

Online Supplement

Lung Structure and Risk of Sleep Apnea in SPIROMICS

Abigail L. Koch, MD¹ Tracie L. Shing, DrPH² Andrew Namen, MD³ David Couper, PhD² Benjamin Smith, MD, MSc⁴ R. Graham Barr, MD, PhD⁴ Surya Bhatt, MD, MSPH⁵ Nirupama Putcha, MD, MHS⁶ Aaron Baugh, MD⁷ Amit K. Saha, PhD, MS³ Michelle Zeidler, MD⁸ Alejandro Comellas, MD⁹ Christopher B. Cooper, MD⁸ Igor Barjaktarevic, MD, PhD⁸ Russell P. Bowler, MD, PhD¹⁰ MeiLan K. Han, MD, MS¹¹ Victor Kim, MD¹² Robert Paine, III, MD¹³ Richard E. Kanner, MD¹³ Jerry A. Krishnan, MD, PhD¹⁴ Fernando J. Martinez, MD, MS¹⁵ Prescott G. Woodruff, MD, MPH⁷ Nadia N. Hansel, MD⁶ Eric A. Hoffman, PhD⁹ Stephen P. Peters, MD, PhD³ Victor E. Ortega, MD, PhD¹⁶ for the SubPopulations and Intermediate Outcome Measures in COPD Study (SPIROMICS) Investigators

1. Leonard M. Miller School of Medicine, University of Miami, Miami, Florida, United States
2. Collaborative Studies Coordinating Center, Department of Biostatistics, Gillings' School of Global Public Health, University of North Carolina, Chapel Hill, North Carolina, United States
3. Section on Pulmonary, Critical Care, Allergy and Immunological Diseases, Wake Forest School of Medicine, Wake Forest, North Carolina, United States
4. Department of Medicine, Columbia University Medical Center, New York, New York, United States
5. Division of Pulmonary, Allergy, and Critical Care Medicine, University of Alabama at Birmingham, Birmingham, Alabama, United States
6. Division of Pulmonary and Critical Care Medicine, Johns Hopkins University, Baltimore, Maryland, United States
7. Division of Pulmonary and Critical Care Medicine, Department of Medicine, University of California, San Francisco, California, United States
8. Division of Pulmonary and Critical Care Medicine, Department of Medicine, David Geffen School of Medicine, University of California at Los Angeles, Los Angeles, California, United States
9. Departments of Radiology, Medicine, and Bioengineering, University of Iowa, Iowa City, Iowa, United States
10. Division of Pulmonary, Critical Care, and Sleep Medicine, National Jewish Health, Denver, Colorado, United States

11. Division of Pulmonary and Critical Care Medicine, School of Medicine, University of Michigan, Ann Arbor, Michigan, United States

12. Division of Pulmonary and Critical Care Medicine, Department of Medicine, Temple University School of Medicine, Philadelphia, Pennsylvania, United States

13. Division of Respiratory, Critical Care, and Occupational Pulmonary Medicine, Spencer Fox Eccles School of Medicine, University of Utah, Salt Lake City, Utah, United States

14. Division of Pulmonary, Critical Care, Sleep, and Allergy, University of Illinois at Chicago, Chicago, Illinois, United States

15. Division of Pulmonary and Critical Care Medicine, Weill Cornell Medical College, New York, New York, United States

16. Department of Internal Medicine, Division of Respiratory Diseases, Center for Individualized Medicine, Mayo Clinic, Scottsdale, Arizona, United States

Table A1. Descriptive Statistics of High Risk OSA

Variable*	Overall Study Population (n=1767)		DOISNORE50 High Risk (n=642)		BSQ Apnea High Risk (n=1070)	
Age (years)	1767	62.9 (8.9)	642	64.3 (7.9)	1070	62.7 (8.8)
Gender [Male] (%)	1767	973 (55.1%)	642	477 (74.3%)	1070	592 (55.3%)
Race						
White (%)	1767	1370 (77.5%)	642	516 (80.4%)	1070	809 (75.6%)
Black (%)	1767	314 (17.8%)	642	92 (14.3%)	1070	195 (18.2%)
Other (%)	1767	83 (4.7%)	642	34 (5.3%)	1070	66 (6.2%)
Ethnicity [Hispanic] (%)	1766	81 (4.6%)	642	35 (5.5%)	1070	55 (5.1%)
BMI	1767	28.1 (5.2)	642	31.1 (4.9)	1070	29.9 (5.2)
Height (cm)	1767	170.2 (9.6)	642	172.9 (9.1)	1070	170.2 (9.6)
Neck circumference (cm)						
Male	973	40.3 (3.8)	477	42.0 (3.8)	592	41.3 (3.8)
Female	794	34.9 (4.0)	165	37.7 (3.6)	478	35.8 (4.3)
Current smoking (%)	1767	730 (41.3%)	642	226 (35.2%)	1070	451 (42.1%)
Pack years smoking	1767	48.5 (27.1)	642	51.7 (28.6)	1070	49.0 (24.3)
History of stroke (%)	1766	81 (4.6%)	641	46 (7.2%)	1069	59 (5.5%)
History of hypertension (%)	1767	811 (45.9%)	642	482 (75.1%)	1070	710 (66.4%)
History of palpitations, irregular heartbeat (%)	1766	200 (11.3%)	641	98 (15.3%)	1069	129 (12.1%)
BSQ Apnea Risk [High Risk] (%)	1767	1070 (60.6%)	642	557 (86.8%)	1070	1070 (100.0%)
DOISNORE50 Score	1767	5.0 (1.6)	642	6.6 (0.8)	1070	5.6 (1.3)
DOISNORE50 Risk [High Risk] (%)	1767	642 (36.3%)	642	642 (100.0%)	1070	557 (52.1%)
Percent Predicted Pre-Bronchodilator FEV1	1767	68.1 (26.8)	642	65.7 (25.1)	1070	67.7 (25.7)
Percent Predicted Post-Bronchodilator FEV1	1767	74.8 (26.3)	642	72.3 (24.6)	1070	74.3 (25.1)
Percent Predicted Pre-Bronchodilator FVC	1767	86.0 (19.6)	642	83.3 (18.8)	1070	84.6 (19.0)
Percent Predicted Post-Bronchodilator FVC	1767	91.9 (18.1)	642	89.2 (17.3)	1070	90.5 (17.5)
Pre-Bronchodilator FEV1/FVC	1767	0.6 (0.2)	642	0.6 (0.2)	1070	0.6 (0.2)
Post-Bronchodilator FEV1/FVC	1767	0.6 (0.2)	642	0.6 (0.2)	1070	0.6 (0.2)
Gold Stage COPD Severity						
No airflow limitation	1767	648 (36.7%)	642	203 (31.6%)	1070	402 (37.6%)
GOLD 1: Mild	1767	256 (14.5%)	642	95 (14.8%)	1070	139 (13.0%)
GOLD 2: Moderate	1767	504 (28.5%)	642	215 (33.5%)	1070	326 (30.5%)
GOLD 3: Severe	1767	261 (14.8%)	642	98 (15.3%)	1070	150 (14.0%)
GOLD 4: Very severe	1767	98 (5.5%)	642	31 (4.8%)	1070	53 (5.0%)
CAT Score	1687	13.9 (8.2)	620	16.1 (8.1)	1028	15.5 (8.3)
SGRQ Score	1624	32.8 (20.4)	595	38.3 (20.2)	979	37.3 (20.7)
Annualized Rate of HCU/Drug Exacerbations	1716	0.4 (0.7)	628	0.4 (0.8)	1039	0.4 (0.8)
Annualized Rate of Severe Exacerbations	1716	0.1 (0.4)	628	0.2 (0.5)	1039	0.2 (0.5)
Low attenuation areas on full-lung CT						
Percent below and including - 856 Hounsfield units at RV	1755	23.7 (21.4)	639	22.3 (19.8)	1062	21.2 (19.9)
Percent below and including - 950 Hounsfield units at TLC	1756	7.7 (10.2)	640	6.6 (8.8)	1064	6.4 (9.1)
Airway Dimensions						
Trachea lumen area (mm ²)	1756	275.1 (75.4)	641	284.8 (75.2)	1064	269.6 (74.5)

Trachea wall area (mm²)	1756	181.7 (35.5)	641	192.9 (35.4)	1064	182.1 (36.0)
Trachea percent wall area	1756	40.2 (3.3)	641	40.8 (3.3)	1064	40.8 (3.3)
Mean segmental lumen area (mm²)	1756	24.5 (7.4)	640	24.9 (6.7)	1065	24.2 (6.8)
Mean segmental wall area (mm²)	1758	34.4 (6.2)	641	36.0 (6.0)	1066	34.6 (6.2)
Mean segmental percent wall area	1758	60.3 (2.9)	641	60.9 (2.8)	1066	60.6 (2.8)
PRM fSAD (Ratio of voxels fSAD to the total voxels in the lung)	1588	19.7 (15.2)	579	19.6 (14.9)	960	18.4 (14.8)
Dysanapsis (airway to lung ratio)	1755	0.031 (0.004)	640	0.031 (0.004)	1064	0.031 (0.004)

*Values are mean (SD) except as stated

Table A2. Descriptive Statistics of High Risk OSA by Gender

Variable*	Overall		Males (n=973)	Females (n=794)	P-value†		
	Study Population (n=1767)						
Age (years)	1767	62.9 (8.9)	973	63.8 (8.7)	794	61.7 (8.9)	<.001
Race							0.001
White (%)	1767	1370 (77.5%)	973	781 (80.3%)	794	589 (74.2%)	
Black (%)	1767	314 (17.8%)	973	144 (14.8%)	794	170 (21.4%)	
Other (%)	1767	83 (4.7%)	973	48 (4.9%)	794	35 (4.4%)	
Ethnicity [Hispanic] (%)	1766	81 (4.6%)	973	52 (5.3%)	793	29 (3.7%)	0.092
BMI	1767	28.1 (5.2)	973	28.1 (4.8)	794	28.2 (5.7)	0.774
Height (cm)	1767	170.2 (9.6)	973	176.4 (7.1)	794	162.7 (6.3)	<.001
Neck circumference (cm)	1767	37.8 (4.7)	973	40.3 (3.8)	794	34.9 (4.0)	<.001
Current smoking (%)	1767	730 (41.3%)	973	378 (38.8%)	794	352 (44.3%)	0.020
Pack years smoking	1767	48.5 (27.1)	973	51.7 (29.1)	794	44.7 (24.0)	<.001
History of stroke (%)	1766	81 (4.6%)	973	40 (4.1%)	793	41 (5.2%)	0.290
History of hypertension (%)	1767	811 (45.9%)	973	450 (46.2%)	794	361 (45.5%)	0.743
History of palpitations, irregular heartbeat (%)	1766	200 (11.3%)	972	97 (10.0%)	794	103 (13.0%)	0.048
BSQ Apnea Risk [High Risk] (%)	1767	1070 (60.6%)	973	592 (60.8%)	794	478 (60.2%)	0.784
DOISNORE50 Score	1767	5.0 (1.6)	973	5.4 (1.5)	794	4.4 (1.4)	<.001
DOISNORE50 Risk [High Risk] (%)	1767	642 (36.3%)	973	477 (49.0%)	794	165 (20.8%)	<.001
Percent Predicted Pre-Bronchodilator FEV1	1767	68.1 (26.8)	973	67.6 (27.2)	794	68.7 (26.2)	0.375
Percent Predicted Post-Bronchodilator FEV1	1767	74.8 (26.3)	973	74.1 (26.7)	794	75.6 (25.9)	0.219
Percent Predicted Pre-Bronchodilator FVC	1767	86.0 (19.6)	973	86.9 (19.8)	794	85.0 (19.4)	0.042
Percent Predicted Post-Bronchodilator FVC	1767	91.9 (18.1)	973	92.7 (18.0)	794	90.8 (18.3)	0.027
Pre-Bronchodilator FEV1/FVC	1767	0.6 (0.2)	973	0.6 (0.2)	794	0.6 (0.2)	<.001
Post-Bronchodilator FEV1/FVC	1767	0.6 (0.2)	973	0.6 (0.2)	794	0.6 (0.2)	<.001
CAT Score	1687	13.9 (8.2)	935	13.2 (8.2)	752	14.9 (8.2)	<.001
SGRQ Score	1624	32.8 (20.4)	901	30.4 (20.1)	723	35.7 (20.4)	<.001
Annualized Rate of HCU/Drug Exacerbations	1716	0.4 (0.7)	945	0.3 (0.6)	771	0.5 (0.9)	<.001
Annualized Rate of Severe Exacerbations	1716	0.1 (0.4)	945	0.1 (0.3)	771	0.2 (0.5)	0.011

Low attenuation areas on full-lung CT							
Percent below and including - 856 Hounsfield units at RV	1755	23.7 (21.4)	965	26.0 (21.6)	790	20.8 (20.7)	<.001
Percent below and including - 950 Hounsfield units at TLC	1756	7.7 (10.2)	968	8.6 (10.5)	788	6.5 (9.7)	<.001
Airway Dimensions							
Trachea lumen area (mm²)	1756	275.1 (75.4)	970	315.4 (70.3)	786	225.2 (45.7)	<.001
Trachea wall area (mm²)	1756	181.7 (35.5)	970	205.0 (26.9)	786	152.8 (20.5)	<.001
Trachea percent wall area	1756	40.2 (3.3)	970	39.8 (3.5)	786	40.7 (3.1)	<.001
Mean segmental lumen area (mm²)	1756	24.5 (7.4)	969	27.0 (7.9)	787	21.5 (5.2)	<.001
Mean segmental wall area (mm²)	1758	34.4 (6.2)	970	37.6 (5.7)	788	30.5 (4.3)	<.001
Mean segmental percent wall area	1758	60.3 (2.9)	970	60.2 (3.0)	788	60.4 (2.7)	0.152
PRM fSAD (Ratio of voxels fSAD to the total voxels in the lung)	1588	19.7 (15.2)	892	21.7 (15.3)	696	17.3 (14.8)	<.001
Dysanapsis (airway to lung ratio)	1755	0.031 (0.004)	968	0.031 (0.004)	787	0.031 (0.004)	0.053

*Values are mean (SD) except as stated; †P-value for two sample t-test assuming unequal variances when mean (standard deviation) is presented or for Pearson chi-square test for categorical variables.