

# In-Home Air Pollution is Associated with Respiratory Symptoms in Patients with Chronic Obstructive Pulmonary Disease

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## BACKGROUND

Ambient particulate matter (PM) can trigger adverse reactions in the respiratory system, but less is known about the effect of indoor PM.

## PURPOSE

In this longitudinal study, we investigated the relationships between indoor PM and clinical parameters in patients with moderate to very severe chronic obstructive pulmonary disease (COPD).

## METHODS

- Indoor air quality (PM<sub>2.5</sub> and PM<sub>10</sub> levels) was monitored in the patients' bedroom, kitchen, living room, and front door at baseline and every two months until one year.
- At each home visit, the patients were asked to complete spirometry and self-report respiratory symptoms.

**Table 1.** Demographic and clinical characteristics of the study participants (N = 19)

Variable	N (%) or Mean ± SD	Variable	Mean ± SD
<b>Gender</b>		Age (yrs)	72.6 ± 6.8
Male	19 (100.0)	BMI (kg/m <sup>2</sup> )	22.7 ± 6.7
<b>Weight status</b>		Waist-hip ratio	1.00 ± 0.11
Underweight	5 (26.3)	Charlson comorbidity index (CCI) <sup>#</sup>	5.7 ± 1.1
Normal	8 (42.1)	FEV <sub>1</sub> at 1 <sup>st</sup> visit (%)	42.4 ± 15.0
Overweight	3 (15.8)	Disease (COPD) duration (yrs)	5.1 ± 2.9
Obese	3 (15.8)		
<b>Employment status</b>			
Part-time job	2 (10.5)		
Retired	17 (89.5)		
<b>Education level</b>			
Uneducated	3 (15.8)		
Elementary school	10 (52.6)		
Junior high school or above	6 (31.5)		
<b>Regular exercise</b>			
No	14 (73.7)		
Yes	5 (26.3)		
<b>Cigarette smoking</b>			
Quit	14 (73.7)		
Current smoker	5 (26.3)		
<b>Family smoking</b>			
No	10 (52.6)		
Yes	9 (47.4)		
Sometimes	1 (5.3)		
<b>Whether open window or not</b>			
Always open	10 (52.6)		
Always close	8 (42.1)		
Sometimes	1 (5.3)		
<b>Disease severity<sup>†</sup></b>			
Moderate	6 (31.6)		
Severe	8 (42.1)		
Very severe	5 (26.3)		

Note. <sup>\*</sup> Based on guideline of GOLD, moderate (79% ≤ FEV<sub>1 predicted</sub> ≤ 50%); severe (49% ≤ FEV<sub>1 predicted</sub> ≤ 30%); very severe (FEV<sub>1 predicted</sub> < 30%).  
<sup>#</sup> Higher CCI scores indicate higher level of burden of disease.

## RESULTS

Generalized estimating equation (GEE) analysis (n = 83) showed that the level of wheezing was significantly higher in patients whose living room and kitchen had abnormal (higher than the maximum accepted) PM<sub>2.5</sub> and PM<sub>10</sub> levels.

## CONCLUSION

Increased PM levels were associated with worse respiratory symptoms in patients with moderate to severe COPD.

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**Table 2.** Association between PM<sub>2.5</sub> level and the symptoms and activity of daily living of COPD patients

Variable	Outdoor			Living room			Bedroom			Kitchen		
	Normal <sup>#</sup> (obs = 6)	Abnormal <sup>*</sup> (obs = 77)	B	Normal <sup>#</sup> (obs = 9)	Abnormal <sup>*</sup> (obs = 74)	B	Normal <sup>#</sup> (obs = 13)	Abnormal <sup>*</sup> (obs = 70)	B	Normal <sup>#</sup> (obs = 7)	Abnormal <sup>*</sup> (obs = 76)	B
<b>Respiratory Symptoms</b>												
Cough	3.8±1.8	3.3±1.8	-0.20	3.8±1.9	3.3±1.8	-0.56	3.4±1.9	3.3±1.8	-0.10	3.4±2.0	3.3±1.8	-0.57
Phlegm	4.2±1.3	3.5±1.8	-0.22	3.8±1.9	3.5±1.8	-0.49	3.5±1.8	3.5±1.8	-0.12	3.7±1.7	3.5±1.8	-0.64
Dyspnea	2.2±1.6	2.9±1.6	0.84	3.1±1.9	2.8±1.6	-0.32	2.8±1.8	2.8±1.6	-0.10	2.0±1.5	2.9±1.6	0.48
Wheezing	1.2±0.4	2.3±1.5	1.46**	1.1±0.3	2.4±1.6	0.80***	1.5±1.2	2.4±1.5	0.45	1.1±0.4	2.3±1.5	1.03**
<b>Total</b>	11.3±4.1	12.0±4.8	1.88	11.8±4.5	11.9±4.8	-0.62	11.3±5.3	12.0±4.6	0.09	10.3±4.6	12.1±4.7	0.00

Note. B = regression coefficient derived from GEE model with adjustment of age at baseline, FEV<sub>1</sub> predicted at each visit, smoking status, and whether open window or not; obs = observation; <sup>#</sup> Normal : Daily mean or 24 hour maximum of PM<sub>10</sub> is below 125µg/m<sup>3</sup>, and of PM<sub>2.5</sub> is below 35µg/m<sup>3</sup>; <sup>\*</sup> Abnormal: Daily mean or 24 hour maximum of PM<sub>10</sub> is above 125µg/m<sup>3</sup>, and of PM<sub>2.5</sub> is above of 35µg/m<sup>3</sup>.  
<sup>\*</sup> p < 0.05; <sup>\*\*</sup> p < 0.01; <sup>\*\*\*</sup> p < 0.001.

**Table 3.** Association between PM<sub>10</sub> and the symptoms and activity of daily

Variable	Outdoor			Living room			Bedroom			Kitchen		
	Normal <sup>#</sup> (obs = 43)	Abnormal <sup>*</sup> (obs = 40)	B	Normal <sup>#</sup> (obs = 46)	Abnormal <sup>*</sup> (obs = 37)	B	Normal <sup>#</sup> (obs = 50)	Abnormal <sup>*</sup> (obs = 33)	B	Normal <sup>#</sup> (obs = 46)	Abnormal <sup>*</sup> (obs = 37)	B
<b>Respiratory Symptoms</b>												
Cough	3.3±1.8	3.4±1.9	-0.25	3.4±1.8	3.2±1.8	-0.26	3.5±1.8	3.2±1.9	-0.08	3.3±1.8	3.4±1.8	-0.06
Phlegm	3.4±1.7	3.6±1.8	-0.07	3.5±1.7	3.5±1.8	-0.24	3.6±1.7	3.4±1.9	0.04	3.4±1.7	3.7±1.8	0.02
Dyspnea	2.6±1.6	3.1±1.6	0.40	2.7±1.7	3.0±1.5	0.39	2.8±1.7	2.8±1.5	0.13	2.6±1.7	3.1±1.5	0.25
Wheezing	2.1±1.5	2.4±1.6	0.43	2.0±1.5	2.5±1.5	0.36*	2.1±1.6	2.4±1.5	0.18	2.0±1.5	2.5±1.5	0.38*
<b>Total</b>	11.4±5.1	12.5±4.2	0.40	11.6±5.0	12.3±4.3	0.30	12.0±4.9	11.8±4.5	0.32	11.3±5.2	12.7±4.0	0.51

Note. B = regression coefficient derived from GEE model with adjustment of age at baseline, FEV<sub>1</sub> predicted at each visit, smoking status, and whether open window or not; obs = observation; <sup>#</sup> Normal : Daily mean or 24 hour maximum of PM<sub>10</sub> is below 125µg/m<sup>3</sup>, and of PM<sub>2.5</sub> is below 35µg/m<sup>3</sup>; <sup>\*</sup> Abnormal: Daily mean or 24 hour maximum of PM<sub>10</sub> is above 125µg/m<sup>3</sup>, and of PM<sub>2.5</sub> is above of 35µg/m<sup>3</sup>.  
<sup>\*</sup> p < 0.05; <sup>\*\*</sup> p < 0.01; <sup>\*\*\*</sup> p < 0.001.