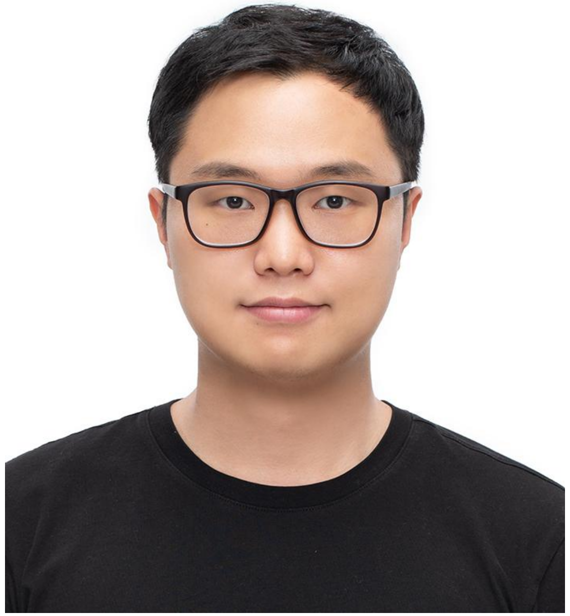
ATS 2026 Highlights

Respiratory Structure and Function Early Career Professionals

Get to know members of the RSF Assembly



Yonghyun Lee, Ph.D.

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Is your research clinical, basic science or translational?

Basic and translational.

Tell us about your research?

My work leverages quantitative CT (qCT) imaging and artificial intelligence (AI) for precise characterization of regional lung structure and function impairment by constructing a healthy-assumed digital twin lung. AI-predicted healthy-assumed reference values and normal ranges at local lung regions allows to identify hyper-and hypo-functioning regions, for ventilation, deformation, and airway metrics. I currently apply this CT digital twin-based functional imaging biomarkers to characterize/predict clinical outcomes in COPD.

Where do you see yourself in 5 years?

I plan to continue active research in academia. As an AI expert, I will closely collaborate with my fellow researchers including clinicians and engineers to develop novel AI models to unveil mechanisms under complicated process of respiratory structure-function impairment. Particularly, I seek to advance digital twin-based qCT biomarkers, to provide pathophysiologically interpretable imaging evidence of early-stage and phenotypic respiratory functional defects and treatment responses in COPD and other lung diseases.

What do you find is the major benefit of RSF Assembly Membership?

The major benefit of RSF Assembly Membership is being part of a collaborative, interdisciplinary community that shares outstanding research and drives progress in respiratory imaging for both scientific and clinical impacts. It has also been invaluable for networking—connecting with influential researchers and colleagues, opening doors to mentorship and collaboration.

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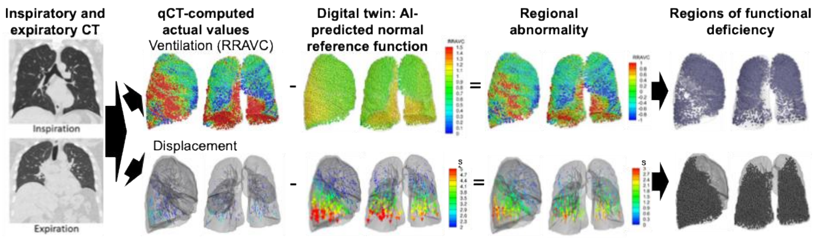
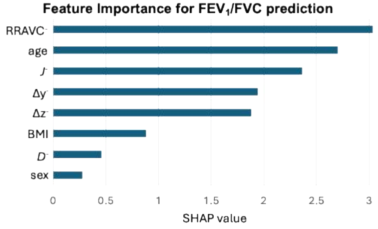


FEV_1/FVC prediction model performance

Model	Train RMSE	Test R^2	Test RMSE
Random Forest	8.10	0.71	6.23
XGBoost	8.26	0.69	6.45
Gradient Boosting	8.64	0.58	7.58
LightGBM	8.97	0.48	8.40
Linear Regression	7.76	0.44	8.74
Decision Tree	12.37	0.22	10.26



Inspiratory-expiratory CT image matching and healthy digital twin lung model-based assessment of regional functional defects (top) and FEV_1/FVC prediction (bottom). RMSE values are in percentage.

CT Digital Twin Lung-based Regional Functional Defects Explain Airflow Obstruction in COPD

Objective: To develop quantitative computed tomography (qCT) digital twin lung-based novel functional imaging biomarkers and identify the importance of key functional abnormalities for predicting airflow obstruction in COPD.

Methods: Inspiratory and expiratory lung CTs, demographics, and pulmonary function test results were collected from 26 healthy individuals (58.0±5.8y;M:F=20:6) and 79 patients with COPD (71.2±7.4y;M:F=72:7) at Jeonbuk National University Hospital (Jeonju, Korea). Commercial (VIDA Vision 2.2, Coralville, IA) and *in-house* qCT software computed local lung structural-functional features including ventilation (relative regional air volume change, RRAVC), volumetric deformation (*J*), motion (dorsoventral [Δy] and apicobasal [Δz] displacements), and airway diameters (*D*). Local lung abnormality of each feature was computed subtracting LightGBM machine learning model-predicted healthy reference values from qCT-computed values. Then, percent lung volumes of the regions with ventilation and deformation defects ($RRAVC^-$, J^-, $Δy^-$, and $Δz^-$) and airway narrowing were used to predict airflow obstruction by post-bronchodilator FEV_1/FVC, by multiple machine learning prediction approaches (decision tree, random forest, gradient boosting, XGBoost, LightGBM, and linear regression). SHapley Additive exPlanations (SHAP) feature importance analysis identified key features.

Results: Spearman correlations and age, sex, and BMI-adjusted linear regression showed strong/moderate association of showed strong association post-bronchodilator FEV_1/FVC with proposed ventilation and deformation defect percentages (r=-0.66, -0.68, -0.62, and -0.56 for $RRAVC^-$, J^-, $Δy^-$, and $Δz^-$, respectively; all p<0.001). The random forest model (RMSE=0.062; R^2=0.71) showed the best performance to predict post-bronchodilator FEV_1/FVC followed by XGBoost (RMSE=0.065; R^2=0.69). Top two model-based Shapley (SHAP) feature importance analysis identified ventilation defect percentage ($RRAVC^-$) as the most important feature to predict post-bronchodilator FEV1/FVC, followed by age, volumetric deformation defect percentage (J^-), and motion defects ($Δy^-$, and $Δz^-$). Among others, $RRAVC^-$ also showed the strongest correlation with reduced diffusing capacity of the lungs for carbon monoxide (DLCO) and Global Initiative Obstructive Lung Disease (GOLD) stage (r=-0.63, 0.64; both p<0.001).

Conclusion: Functional defects from the qCT and machine learning-based digital twin lung had strong association with and decent predictability for clinically measured airflow obstruction for COPD. The proposed imaging-based digital twin lung approach may allow CT imaging to be a useful tool for interpretation of regional lung functional defects and screening of airflow obstruction for individuals at risk for COPD.

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