

L'impatto sulla salute: i danni d'organo e gli effetti noti e meno noti

Polmone e vie aeree

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Polmone e vie aeree

.....un caso clinico



Un caso clinico

Giorgio, 78 anni 

- Ex fumatore p/ys 3
- Non esposizione professionale
- Non riferita familiarità per patologie respiratorie croniche e/o neoplastiche
- Comorbidità: Fibrillazione atriale, Ipertensione a, Ipertrofia prostatica benigna,
- Nel 2023 polmonite da Sars CoV 2 con IR e ricovero e

- diagnosi di **Broncopneumopatia Cronica Ostruttiva** con componente enfisematosa

- Visita amb pneumologico 2025: Frequenti riacutizzazioni, 3 all'anno, in terapia massimale; Ostruzione al flusso di grado grave (VEMS: 0,61L). Ipossiemia per età.

Un caso clinico

4/11/25
Rientro da un soggiorno in India

6/11/25
Insorgenza di tosse produttiva e aggravamento dispnea

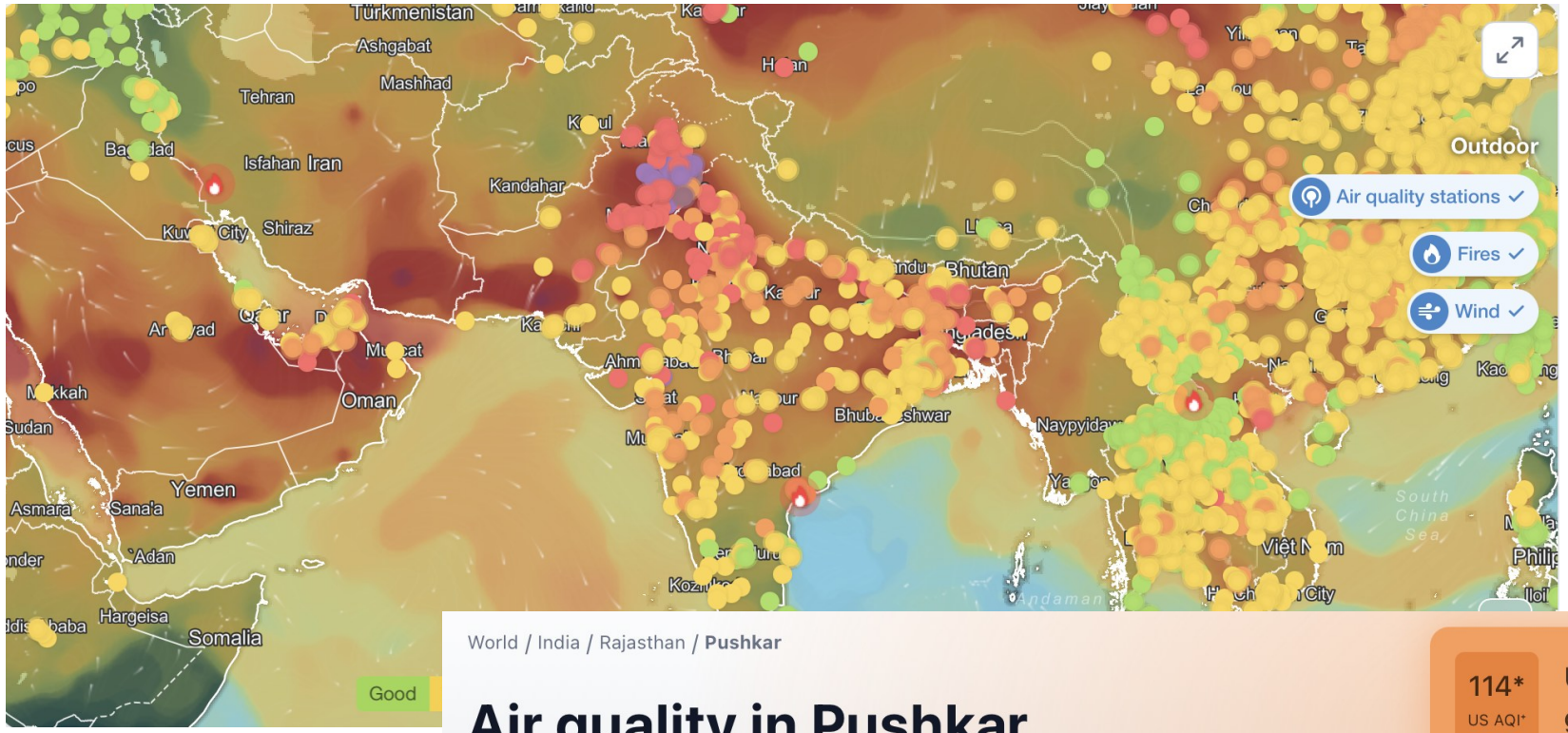
Trattamento domiciliare

11/11/25
Accesso in Pronto Soccorso

Insufficienza respiratoria ipercapnica O^2,NIV, PCR 11, 65 mg/dL e NTproBNP 6778 mg/dL, terapia medica; miglioramento
6MWT desaturazione sotto sforzo >>>> concentratore domiciliare

Dato interessante che emerge durante il ricovero, altri episodi di riacutizzazione di BPCO in concomitanza di viaggi in **INDIA**





World / India / Rajasthan / **Pushkar**

Air quality in Pushkar

Air quality index (AQI[US]) and PM2.5 air pollution in Pushkar • 2.8K Followers • 11:30, May 10 Local time

Data attribution

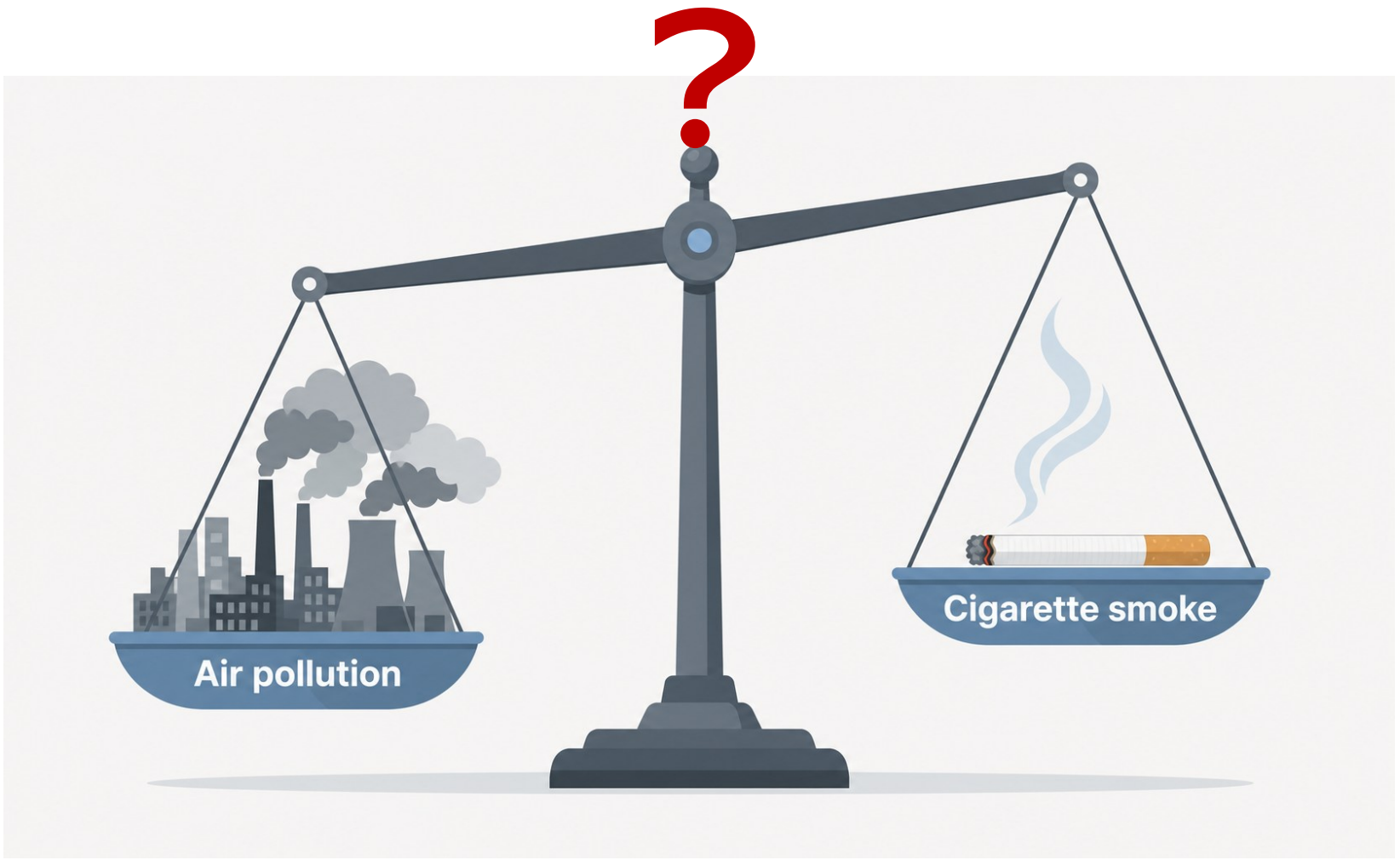
Data provided by a satellite-derived model

114* US AQI[US]

Unhealthy for sensitive groups

Main pollutant: PM2.5 40.7 µg/m³

40° 6 km/h 13 %


?
Air pollution
Cigarette smoke

Fattori di rischio associati a BPCO: percentuale di DALYs/100.000 ab

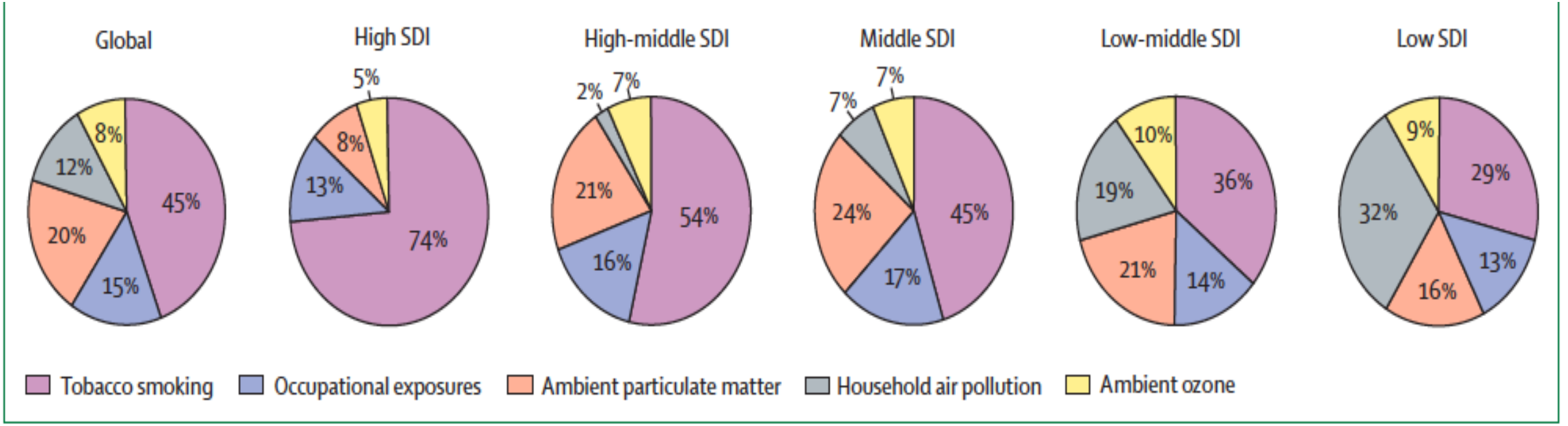


Figure: Global risk factors associated with COPD according to SDI

- Globalmente nel mondo circa la metà dei casi di BPCO sono associati a fattori diversi dal fumo; il **20% esposizione a particelle, 8% ad O3**
- L'effetto dei fattori diversi dal fumo è più forte al decrescere di SDI Socio Demographic Index

Contributo attribuibile a PM2.5 e NO2

per malattie respiratorie – Europa 40

	AD (n di morti)	DALY
Lung cancer	22,340 (8,526-34,886)	334,831 (127,834-523,307)
COPD	15,286 (271-28,001)	245,101 (38,838-422,180)
Asthma in children/adolescents	3 (1-5)	33,266 (12,027-51,366)

- La riduzione dei livelli secondo le indicazioni WHO preverrebbe 182,000 morti attribuibili a PM2.5 e 63.000 a NO2 (morti tot per malattie, dati 2023).
- Per alcune malattie come l'asma il maggior impatto è il peggioramento della malattia.
- Per altre (mal ischemiche, tumore polmonare) è la morte prematura.

https://www.eea.europa.eu/en/analysis/publications/harm-to-human-health-from-air-pollution-burden-of-disease-status-2025

European Environment Agency

Inquinanti atmosferici e penetrazione nel tratto respiratorio

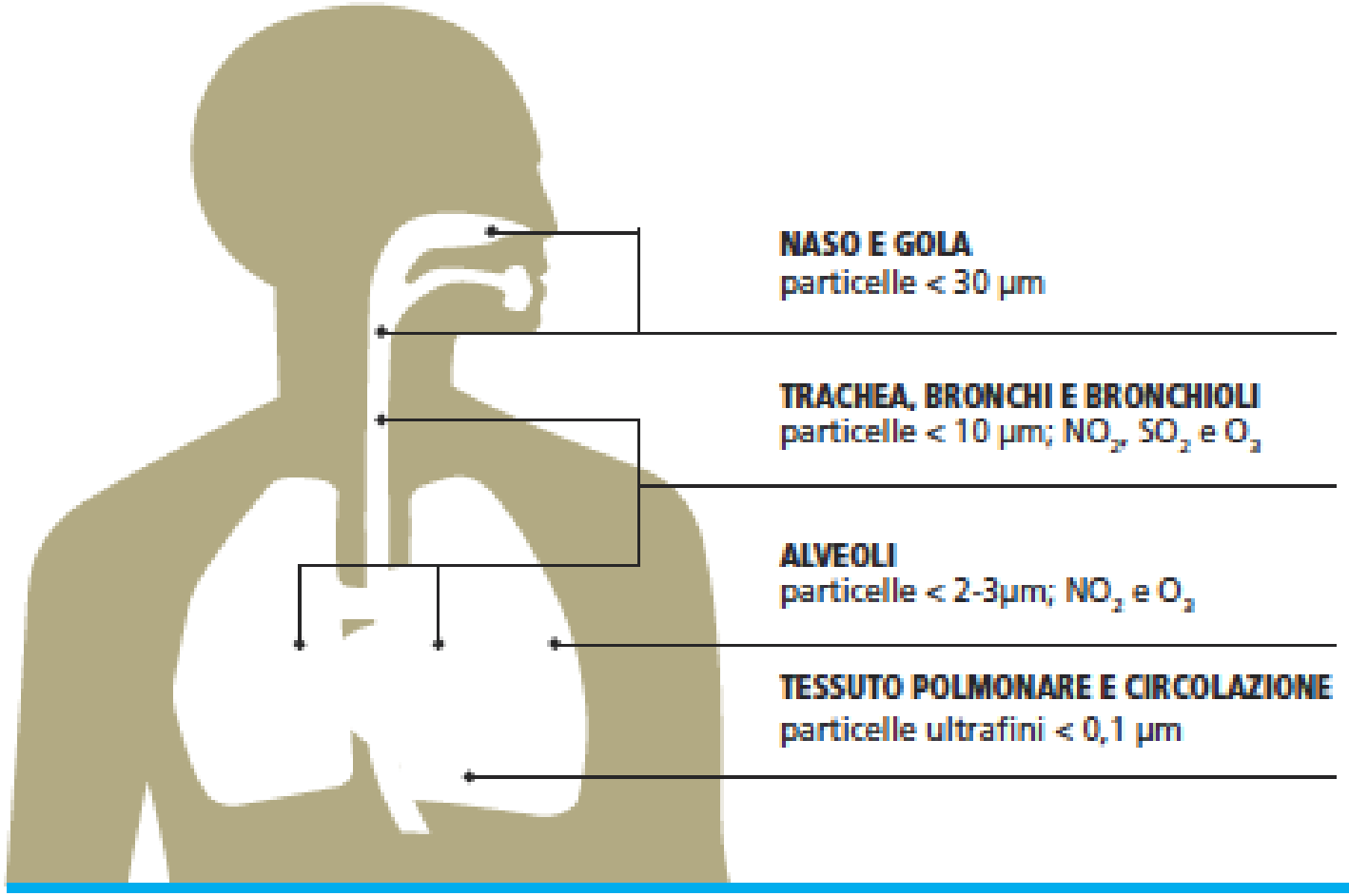


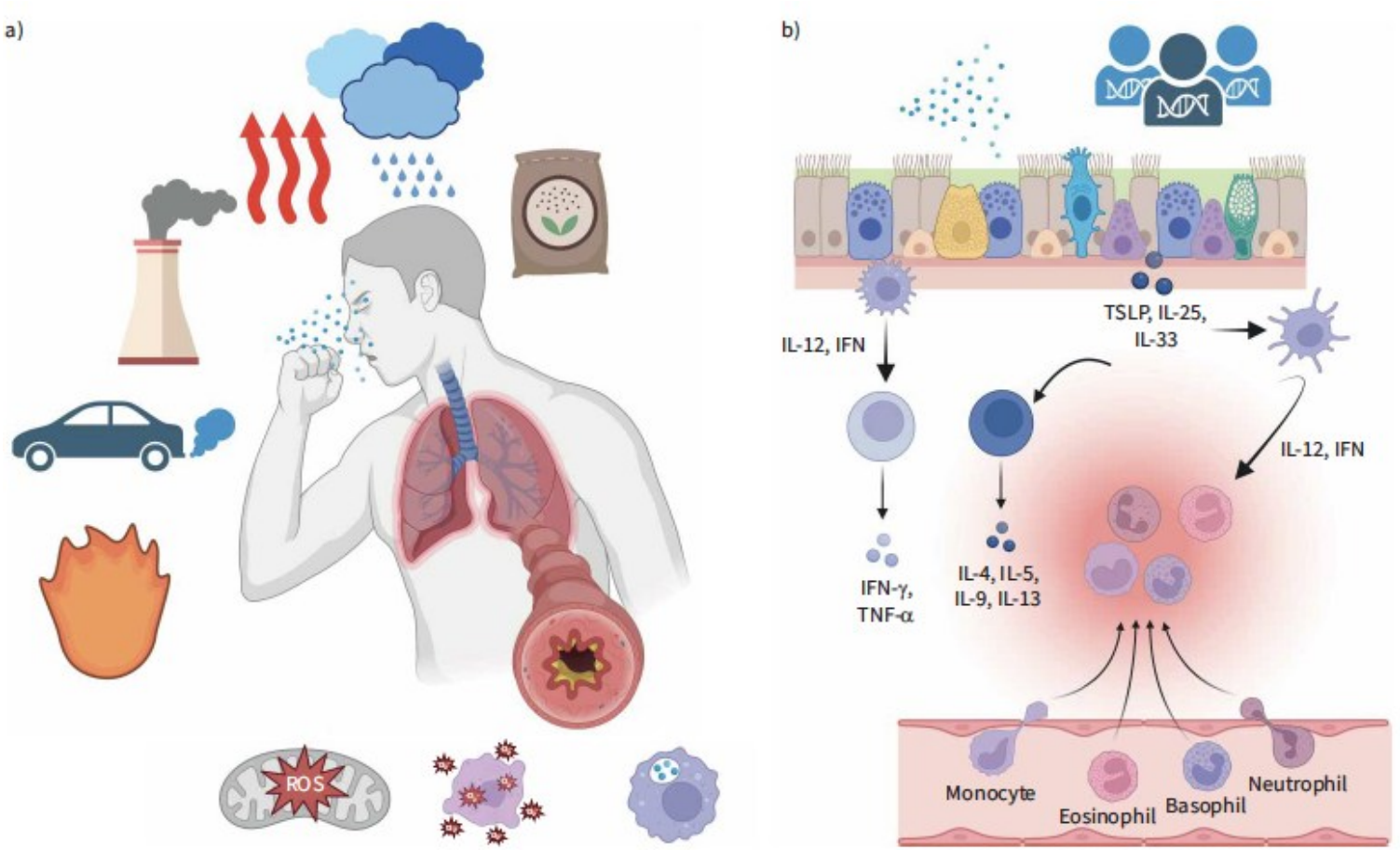
Figura 4. Penetrazione degli inquinanti nel tratto respiratorio. Modificata da Künzli et al.[5]

Epidemiol Prev 2013; 37(4-5) suppl 2: 1-86

Air pollution and COPD: GOLD 2023 committee report

Eur Respir J 2023; 61: 2202469

Don D. Sin[1], Dany Doiron[2], Alvar Agusti[3], Antonio Anzueto[4], Peter J. Barnes[5], Bartolome R. Celli[6], Gerard J. Criner[7], David Halpin[8], MeiLan K. Han[9], Fernando J. Martinez[10], Maria Montes de Oca[11], Alberto Papi[12], Ian Pavord[13], Nicolas Roche[14], Dave Singh[15], Robert Stockley[16], M. Victorina Lopez Varlera[17], Jadwiga Wedzicha[5], Claus Vogelmeier[18] and Jean Bourbeau[2] on behalf of the GOLD Scientific Committee



Meccanismi patogenetici:

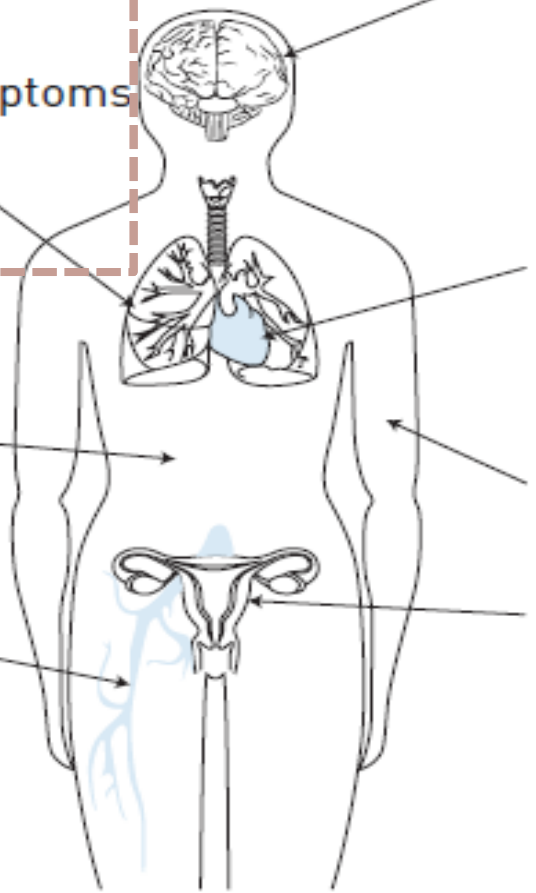
- disfunzione mitocondriale, morte cellulare accelerata e rimodellamento tissutale, secondari all'accumulo di ossigeno reattivo specie (ROS) nei mitocondri e nelle cellule immunitarie.
- infiammazione (sia di tipo 1 che di tipo 2)
- le particelle di inquinamento atmosferico possono accumularsi nei macrofagi tissutali (anche decenni) e perpetuare il processo infiammatorio.

Effetti dell'inquinamento atmosferico: A joint ERS/ATS policy statement

Respiratory disease mortality
Respiratory disease morbidity
Lung cancer
Pneumonia
Upper and lower respiratory symptoms
Airway inflammation
Decreased lung function
Decreased lung growth

Insulin resistance
Type 2 diabetes
Type 1 diabetes
Bone metabolism

High blood pressure
Endothelial dysfunction
Increased blood coagulation
Systemic inflammation
Deep venous thrombosis



Stroke
Neurological development
Mental health
Neurodegenerative diseases

Cardiovascular disease mortality
Cardiovascular disease morbidity
Myocardial infarction
Arrhythmia
Congestive heart failure
Changes in heart rate variability
ST-segment depression

Skin ageing

Premature birth
Decreased birthweight
Decreased fetal growth
Intrauterine growth retardation
Decreased sperm quality
Pre-eclampsia

Eur Respir J 2017; 49: 1600419

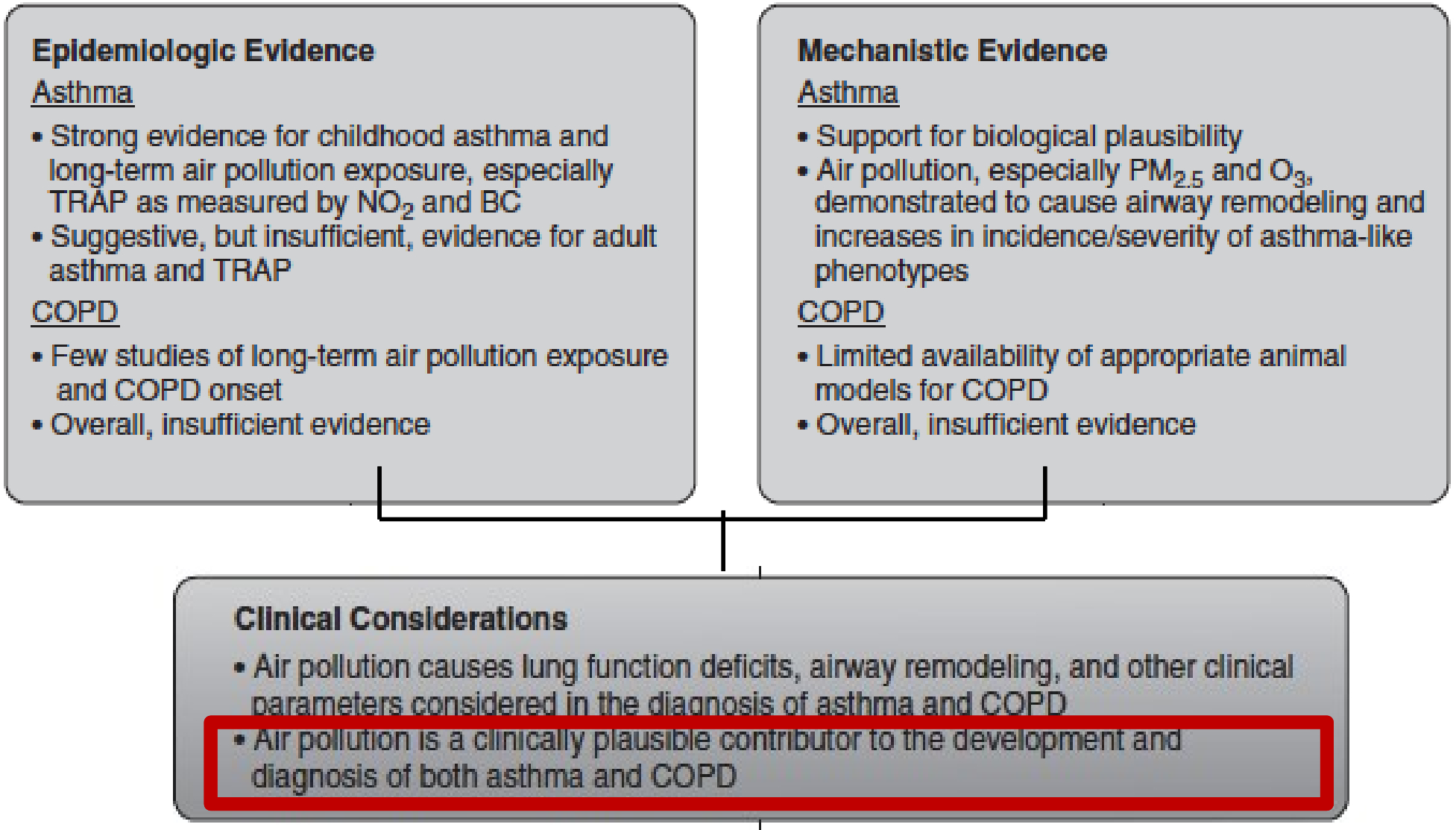
FIGURE 1 Overview of diseases, conditions and biomarkers affected by outdoor air pollution. Updated based on [31]. Bold type indicates conditions currently included in the Global Burden of Disease categories.

Inquinamento e Insorgenza di Asma e BPCO?

AMERICAN THORACIC SOCIETY DOCUMENTS

Annals ATS Volume 17 Number 4| April 2020

Outdoor Air Pollution and New-Onset Airway Disease
An Official American Thoracic Society Workshop Report



Inquinamento e Insorgenza di Asma e BPCO

AMERICAN THORACIC SOCIETY DOCUMENTS

Outdoor Air Pollution and New-Onset Airway Disease Annals ATS Volume 17 Number 4| April 2020
An Official American Thoracic Society Workshop Report

Epidemiologic evidence + **Mechanistic evidence**

Clinical considerations

Workshop Conclusions

- Epidemiologic and toxicological evidence convincingly indicate a causal induction of new childhood asthma by long-term outdoor air pollution exposure
- Although combined evidence supports the hypothesis that air pollution is related to adult onset asthma and COPD, additional evidence is needed to definitively conclude a causal connection

Air pollution, genetic susceptibility and risk of progression from asthma to COPD

Li G, *et al*. *Thorax* 2025;**0**:1–10. doi:10.1136/thorax-2024-222871

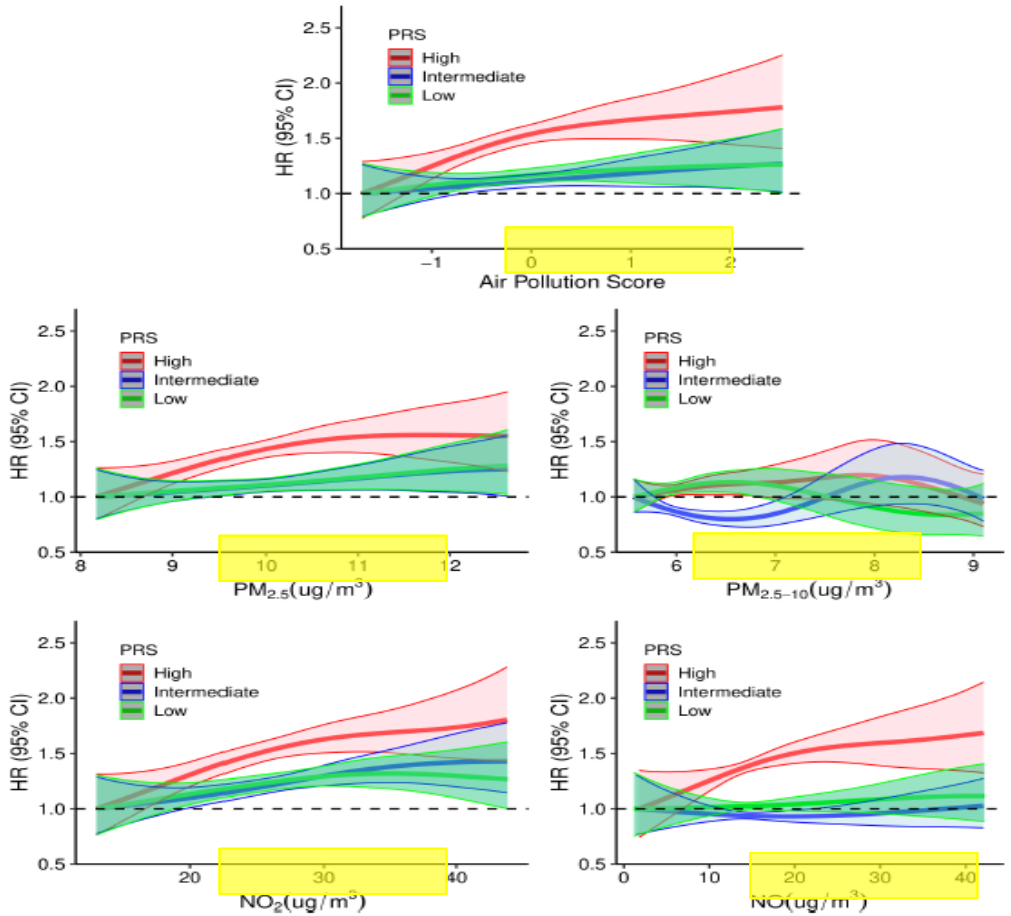


Figure 3 Exposure-response curves between air pollution and incidence of chronic obstructive pulmonary disease in the asthma population with different polygenic risk scores. The results were based on the main model, which was adjusted for age, sex, ethnicity, BMI, length of time at residence, assessment centre, Townsend Deprivation Index, education level, economic status, smoking status and alcohol consumption. BMI, body mass index; NO_2, nitrogen dioxide; NO, nitric oxide; $PM_{2.5}$, particulate matter with aerodynamic diameter ≤2.5 µm; $PM_{2.5\text{-}10}$, PM with aerodynamic diameter between 2.5 and 10 µm; PRS, Polygenic Risk Score.

- Long term exposure to ambient air pollution, **indicated** by of PM 2.5 or NO2, was significant associated with development of COPD in asthma patients.
- Such associations were only evident among participants who carry high polygenetic risk scores for asthma+COPD.
- Gene-Environment interaction for Asthma+COPD susceptibility

In Italia?

An expert position paper on environment, occupation and climate change effects on allergic respiratory diseases in Italy

Giovanni Viegi[1,2*], Sara Maio[1], Augusto Arsieni[3], Carlo Barbetta[4], Paolo Borrelli[5], Laura Carrozzi[6], Massimo Corradi[7], Gabriele Cortellini[8], Manuela De Sario[9], Giuliana Ferrante[2,10], Cristiana Indolfi[11], Silvia Maritano[12], Francesco Menzella[13,14], Manlio Milanese[15], Nicola Murgia[16], Raffaella Nenna[17], Emma Tedeschini[18], Giovanni Traina[19], Vincenzo Patella[20]

Explor Asthma Allergy. 2026;4:1009135 | https://doi.org/10.37349/eaa.2026.10091345

Obiettivo: affrontare in modo integrato e multidisciplinare le complesse interazioni tra ambiente e esposizioni professionali, cambiamenti climatici e insorgenza di malattie allergiche respiratorie nell'adulto e popolazione pediatrica.

Tabella 5. Effetti dell'inquinamento atmosferico outdoor sulla salute respiratoria degli adulti

Studio	Popolazione / Area	Esposizione	Esiti	Stima effetto

Mortalità/ospedalizzazione: n= 4 studi
BPCO e ostruzione vie aeree: n= 6 studi
Asma/ Allergie: n= 9 studi
Infezioni respiratorie: n= 4 studi

Tabella 6. Effetti dell'inquinamento atmosferico outdoor sulla salute respiratoria di bambini e adolescenti

Studio	Popolazione / Area	Esposizione outdoor	Esiti	Stima effetto

Asma/rinite/Funzione/Uso di farmaci/ Rimodellamento/ricoveri/controllo/ Visite allergologico, ORL, pneumo: n=9 studi

AIE AAITO AIPO SIAAIC SIAIP SIAMA SIML SIMRI SIP

Geographical Information System: effetti del traffico autoveiscolare sulla salute respiratoria

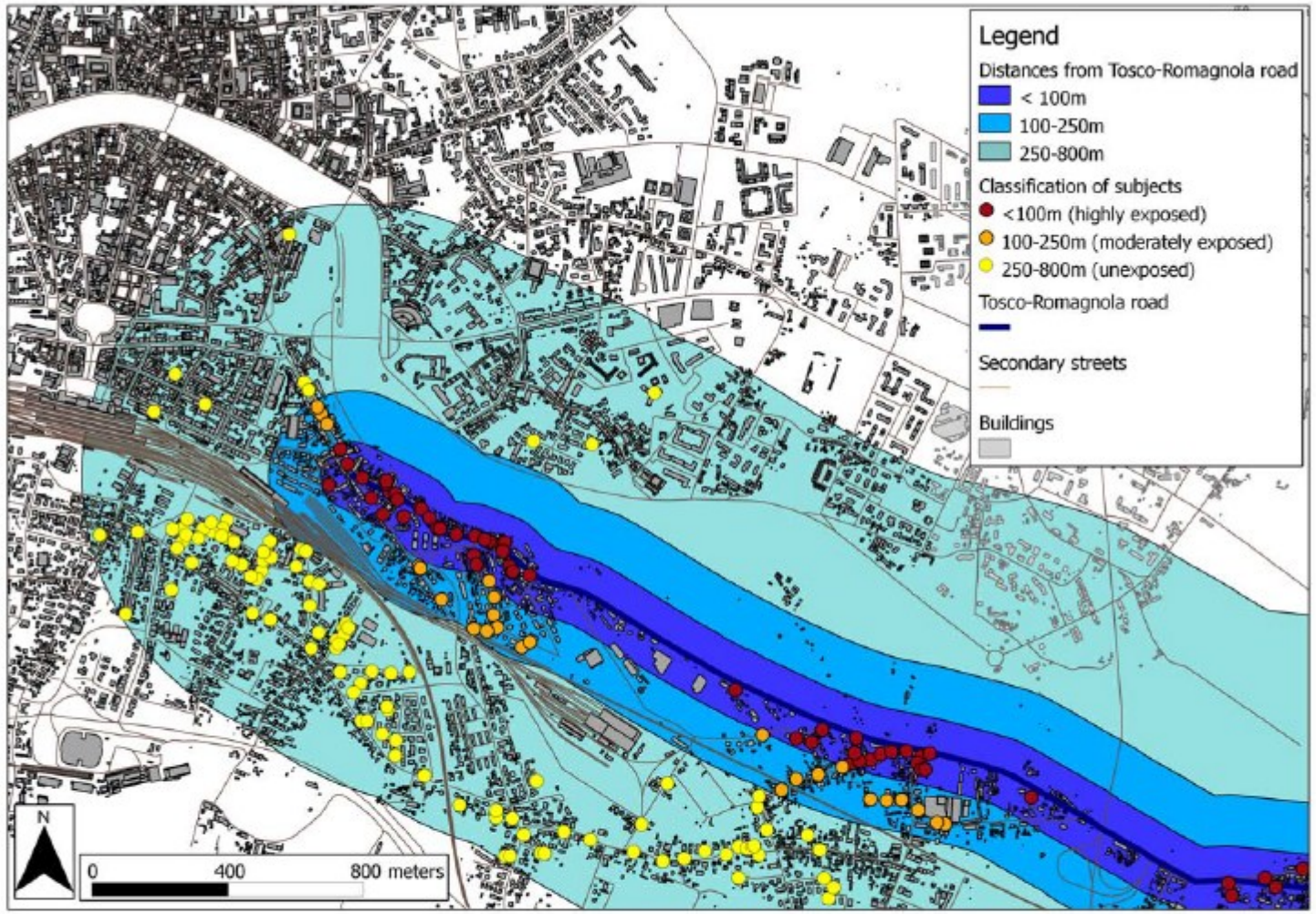


Figure 2 Classification of subjects based on the distance of each home from the main road. Zoomed map representing the classification of subjects according to the distance of each home from the main road. Highly exposed subjects are those living in the buffer area 0-100 m from the road, moderately exposed subjects living in the buffer area 100-250 m and unexposed are those living between 250 and 800 m from the road.

Nuvolone *et al. Environmental Health* 2011, **10**:12
http://www.ehjournal.net/content/10/1/12

Geographical information system and environmental epidemiology: a cross-sectional spatial analysis of the effects of traffic-related air pollution on population respiratory health

Daniela Nuvolone[1,2*], Roberto della Maggiore[2], Sara Maio[3], Roberto Fresco[2], Sandra Baldacci[3], Laura Carrozzi[3], Francesco Pistelli[3], Giovanni Viegi[3,4]

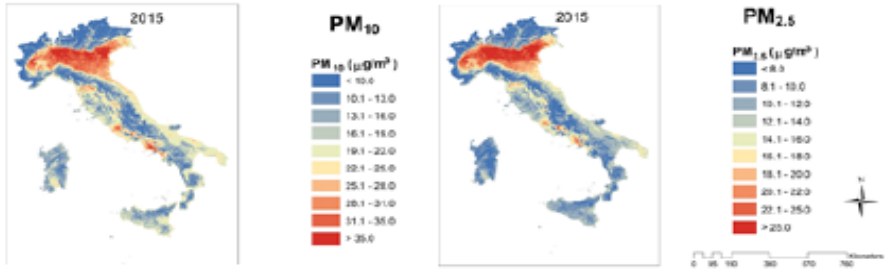
Living within 100 m of the main road was associated with higher risks for persistent wheeze, COPD, and airway obstruction **on males**, as well higher risks for asthma, SOBWz, dyspnea and positivity to skin prick tests **in females.**

Ospedalizzazioni per malattie respiratorie

Graphical abstract

A nationwide study of air pollution and daily hospitalizations for respiratory diseases in Italy

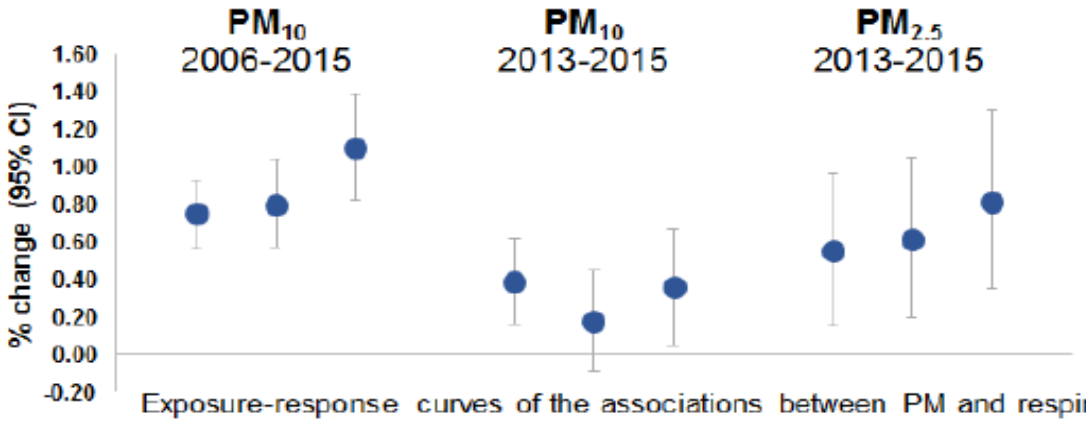
- Machine-learning approach to estimate PM exposure
- National health data database
- Sensitivity analyses (subgroup outcomes, effect modification, exposure-response curves)



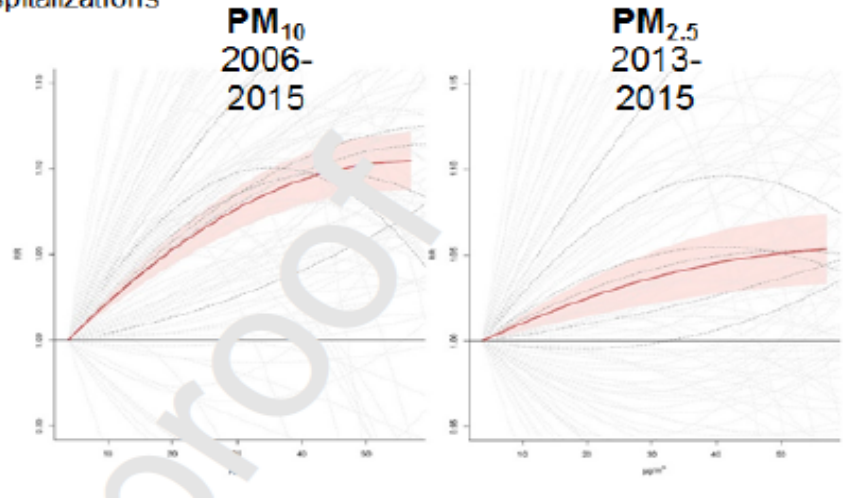
Annual concentrations of PM10 and PM2.5 in Italy

Conclusions:
In this study we provided evidence of harmful effect of PM_{10} and $PM_{2.5}$ on respiratory hospitalizations in Italy during 2006-2015 and we reported a positive association for a subgroup of respiratory outcomes such as asthma, COPD and LRTI. Low-level effects were detected.

Association with total respiratory hospitalizations



Exposure-response curves of the associations between PM and respiratory hospitalizations



Proof

Renzi, Sci Total Environ 2022

Diagnosi e sintomi: studio multicentrico

Relationship of long-term air pollution exposure with chronic obstructive pulmonary disease: an Italian multicentre observational study

Maio S et al, Occup Environ Med 2025

- N=14.420 adulti in Italia (Ancona Pavia Pisa Sassari, Torino, Verona)
- Esposizione machine learning
- Diagnosi di BPCO , sintomi e dispnea associate a 10 um di incremento di PM10, PM 2.5, NO2.
- PM principale fattore

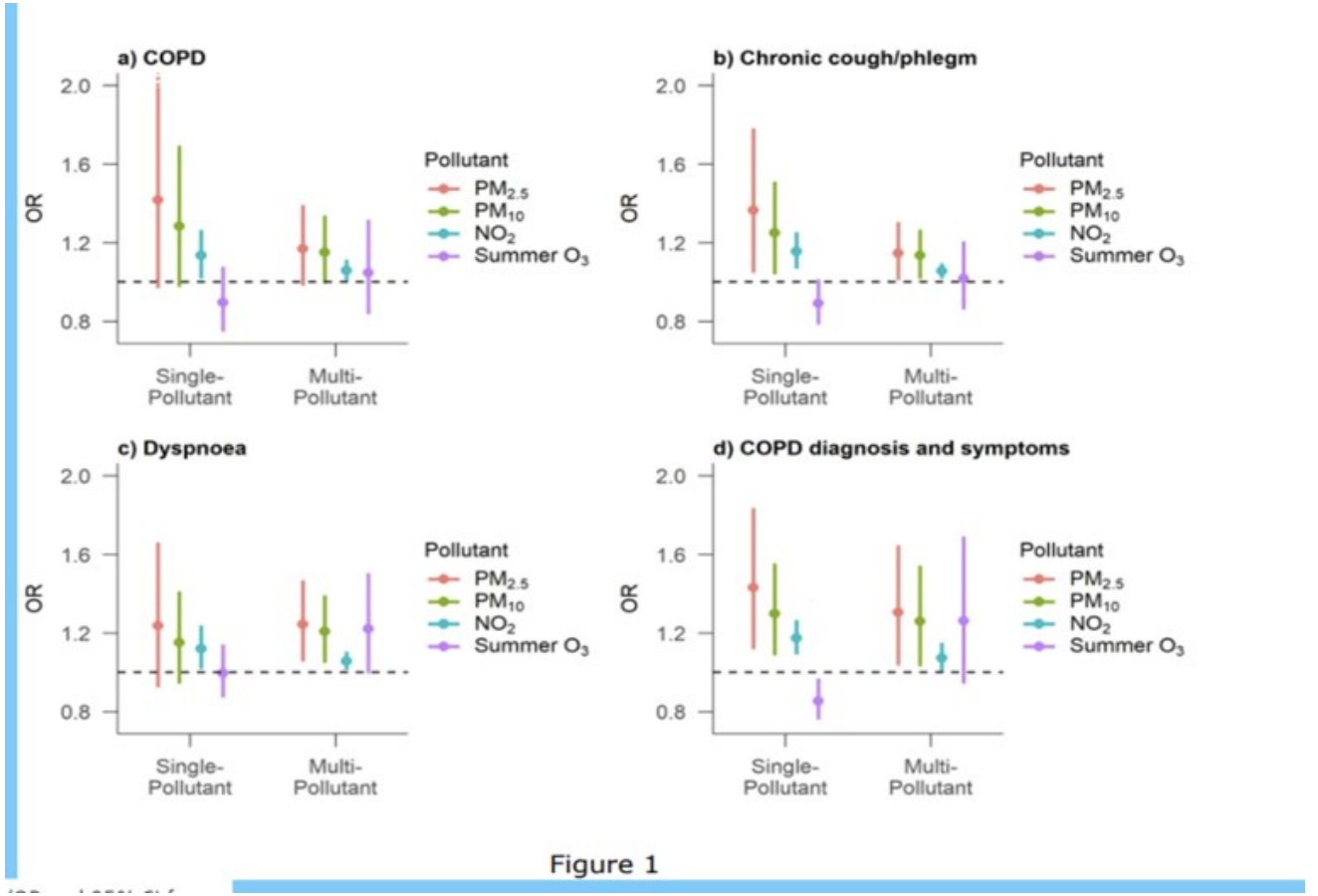


Figure 1

In Italia?

An expert position paper on environment, occupation and climate change effects on allergic respiratory diseases in Italy

Giovanni Viegi[1,2*], Sara Maio[1], Augusto Arsieni[3], Carlo Barbetta[4], Paolo Borrelli[5], Laura Carrozzi[6], Massimo Corradi[7], Gabriele Cortellini[8], Manuela De Sario[9], Giuliana Ferrante[2,10], Cristiana Indolfi[11], Silvia Maritano[12], Francesco Menzella[13,14], Manlio Milanese[15], Nicola Murgia[16], Raffaella Nenna[17], Emma Tedeschini[18], Giovanni Traina[19], Vincenzo Patella[20]

Explor Asthma Allergy. 2026;4:1009135 | https://doi.org/10.37349/eaa.2026.10091345

Executive summary

- A partire dagli anni ’90 è evidente che vivere in aree urbane è associato a sintomi, mal respiratorie, mortalità e ricoveri per mal respiratorie e infezioni.
- Esposizione a PM10, PM2,5, NO2, O3
- Aumento stress ossidativo in sogg sucettibili
- Risultati negli adulti e nei bambini

- Aumento della frequenza e gravità delle malattie allergiche.
- Maggiore produzione e durata di allergeni ma anche sinergie negative tra pollini e inquinamento per maggiore allergenicità e maggiore penetrazione nelle vie respiratorie
- [Importanza inquinamento indoor ed esposizione lavorativa]

Effetti noti e meno noti

Inquinamento e tumore polmonare: esposizione a lungo termine a bassi livelli di inquinanti

ELAPSE collaboration, 7 coorti europee; n= 307,550 soggetti, 1985-2005

Table 3
Pooled analyses of air pollutants exposure and risk of all lung cancers, adenocarcinomas, and squamous-cell carcinomas.

		Model 1[a] N = 307,550			Model 2[b] N = 307,550			Model 3[c] N = 307,550		
	Increment	HR	95% CI		HR	95% CI		HR	95% CI	
All lung cancers (N = 3956)										
NO_2	10 μg/m^3	1.10	1.05	1.15	1.00	0.95	1.05	1.02	0.97	1.07
$PM_{2.5}$	5 μg/m^3	1.21	1.11	1.31	1.12	1.03	1.21	1.13	1.05	1.23
BC	0.5 10^{-5} m^{-1}	1.10	1.05	1.16	1.01	0.96	1.06	1.02	0.97	1.07
O_3w	10 μg/m^3	0.82	0.77	0.88	0.95	0.89	1.01	0.95	0.89	1.02
Adenocarcinoma (N = 1541)										
NO_2	10 μg/m^3	1.08	1.00	1.17	1.01	0.94	1.09	1.02	0.94	1.10
$PM_{2.5}$	5 μg/m^3	1.22	1.07	1.39	1.16	1.02	1.32	1.16	1.02	1.32
BC	0.5 10^{-5} m^{-1}	1.06	0.98	1.15	0.99	0.92	1.07	1.00	0.92	1.08
O_3w	10 μg/m^3	0.83	0.75	0.92	0.92	0.83	1.03	0.92	0.83	1.03
Squamous-cell (N = 740)										
NO_2	10 μg/m^3	1.04	0.92	1.17	0.93	0.83	1.05	0.97	0.86	1.09
$PM_{2.5}$	5 μg/m^3	1.10	0.91	1.32	1.02	0.85	1.22	1.04	0.87	1.25
BC	0.5 10^{-5} m^{-1}	1.07	0.95	1.21	0.96	0.86	1.09	0.99	0.88	1.12
O_3w	10 μg/m^3	0.79	0.68	0.91	0.94	0.80	1.09	0.94	0.81	1.10

HR, hazard ratio; CI, confidence interval; O_3w, Ozone in the warm season.
[a] Adjusted for study (strata), age, sex (strata), year of baseline visit.
[b] Further adjusted for smoking status, duration, intensity, intensity^2, BMI, marital status, and employment status.
[c] Further adjusted for 2001 mean income at the neighborhood level.

Associazione lineare tra **$PM_{2.5}$** e rischio di tumore polmonare per ogni incremento di 5ug/m^3 (1.13, CI 1.95-1.23)

Environment International 146 (2021) 106249

Inquinamento e tumore polmonare: esposizione a lungo termine a bassi livelli di inquinanti

Sottoanalisi dei soggetti esposti al di sotto del limite europeo di 25 ug/m³

Table 4
Subset analyses of $PM_{2.5}$ and lung cancer.

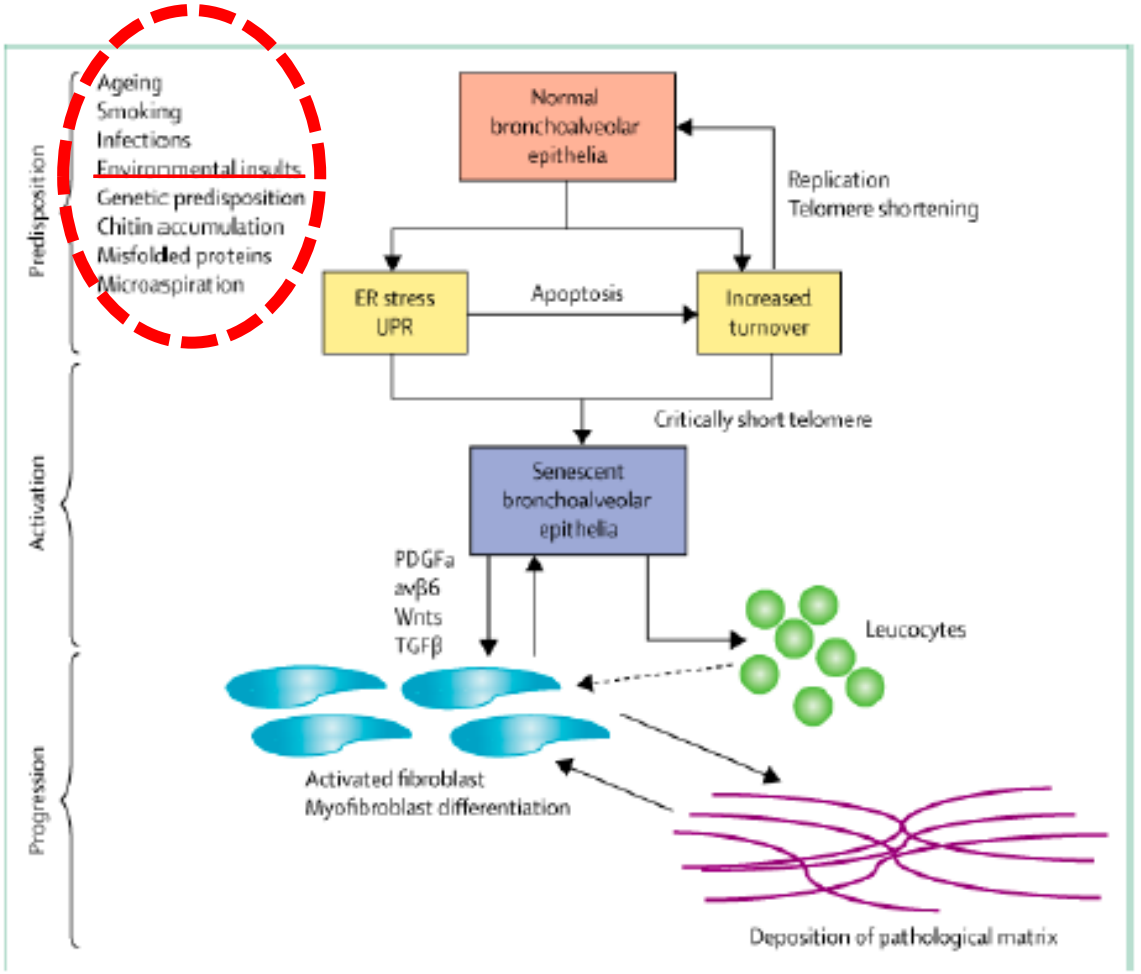
			All lung cancers[a]		
Subset[b]	No Obs	No cases	HR	95% CI	
Full dataset	307,550	3956	1.13	1.05	1.23
<25 μg/m³	307,524	3956	1.13	1.05	1.23
<20 μg/m³	299,514	3897	1.15	1.06	1.25
<15 μg/m³	145,078	2147	1.09	0.90	1.30
<12 μg/m³	49,834	589	1.21	0.75	1.96
<10 μg/m³	23,554	185	2.01	0.80	5.04

HR, hazard ratio; CI, confidence interval.

I risultati dello studio confermano il ruolo delle particelle aeree outdoor sull'incidenza di tumore polmonare, anche a concentrazioni più basse degli attuali limiti EU e probabilmente anche al di sotto dei valori delle WHO Air Quality Guidelines

Environment International 146 (2021) 106249

Time for a change: is idiopathic pulmonary fibrosis still idiopathic and only fibrotic?



Processo a tre stadi

⇛Predisposizione

,

ruolo dei fattori
li rischio

⇛Attivazione,

alterazione
dell'epitelio

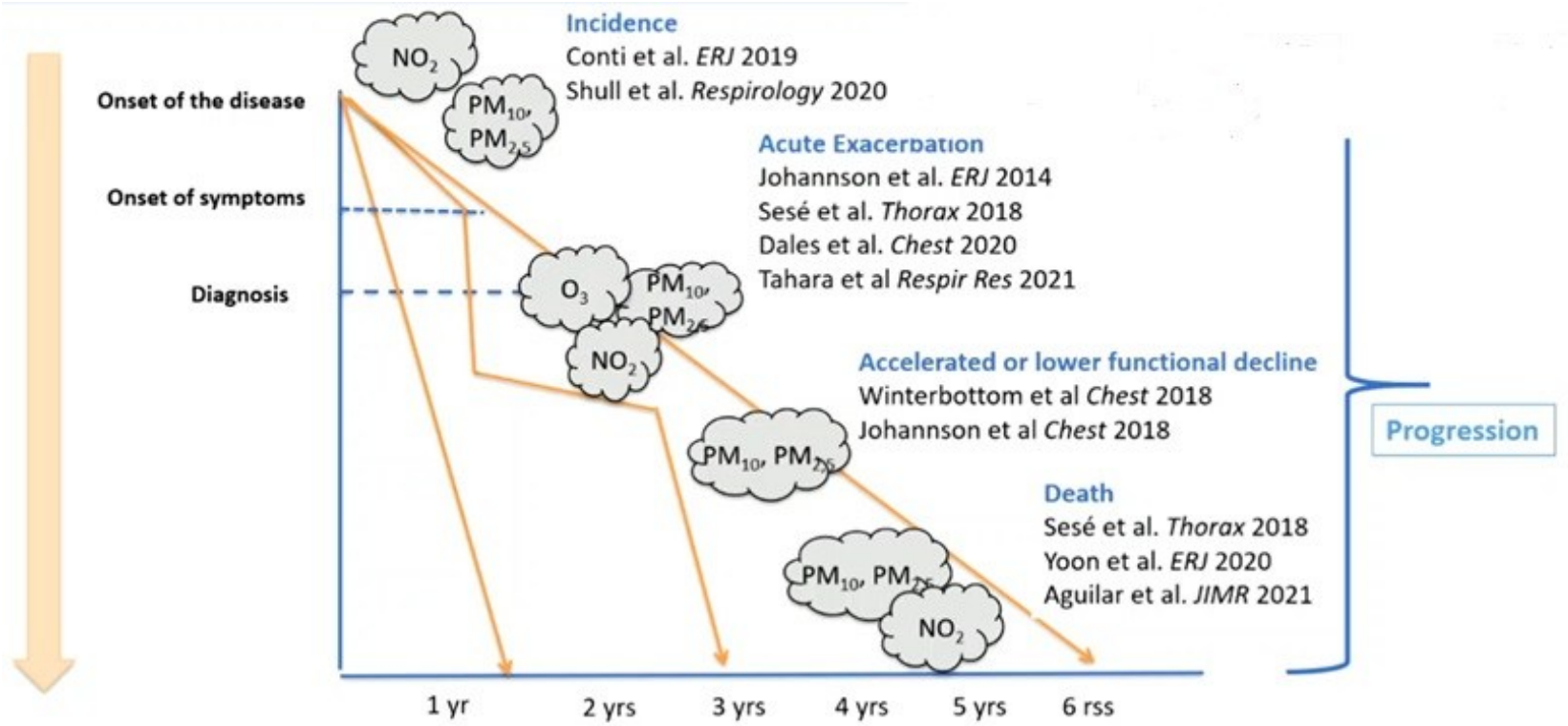
⇛Progressione,

perdita della normale
struttura,
rimodellamento fibrotico

Lancet Respir Med. 2018 February ; 6(2): 154–160. doi:10.1016/S2213-2600(18)30007-9.

Fibrosi polmonare: dall'esposizione alla mortalità

Functional Decline: The Measurable Signal

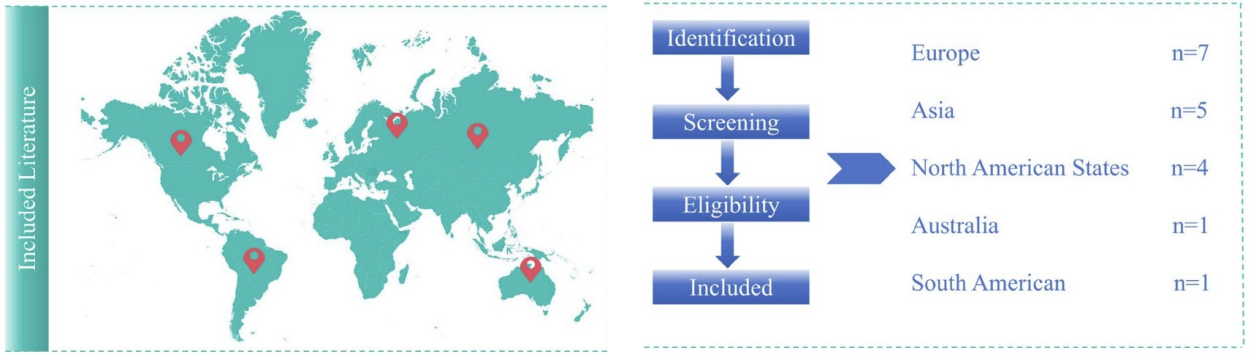


- Air pollution exposure
- Chronic epithelial injury + Acute exacerbations
- Accelerated FVC decline
- Reduced survival

ICourtesy of prof. Annesi-Maesano I., ERS conference 2024

Evidenze attuali: suggestive ma eterogenee

*A recent large-scale meta-analysis confirmed a role in **disease progression and incidence**, but found no significant association with **mortality***



Pollutant	Outcome	RR (95% CI)
NO_2 (+10 µg/m³)	Progression	1.32 (1.16–1.50)
$PM_{2.5}$ (+5 µg/m³)	Progression	1.08 (1.01–1.15)
NO_2 (+10 µg/m³)	Incidence	1.67 (1.05–2.66)
NO_2, $PM_{2.5}$, O_3	Mortality	No significant association

Luo et al. BMC Public Health, 2025

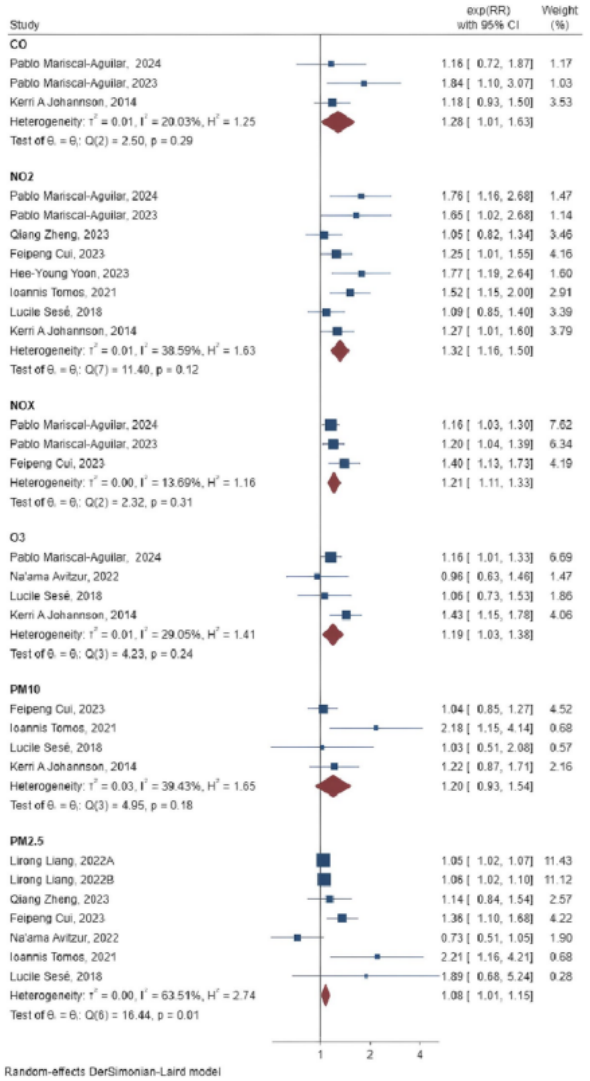


Fig. 2 Forest plot of studies reporting exposure to ambient air pollutants and progression of IPF risk. Random-effects meta-analysis was used to meta-analyse the evidence for an association between exposure to air pollutants in the environment and the risk of disease progression in IPF. Squares indicate relative risk and bars indicate 95% CI for each study. All statistical tests were two-sided

Studio retrospettivo monocentrico • Ambulatorio Interstiziopatie Polmonari, AOUPisana

Esposizione: modello spazio-temporale ad alta risoluzione (1 km²) che copre l'intera Italia
Popolazione: n= 290 pz con diagnosi di IPF, aa 2014-2026

Ogni aumento di **1 µg/m³ di $PM_{2.5}$ e NO_2** è associato ad **aumento del rischio di mortalità** rispettivamente **del 29% e del 12%.**

$PM_{2.5}$
OR 1,29 (IC 95% 1,14–1,45)

NO_2
OR 1,12 (IC 95% 1,06–1,18)

PM_{10}
OR 1,07 (IC 95% 0,98–1,17)

Ogni aumento di **1 µg/m³ di $PM_{2.5}$ e NO_2** si associa con **aumento del rischio di riacutizzazione** rispettivamente **del 28% e del 9%.**

$PM_{2.5}$
OR 1,28 (IC 95% 1,12–1,46)

NO_2
OR 1,09 (IC 95% 1,02–1,15)

PM_{10}
OR 1,05 (IC 95% 0,95–1,15)

Studio retrospettivo monocentrico • Ambulatorio Interstiziopatie Polmonari, AOUPisana.

Esposizione: modello spazio-temporale ad alta risoluzione (1 km^2) che copre l'intera Italia*
Popolazione: n= 290 pz con diagnosi di IPF, aa 2014-2026; residenti in Toscana



- L ’esposizione media annua stimata a livello residenziale a **$PM_{2.5}$, PM_{10}, NO_2 è superiore ai limiti UE2024** ed **oltre i valori delle linee guida OMS 2021**

- Ogni aumento di **1 µg/m³ di $PM_{2.5}$ e NO_2** si associa con **aumento del rischio di riacutizzazione** rispettivamente **del 28% e del 9%.**

- Ogni aumento di **1 µg/m³ di $PM_{2.5}$ e NO_2** si associa con **aumento del rischio di mortalità** rispettivamente **del 29% e del 12%.**

- **Nessuna associazione** con peggioramento della dispnea e del declino funzionale

Unpublished data, confidential

** M. Stafoggia et al., Environment International 2019 ; M. Stafoggia et al., Epidemiol Prev 2020*

Studio retrospettivo monocentrico • Ambulatorio Interstiziopatie Polmonari, AOUPisana: CONFRONTO CON LA LETTERATURA



Mortalità

Nostro studio **$PM_{2.5}$ OR 1,29 • NO_2 OR 1,12 per +1 µg/m³**

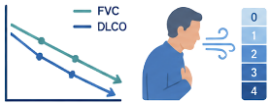
- **COFI – Francia (Sesé 2018; 192 IPF)**
  $PM_{2.5}$ cumulativo: rischio di morte aumenta di 8 volte per ogni incremento di 10 µg/m³ (≈ HR 1,23 per µg/m³)
- **Corea (Yoon 2021; 1.114 IPF)**
  NO_2: +17% di mortalità per 10 ppb; PM_{10} non associato, come nel nostro studio
- **Meta-analisi di Luo 2025 (18 studi)**
  nessuna associazione significativa con la mortalità per IPF



Riacutizzazioni

Nostro studio **$PM_{2.5}$ OR 1,28 • NO_2 OR 1,09 per +1 µg/m³**

- **Johannson 2014 – Corea**
  O_3 e NO_2 nelle 6 settimane precedenti l'evento (breve termine)
- **Tomos 2021 – Grecia • disegno più simile al nostro**
  NO_2 medio dell'anno precedente, confermato dopo aggiustamento



Declino funzionale e peggioramento della dispnea

Nostro studio **nessuna associazione (DLCO: $PM_{2.5}$ OR 1,07, NS)**

Letteratura ancora eterogenea

- **Winterbottom 2018 – USA**
  PM_{10} → declino più rapido della FVC
- **Zheng 2023 – Australia**
  $PM_{2.5}$ → declino della DLCO, non della FVC
- **Mariscal-Aguilar 2024 – Madrid**
  O_3 → peggioramento mMRC o nuova tosse
- **Goobie 2022 – Nord America**
  declino della FVC in 1 sola coorte su 3
- **Sesé 2018 – COFI, Francia**
  nessuna associazione con la progressione
- **Sack 2025 – IPF-PRO, USA**
  solo funzione peggiore al basale, non declino

Polmone e vie aeree: Indicazioni per la prevenzione

An expert position paper on environment, occupation and climate change effects on allergic respiratory diseases in Italy

Giovanni Viegi[1,2*], Sara Maio[1], Augusto Arsieni[3], Carlo Barbetta[4], Paolo Borrelli[5], Laura Carrozzi[6], Massimo Corradi[7], Gabriele Cortellini[8], Manuela De Sario[9], Giuliana Ferrante[2,10], Cristiana Indolfi[11], Silvia Maritano[12], Francesco Menzella[13,14], Manlio Milanese[15], Nicola Murgia[16], Raffaella Nenna[17], Emma Tedeschini[18], Giovanni Traina[19], Vincenzo Patella[20]

Explor Asthma Allergy. 2026;4:1009135 | https://doi.org/10.37349/eaa.2026.10091345

Informarsi sui livelli di inquinamento nella città in cui si abita per pianificare le proprie attività
Camminare scegliendo orari e percorsi con minor traffico
Evitare le attività all'aria aperta (es. camminare, fare jogging, andare in bicicletta) vicino a strade trafficate e vicino alle aree industriali
D'estate evitare attività all'aria aperta dalle 12 alle 16, quando i livelli di ozono sono molto elevati
Se si usa la bicicletta, al semaforo meglio sostare davanti alla prima macchina e non fermi in coda a respirare gas nocivi
Durante l'inverno stare fuori casa nelle ore più calde, con il freddo il particolato si condensa a formare goccioline di aerosol più facilmente respirabili
Negli spostamenti in auto chiudere i finestrini ed utilizzare l'impostazione del ricircolo dell'aria in caso di traffico intenso, ma ventilare periodicamente il veicolo
Assumere molta frutta e verdura, alimenti ricchi di antiossidanti
Coprirsi il naso e la bocca all'esterno in condizioni di freddo o forte inquinamento
Durante i picchi di inquinamento ricordarsi di tenere a portata di mano le medicine per evitare un eventuale peggioramento della patologia respiratoria

- Proposto l'uilizzo del fascicolo sanitaria elettroncio per monitorare le relazioni ambiente-salute a livello individuale
- "Eletctronic Health Record (HER)"

Polmone e vie aeree



Palazzo "La Sapienza"

Grazie per l'attenzione!

laura.carrozzi@unipi.it

Meccanismi fisiopatologici delle malattie indotte da Inquinamento dell'aria

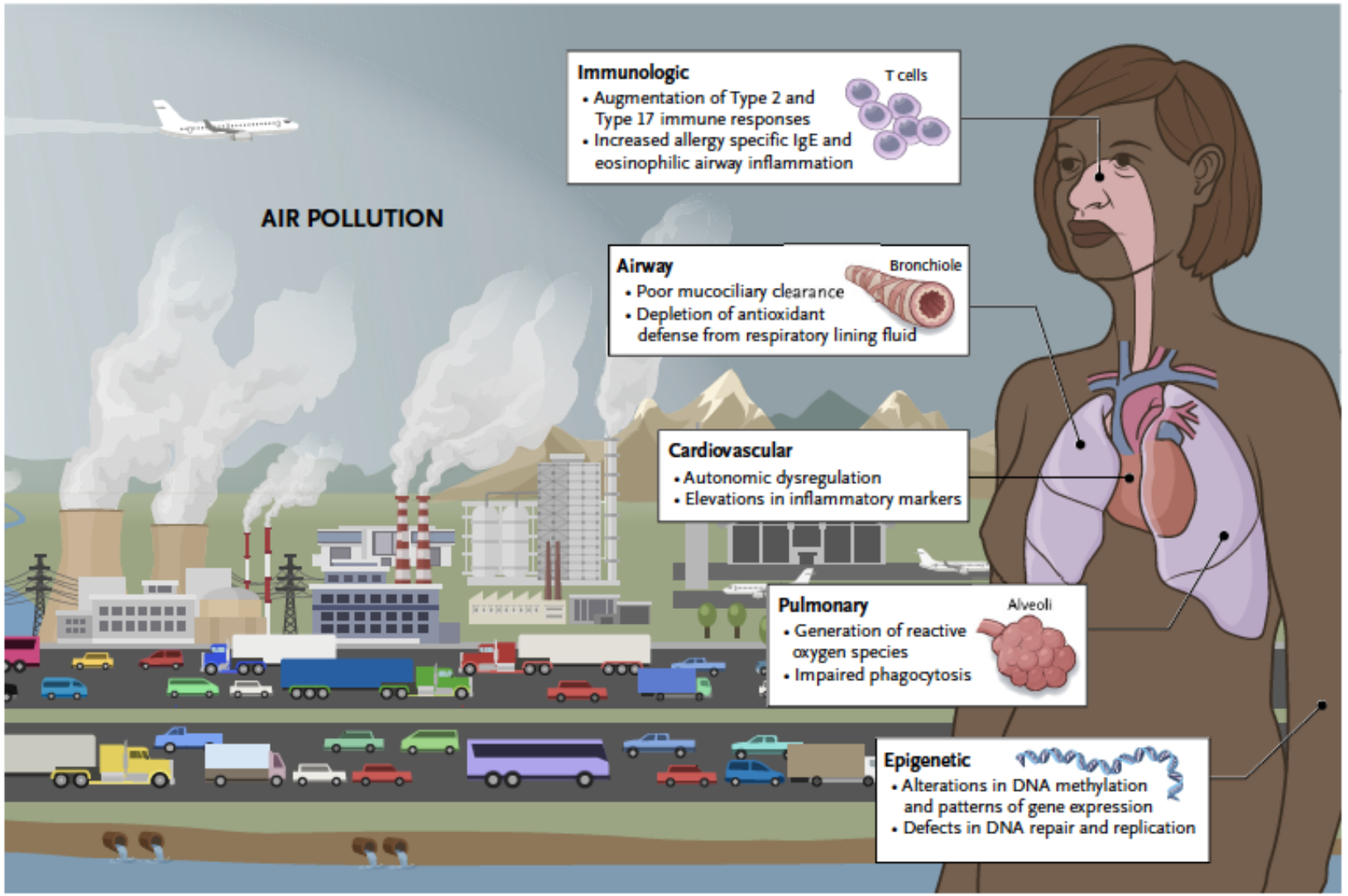


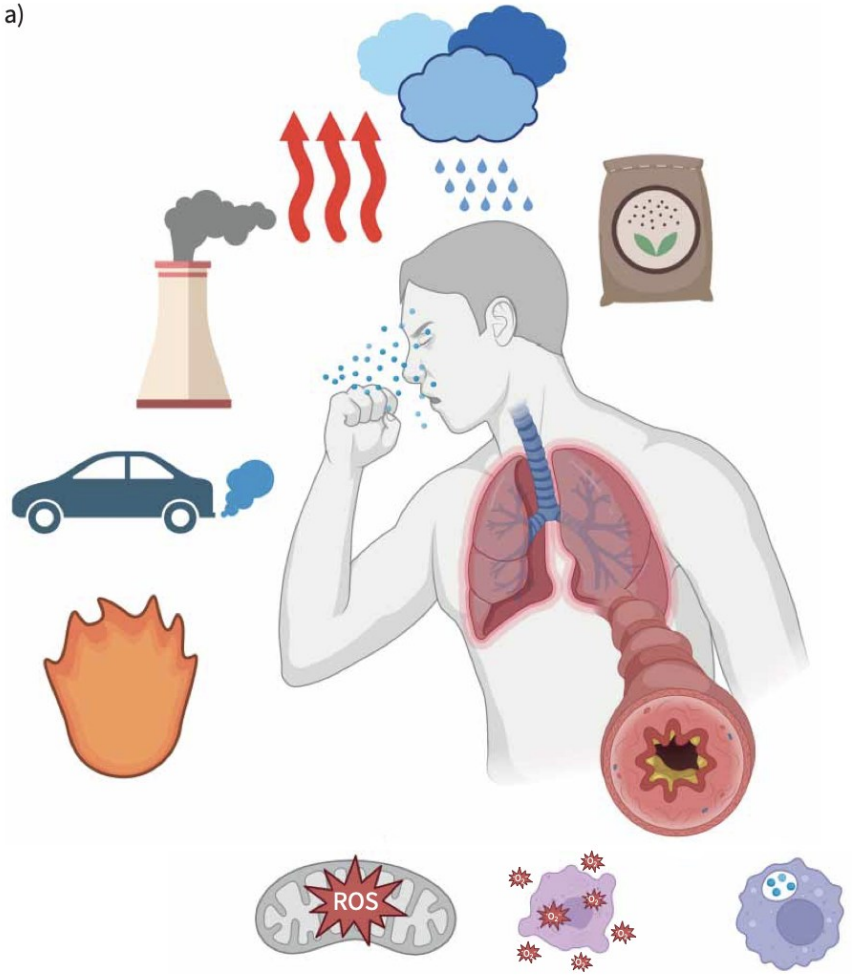
Figure 2. Pathophysiology of Air Pollution–Driven Disease.

IgE denotes immunoglobulin E.

- Stress ossidativo, infiammazione nel polmone
- Effetto cancerogeno sul polmone
- Trasferimento di mediatori infiammatori e componenti delle particelle nel flusso sanguigno e negli organi
- Effetti a breve e a lungo termine su quasi tutti i sistemi di organi importanti

NEJM Evid 2022;
Anjeni Keswani, M.D., M.S.C.I.,[1] Hana Akselrod, M.D., M.P.H.,[2] and Susan C. Anenberg, Ph.D.[3]

a)



Air pollution and COPD: GOLD 2023 committee report

Don D. Sin[1], Dany Doiron[2], Alvar Agusti[3], Antonio Anzueto[4], Peter J. Barnes[5], Bartolome R. Celli[6], Gerard J. Criner[7], David Halpin[8], MeiLan K. Han[9], Fernando J. Martinez[10], Maria Montes de Oca[11], Alberto Papi[12], Ian Pavord[13], Nicolas Roche[14], Dave Singh[15], Robert Stockley[16], M. Victorina Lopez Varlera[17], Jadwiga Wedzicha[5], Claus Vogelmeier[18] and Jean Bourbeau[2] on behalf of the GOLD Scientific Committee

Air pollution and exacerbations of COPD

Patients living with COPD are susceptible to (even modest) acute increases in air pollution levels and to extreme changes in weather, which may be seasonal or sporadic. Thus, acute increases in air pollution are major contributors to exacerbations of COPD. A systematic review in 2016 identified 59 primary studies on this topic and in aggregate found that acute reductions in air quality were associated with increased risk of COPD exacerbations [20]. For the gas constituents of air pollution, the relationships with COPD

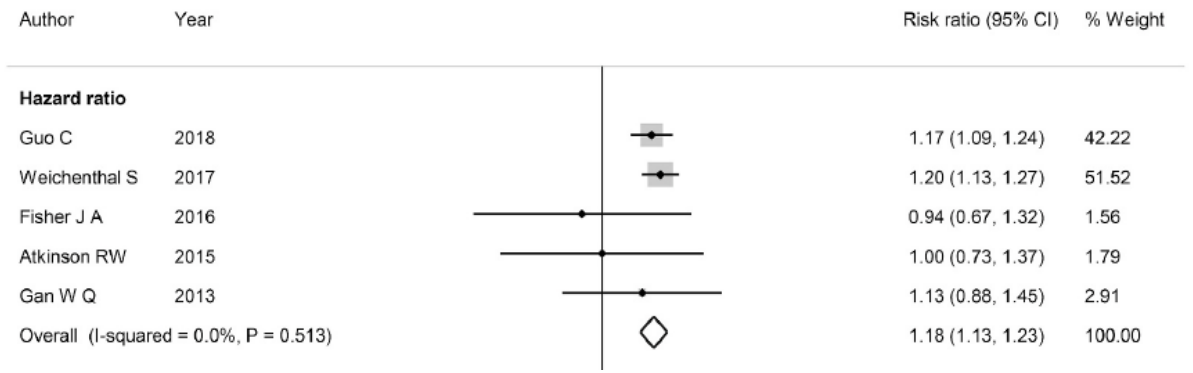
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Environmental Research

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Impact of long-term exposure to ambient air pollution on the incidence of chronic obstructive pulmonary disease: A systematic review and meta-analysis☆

studied included particulate matter ($PM_{2.5}$ and PM_{10}) and nitrogen dioxide (NO_2). Results: Of the 436 studies identified, seven met our eligibility criteria. Among the seven studies, six, three, and five had data on $PM_{2.5}$, PM_{10}, and NO_2, respectively. The meta-analysis results showed that a 10 $\mu g/m^3$ increase in $PM_{2.5}$ is associated with increased incidence of COPD (pooled HR 1.18, 95% CI 1.13–1.23). We also noted that a 10 $\mu g/m^3$ increase in NO_2 is marginally associated with increased incidence of COPD (pooled HR 1.07, 95% CI 1.00–1.16). PM_{10} seems to have no significant impact on the incidence of COPD (pooled HR 0.95, 95% CI 0.83–1.08), although the number of studies was too small. Meta-regression analysis found no significant effect modifiers. Conclusions: Long-term exposure to $PM_{2.5}$ and NO_2 can be associated with increased incidence of COPD.



- **Causal relationship** between air pollution (PM2.5 and NO2) and COPD. PM10: no significant impact

Environmental Research 194 (2021) 110703

Tumore del polmone ed esposizione a particelle ultrafini

L' esposizione cronica a particelle ultrafini è associata a tumore polmonare, in particolare adenocarcinoma.

Rationale: [illegible] ($PM_{2.5}$) is an established cause of lung cancer, but the association with ultrafine particulate matter (UFP; aerodynamic diameter < 0.1 μm) is unclear.

Objectives: To investigate the association between UFP and lung cancer overall and by histologic subtype.

Methods: The Los Angeles Ultrafines Study includes 45,012 participants aged ⩾50 years in southern California at enrollment (1995–1996) followed through 2017 for incident lung cancer ($n = 1{,}770$). We estimated historical residential ambient UFP number concentrations via land use regression and back extrapolation using $PM_{2.5}$. In Cox proportional hazards models adjusted for smoking and other confounders, we estimated associations between 10-year lagged UFP (per 10,000 particles/cm^3 and quartiles) and lung cancer overall and by major histologic subtype (adenocarcinoma, squamous cell carcinoma, and small cell carcinoma). We also evaluated relationships by smoking status, birth cohort, and historical duration at the residence.

Measurements and Main Results: UFP was modestly associated with lung cancer risk overall (hazard ratio [HR], 1.03 [95% confidence interval (CI), 0.99–1.08]). For adenocarcinoma, we observed a positive trend among men; risk was increased in the highest exposure quartile versus the lowest (HR, 1.39 [95% CI, 1.05–1.85]; P for trend = 0.01) and was also increased in continuous models (HR per 10,000 particles/cm^3, 1.09 [95% CI, 1.00–1.18]), but no increased risk was apparent among women (P for interaction = 0.03). Adenocarcinoma risk was elevated among men born between 1925 and 1930 (HR, 1.13 [95% CI, 1.02–1.26] per 10,000) but not for other birth cohorts, and was suggestive for men with ⩾10 years of residential duration (HR, 1.11 [95% CI, 0.98–1.26]). We found no consistent associations for women or other histologic subtypes.

Conclusions: UFP exposure was modestly associated with lung cancer overall, with stronger associations observed for adenocarcinoma of the lung.

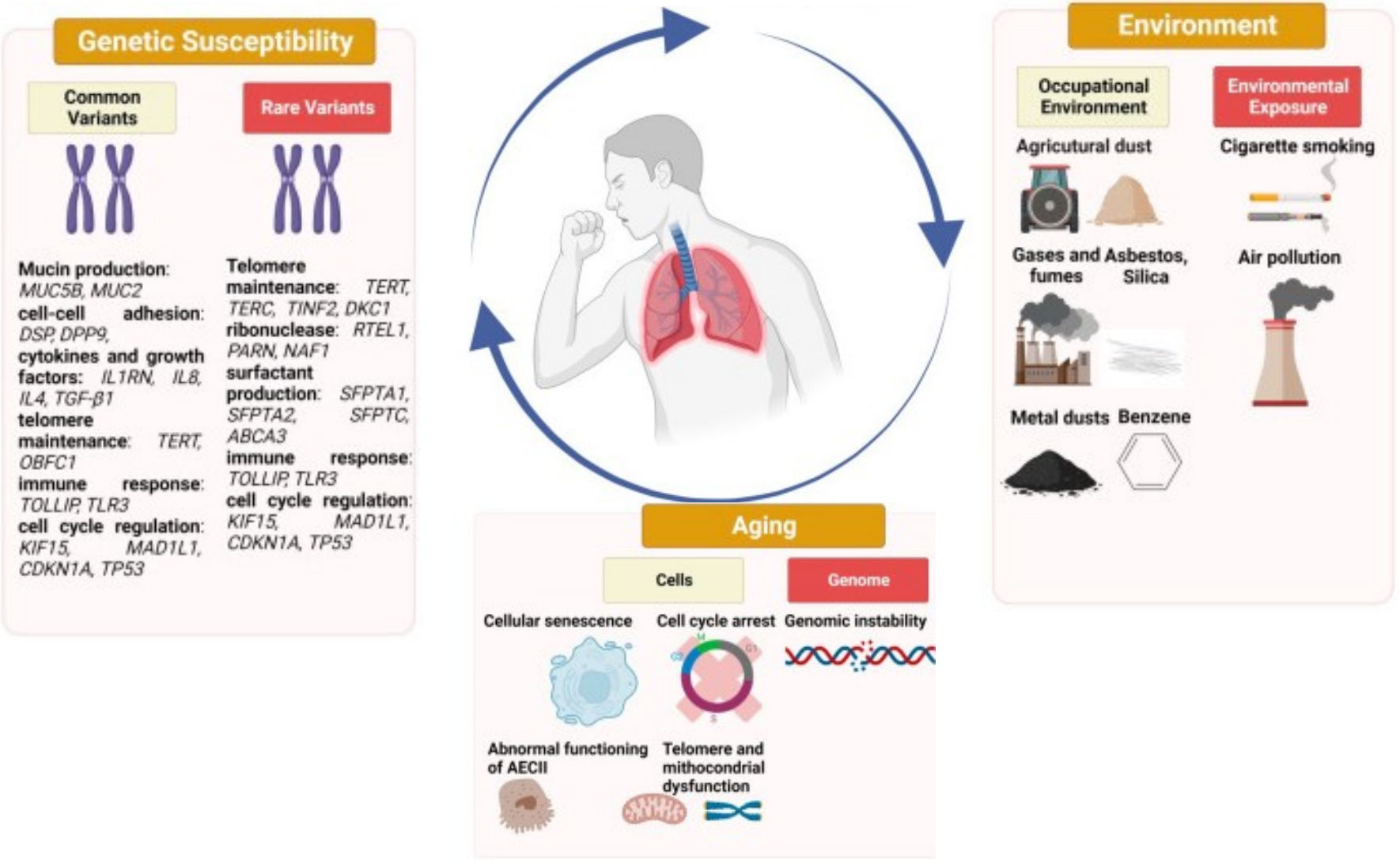
Outdoor Ultrafine Particulate Matter and Risk of Lung Cancer in Southern California

Rena R. Jones[1], Jared A. Fisher[1], Sina Hasheminassab[3*], Joel D. Kaufman[4], Neal D. Freedman[2], Mary H. Ward[1], Constantinos Sioutas[3], Roel Vermeulen[5,6], Gerard Hoek[5], and Debra T. Silverman[1]

Am J Respir Crit Care Med Vol 209, Iss 3, pp 307–315, Feb 1, 2024

Air Pollution Matters in IPF (1)

Environmental modifiers may play a key role



Gandhi S. et al., Int. J. Mol. Sci 2023

Does Polluted Air Shorten Survival in IPF?

Air Pollution and Survival-Related Outcomes

Outcome	Key evidence	Reference
Mortality	↑ NO_2 → ↑ mortality (especially in elderly males)	Yoon et al., *Eur Respir J*, 2021
Composite endpoints	IPF-PRO Registry: pollution was associated with worse quality of life and lung function at enrollment, but not with progression or mortality.	Sack et al., *Ann Am Thorac Soc.*, 2025
Acute exacerbations and hospitalization	$PM_{2.5}$ is associated with risk of AE-IPF. O_3, NO_X, and PM_{10} are linked to higher hospitalization rates.	Lan et al., *Front Med*, 2023; Mariscal-Aguilar et al., *Front Public Health*, 2024