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Clinical, functional, and radiological profile of fibrotic interstitial lung disease at high altitude: a registry-based cohort from two referral centres in Bogotá, Colombia (2,600 metres above sea level)

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Abstract

Interstitial lung diseases (ILD) are a heterogeneous group of conditions characterised by variable degrees of inflammation and pulmonary fibrosis. Data from high-altitude settings, where hypobaric hypoxia may modulate disease expression and functional thresholds, remain scarce. We describe the demographic, clinical, functional, radiological, and therapeutic profile of 148 patients with fibrotic ILD (fILD) enrolled in the REPIFCO registry at two referral centres in Bogotá, Colombia (2,600 m above sea level), between 2022 and 2026. Connective tissue disease-associated ILD (CTD-ILD) was the most frequent diagnosis (36%), followed by hypersensitivity pneumonitis (HP, 26%), unclassifiable ILD (19%), and idiopathic pulmonary fibrosis (IPF, 15%). The median age was 70 years (IQR 60–75) and 59% were female. Despite a median time to diagnosis of 6 months (IQR 2–30), symptom burden was high: 56% of patients had mMRC 3–4 dyspnoea and 45% required home oxygen therapy. Pulmonary function showed a mild restrictive pattern overall; HP exhibited the greatest functional impairment. A significant clinical-radiological association was observed ($\chi^2 = 133.88$; $df = 18$; $p < 0.001$). These findings characterise, for the first time, a fibrotic ILD cohort from a two high-altitude referral centres in Latin America, highlighting a diagnostic and therapeutic profile that may be influenced by altitude-related physiological adaptations.

Introduction

ILD comprise a heterogeneous group of disorders characterized by variable degrees of inflammation, fibrosis, or both, in the interstitium of the lungs with diverse clinical, functional, radiological, and prognostic profiles.[1][2]

The epidemiology of ILD varies widely across geographic regions and healthcare settings. Reported incidence ranges from 1 to 31.5 cases per 100,000 person-years, and prevalence ranges from 6.3 to 71 cases per 100,000 people.[3] Differences in environmental exposures, referral patterns, access to high-resolution computed tomography (HRCT), and availability of multidisciplinary discussion (MDD) may influence the relative frequency of ILD subtypes. Notably, the vast majority of published epidemiological data originates from sea-level or low-altitude settings.

High altitude introduces a distinct physiological context that has been poorly explored in the ILD literature. Bogotá, the capital of Colombia, is situated at 2,600 metres above sea level (m.a.s.l.), where chronic exposure to hypobaric hypoxia triggers the hypoxic ventilatory response, increasing the utilization of oxygen reserves and raising the risk of clinically significant hypoxaemia.[4] This susceptibility has been demonstrated experimentally: when patients with ILD and those with chronic obstructive pulmonary disease (COPD) were exposed to a fraction of inspired oxygen (FiO_2) of 15%—equivalent to conditions at high altitude—ILD patients developed more severe hypoxaemia than their COPD counterparts, underscoring the particular vulnerability of this population to reduced ambient oxygen tension.[5] Beyond hypoxaemia, chronic hypobaric hypoxia promotes pulmonary arterial vasoconstriction, which, over time, may favor the development of pulmonary hypertension an established complication that worsens prognosis in fILD.[6]

Evidence regarding the clinical impact of high altitude on specific ILD subtypes is beginning to emerge. A retrospective observational study comparing patients with IPF and CTD-ILD between a hospital in Qinghai and one in Tibet found a higher proportion of CTD-ILD in the higher-altitude Tibetan cohort, alongside lower values of forced expiratory volume at first second (FEV_1), forced vital capacity (FVC), and diffusing capacity for carbon monoxide (DLCO).[7]

Given the differential behaviour of respiratory diseases at high altitude, and the scarcity of data from Latin American high-altitude settings, this study aimed to describe the demographic, clinical, functional, radiological, therapeutic, and aetiological characteristics of patients with fILD enrolled in the Colombian REPIFCO registry at referral centres in Bogotá between 2022 and 2026, and to contexualise these findings within the framework of altitude-related physiological considerations.

Results

Demographic and clinical characteristics

A total of 148 patients with fILD were included. Baseline demographic and clinical characteristics are summarised in Table 1. The median age was 70 years (IQR 60–75), and 87 patients (59%) were female. Most patients were never smokers (49%), or former smokers (36%), with a median cumulative smoking exposure of 10 pack-years (interquartile range: IQR 3–20). The median time from symptom onset to diagnosis was 6 months (IQR 2–30). Clinically relevant dyspnea was frequent: 82% of patients classified as mMRC ≥ 2 and 56% as mMRC 3–4. Home oxygen therapy was required by 45% of patients, and 51% were referred to pulmonary rehabilitation.

Table 1
Baseline demographic and clinical characteristics

Characteristics	Total cohort, n = 148, (%)
Female sex	87 (59)
Age, years[1]	70 (60–75)
BMI, kg/m[1]	23.7 (21.1–27.3)
Never smoker	72 (49)
Former smoker	53 (36)
Current smoker	6 (4.1)
Passive smoking exposure	16 (11)
Pack-years[1]	10 (3–20)
Time from symptom onset to diagnosis, months[1]	6 (2–30)
mMRC ≥ 2	114 (82)
mMRC 3–4	78 (56)
Home oxygen therapy	65 (45)
Pulmonary rehabilitation referral	72 (51)

BMI: body mass index; mMRC: modified Medical Research Council dyspnea scale.

Values are expressed as n (%) or [1]median (interquartile range).

Diagnostic distribution and tomographic patterns

The distribution of final clinical diagnoses and tomographic patterns is shown in Table 2. The most frequent diagnosis was CTD-ILD, identified in 47 patients (36%), followed by HP in 34 (26%), unclassifieable ILD in 25 (19%), and IPF in 20 (15%). Less frequent diagnoses including drug induced interstitial lung disease, pneumoconiosis, and sarcoidosis, accounted for 3.8% of cases. Of the 47 patients with CTD-ILD, information on the underlying connective tissue disease was available in 40 cases (85.1%). The most common condition was systemic sclerosis (n = 14; 35.0%), followed by rheumatoid arthritis (RA) (n = 11; 27.5%),

The most common tomographic pattern was definite usual interstitial pneumonia (UIP) (27%), followed by HP pattern (23%) and non-specific interstitial pneumonia (NSIP) 20%. A significant association was observed between clinical diagnosis and tomographic pattern ($\chi^2 = 133.88$; df = 18; $p < 0.001$), supporting adequate clinical-radiological agreement in the cohort **(**Fig. 1**).**

Table 2
Final clinical diagnosis and tomographic pattern

Characteristic	n (%)
Final clinical diagnosis	
CTD-ILD	47 (36)
Hypersensitivity pneumonitis	34 (26)
Unclassifiable ILD	25 (19)
Idiopathic pulmonary fibrosis	20 (15)
Other diagnoses	5 (3.8)
Tomographic pattern	
Definite UIP	36 (27)
Probable UIP	14 (11)
Indeterminate UIP	14 (11)
Hypersensitivity pneumonitis pattern	31 (23)
NSIP	27 (20)
CPFE	6 (4.5)
Other patterns	4 (3.2)

CPFE: combined pulmonary fibrosis and emphysema; CTD-ILD: connective tissue disease-associated interstitial lung disease; ILD: interstitial lung disease; NSIP: nonspecific interstitial pneumonia; UIP: usual interstitial pneumonia.

Pulmonary function test and exercise capacity

Pulmonary function tests and treatment are summarised in Table 3. The overall cohort showed a a mild restrictive pattern, with a median FVC of 75% predicted (IQR 59–90), FEV_1 of 81% predicted (IQR 67–100), and total lung capacity (TLC) of 79% predicted (IQR 62–96). The median DLCO was 13.1 ml/min/mmHg (IQR 6.8–18.4), The median six-minute walk distance (6MWT) was 415.5 m (IQR 337–510), with a median oxygen oxygen desaturation of − 11 percentage points (IQR − 15.5 to − 8).

Table 3
Pulmonary function tests and treatment

Characteristic	Total cohort, n = 148
Pulmonary function tests	
FVC, % predicted	75 (59–90)
FEV_1, % predicted	81 (67–100)
FEV_1/FVC	0.80 (0.80–0.90)
TLC, % predicted[1]	79 (62–96)
DLCO, ml/min/mmHg[1]	13.1 (6.8–18.4)
Six-minute walk distance, m[1]	415.5 (337–510)
ΔSpO_2 during 6MWT, %	−11 (− 15.5 to − 8)
Treatment	
Oral corticosteroids	47 (33)
Azathioprine	16 (11)
Mycophenolate	4 (2.8)
Nintedanib	17 (12)
Pirfenidone	5 (3.5)

Values are expressed as n (%) or [1]median (interquartile range).

6MWT: six-minute walk test; **DLCO**: diffusing capacity for carbon monoxide; **FEV_1**: forced expiratory volume in 1 second; **FVC**: forced vital capacity; **SpO_2**: peripheral oxygen saturation; **TLC**: total lung capacity.

Subgroup analysis by diagnosis

The main clinical characteristics according to the three most frequent diagnostic subgroups are presented in Table 4. Patients with HP showed the greatest functional impairment, with the lowest median FVC, DLCO, and 6MWT (Fig. 2).

Regarding pharmacological treatment, systemic corticosteroids were used in 33% of the overall cohort, azathioprine in 11%, and mycophenolate in 2.8%. Antifibrotic therapy was used infrequently: nintedanib used in 12% and pirfenidone in 3.5% of patients. Antifibrotic use was highest among patients with IPF.

Table 4
Main characteristics according to the most frequent ILD subgroups

Characteristic	IPF, n = 20	HP, n = 34	CTD-ILD, n = 47
Age, years[1]	73.5 (66–78.5)	70.5 (62–75)	63 (58–73)
Female sex	10 (50)	19 (56)	35 (74)
Time to diagnosis, months[1]	3 (1–12)	12 (2–36)	6 (3–24)
mMRC 3–4	10 (50)	23 (67)	23 (50)
Predominant tomographic pattern	Definite UIP, 13 (68)	HP pattern, 27 (84)	UIP/NSIP, 20 (44)/18 (40)
FVC, % predicted[1]	82 (68.5–95)	68 (44–87)	75 (60–85.2)
TLC, % predicted[1]	70.5 (53–84.5)	78 (61–87)	68 (62–106)
DLCO, ml/min/mmHg[1]	13.2 (5.2–16.6)	8 (6–14.3)	14.2 (7.9–19.2)
Six-minute walk distance, m[1]	403.5 (332.5–496)	396 (300–510)	429 (348–510)
Home oxygen therapy	8 (44)	20 (59)	20 (43)
Antifibrotic therapy	7 (36)	4 (11.7)	6 (13.1)
Corticosteroids	1 (5.3)	15 (44)	21 (46)

Values are expressed as n (%) or [1]median (interquartile range).

CTD-ILD: connective tissue disease-associated interstitial lung disease; **DLCO**: diffusing capacity for carbon monoxide; **FVC**: forced vital capacity; **HP**: hypersensitivity pneumonitis; **ILD**: interstitial lung disease; **IPF**: idiopathic pulmonary fibrosis; **mMRC**: modified Medical Research Council dyspnea scale; **NSIP**: nonspecific interstitial pneumonia; **TLC**: total lung capacity; **UIP**: usual interstitial pneumonia.

Discussion

This registry-based study describes, for the first time, the clinical, functional, and radiological profile of patients with fILD treated at referral centres in Bogotá, Colombia, a high altitude city situated at 2,600 m.a.s.l. The main findings include a predominance of CTD-ILD and HP, a substantial proportion of unclassifiable ILD, high symptom burden, and significant association between clinical diagnosis and tomographic pattern. Taken together, these results offer a novel characterization of fILD in a high-altitude Latin American setting.

The predominance of CTD-ILD in our cohort (36%), followed by HP (26%), is consistent with patterns reported in cohorts from Brazil,[8] Saudi Arabia, [9] and the Canadian CARE-PF registry, [10] in which the

proportion of CTD-ILD ranged from 26.8% to 34.8%. These findings are also aligned with a retrospective observational study comparing ILD cohorts from two regions of China at different altitudes, which showed a higher frequency of CTD-ILD in the high-altitude region of Tibet.[7] In contrast, this distribution differs from that reported in cohorts from Germany[11] and Belgium.[12] Previous studies have suggested that high-altitude environments may contribute to the occurrence and progression of connective tissue diseases, including rheumatoid arthritis, which represented the second most frequent CTD diagnosis in the present cohort.[13]

Unclassifiable ILD accounted for 19% of cases, a proportion higher than the 10% reported by Ryerson et al.[14] in a longitudinal cohort from a specialized center, where the main reason for this classification was the lack of histopathological confirmation due to the high risk associated with surgical lung biopsy. This percentage was, in turn, lower than the 22.3% described in the Canadian CARE-PF registry.[10] The figure is clinically relevant, as unclassifiable ILD is associated with an adverse prognosis, with lower survival and greater progression of fibrosis compared to well-defined entities.[14] In this context, the observed percentage underscores the need to strengthen and expand multidisciplinary ILD panels in Colombia, as structured multidisciplinary discussion is the most effective tool for reducing the proportion of unclassifiable cases, optimizing diagnostic accuracy, and improving access to targeted treatments[15]

The overall cohort demonstrated a mild restrictive pattern. This finding warrants interpretation in the context of high-altitude physiology, as chronic residence at altitude has been associated with higher spirometric values compared to sea-level populations. A cross-sectional study comparing two genetically related Kichwa indigenous populations from Ecuador—residents of Limoncocha in the Amazon basin (230 m.a.s.l.) and Oyacachi in the Andean highlands (3,180–3,800 m.a.s.l.)—documented higher FVC and FEV_1 values among high-altitude residents, attributed to lower air density, reduced airway resistance, and greater pulmonary expansibility.[16] Consistently, Andean populations adapted to high altitude tend to exhibit larger lung volumes, greater thoracic demensions, and enhanced ventilatory capacity compared to sea-level counterparts.[17][18] These considerations suggest that the mild restriction observed in our cohort may be partially attenuated by altitude-related physiological adaptations, implying that conventional spirometric reference values derived from sea-level populations may underestimate the true degree of functional impairment in high-altitude residents fILD.

Among diagnostic subgroups, patients with HP exhibited the greatest functional impairment, with the lowest median FVC, DLCO, and 6MWD compared to other ILD subtypes. This pattern is consistent with previously reported data showing that HP is characterised by a restrictive ventilatory defect with reduced DLCO, and that patients with HP displaying a restrictive pattern experience greater oxygen desaturation during the 6MWT.[19] At high altitude, where the reduced ambient partial pressure of oxygen narrows the physiological oxygen reserve, this exercise-induced desaturation is expected to be further amplified, with potentially greater clinical impact on functional capacity and quality of life in this subgroup.

The high rate of home oxygen therapy observed in this cohort (45%)—more than double the 22.1% reported in the Canadian CARE-PF registry—may reflect not only disease severity but also the reduced ambient oxygen tension that lowers the tolerance threshold for exertional hypoxaemia in everyday activities.[10][7] At this altitude, barometric pressure is approximately 560 mmHg and the partial pressure of inspired oxygen is around 117 mmHg—roughly 23% lower than at sea level—placing patients with fibrotic ILD in a state of chronic baseline hypoxaemia that is further exacerbated by exertion.

The association between clinical diagnosis and tomographic pattern, illustrated in Fig. 1, represents an additional finding of interest. The statistically robust association observed ($\chi^2 = 133.88$; $p < 0.001$) indicates that radiological patterns are not randomly distributed across diagnoses. However, the relationship was heterogeneous across entities: IPF was characterised by a predominance of definite or probable UIP pattern, consistent with current diagnostic criteria that assign HRCT a central—and sometimes sufficient—role in establishing this diagnosis.[20] HP showed strong association with its corresponding tomographic pattern, while CTD-ILD displayed a more heterogeneous radiological distribution, with both UIP and NSIP patterns, reflecting the recognised radiological variability of this entity.[21]

These findings carry a direct clinical implication: despite the overall significant association, tomographic pattern alone is insufficient to establish a diagnosis in the majority of cases, particularly for the most frequent entity in this cohort. Silva et al. reported that reliable radiological classification was achievable in only approximately 50% of ILD cases,[22] reinforcing the irreplaceable role of multidisciplinary discussion, where the integration of clinical, serological, functional, and radiological findings enables more precise diagnoses—especially in entities with non-specific or overlapping tomographic appearances.[23]

The use of antifibrotic therapy was relatively low in this cohort, with nintedanib prescribed in 12% and pirfenidone in 3.5% of patients. This finding is partly explained by the diagnostic distribution of the cohort, in which CTD-ILD and HP predominated over IPF. Nevertheless, even within the IPF subgroup, only 36% of patients received antifibrotic therapy—a proportion lower than expected for an entity with a well-established therapeutic indication.[24] Several factors may account for this gap: some patients may have initiated treatment at subsequent follow-up visits not captured by the cross-sectional design of the study; others may have presented with advanced disease at the time of evaluation; and barriers related to drug access, reimbursement constraints, and loss to follow-up inherent to the Colombian healthcare context may have further contributed. Data from the German EXCITING-ILD registry are instructive in this regard: antifibrotic use in IPF increased from 35.2% before 2015 to 48.4% by 2019,[11] suggesting that with improved access and structured follow-up, this gap is reducible. These findings underscore the need for studies evaluating the impact of multidisciplinary discussion on antifibrotic prescribing and treatment access in the Colombian setting.

This study has several limitations that should be acknowledged. Its observational, cross-sectional design precludes causal inference and does not allow temporality to be established between the

variables assessed. A relevant proportion of missing data existed for pulmonary function tests, which may limit the reliability of comparative analyses across diagnostic subgroups. Finally, as this cohort was recruited from tertiary referral centres, the findings may be subject to referral bias and may not necessarily reflect the distribution of fILD in the general population.

In conclusion, this cohort from a high-altitude referral setting in Colombia characterises a fibrotic ILD population with a predominance of CTD-ILD and HP, high symptom burden, and a significant association between clinical diagnosis and tomographic pattern. The altitude context of Bogotá adds a novel physiological dimension to the interpretation of functional findings, oxygen requirements, and exercise desaturation, with implications for clinical practice guidelines in similar settings. Future prospective studies incorporating altitude-adjusted reference values and longitudinal outcomes will be essential to advance the understanding of fILD at high altitude in Latin America.

Methods

Study design and setting

This was a multicenter, observational, descriptive study based on a bidirectional cohort from the REPIFCO registry. Retrospective data were obtained from patients previously enrolled in the registry, while prospective data were collected from newly eligible patients during the study period (2022–2026). The study was conducted at two academic referral centres in Bogotá, Colombia, situated at 2,600 m above sea level: Hospital Universitario San Ignacio and Hospital Universitario Mayor Méderi. Medical records and registry data were reviewed to retrieve demographic, clinical, serological, functional, radiological, therapeutic, and aetiological information.

Participants

Eligible patients were adults aged ≥ 18 years with a confirmed diagnosis of fibrotic ILD, established through clinical, functional, radiological, and/or histopathological evaluation. Inclusion required fibrotic abnormalities on HRCT (traction bronchiectasis, reticular abnormalities, honeycombing, or architectural distortion involving > 10% of the lung parenchyma) and fulfilment of criteria for one of the fibrotic ILD subtypes described in the 2013 ATS/ERS classification statement.[25]

Ethics

The study was conducted in accordance with the principles of the Declaration of Helsinki. The research protocol was approved by the ethics committees of Hospital Universitario San Ignacio and Hospital Universitario Mayor Méderi (approval code MI 008-2025). Informed consent was obtained from all participants. The study did not use Large Language Models (LLMs) as contributors to data collection or analysis; no AI authorship applies.

Statistical analysis

Demographic and clinical characteristics are summarised using descriptive statistics. Categorical variables are presented as absolute and relative frequencies. Normality was assessed using the Shapiro-Wilk test. Normally distributed continuous variables are reported as mean ± standard deviation; non-normally distributed variables as median (interquartile range, IQR). The association between clinical diagnosis and tomographic pattern was assessed using the chi-square test (χ^2). All analyses were performed using RStudio (version 2023.03.1 + 446). A p value < 0.05 was considered statistically significant.

Declarations

Competing interests

The authors declare no competing interests.

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Author Contribution

Dolfus Santiago Romero, Juan Ricardo Lutz, Carlos Andrés Celis-Preciado and Leonardo Galindo conceptualised the study. Ingrid Ruiz Ordoñez performed data collection and curation. Juan Ricardo Lutz conducted the statistical analysis. All authors contributed to interpretation of results, reviewed the manuscript critically, and approved the final version for submission

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Data Availability

The datasets generated and/or analysed during the current study are available from the corresponding author upon reasonable request, subject to the applicable ethical and regulatory constraints of the REPIFCO registry.

References

1. Ryerson, C. J. et al. Update of the international multidisciplinary classification of the interstitial pneumonias: an ERS/ATS statement. *Eur Respir J* **66**, (2025).
2. Althobiani, M. A. et al. Interstitial lung disease: a review of classification, etiology, epidemiology, clinical diagnosis, pharmacological and non-pharmacological treatment. *Front. Med.* **11**, 1296890 (2024).
3. Kaul, B., Cottin, V., Collard, H. R. & Valenzuela, C. Variability in Global Prevalence of Interstitial Lung Disease. *Front. Med.* **8**, 751181 (2021).
4. Peacock, A. J. ABC of oxygen: oxygen at high altitude. *BMJ* **317**, 1063–1066 (1998).
5. Seccombe, L. M. et al. Effect of simulated commercial flight on oxygenation in patients with interstitial lung disease and chronic obstructive pulmonary disease. *Thorax* **59**, 966–970 (2004).
6. West, J. B. High-altitude medicine. *Am. J. Respir Crit. Care Med.* **186**, 1229–1237 (2012).
7. Zhou, L. et al. Clinical characteristics of high-altitude interstitial lung disease: a two-center, retrospective, observational study. *BMC Pulm Med.* **26**, 75 (2026).
8. Lobo, S. et al. Relative incidence of interstitial lung diseases in Brazil. **50**, 1–7 (2024).
9. Alhamad, E. H. Interstitial lung diseases in Saudi Arabia: A single-center study. *Ann. Thorac. Med.* **8**, 33–37 (2013).
10. Fisher, J. H. et al. Baseline characteristics and comorbidities in the CAnadian REgistry for Pulmonary Fibrosis. *BMC Pulm Med.* **19**, 223 (2019).
11. Buschulte, K. et al. Baseline characteristics from the EXCITING-ILD registry. *BMJ open. Respir Res* **12**, (2025).
12. Thomeer, M., Demedts, M. & Vandeurzen, K. Registration of interstitial lung diseases by 20 centres of respiratory medicine in Flanders. *Acta Clin. Belg.* **56**, 163–172 (2001).
13. Arima, H. et al. High prevalence of rheumatoid arthritis and its risk factors among Tibetan highlanders living in Tsarang, Mustang district of Nepal. *J. Physiol. Anthropol.* **41**, 12 (2022).
14. Troy, L. et al. Prevalence and prognosis of unclassifiable interstitial lung disease. *Eur. Respir. J.* **43**, 1529–1530 (2014).
15. Khan, M. A. et al. Role of Multidisciplinary Team Meetings in the Diagnosis and Management of Diffuse Parenchymal Lung Diseases in a Tertiary Care Hospital. *Avicenna J. Med.* **13**, 230–236 (2023).
16. Reiser, R. et al. Lung function parameters are associated with acute mountain sickness and are improved at high and extreme altitude. *Respir Physiol. Neurobiol.* **330**, 104318 (2024).
17. Callison, W. É., Kiyamu, M., Villafuerte, F. C., Brutsaert, T. D. & Lieberman, D. E. Comparing high versus low-altitude populations to test human adaptations for increased ventilation during sustained aerobic activity. *Sci. Rep.* **12**, 11148 (2022).
18. Brody, J. S., Lahiri, S., Simpser, M., Motoyama, E. K. & Velasquez, T. Lung elasticity and airway dynamics in Peruvian natives to high altitude. *J. Appl. Physiol.* **42**, 245–251 (1977).

19. Spalgais, S., Mrigpuri, P., Ravishankar, N. & Kumar, R. Pulmonary Function and Diffusing Capacity of Carbon Monoxide in Hypersensitivity Pneumonitis: An Observational Study of 152 Patients. *Thorac. Res. Pract.* **25**, 51–56 (2024).
20. Raghu, G. et al. Diagnosis of Idiopathic Pulmonary Fibrosis. An Official ATS/ERS/JRS/ALAT Clinical Practice Guideline. *Am. J. Respir Crit. Care Med.* **198**, e44–e68 (2018).
21. Oliveira, R. P. et al. Connective tissue disease-associated interstitial lung disease. **28**, 113–118 (2022).
22. Silva, C. I. S. et al. Chronic hypersensitivity pneumonitis: differentiation from idiopathic pulmonary fibrosis and nonspecific interstitial pneumonia by using thin-section CT. *Radiology* **246**, 288–297 (2008).
23. Guler, S. A., Scheschkowski, T., Renner, A., Kämpf, L. & Gasser, M. Interdisciplinary Diagnosis and Management of Patients With Interstitial Lung Disease and Connective Tissue Disease. *Chest* **166**, 352–361 (2024).
24. Glass, D. S. et al. Idiopathic pulmonary fibrosis: Current and future treatment. *Clin. Respir J.* **16**, 84–96 (2022).
25. Raghu, G. et al. Idiopathic Pulmonary Fibrosis (an Update) and Progressive Pulmonary Fibrosis in Adults: An Official ATS/ERS/JRS/ALAT Clinical Practice Guideline. *Am. J. Respir Crit. Care Med.* **205**, e18–e47 (2022).

Figures

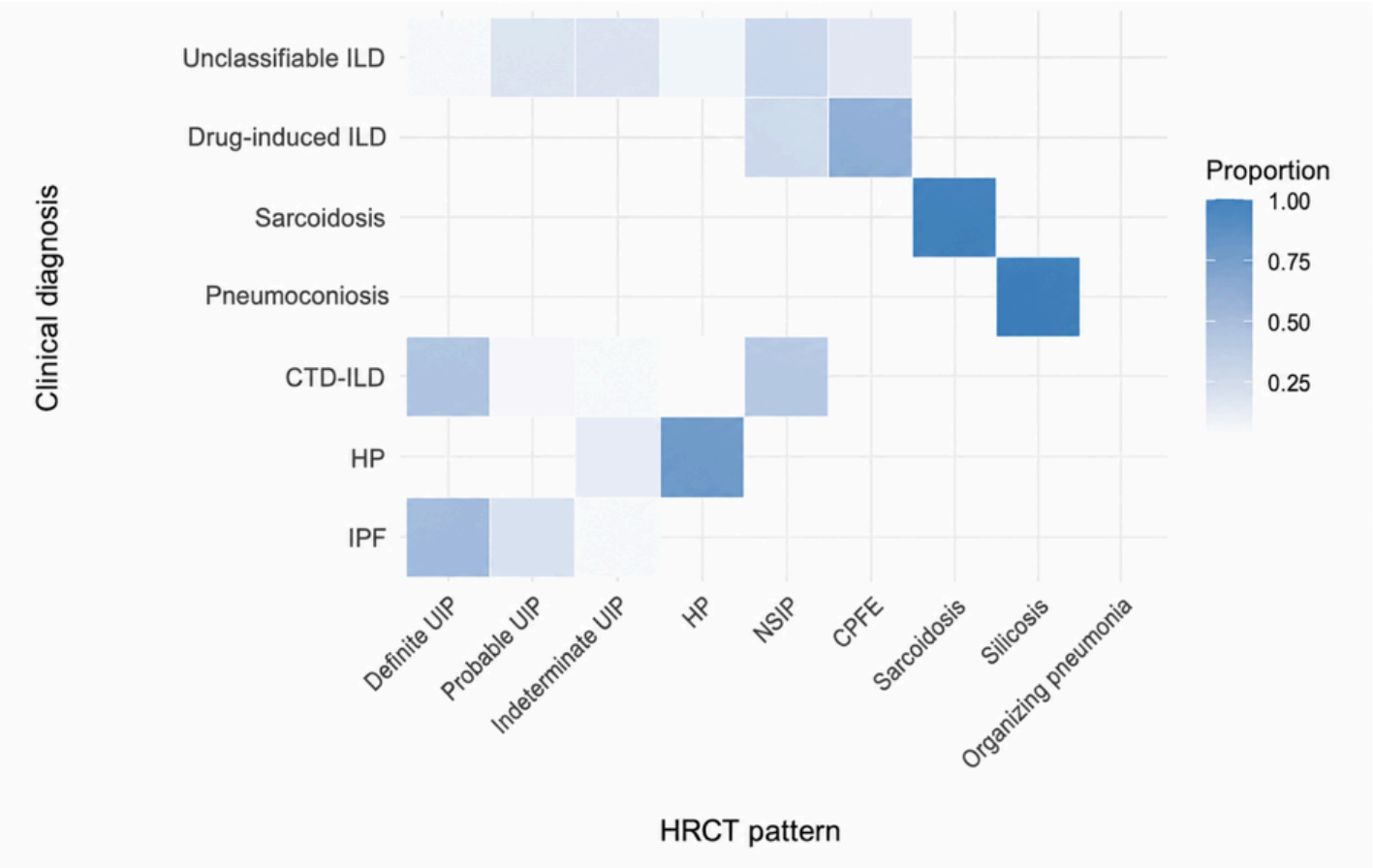


Figure 1

Clinical-radiological concordance in fibrotic ILD

Heatmap showing the distribution of tomographic patterns according to final clinical diagnosis. A significant association was observed between clinical diagnosis and tomographic pattern ($\chi^2 = 133.88$; df = 18; $p < 0.001$)

HRCT, high-resolution computed tomography; ILD, interstitial lung disease; CTD-ILD, connective tissue disease-associated interstitial lung disease; HP, hypersensitivity pneumonitis; IPF, idiopathic pulmonary fibrosis; UIP, usual interstitial pneumonia; NSIP, nonspecific interstitial pneumonia; CPFE, combined pulmonary fibrosis and emphysema.

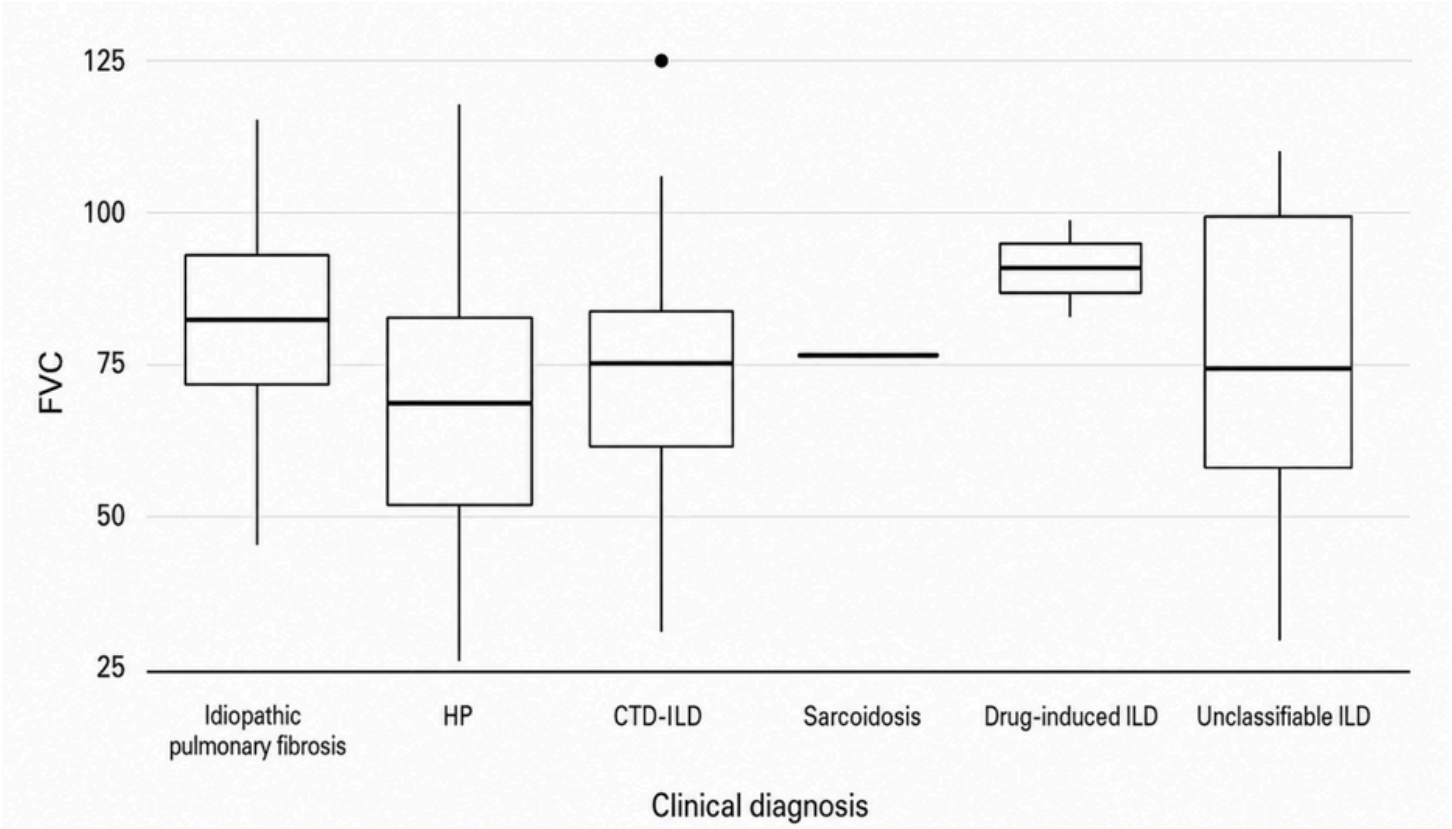


Figure 2

Distribution of FVC according to clinical diagnosis

Box-and-whisker plot showing FVC distribution according to final clinical diagnosis.

CTD-ILD, connective tissue disease-associated interstitial lung disease; FVC, Force vital capacity; HP, hypersensitivity pneumonitis; HRCT, high-resolution computed tomography; ILD, interstitial lung disease; HP, hypersensitivity pneumonitis