

POLLUTION & PATHOLOGIES RESPIRATOIRES

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SERVICE DE PNEUMOLOGIE ET USIR

CHU AMIENS

POLLUANTS ATMOSPHÉRIQUES

- **Les matières particulaires (PM)** : indicateur indirect courant de la pollution de l'air.
- **L'ozone (O₃)** : un des principaux constituants du smog photochimique, formé lors de la réaction des gaz sous l'effet du rayonnement solaire.
- **Le dioxyde d'azote (NO₂)** : gaz libéré par les combustibles de l'industrie et des transports.

PubMed for PM_{2,5}

28,713 results

Corpus scientifique le plus important relatif à la pollution atmosphérique



“Furthermore, ever-expanding consumption puts strains on the environment.”

PARAMÈTRES TOXICITÉ PARTICULAIRE

1) TAILLE

- PM_{10} → $< 10 \mu m$: bronches et bronchioles
- $PM_{2,5}$ → $< 2,5 \mu m$: alvéoles
- PUF → $< 0,1 \mu m$: circulation sanguine

1) SURFACE

	10 μm (Coarse)	2.5 μm (Fine)	0.1 μm (Ultrafine)
Total mass	1	1	1
Particle number	1	64	1,000,000
Surface area per particle	1	0.0625	0.0001
Total surface area per mass	1	4	100
	<ul style="list-style-type: none"> • Filtered in proximal airway • May irritate skin, mucosa 	<ul style="list-style-type: none"> • Reaches peripheral airway • Cannot enter systemic circulation 	<ul style="list-style-type: none"> • Higher adsorbed toxic material on surface • May enter systemic circulation

↑ Surface d'adsorption avec ↓ diamètre particulaire

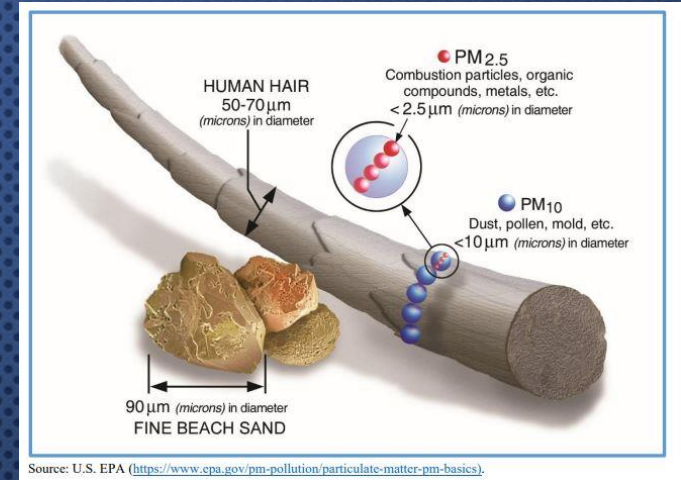
↑ Adsorption des hydrocarbures polycycliques

↑ Inflammation

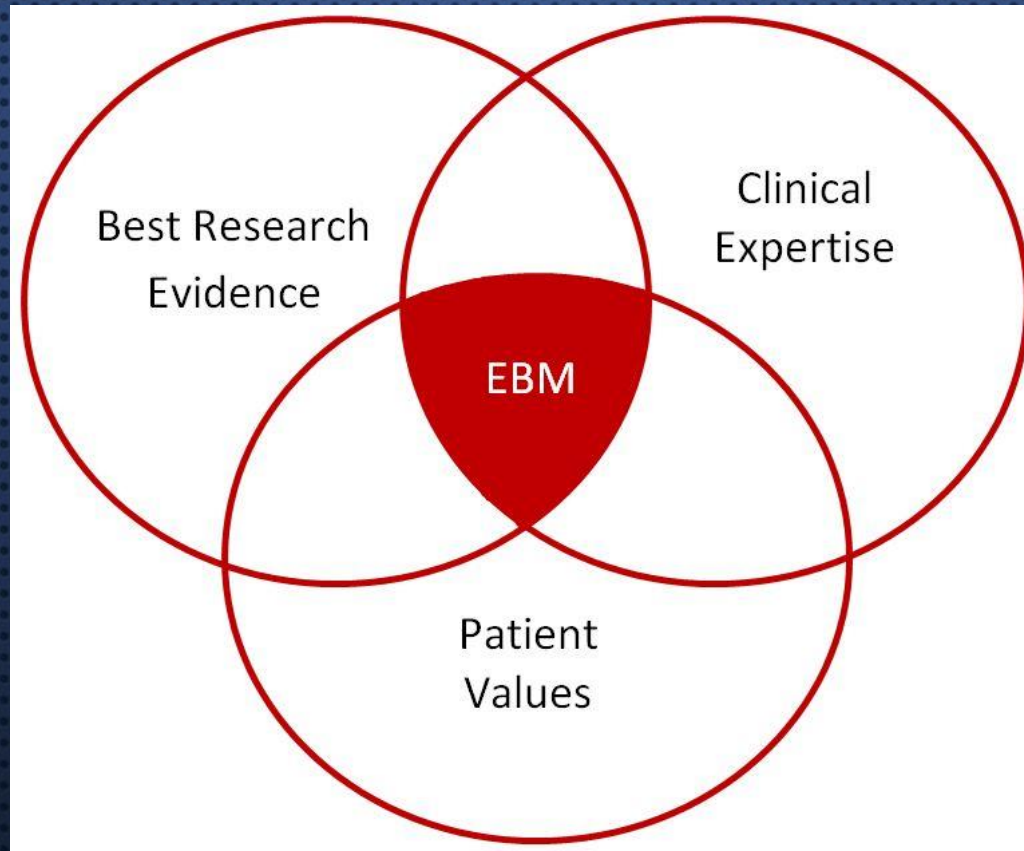
KWON HS et al. Exp Mol Med. 2020 Mar;52(3):318-328.

3) DUREE D'EXPOSITION

- Effets à long terme : études de cohortes
- Effets à court terme : études écologiques spatio-temporelles



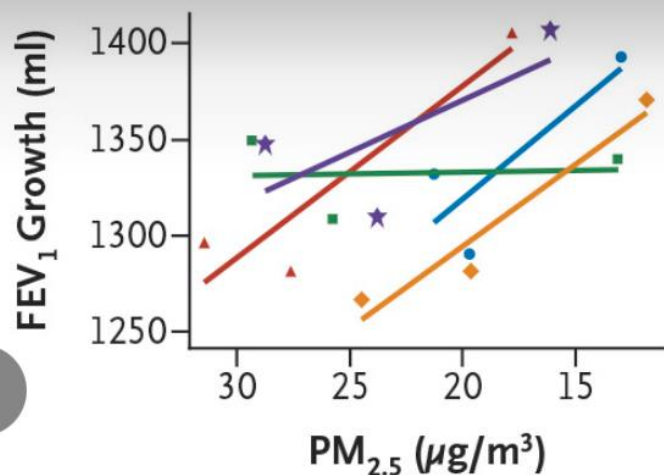
EVIDENCE BASED MEDICINE



ASTHME



The NEW ENGLAND
JOURNAL of MEDICINE



Gauderman W et al. N Engl J Med 2015;372:905-913

Lung-function development from 11 to 15 years of age in 2127 children (↑ asthma risk)

↑ FEV₁ and FVC with declining levels of nitrogen dioxide (P<0.00), PM_{2.5} (P= 0.008) and PM₁₀ (P<0.001)

Effets à long terme PM_{2.5} :

↑ incidence asthme chez l'enfant et l'adulte

Effets à court terme PM_{2.5} :

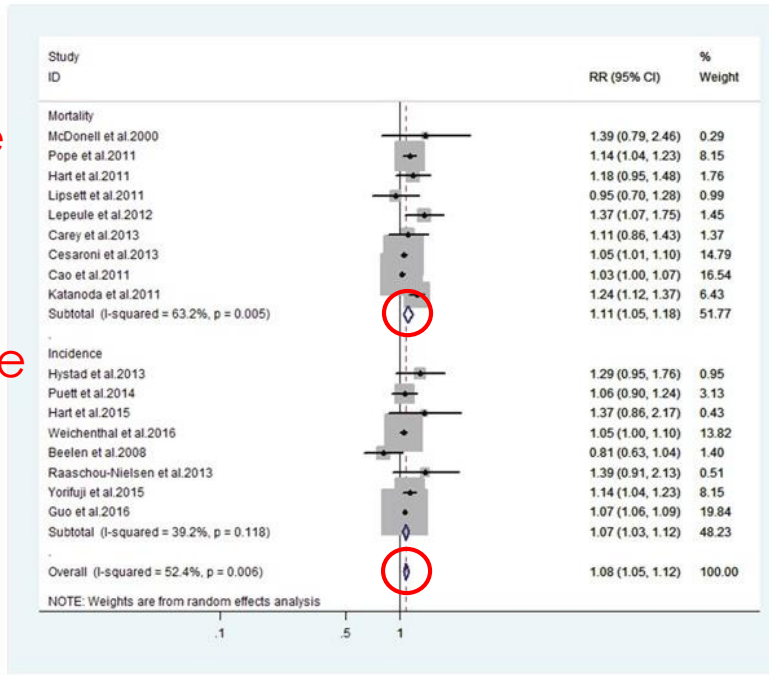
- ✓ ↑ exacerbation avec ↑ consultations en urgence et ↑ hospitalisations
- ✓ Relation linéaire sans seuil entre le taux PM_{2.5} et le risque d'hospitalisation
- ✓ ↑ 10% risque d'hospitalisation pour ↑ 10µg/m³ PM_{2.5}

CANCER BRONCHIQUE

Estimates of lung cancer risk associated a 10- $\mu\text{g}/\text{m}^3$ change in exposure to PM_{2.5}.

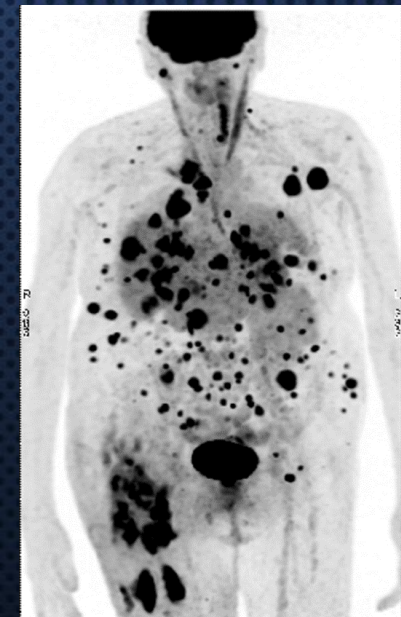
Mortalité

Incidence



Relative risks between \uparrow 10 $\mu\text{g}/\text{m}^3$ PM_{2.5} and lung cancer :

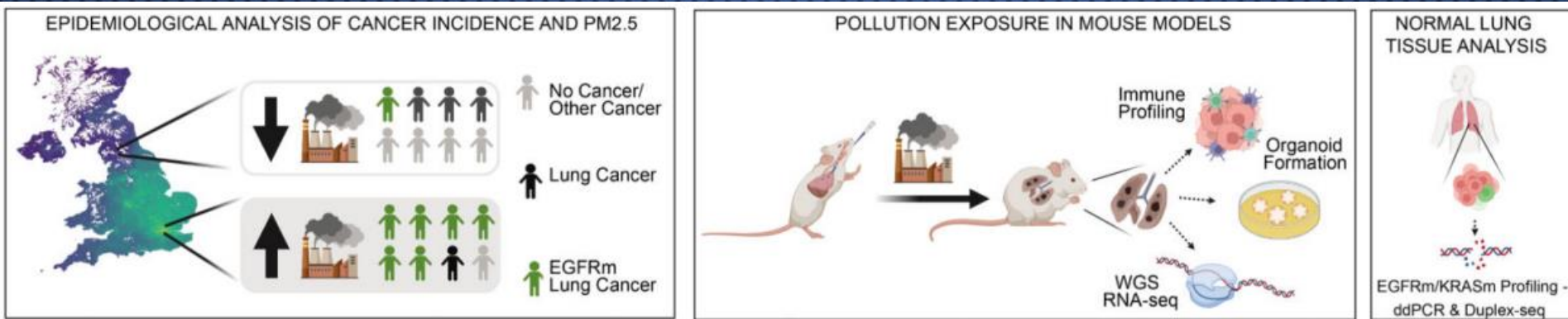
- Incidence : 1.08 (95% CI: 1.03, 1.12)
- Mortality : 1.11 (95% CI: 1.05, 1.18)
+++ current smokers



Feifei Huang et al. Oncotarget, 2017 Apr 21;8(26):43322–43331

HILL W ET AL.

NATURE. 2023 APRIL 01; 616(7955): 159–167.



- ✓ Significant association between PM_{2.5} levels and the incidence of lung cancer for 32,957 EGFR-driven lung cancer cases in four within-country cohorts.
- ✓ Mouse models : PM_{2.5} → influx of macrophages into the lung → release of interleukin-1 β → x EGFR mutant type II epithelial cells.
- ✓ Ultradeep mutational profiling of histologically normal lung tissue from 295 individuals across 3 clinical cohorts revealed oncogenic EGFR driver mutations in 18% of healthy tissue samples

Tumour-promoting role for PM_{2.5} air pollutants



BPCO



Doiron D et al. *Eur Resp J* 2019 54(1): 1802140.

UK Biobank data on 303 887 individuals aged 40–69 years

Higher exposures to each pollutant were significantly associated with lower lung function.

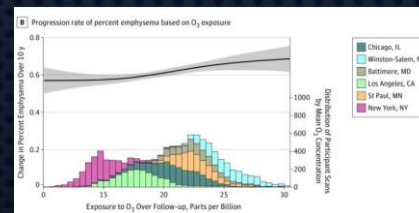
A $5 \mu\text{g} \cdot \text{m}^{-3}$ increase in $\text{PM}_{2.5}$ concentration was associated with lower FEV_1 (-83.13 mL , 95% CI -92.50 – -73.75 mL).

COPD prevalence was associated with higher concentrations of $\text{PM}_{2.5}$ (OR 1.52, 95% CI 1.42–1.62, per $5 \mu\text{g} \cdot \text{m}^{-3}$), PM_{10} (OR 1.08, 95% CI 1.00–1.16, per $5 \mu\text{g} \cdot \text{m}^{-3}$) and NO_2 (OR 1.12, 95% CI 1.10–1.14, per $10 \mu\text{g} \cdot \text{m}^{-3}$),

Wang M et al. *JAMA*. 2019 ; 13:322(6):546–556.

Cohort study (2000 / 2018): 5780 participants followed for a median of 10 years

Statistically significant association between baseline ambient concentrations of ambient ozone (O_3), fine particulate matter ($\text{PM}_{2.5}$), oxides of nitrogen (NO_2), and **black carbon** with greater increases in **emphysema** assessed quantitatively using computed tomographic (CT) imaging.



EXACERBATIONS BPCO : ÉTUDE POLLU-BPCO

RESEARCH

Open Access

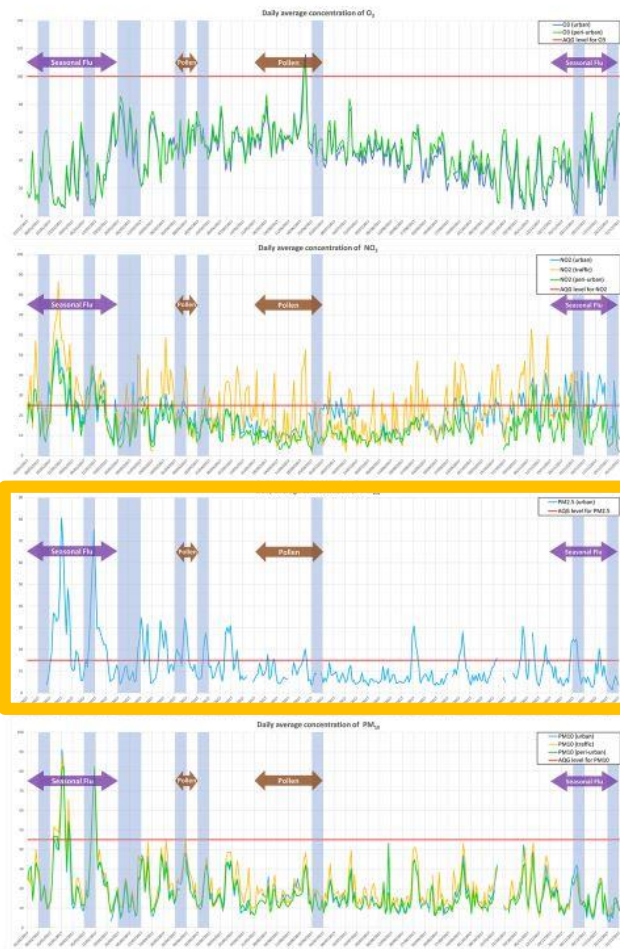
Basille et al. *Environmental Health* (2024) 23:107
<https://doi.org/10.1186/s12940-024-01146-3>

Association between acute exacerbation of chronic obstructive pulmonary disease and short-term exposure to ambient air pollutants in France



Environmental Health

Damien Basille^{1,2*}, Lola Soriot¹, Florence Weppe¹, Peggy Desmetres³, Paulo Henriques⁴, Nicolas Benoit⁵, Stéphanie Devaux¹, Momar Diouf⁶, Vincent Jounieux^{1,2} and Claire Andrejak^{1,2}



Two-center ecological cohort study conducted in Amiens, France

Measurements of nitrogen dioxide (NO₂), ozone (O₃) and particulate matter (PM_{2.5} and PM₁₀)

240 emergency room visits (9 peaks - > 6 ERV during 3 consecutive days) of among 168 COPD patients in 2017.

- **Significant positive correlation between the daily ERV for AECOPD and the daily average concentrations of PM_{2.5}**
(RR = 1.06 (95%CI = [1.00–1.11]), p = 0.049)

- No correlation with NO₂, O₃ or PM₁₀,

ÉTUDE POLLU-BPCO

RESEARCH

Open Access

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Mean annual exposure to outdoor air pollutants at the home address of the 58 subjects included in the modelling study

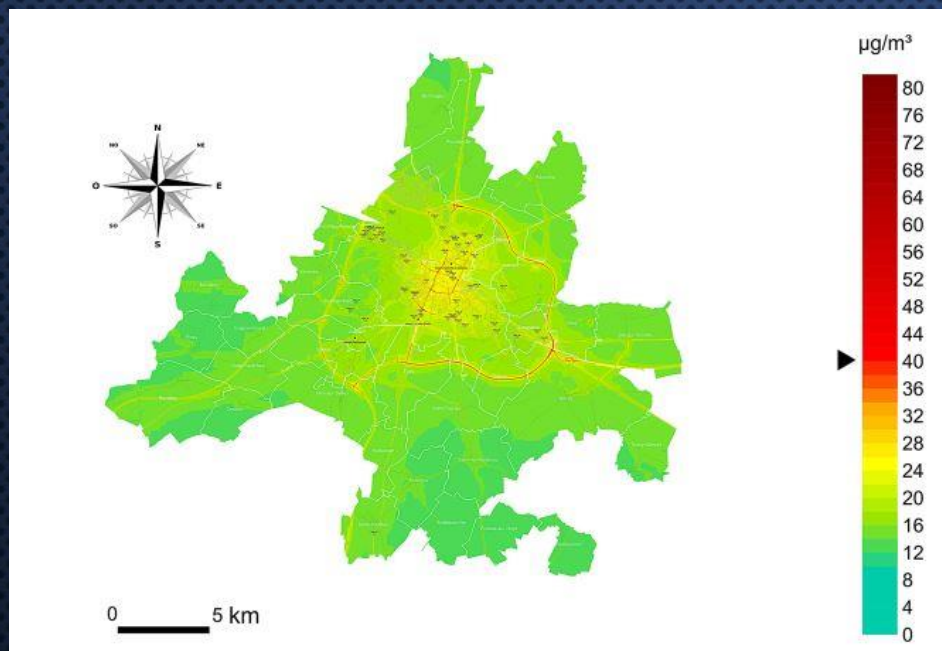
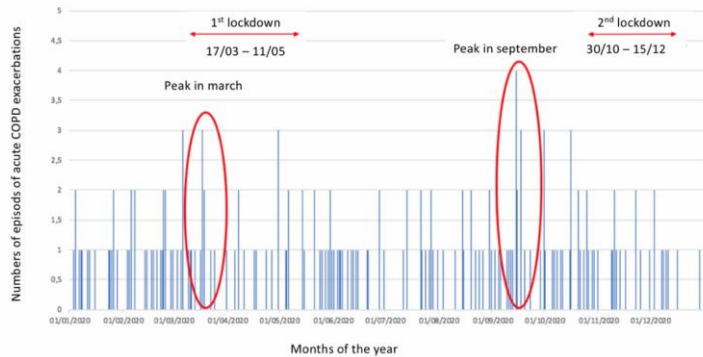


Table 3 Mean annual exposure to outdoor air pollutants at the home address of the 58 subjects included in the modeling study

	Mean annual concentration (µg/m ³)	2010 French quality objectives (µg/m ³)	2008 Euro-pean limits values (µg/m ³)	2021 Long-term AQG levels (µg/m ³)
PM ₁₀	20.2 ± 1.2 [18.8–23.2]	30	40	15
PM _{2.5}	13.2 ± 0.9 [12.1–15.4]	10	25	5
NO ₂	20.4 ± 2.7 [15.5–26.3]	40	40	10
O ₃	38.9 ± 3.1 [31.9–45.4]	120	120	60

Data are expressed as mean ± standard deviation [Min – Max]
 AQG: air quality guidelines

EXACERBATIONS BPCO : ÉTUDE BEPOPI



Two-center ecological cohort study conducted in Amiens, France

Measurements of nitrogen dioxide (NO_2), ozone (O_3) and particulate matter ($\text{PM}_{2.5}$ and PM_{10})

+ *ultra-fine particle (UFP), heavy metal (HV) and black carbon (BC) ($\epsilon \text{PM}_{2.5}$)*

180 emergency room visits (2 peaks) of among 110 COPD patients in 2020.



• **Significant positive correlation between the daily ERV for AECOPD and the daily manganese concentration (after adjustment on UFP, NO_2 , O_3 , BC, temperature, pollens and odours)**

(RR 1,2 IC95% [1,02-1,48] $p = 0,0342$)

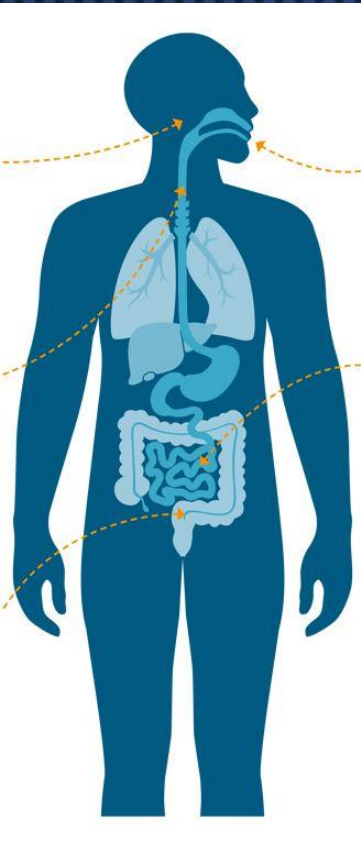
• No correlation with NO_2 , O_3 or PM_{10} , **$\text{PM}_{2.5}$**

EXACERBATIONS BPCO : ÉTUDE BEPOPI



	Période confinement (101 jours)	Période de non confinement (265 jours)	p
PM ₁₀	20,0 ± 9,0	13,0 ± 6,1	<0,001
PM _{2,5}	14,2 ± 7,8	8,1 ± 4,5	<0,001
NO ₂	12,8 ± 6,0	12,1 ± 6,1	NS
O ₃	42,6 ± 19,9	48,6 ± 16,5	NS
ERV	0,4 ± 0,7	0,5 ± 0,7	NS

AUTRES PATHOLOGIES



- ✓ **Pathologies cardio-vasculaires** (athérosclérose, maladie coronarienne, AVC, HTA, mortalité par cardiopathies ischémiques....)
- ✓ **Pathologies neurologiques** (troubles du neurodéveloppement, anxiété, dépression, démence, parkinson, alzheimer...)
- ✓ **Pathologies endocriniennes** (diabète de type II, syndrome métabolique, obésité...)
- ✓ **Pathologies de la grossesse** (fausses couches, prématurité, mortinatalité...)
- ✓ **Pathologies dermatologiques** (dermatite atopique, cancers...)
- ✓ **Pathologies cancéreuses** (cerveau, sein, peau, poumon, colon, vessie, leucémies, rein...)



Relation causale, linéaire, sans seuil, de la mortalité avec le taux $PM_{2.5}$

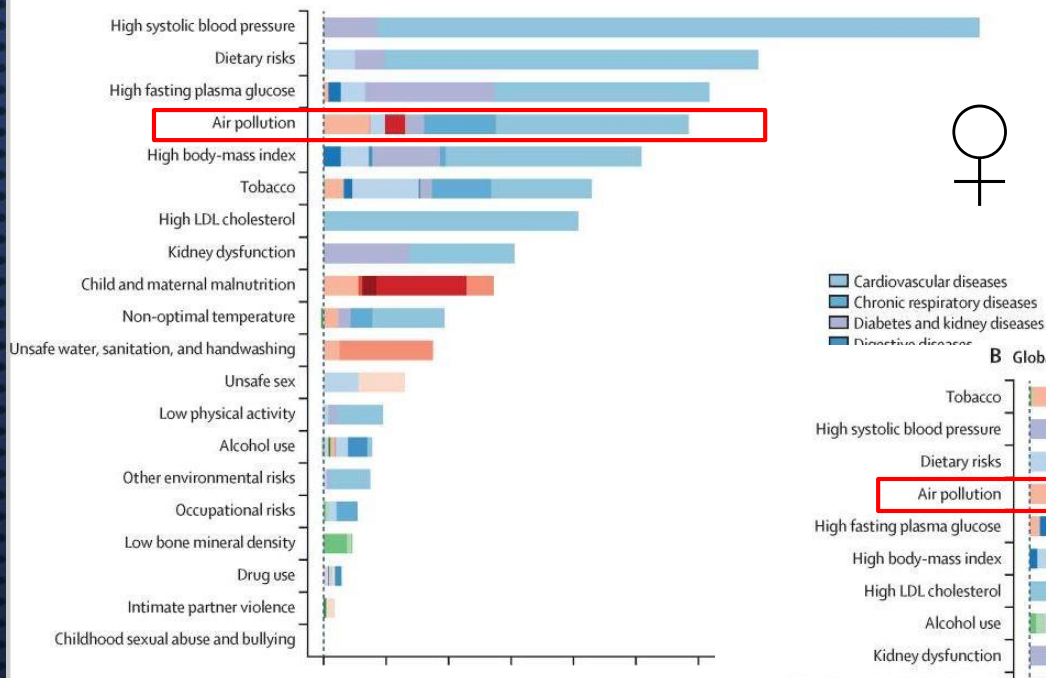
VALEURS RÉGLEMENTAIRES ET VALEURS RECOMMANDÉES...



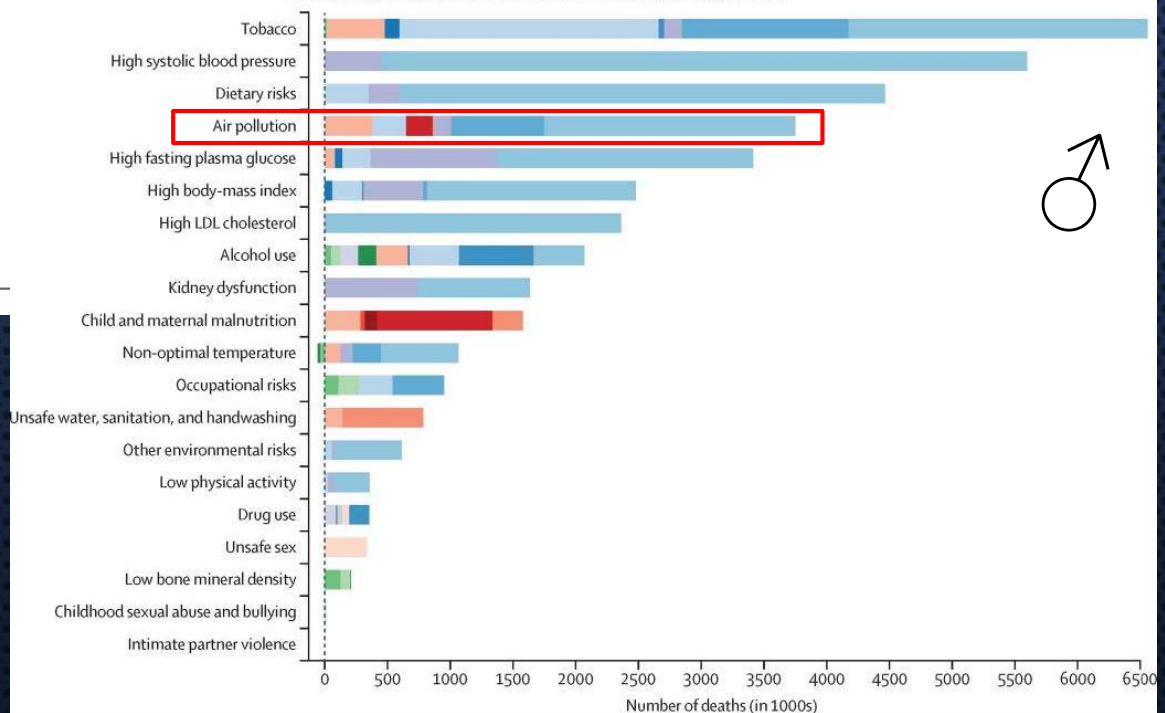
	Valeurs réglementaires actuelles	Valeurs réglementaires applicables au + tard en 2030	Recommandations OMS	
Dioxyde d'azote (NO ₂)	40 µg/m ³	20 µg/m ³	10 µg/m ³	x 4
Particules PM ₁₀	40 µg/m ³	20 µg/m ³	15 µg/m ³	x 3,75
Particules PM _{2,5}	25 µg/m ³	10 µg/m ³	5 µg/m ³	x 5
Ozone (O ₃)	120 µg/m ³ sur 8 heures à ne pas dépasser plus de 25 jours par an en moyenne sur 3 ans	120 µg/m ³ sur 8 heures à ne pas dépasser plus de 18 jours par an en moyenne sur 3 ans	100 µg/m ³ sur 8 heures à ne pas dépasser plus de 3 à 4 jours par an	x 1,2

RISQUE CLINIQUEMENT PERTINENT ?

A Global attributable deaths from Level 2 risk factors for females in 2019



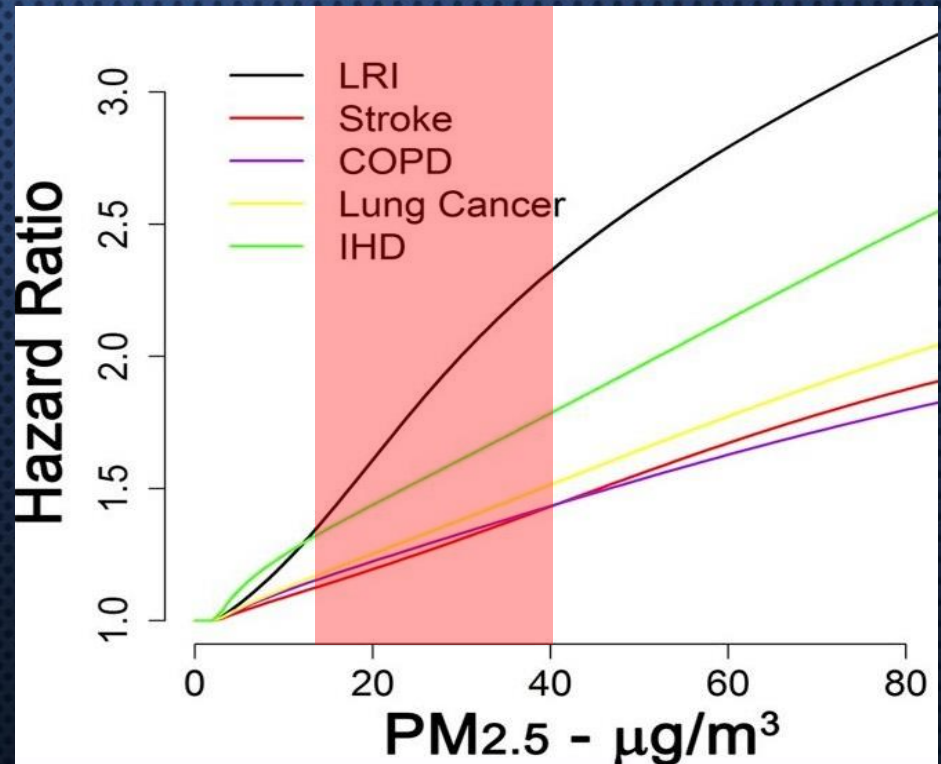
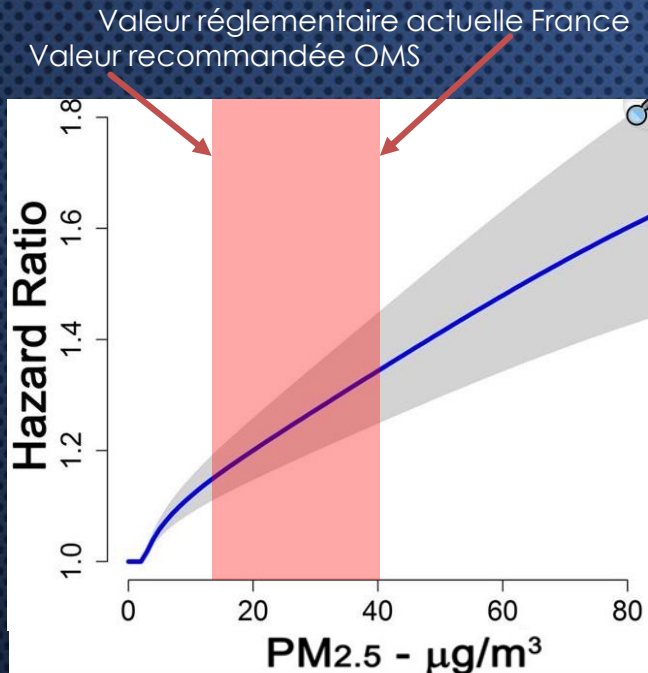
B Global attributable deaths from Level 2 risk factors for males in 2019



GBD 2019 Risk Factors Collaborators, Lancet. 2020; 396(10258):1223–1249.

IMPACT SUR L'ESPÉRANCE DE VIE

BURNETT R ET AL. PROC NATL ACAD SCI U S A. 2018 SEP 18;115(38):9592-9597.



1. Lower respiratory infections (LRIs)
2. Ischemic heart disease (IHD)
3. Lung cancer
4. Stroke
5. COPD

PROBLÈME DE SANTÉ PUBLIQUE

Monde :

4^e facteur de risque de mortalité

4,2 millions de décès prématurés /an (2019) dans les pays à revenus faibles ou intermédiaires

Europe :

300 000 décès/ an (European Environment Agency - 2021)

- ✓ PM : **238 000 décès**
- ✓ NO₂ : 49 000 décès
- ✓ O₃ : 24 000 décès

France :

± 50 500 décès/ an

- ✓ PM_{2,5} : **40 000 décès** (Santé Publique France-AMSE 2021)
- ✓ NO₂ : ± 8 000 décès
- ✓ O₃ : ± 2 500 décès



↑ **Significative de la mortalité toutes causes confondues**

CONCLUSIONS



LUTTE CONTRE LA POLLUTION ATMOSPHÉRIQUE : UNE DES INTERVENTIONS MÉDICALES LES PLUS EFFICACES DE CES 20, 30 DERNIÈRES ANNÉES...

PR ARDEN POPE, BRIGHAM YOUNG UNIVERSITY (UTAH) 2013

MERCI POUR VOTRE ATTENTION



RAPPORT SUR L'ÉCOLOGIE

