COPD-P 맞춤형 접근법

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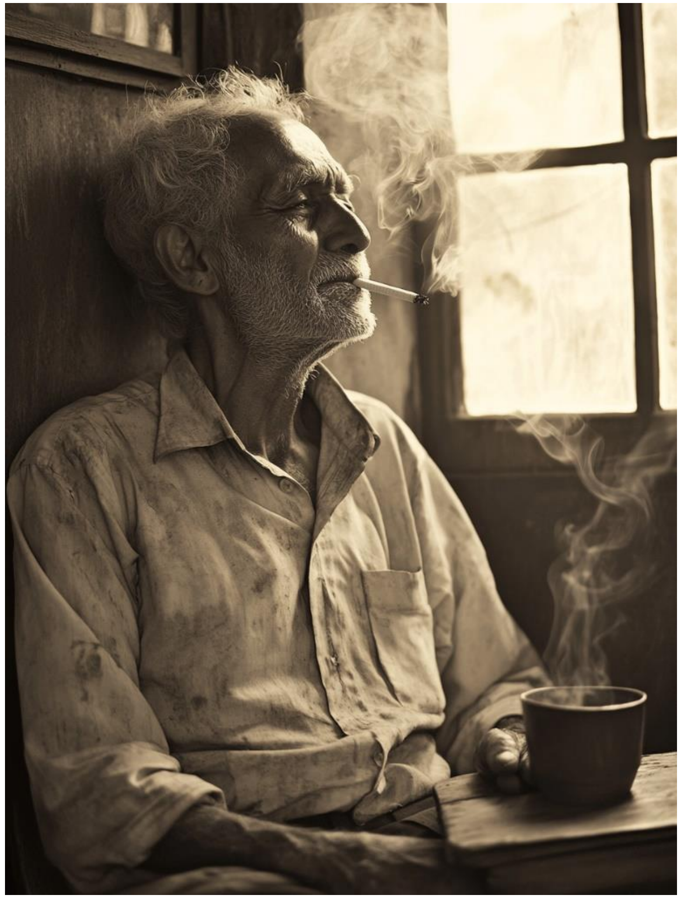
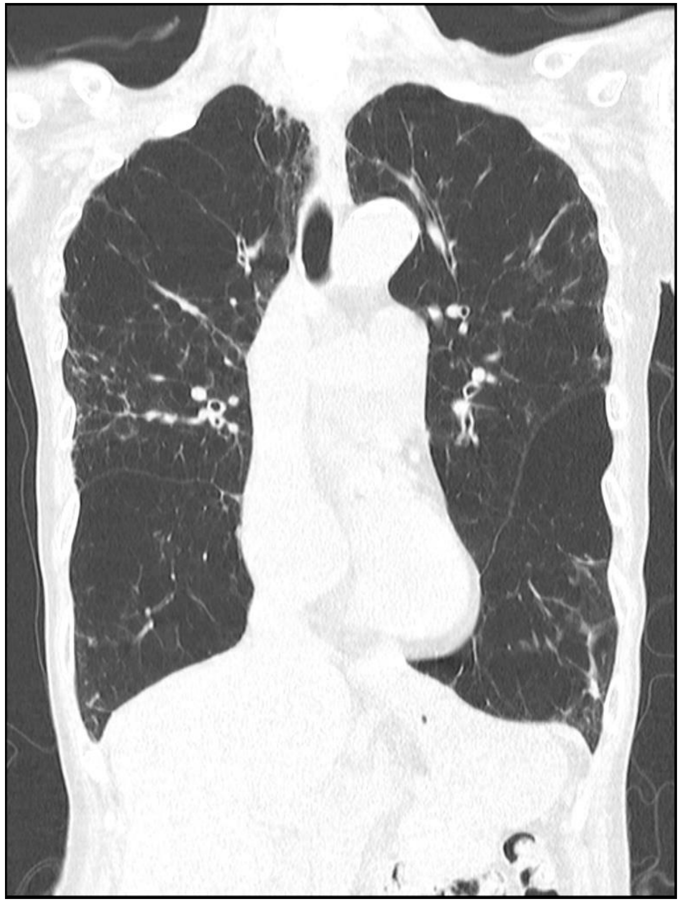
1. COPD-P and the burden of air pollution in COPD patients

Traditional concept of COPD





- 75-years old
- 40PY smoking history
- Lung function
  - ✓ FEV1 35%
  - ✓ FEV1/FVC 0.52

Etiotypes for COPD : COPD is a heterogeneous disease

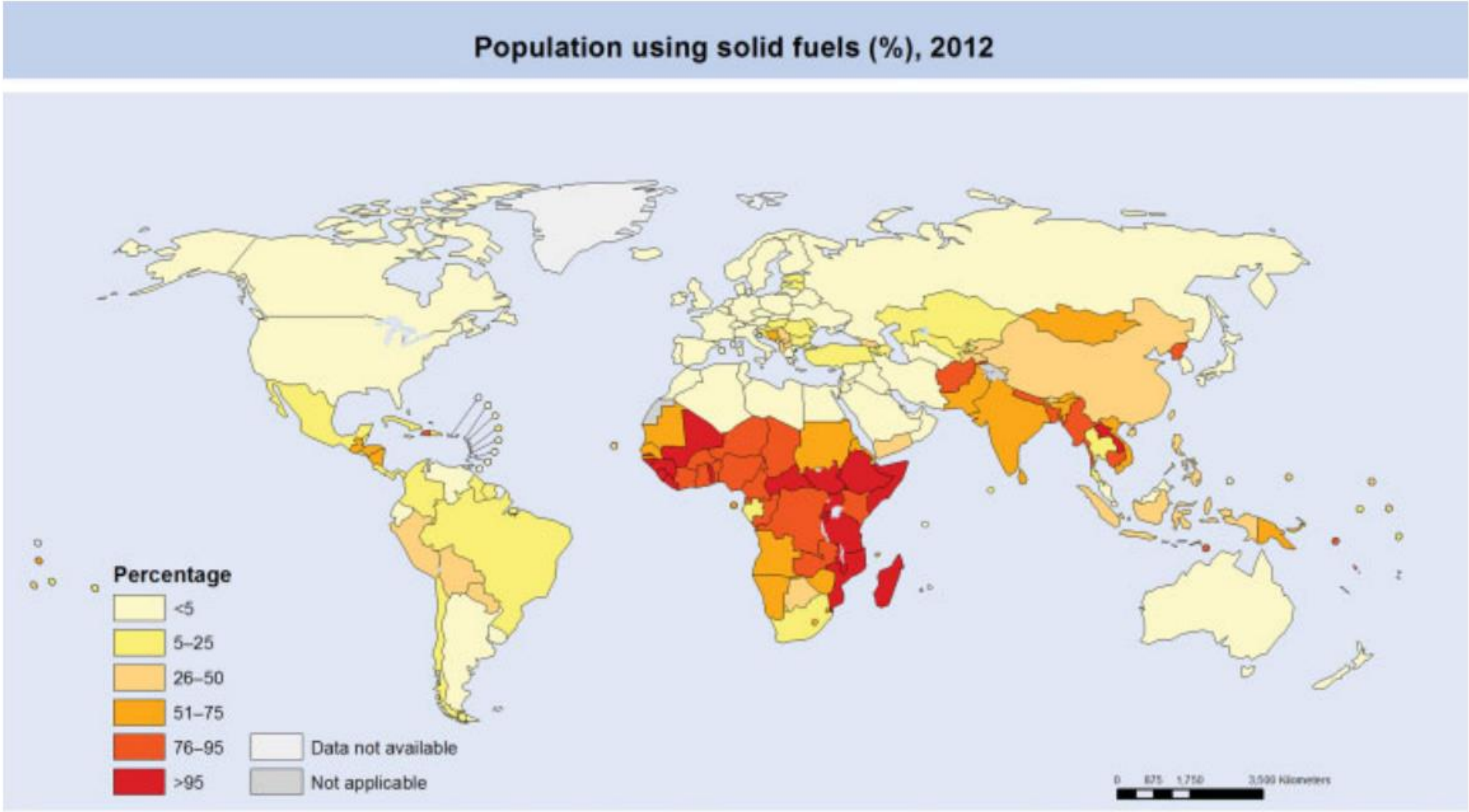
Proposed Taxonomy (Etiotypes) for COPD

Figure 1.2

Classification	Description
Genetically determined COPD (COPD-G)	Alpha-1 antitrypsin deficiency (AATD) Other genetic variants with smaller effects acting in combination
COPD due to abnormal lung development (COPD-D)	Early life events, including premature birth and low birthweight, among others
Environmental COPD	
Cigarette smoking COPD (COPD-C)	• Exposure to tobacco smoke, including *in utero* or via passive smoking • Vaping or e-cigarette use • Cannabis
Biomass and pollution exposure COPD (COPD-P)	Exposure to household pollution, ambient air pollution, wildfire smoke, occupational hazards
COPD due to infections (COPD-I)	Childhood infections, tuberculosis-associated COPD, HIV-associated COPD
COPD & asthma (COPD-A)	Particularly childhood asthma
COPD of unknown cause (COPD-U)	

GOLD 2025.

Global use of indoor solid fuels in 2012 by the WHO



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Public Health Information and Geographic Information Systems (GIS)
World Health Organization

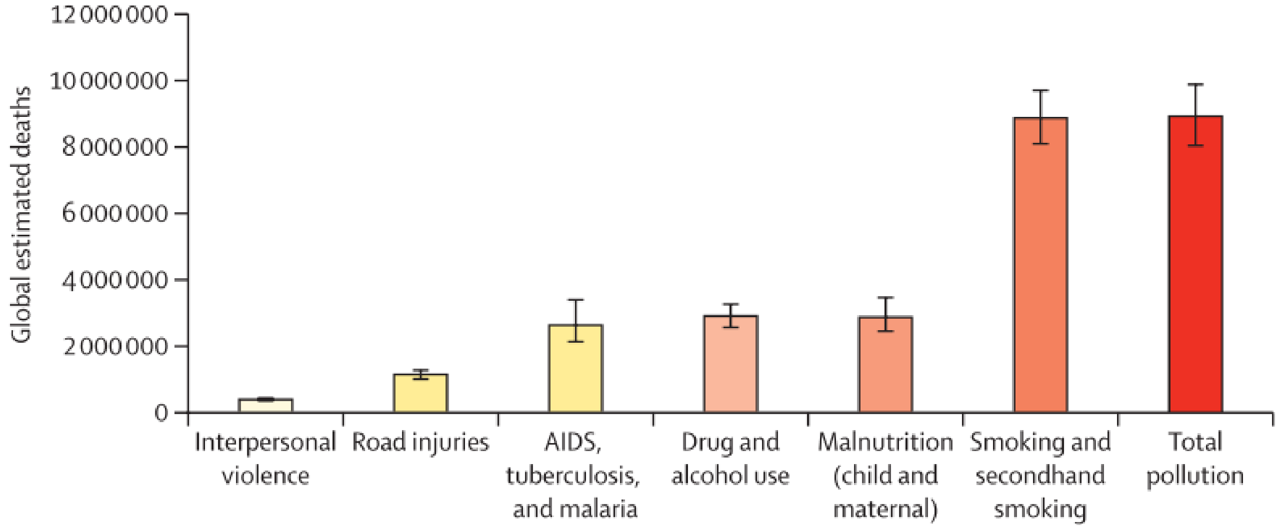
World Health Organization

WHO, 2013

Burden of Air Pollution - Global estimated deaths by major risk factor

Pollution and health: a progress update

Richard Fuller, Philip J Landrigan, Kalpana Balakrishnan, Glynda Bathan, Stephan Bose-O'Reilly, Michael Brauer, Jack Caravanos, Tom Chiles, Aaron Cohen, Lilian Corra, Maureen Cropper, Greg Ferraro, Jill Hanna, David Hanrahan, Howard Hu, David Hunter, Gloria Janata, Rachael Kupka, Bruce Lanphear, Maureen Lichtveld, Keith Martin, Adetoun Mustapha, Ernesto Sanchez-Triana, Karti Sandilya, Laura Schaefli, Joseph Shaw, Jessica Seddon, William Suk, Martha María Téllez-Rojo, Chonghuai Yan



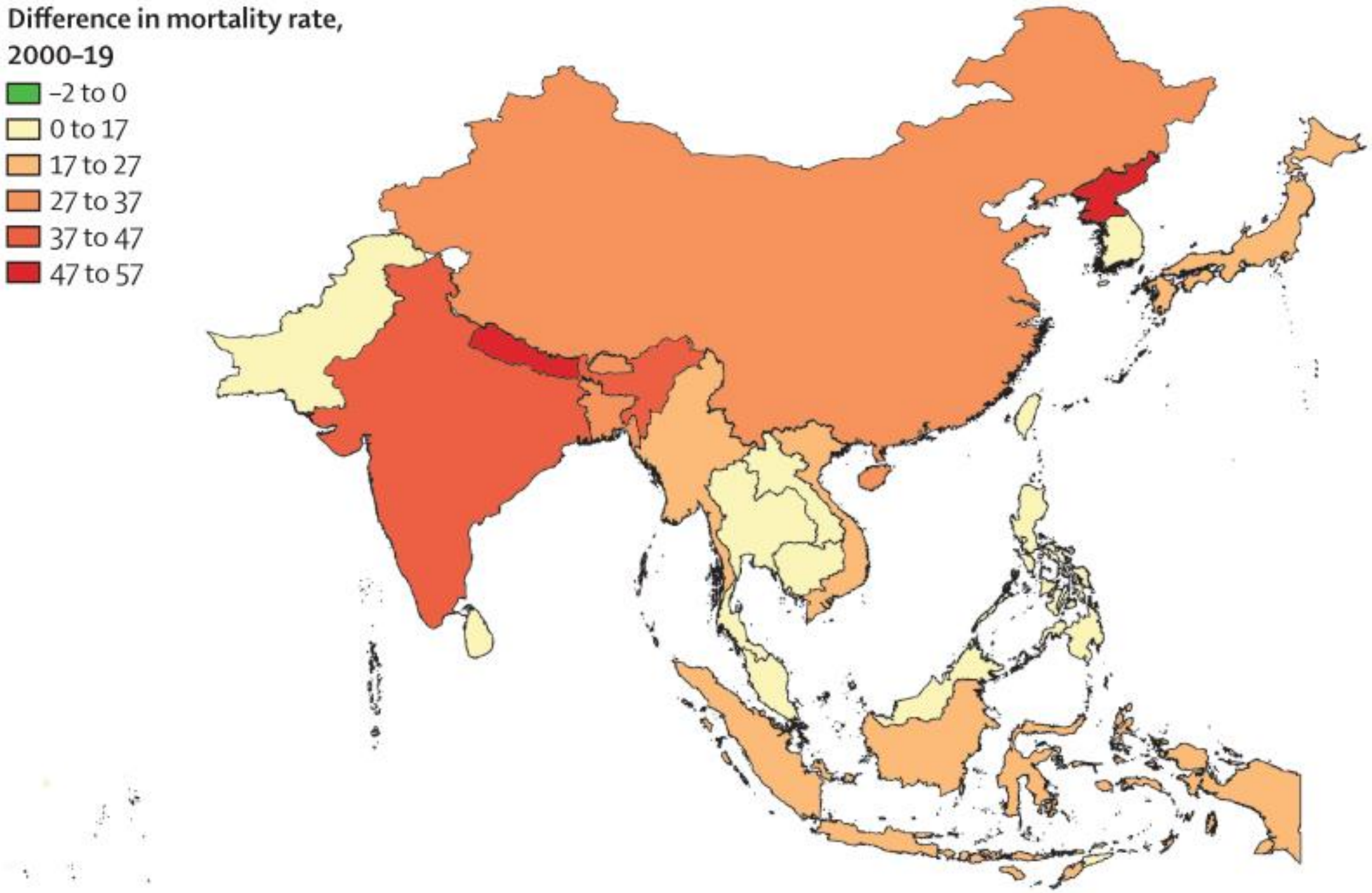
	Female	Male	Total
Total air pollution*	2·92 (2·53–3·33)	3·75 (3·31–4·25)	6·67 (5·90–7·49)
Household air†	1·13 (0·80–1·50)	1·18 (0·79–1·66)	2·31 (1·63–3·12)
Ambient particulate‡§	1·70 (1·38–2·01)	2·44 (2·02–2·83)	4·14 (3·45–4·8)
Ambient ozone‡	0·16 (0·07–0·25)	0·21 (0·09–0·33)	0·37 (0·17–0·56)
Total water pollution*	0·73 (0·40–1·26)	0·63 (0·46–0·95)	1·36 (0·96–1·96)
Unsafe sanitation†	0·40 (0·23–0·68)	0·36 (0·26–0·54)	0·76 (0·54–1·09)
Unsafe source†	0·66 (0·35–1·15)	0·57 (0·39–0·88)	1·23 (0·82–1·79)
Total occupational pollution*	0·22 (0·17–0·28)	0·65 (0·54–0·79)	0·87 (0·74–1·02)
Carcinogens‡	0·07 (0·05–0·09)	0·28 (0·22–0·35)	0·35 (0·28–0·42)
Particulates‡¶	0·15 (0·10–0·21)	0·37 (0·27–0·47)	0·52 (0·42–0·64)
Lead pollution*‡	0·35 (0·19–0·53)	0·56 (0·36–0·77)	0·90 (0·55–1·29)
Total modern pollution*	2·28 (1·86–2·67)	3·55 (3·08–4·04)	5·84 (5·03–6·61)
Total traditional pollution*	1·85 (1·39–2·42)	1·81 (1·36–2·38)	3·66 (2·82–4·63)
Total pollution*	3·92 (3·39–4·47)	5·09 (4·57–5·68)	9·01 (8·12–10·0)

Data are N in millions (95% CI). *Custom aggregate from Institute for Health Metrics and Evaluation corrected for overlap. The totals for air, water, modern, traditional, and all pollution are less than the arithmetic sum of the individual risk factors within each of these categories because their contributions overlap (eg, household air and ambient air pollution each can contribute to the same diseases). †Traditional pollution risk factor. ‡Modern pollution risk factors. §Ambient particulate matter is $PM_{2.5}$. ¶Occupational exposure to respirable, thoracic, or inhalable particulate matter.

Table: **Global estimated pollution-attributable deaths (millions) by type of pollution and sex, 2019**

Fuller R et al. *Lancet Planet Health. 2022;6(6):e535-e547.*

Upward trend in mortality from modern pollution in south Asia and southeast Asia, 2000–19



Fuller R et al. *Lancet Planet Health. 2022;6(6):e535-e547.*

Burden of pollution

Air pollution causes 6.5 million deaths each year globally

Death by modern pollution have increased by 66% over two decades

More than 90% of pollution-related deaths occur in LMICs

Fuller R et al. *Lancet Planet Health. 2022;6(6):e535-e547.*

Burden of air pollution in COPD

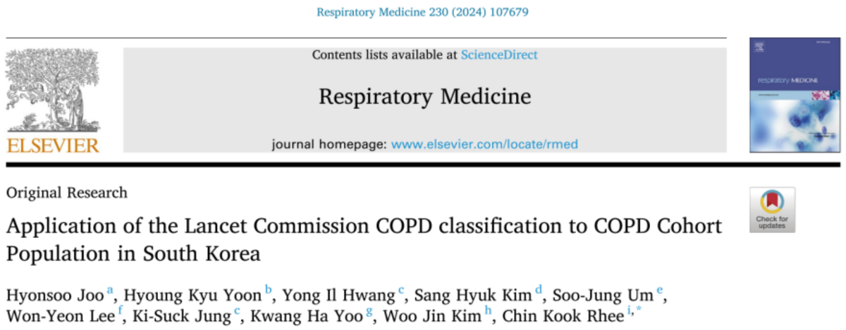
- Air pollution → ~50% of the risk
- Risk amplifying in those living in LMICs.
- In life-time nonsmokers, air pollution is the leading known risk factor for COPD

➔ GOLD committee

"Air pollution is a major health threat to patients living with COPD, and actions are urgently required to reduce the morbidity and mortality related to poor air quality around the world."

Ryu et al. *Chest. 2024;165(4):836-846.*

Proportion of COPD-P in Korea



Respiratory Medicine 230 (2024) 107679

Contents lists available at ScienceDirect

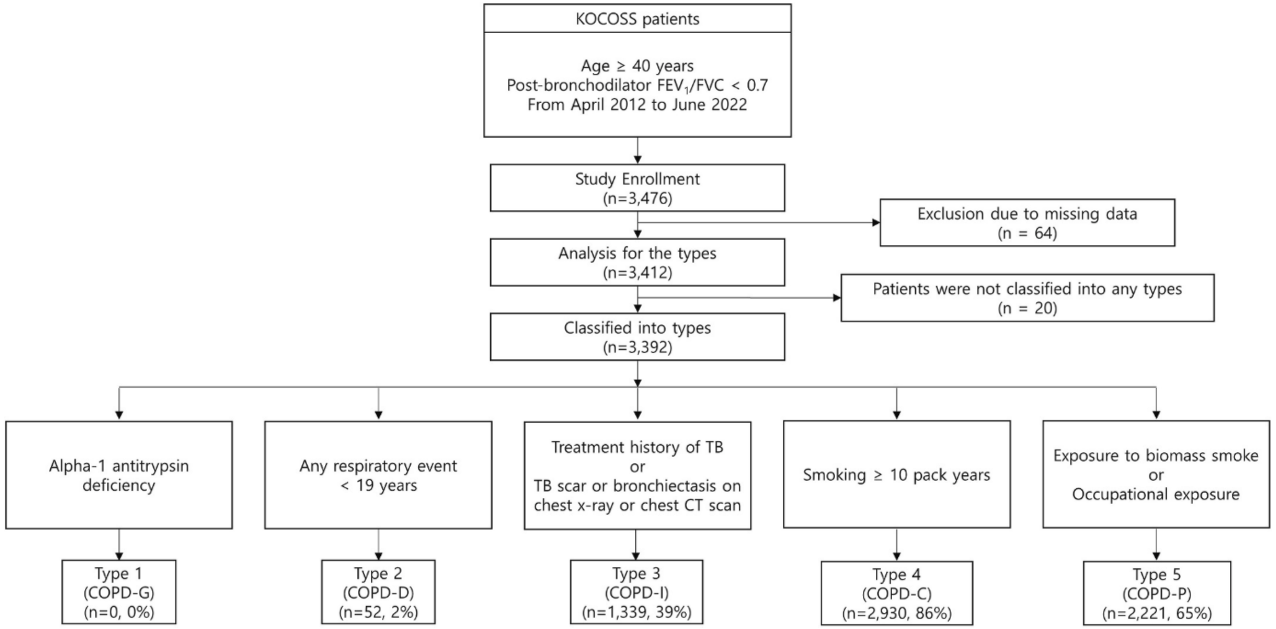
Respiratory Medicine

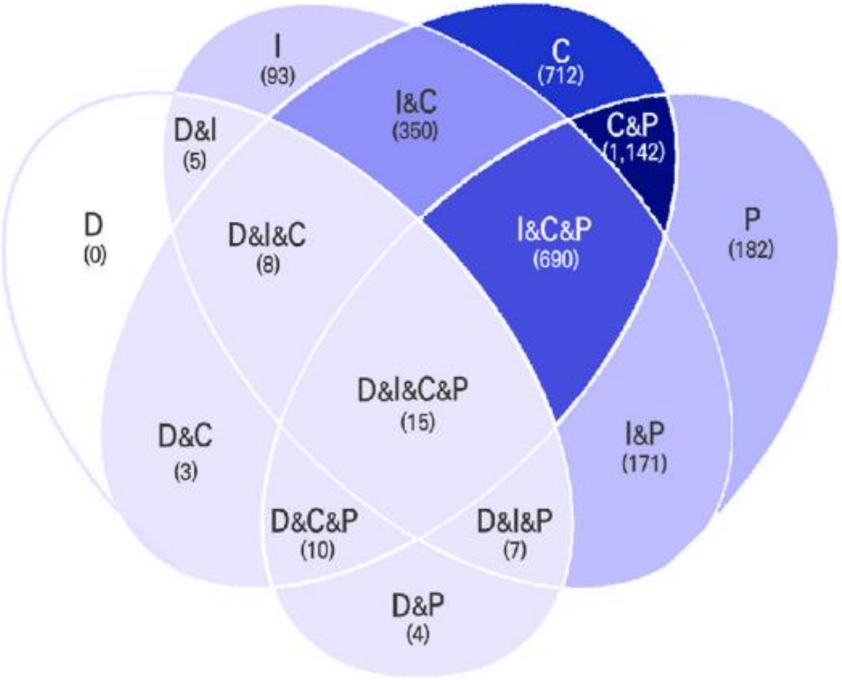
journal homepage: www.elsevier.com/locate/rmed

Original Research

Application of the Lancet Commission COPD classification to COPD Cohort Population in South Korea

Hyonsoo Joo[a], Hyoung Kyu Yoon[b], Yong Il Hwang[c], Sang Hyuk Kim[d], Soo-Jung Um[e], Won-Yeon Lee[f], Ki-Suck Jung[c], Kwang Ha Yoo[g], Woo Jin Kim[h], Chin Kook Rhee[i,*]





Joo H et al. *Respiratory Medicine. 2024;230:107679.*

PM2.5 and PM10 is associated with COPD prevalence and death

UK Biobank

Respiratory epidemiology

Original research

Air pollution associated with incidence and progression trajectory of chronic lung diseases: a population-based cohort study

Table 3 HR (95% CIs) for each transition in transition pattern B by ambient air pollutants

	HR (95% CI), per 5 μg/m^3				
	$PM_{2.5}$	$PM_{2.5\text{-}10}$	PM_{10}	NO_2	NO_x
Baseline →incident chronic lung disease					
Baseline → asthma	**1.18 (1.05 to 1.33)**	0.93 (0.81 to 1.06)	1.03 (0.96 to 1.10)	1.01 (0.99 to 1.02)	**1.01 (1.00 to 1.02)**
Baseline → COPD	**1.42 (1.27 to 1.59)**	0.95 (0.83 to 1.09)	**1.19 (1.11 to 1.26)**	**1.03 (1.02 to 1.04)**	**1.02 (1.01 to 1.03)**
Baseline → lung cancer	**1.43 (1.07 to 1.91)**	0.94 (0.66 to 1.33)	**1.17 (1.02 to 1.34)**	**1.05 (1.01 to 1.08)**	**1.02 (1.00 to 1.04)**
Incident chronic lung disease → chronic lung multimorbidity					
Asthma → chronic lung multimorbidity	**2.01 (1.32 to 3.08)**	1.01 (0.60 to 1.71)	**1.35 (1.03 to 1.77)**	**1.12 (1.06 to 1.18)**	**1.05 (1.02 to 1.07)**
COPD → chronic lung multimorbidity	0.99 (0.63 to 1.54)	1.44 (0.87 to 2.39)	1.08 (0.83 to 1.39)	1.01 (0.95 to 1.09)	1.00 (0.98 to 1.03)
Lung cancer →chronic lung multimorbidity	0.69 (0.26 to 1.84)	0.81 (0.29 to 2.28)	0.90 (0.54 to 1.49)	0.96 (0.86 to 1.08)	0.97 (0.91 to 1.05)
Baseline → death	**1.32 (1.21 to 1.45)**	0.98 (0.88 to 1.09)	**1.05 (1.00 to 1.11)**	**1.02 (1.01 to 1.03)**	**1.02 (1.01 to 1.02)**
Incident chronic lung disease → death					
Asthma → death	1.10 (0.65 to 1.89)	1.45 (0.81 to 2.60)	1.24 (0.90 to 1.70)	1.02 (0.95 to 1.09)	1.01 (0.98 to 1.05)
COPD → death	**1.55 (1.15 to 2.07)**	1.07 (0.74 to 1.55)	**1.30 (1.09 to 1.54)**	1.01 (0.96 to 1.07)	**1.03 (1.01 to 1.04)**
Lung cancer → death	0.85 (0.57 to 1.27)	1.01 (0.67 to 1.53)	0.82 (0.66 to 1.01)	0.97 (0.93 to 1.01)	1.00 (0.97 to 1.03)
Chronic lung multimorbidity → death	**1.89 (1.12 to 3.19)**	1.18 (0.64 to 2.17)	**1.53 (1.12 to 2.09)**	**1.10 (1.04 to 1.17)**	**1.04 (1.01 to 1.07)**

Bold values denote statistically significant results.
COPD, chronic obstructive pulmonary disease; NO_2, nitrogen dioxide; NO_x, nitrogen oxides; PM_{10}, particulate matter with diameter ≤10μm.

Wang et al. *Thorax. 2023;78(7):698-705.*

Air pollution was associated with lower lung function and increased COPD prevalence

UK Biobank

ORIGINAL ARTICLE
COPD AND LUNG FUNCTION

CrossMark

Air pollution, lung function and COPD: results from the population-based UK Biobank study

Dany Doiron[1,2,3], Kees de Hoogh[2,3], Nicole Probst-Hensch[2,3], Isabel Fortier[1], Yutong Cai[4,5], Sara De Matteis[6] and Anna L. Hansell[4,7]

TABLE 3 Associations of lung function and ambient air pollution exposure#

	Subjects n	FEV_1 (mL) β (95% CI)	FVC (mL) β (95% CI)	FEV_1/FVC β (95% CI)
$PM_{2.5}$ per 5 $\mu g \cdot m^{-3}$	278 228	**−83.13 (−92.50– −73.75)**	**−62.62 (−73.91– −51.32)**	**−9.68 (−10.81– −8.56)**
PM_{10} per 10 $\mu g \cdot m^{-3}$	278 228	**−94.41 (−104.59– −84.22)**	**−122.95 (−135.22– −110.68)**	−0.34 (−1.56–0.89)
PM_{coarse} per 5 $\mu g \cdot m^{-3}$	278 228	**−68.61 (−79.37– −57.85)**	**−96.69 (−109.65– −83.73)**	**1.34 (0.04–2.63)**
NO_2 per 10 $\mu g \cdot m^{-3}$	299 537	**−33.85 (−36.34– −31.36)**	**−33.47 (−36.47– −30.46)**	**−2.27 (−2.57– −1.96)**

TABLE 4 Associations of chronic obstructive pulmonary disease and ambient air pollution exposure#

	Cases/non-cases n/n	OR (95% CI)
$PM_{2.5}$ per 5 $\mu g \cdot m^{-3}$	20 478/257 089	**1.52 (1.42–1.62)**
PM_{10} per 10 $\mu g \cdot m^{-3}$	20 478/257 089	**1.08 (1.00–1.16)**
PM_{coarse} per 5 $\mu g \cdot m^{-3}$	20 478/257 089	0.99 (0.91–1.07)
NO_2 per 10 $\mu g \cdot m^{-3}$	21 900/276 948	**1.12 (1.10–1.14)**

Doiron et al. *Eur Respir J. 2019;54(1).*

TABLE 5 Lung function subgroup analyses for fine particulate matter with diameter <2.5 µm ($PM_{2.5}$) and nitrogen dioxide (NO_2)#

	FEV1 mL				FVC mL				FEV1/FVC			
	$PM_{2.5}$ per 5 µg·m^{-3}		NO_2 per 10 µg·m^{-3}		$PM_{2.5}$ per 5 µg·m^{-3}		NO_2 per 10 µg·m^{-3}		$PM_{2.5}$ per 5 µg·m^{-3}		NO_2 per 10 µg·m^{-3}	
	β (95% CI)	Interaction p-value	β (95% CI)	Interaction p-value	β (95% CI)	Interaction p-value	β (95% CI)	Interaction p-value	β (95% CI)	Interaction p-value	β (95% CI)	Interaction p-value
Sex		<0.001		<0.001		<0.001		<0.001		0.928		0.883
Male	−102.32 (−118.16– −86.48)		−41.22 (−45.44– −37.00)		−78.48 (−97.42– −59.54)		−40.85 (−45.89– −35.81)		−9.52 (−11.25– −7.80)		−2.27 (−2.73– −1.80)	
Female	−68.14 (−78.68– −57.59)		−28.01 (−30.82– −25.21)		−50.47 (−63.28– −37.67)		−27.66 (−31.06– −24.26)		−9.79 (−11.26– −8.32)		−2.25 (−2.65– −1.86)	
Age		0.574		0.113		0.187		0.014		<0.001		<0.001
<65 years	−83.63 (−93.85– −73.40)		−32.55 (−37.27– −31.83)		−65.06 (−77.40– −52.71)		−34.86 (−38.15– −31.58)		−8.92 (−10.11– −7.73)		−2.04 (−2.36– −1.72)	
⩾65 years	−85.32 (−108.62– −62.01)		−31.64 (−37.82– −25.47)		−54.05 (−81.85– −26.25)		−27.41 (−34.78– −20.05)		−13.73 (−16.91– −10.54)		−3.50 (−4.35– −2.65)	
Obesity		0.068		0.003		0.460		0.082		0.005		0.005
Non-obese	−78.68 (−89.31– −68.04)		−31.69 (−34.51– −28.87)		−58.93 (−71.78– −46.08)		−31.65 (−35.05– −28.24)		−9.07 (−10.36– −7.79)		−2.07 (−2.41– −1.73)	
Obese	−95.53 (−115.24– −75.82)		−40.36 (−45.68– −35.04)		−76.78 (−100.30– −53.27)		−40.78 (−47.12– −34.45)		−10.99 (−13.32– −8.67)		−2.61 (−3.24– −1.98)	
Smoking status		0.388		<0.001		<0.001		<0.001		<0.001		<0.001
Never-smoker	−84.49 (−96.74– −72.25)		−38.11 (−41.37– −34.85)		−76.56 (−91.51– −61.60)		−41.89 (−45.87– −37.91)		−6.91 (−8.35– −5.47)		−1.61 (−2.00– −1.23)	
Current or past smoker	−87.08 (−101.61– −72.55)		−30.42 (−34.28– −26.56)		−49.66 (−66.87– −32.46)		−24.42 (−28.99– −19.85)		−13.80 (−15.59– −12.00)		−3.31 (−3.79– −2.83)	
Household income	<0.001		<0.001		<0.001		<0.001		<0.001		<0.001	
<GBP 31 000	−78.85 (−93.56– −64.13)		−35.76 (−39.79– −31.73)		−95.83 (−112.86– −78.79)		−46.92 (−51.58– −42.25)		−13.70 (−15.49– −11.91)		−3.46 (−3.96– −2.97)	
⩾GBP 31 000	−39.12 (−52.30– −25.94)		−21.81 (−25.24– −18.37)		−31.69 (−46.76– −16.62)		−22.15 (−26.08– −18.23)		−6.38 (−7.82– −4.95)		−1.41 (−1.78– −1.03)	
Asthma status		0.002		0.033		0.094		0.319		0.013		0.113
Never had asthma	−84.84 (−94.61– −75.08)		−33.93 (−36.53– −31.33)		−63.17 (−75.10– −51.24)		−33.21 (−36.38– −30.04)		−9.78 (−10.92– −8.64)		−2.27 (−2.57– −1.96)	
Ever had asthma	−70.01 (−99.76– −40.26)		−33.13 (−41.08– −25.17)		−54.57 (−89.32– −19.81)		−34.12 (−43.40– −24.85)		−9.25 (−13.30– −5.21)		−2.43 (−3.51– −1.34)	
Occupational status	0.001		<0.001		0.002		<0.001		0.431		0.594	
Non-"at-risk" occupation	−71.88 (−83.25– −60.51)		−30.88 (−33.87– −27.89)		−57.95 (−71.67– −44.24)		−32.20 (−35.81– −28.59)		−6.94 (−8.25– −5.62)		−1.57 (−1.92– −1.22)	
"At-risk" occupation	−183.85 (−271.13– −96.56)		−77.71 (−101.86– −53.57)		−192.19 (−296.36– −88.01)		−91.28 (−120.11– −62.46)		−9.18 (−19.57–1.20)		−1.81 (−4.71–1.09)	

FEV1: forced expiratory volume in 1 s; FVC: forced vital capacity. #: adjusted for age (continuous), age-squared, sex, height, body mass index (kg·m^{-2}), household income (<GBP 31 000/⩾GBP 31 000), education level (lower vocational or less/higher vocational or more), smoking status (never/former/current) and passive smoking exposure at home (none/any).

Doiron et al. *Eur Respir J. 2019;54(1).*

TABLE 6 Chronic obstructive pulmonary disease subgroup analyses for fine particulate matter with diameter <2.5 µm ($PM_{2.5}$) and nitrogen dioxide (NO_2)#

	$PM_{2.5}$ per 5 $\mu g \cdot m^{-3}$			NO_2 per 10 $\mu g \cdot m^{-3}$		
	Cases/ non-cases	**OR (95% CI)**	**Interaction p-value**	**Cases/ non-cases**	**OR (95% CI)**	**Interaction p-value**
Sex			0.024			0.101
Male	10 615/120 233	1.40 (1.27–1.54)		11 279/129 269	1.10 (1.07–1.13)	
Female	9863/136 856	1.64 (1.49–1.81)		10 621/147 679	1.13 (1.10–1.16)	
Age			0.128			0.260
<65 years	16 685/214 004	1.49 (1.38–1.60)		17 854/230 661	1.11 (1.09–1.13)	
⩾65 years	3793/43 085	1.64 (1.40–1.92)		4046/46 287	1.13 (1.09–1.18)	
Obesity			0.002			0.002
Non-obese	16 508/195 722	1.44 (1.34–1.56)		17 646/210 967	1.10 (1.08–1.12)	
Obese	3970/61 367	1.80 (1.55–2.09)		4254/65 981	1.17 (1.12–1.22)	
Smoking status			0.009			0.181
Never-smoker	10 574/152 753	1.39 (1.26–1.53)		11 319/165 120	1.10 (1.07–1.13)	
Current or past smoker	9904/104 336	1.69 (1.53–1.85)		10 581/111 828	1.14 (1.11–1.17)	
Household income			<0.001			<0.001
<GBP 31 000	10 090/113 656	1.85 (1.69–2.04)		10 700/121 462	1.19 (1.15–1.22)	
⩾ GBP 31 000	10 388/143 433	1.25 (1.14–1.38)		11 200/155 486	1.06 (1.03–1.09)	
Asthma status			<0.001			<0.001
Never had asthma	14 484/233 176	1.66 (1.53–1.79)		15 510/251 382	1.14 (1.12–1.17)	
Ever had asthma	5967/23 729	1.24 (1.08–1.42)		6362/25 371	1.06 (1.02–1.10)	
Occupational status			0.742			0.725
Non-"at-risk" occupation	13 512/178 876	1.37 (1.26–1.49)		14 354/191 700	1.09 (1.06–1.11)	
"At-risk" occupation	381/3161	1.46 (0.89–2.39)		399/3314	1.11 (0.97–1.27)	

Data are presented as n/n, unless otherwise stated. #: adjusted for age (continuous), sex, body mass index ($kg \cdot m^{-2}$), household income (<GBP 31 000/⩾GBP 31 000), education level (lower vocational or less/higher vocational or more), smoking status (never/former/current) and passive smoking exposure at home (none/any).

Doiron et al. *Eur Respir J. 2019;54(1).*

Risk of COPD due to indoor air pollution

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2020, VOL. 30, NO. 1, 75–88
https://doi.org/10.1080/09603123.2019.1575951

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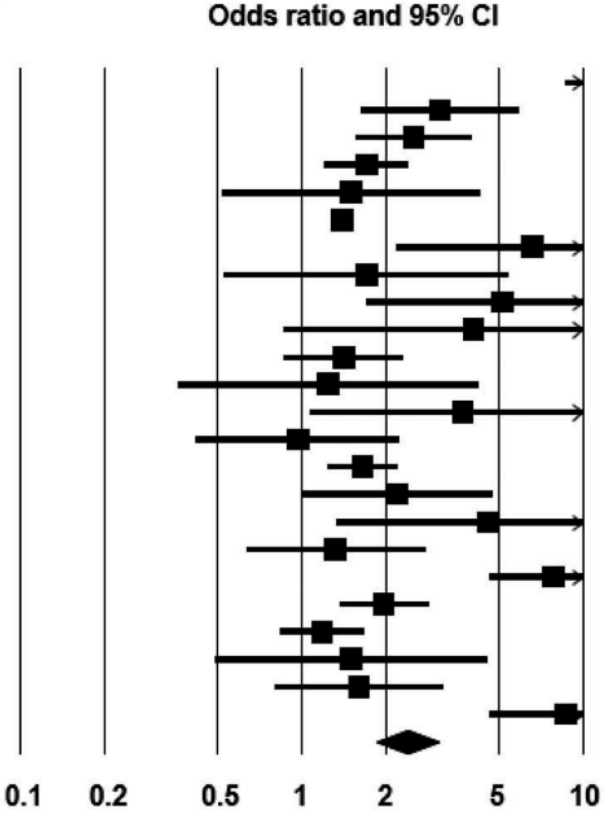
Risk of COPD due to indoor air pollution from biomass cooking fuel: a systematic review and meta-analysis

Utkarsha Pathak[a], Naresh Chandra Gupta[a] and Jagdish Chandra Suri[b]

Chest Research Foundation, Pune, India

Biomass fuel exposure → COPD risk ↑ (OR 2.38, 95% CI: 1.85–3.06)

Study name	Statistics for each study: Odds ratio	Lower limit	Upper limit	Relative weight
Kiraz 2003	28.90	8.71	95.90	2.65
Liu 2007a	3.10	1.63	5.90	4.70
Ekici 2005	2.50	1.56	4.00	5.49
Liu 2007c	1.70	1.20	2.40	6.03
Regaldo 2006	1.50	0.52	4.31	3.07
Zhong 2007	1.40	1.31	1.50	6.79
Sezer 2004	6.60	2.16	20.18	2.88
Van Gemert 2015	1.70	0.53	5.48	2.73
Mukhergee 2014	5.20	1.69	15.95	2.87
Dutta 2014	4.07	0.86	19.19	1.88
Sukhsohale 2013	1.41	0.86	2.31	5.39
Johnson 2011	1.24	0.36	4.26	2.56
Desalu 2010	3.75	1.07	13.15	2.51
Ornek 2015	0.97	0.42	2.23	3.88
Laniado-Laborin 2011	1.65	1.24	2.20	6.26
Jaganath 2015	2.20	1.01	4.78	4.12
Alim 2014	4.62	1.32	16.18	2.51
Sezer 2006	1.32	0.63	2.75	4.30
Pandey 1984	7.87	4.67	13.26	5.26
Cetinkaya 2000	1.96	1.36	2.82	5.95
Bahera 1991	1.18	0.83	1.67	6.02
Orozco-levi 2006c	1.50	0.49	4.60	2.88
Liu 2007d	1.60	0.80	3.20	4.47
Umoh 2013a	8.70	4.67	16.20	4.79
	2.38	1.85	3.06	



Pathak et al. *Int J Environ Health Res. 2020;30(1):75-88.*

2. Distinct characteristics of COPD-P

Clinical characteristics of COPD-P

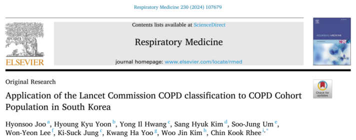

Respiratory Medicine 230 (2024) 107679
Contents lists available at ScienceDirect
Respiratory Medicine
journal homepage: www.elsevier.com/locate/rmed
Original Research
Application of the Lancet Commission COPD classification to COPD Cohort Population in South Korea
Hyonsoo Joo[a], Hyoung Kyu Yoon[b], Yong Il Hwang[c], Sang Hyuk Kim[d], Soo-Jung Um[e], Won-Yeon Lee[f], Ki-Suck Jung[c], Kwang Ha Yoo[g], Woo Jin Kim[h], Chin Kook Rhee[i,*]

Table 3
Comparison of characteristics among non-overlapping patients with COPD according to the new classification.

	Type 3 (COPD-I) only (N = 93)	Type 4 (COPD-C) only (n = 712)	Type 5 (COPD-P) only (n = 182)	P-value
Age, years	65.61 ± 9.81	68.43 ± 8.20	69.53 ± 8.64	0.001
Sex, M	52 (56 %)	690 (97 %)	126 (69 %)	0.000
BMI, kg/m^2	23.79 ± 3.96	23.23 ± 3.43	23.80 ± 3.40	0.074
Never smoker, %	71 (76 %)	0 (0 %)	89 (49 %)	<0.001
Ex-smoker, %	15 (16 %)	502 (71 %)	56 (31 %)	<0.001
Current smoker, %	7 (8 %)	210 (30 %)	37 (20 %)	<0.001
Pack-years	0.83 ± 2.09	43.43 ± 24.18	1.60 ± 2.99	<0.001
COPD grades				
GOLD 1	12 (13 %)	106 (15 %)	24 (13 %)	0.770
GOLD 2	40 (43 %)	369 (52 %)	102 (56 %)	0.123
GOLD 3	34 (37 %)	193 (27 %)	50 (27 %)	0.159
GOLD 4	7 (8 %)	44 (6 %)	6 (3 %)	0.247
FVC, L	2.75 ± 0.95	3.39 ± 0.80	2.86 ± 0.83	<0.001
FVC, %pred	74 ± 18	80 ± 16	78 ± 16	0.001
FEV_1, L	1.51 ± 0.62	1.76 ± 0.66	1.54 ± 0.56	<0.001
FEV_1, %pred	56 ± 19	59 ± 19	59 ± 18	0.276
FEV_1/FVC, %	56 ± 12	53 ± 13	55 ± 12	0.005
DLCO	13.70 ± 4.57	13.91 ± 5.16	13.55 ± 4.59	0.722
DLCO, %pred	701 ± 19	66 ± 21	71 ± 21	0.011
TLC, L	5.17 ± 1.24	6.12 ± 1.22	5.24 ± 1.21	<0.001
TLC, %pred	99 ± 23	100 ± 21	97 ± 18	0.664
RV/TLC, %	46 ± 14	40 ± 13	44 ± 12	0.002
mMRC	1.16 ± 0.94	1.20 ± 0.87	1.29 ± 0.96	0.411
CAT	13.84 ± 8.81	12.93 ± 7.58	14.17 ± 7.93	0.123
Inhalers				
ICS	1 (1 %)	1 (0 %)	0 (0 %)	0.146
LABA	5 (6 %)	34 (6 %)	6 (4 %)	0.672
LAMA	24 (30 %)	120 (21 %)	31 (21 %)	0.130
LABA/LAMA	25 (32 %)	216 (37 %)	46 (31 %)	0.326
ICS/LABA	9 (11 %)	88 (15 %)	27 (18 %)	0.375
Triple	15 (19 %)	125 (21 %)	38 (26 %)	0.420
Previous history of moderate to severe exacerbation, n (%)	8/49 (16 %)	74/402 (18 %)	16/100 (16 %)	0.820

Table 4
Acute exacerbation rates and frequency of non-overlapping COPD during prospective follow-up according to the new classification.

	Type 3 (COPD-I) only (n = 41)	Type 4 (COPD-C) only (n = 296)	Type 5 (COPD-P) only (n = 86)	P-value
Moderate exacerbation over 1 year				
Rate	15 (37 %)	115 (39 %)	26 (30 %)	0.345
Mean number	0.73 ± 1.23	0.88 ± 1.64	0.60 ± 1.27	0.336
Severe exacerbation over 1 year				
Rate	6 (15 %)	22 (7 %)	2 (2 %)	0.038
Mean number	0.24 ± 0.73	0.11 ± 0.49	0.02 ± 0.15	0.048
Moderate to severe exacerbation over 1 year				
Rate	17 (41 %)	123 (42 %)	27 (31 %)	0.228
Mean number	0.98 ± 1.52	0.99 ± 1.84	0.63 ± 1.26	0.227

Table 5
Factors associated with severe exacerbation in non-overlapping patients with COPD.

	Binary logistic regression*		Negative binomial regression*	
Factor	OR (95 % CI)	P-value	IRR (95 % CI)	P-value
Type 5 (COPD-P)	Reference		Reference	
Type 4 (COPD-C)	3. 9 (0.8–18.4)	0.546	5.0 (1.1–22.5)	0.038
Type 3 (COPD-I)	5.7 (1.0–32.4)	0.049	8.7 (1.7–44.0)	0.009

CI: confidence interval; COPD: chronic obstructive pulmonary disease; IRR: Incidence rate ratio; OR: odds ratio. * Adjusted by age, sex, body mass index, and post-bronchodilator FEV_1.

Joo H et al. *Respiratory Medicine. 2024;230:107679.*

330. Joo H, Yoon HK, Hwang YI, et al. Application of the Lancet Commission COPD classification to COPD Cohort Population in South Korea. *Respir Med* 2024; **230**: 107679 https://pubmed.ncbi.nlm.nih.gov/38797345.
331. Fabbri LM, Celli BR, Agustí A, et al. COPD and multimorbidity: recognising and addressing a syndemic occurrence. *Lancet Respir Med* 2023; **11**(11): 1020-34 https://pubmed.ncbi.nlm.nih.gov/37696283.
332. Dharmage S, Agusti A. Personal communication. 2022:
333. Stolz D, Mkorombindo T, Schumann DM, et al. Towards the elimination of chronic obstructive pulmonary disease: a Lancet Commission. *Lancet* 2022; **400**(10356): 921-72 https://pubmed.ncbi.nlm.nih.gov/36075255.

Lung function decline of COPD-P

ORIGINAL ARTICLE

FEV_1 Decline in Patients with Chronic Obstructive Pulmonary Disease Associated with Biomass Exposure

Alejandra Ramírez-Venegas, Raul H. Sansores, Roger H. Quintana-Carrillo, Monica Velázquez-Uncal, Rafael J. Hernandez-Zenteno, Candelaria Sánchez-Romero, Alejandra Velazquez-Montero, and Fernando Flores-Trujillo

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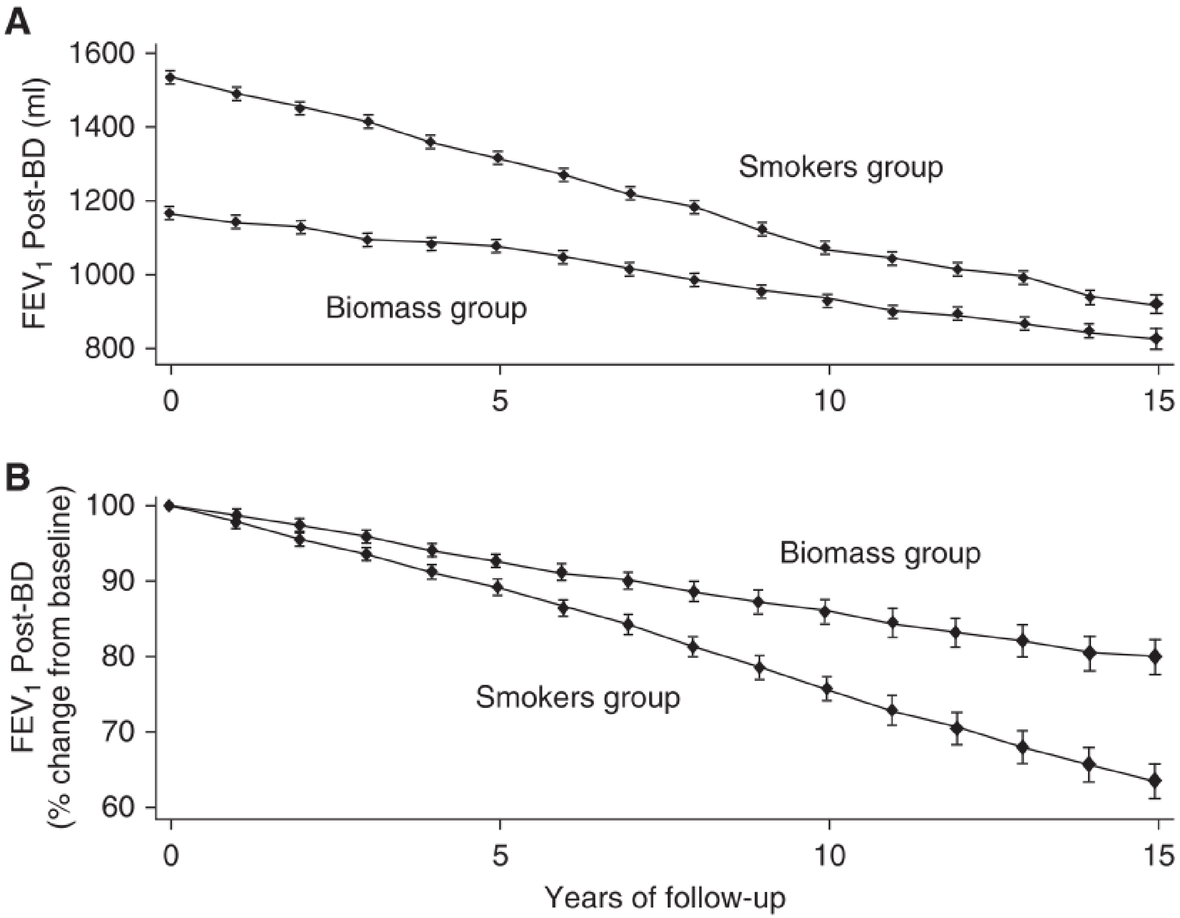
Table 1. Baseline Characteristics of Patients with COPD According to Risk Factors

Characteristics	Tobacco [*n* = 302 (73%)]	Biomass [*n* = 112 (27%)]	*P* Value
Age, yr	68 ± 9	73 ± 9	<0.001
Female, n (%)	80 (26)	97 (87)	<0.001
BMI	25 ± 4	27 ± 5	0.01
Tobacco index, packs/yr	57 ± 32	—	—
Smoking status, former, n (%)	285 (94)	—	—
Biomass index, h/yr	—	234 ± 122	—
Biomass exposure, past	—	106 (95)	—
Pulmonary function			
FEV_1 post-BD, ml	1,255 ± 433	1,030 ± 297	<0.001
FEV_1 post-BD, % predicted	50 ± 18	63 ± 20	<0.001
FEV_1/FVC post-BD	0.47 ± 0.12	0.56 ± 0.09	<0.001
Reversibility, %	13 ± 11	10 ± 10	0.07
Pa_{O_2}, mm Hg	59 ± 13	54 ± 9	0.008
Pa_{CO_2}, mm Hg	33 ± 6	35 ± 5	0.17
Sa_{O_2}, %	89 ± 7	87 ± 5	0.13
GOLD classification, n (%)			<0.001
I	14 (5)	21 (19)	
II	126 (42)	57 (51)	
III	121 (40)	31 (28)	
IV	41 (13)	3 (2)	
Different estimates of FEV_1 annual decline			
ml/yr	42 ± 26	23 ± 17	<0.001
%/yr from baseline	2.3 ± 2.1	1.2 ± 1.2	<0.001
%/yr	4 ± 2.8	2.6 ± 1.6	<0.001
% predicted	0.61 ± 1.1	0.01 ± 1.6	<0.001



-41.7±26.2ml

-23.1±16.9ml

-1.2±1.2%

-2.3±2.1%

Ramírez-Venegas et al. *AJRCCM 2014;190(9):996-1002.*

3. Impact of air pollution on patients with COPD

Exacerbation

[COPD Original Research]

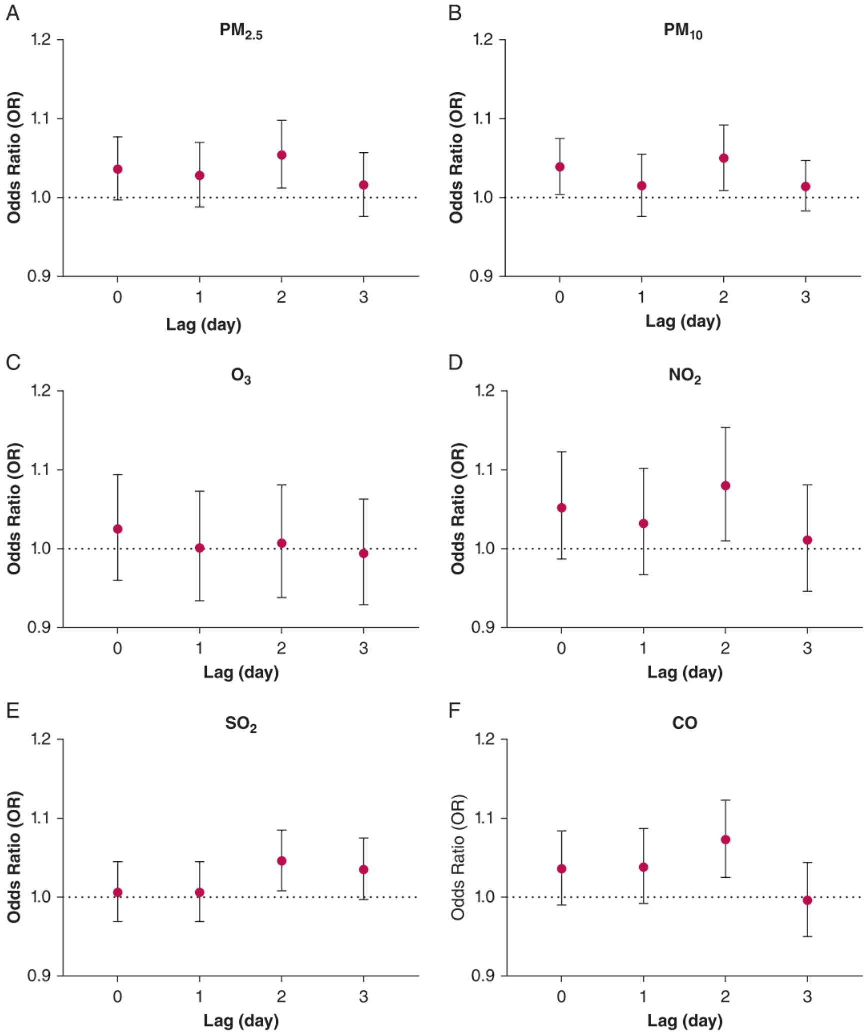
CHEST

Associations Between Air Pollution and the Onset of Acute Exacerbations of COPD

A Time-Stratified Case-Crossover Study in China

Check for updates

- Study Design: Bidirectional time-stratified case-crossover (ACURE study)
- Case & Control Selection:
    - Case day: Self-reported AE-COPD onset date
    - Control days: Matched by day of the week, month, and year
- Exposure Assessment: Air pollution data assigned from the nearest monitoring station
- Lag Analysis: Examined single-day (Lag 0-3) and moving-average (Lag 0-3) exposures



Niu Y et al. *Chest. 2024;166(5):998-1009.*

Exacerbation

TABLE 2] ORs (95% CIs) for Acute Exacerbations of COPD Associated With Each Interquartile Range Increase in $PM_{2.5}$ and PM_{10} at a Lag of 2 Days in Stratified Analyses

Classification	$PM_{2.5}$	PM_{10}
Age, y		
< 65	1.090 (1.008-1.178)[a]	1.071 (1.001-1.146)[a]
≥ 65	1.041 (0.993-1.092)	1.039 (0.988-1.092)
Sex		
Male	1.050 (1.003-1.099)[a]	1.048 (1.000-1.098)
Female	1.068 (0.981-1.162)	1.055 (0.978-1.138)
Smoking history		
Never	1.066 (0.990-1.149)	1.054 (0.977-1.136)
Former or current	1.048 (0.999-1.110)	1.048 (1.000-1.098)
Frequency of severe exacerbations in the past year		
0	1.032 (0.979-1.087)	1.033 (0.984-1.084)
≥ 1	1.094 (1.026-1.168)[a]	1.089 (1.017-1.167)[a]
CAT score		
< 10	1.028 (0.881-1.200)	1.033 (0.879-1.214)
≥ 10	1.056 (1.013-1.101)[a]	1.050 (1.008-1.094)[a]
Newly diagnosed COPD		
Yes	1.092 (1.009-1.182)[a]	1.050 (0.974-1.132)
No	1.040 (0.993-1.091)	1.048 (1.000-1.098)[a]
Young COPD		
Yes	1.219 (1.072-1.386)[a]	1.118 (1.002-1.247)[a]
No	1.038 (0.994-1.083)	1.035 (0.990-1.083)
Asthma		
Yes	1.153 (1.019-1.304)[a]	1.124 (0.997-1.267)
No	1.043 (1.000-1.089)	1.037 (0.992-1.084)
Season		
Warm	1.005 (0.911-1.108)	0.991 (0.913-1.077)
Cool	1.071 (1.024-1.120)[a]	1.074 (1.026-1.126)[a]

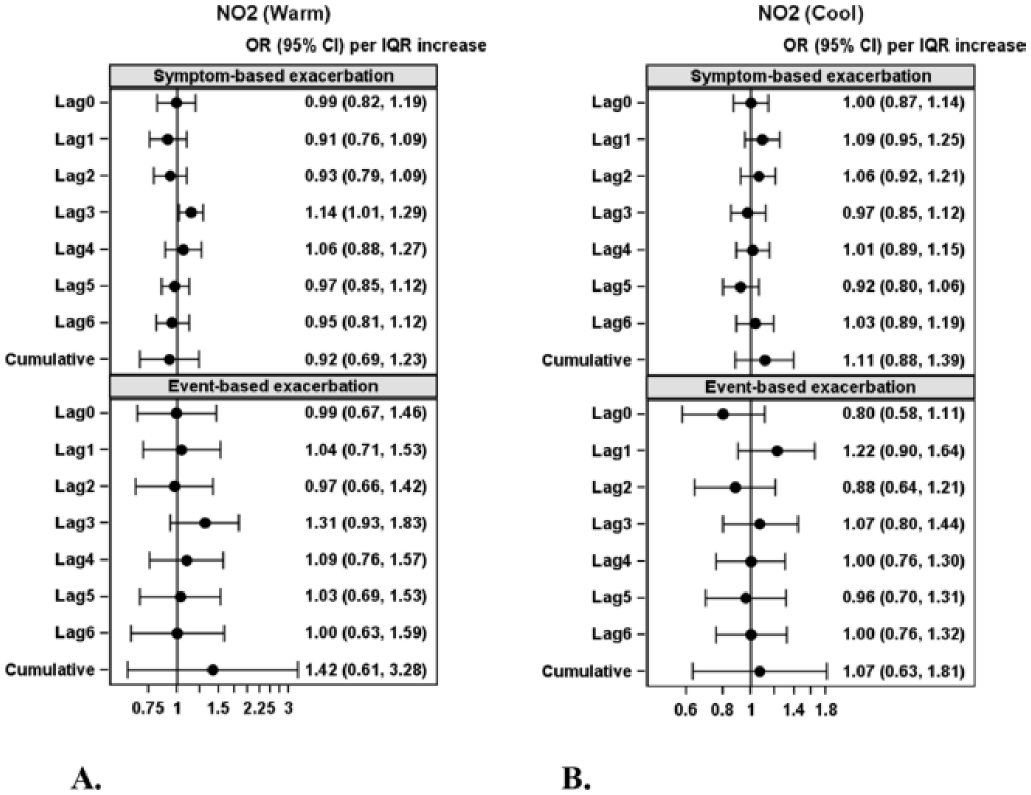
Niu Y et al. *Chest. 2024;166(5):998-1009.*

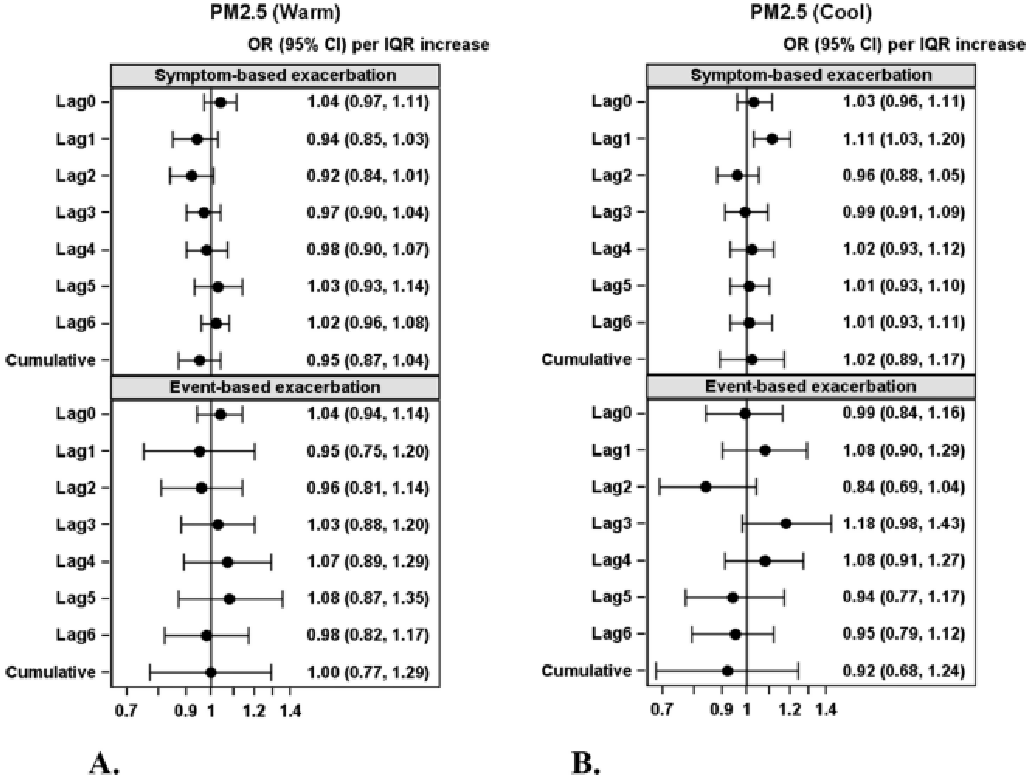
Exacerbation

Chronic obstructive pulmonary disease

Original research

Short-term air pollution exposure and exacerbation events in mild to moderate COPD: a case-crossover study within the CanCOLD cohort





Ross et al. *Thorax. 2023;78(10):974-982.*

Hospitalization

The impact of air pollution on hospitalization for COPD patients in China

Chen Chen[1], Yi Wang[1], Jinglin Song[2], Juanjuan Yan[3]

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2 Post-Doctoral Research Center, Bank of Chongqing, Chongqing, China
3 School of Health Services and Management, Shanxi University of Chinese Medicine, Jinzhong, China

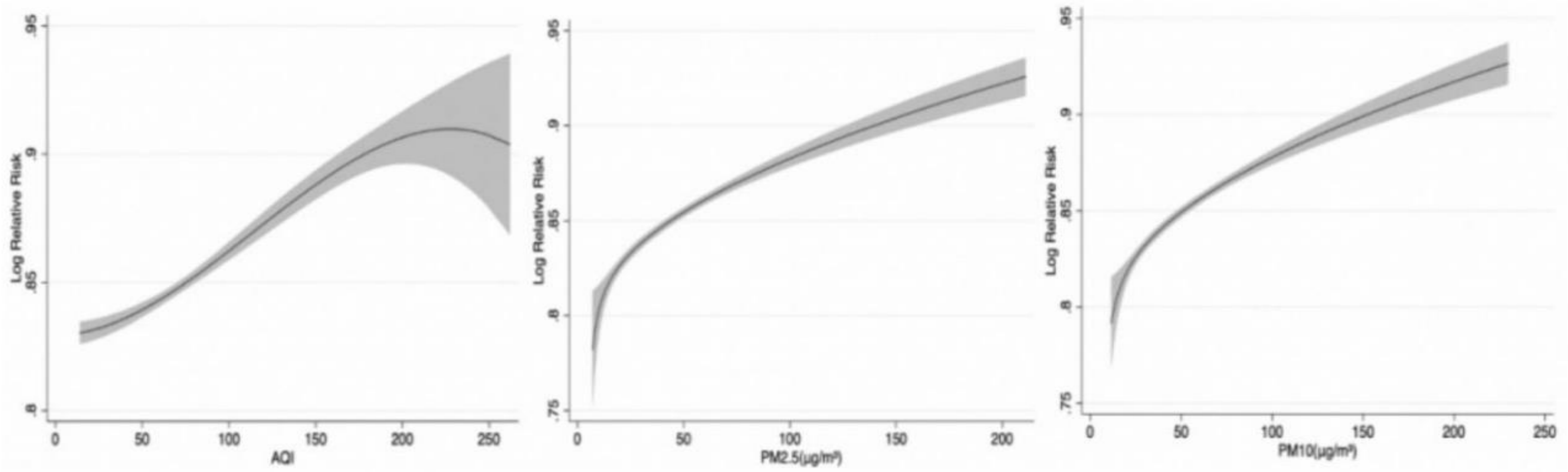


Figure 1 Does-response relationships between air pollutants and COPD hospitalization. (The *X*-axis represented the concentration of air pollutants at the lag of three days, the *Y*-axis indicated Log relative risk of COPD hospitalization. The shaded areas were the 95% confidence interval.)

Chen et al. *Eur J Public Health. 2024;34(1):150-155.*

Lung function decline

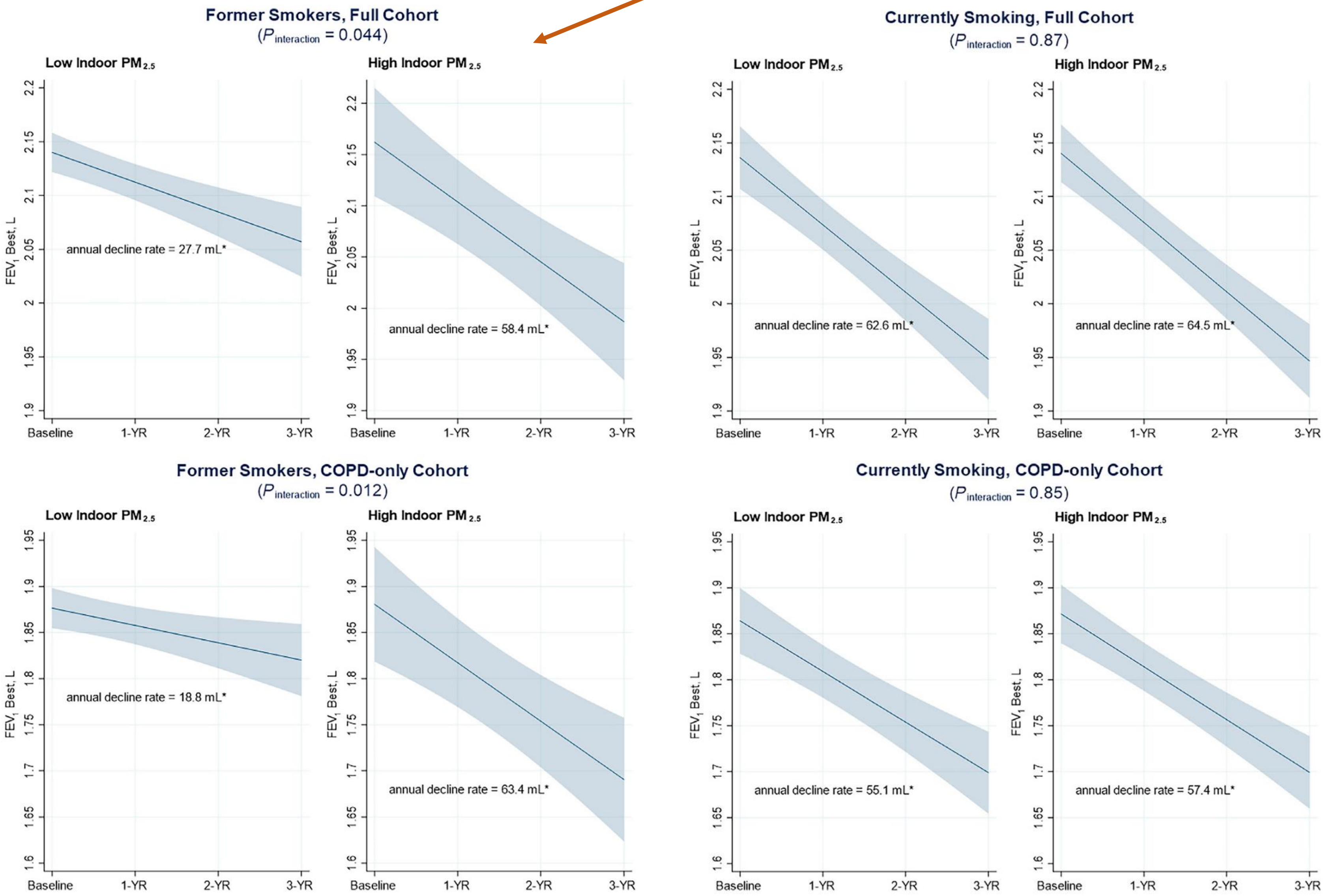
PM2.5↑ 10 μg/m³ →
FEV1 decline↑ 10 mL/yr

Check for updates

ORIGINAL ARTICLE

Indoor Pollution and Lung Function Decline in Current and Former Smokers
SPIROMICS AIR

- Study Design: Longitudinal cohort study (SPIROMICS AIR)
- Participants: 1,208 current and former smokers with or without COPD
- Exposure Assessment: Indoor PM2.5 and NO_2 estimated using individual-based prediction models
- Outcome Measures: Annual decline in FEV1 measured over up to 3 years



Hansel et al. *Am J Respir Crit Care Med. 2023;208(10):1042-1051.*

Lu et al. Respiratory Research (2022) 23:71
https://doi.org/10.1186/s12931-022-01989-9

Respiratory Research

RESEARCH Open Access

Short-term exposure to ambient air pollution and pneumonia hospital admission among patients with COPD: a time-stratified case-crossover study

Lee et al. Respiratory Research (2022) 23:77
https://doi.org/10.1186/s12931-022-02000-1

Respiratory Research

RESEARCH Open Access

Association of air pollution exposure with exercise-induced oxygen desaturation in COPD

Published in final edited form as:
COPD. 2017 February ; 14(1): 113–121. doi:10.1080/15412555.2016.1216956.

Outdoor Air Pollution and COPD Related Emergency Department Visits, Hospital Admissions and Mortality: A Meta-Analysis

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EUROPEAN RESPIRATORY JOURNAL
ORIGINAL RESEARCH ARTICLE
D. EVANGELOPOULOS ET AL.

Personal exposure to air pollution and respiratory health of COPD patients in London

Dimitris Evangelopoulos[1,2], Lia Chatzidiakou[3], Heather Walton[1,2], Klea Katsouyanni[1,4], Frank J. Kelly[1,2], Jennifer K. Quint[5], Roderic L. Jones[3] and Benjamin Barratt[1,2]

Evangelopoulos et al. *Eur Respir J. 2021;58(1).* Lu et al. *Respir Res. 2022;23(1):71.* DeVries et al. *COPD. 2017;14(1):113-121.* Lee et al. *Respir Res. 2022;23(1):77.*

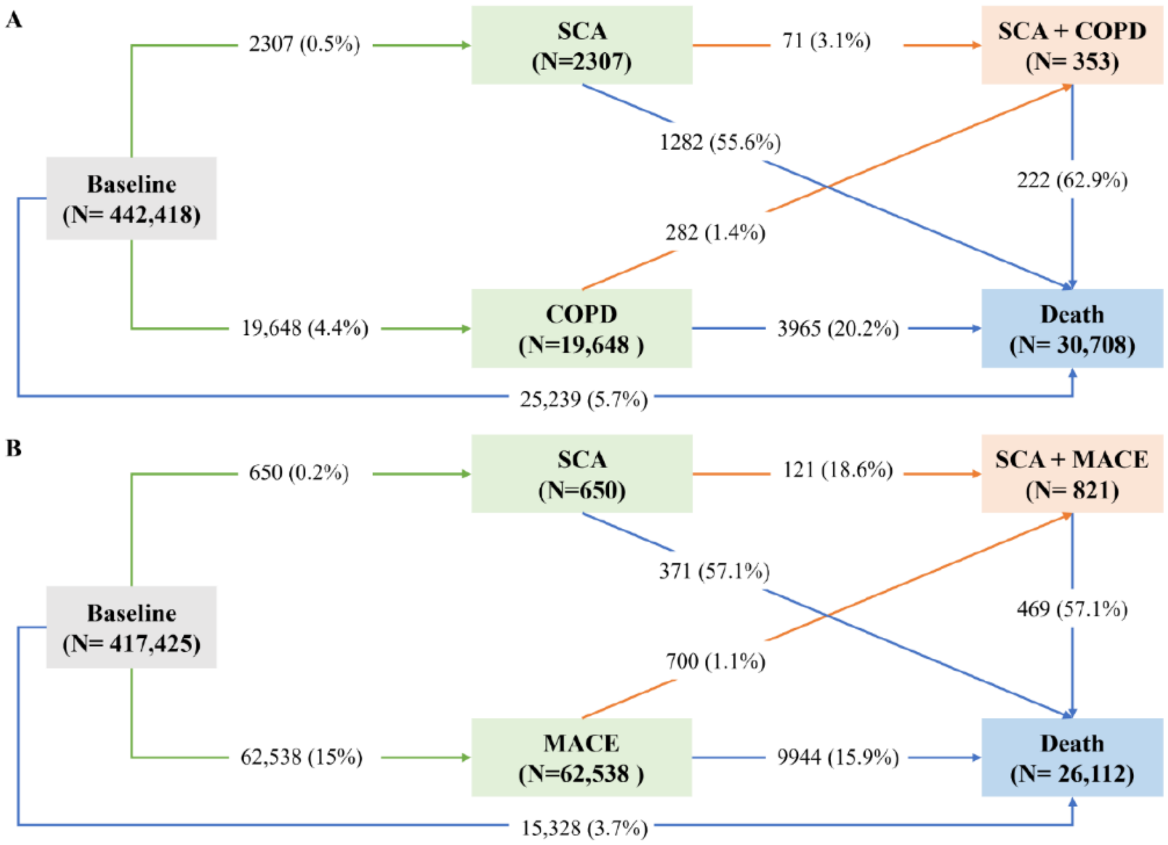
Cardiac events – Sudden cardiac arrest

Environmental Science & Technology
pubs.acs.org/est Article

Air Pollution and Cardiac Arrest: A More Significant Intermediate Role of COPD than Cardiac Events

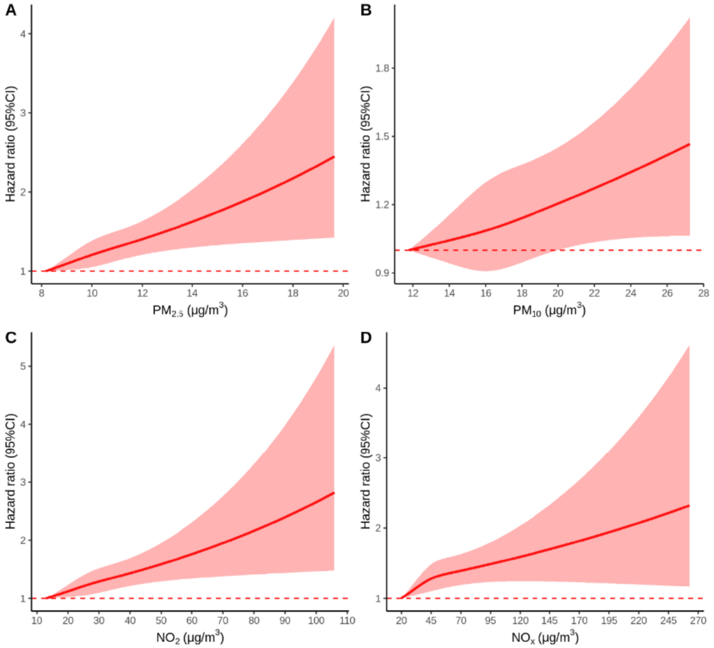
Huihuan Luo, Qingli Zhang, Xia Meng, Haidong Kan, and Renjie Chen*

- Study Design: Prospective cohort study (UK Biobank)
- Participants: 458,237 individuals, followed for a median of 13.7 years
- Exposure Assessment: Long-term air pollution levels (PM2.5, PM10, NO_2, NO_x) estimated using land-use regression models
- Outcome Measures: Incident sudden cardiac arrest (SCA) and intermediate diseases (COPD, MACE)



Luo H et al. *Environ Sci Technol. 2024;58(18):7782-7790.*

Cardiac events – Sudden cardiac arrest



	cases	$PM_{2.5}$	PM_{10}	NO_2	NO_x
underlying cardiorespiratory disease: COPD					
baseline → COPD	19 648	1.21 (1.19, 1.23)	1.06 (1.05, 1.08)	1.24 (1.22, 1.27)	1.14 (1.13, 1.16)
COPD → COPD+SCA	282	1.27 (1.10, 1.47)	1.16 (1.03, 1.29)	1.26 (1.08, 1.47)	1.18 (1.07, 1.31)
underlying cardiorespiratory disease: MACE					
baseline → MACE	62 538	1.06 (1.05, 1.07)	1.02 (1.01, 1.03)	1.07 (1.06, 1.08)	1.05 (1.04, 1.06)
MACE → MACE+SCA	700	1.12 (1.01, 1.23)	1.06 (0.99, 1.14)	1.16 (1.04, 1.30)	1.13 (1.05, 1.22)

Luo H et al. *Environ Sci Technol. 2024;58(18):7782-7790.*

Cardiac events – Cardiac autonomic function

Check for updates

ORIGINAL ARTICLE

Indoor Air Pollution and Impaired Cardiac Autonomic Function in Chronic Obstructive Pulmonary Disease

Sarath Raju[1], Han Woo[1], Kirsten Koehler[2], Ashraf Fawzy[1], Chen Liu[1], Nirupama Putcha[1], Aparna Balasubramanian[1], Roger D. Peng[3], Cheng Ting Lin[4], Chantal Lemoine[5], Jennifer Wineke[6], Ronald D. Berger[1], Nadia N. Hansel[1,2], and Meredith C. McCormack[1,2]

- Study Design: Randomized controlled trial (CLEAN AIR & CLEAN AIR Heart Study)
- Participants: Former smokers with moderate-severe COPD
- Exposure Assessment: Indoor PM2.5, PM10, ultrafine particles measured in homes
- Intervention: Portable air cleaner vs. placebo for 6 months
- Outcome Measures: Heart rate variability (HRV) assessed via 24-hour Holter monitoring

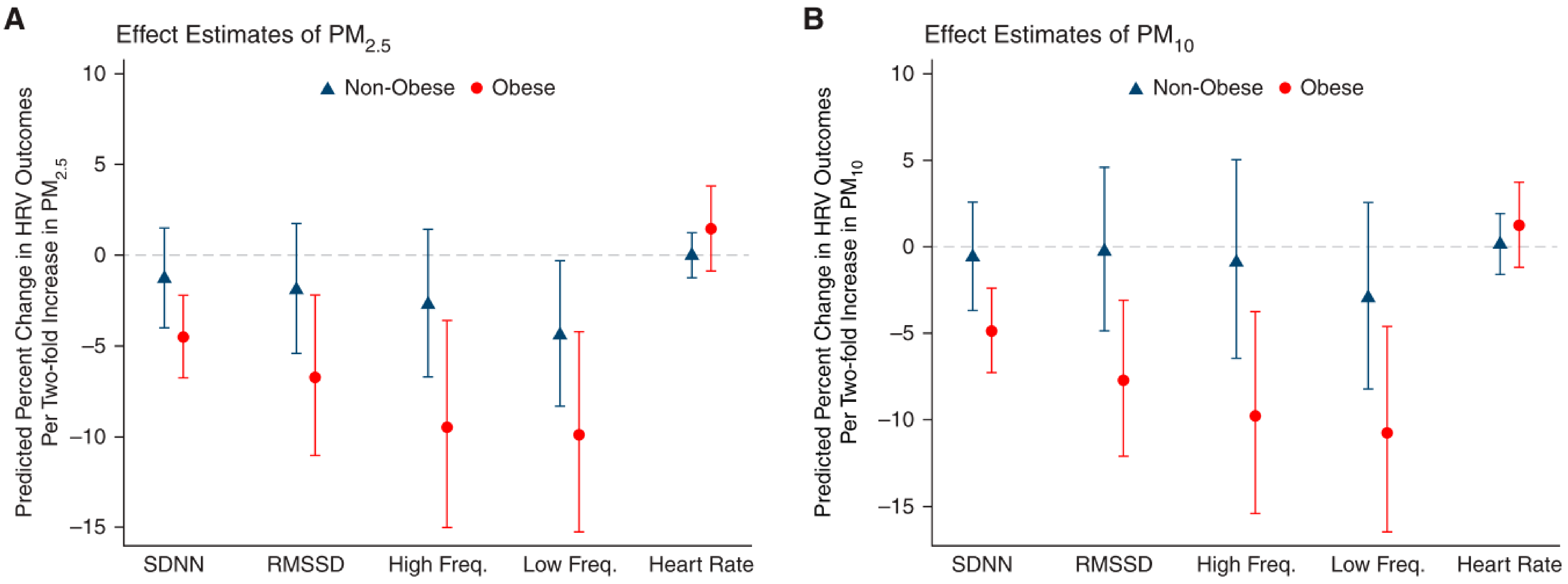
- SDNN ➔ overall HRV
- RMSSD, HF ➔ parasympathetic
- LF ➔ sympathetic

Table 2. Association between a Twofold Increase in Indoor Pollutants and Heart Rate Variability Indices*

	PM_{10}		$PM_{Coarse(10-2.5)}$		$PM_{2.5}$		Ultrafine Particles†	
Exposures	**Mean Difference (95% CI)**	***P* Value**	**Mean Difference (95% CI)**	***P* Value**	**Mean Difference (95% CI)**	***P* Value**	**Mean Difference (95% CI)**	***P* Value**
HRV measures								
SDNN	−2.98 (−5.12, −0.78)	**0.008**	−0.67 (−2.86, 1.57)	0.56	−2.92 (−4.81, −0.99)	**0.003**	−2.30 (−6.91, 2.54)	0.35
RMSSD	−4.57 (−7.87, −1.16)	**0.009**	0.54 (−2.66, 3.85)	0.74	−4.44 (−7.35, −1.44)	**0.004**	−16.4 (−22.3, −10.1)	**<0.001**
High-frequency power	−5.97 (−10.14, −1.60)	**0.008**	0.41 (−3.75, 4.74)	0.85	−6.22 (−9.94, −2.34)	**0.002**	−20.5 (−27.4, −12.9)	**<0.001**
Low-frequency power	−7.31 (−11.46, −2.97)	**0.001**	−1.24 (−5.54, 3.25)	0.58	−7.11 (−10.71, −3.36)	**<0.001**	−19.4 (−28.9, −8.69)	**0.001**
Heart rate	0.78 (−0.77, 2.36)	0.33	0.47 (−0.65, 1.60)	0.41	0.77 (−0.51, 2.07)	0.24	0.18 (−1.44, 1.83)	0.83

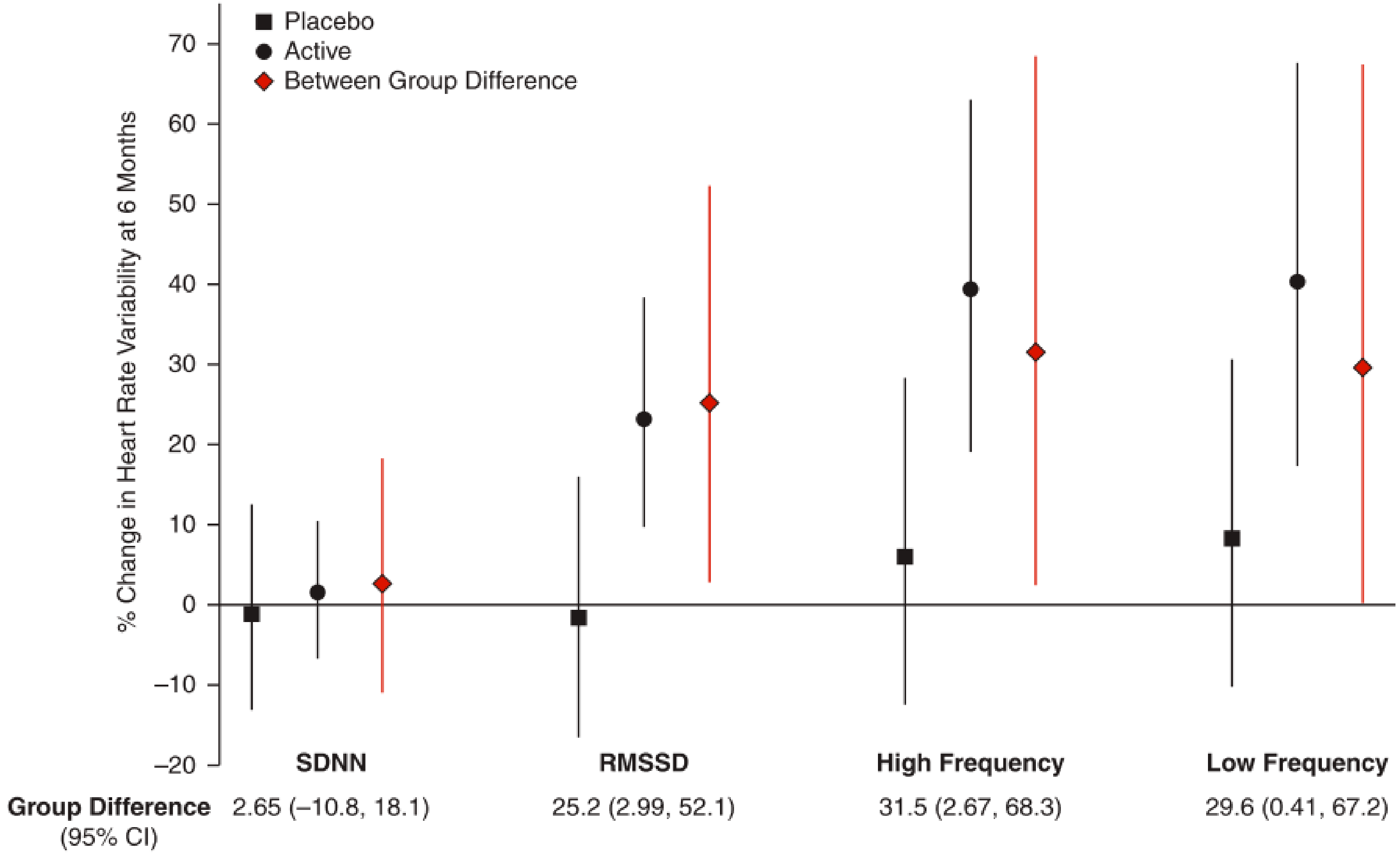
Raju et al. *Am J Respir Crit Care Med. 2023;207(6):721-730.*

Cardiac events – Cardiac autonomic function



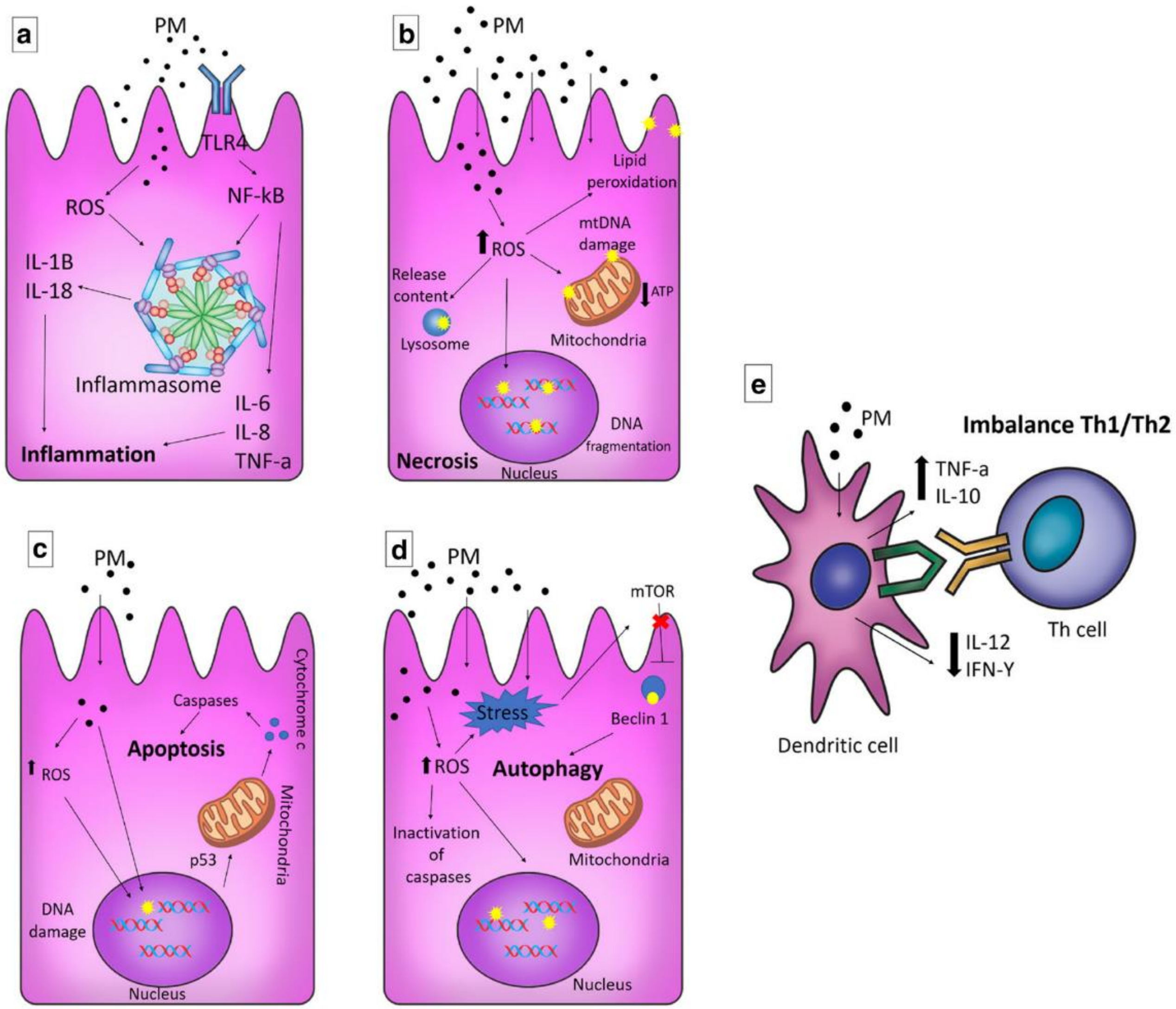
Raju et al. *Am J Respir Crit Care Med. 2023;207(6):721-730.*

Cardiac events– Cardiac autonomic function ➔ Air cleaner intervention



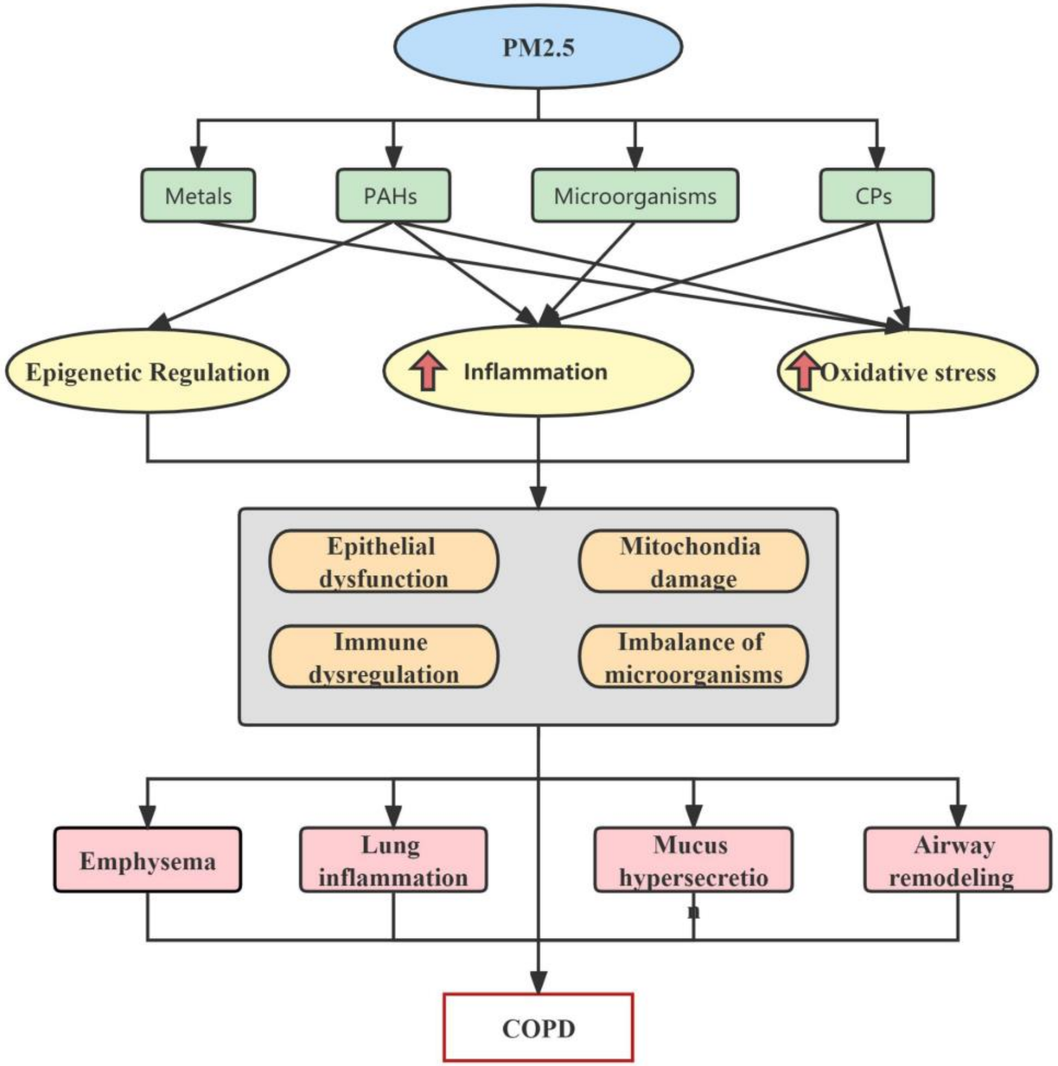
Raju et al. *Am J Respir Crit Care Med. 2023;207(6):721-730.*

Main effects of particulate material in the respiratory system.



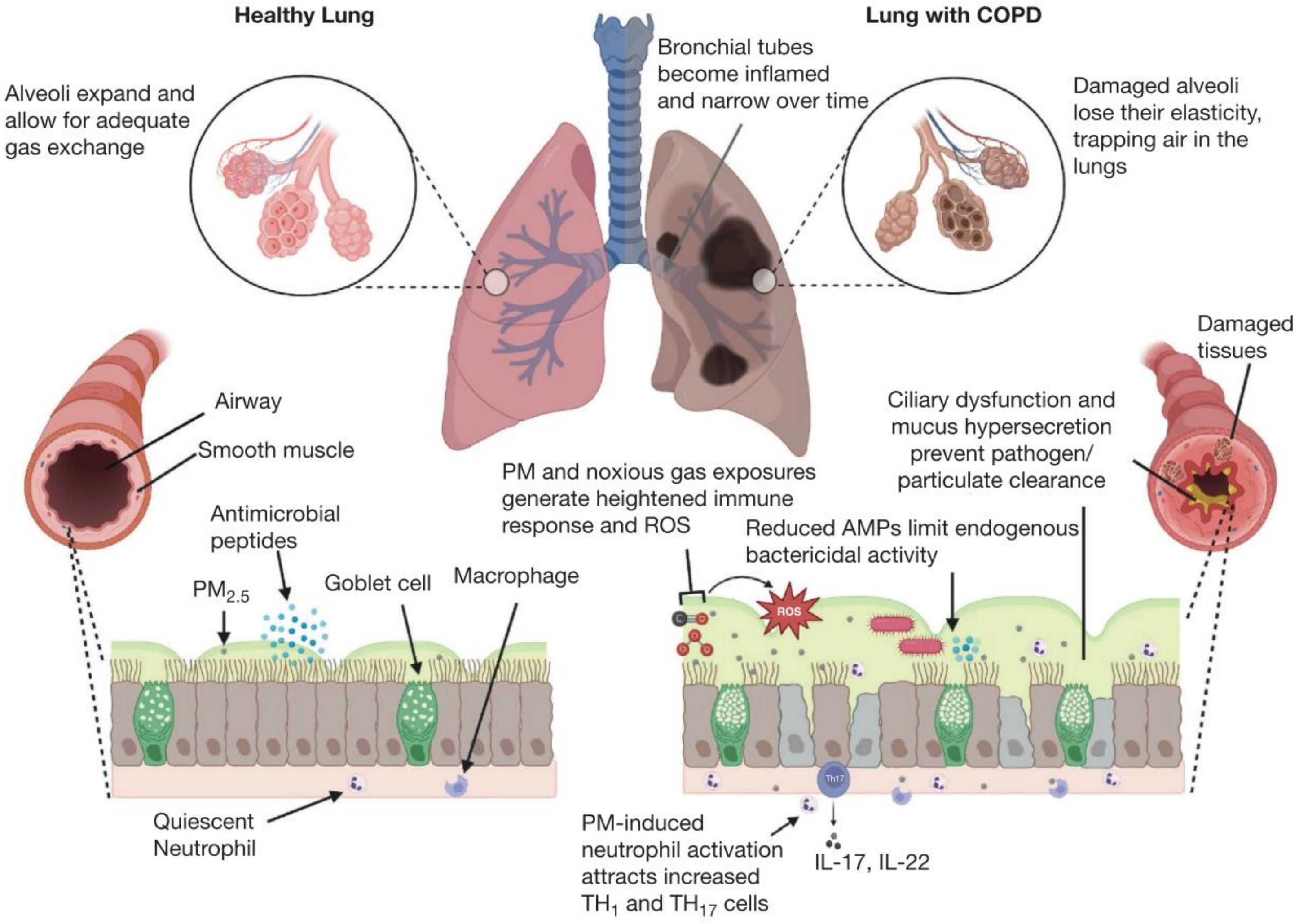
Arias-Pérez et al.. *Environ Sci Pollut Res Int. 2020;27(34):42390-42404.*

Pathogenesis of PM2.5 and Its Components on COPD



Wang et al. IJCOPD. *2023;18:493-506*.

Pathologic changes in COPD increase susceptibility to negative health effects of air pollution exposure

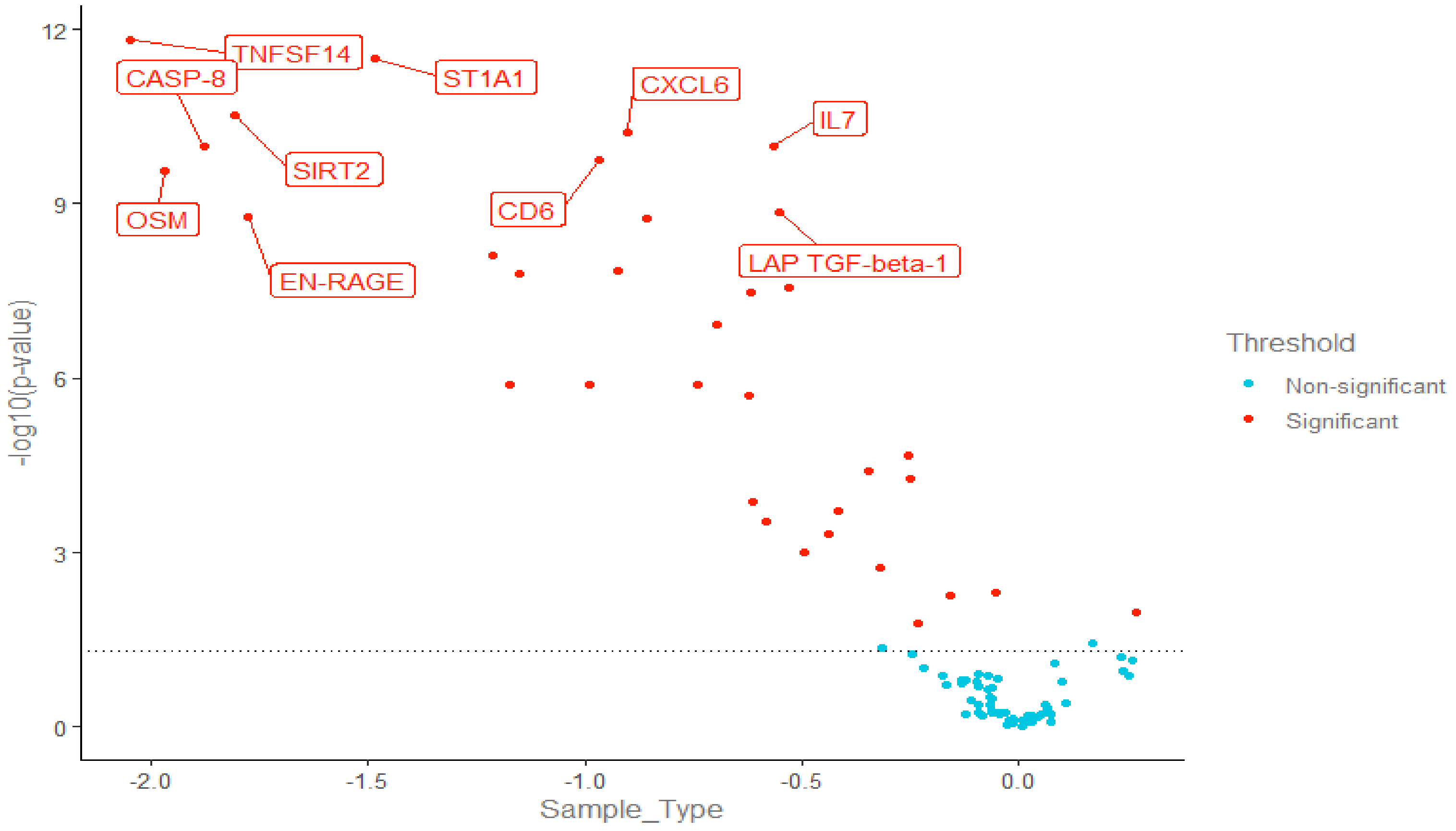


Ryu et al. *Chest. 2024;165(4):836-846.*

Proteomics analysis of KOCOSS data – volcano plot : 10 significant proteins

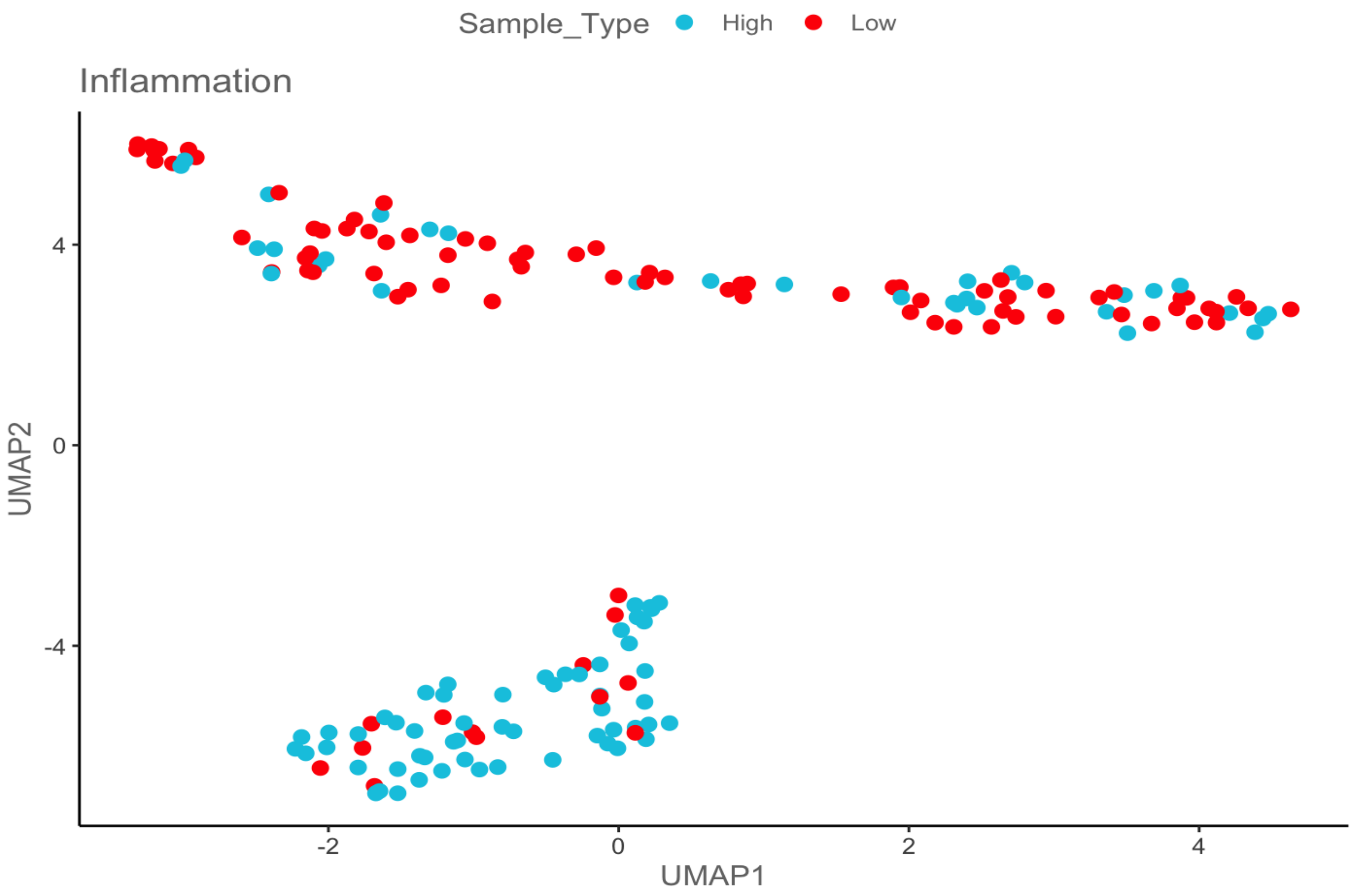
- KOCOSS database
- PM2.5 low vs high group

➔ OLINK proteomics



Unpublished data

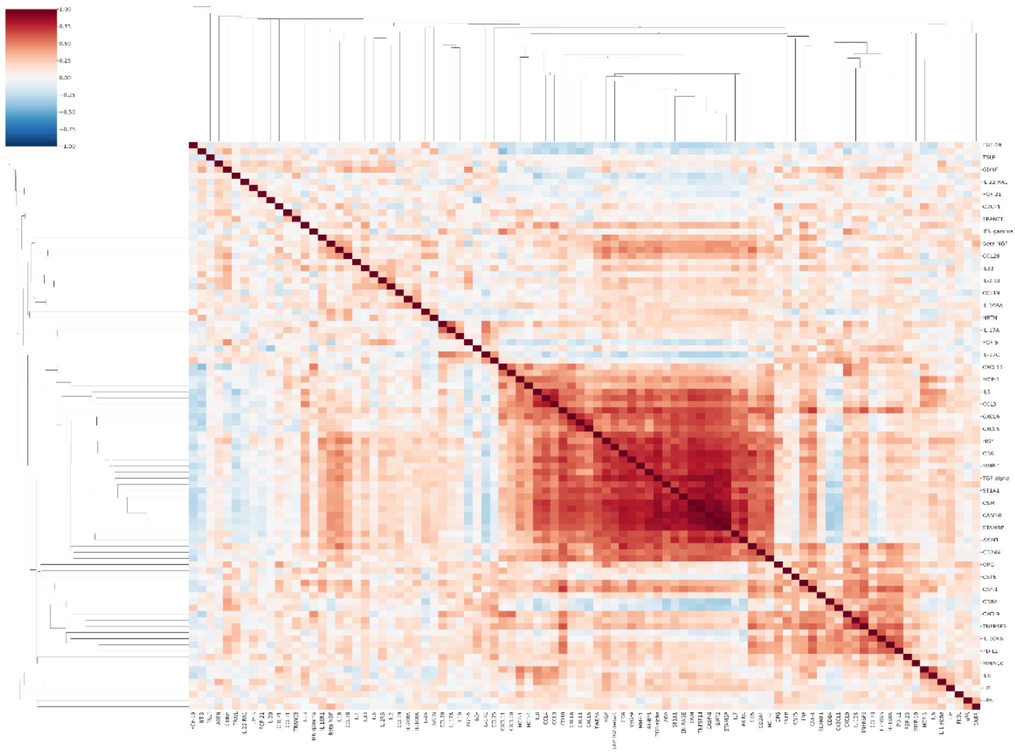
Proteomics analysis of KOCOSS data – UMAP : top 10 significant proteins



Unpublished data

Proteomics analysis of KOCOSS data

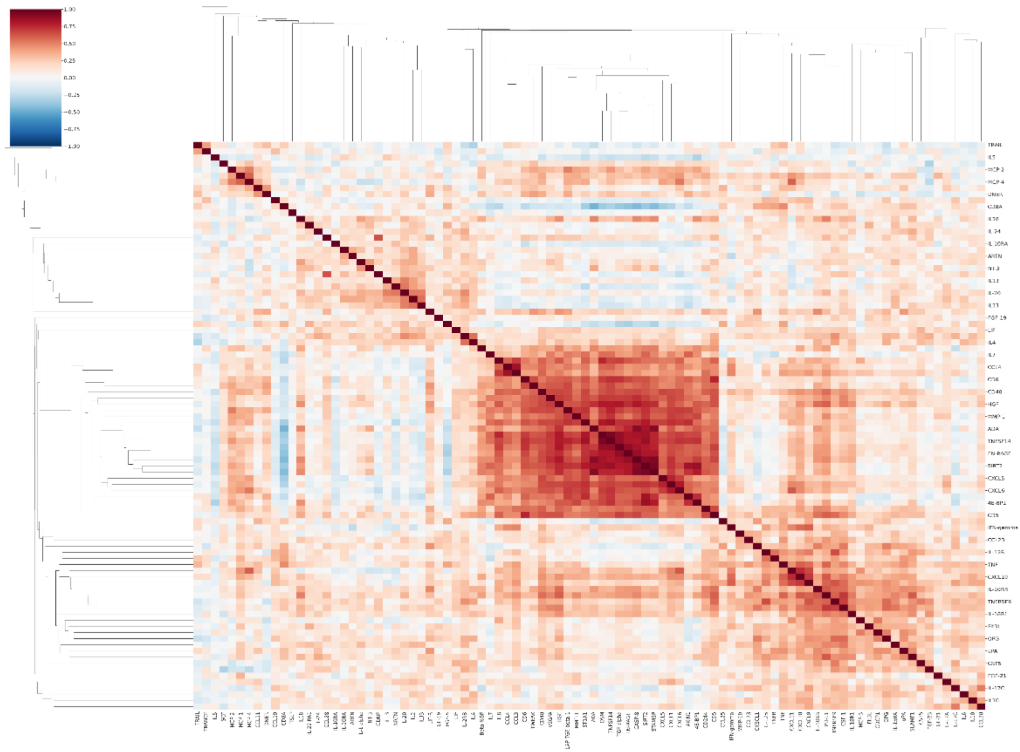
Exposure High



CXCL6, CXCL5, HGF, **CD6**, MMP1,
TGF-alpha, ST1A1, OSM, CASP-8,
STAMBP, AXIN1, CD24

ST1A1, **EN-RAGE**, **OSM, TNFSF14**, **CASP-8, SIRT2**, STAMBP, IL5, AXIN1, CD5

Exposure Low



IL4, IL7, CCL4, CD6, CD40, HGF,
MMP-1,ADA, **TNFSF14, EN-RAGE,**
SIRT2, CXCL5, CXCL6, 4E-BP1, CD5

HGF, LAP TGF-beta-1, MMP-1, STAT1, **OSM, TNFSF14, EN-RAGE, CASP-8, SIRT2, STAMBP**, CXCL5, CXCL1, **CXCL6,** AXIN1, 4E-BP1, CD244

Unpublished data

4. Mitigate strategies from air pollution

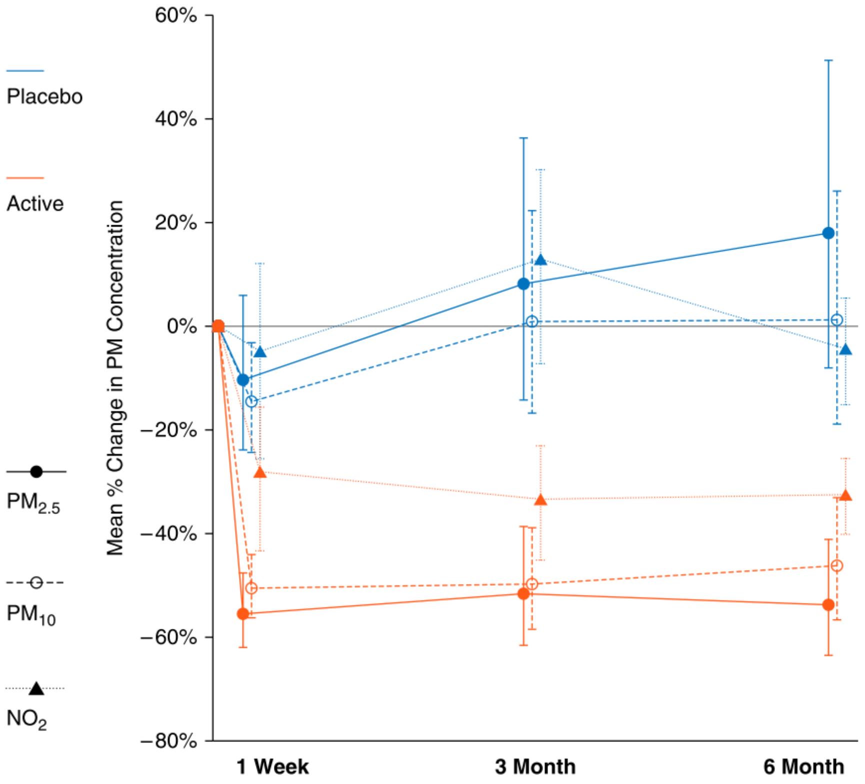
Air cleaners may help

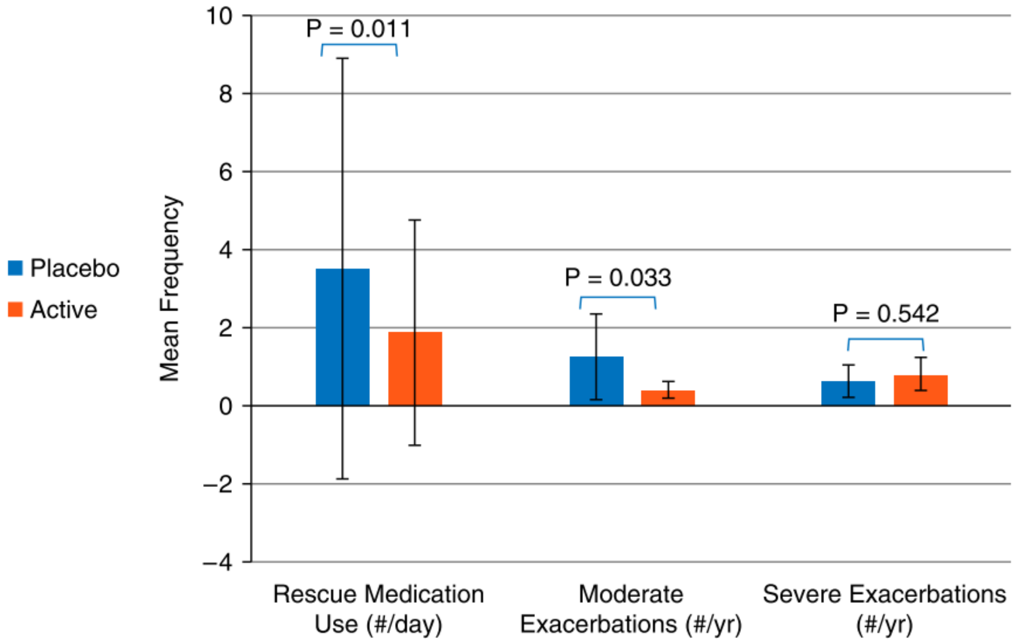
ORIGINAL ARTICLE

Randomized Clinical Trial of Air Cleaners to Improve Indoor Air Quality and Chronic Obstructive Pulmonary Disease Health
Results of the CLEAN AIR Study

Nadia N. Hansel[1,2], Nirupama Putcha[1], Han Woo[1], Roger Peng[3], Gregory B. Diette[1,2], Ashraf Fawzy[1], Robert A. Wise[1], Karina Romero[1], Meghan F. Davis[2], Ana M. Rule[2], Michelle N. Eakin[1], Patrick N. Breysse[2,4], Meredith C. McCormack[1,2], and Kirsten Koehler[2]

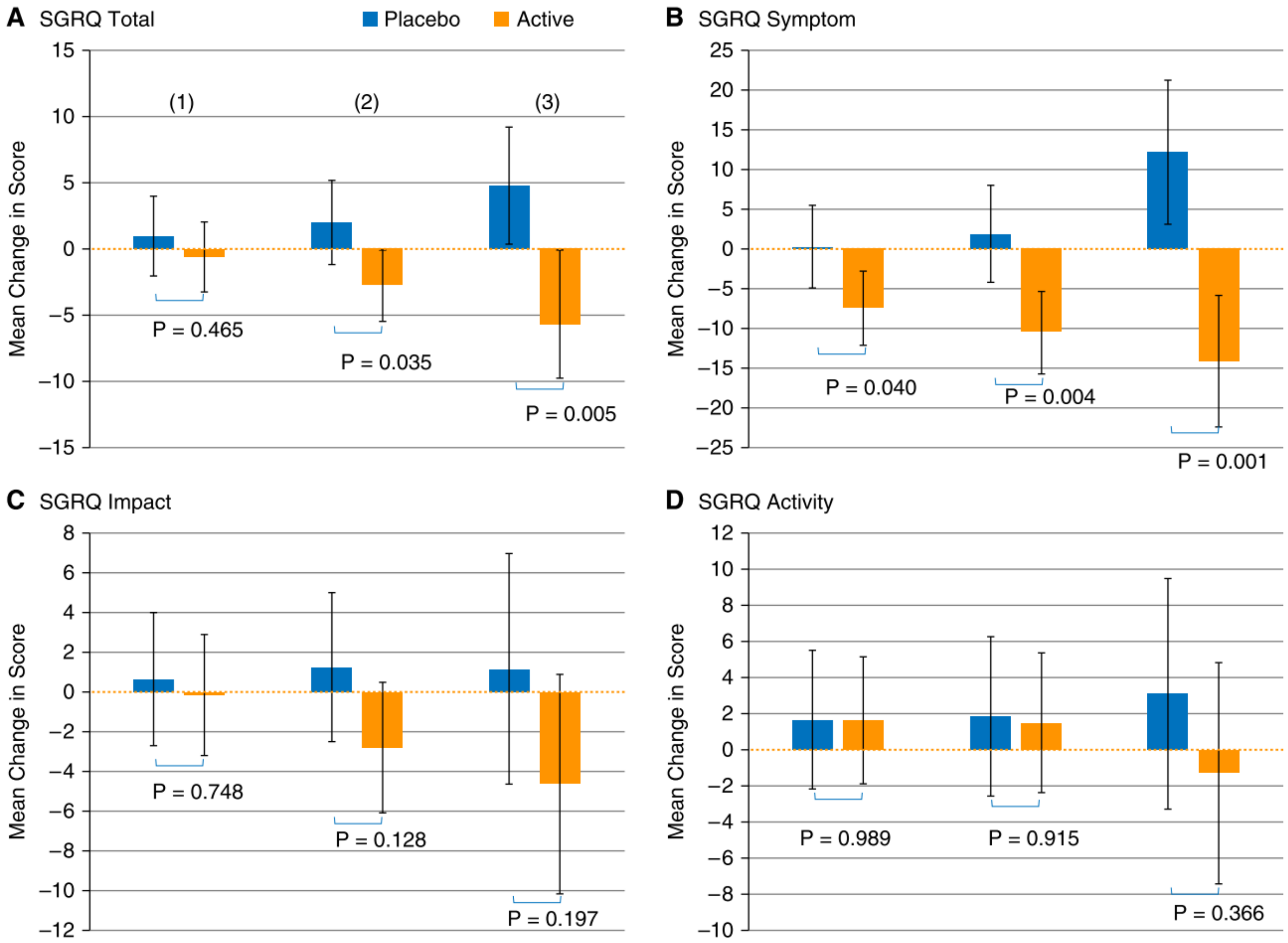
- Study Design: Randomized controlled trial (CLEAN AIR Study)
- Participants: Former smokers with moderate-to-severe COPD
- Exposure Assessment: Indoor PM2.5 and NO_2 levels measured in homes
- Intervention: Portable HEPA and carbon filter air cleaners vs. sham cleaners for 6 months





Hansel et al. *Am J Respir Crit Care Med. 2022;205(4):421-430.*

Air cleaners may help



(1) All participants
(2) Participants who used more than 80% of the time
(3) Participants who used air cleaner continuously throughout the study

Hansel et al. *Am J Respir Crit Care Med. 2022;205(4):421-430.*

Improvement in cooking fuels and kitchen ventilation

OPEN ACCESS Freely available online PLOS | MEDICINE

Lung Function and Incidence of Chronic Obstructive Pulmonary Disease after Improved Cooking Fuels and Kitchen Ventilation: A 9-Year Prospective Cohort Study

**Yumin Zhou[1], Yimin Zou[1], Xiaochen Li[1], Shuyun Chen[1], Zhuxiang Zhao[1], Fang He[1], Weifeng Zou[1], Qiuping Luo[1], Wenxi Li[1], Yiling Pan[1], Xiaoliang Deng[1], Xiaoping Wang[2], Rong Qiu[2], Shiliang Liu[3], Jingping Zheng[1], Nanshan Zhong[1], Pixin Ran[1]*

1 State Key Laboratory of Respiratory Disease, Guangzhou Institute of Respiratory Diseases, First Affiliated Hospital, Guangzhou Medical University, Guangzhou, Guangdong, China, 2 First Municipal People Hospital of Shaoguan, Shaoguan, Guangdong, China, 3 Third Affiliated Hospital, Guangzhou Medical University, Guangzhou, Guangdong, China

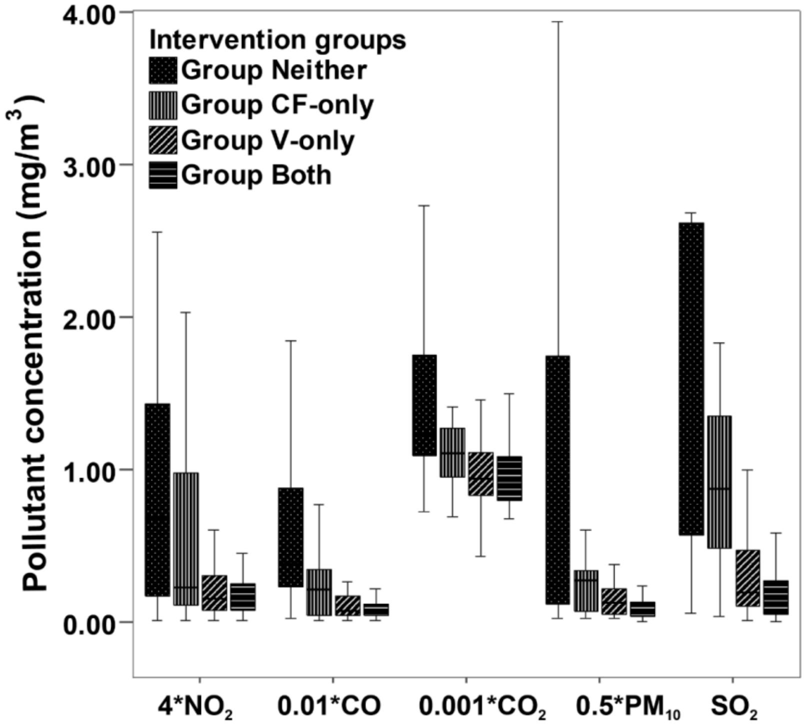


Table 4. COPD incidence and OR (95% CI) by characteristic.

Characteristic	Participants ($n=604$)	COPD			Adjusted OR (95% CI)
		n	Incidence	*p*-Value	
Use of clean fuel and improved ventilation				0.14	
Neither	144	20	13.9%		1.00 (reference)
CF-only	129	18	14.0%		0.62 (0.23 to 1.65)
V-only	76	10	13.2%		0.43 (0.14 to 1.34)
Both	255	24	9.4%		0.28 (0.11 to 0.73)
Years of improved ventilation[a]				0.053	
0 y	273	38	13.9%		1.00 (reference)
1–4.9 y	159	21	13.2%		0.52 (0.23 to 1.19)
5–9 y	172	13	7.6%		0.39 (0.15 to 0.99)

Zhou et al. PLoS Med. 2014 Mar 25;11(3):e1001621.

Measures to improve air quality and manage chronic airway diseases

Review

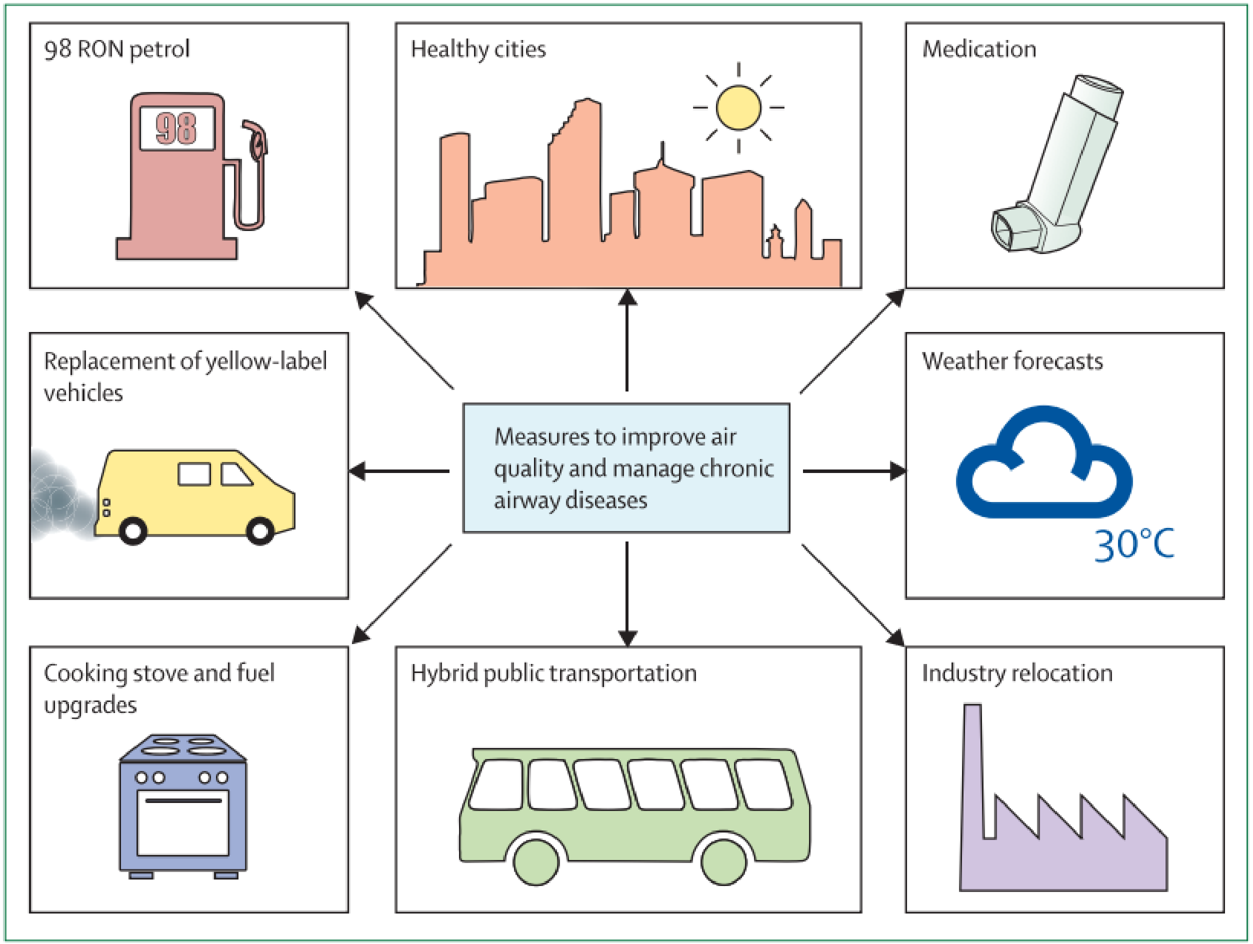
Impact of air pollution on the burden of chronic respiratory diseases in China: time for urgent action

Wei-Jie Guan, Xue-Yan Zheng, Kian Fan Chung, Nan-Shan Zhong

	Risk grading	Flag	Susceptible population	General population
0–3	Low	Green	Outdoor activity recommended; restrict outdoor activity for patients with ongoing respiratory or cardiovascular symptoms	Outdoor activity recommended
4–6	Moderate	Blue	Restrict outdoor activity for patients with ongoing respiratory or cardiovascular symptoms	Maintain daily outdoor activity
7–10	High	Orange	Restrict outdoor activity among the elderly, children, and patients with respiratory or cardiovascular diseases	Outdoor activity restricted in case of respiratory or cardiovascular symptoms
>10	Very high	Red	Avoid outdoor activity among the elderly, children, and patients with respiratory or cardiovascular diseases	Avoid outdoor activity

The formula for calculation of SAQHI is $SAQHI = 10/17 \times [\exp(0{\cdot}000153 \times PM_{10}) - 1 + \exp(0{\cdot}000662 \times NO_2) - 1] \times 10$. Both PM_{10} and NO_2 levels are presented as μg/m³. PM_{10}=particulate matter of diameter ≤10 μm. NO_2=nitrogen dioxide.

Table 3: **Recommended health information based on the Shanghai air quality health index (SHAQHI)[109]**



Guan et al. *Lancet. 2016;388(10054):1939-1951.*

Take home messages

1. Burden of air pollution is substantial : 6.5 million deaths each year globally.
2. 65% of Korean COPD population have history of high air pollution exposure
3. Indoor and outdoor air population is a major risk of COPD prevalence
4. Air pollution is a major risk for exacerbation, lung function decline, hospitalization, mortality, poor quality-of-life, and cardiac outcomes in COPD patients.
5. Mitigate strategies are needed
    - air conditioner, improved cooking fuels and ventilation system etc.