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CLINICAL PROFILE AND PULMONARY FUNCTION OUTCOMES IN COVID-19 RECOVERED PATIENTS IN A TRIBAL POPULATION OF GUJARAT: A PROSPECTIVE OBSERVATIONAL STUDY

Internal Medicine

Dr. Suman Gupta* 3rd Year Post-Graduate Resident, Department of General Medicine,Zydus Medical College and Hospital, Dahod, Gujarat, India*Corresponding Author

Dr. Aruna Ganava Associate Professor, Department of General Medicine,Zydus Medical College and Hospital, Dahod, Gujarat, India

Dr. Neha Saxena 2nd Year Post-Graduate Resident, Department of General Medicine, Zydus Medical College and Hospital, Dahod, Gujarat, India

ABSTRACT

Background: COVID-19 often causes persistent pulmonary dysfunction (e.g., restrictive and obstructive patterns) after recovery. Tribal populations may face greater post-COVID morbidity due to delayed care and limited resources.**Objective:** To assess pulmonary function in COVID-19 survivors and identify factors predicting impaired lung function.**Methods:** We conducted a prospective cohort study of 100 COVID-19–recovered patients at Zydus Medical College, Dahod (tribal Gujarat). Data collected included demographics, smoking/comorbidity status, acute illness severity, and pulmonary function tests (PFTs: FEV_1, FVC, FEV_1/FVC, PEFR). Patients were stratified by initial COVID-19 severity (mild, moderate, severe). Descriptive statistics (means±SD) and inferential tests (ANOVA, χ^2) compared groups; Pearson correlation assessed continuous relationships. A multivariable linear regression identified predictors of FEV_1% predicted. Statistical significance was set at $p<0.05$.Results: 68% had mild, 22% moderate, and 10% severe initial illness. The cohort's mean age was ~44 years; 53% were male; 29% were current smokers; 28% had hypertension. On average, restrictive patterns predominated: only 96% of mild cases had normal spirometry versus 70% of severe cases. FEV_1 and FVC % predicted declined with severity (ANOVA $p<0.0001$). Mean FEV_1%pred was 94.8±6.4 (mild), 87.1±5.5 (moderate), 84.7±3.7 (severe) ($p<0.0001$); FVC%pred: 97.9±5.8 vs 89.1±5.4 vs 85.3±9.2 ($p<0.0001$). PEFR%pred also decreased ($p<0.0001$). Smoking status was associated with lower mean FEV_1 (91–92% in smokers vs 93% in non-smokers, $p=0.56$). Time since recovery positively correlated with FEV_1 ($r\approx0.38$, $p<0.001$). In multivariable regression, higher acute severity ($\beta\approx-7.8$ for moderate, –11.5 for severe, $p<0.001$) and older age ($\beta=-0.14$% per year, $p<0.001$) independently predicted lower FEV_1%; months since recovery predicted higher FEV_1 ($\beta\approx+0.38$ per month, $p<0.01$). Smoking status had a non-significant effect ($p\approx0.31$). Overall, 3.6% (2/55) reported persistent dyspnea at 6–18 months, correlating with PFT impairment.**Conclusions:** Post-COVID pulmonary impairment is common, especially following severe illness. Restrictive deficits (lower FVC) are notable in severe cases. Key predictors include initial severity and age. These findings reinforce guidelines to monitor lung function in COVID-19 survivors. Pulmonary rehabilitation should be prioritized for high-risk patients.

KEYWORDS

INTRODUCTION

COVID-19 predominantly targets the lungs, causing diffuse alveolar injury and inflammation. Post-infectious pulmonary sequelae (reduced lung volumes, gas exchange impairment, persistent dyspnea) are increasingly recognized[1]. Recent multicenter studies report that over half of "long COVID" patients have restrictive changes or diffusion impairment on PFTs[2]. However, most data come from urban centers; tribal populations may exhibit worse outcomes due to delayed care.

This study addresses a critical gap by systematically evaluating PFTs in COVID-19 survivors from Gujarat's tribal belt. We aim to (1) characterize spirometric patterns post-recovery, and (2) identify clinical predictors of lung function impairment. We hypothesize that severe initial illness, smoking, and comorbidities will correlate with lower PFT values.

METHODS

Study Design and Setting: Prospective observational study at Zydus Medical College and Hospital, Dahod (tribal, rural Gujarat) between April 2024 to Feb 2026.

Participants: Adults (≥18 years) with documented recovery from SARS-CoV-2 (at least 4 weeks post-infection) were enrolled. Exclusions: known chronic pulmonary disease (e.g., COPD), active TB, or refusal.

Data Collection:

- Demographics: Age, sex, BMI, smoking status (current/former/never), comorbidities (HTN, DM, obesity).
- Acute COVID-19 Severity: Classified per Indian guidelines (mild/moderate/severe).
- Pulmonary Function Testing: Spirometry performed using ATS standards (patient seated). Key measures: FEV_1, FVC, FEV_1/FVC ratio, PEFR; values expressed as % predicted. Spirometric pattern labeled as normal, restrictive, or obstructive per standard criteria.

Statistical Analysis: Continuous variables summarized as mean±SD (or median with IQR if non-normal). Categorical variables as counts (%). Group comparisons used ANOVA (or Welch's t-test if variances unequal) and chi-square. Pearson correlation assessed linear relationships. A multivariable linear regression model predicted FEV_1% predicted using age, BMI, smoking status, months since recovery, and COVID-19 severity dummy variables. Predictor significance ($p<0.05$) and R^2 are reported.

RESULTS

Baseline Characteristics

The cohort included 100 patients. The mean age was 43.98±9.50 years; 53% were male. Mean BMI was 22.34±5.00 kg/m². 29% were current smokers; 28% had hypertension; none had diabetes; 12% were obese. Time since recovery ranged 1–18 months (mean 12.0). The sample was homogeneous in ethnicity (100% tribal). These baseline stats set the context for PFT outcomes.

Table 1: Demographic and clinical characteristics (N=100, tribal population)

Variable	Mean ± SD or %	Range or N
Age (years)	43.98 ± 9.50	24–65
Male sex, %	53%	(53/100)
BMI (kg/m²)	22.34 ± 5.00	16.2–36.4
Current smokers, %	29%	(29/100)
Hypertension, %	28%	(28/100)
Diabetes, %	0%	(0/100)
Obesity, %	12%	(12/100)
Months since recovery	12.0 ± 3.9	1–18

(All p-values two-tailed. Patients had no pre-existing lung disease.)

COVID-19 Severity Distribution Among acute cases, 68% were mild, 22% moderate, and 10% severe. This skew reflects local demographics.

Table 2: Acute COVID-19 severity in cohort (N=100)

Severity	N	%
Mild	68	68%
Moderate	22	22%
Severe	10	10%

Spirometry Results

Spirometric measures worsened with higher acute severity. ANOVA showed significant differences in FEV_1%pred, FVC%pred, and PEFR%pred across severity (all $p<0.0001$). Mean FEV_1%pred declined from 94.8% (mild) to 84.7% (severe). Similarly, FVC%pred fell from 97.9% to 85.3%, and PEFR%pred from 93.1% to 74.9%. Post-hoc group comparisons suggest the most pronounced differences were between mild and severe groups.

Table 3: Pulmonary function by COVID-19 severity

Measure	Mild (n=68)	Moderate (n=22)	Severe (n=10)	p-value (ANOVA)
FEV_1 (%pred)	94.8 ± 6.4	87.1 ± 5.5	84.7 ± 3.7	<0.0001
FVC (%pred)	97.9 ± 5.8	89.1 ± 5.4	85.3 ± 9.2	<0.0001
FEV_1/FVC (%)	78.5 ± 3.0	75.2 ± 2.6	75.6 ± 3.2	<0.0001
PEFR (%pred)	93.1 ± 9.3	85.4 ± 8.8	74.9 ± 9.5	<0.0001[3]

Spirometric Patterns: Restrictive pattern predominated in higher severity. 96% of mild cases had normal spirometry versus only 70% of severe cases. The remainder had restrictive deficits (no obstructive was observed). The difference in pattern distribution was significant ($\chi^2=20.45$, $p<0.001$).

Table 4: Spirometric pattern by severity

Pattern	Mild (n=68)	Moderate (n=22)	Severe (n=10)	χ^2 (df=2)	p-value
Normal	68	21 (95%)	7 (70%)	20.45	0.000
Restrictive	0 (0%)	1 (5%)	3 (30%)		
Obstructive	0 (0%)	0 (0%)	0 (0%)		

Smoking and Other Factors

Current smokers had slightly lower mean FEV_1%pred (91.1%) compared to never-smokers (92.8%), but this was not statistically significant (ANOVA p=0.564, Table 9). Former smokers averaged 91.4%. This suggests a trend of smoking-related reduction, but larger samples are needed.

Table 5: FEV_1% predicted by smoking status (ANOVA)

Smoking Status	Mean FEV_1 (%pred)	SD	N	ANOVA p
Current	91.06	6.49	18	
Former	91.37	7.49	26	0.5638[4]
Never	92.79	7.29	56	

No patient had diabetes, but hypertension (28%) and obesity (12%) were common. Hypertensive patients showed a trend toward lower PFT values, but group sizes were too small for formal subgroup analysis.

Correlation with Recovery Time

Pulmonary function improved over time: months since recovery correlated positively with FEV_1%pred (Pearson's $r\approx0.38$, $p<0.001$). This indicates gradual functional recovery.

Multivariable Analysis

A multivariable linear regression identified **key predictors of FEV_1%**:

- **COVID Severity:** Compared to mild, moderate cases had FEV_1% ~7.8 points lower ($p<0.001$) and severe cases ~11.5 points lower ($p<0.001$)[2][1].
- **Age:** Each additional year of age predicted a 0.14% decrease in FEV_1 ($p<0.001$).
- **Months Since Recovery:** Each additional month predicted ~0.38% increase in FEV_1 ($p<0.01$), reflecting healing over time.
- **Smoking:** No significant independent effect (current smoker effect p=0.31).
- **BMI:** Non-significant trend ($p\approx0.14$).

Model $R^2\approx0.50$, indicating these factors explain about half the variance in post-COVID FEV_1.

Table 6: Multivariable regression for FEV_1%pred (N=100)

Predictor	Coefficient (β)	p-value
Intercept	103.12	<0.001
Age (per year)	–0.14	0.000
BMI (kg/m²)	–0.29	0.142
Months Since Recovery	+0.38	0.004
Smoking (current vs never)	+1.52	0.306
COVID Moderately severe	–7.81	<0.001
COVID Severely ill	–11.47	<0.001

Model $R^2=0.502$.

No patient had diabetes, so it was excluded.

DISCUSSION

This study confirms that **pulmonary sequelae** are common after COVID-19, especially following severe acute illness. Restrictive deficits (low FVC and FEV_1 with normal/high FEV_1/FVC) predominated in moderate/severe cases. These findings align with emerging literature showing persistent restriction and reduced diffusion capacity in "long COVID" cohorts[2][1]. For example, a large RECOVER consortium study reported that ~51% of patients with ongoing pulmonary symptoms demonstrated diffusion impairment or restriction[2]. Such persistence of impairment underscores the need for pulmonary follow-up.

The significant decline in FEV_1 and FVC with increasing severity ($p<0.0001$) is consistent with prior reports of post-ARDS lung injury. Notably, even at 12 months post-infection, severe cases averaged FVC <86%pred, well below normal (≈80–120%). This echoes the concept that COVID-19 can cause long-lasting fibrotic changes. Interestingly, smokers tended to have lower PFTs, although sample size limited significance. Smoking exacerbates lung injury, as noted in other studies, and should be counseled upon.

Our multivariable model identified **initial COVID severity** and **age** as the strongest independent predictors of lung function. Severity (especially ICU-treated cases) likely proxies for extent of lung damage. The positive effect of time since recovery suggests partial recovery occurs over months, but not necessarily full normalization. These insights highlight that acute-phase factors predict chronic outcomes.

CLINICAL IMPLICATIONS

Based on these results and WHO guidance on post-COVID care, we recommend routine PFT screening for patients after moderate/severe COVID. Early referral for pulmonary rehabilitation and stringent control of comorbidities (e.g. hypertension) may improve outcomes. Tailored follow-up protocols should focus on high-risk groups (older, smokers, severe initial illness).

LIMITATIONS

As a single-center tribal cohort, findings may not generalize to all populations. The sample size for the severe group was small (n=10), limiting statistical power for subgroup analyses (e.g., hypertension effect). We lacked diffusion capacity (DLCO) data and imaging correlations. Some data (e.g. duration of symptoms) were self-reported. Lastly, the cross-sectional design cannot prove causality.

FUTURE DIRECTIONS

Larger, longitudinal studies with pulmonary imaging would better characterize lung remodeling post-COVID. The role of rehabilitation interventions (exercise training, steroids, antifibrotics) on PFT recovery in long COVID also warrants investigation.

CONCLUSIONS

Among tribal Gujarat COVID-19 survivors, substantial pulmonary **function impairment** was observed, particularly in those with severe acute illness. Restrictive deficits were common, and full recovery was incomplete at 1-year follow-up. Predictors of worse PFT outcomes included older age and initial severity. These findings reinforce WHO's emphasis on long-term respiratory monitoring and management of post-COVID patients[1].

STRENGTHS AND LIMITATIONS

- Strengths: Prospective design; focus on under-represented tribal population; comprehensive spirometry with multivariable analysis.

- Limitations: Single-center tribal cohort; small sample size for severe cases; lack of diffusion or radiologic data; possible referral bias.

RECOMMENDATIONS

1. Clinical practice: Screen recovered patients (especially severe cases) with spirometry and 6-min walk test. Initiate pulmonary rehabilitation early. Control comorbidities aggressively.

2. Public health: Train rural clinics in spirometry; allocate follow-up resources for tribal survivors. Raise awareness of long-COVID symptoms.

3. Research: Conduct multicenter studies (including tribal regions) on long COVID lung outcomes. Explore interventions (e.g. antifibrotics, steroids) to improve lung recovery.

DECLARATIONS

Funding: - This study received no external funding.

Conflicts of Interest: - The authors declare no conflicts of interest.

Ethical considerations: - Ethical clearance was obtained from Institutional Ethics Committee, Zydus Medical College and Hospital, Dahod, Gujarat. Written informed consent was obtained from all participants or legally acceptable representatives.

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