# Ambient air pollution and chronic airway diseases


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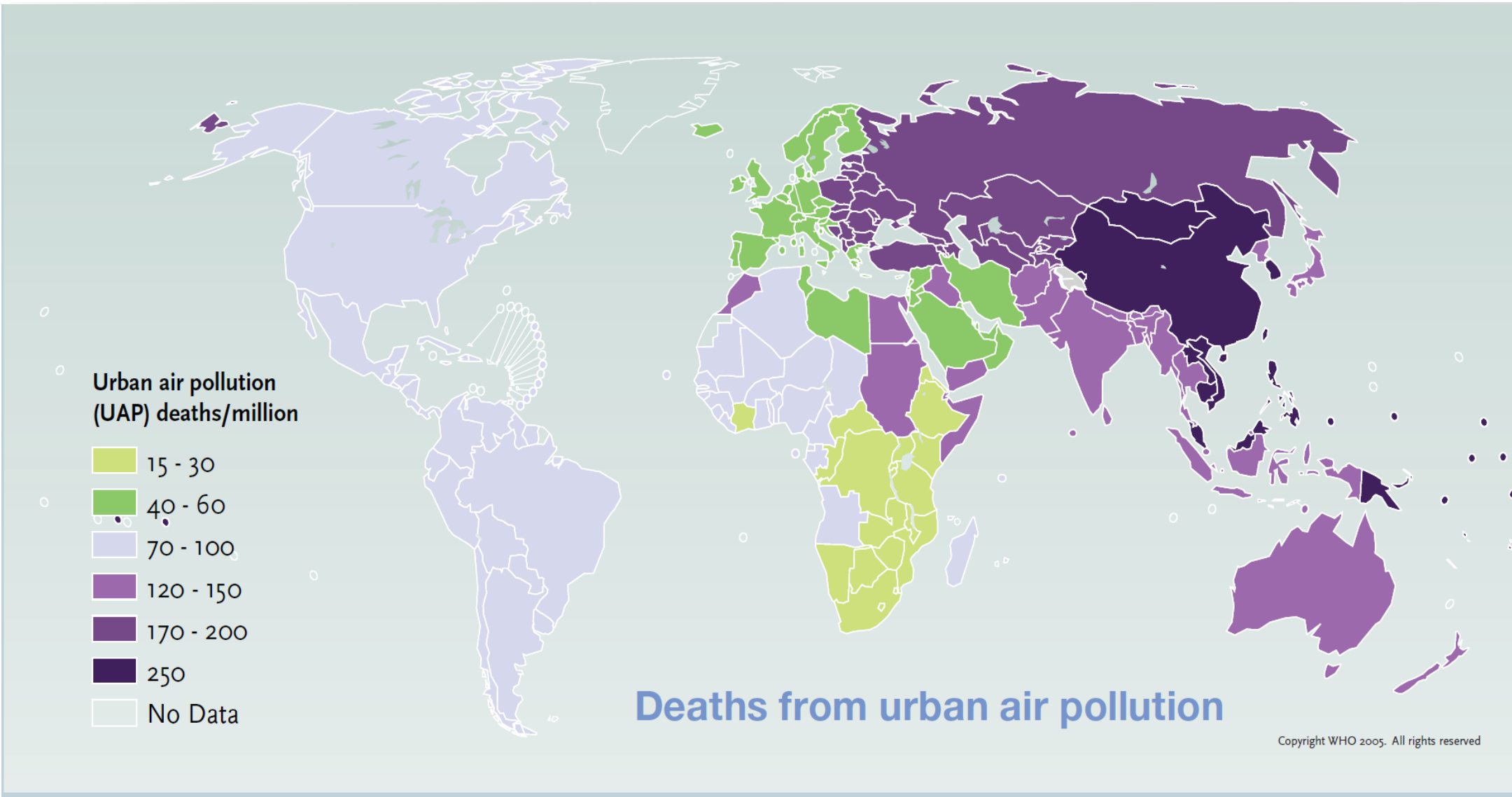
2019/06/23. 胸腔重症醫學會夏季會. 宜蘭

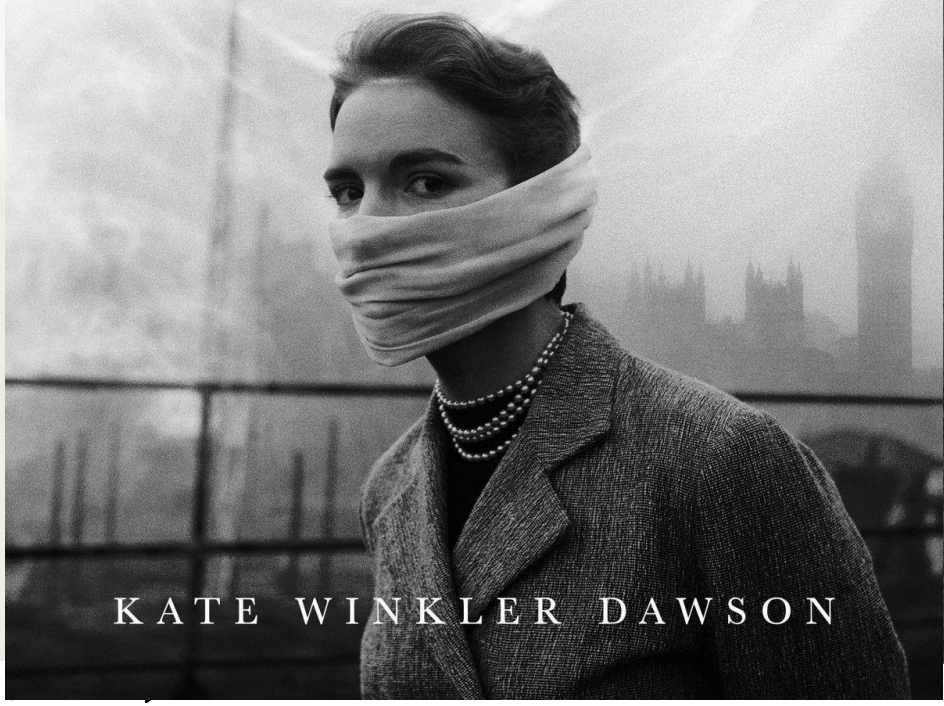

BEIJING'S
AIR POLLUTION

# Death From Urban air Pollution



# DEATH IN THE AIR

THE TRUE STORY OF A SERIAL KILLER,
THE GREAT LONDON SMOG,
AND THE STRANGLING OF A CITY



KATE WINKLER DAWSON

ETPM1310529 Hampstead Health, London, England: December 8, 1952. The great smog blanket - mixture of smoke and fog that is said to be costing £2,000,000 a day - thickened to what was described as the worst blackout of London for 25 years . This picture was taken by a pond on Hampstead Heath. ©TopFoto/ The Image Works NOTE: The copyright notice must include "The Image Works" DO NOT SHORTEN THE NAME OF THE COMPANY ©TopFoto/ The Image Works

Dr.

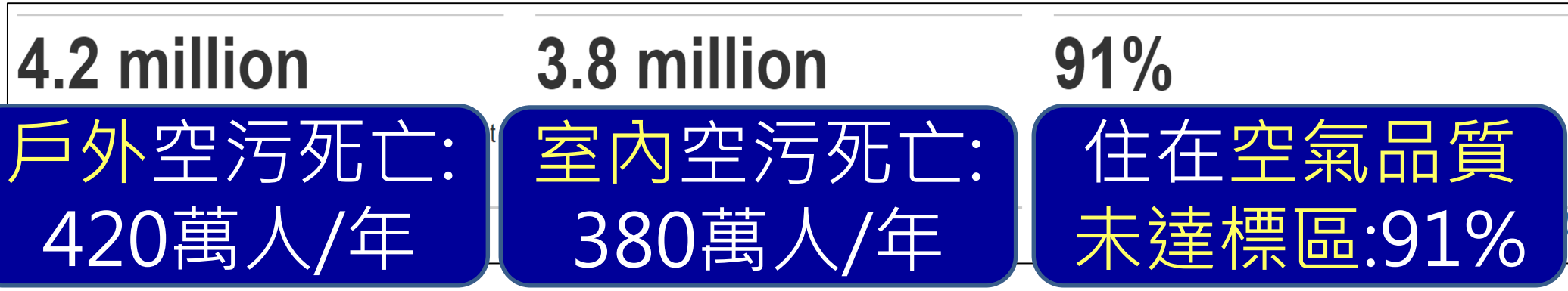
# 倫敦霧霾 London Smog, 1952

- **1952年12月5-9日嚴重空污事件**
- **死亡人數高達12000人。**
  - 直接死亡：4000人(支氣管炎704人，冠心病281人、心臟衰竭244人、結核病77人)。
  - 間接：8000人。2個月因呼吸道疾病(肺炎、肺癌、 流感)顯著增加
- **原因：**
  - 逆溫層籠罩，空氣不流通，時值冬季多使用**燃煤取暖**，產生**二氧化硫和粉塵污染**，且因逆溫層而污染物無法排散，蓄積於倫敦市。

World Health Organization

# 從公共衛生、全球視角
# 看環境與健康衝擊

**https://www.who.int/airpollution/en/**



# Health and Environment Linkages Initiative (HELI) 健康與環境鏈結倡議

- HELI is a ***global effort*** by WHO and UNEP to support action by developing ***country policymakers*** on ***environmental threats*** to health.

**25%** 全球疾病衝擊

環境風險

**35%** 南撒哈拉非洲

World Health Organization

http://www.who.int/heli/en/

# The aim and scope of the Health and Environment Linkages Initiative (HELI)

- **HELI aims to ensure that *environment and health considerations* are given their *proper weight* in decisions, particularly in the context of economic development.**

確保環境與健康在經濟發展中的適當角色

World Health Organization

The WHO/UNEP Health and Environment Linkages Initiative
ISBN 978 92 4 156372 7 (NLM classifi cation: WA 30.5)

# The aim and scope of the Health and Environment Linkages Initiative (HELI)

- **HELI addresses *targeted gaps* *in knowledge* and *tools* needed for more effective *integration of environment and health issues* into decision making**

凸顯環境與健康在政策制定考量中的不足

World Health Organization

The WHO/UNEP Health and Environment Linkages Initiative
ISBN 978 92 4 156372 7 (NLM classifi cation: WA 30.5)

# The aim and scope of the Health and Environment Linkages Initiative (HELI)

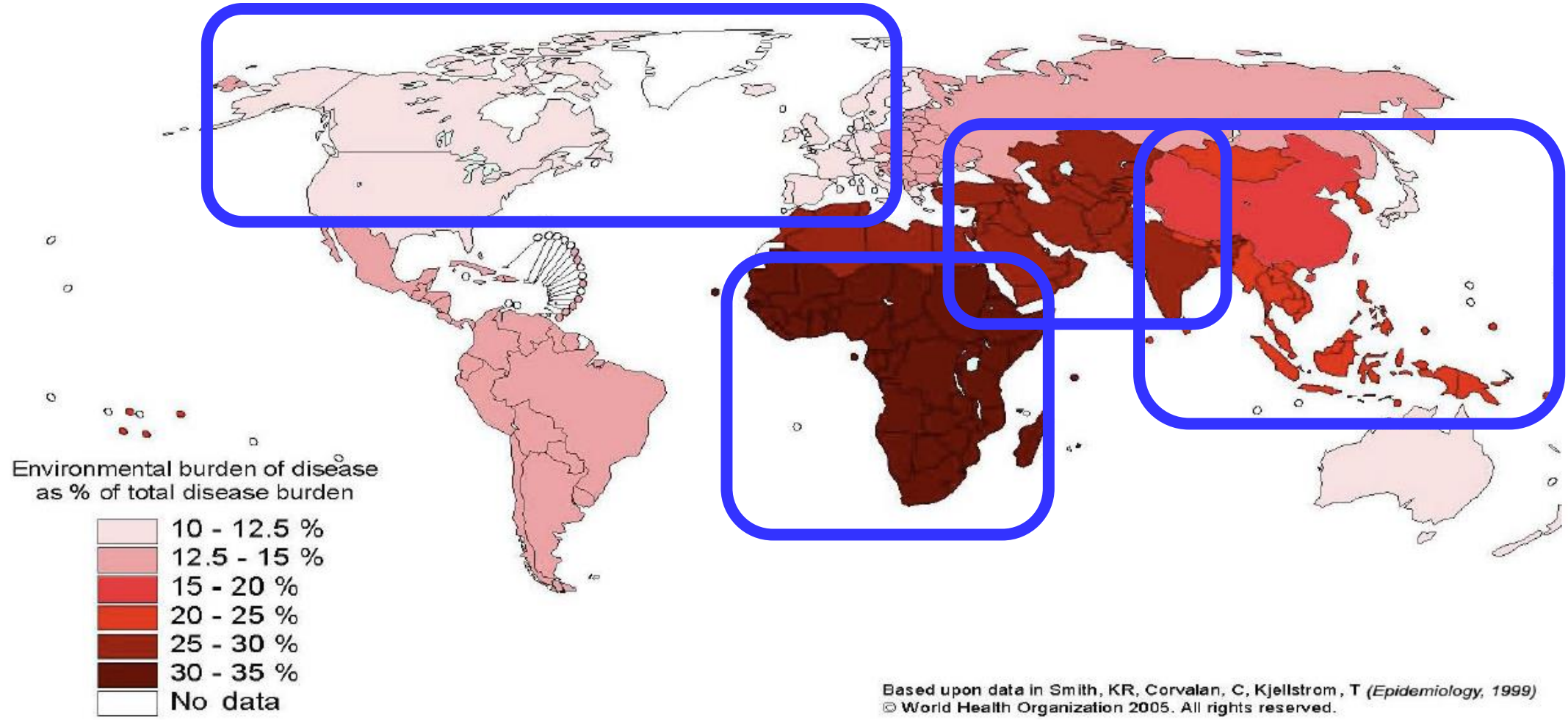
- **The initiative is designed primarily to *inform the decision-making process* rather than generate scientific knowledge.**

主要目的是在影響決策過程，而非發展科學知識

World Health Organization

The WHO/UNEP Health and Environment Linkages Initiative
ISBN 978 92 4 156372 7 (NLM classifi cation: WA 30.5)

# 全球環境污染對健康衝擊程度




*Epidemiology*, 1999, 10 (5): 573-84

# WHO: Environmental risks of disease for 192 countries

三種環境風險

不安全的水、
清潔與個人衛生

生質燃料所致
室內空氣汙染

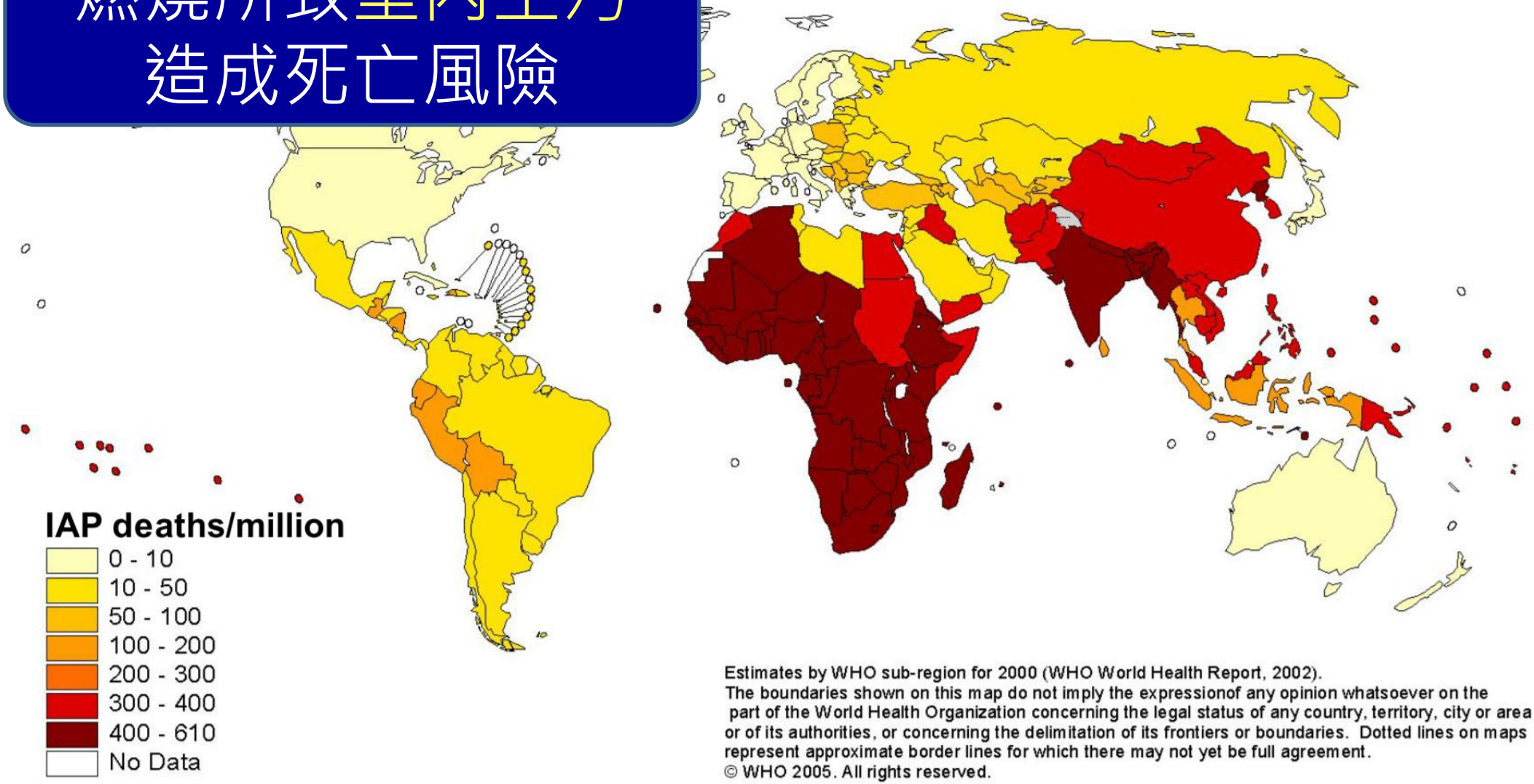
城市空氣汙染

World Health Organization

The WHO/UNEP Health and Environment Linkages Initiative
ISBN 978 92 4 156372 7 (NLM classifi cation: WA 30.5)

# Deaths from indoor smoke from solid fuels

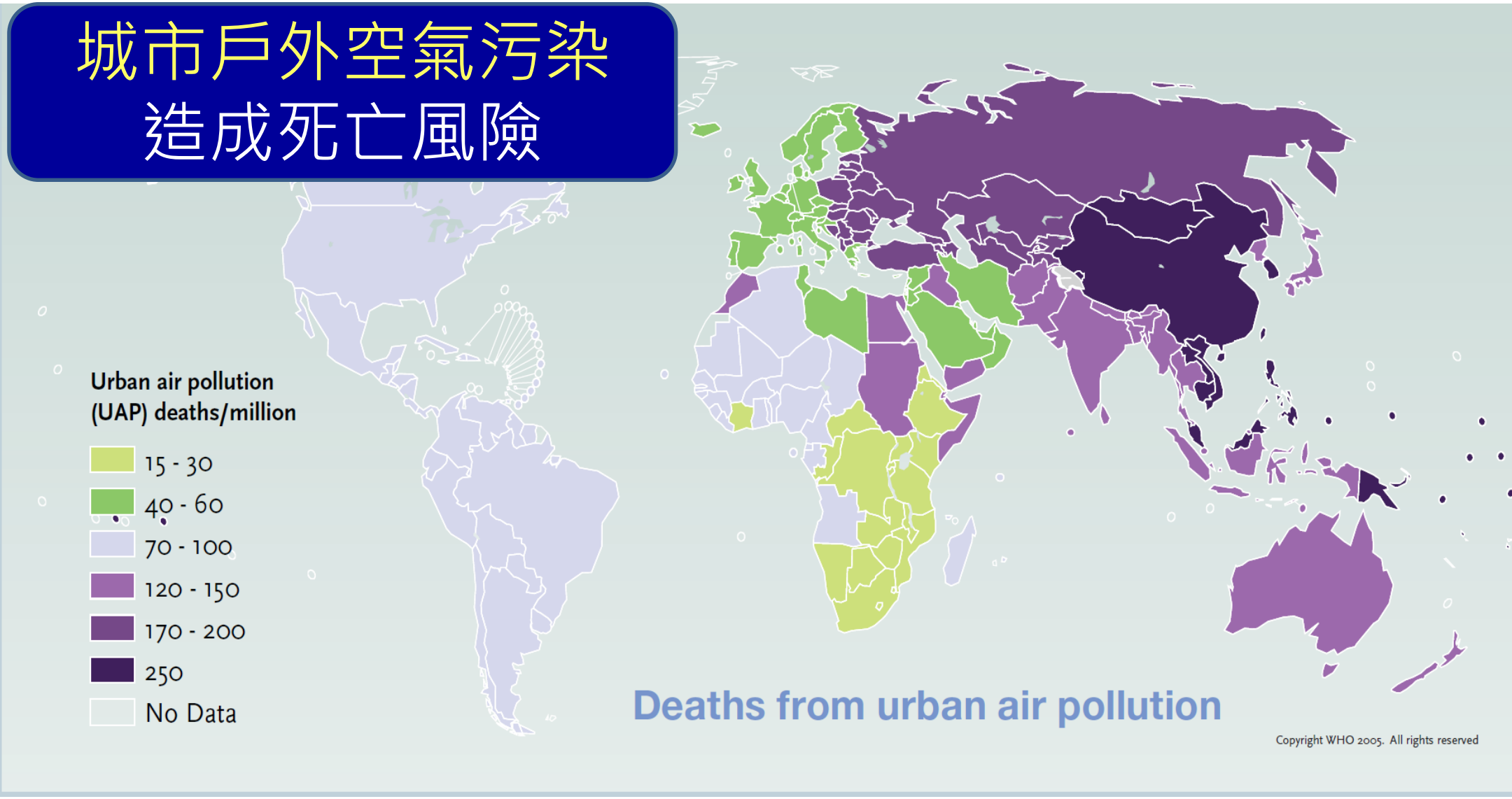
## 燃燒所致室內空污
## 造成死亡風險




Estimates by WHO sub-region for 2000 (WHO World Health Report, 2002).
The boundaries shown on this map do not imply the expressionof 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 lines on maps represent approximate border lines for which there may not yet be full agreement.

# Death From Urban air Pollution

## 城市戶外空氣污染
## 造成死亡風險



# WHO Global Ambient Air Quality Database (update 2018)

- **Air pollution** affects **all regions of the world**.
- Populations in **low-income cities** are the most impacted
  - **97%** of cities in **low- and middle- income** countries ***do not meet*** **WHO air quality guidelines**.
- However, in **high-income countries**, that percentage decreases to **49%**.

World Health Organization

https://www.who.int/airpollution/data/cities/en/

# AIR POLLUTION – THE SILENT KILLER

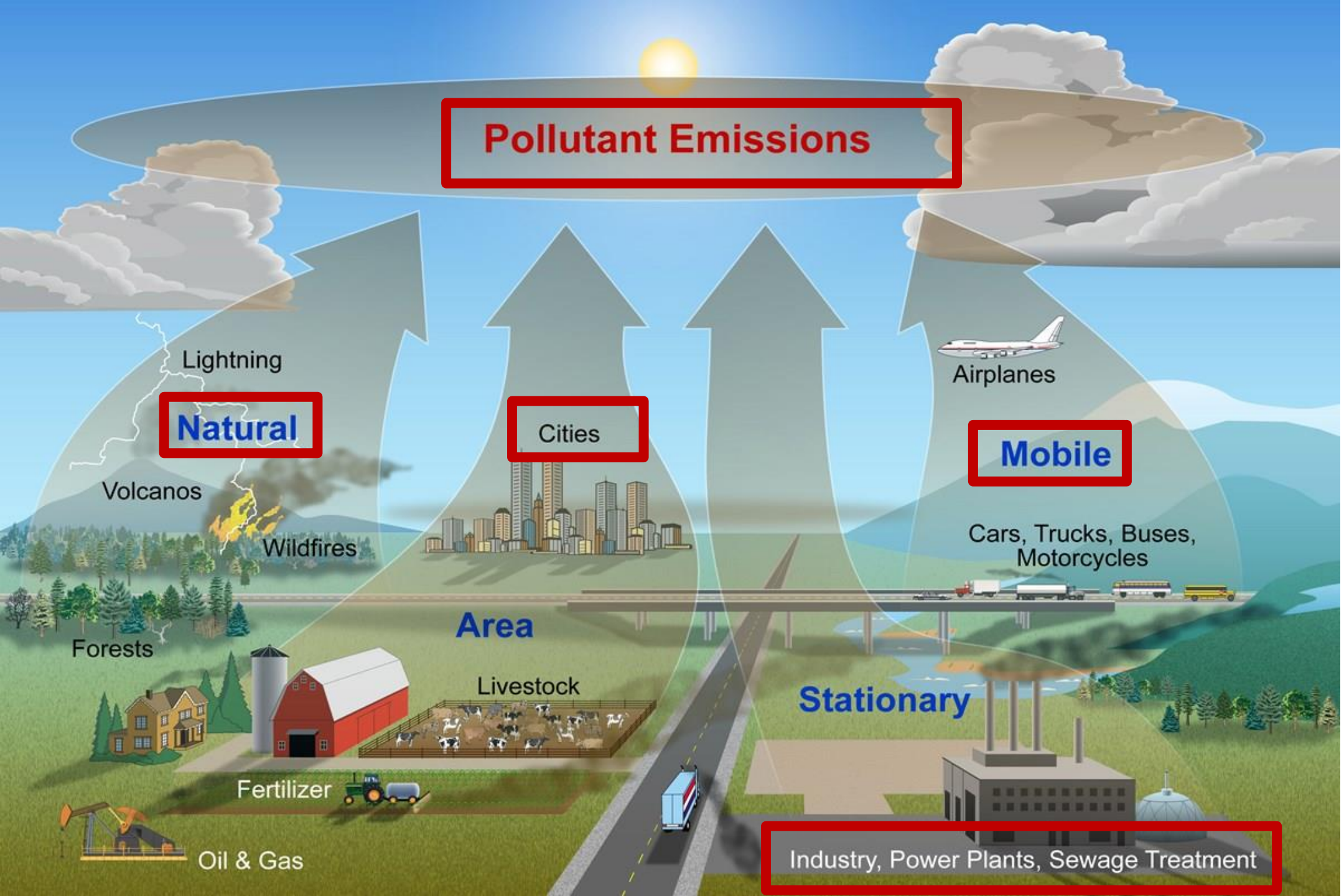
**REGIONAL ESTIMATES ACCORDING TO WHO REGIONAL GROUPINGS:**


**CLEAN AIR FOR HEALTH**

#AirPollution

World Health Organization

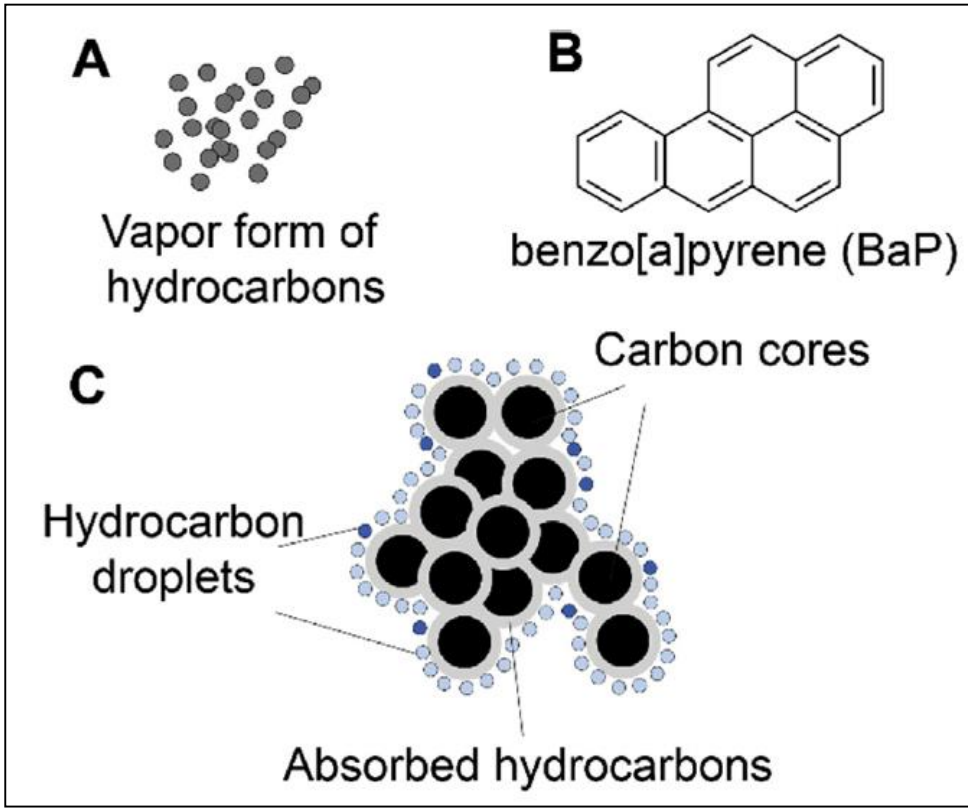
# 空氣污染物質: 初級與次級


Pollutant Emissions
Lightning
Natural
Volcanos
Wildfires
Forests
Cities
Airplanes
Mobile
Cars, Trucks, Buses, Motorcycles
Area
Livestock
Fertilizer
Stationary
Oil & Gas
Industry, Power Plants, Sewage Treatment

# 空氣污染物的分類

- **無機氣體**
  - Ozone ($O_3$)
  - CO
  - Sulfur dioxide ($SO_2$),
  - Nitrogen dioxide ($NO_x$)
- **有機氣體**
  - PAH
  - Monocyclic hydrocarbons
  - Benzene
- **懸浮顆粒(PM)**
  - Inner: carbon core

  Surface: organic pollutants and/or heavy metals ex. **DEP**




DEP: Diesel exhaust particle

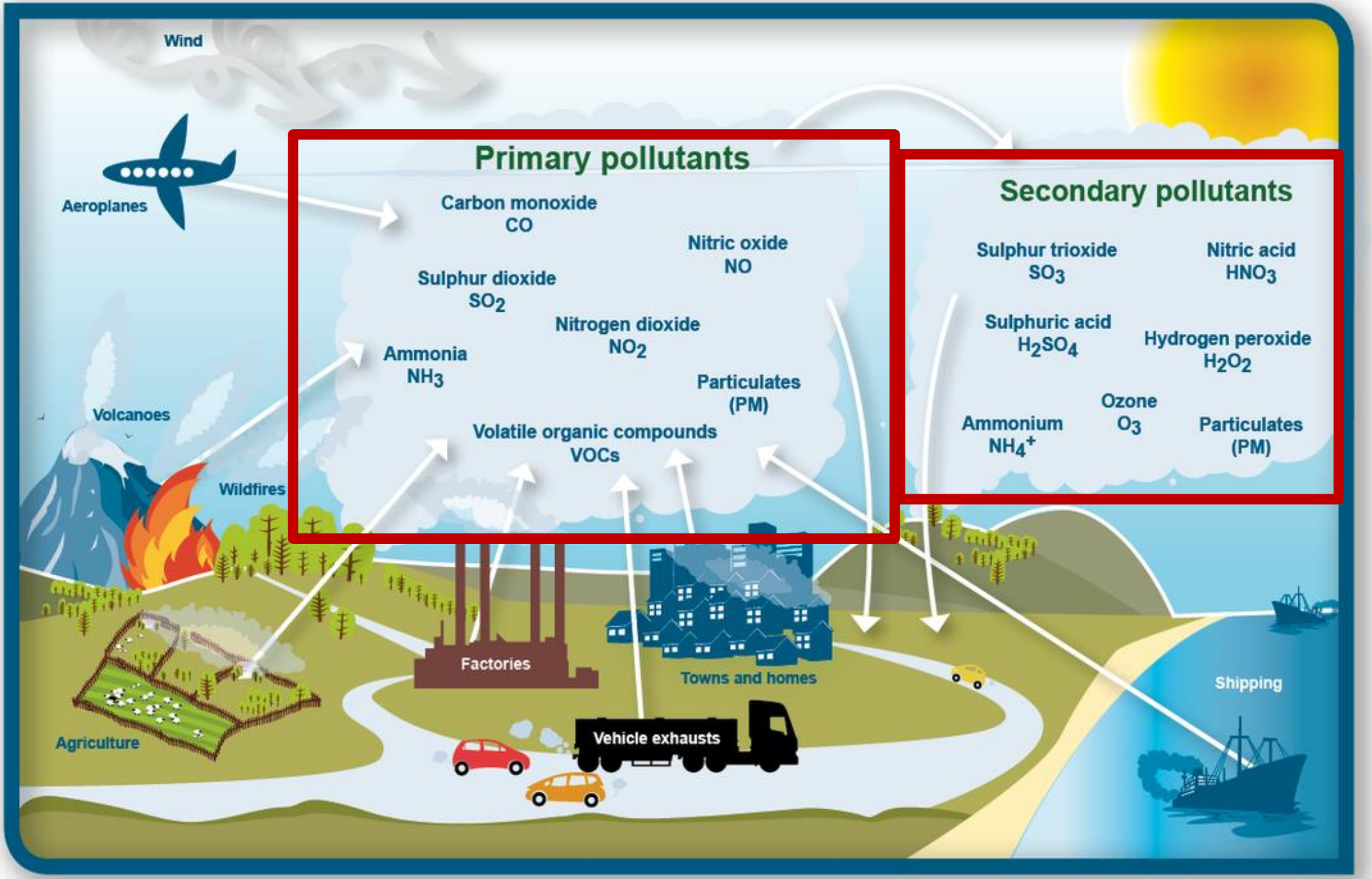
柴油引擎微粒

# 空氣污染物種類

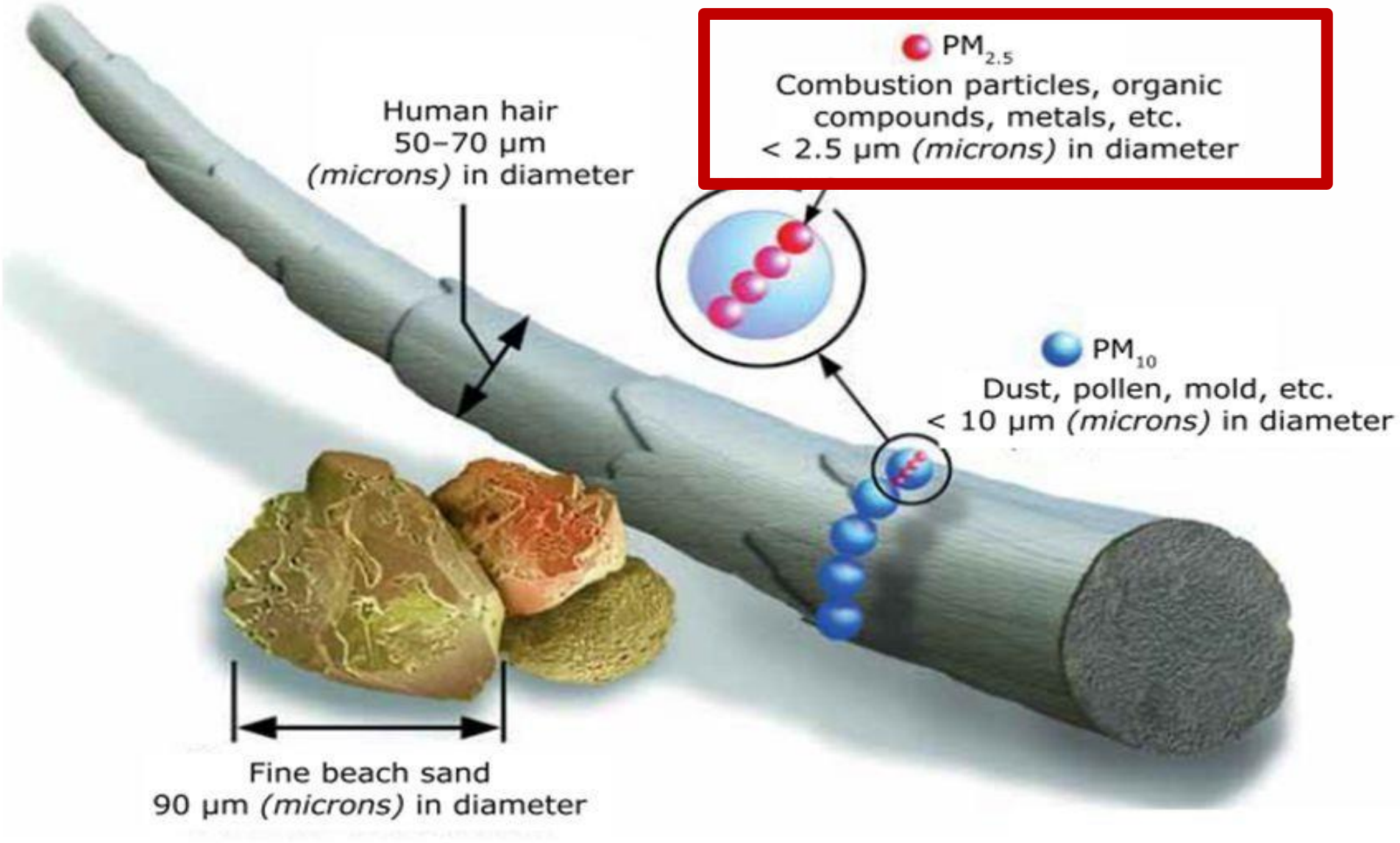
## 空氣污染防制法定義：

－「空氣中足以**直接或間接妨害健康或生活環境之物質**」

| 氣狀污染物 | 粒狀污染物 | 衍生性污染物 |
| --- | --- | --- |
| SOx、CO、Nox、CxHy、HCl、$CS_2$、CmHnXx、CFCs、VOCs | 酸霧、油煙、懸浮微粒、黑煙、總懸浮微粒、落塵金屬燻煙及其化合物 | 光化學霧及光化學性高氧化物($O_3$、PAN) |
| **毒性污染物** | **惡臭污染物** | **其他經中央主管機關指定公告之物質** |
| 氟化物、$Cl_2$、$NH_3$、$H_2S$、HCHO、含重金屬之氣體、VCM、 PCBs、HCN、Dioxins、致癌性多環芳香烴、致癌揮發性有機物、石綿及含石綿之物質 | 硫醇類<br>硫化甲基<br>甲基胺類 | 異味污染物、「二氧化碳、甲烷、氧化亞氮、氫氟碳化物、六氟化硫及全氟化碳等溫室氣體」 |


Wind
Aeroplanes
Primary pollutants
Carbon monoxide
CO
Nitric oxide
NO
Sulphur dioxide
$SO_2$
Nitrogen dioxide
$NO_2$
Ammonia
$NH_3$
Particulates
(PM)
Volatile organic compounds
VOCs
Secondary pollutants
Sulphur trioxide
$SO_3$
Nitric acid
$HNO_3$
Sulphuric acid
$H_2SO_4$
Hydrogen peroxide
$H_2O_2$
Ozone
$O_3$
Ammonium
$NH_4^+$
Particulates
(PM)
Volcanoes
Wildfires
Factories
Towns and homes
Shipping
Agriculture
Vehicle exhausts

# $PM_{10}$ and $PM_{2.5}$ particle size




EEA 2013

# 懸浮微粒($PM_{10}$)與細懸浮微粒($PM_{2.5}$)

$PM_{2.5}$已被世界衛生組織訂為一級致癌物，易附著汞、鉛、硫酸、苯、戴奧辛等致癌物深入氣管、支氣管，並且隨著血液到達人體的各種器官。

**粒徑<10μm**

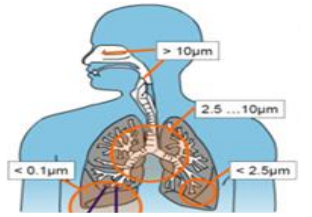
**懸浮微粒（$PM_{10}$）**

約為沙子直徑的1/10，容易通過鼻腔鼻毛與彎道到達喉嚨。

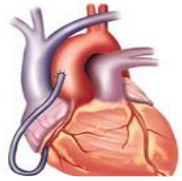
**粒徑<2.5μm**

**細懸浮微粒（$PM_{2.5}$）**

約頭髮直徑的1/28，可穿透肺部氣泡，直接進入血管中隨著血液循環全身。



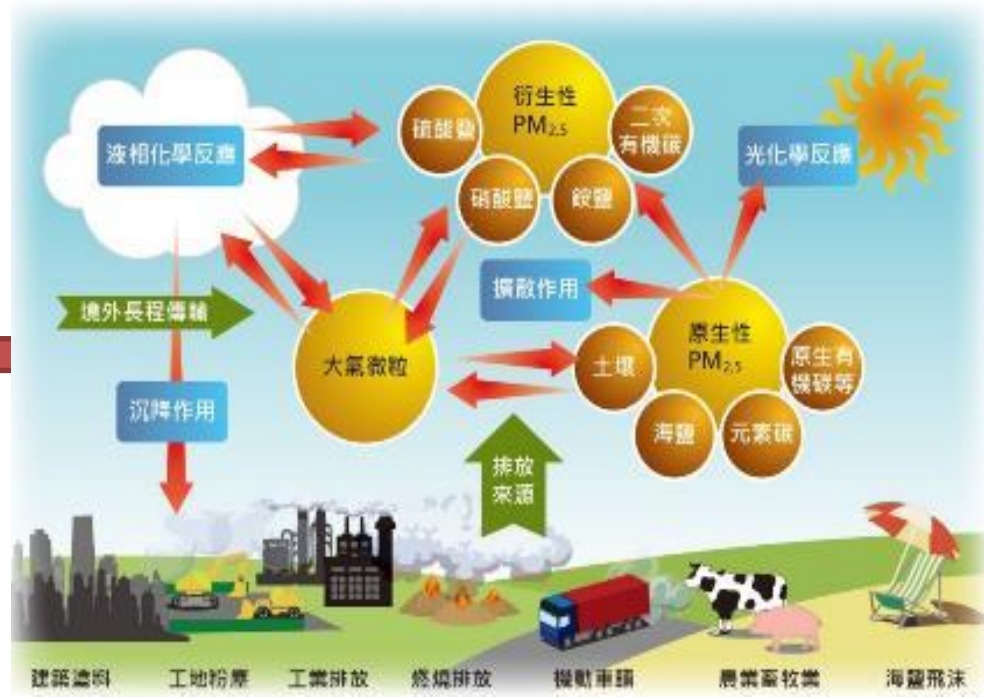

呼吸系統疾病



心血管疾病

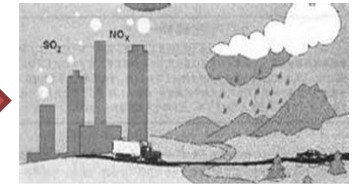
毒性反應及致癌

健康影響




環境影響

能見度

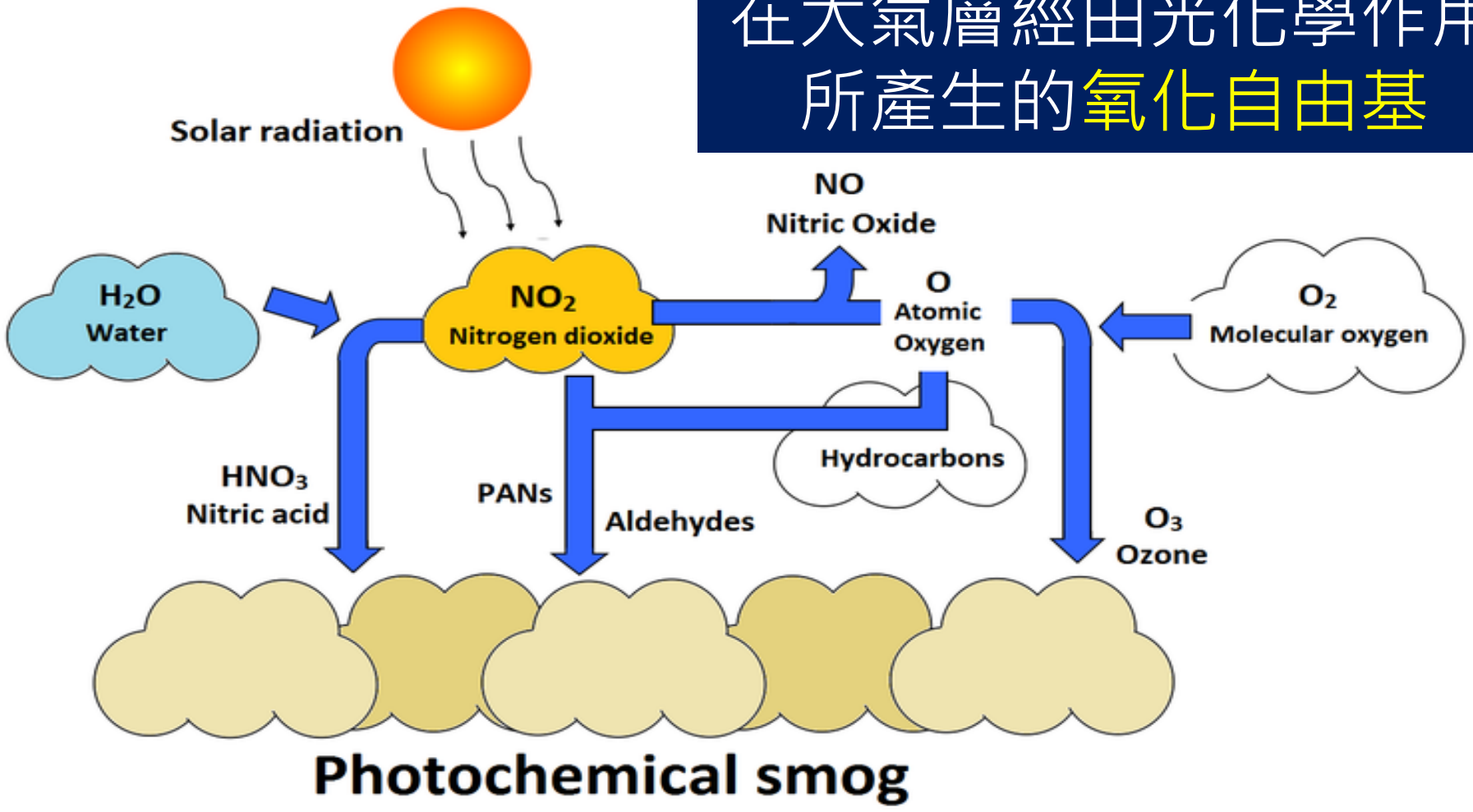



酸沉降及生態破壞

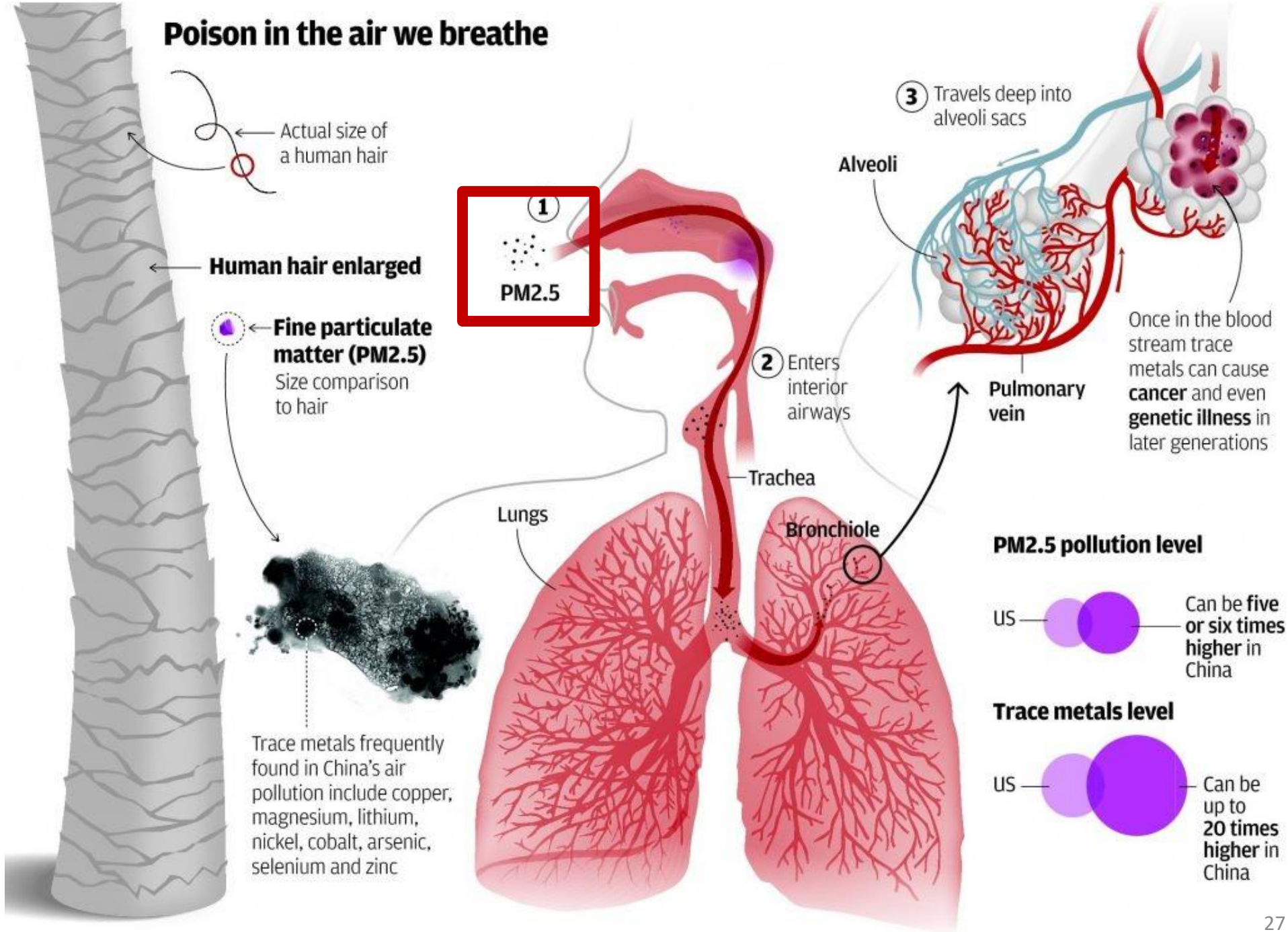
氣候變遷

# Secondary Air Pollutants

在大氣層經由光化學作用
所產生的氧化自由基



# 空氣污染對於健康衝擊




Environmental Protection Department, Greenpeace.

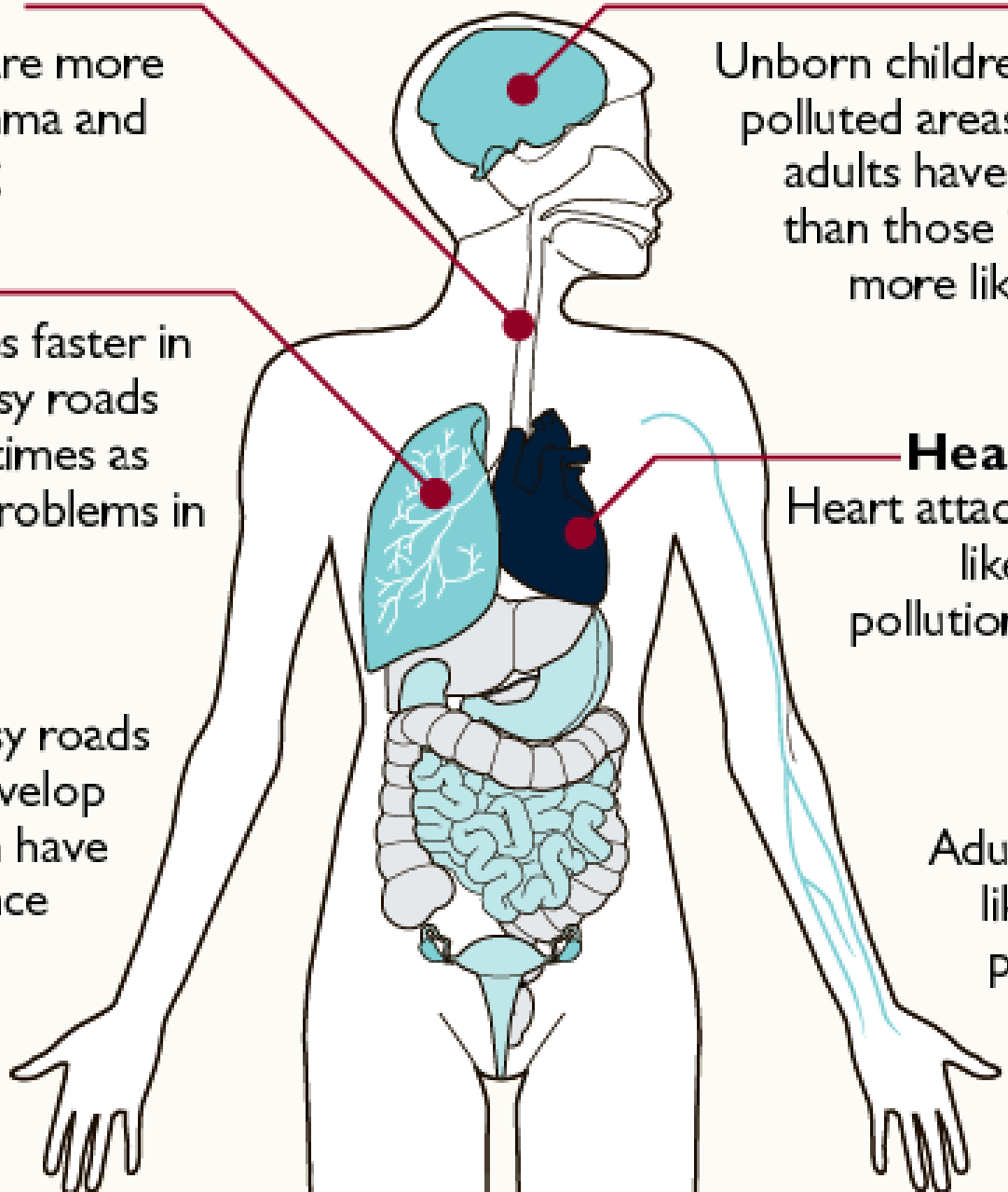
SCMP Graphic: Adolfo Arranz

# Toxic effects

**Asthma/airways**
Children and adults are more likely to develop asthma and suffer from wheezing

**Lungs**
Lung capacity declines faster in people living near busy roads while there are four times as many children with problems in polluted areas

**Diabetes**
Adults living near busy roads are more likely to develop diabetes and children have higher insulin resistance



**Brain**
Unborn children whose mothers live in polluted areas have smaller heads and adults have brains 2-3 years "older" than those in cleaner places and are more likely to develop dementia

**Heart and blood vessels**
Heart attacks and strokes are more likely in people exposed to pollution and even children have higher blood pressure

**Cancer**
Adults are 20 per cent more likely to get lung cancer in polluted area and there is limited evidence of an increased risk of leukaemia in children

Source: Royal College of Physicians

# DEATHS LINKED TO OUTDOOR AND HOUSEHOLD AIR POLLUTION

**7 million** people die prematurely every year from air pollution – both household and outdoor.

Among these deaths:

**21%** are Pneumonia

**20%** from stroke

Stroke

Ischemia Heart Disease

**34%** from ischaemic heart disease

**19%** from chr… obstructive pulmonary disease (COPD)

COPD

**7%** from lung cancer

Lung ca

CLEAN AIR FOR HEALTH #AirPollution

World Health Organization

Dr. …

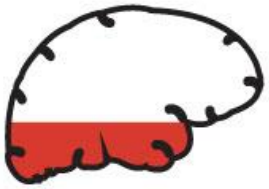
https://www.who.int/airpollution/data/cities/en/

THE
# INVISIBL

Air pollution may not always

**29%**

OF DEATHS FROM
**LUNG CANCER**



**24%**

OF DEATHS FROM
**STROKE**

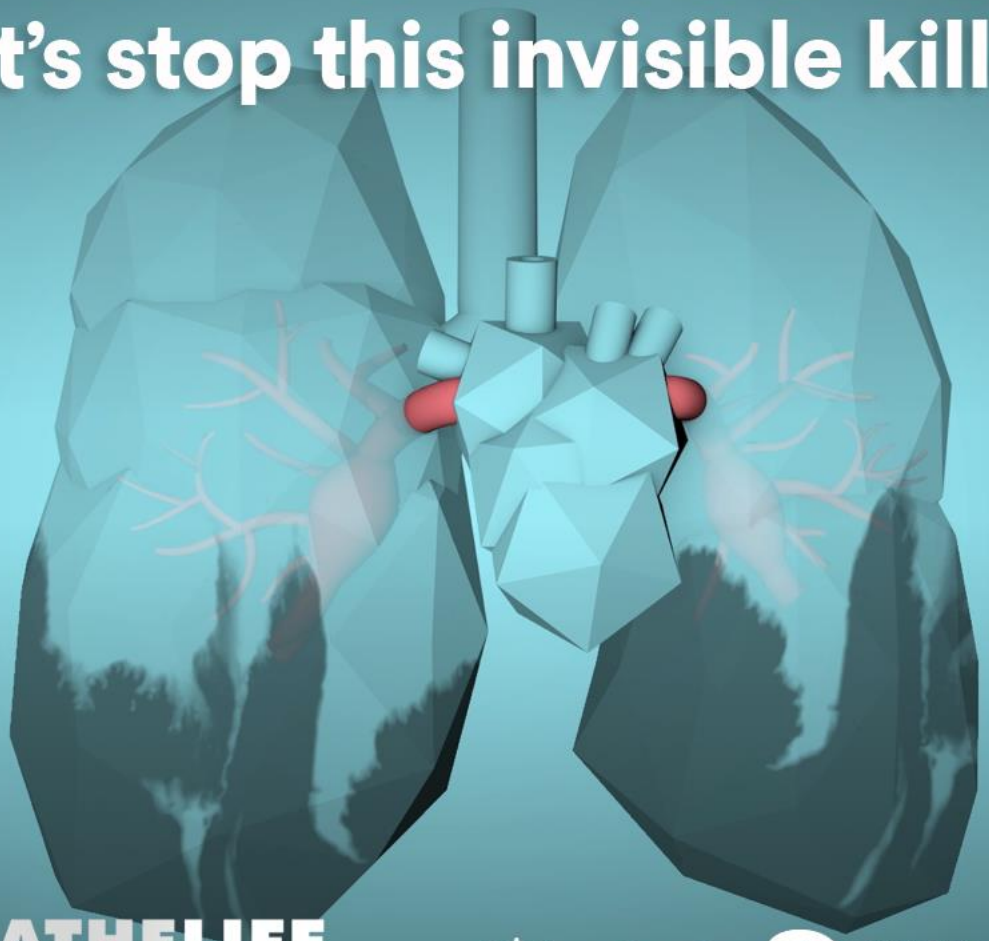
**BREATHELIFE.**
Clean Air. Healthy Future.

Dr. Pin-Kuei Fu

AIR POLLUTION'S YEARLY HIT LIST:

# 1.8 million deaths due to lung disease and cancer.

# Let's stop this invisible killer.



**BREATHELIFE**
Clean air. Healthy future.

World Health Organization

CLIMATE & CLEAN AIR COALITION
TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

UN environment

# 空污對肺部健康的影響

COPD

氣喘

肺炎

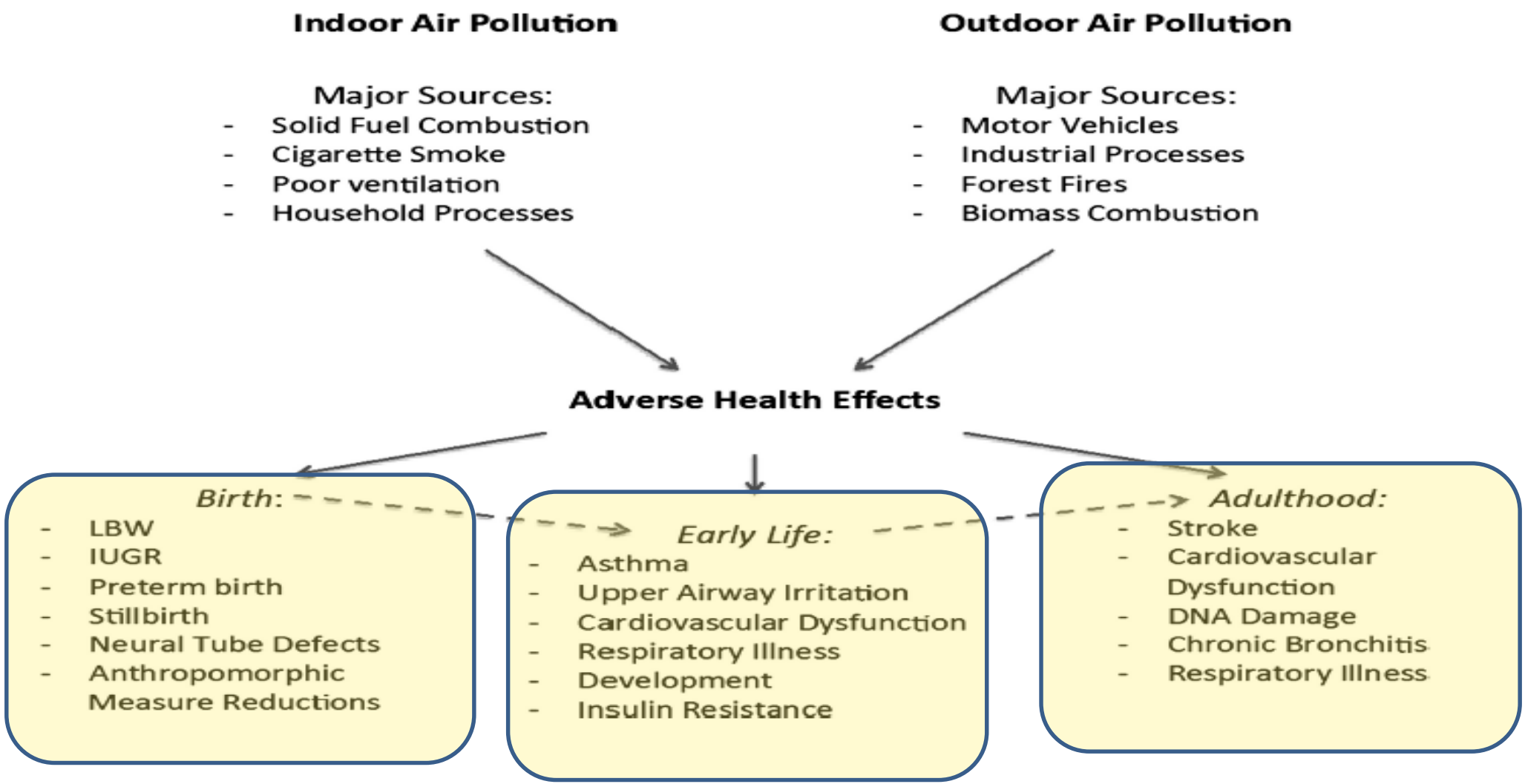
肺纖維化

呼吸道症狀

*Aust Fam Physician. 2015;44:546-52.*

# 空氣污染 & 兒童肺部健康衝擊

# Air pollution: complex triggers of disease

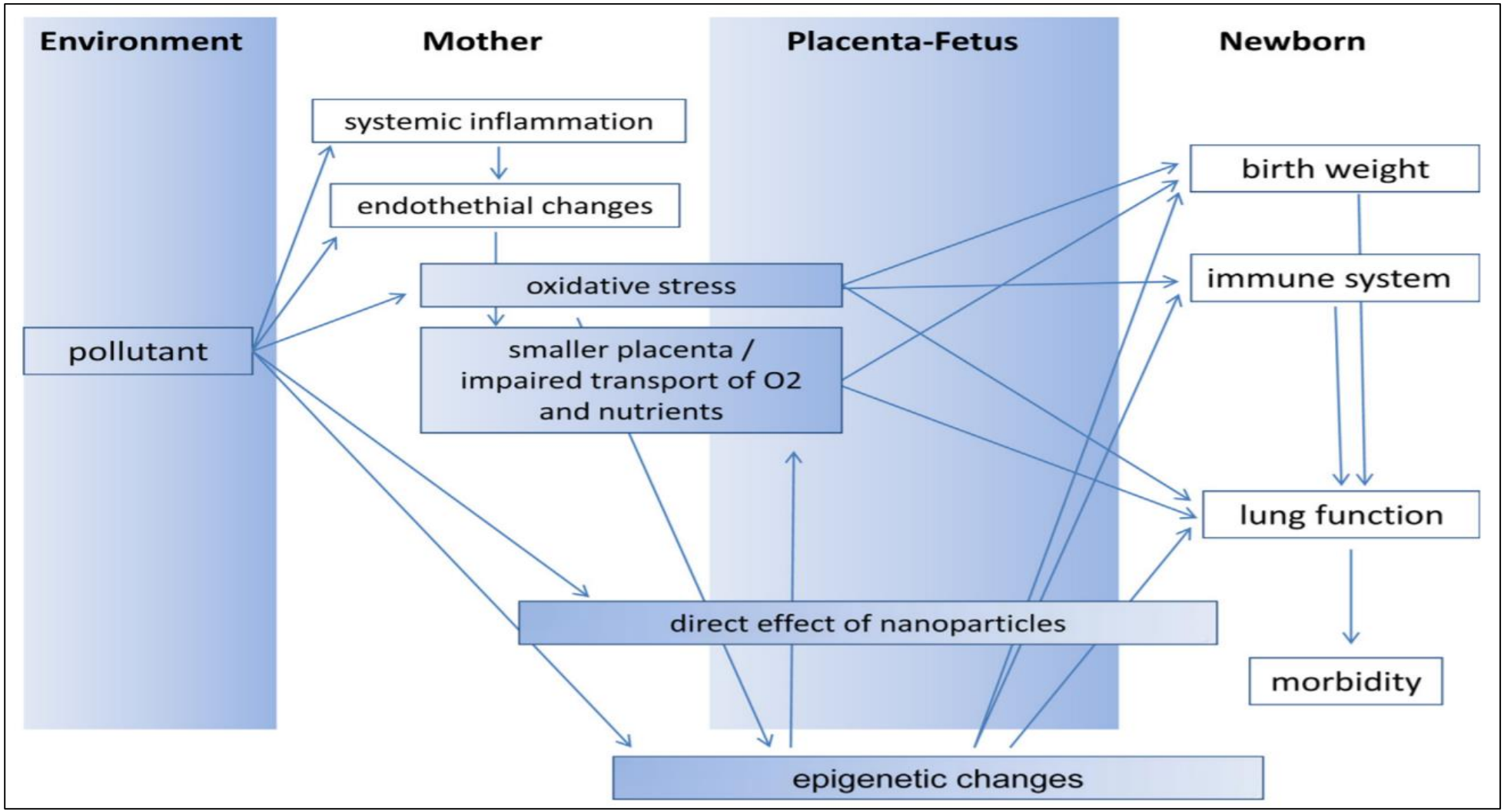






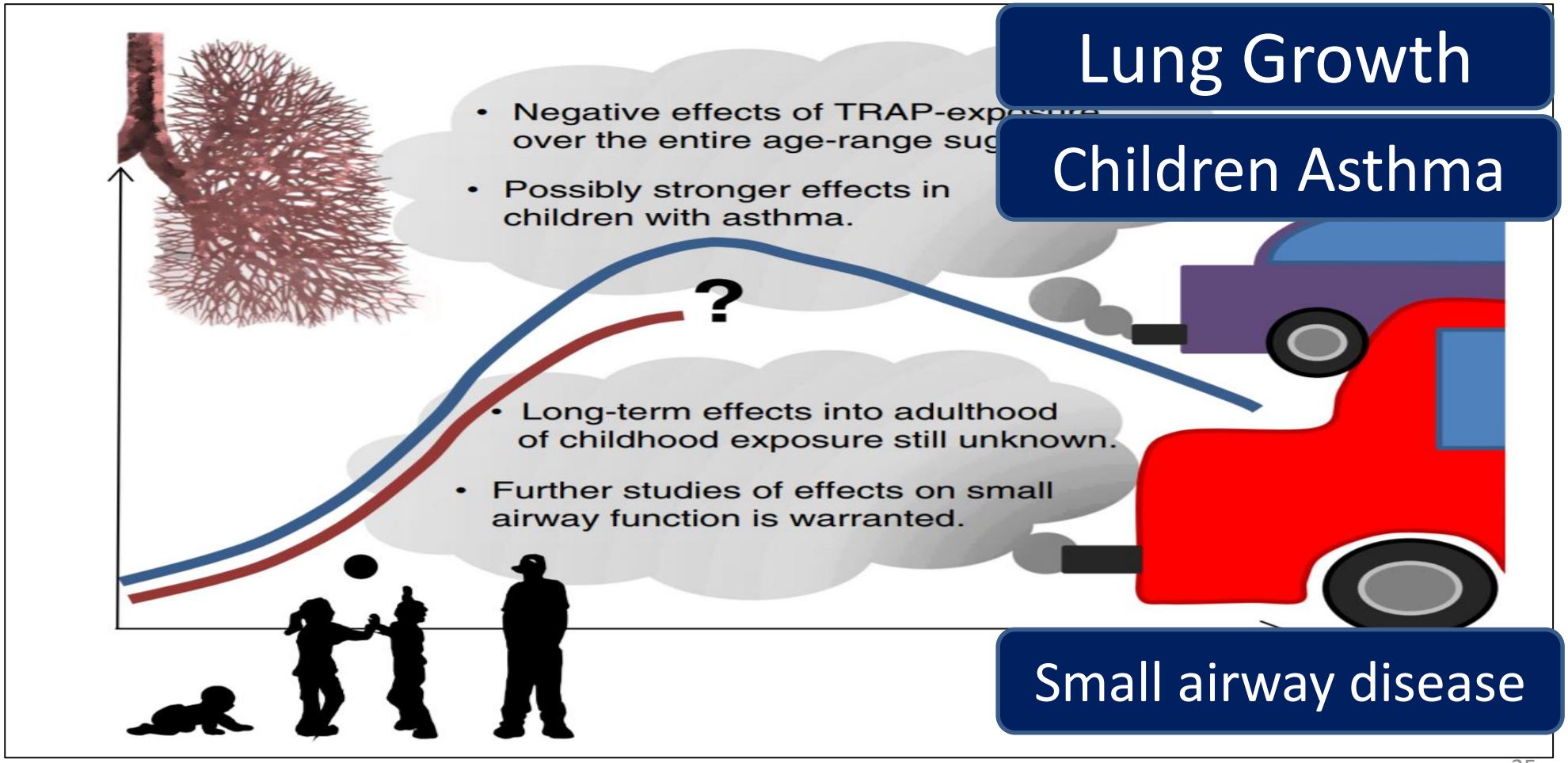

*Am J Physiol Heart Circ Physiol. 2014 Aug 15;307(4):H467-76.*

# Air pollution during pregnancy and lung development in the child




*Paediatr Respir Rev. 2017 Jan;21:38-46*

# Effects of Long-Term Exposure to Traffic-Related Air Pollution on Lung Function in Children








*Curr Allergy Asthma Rep. 2017 Jun;17(6):41.*

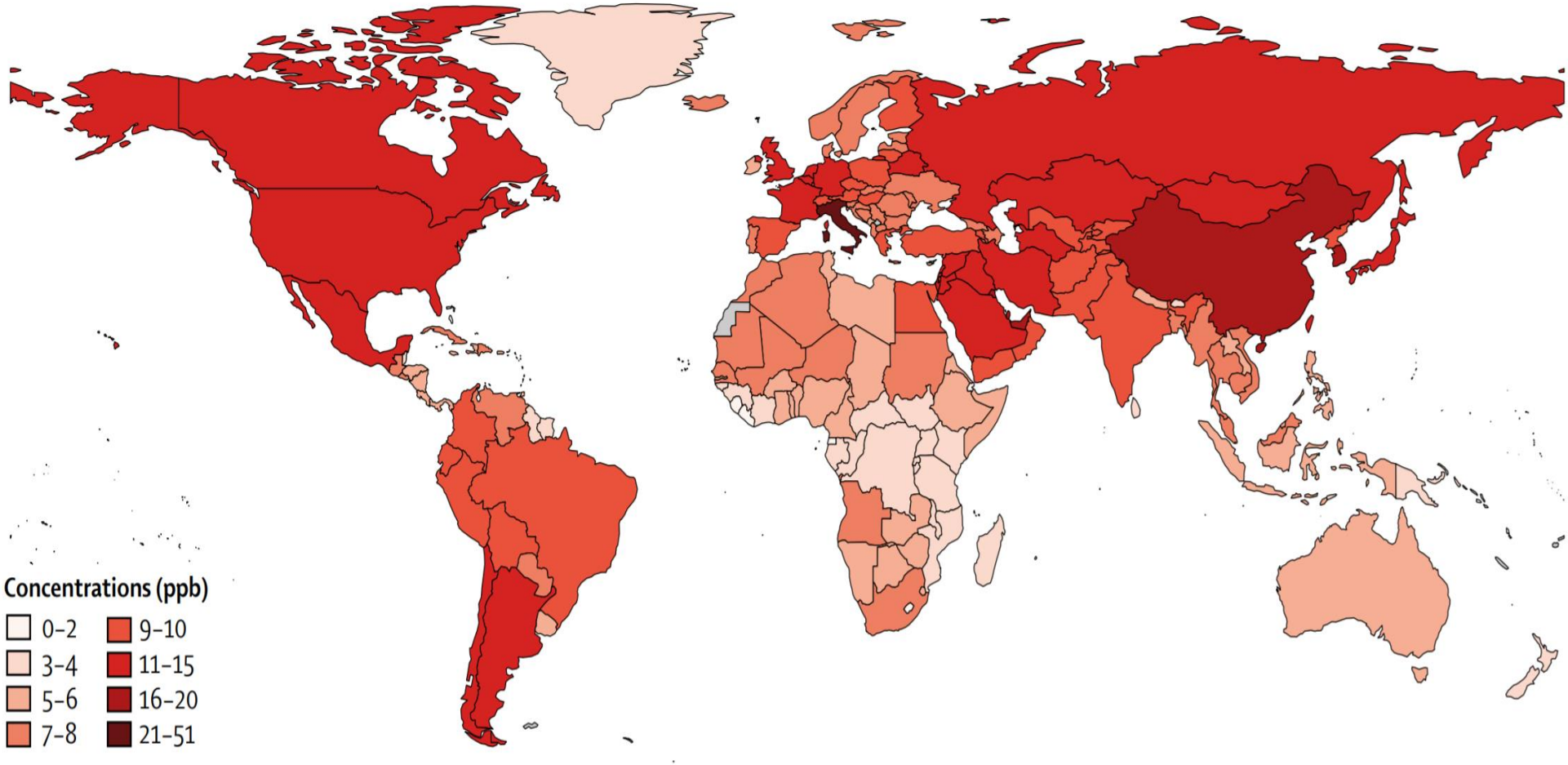
# Global, national, and urban burdens of paediatric asthma incidence attributable to ambient $NO_2$ pollution: estimates from global datasets

*Pattanun Achakulwisut, Michael Brauer, Perry Hystad, Susan C Anenberg*

- **Aim:**
  - To estimated the annual global number of **new paediatric asthma cases** attributable to NO2 exposure.
- **Methods:**
  - Obtained **2015 country-specific and age-group-specific asthma** incidence rates for 194 countries
  - Estimated the **NO2-attributable burden of asthma incidence** in children aged 1–18 years in **194 countries/ 125 cities** .

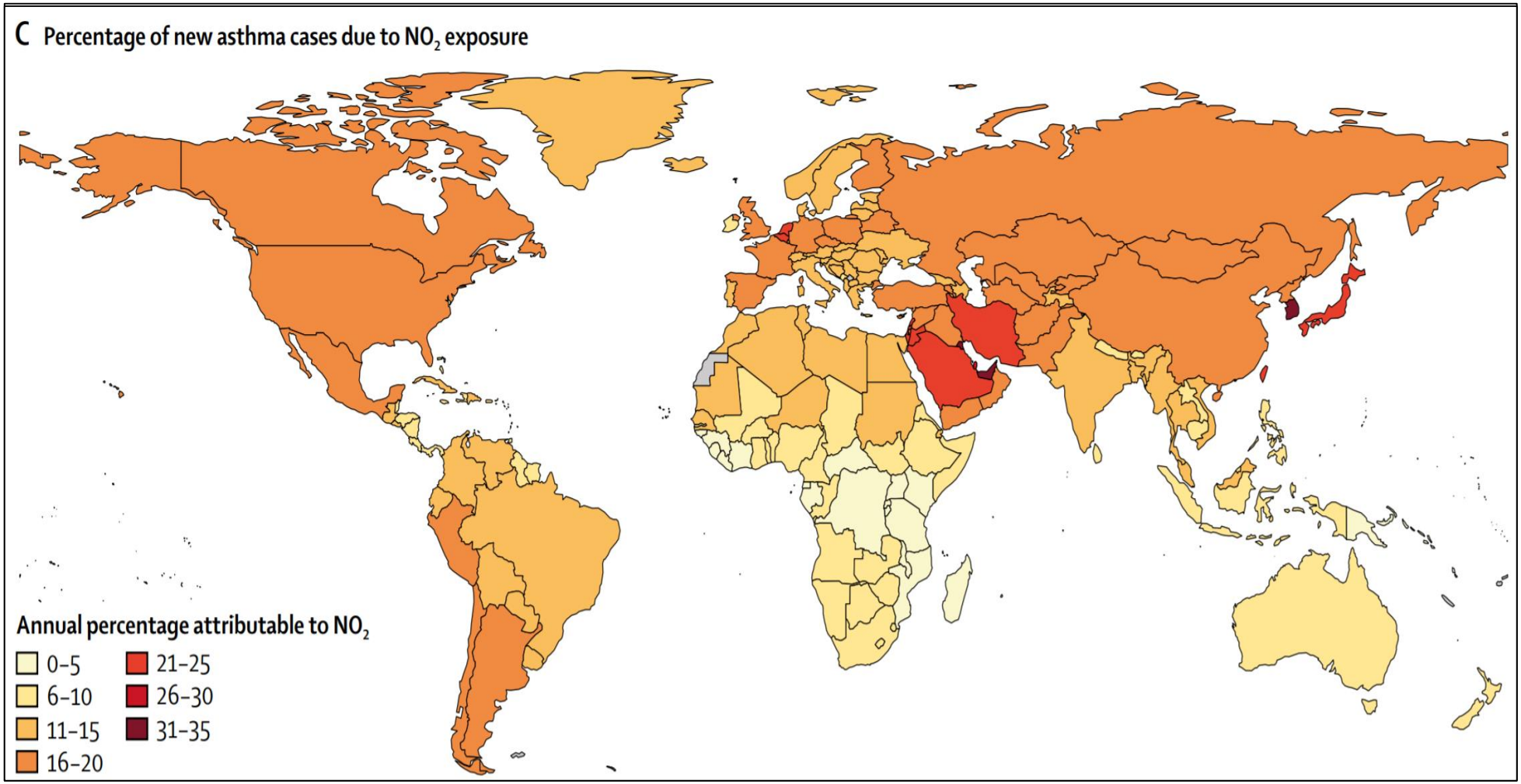
*Lancet Planet Health. 2019 Apr;3(4):e166-e178.*

# Population-weighted NO2 concentrations




*Lancet Planet Health. 2019 Apr;3(4):e166-e178.*

# Number of **new asthma** cases due to NO2 exposure




*Lancet Planet Health. 2019 Apr;3(4):e166-e178.*

# 交通污染相關兒童哮喘：台灣全球第四

- 與交通污染有關的兒童哮喘病例比例最高的國家是：科威特(550/10萬)；阿拉伯聯合大公國(460/10萬)；加拿大(450/10萬)；台灣(420/10萬)

| | | (95% UI) | incidence (95% UI) |
|---|---|---|---|
| High income | | | |
| Australasia | 12 (5·2–15) | 170 (77–230) | 8·7% (3·8–11) |
| High-income Asia Pacific | 97 (46–120) | 300 (140–370) | 25% (12–32) |
| High-income North America | 270 (120–340) | 310 (140–400) | 19% (8·5–24) |
| Southern Latin America | 56 (26–72) | 290 (130–370) | 18% (8·4–23) |
| Western Europe | 150 (70–200) | 190 (85–240) | 17% (7·8–22) |

*Lancet Planet Health. 2019 Apr;3(4):e166-e178.*

# 空氣污染 & COPD

International Journal of COPD

Dovepress
open access to scientific and medical research

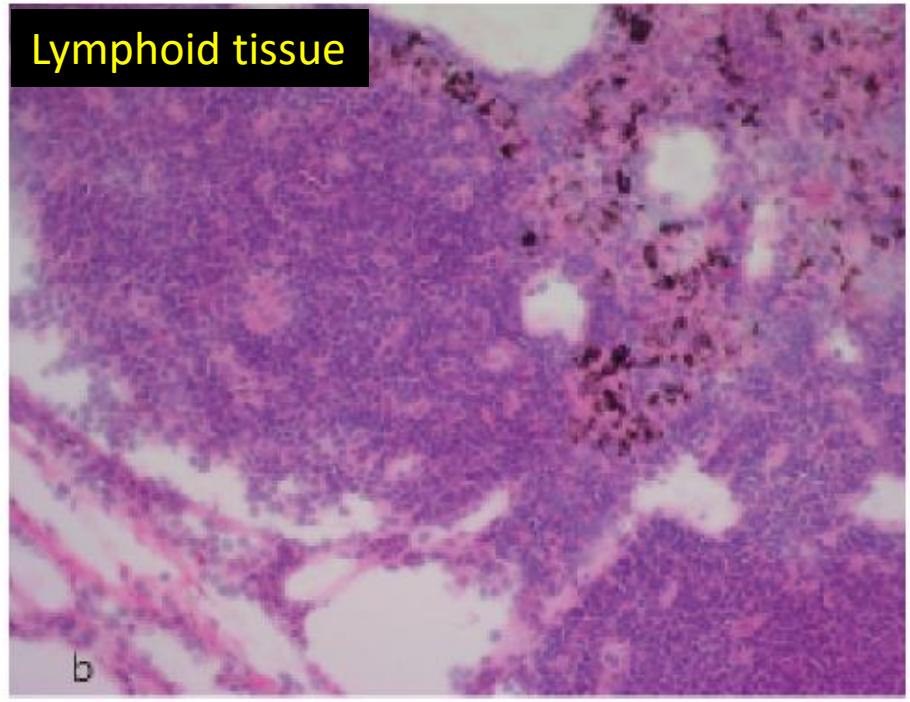
Open Access Full Text Article

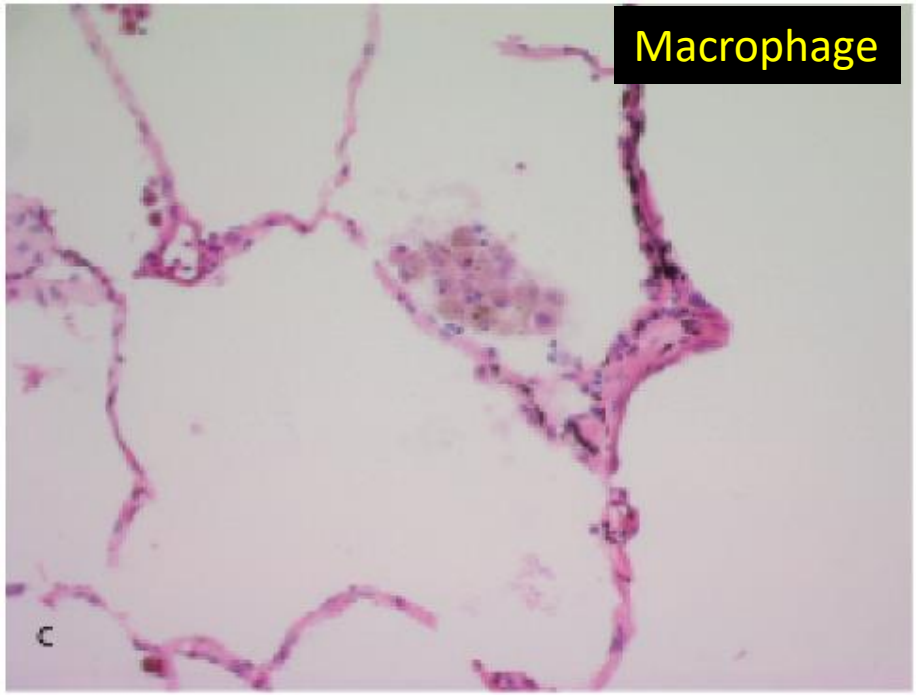
REVIEW

# Particulate matter air pollution exposure: role in the development and exacerbation of chronic obstructive pulmonary disease

- Strong epidemiological evidence suggests that **exposure to PM air pollution** causes **exacerbations of COPD** resulting in increased morbidity and mortality.
- Ineffective clearance of this PM could cause **particle retention in lung tissues**, resulting in a chronic, low-grade inflammatory response that may be pathogenetically important in both **exacerbation** and **progression**.


blood vessel walls
a


Lymphoid tissue
b


Macrophage
c

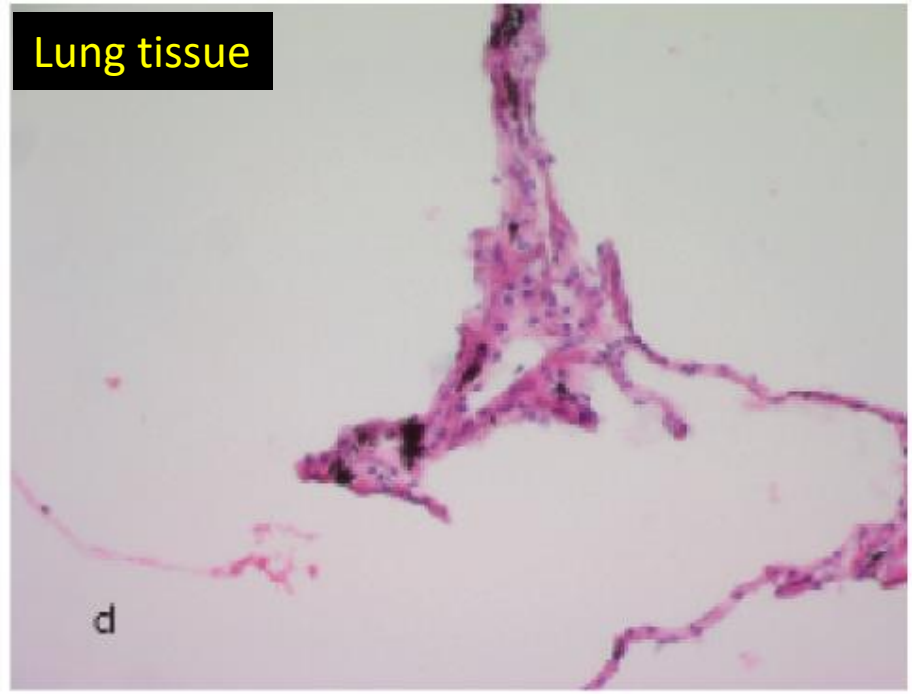
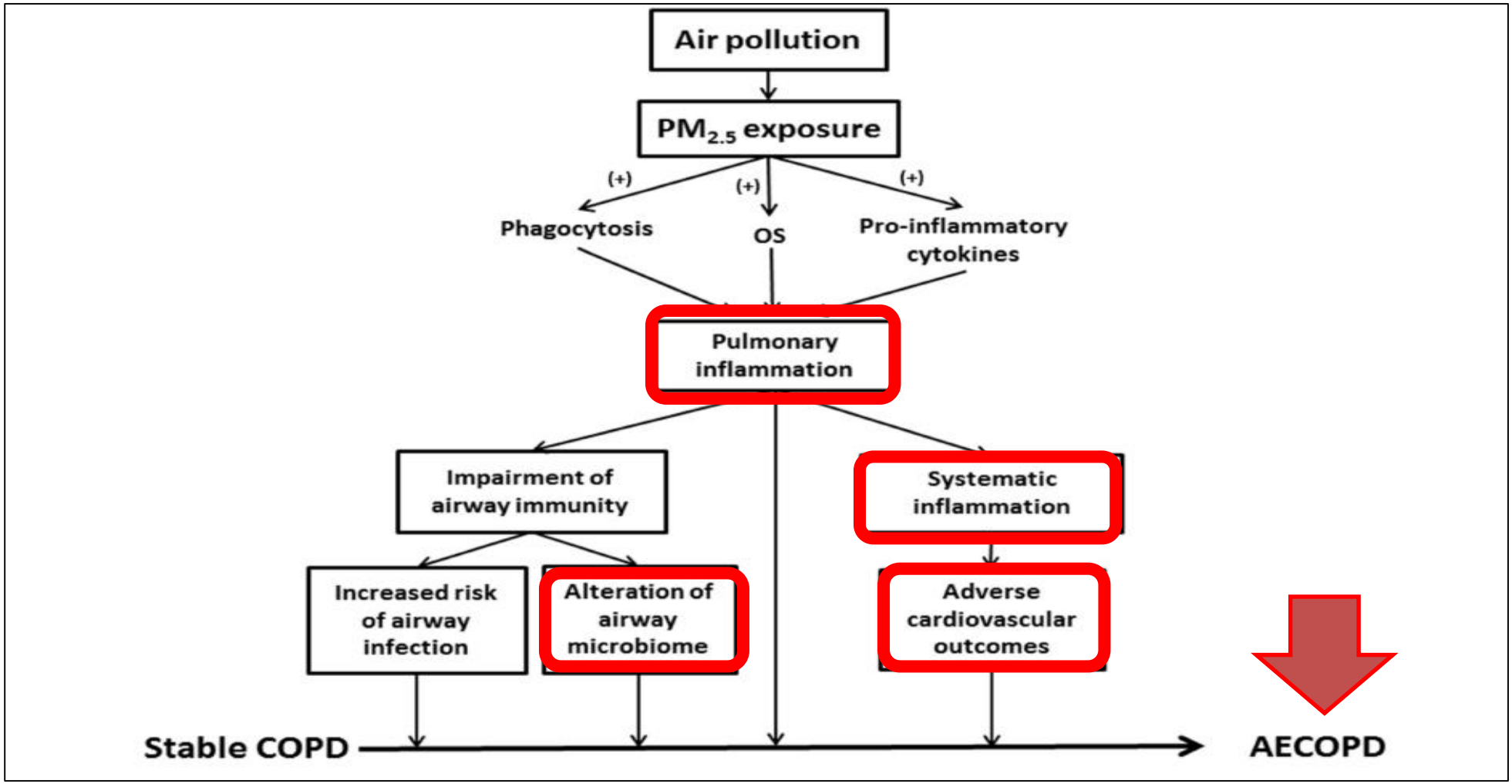

Lung tissue
d

**Table 1** Key studies in the role of particulate matter in the development and progression of COPD

| *Author(s)* | *Study description* |
|---|---|
| **Epidemiological evidence** | |
| Schikowski et al[19] | Long term exposure to air pollution from high traffic and industrial sources resulted in rapid decline of $FEV_1$, a high risk ratio to develop COPD and poorer respiratory health |
| Liu et al[18] | Significant association between prevalence of COPD and biomass fuel for cooking in rural China |
| Viegi et al[21] | Exposure to PM by internal combustion and industrial emissions recognized as significant contributors to exacerbation of COPD |
| Dockery et al[32] | Relationship between increased levels of air pollution and mortality and morbidity rates from respiratory diseases |
| Torres-Duque et al[23] | Indoor air pollution from the combustion of biomass fuels related to respiratory diseases |
| Sunyer et al[1] | Effect of acute increase in urban air pollution on respiratory health and what factors could attribute to this effects |
| Sint et al[3] | COPD patients have an increased sensitivity to PM and should reduce their exposure to PM whenever possible |
| **Alveolar macrophage (AM) response to PM** | |
| van Eeden et al[54] | Exposure of lung macrophages to atmospheric particles influences their phagocytic activity and pro-inflammatory responses |
| Oberdorster et al[71] | Suggests a duel role of lung macrophages exposed to PM: both preventing and contributing to chronic lung injury |
| Morrow[50] | Reviews possible mechanisms as to how dust overloading can compromise the phagocytic and chemotactic ability of AMs |
| **Lung inflammation in response to PM** | |
| Churg et al[76] | Particulate matter activates NF-KB in tracheal epithelial cells |
| Montano et al[82] | Increase MMP activity in macrophages exposed to wood smoke, suggesting subsequent emphysematous destruction |
| Risom et al[85] | Particulate matter induced oxidative stress-induced DNA damage is an important ways in which PM can be harmful |
| Li et al[53] | PM induces HO-1, key marker for oxidative stress resulting in structural damage of mitochondria |

# Fine particulate matter in acute exacerbation of COPD




*Front Physiol. 2015 Oct 23;6:294*

# Prevalence and risk factors of chronic obstructive p disease in China (the China Pulmonary Health [CPH a national cross-sectional study

**the China Pulmonary Health (CPH)**

- **Aim:** to assess the prevalence and risk factors of COPD.
- **Methods**:
  - a **cross-sectional study** from **10 provinces** in mainland China.
  - All participants underwent a post-BT lung function test.
  - COPD was diagnosed according to GOLD 2017 criteria.
- **Results:**
  - spirometry-defined COPD was **8·6%**
  - **RF of COPD: Cigarette smoking, ambient air pollution,** underweight, childhood chronic cough, parental history of respiratory diseases, and low education.

*Lancet. 2018 Apr 28;391(10131):1706-1717*

# Annual mean PM2.5 ≧50

| | Entire population | | | | Never-smokers | | | |
|---|---|---|---|---|---|---|---|---|
| | Age and sex adjusted | | Multivariable adjusted* | | Age and sex adjusted | | Multivariable adjusted* | |
| | OR (95% CI) | p | OR (95% CI) | p | OR (95% CI) | p | OR (95% CI) | p |
| Male sex | 2·70 (2·24–3·26) | <0·0001 | 2·25 (1·83–2·77) | <0·0001 | 1·90 (1·64–2·19) | <0·0001 | 2·34 (1·99–2·75) | <0·0001 |
| Biomass use | 1·62 (1·21–2·18) | 0·003 | 1·25 (0·95–1·65) | 0·10 | 1·42 (1·09–1·84) | 0·01 | 1·17 (0·92–1·49) | 0·19 |
| Annual mean $PM_{2·5}$ exposure (µg/m$^3$) | | | | | | | | |
| <50 | 1·00 (ref) | .. | 1·00 (ref) | .. | 1·00 (ref) | .. | 1·00 (ref) | .. |
| 50–74 | 1·40 (0·82–2·36) | 0·20 | 1·85 (1·23–2·77) | 0·005 | 1·83 (1·31–2·56) | 0·001 | 2·27 (1·72–2·99) | <0·0001 |
| ≥75 | 1·64 (0·97–2·80) | 0·07 | 2·00 (1·36–2·92) | 0·001 | 2·08 (1·49–2·90) | 0·0002 | 2·34 (1·90–2·88) | <0·0001 |
| p for trend | 0·07 | .. | 0·001 | .. | 0·0002 | .. | <0·0001 | .. |

*Lancet. 2018 Apr 28;391(10131):1706-1717*

International Journal of COPD

open access to scien

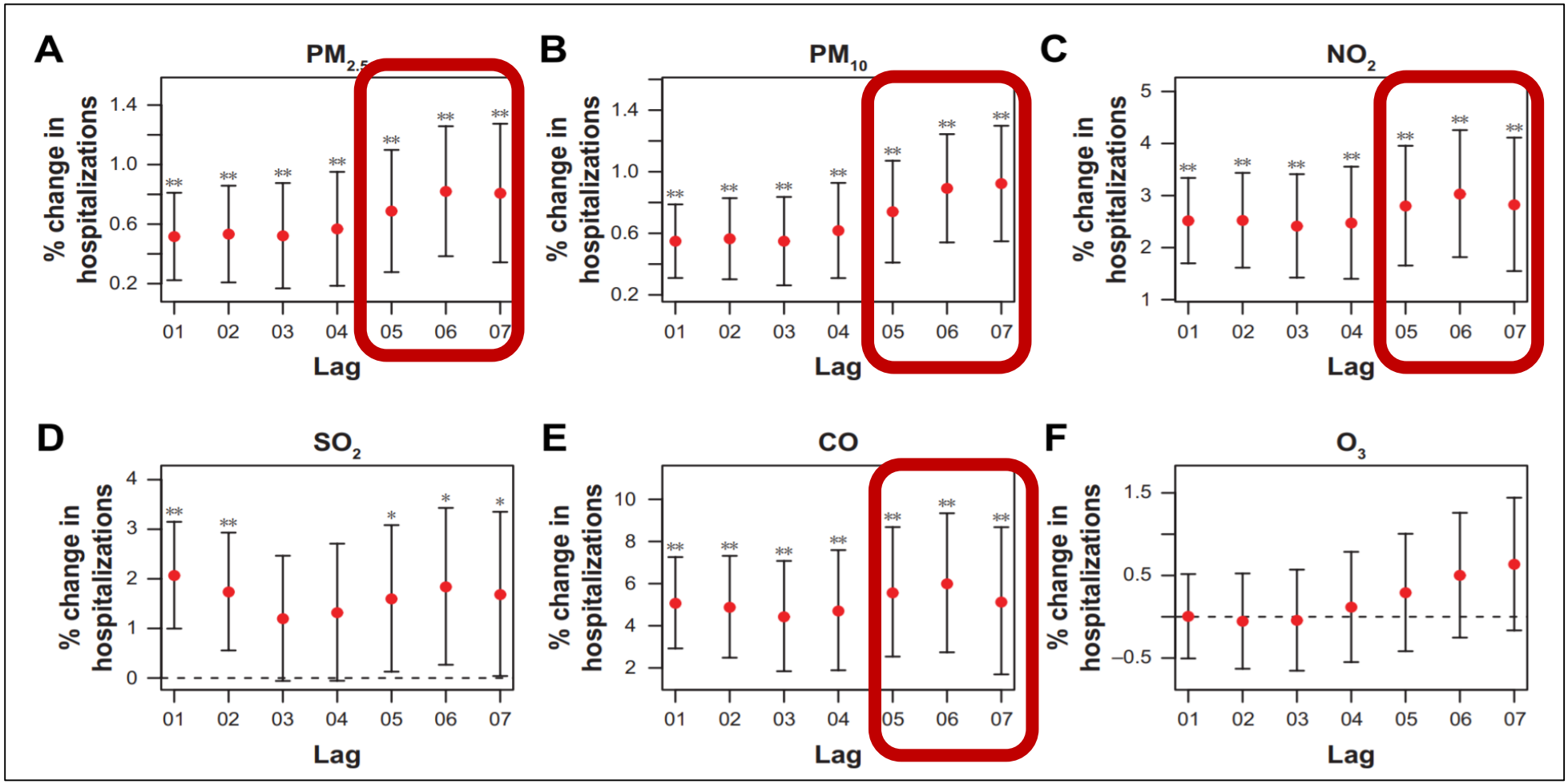
Open Access Full Text Article

ORIGINA

# Short-term effects of ambient air pollution on chronic obstructive pulmonary disease admissions in Beijing, China (2013–2017)

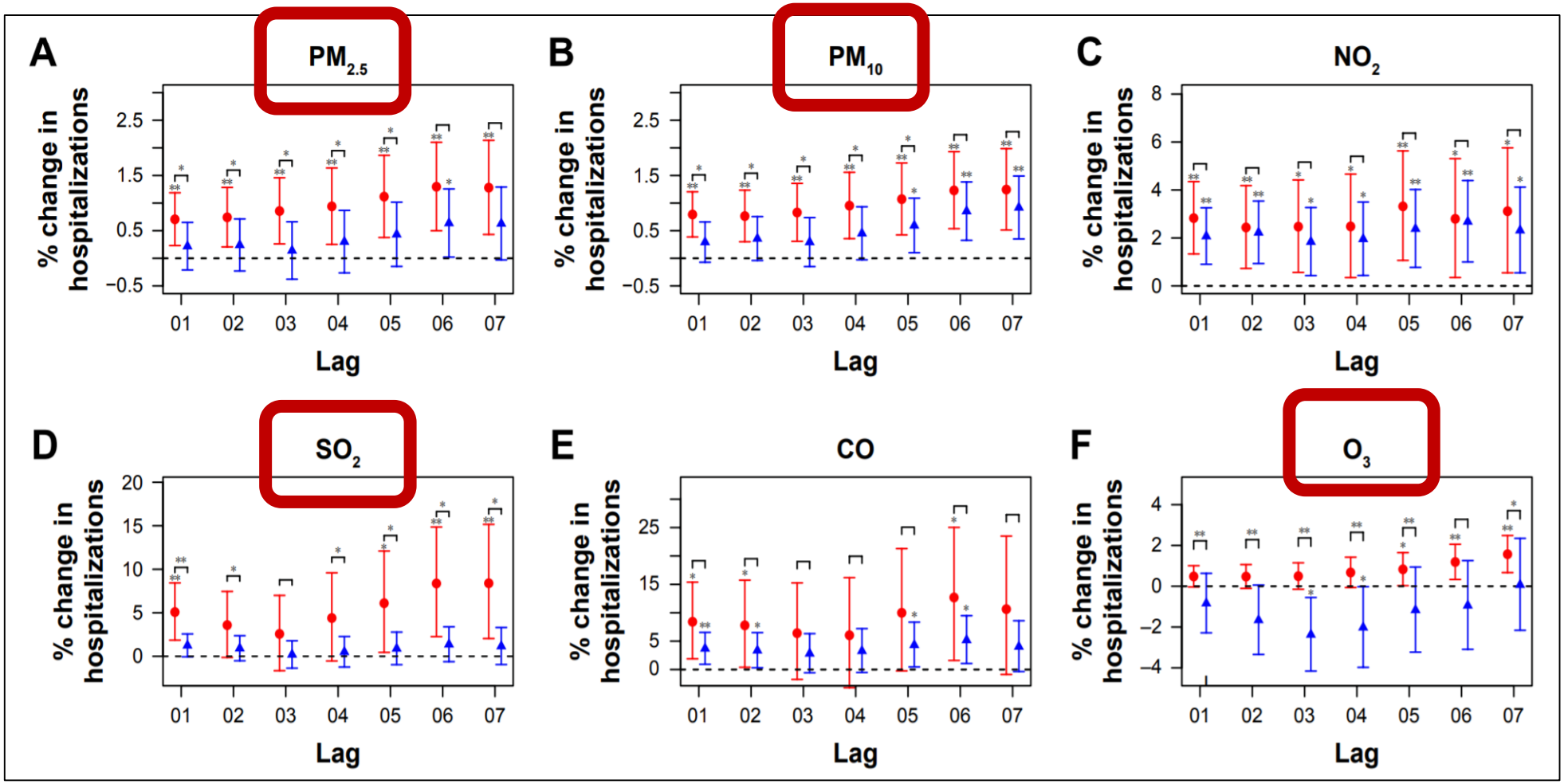
- **Aim:** to explore the effects of **air pollutants** on COPD admissions in Beijing, China.
- **Methods**: **10 μg/m³** increases in pollutants levels and **COPD admission**.
- **Results:** Short-term exposures to **PM2.5, PM10, NO2, SO2, and CO** increased the COPD hospitalizations.

# $PM_{2.5}$, $PM_{10}$, $NO_2$ , and CO had maximum cumulative lag effects




*International Journal of COPD 2019:14 297–309*

# Significant higher effects in the warm season for $PM_{2.5}$, $PM_{10}$, $SO_2$ , and $O_3$




*International Journal of COPD 2019:14 297–309*

PLOS ONE

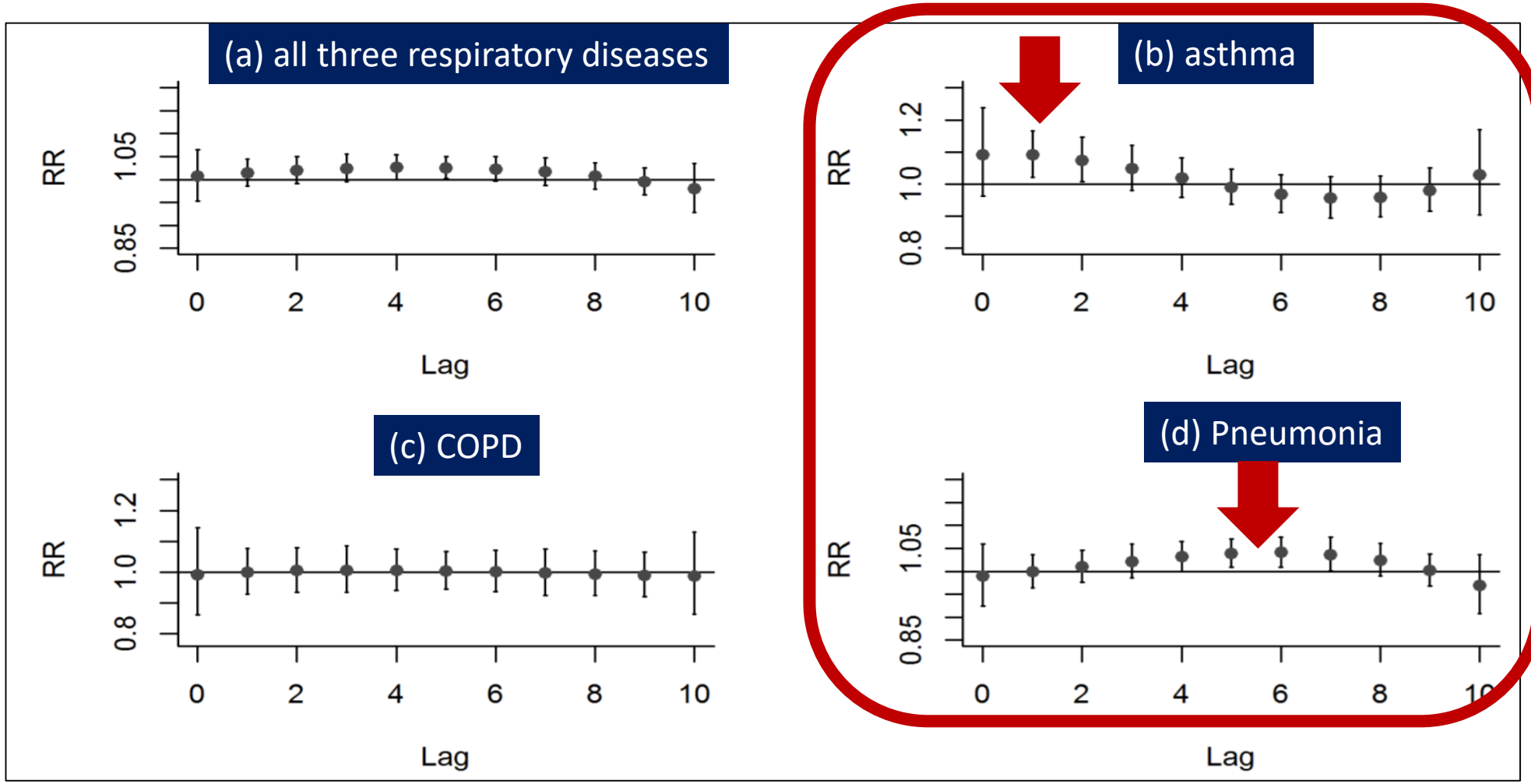
# Association of time-serial changes in aml particulate matters (PMs) with respirator emergency cases in Taipei's Wenshan Di

Jer-Hwa Chang[1,2], Shih-Chang Hsu[3], Kuan-Jen Bai[1,2], Shau-Ku Huang[4,5,6,7], Ch Wang Hsu[3,8]*

- **Aim:** ambient **PM2.5, NO2, SO2** and their association with ERV for **asthma**, **COPD** and **pneumonia** in a four-year time span.
- **Methods**:
  - **Daily 24-h average concentrations of PM2.5** and pollutant gases (**NO2, SO2** )were obtained from a local Gutting airquality monitoring station (古亭監測站)

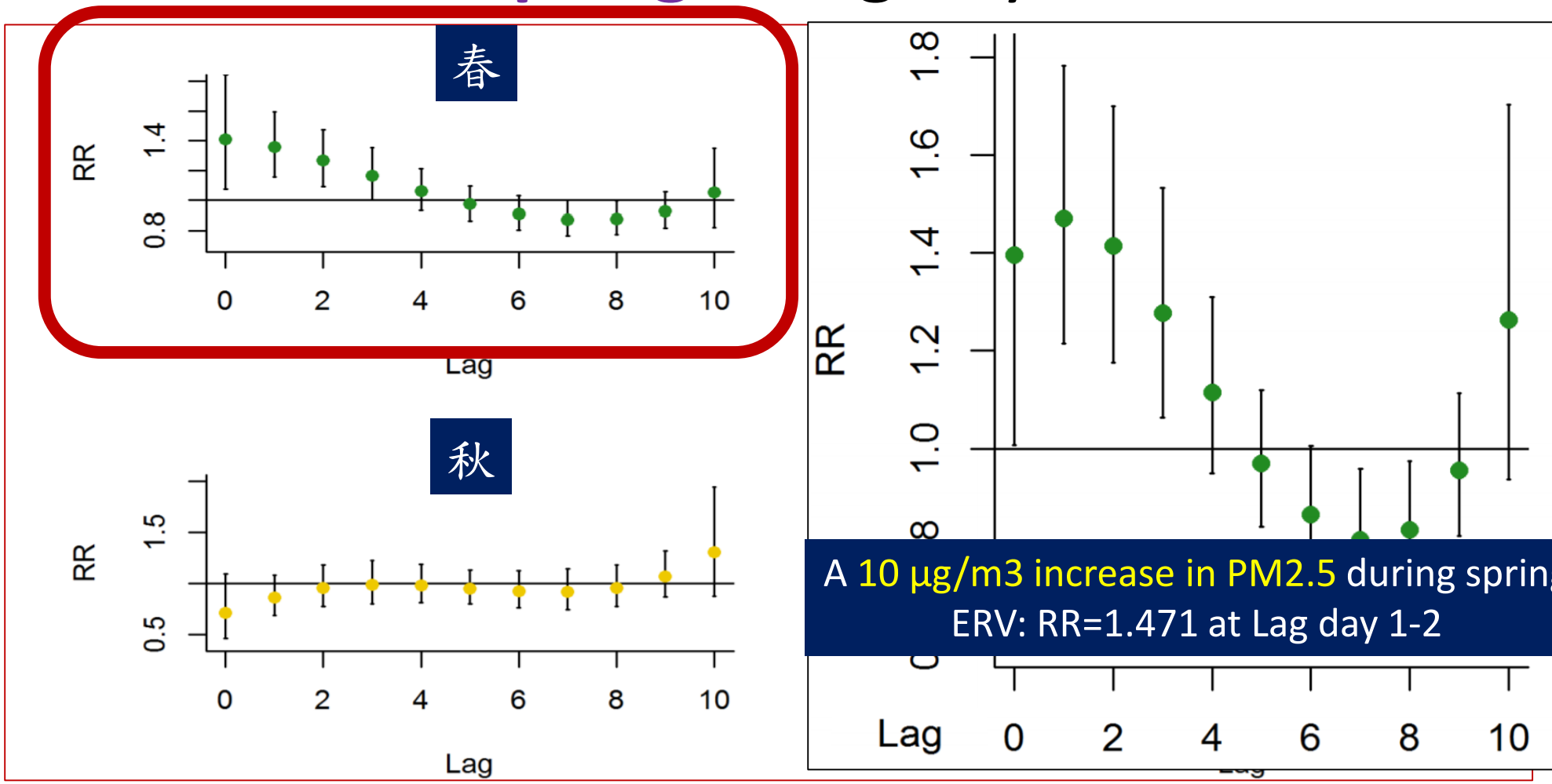
PLoS One. 2017 Jul 21;12(7):e0181106.

# ERVs for **pneumonia** and **asthma** were associated with the level of PM2.5



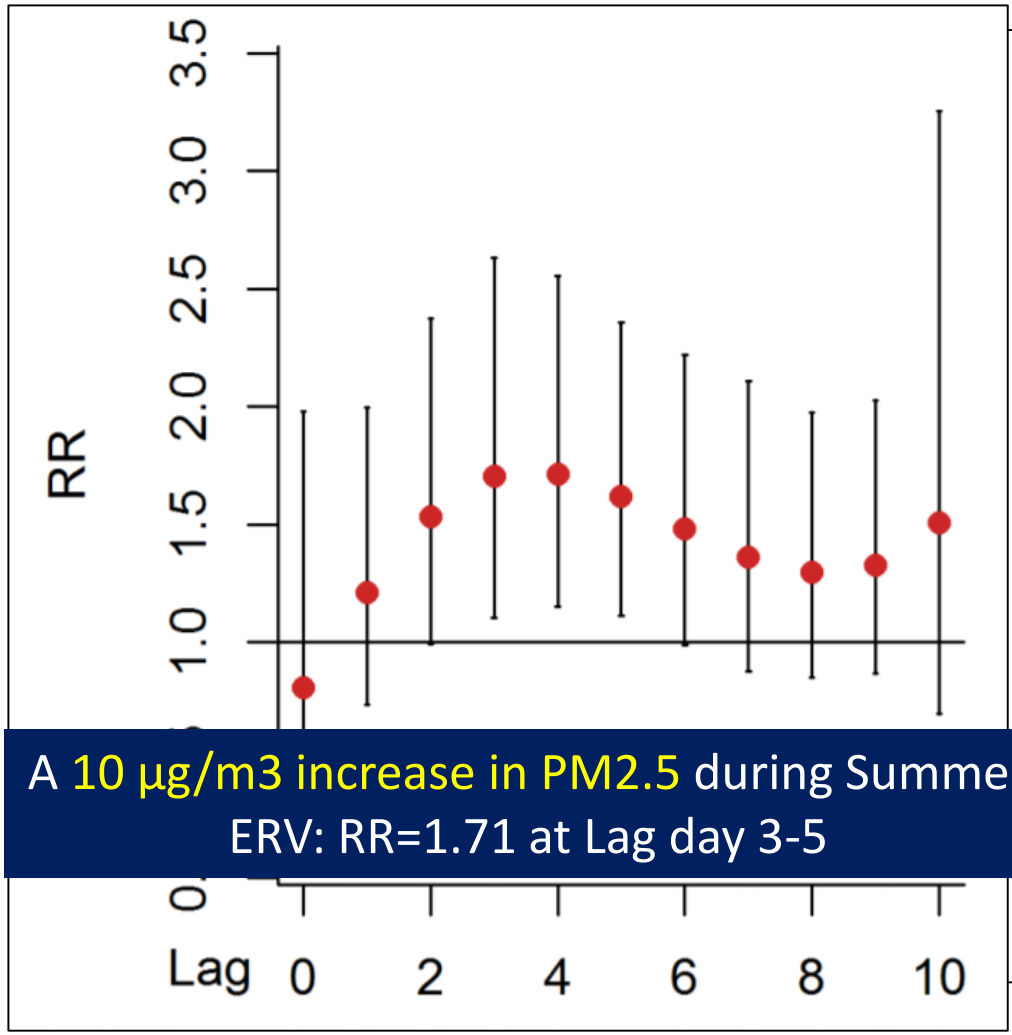

PLoS One. 2017 Jul 21;12(7):e0181106.

# Significantly increased risk of ERVs for **asthma in spring** at lag days 0, 1 and 2

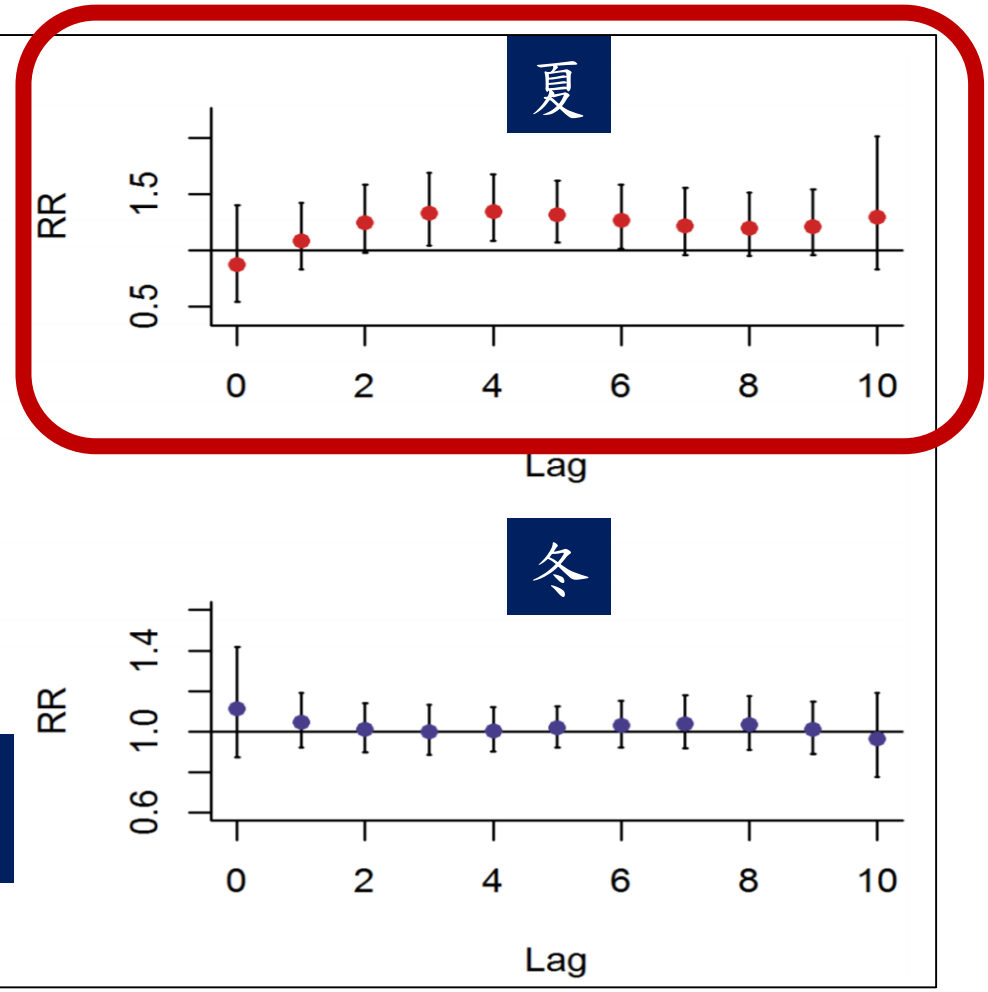



PLoS One. 2017 Jul 21;12(7):e0181106.

# Significantly increased risk of ERVs for **COPD in Summer** at lag days 3,4,5 and 6




A 10 μg/m3 increase in PM2.5 during Summer
ERV: RR=1.71 at Lag day 3-5




PLoS One. 2017 Jul 21;12(7):e0181106.

ORIGINAL ARTICLE

# Burden of disease attributable to ambie fine particulate matter exposure in Tai

Wei-Cheng Lo [a,b], Ruei-Hao Shie [c,d], Chang-Chuan Chan [
Hsien-Ho Lin [a,*]

- **Aim:** quantified the burden of **mortality** attributable to ambient fine particulate matter (**PM2.5**) among the Taiwanese population in 2014.
- **Results**:
  - In 2014, $PM_{2.5}$ accounted for 6282 deaths. **Ischemic heart disease** (2244 deaths), **stroke** (2140 deaths), **lung cancer** (1252 deaths) and **COPD** (645 deaths)
  - Nationally, **attributable mortality fraction of $PM_{2.5}$** for the four disease causes was **18.6%** (95% CI, 16.9-20.3%)

*J Formos Med Assoc. 2017 Jan;116(1):32-40.*

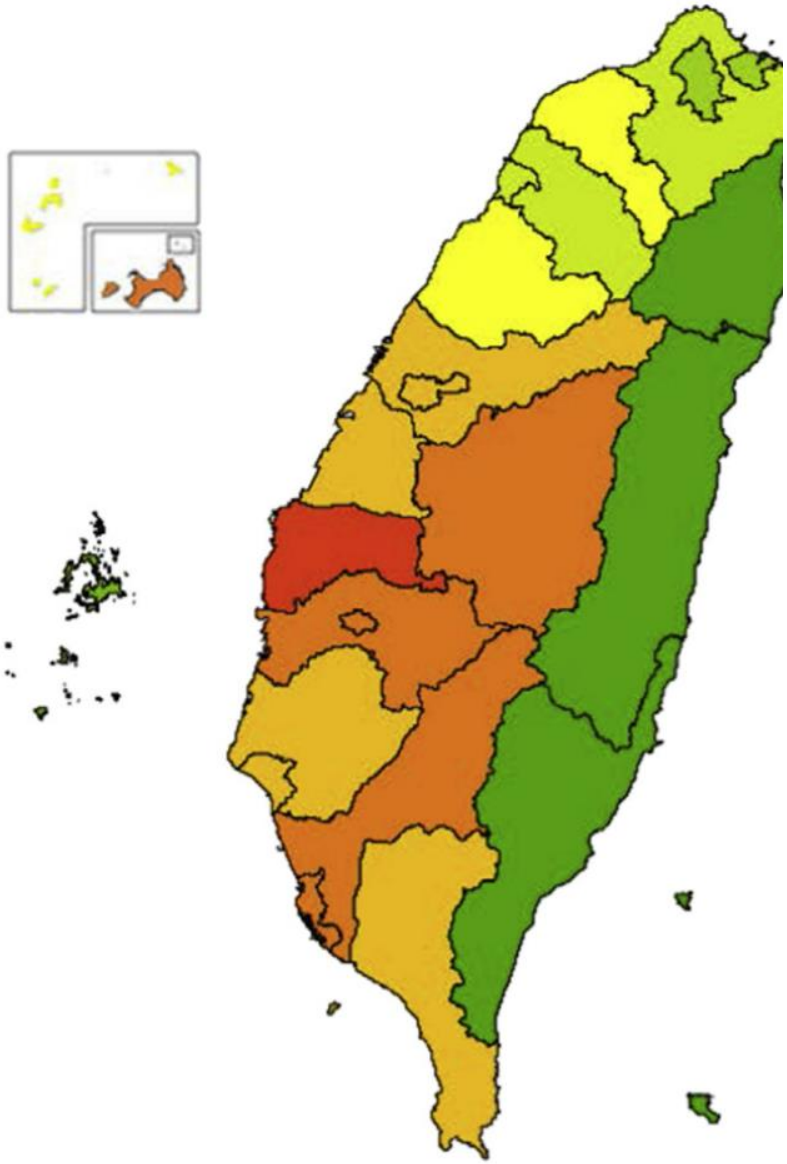
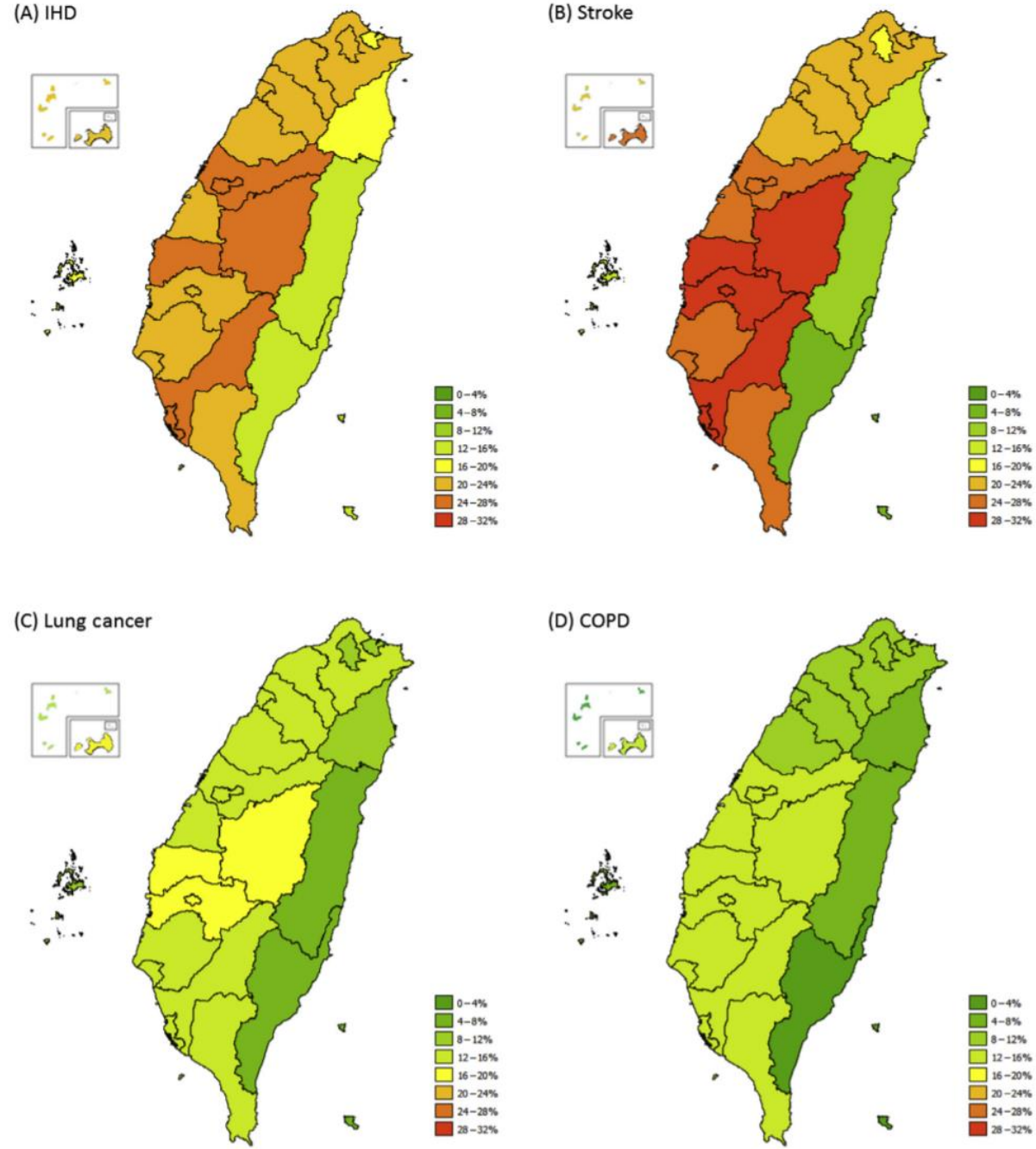
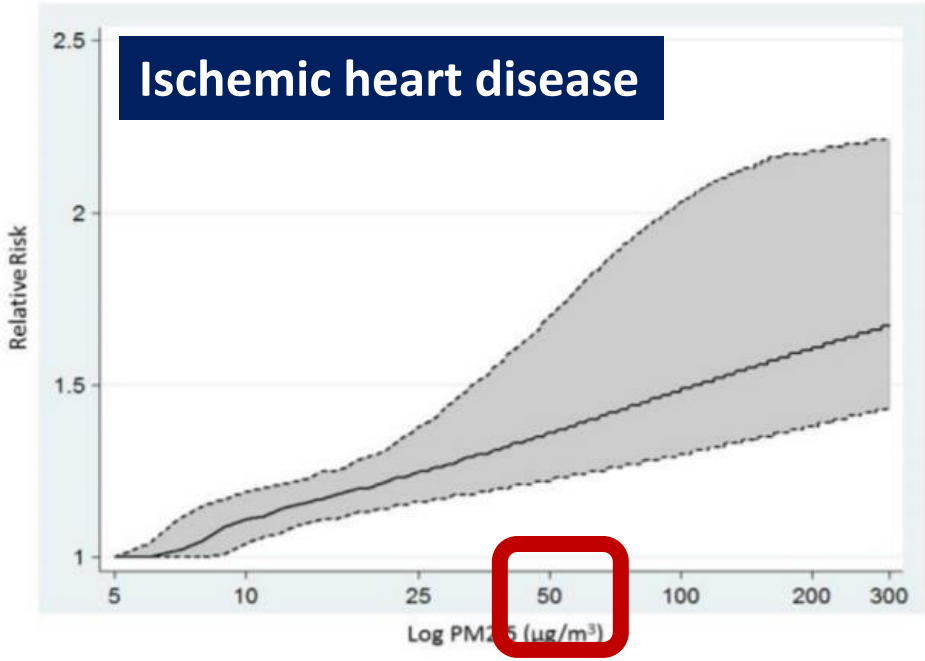
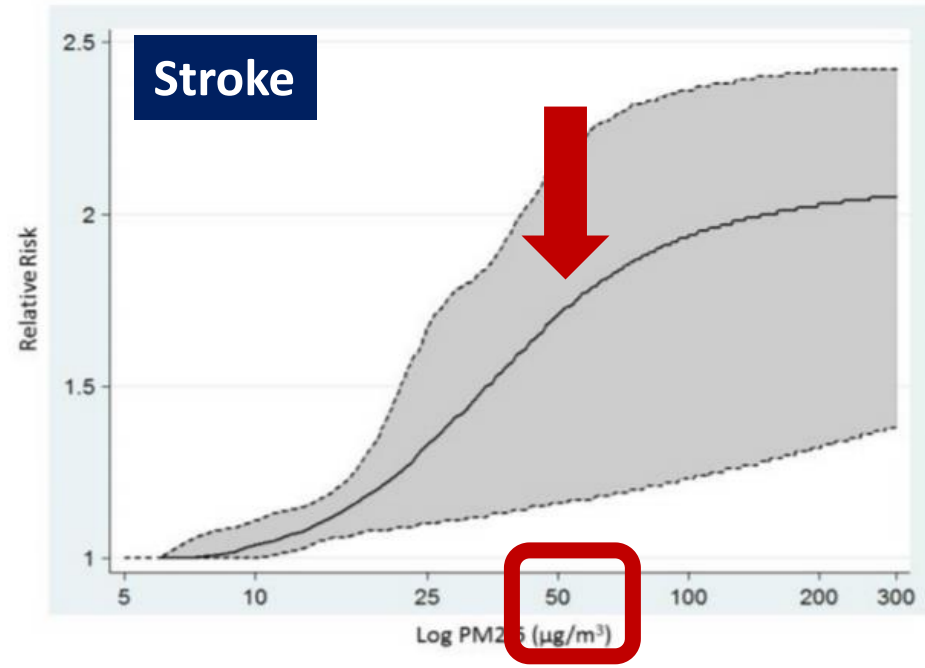


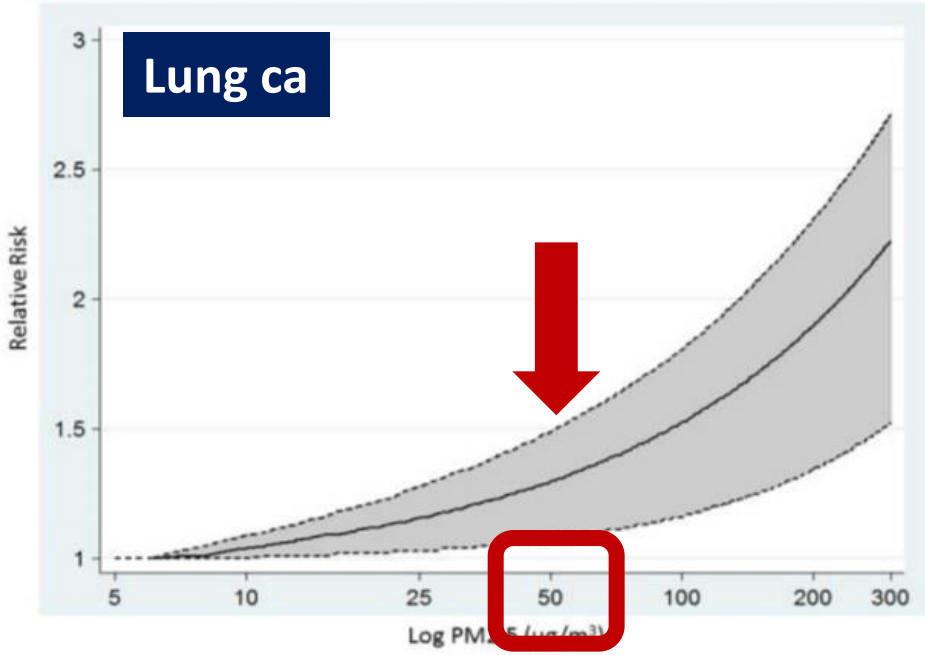
**Figure 2** Annual average of fine particulate ($\mu g/m^3$) by county, 2014.

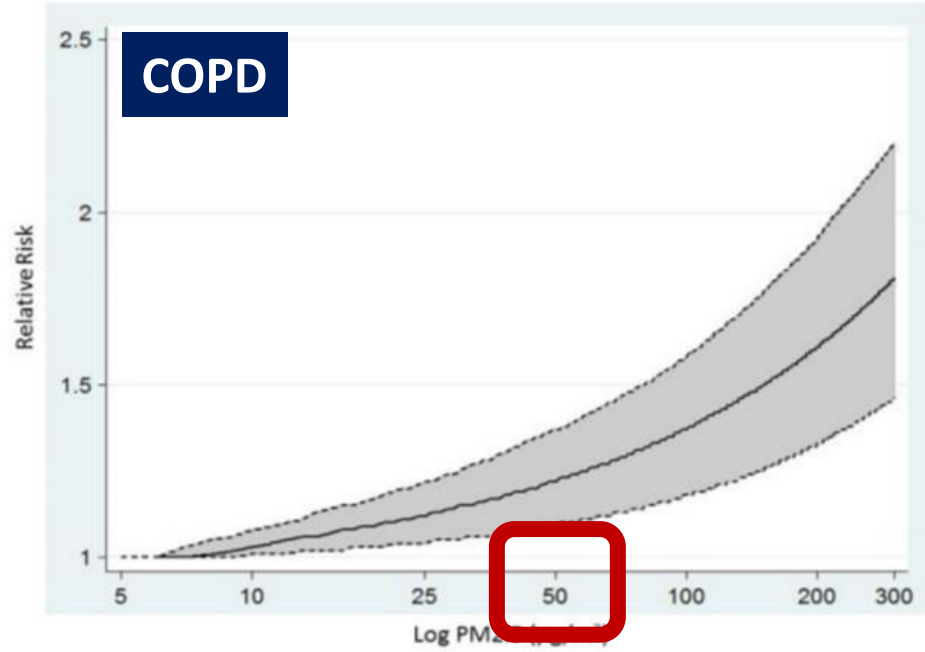



*J Formos Med Assoc. 2017 Jan;116(1):32-40.*


Ischemic heart disease
Relative Risk
2.5
2
1.5
1
5
10
25
50
100
200
300
Log PM2.5 (μg/m³)


Stroke
Relative Risk
2.5
2
1.5
1
5
10
25
50
100
200
300
Log PM2.5 (μg/m³)


Lung ca
Relative Risk
3
2.5
2
1.5
1
5
10
25
50
100
200
300


COPD
Relative Risk
2.5
2
1.5
1
5
10
25
50
100
200
300

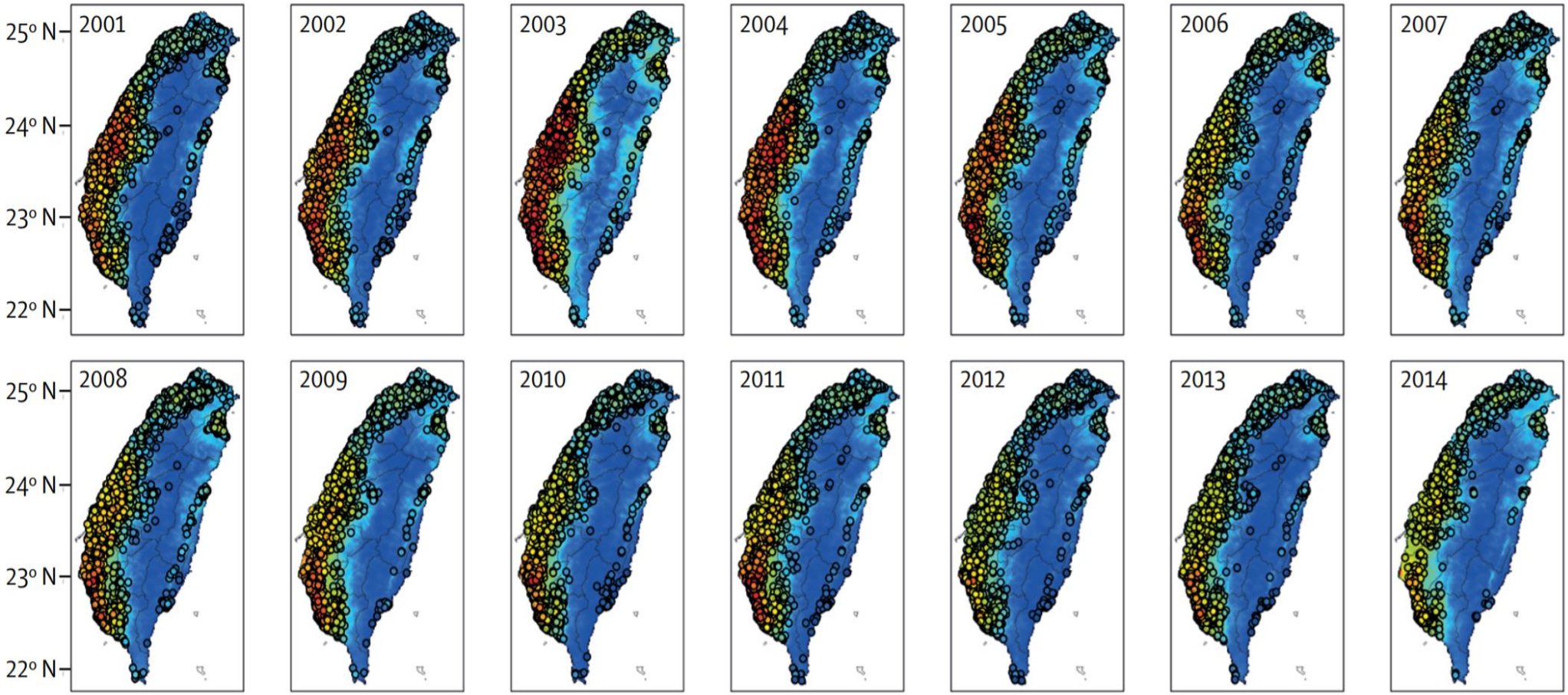
# Effect of long-term exposure to fine particulate matte lung function decline and risk of chronic obstructive pulmonary disease in Taiwan: a longitudinal, cohort s

*Cui Guo, Zilong Zhang, Alexis K H Lau, Chang Qing Lin, Yuan Chieh Chuang, Jimmy Chan, Wun Kai Jiang, Tony Tam, Eng-Kiong Y Ta-Chien Chan, Ly-Yun Chang, Xiang Qian Lao*

- **Aim:** **long-term exposure to PM2·5** & **lung function decline** in COPD in a large-scale **longitudinal cohort**.
- **Methods**:
  - Enrolled 28,5046 participants, ≧20 years, **Taiwan MJ Health Management Institution (美兆健康管理集團)**
  - **2001 ~ 2014**, **spirometric tests** confirmed COPD.
  - Estimate the **2-year average ground concentration of PM2·5** at each participant's address.
  - the **Generalised linear mixed model**; **the Cox proportional hazard regression model**.

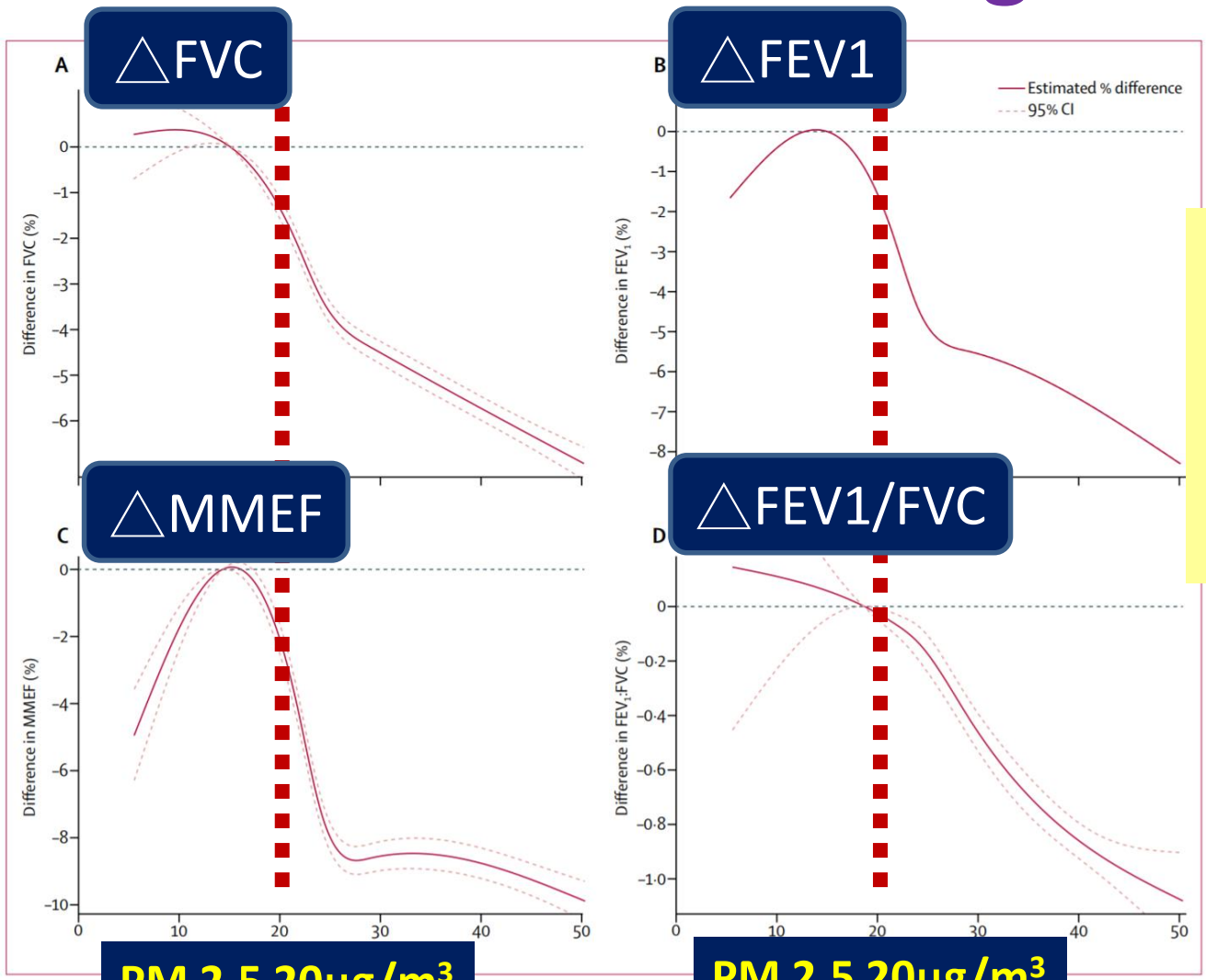
*Lancet Planet Health. 2018 Mar;2(3):e114-e125.*

# The **south-western areas** were generally the most heavily polluted in Taiwan



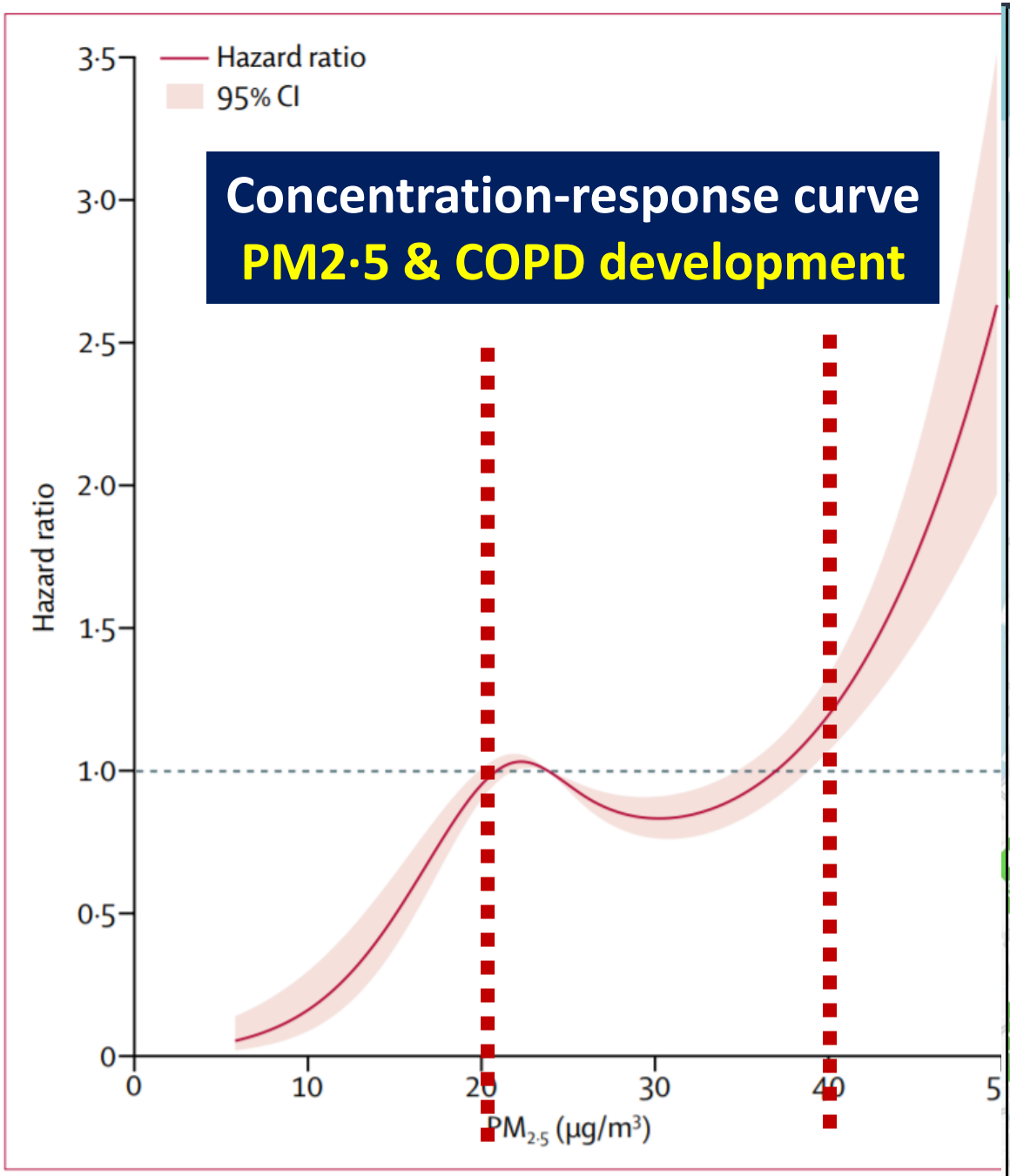

*Lancet Planet Health. 2018 Mar;2(3):e114-e125.*

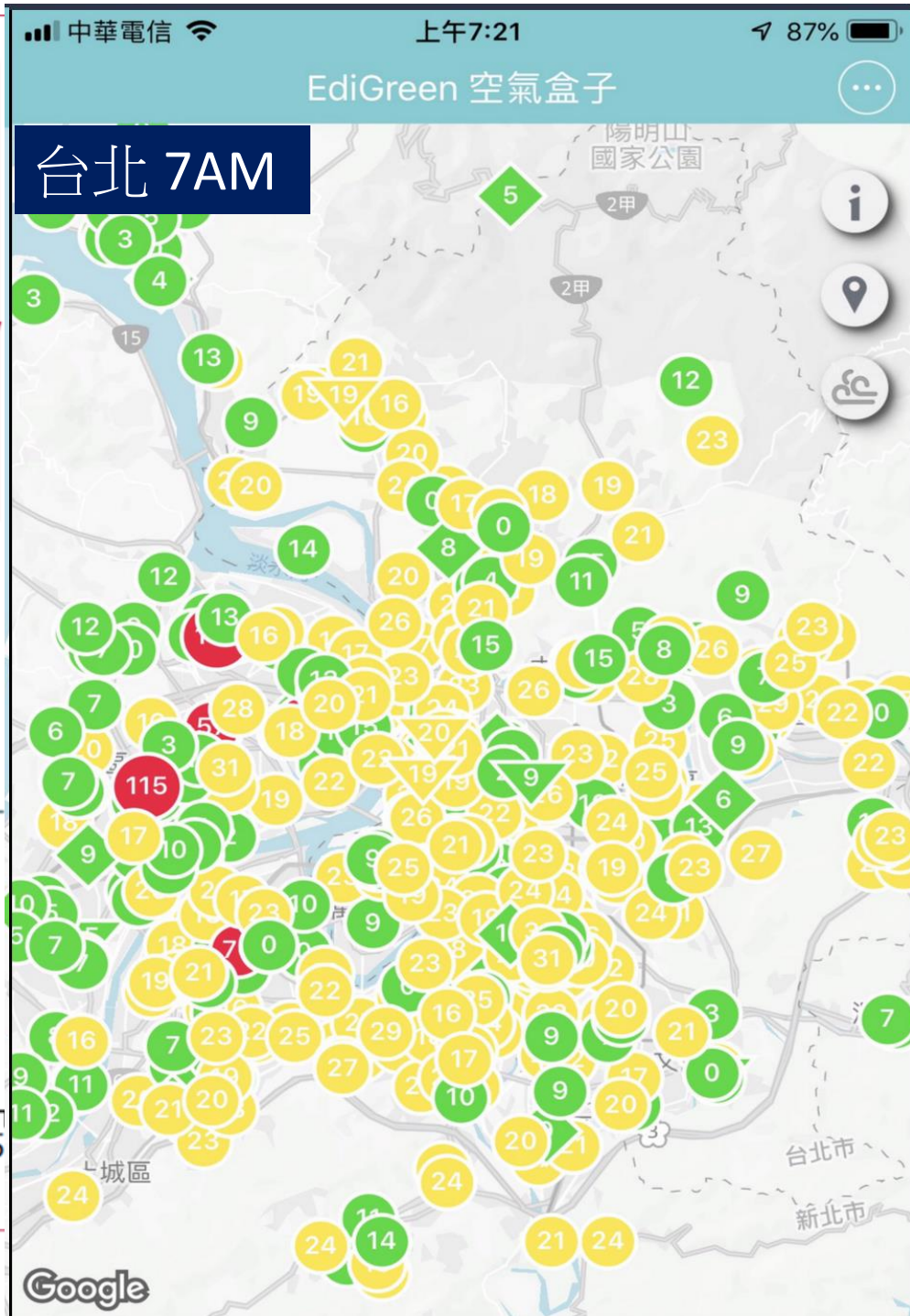
# **Concentration-response curves** between **PM2·5** and **lung function**




**Every 5 μg/m³ ↑ in PM2·5**

- ↓ 1·18% for FVC,
- ↓ 1·46% for FEV1
- ↓ 1·65% for MMEF
- ↓ 0·21% for FEV1/FVC



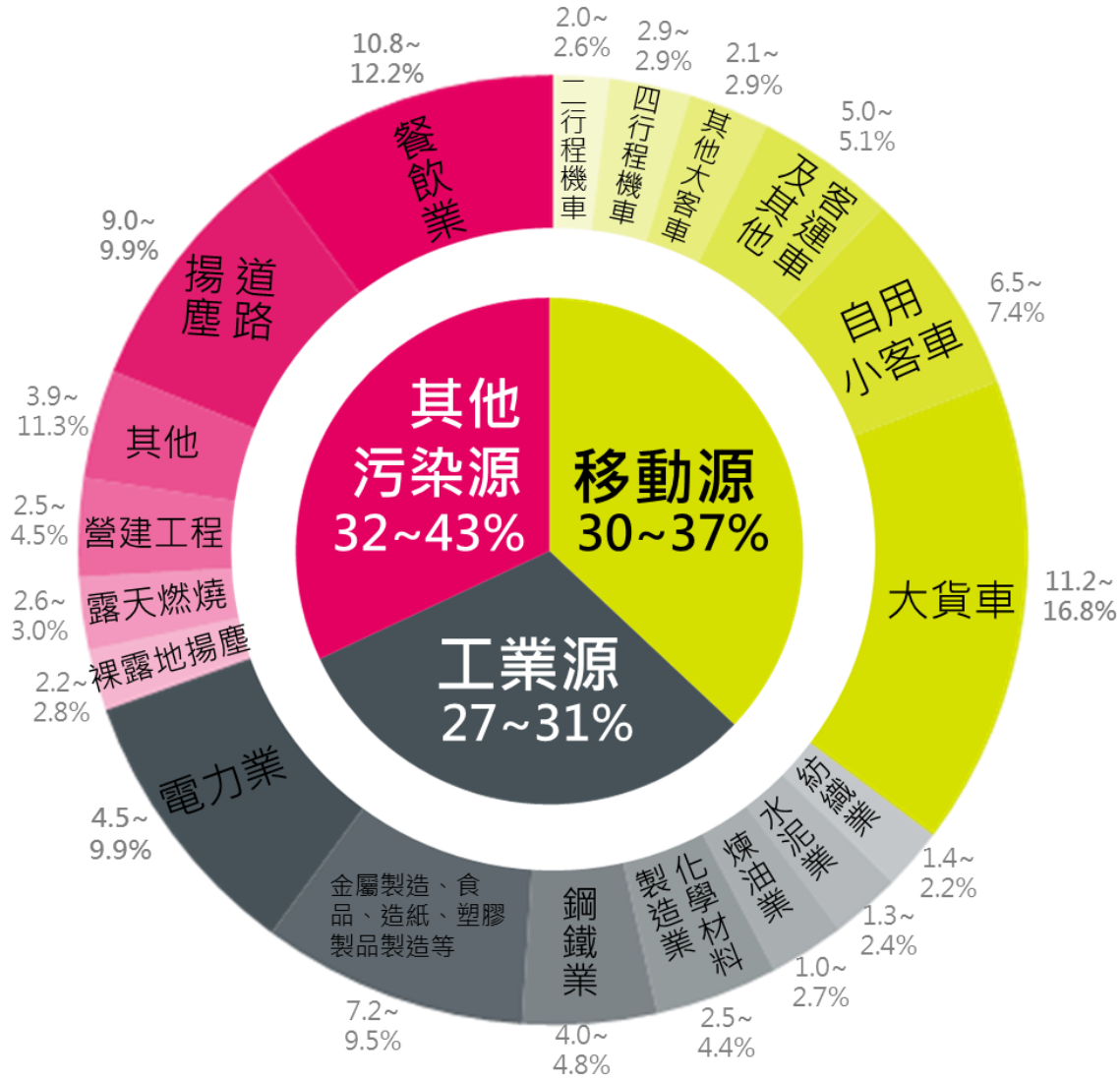




Dr. Pin-Kuei Fu

# 政府對於空汙的政策作為

# 我國境內$PM_{2.5}$來源比率分析

來源眾多，只管制單一污染源，無法產生全面性成效。




資料來源:環保署委託成功大學吳義林教授「台灣細懸浮微粒($PM_{2.5}$)成分與形成速率分析計畫」[ 性能評估結果：配對值分數偏差(Mean Fractional Bias, MFB)為$PM_{2.5}$=-12.8%，配對值絕對分數誤差(Mean Fractional Error, MFE)為$PM_{2.5}$=40.9% ] 及雲林科技大學張艮輝教授「強化空氣品質模式制度計畫(第二年)」研究成果 [ 性能評估結果：MFB為$PM_{2.5}$=-9.1%，MFE為$PM_{2.5}$=38.4% ]

註：依據排放清冊（TEDS 8.1版）估算；網格模式模擬結果性能評估規範：配對值分數偏差MFB為$PM_{2.5}$= ±35%，配對值絕對分數誤差MFE 為$PM_{2.5}$= 55%以內。

依污染等級提高管制強度

- 平日需落實執行常態性空污防制策略
- 秋冬季節則加強管制作為減少不良空品對健康之影響
- 嚴重惡化事件日應採取最高強度緊急應變作為立即降低空品危害

**嚴重惡化**

**短期性應變作為**

緊急應變、
禁止及強制減量

AQI>200

**預警**

**季節性管制作為**

預防異常（加強稽查管制：露天燃燒、河川揚塵等）、自主減排、季節性空污費

AQI>100

**長期全面性管制**

**持續性管制作為**

14+N空污防制策略（固定及移動污染源管制）、降低健康風險、強化監測系統、法規修正及訂定

| 良好 | 普通 | 對敏感族群不健康 | 對所有族群不健康 | 非常不健康 | 有害 |
|---|---|---|---|---|---|

# 14 + N空氣污染防制策略

降低基礎污染排放

## 固定污染源管制

**大型固定污染源管制**
- 電力設施管制
- 鍋爐管制

**其他逸散源管制**
- 河川揚塵防制
- 營建及堆置揚塵管制
- 農業廢棄物燃燒排煙管制

**生活尺度防護**
- 餐飲油煙管制
- 鼓勵少香、少金、少炮

## 移動污染源管制

**個別高污染機械減量**
- 汰換一、二期柴油大貨車
- 三期柴油車加裝濾煙器
- 汰除二行程機車
- 推動電動蔬果運輸車

**其他移動源管制**
- 港區運輸管制

**整體交通排放減量**
- 提升公共運輸使用人次
- 提升軌道貨運運能

# 與「清淨空氣行動計畫」有別之處


## 跨部會共同協力

- 強化大型固定污染源管制
  - 國營事業空氣污染防制設備盤點（中鋼、中油、台電之改善）
  - 加強有害空氣污染物的管制
- 加強個別高污染機械減量
  - 一二期柴油大貨車
- 落實綠色港埠管理機制
- 透過交通運輸改善減少污染排放
  - 提升公共運輸使用人次
  - 提升軌道貨運運能

# 14 + N空氣污染防制策略

## 現階段執行成果

統計至106年11月30日

| 項目 | 改造或汰換商業鍋爐 | 工業鍋爐改善(座) | 餐飲業增設油煙防制設備 | 紙錢集中焚燒數量提高 | 營建工程空污防制設施符合率 | 汰除一、二期柴油車[註2] | 三期柴油車加裝濾煙器[註3] | 汰除二行程機車 | 推動電動蔬果運輸車 |
|---|---|---|---|---|---|---|---|---|---|
| **執行成果** | 133座<br>(僅到10月底) | **經濟部與本署尚規劃推動策略中** | 1,801家<br>(僅到10月底) | 11,905公噸<br>(僅到10月底) | 88.35%[註1]<br>(僅到10月底) | 5,359輛 | 629輛 | 37萬3,400輛 | 283輛<br>(僅到10月底) |
| 106年目標 | 100座 | | 2,500家 | 11,000公噸 | 80%→≧83.3% | 1萬輛 | 8,000輛 | 50萬輛 | 550輛 |
| 年度達成率 | 達標 | | 72% | 達標 | – | 54% | 8% | 75% | 51% |
| 108年累計**總目標** | 1,000座 | 5,000座 | 7,000家 | 2萬2,000公噸 | 90%以上 | 8萬輛 | 3萬8,000輛 | 100萬輛 | 2,100輛 |

註：
1. 總符合率為符合營建工程空氣污染防制設施之工程件數與總查核件數之比率。
2. 汰換補助辦法生效日為106年8月18日，地方環保局已受理補助申請案件2,674件，其餘數量為自然淘汰。
3. 加裝補助辦法生效日為106年8月10日，目前推動主要為本署補助垃圾車示範運行及地方環保局自編經費安裝之數量。

# 空污法修正重點─固定污染源

| 修正重點 | 修正前 | 修正後 | 管制效應 |
|---|---|---|---|
| **燃料、產品污染成分等源頭管制** | 燃料燃燒後空氣污染物排放標準之管末管制 | **從源頭管制：**<br>➢ **限制燃料、輔助燃料之成分及混燒比例。**<br>➢ **限制消費性產品(如油漆、有機溶劑芳香劑等)之VOC含量。** | ➢ **從源頭控管易產生空氣污染物物質。**<br>➢ **燃料的部分，主要針對生煤的含硫量進行管控。** |
| **強化有害空氣污染物管制** | 未強調與其他一般性空氣污染物(如硫氧化物、氮氧化物、揮發性有機物等) 管制之不同作法 | ➢ **明訂排放標準之訂定應含有害空氣染物項目**<br>➢ **明訂有害空氣污氣污染物排放標準值訂定應考量健康風險** | ➢ **更加明確的將健康風險評估納入** |
| **調整罰則、擴大處分對象** | 刑責較輕、處分對象為違規人、罰鍰額度過高不易執行或過低未能有效嚇阻 | ➢ **提高刑責、擴大刑罰管制對象**<br>**由行為人擴大至負責人及監督策劃人**<br>➢ **稻草露天燃燒罰鍰下限從5000元調整為1200元；汽機車未定檢從1500元調整為500元。**<br>➢ **其他對污染影響較大之行為，提高罰鍰額度(如：最高100萬元提升20倍至2000萬元，並追償不當利得)** | ➢ **過去由於罰鍰過高實際並不一直行，例如露天燃燒違規人為較弱勢的農民調低下限能更加落實執行。**<br>➢ **比照水污法提高罰鍰額度，加強嚇阻減少違法行為。** |

# 空污法修正重點─移動污染源

| 修正重點 | 修正前 | 修正後 | 管制效應 |
| --- | --- | --- | --- |
| **加速淘汰老舊車輛** | 提供經濟誘因<br>1.補助一、二期柴油車汰換<br>2.補助三期柴油車加裝濾煙器<br>3.補助二行程機車汰換 | **強制要求規定：加嚴出廠10年以上交通工具之排放標準。** | ➢ **透過排放標準的加嚴淘汰仍在使用當中的高污染老舊交通工具** |
| **擴大管制對象** | 以交通工具為管制對象 | **擴大列管交通工具以外之移動污染源（例如：施工機具、船舶、作業機械等）** | ➢ **除了汽機車以外，其他如施工機具等也是移動污染來源也需一併管制。** |
| **劃設空氣品質維護區** | 無此限制措施 | **環保主管機關得劃設空氣品質維護區，實施移動污染源管制措施** | ➢ **透過空氣品質維護區的劃設，可以限制特定車輛在規定期間不得進入，藉以維護空品或預防空品惡化。** |

# Blue Journal & 民眾衛教

## Glossary

- ✔ **Biomass fuel** refers to any livir and/or animal-based material t energy.
- ✔ **Secondhand smoke** refers to t people breathe when they are smoking.
- ✔ **Chronic bronchitis** refers to ch for three months in each of tw patient in whom other causes excluded.
- ✔ **Chronic obstructive pulmona** emphysema and/or chronic br

## Rx Action Plan

- ✔ Improving household air pollut health and may even prevent s and lung disease in adults, and children.
- ✔ Tell family, friends, healthcare about the dangers of burning i
- ✔ If you must burn fuel in your hc air exchange (ventilation) poss fuel you can get.

**Healthcare Provider's Contac**

## Resources

**United States Environmental Protection Agency (EPA)**

https://www.epa.gov/indoor-air-quality-iaq/clean-cookstoves

https://www.epa.gov/indoor-air-quality-iaq/improving-indoor-air-quality

**World Health Organization: Household (Indoor) Air Pollution**

http://www.who.int/indoorair/en/

**Global Alliance for Clean Cookstoves**

http://cleancookstoves.org/

**American Thoracic Society**

www.thoracic.org/patients/

- COPD
- Prescription Medicines & OTC Medicines to Help You Stop Smoking
- Second-and-Third Hand Smoke

## Who gets sick because of indoor air

People who have allergies and/or asthma experience symptoms related to indoor a could potentially get sick or be affected f People with asthma may notice more ast home if the home has a problem with air also have some of these issues, as can of and healthcare facilities. If the condition make a person's asthma symptoms wors exacerbated asthma (WEA). See the ATS Series fact sheet on WEA at www.thorac

## What are the symptoms caused by

Many symptoms may be associated with problems, including

- Trouble breathing
- Wheezing
- Coughing
- Runny/stuffy nose
- Dry/itchy eyes

## What if I think there is a problem at my child's school?

If you suspect that your child's symptoms are related to indoor air at school, you can start by discussing the issue with a teacher, school nurse, or other parents, to find out if other children are experiencing symptoms as well. You may also wish to speak with your child's healthcare provider. Tools for Schools provided by the United States Environmental Protection Agency provides information to improve the indoor air quality in schools (https://www.epa.gov/iaq-schools).

## I am concerned about the air quality at my job—what can I do?

If you have concerns about the indoor air quality at your workplace, you should discuss this with your supervisor at work and/or your healthcare provider.

For more information about workplace-related lung problems see the American Thoracic Society information sheet on work-related lung diseases (www.thoracic.org/patients).

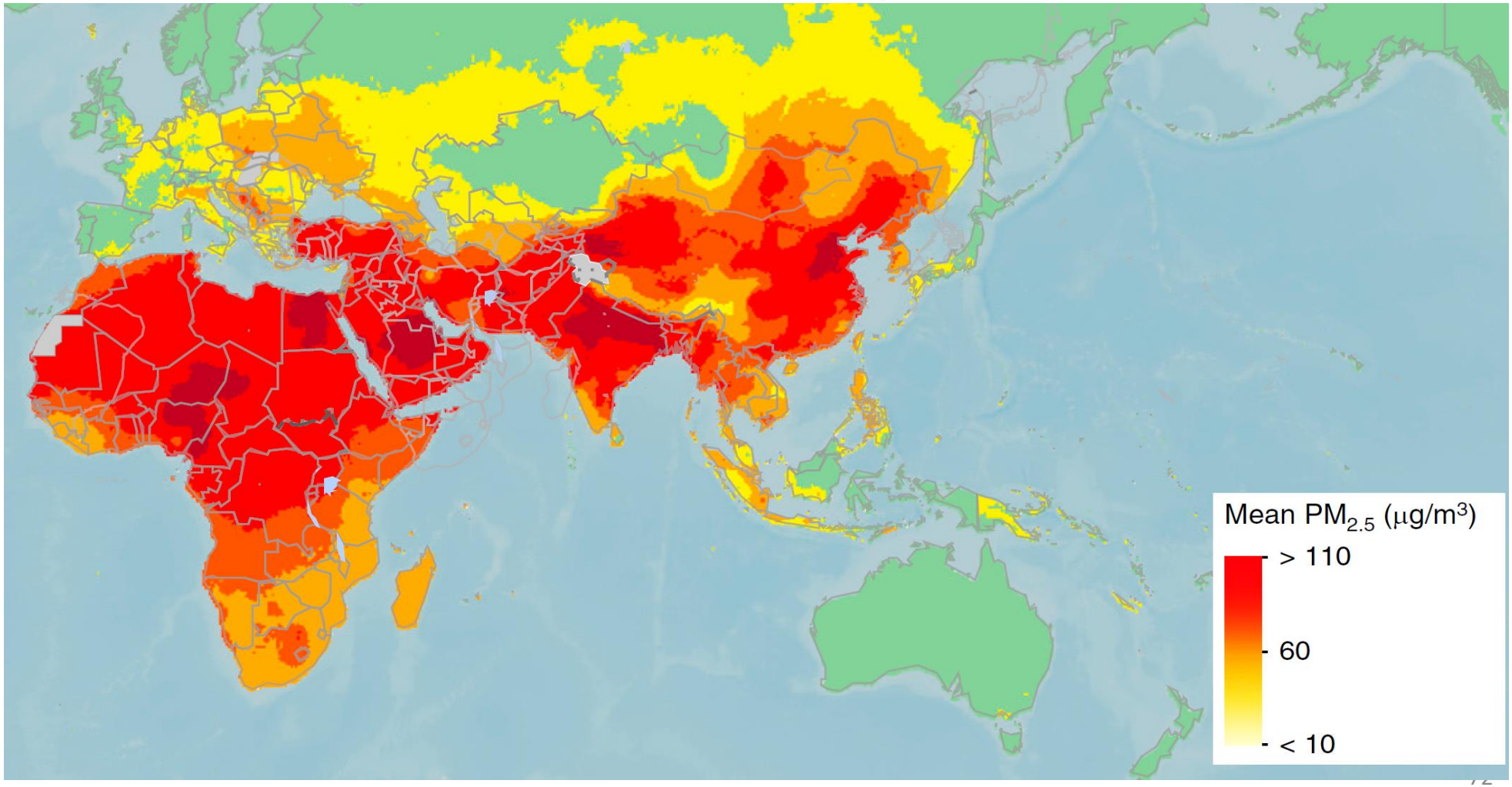
A resource for more information about the indoor air environment in the workplace can be found at the National Institute for Occupational Safety and Health website for Indoor Environmental Quality (https://www.cdc.gov/niosh/topics/indoorenv/default.html).

ATS Pat

Dr. Pin-Kuei Fu

## Air Pollution in the Asia-Pacific Region

A Joint Asian Pacific Society of Respirology/American Thoracic Society



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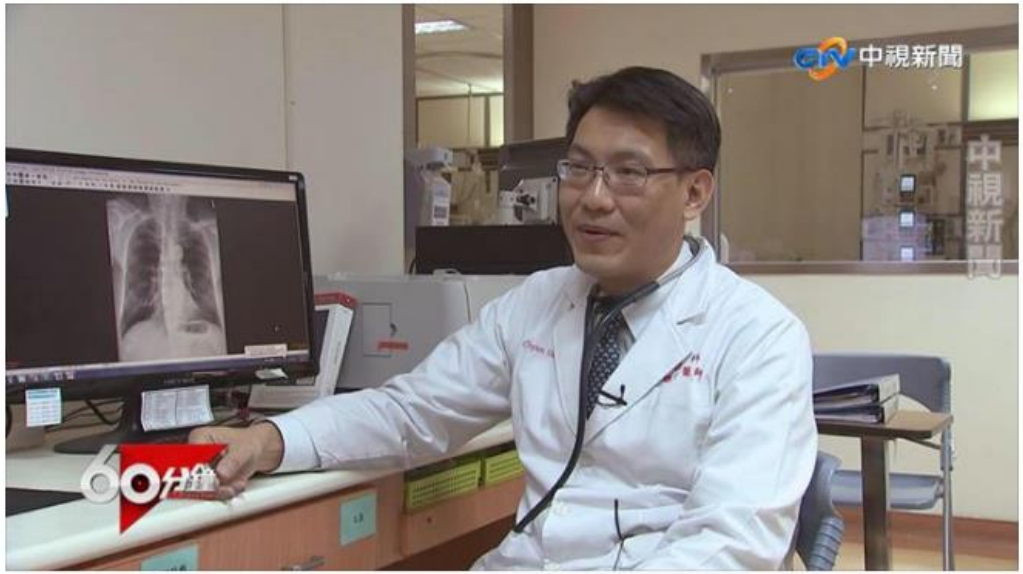
台灣胸腔暨重症加護醫學會

Taiwan Society of Pulmonary and Critical Care Medicine

內政部立案證書台內社字第8905002號




**Jen-Yu Hung**——和 Chau-Chyun Sheu ‧
1月24日 18:21 · 高雄市

台灣胸腔學會重視目前空污問題，成立肺部環境及職業醫學委員會。召集人許超群醫師上電視談空污。

空汙好髒 大口呼吸好毒～

歡迎鎖定【中視主 頻1月27日(六)下午1點《60分鐘》】

於2018年成立【肺部環境及職業醫學委員會】

# Take Home Messages

- **Air pollution** could be classified as:
  - **Indoor** Air pollution; **Ambient** air pollution
- **Pollutants could be classified as:**
  - **Primary air pollutants**: emitted directly from a source
  - **Secondary air pollutants**: not directly emitted as such, but forms when other pollutants (primary pollutants) react in the atmosphere.
- **Air pollution & Health Impact:**
  - significantly effect on **Stroke, Ischemic Heart disease**;
  - **Asthma, COPD, Lung cancer** and **Pneumonia**.

我們需要更多本土研究 學習ATS(AJRCCM)於民眾衛教

# 讓我們為台灣環境的永續一起努力


感謝聆聽，請多指教

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