by shared concerns about the under-use of spirometry to confirm the diagnosis of COPD
COPD is characterised by airflow obstruction and FEV_1/FVC measured by spirometry is an appropriate objective biomarker of airflow obstruction
Spirometry alone is not sufficient to make a diagnosis of COPD: a clinical diagnosis of COPD must be based on integrating a patient's exposures, medical history and symptoms, together with a physiological measure of airflow obstruction
Spirometry is a simple and inexpensive test to perform
Spirometry results can be affected by measurement errors and biological variability which contribute to uncertainty when interpreting results
If the FEV_1, FVC and FEV_1/FVC ratio are normal, the results cannot occur because of a poorly performed manoeuvre
The differences between the fixed ratio and LLN thresholds are irrelevant when the test quality is poor
The race-based reference values previously used can lead to underestimation of disease severity and normalise disparities in lung health and should not be used
The race-neutral equations published by GLI in 2022 are the most appropriate currently available and should be used as standard

FEV_1: forced expiratory volume in 1 s; FVC: forced vital capacity; LLN: lower limit of normal.

test, is essential if we are to reduce the burden of this condition. Harmonising recommendations, including those of national and regional societies, such as ATS and ERS, is important to remove confusion. GOLD and GLI agree that the LLN can be used to identify airflow obstruction more broadly in populations, including younger patients with dyspnoea on exertion, but in the appropriate clinical context (*e.g.* a symptomatic patient with a medical and exposure history suggestive of COPD), recommend that the fixed ratio is used to identify COPD-related airflow obstruction and confirm a diagnosis of COPD.

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References

1 de Oca MM, Perez-Padilla R, Celli B, *et al.* The global burden of COPD: epidemiology and effect of prevention strategies. *Lancet Respir Med* 2025; 13: 709–724.
2 Fisk M, McMillan V, Brown J, *et al.* Inaccurate diagnosis of COPD: the Welsh National COPD Audit. *Br J Gen Pract* 2019; 69: e1–e7.
3 Diab N, Gershon AS, Sin DD, *et al.* Underdiagnosis and overdiagnosis of chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 2018; 198: 1130–1139.
4 Colak Y, Afzal S, Nordestgaard BG, *et al.* Prognosis of asymptomatic and symptomatic, undiagnosed COPD in the general population in Denmark: a prospective cohort study. *Lancet Respir Med* 2017; 5: 426–434.
5 Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease. 2026 Report. www.goldcopd.org
6 Singh D, Stockley R, Anzueto A, *et al.* GOLD Science Committee recommendations for the use of pre- and post-bronchodilator spirometry for the diagnosis of COPD. *Eur Respir J* 2025; 65: 2401603.
7 Pauwels RA, Buist AS, Calverley PM, *et al.* Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. NHLBI/WHO Global Initiative for Chronic Obstructive Lung Disease (GOLD) Workshop summary. *Am J Respir Crit Care Med* 2001; 163: 1256–1276.
8 Rodriguez-Roisin R, Rabe KF, Vestbo J, *et al.* Global Initiative for Chronic Obstructive Lung Disease (GOLD) 20th Anniversary: a brief history of time. *Eur Respir J* 2017; 50: 1700671.

9 Celli BR, MacNee W, ATS/ERS Task Force. Standards for the diagnosis and treatment of patients with COPD: a summary of the ATS/ERS position paper. *Eur Respir J* 2004; 23: 932–946.
10 Stanojevic S, Kaminsky DA, Miller MR, *et al.* ERS/ATS technical standard on interpretive strategies for routine lung function tests. *Eur Respir J* 2022; 60: 2101499.
11 Hansen JE, Sun XG, Wasserman K. Spirometric criteria for airway obstruction: use percentage of FEV_1/FVC ratio below the fifth percentile, not <70%. *Chest* 2007; 131: 349–355.
12 van Dijk W, Tan W, Li P, *et al.* Clinical relevance of fixed ratio vs lower limit of normal of FEV_1/FVC in COPD: patient-reported outcomes from the CanCOLD cohort. *Ann Fam Med* 2015; 13: 41–48.
13 Guder G, Brenner S, Angermann CE, *et al.* GOLD or lower limit of normal definition? A comparison with expert-based diagnosis of chronic obstructive pulmonary disease in a prospective cohort-study. *Respir Res* 2012; 13: 13.
14 Bhatt SP, Sieren JC, Dransfield MT, *et al.* Comparison of spirometric thresholds in diagnosing smoking-related airflow obstruction. *Thorax* 2014; 69: 409–414.
15 Lamprecht B, Schirnhofer L, Kaiser B, *et al.* Subjects with discordant airways obstruction: lost between spirometric definitions of COPD. *Pulm Med* 2011; 2011: 780215.
16 Miller MR, Pedersen OF, Pellegrino R, *et al.* Debating the definition of airflow obstruction: time to move on? *Eur Respir J* 2009; 34: 527–528.
17 Neder JA, Milne KM, Berton DC, *et al.* Exercise tolerance according to the definition of airflow obstruction in smokers. *Am J Respir Crit Care Med* 2020; 202: 760–762.
18 Quanjer PH, Enright PL, Miller MR, *et al.* The need to change the method for defining mild airway obstruction. *Eur Respir J* 2011; 37: 720–722.
19 Quanjer PH, Ruppel G, Brusasco V, *et al.* COPD (confusion over proper diagnosis) in the zone of maximum uncertainty. *Eur Respir J* 2015; 46: 1523–1524.
20 Wollmer P, Frantz S, Engstrom G, *et al.* Fixed ratio or lower limit of normal for the FEV_1/VC ratio: relation to symptoms and extended lung function tests. *Clin Physiol Funct Imaging* 2017; 37: 263–269.
21 Mannino DM, Sonia Buist A, Vollmer WM. Chronic obstructive pulmonary disease in the older adult: what defines abnormal lung function? *Thorax* 2007; 62: 237–241.
22 Arne M, Lisspers K, Stallberg B, *et al.* How often is diagnosis of COPD confirmed with spirometry? *Respir Med* 2010; 104: 550–556.
23 Han MK, Kim MG, Mardon R, *et al.* Spirometry utilization for COPD: how do we measure up? *Chest* 2007; 132: 403–409.
24 Das N, Verstraete K, Stanojevic S, *et al.* Deep-learning algorithm helps to standardise ATS/ERS spirometric acceptability and usability criteria. *Eur Respir J* 2020; 56: 2000603.
25 Halpin DMG, Dickens AP, Skinner D, *et al.* Identification of key opportunities for optimising the management of high-risk COPD patients in the UK using the CONQUEST Quality Standards: an observational longitudinal study. *Lancet Reg Health Eur* 2023; 29: 100619.
26 Koefoed MM, dePont Christensen R, Søndergaard J, *et al.* Lack of spirometry use in Danish patients initiating medication targeting obstructive lung disease. *Respir Med* 2012; 106: 1743–1748.
27 Kim KY, Yoo KH, Choi HS, *et al.* Nationwide quality assessment of treatment for chronic obstructive pulmonary disease. *J Thorac Dis* 2020; 12: 7174–7181.
28 Nishi SP, Wang Y, Kuo YF, *et al.* Spirometry use among older adults with chronic obstructive pulmonary disease: 1999–2008. *Ann Am Thorac Soc* 2013; 10: 565–573.
29 Walters JA, Walters EH, Nelson M, *et al.* Factors associated with misdiagnosis of COPD in primary care. *Prim Care Respir J* 2011; 20: 396–402.
30 Bourbeau J, Sebaldt RJ, Day A, *et al.* Practice patterns in the management of chronic obstructive pulmonary disease in primary practice: the CAGE study. *Can Respir J* 2008; 15: 13–19.
31 Lim R, Smith T, Usherwood T. Barriers to spirometry in Australian general practice: a systematic review. *Aust J Gen Pract* 2023; 52: 585–593.
32 Shahaj O, Meiwald A, Puri Sudhir K, *et al.* Mapping the common barriers to optimal COPD care in high and middle-income countries: qualitative perspectives from clinicians. *Int J Chron Obstruct Pulmon Dis* 2024; 19: 1207–1223.
33 Masekela R, Zurba L, Gray D. Dealing with access to spirometry in Africa: a commentary on challenges and solutions. *Int J Environ Res Public Health* 2018; 16: 62.
34 Topalovic M, Das N, Burgel PR, *et al.* Artificial intelligence outperforms pulmonologists in the interpretation of pulmonary function tests. *Eur Respir J* 2019; 53: 1801660.
35 Wang Y, Li Y, Chen W, *et al.* Deep learning for spirometry quality assurance with spirometric indices and curves. *Respir Res* 2022; 23: 98.
36 Bowerman C, Bhakta NR, Brazzale D, *et al.* A race-neutral approach to the interpretation of lung function measurements. *Am J Respir Crit Care Med* 2023; 207: 768–774.
37 Saad T, Pandey R, Padarya S, *et al.* Application of artificial intelligence in the interpretation of pulmonary function tests. *Cureus* 2025; 17: e82056.

38 Doe G, Banya W, Edwards G, *et al.* AI-assisted spirometry interpretation in primary care: a randomized controlled trial. *NEJM AI* 2025; 2: AIoa2400804.

39 Graham BL, Steenbruggen I, Miller MR, *et al.* Standardization of spirometry 2019 update. An official American Thoracic Society and European Respiratory Society technical statement. *Am J Respir Crit Care Med* 2019; 200: e70–e88.

40 Doust J, Jean Walker M, Rogers WA. Current dilemmas in defining the boundaries of disease. *J Med Philos* 2017; 42: 350–366.

41 Boorse C. Health as a theoretical concept. *Philosophy of Science* 1977; 44: 542–573.

42 Halpin DMG. Defining COPD in the 21st century. *In:* Wedzicha JA, Allinson JP, Calverley PMA, eds. COPD in the 21st Century (ERS Monograph). Sheffield, European Respiratory Society, 2024; pp. 30–44.

43 Aaron SD, Tan WC, Bourbeau J, *et al.* Diagnostic instability and reversals of chronic obstructive pulmonary disease diagnosis in individuals with mild to moderate airflow obstruction. *Am J Respir Crit Care Med* 2017; 196: 306–314.

44 Enright PL, Connett JE, Kanner RE, *et al.* Spirometry in the Lung Health Study: II. Determinants of short-term intraindividual variability. *Am J Respir Crit Care Med* 1995; 151: 406–411.

45 Schermer TR, Robberts B, Crockett AJ, *et al.* Should the diagnosis of COPD be based on a single spirometry test? *NPJ Prim Care Respir Med* 2016; 26: 16059.

46 Calverley PM, Burge PS, Spencer S, *et al.* Bronchodilator reversibility testing in chronic obstructive pulmonary disease. *Thorax* 2003; 58: 659–664.

47 Albert P, Agusti A, Edwards L, *et al.* Bronchodilator responsiveness as a phenotypic characteristic of established chronic obstructive pulmonary disease. *Thorax* 2012; 67: 701–708.

48 Enright PL, Beck KC, Sherrill DL. Repeatability of spirometry in 18,000 adult patients. *Am J Respir Crit Care Med* 2004; 169: 235–238.

49 Fortis S, Eberlein M, Georgopoulos D, *et al.* Predictive value of prebronchodilator and postbronchodilator spirometry for COPD features and outcomes. *BMJ Open Respir Res* 2017; 4: e000213.

50 Al Sa'idi L, Berton DC, Neder JA. The 2022 ERS/ATS z-score classification to grade airflow obstruction: relationship with exercise outcomes across the spectrum of COPD severity. *Eur Respir J* 2024; 64: 2301960.

51 Brems JH, Balasubramanian A, Raju S, *et al.* Changes in spirometry interpretative strategies: implications for classifying COPD and predicting exacerbations. *Chest* 2024; 166: 294–303.

52 Balasubramanian A, Wise RA, Stanojevic S, *et al.* FEV_1Q: a race-neutral approach to assessing lung function. *Eur Respir J* 2024; 63: 2301622.

53 Bhakta NR, Bime C, Kaminsky DA, *et al.* Race and ethnicity in pulmonary function test interpretation: an official American Thoracic Society statement. *Am J Respir Crit Care Med* 2023; 207: 978–995.

54 Burton RF, Nevill AM, Stewart AD, *et al.* Statistical approaches to relationships between sitting height and leg length in adults. *Ann Hum Biol* 2013; 40: 64–69.

55 Pomeroy E, Stock JT, Wells JCK. Population history and ecology, in addition to climate, influence human stature and body proportions. *Sci Rep* 2021; 11: 274.

56 Wang RJ. Beyond race-specific spirometry reference equations: what comes next? *Am J Respir Crit Care Med* 2024; 209: 117–118.

57 Holland R, Bowerman C, Stanojevic S. The contribution of anthropometry and socioeconomic status to racial differences in measures of lung function: a systematic review. *Chest* 2022; 162: 635–646.