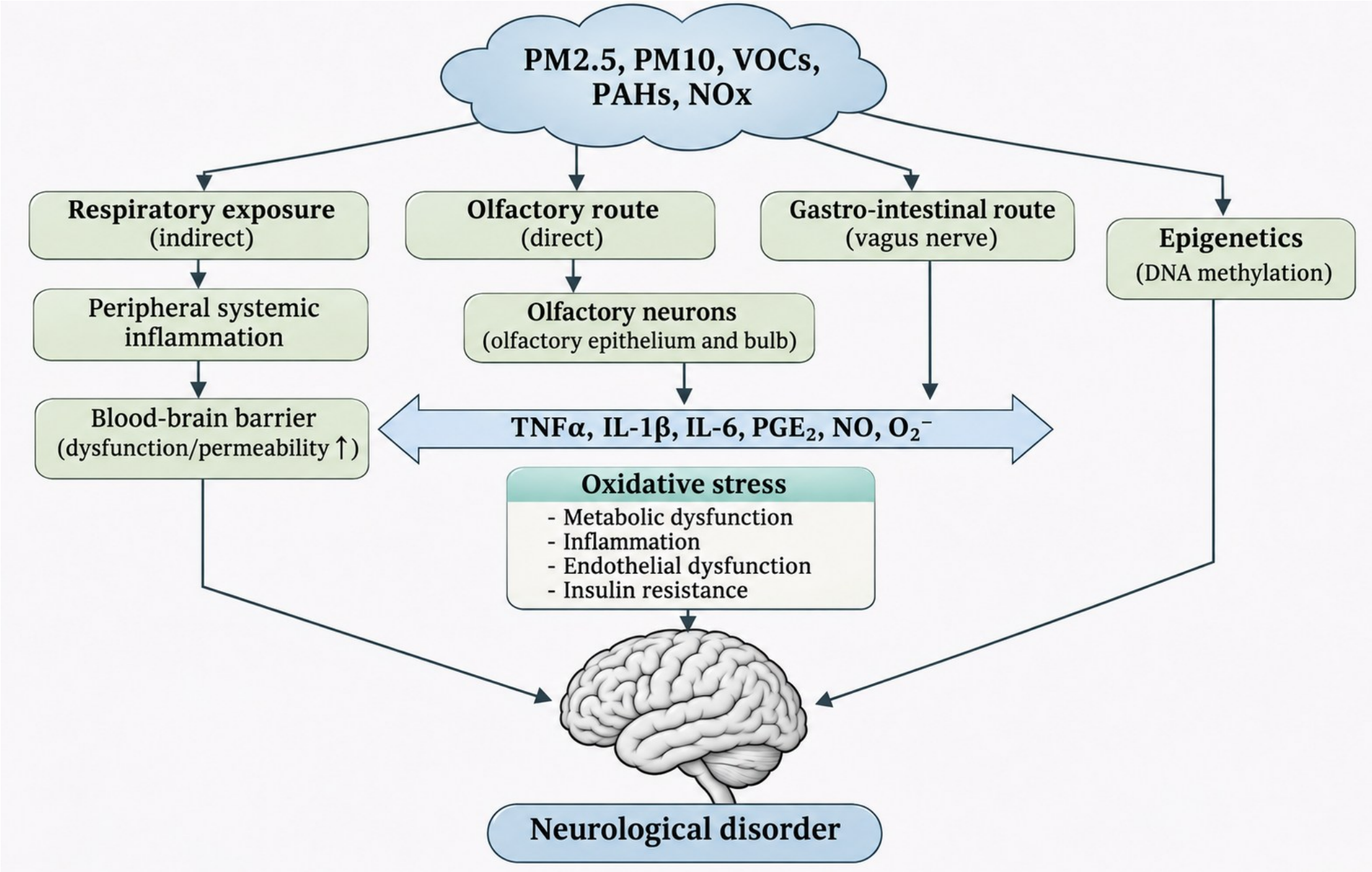
L’impatto sulla salute: i danni d’organo e gli effetti noti e meno noti

Sistema nervoso

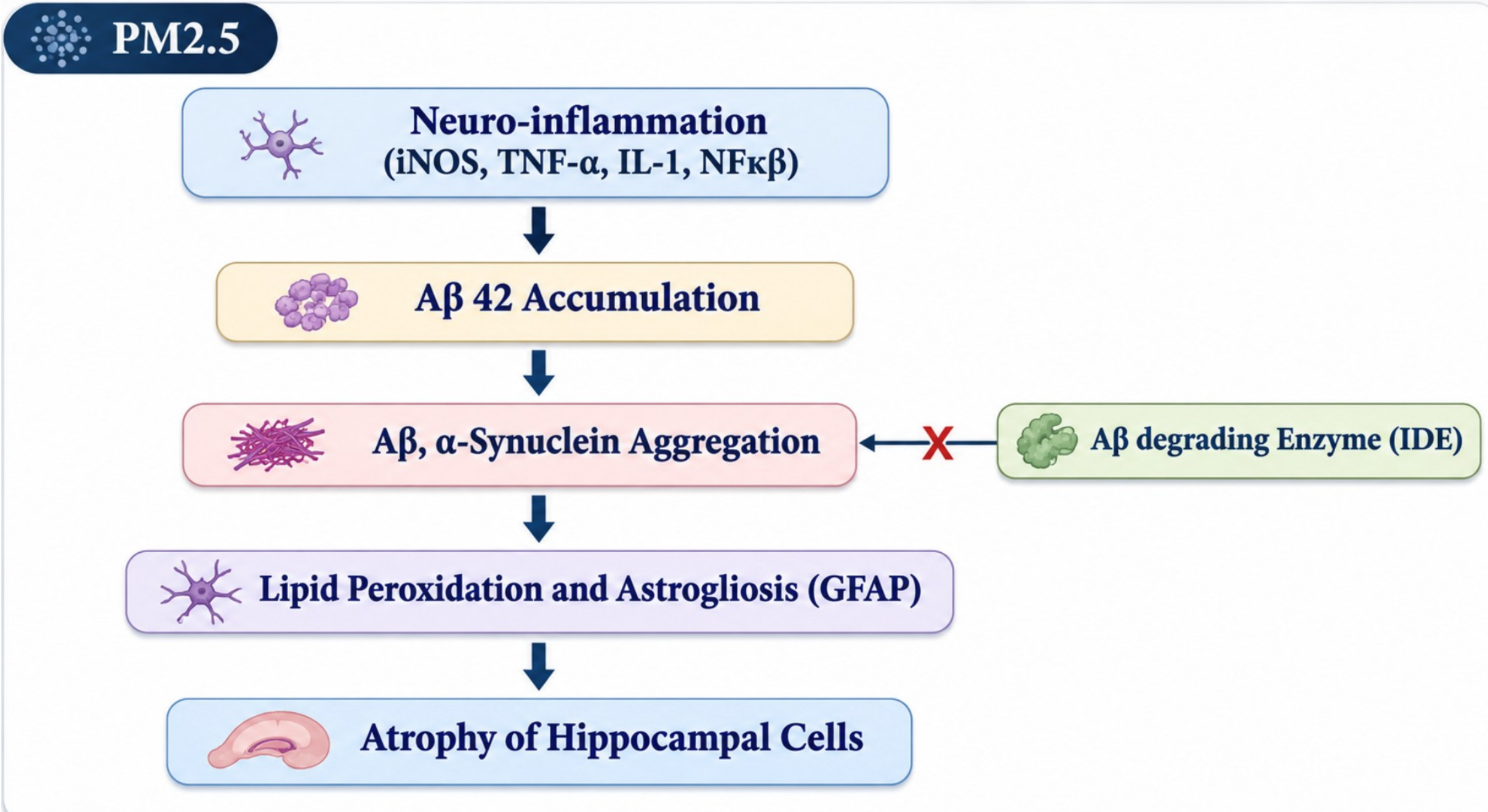
Antonina Luca

Università di Enna Kore

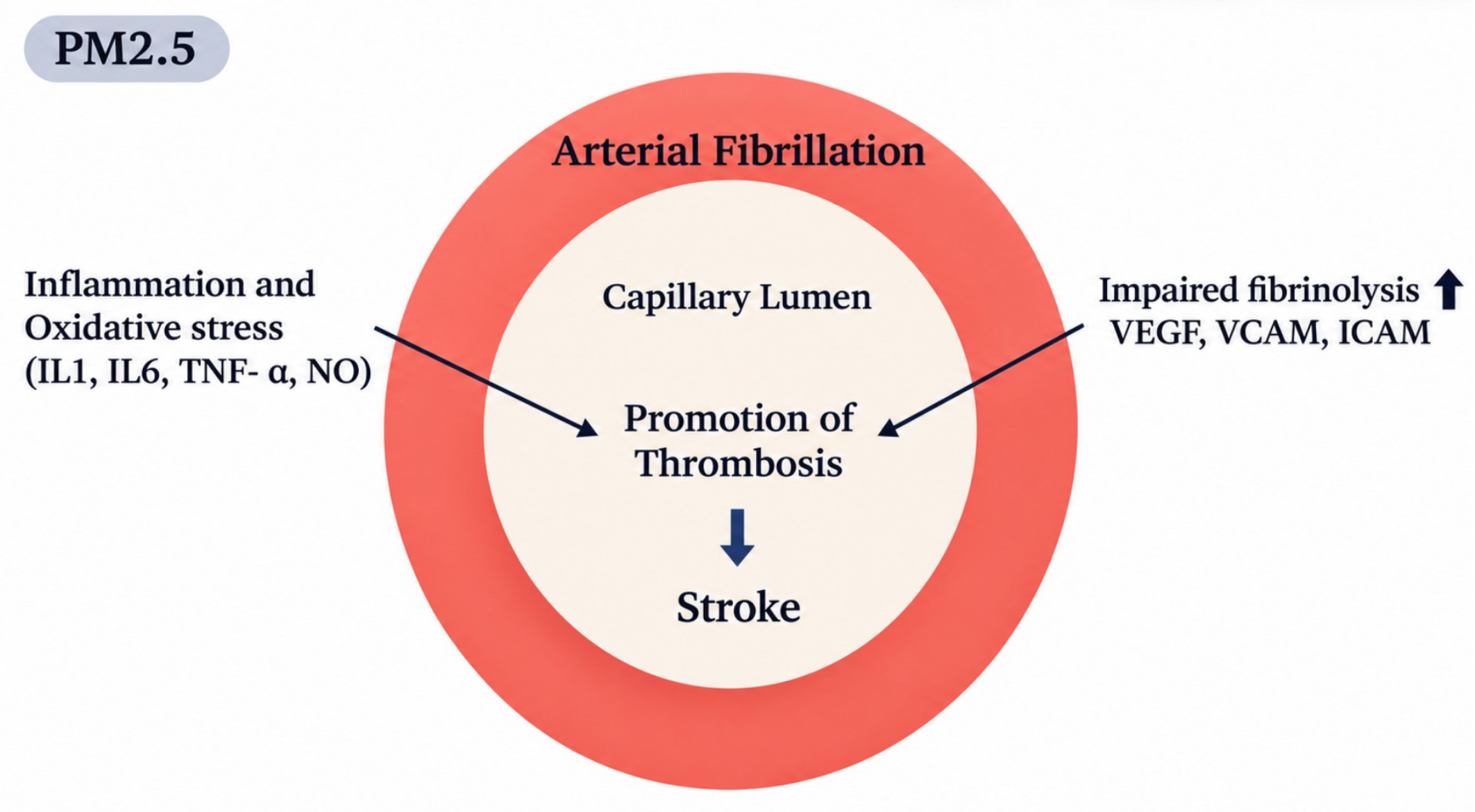




Modified from Kim et al, 2020



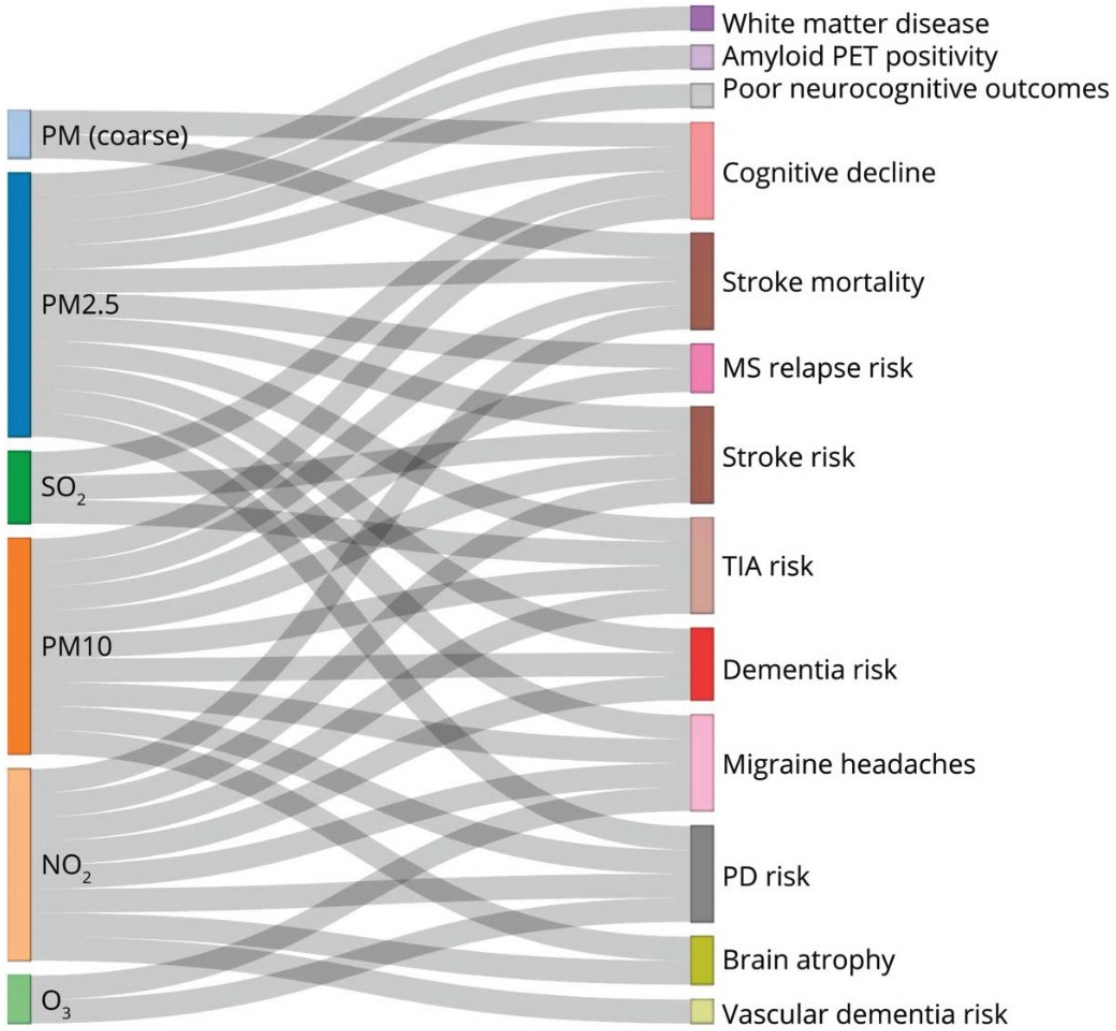
Modified from Kim et al, 2020



Modified from Kim et al, 2020

Impacts of Climate Change and Air Pollution on Neurologic Health, Disease, and Practice





- **PM2.5** is associated with the widest range of neurological outcomes shown.

- **Cerebrovascular effects:** Associations with stroke risk, TIA, and stroke mortality.

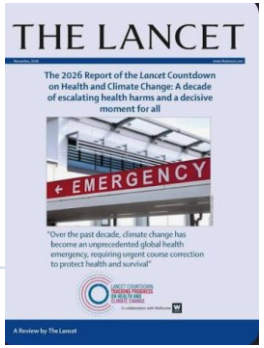
- **Cognitive and neurodegenerative effects:** Associations with cognitive decline, dementia, and Parkinson's disease risk.

- **Broader neurological effects:** Involvement of white matter, migraine, and multiple sclerosis.

Louis et al, 2023

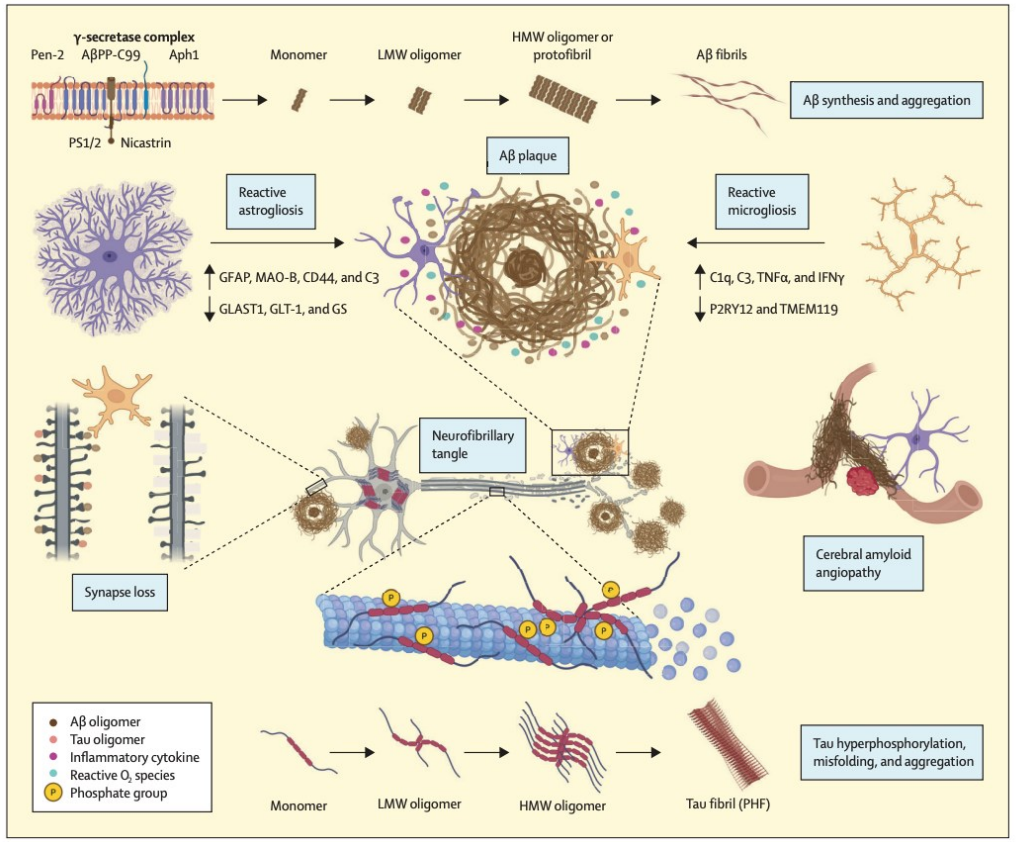
Alzheimer's disease

Alberto Serrano-Pozo, Valentina Escott-Price, Lea T Grinberg, Tharick Pascoal, Marc Suárez-Calvet, Bruno Dubois, Reisa A Sperling



A progressive neurodegenerative disorder and the leading cause of dementia.

- Progressive decline in memory and other cognitive domains with increasing impairment of daily functioning and autonomy
- Amyloid-β plaques and tau neurofibrillary tangles
- Synaptic loss, neuronal degeneration and brain atrophy



Alberto Serrano-Pozo et al, 2026

Burden of Dementia in Europe, 1990–2023: a systematic analysis from the Global Burden of Disease Study 2023

Daniele Urso,[a,b,*] Emma Nichols,[c,d] Stefano Giannoni-Luza,[a,e] Carol Brayne,[f] Nicolas Ray,[b] and Giancarlo Logroscino[a,e]



Dementia burden **worldwide**
(GBD 2023)

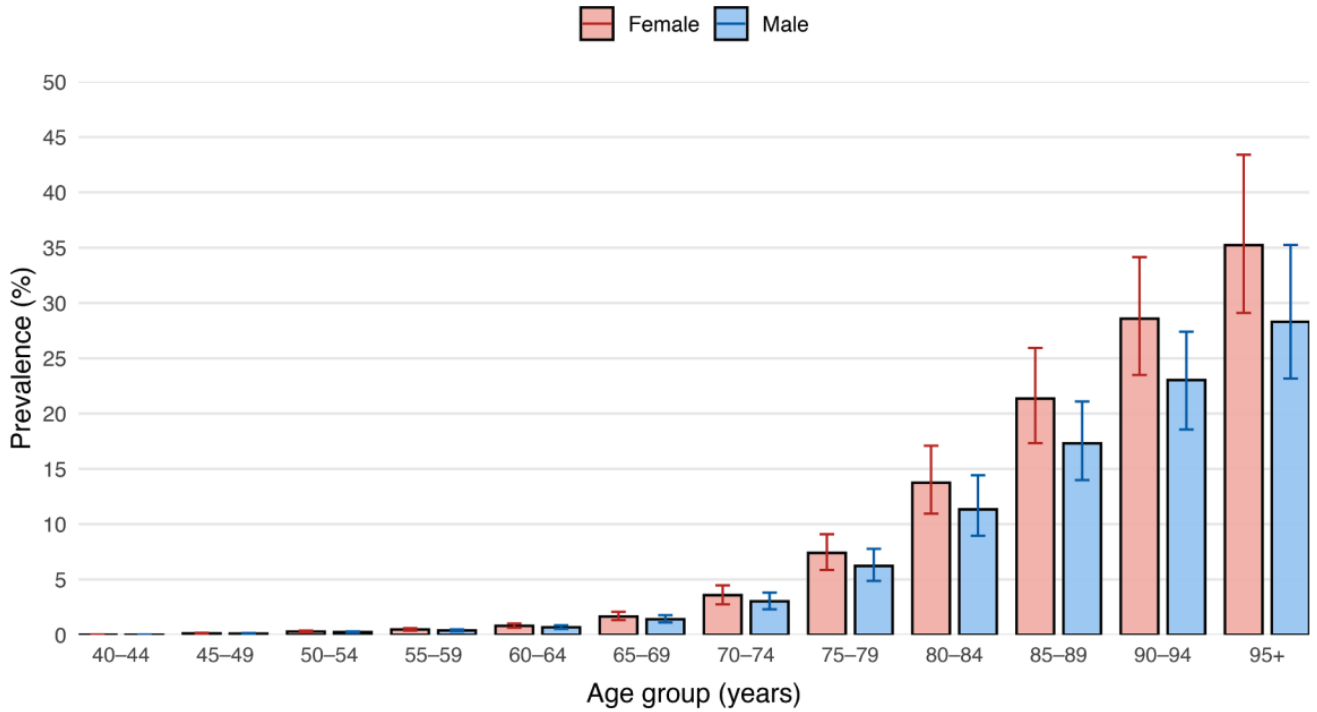
57.4 million
people living with dementia

Dementia burden in **Europe**
(EU-27, GBD 2023)

7.76 million
people living with dementia

+88.5%
increase in prevalent cases since 1990

5.49 million
disability-adjusted life years (DALYs)



Urso et al, 2026

JAMA Internal Medicine | Original Investigation

Comparison of Particulate Air Pollution From Different Emission Sources and Incident Dementia in the US

Boya Zhang, PhD; Jennifer Weuve, ScD; Kenneth M. Langa, MD, PhD; Jennifer D'Souza, PhD; Adam Szpiro, PhD; Jessica Faul, PhD; Carlos Mendes de Leon, PhD; Jiaqi Gao, MPH; Joel D. Kaufman, MD; Lianne Sheppard, PhD; Jinkook Lee, PhD; Lindsay C. Kobayashi, PhD; Richard Hirth, PhD; Sara D. Adar, ScD

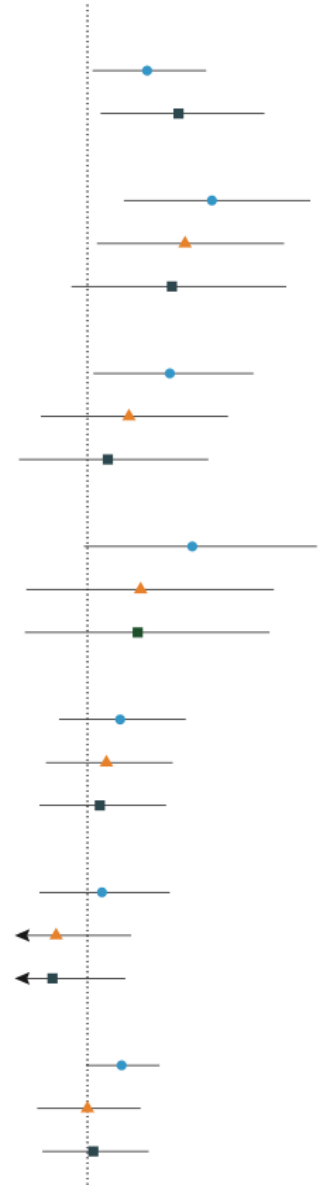
OBJECTIVE To examine associations of long-term exposure of total and source-specific $PM_{2.5}$ with incident dementia in older adults.

DESIGN, SETTING, AND PARTICIPANTS The Environmental Predictors of Cognitive Health and Aging study used biennial survey data from January 1, 1998, to December 31, 2016, for participants in the Health and Retirement Study, which is a nationally representative, population-based cohort study in the US. The present cohort study included all participants older than 50 years who were without dementia at baseline and had available exposure, outcome, and demographic data between 1998 and 2016 (N = 27 857). Analyses were performed from January 31 to May 1, 2022.

EXPOSURES The 10-year mean total $PM_{2.5}$ and $PM_{2.5}$ from 9 emission sources at participant residences for each month during follow-up using spatiotemporal and chemical transport models.

Characteristic	All (N = 27 857)	Dementia free during follow-up (n = 23 752)	Incident dementia during follow-up (n = 4105)
Follow-up time, mean (SD), y	10.2 (5.6)	10.5 (5.6)	8.3 (5.1)
Age at baseline, mean (SD), y	61 (10)	60 (9)	68 (10)
Sex			
Female	15 747 (56.5)	13 236 (55.7)	2511 (61.2)
Male	12 110 (43.5)	10 516 (44.3)	1594 (38.8)

Source (IQR)	HR (95% CI)
Total $PM_{2.5}$ (9.5-13.2)	
Model 1	1.08 (1.01-1.17)
Model 3	1.12 (1.02-1.24)
Agriculture (0.6-1.7)	
Model 1	1.17 (1.05-1.30)
Model 2	1.13 (1.01-1.27)
Model 3	1.12 (0.98-1.27)
Road traffic (1.1-1.7)	
Model 1	1.11 (1.01-1.23)
Model 2	1.06 (0.94-1.19)
Model 3	1.03 (0.91-1.17)
Nonroad traffic (0.3-0.5)	
Model 1	1.14 (1.00-1.32)
Model 2	1.07 (0.92-1.26)
Model 3	1.07 (0.91-1.25)
Energy coal (0.5-1.1)	
Model 1	1.05 (0.96-1.14)
Model 2	1.03 (0.94-1.12)
Model 3	1.02 (0.93-1.11)
Energy other (0.4-0.7)	
Model 1	1.02 (0.93-1.11)
Model 2	0.96 (0.87-1.06)
Model 3	0.95 (0.86-1.05)
Industry coal (0.2-0.3)	
Model 1	1.05 (1.00-1.10)
Model 2	1.00 (0.93-1.07)
Model 3	1.01 (0.94-1.08)

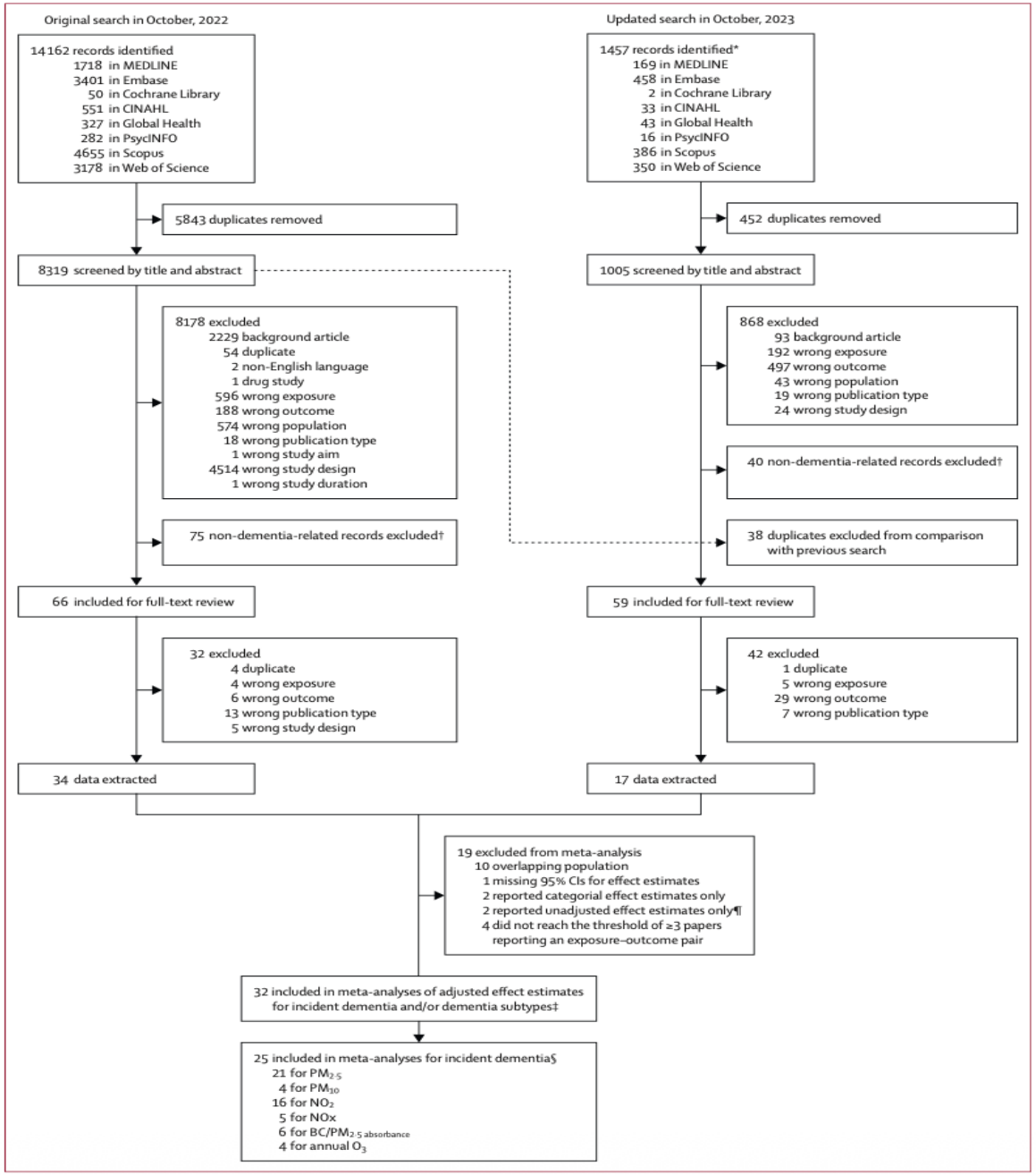


Zhang et al, 2023

Long-term air pollution exposure and incident dementia: a systematic review and meta-analysis

Clare B Best Rogowski, Christiaan Bredell*, Yan Shi, Alexandra Tien-Smith, Magdalena Szybka, Kwan Wai Fung, Lucy Hong, Veronica Phillips, Zorana Jovanovic Andersen, Stephen J Sharp, James Woodcock, Carol Brayne, Annalan Navaratnam, Haneen Khreis*

Methods In this systematic review and meta-analysis, we searched MEDLINE, Embase, Cochrane Library, CINAHL, Global Health, PsycINFO, Scopus, and Web of Science Core Collection from database inception up to Oct 23, 2023, for primary observational studies of adults (aged ≥18 years) that provided a quantitative analysis of the association between long-term (≥1 year) exposure to outdoor air pollutants and a subsequent physician diagnosis of dementia. When three or more independent studies reported an exposure–outcome pair, effect estimates of the association were extracted and harmonised to a prespecified exposure increment, and included in inverse-variance weighted random-effects meta-analyses. Between-study inconsistency was assessed using the I^2 statistic and the Cochran Q test. Study-level risk of bias and confidence in the overall body of evidence were assessed with the Office of Health Assessment and Translation tool, and publication bias was examined. The protocol for this review was registered with PROSPERO, CRD42023414413.



Rogowski et al, 2025

Long-term air pollution exposure and incident dementia: a systematic review and meta-analysis

Clare B Best Rogowski, Christiaan Bredell*, Yan Shi, Alexandra Tien-Smith, Magdalena Szybka, Kwan Wai Fung, Lucy Hong, Veronica Phillips, Zorana Jovanovic Andersen, Stephen J Sharp, James Woodcock, Carol Brayne, Annalan Navaratnam, Haneen Khreis*

Figure 3: **Random-effects meta-analysis of adjusted effect estimates for NO_2**

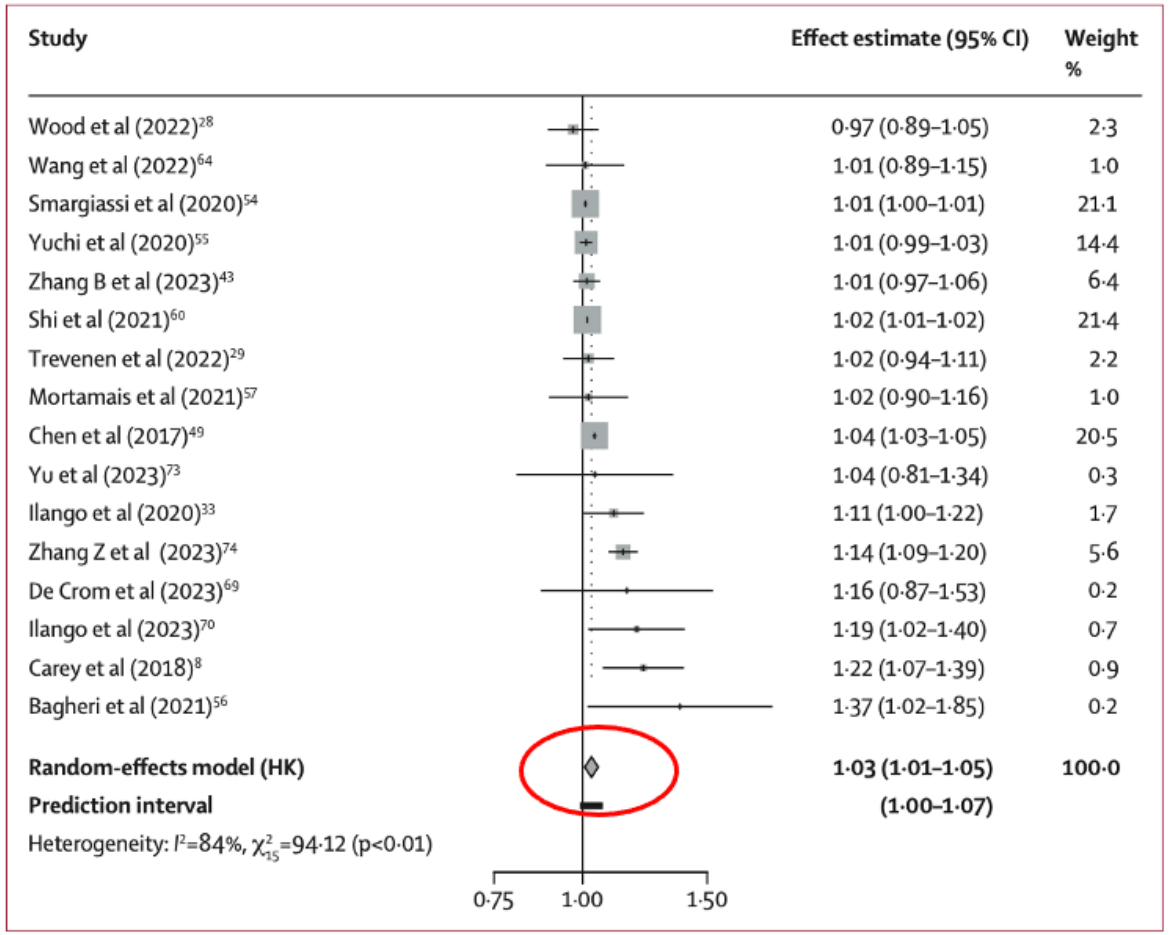
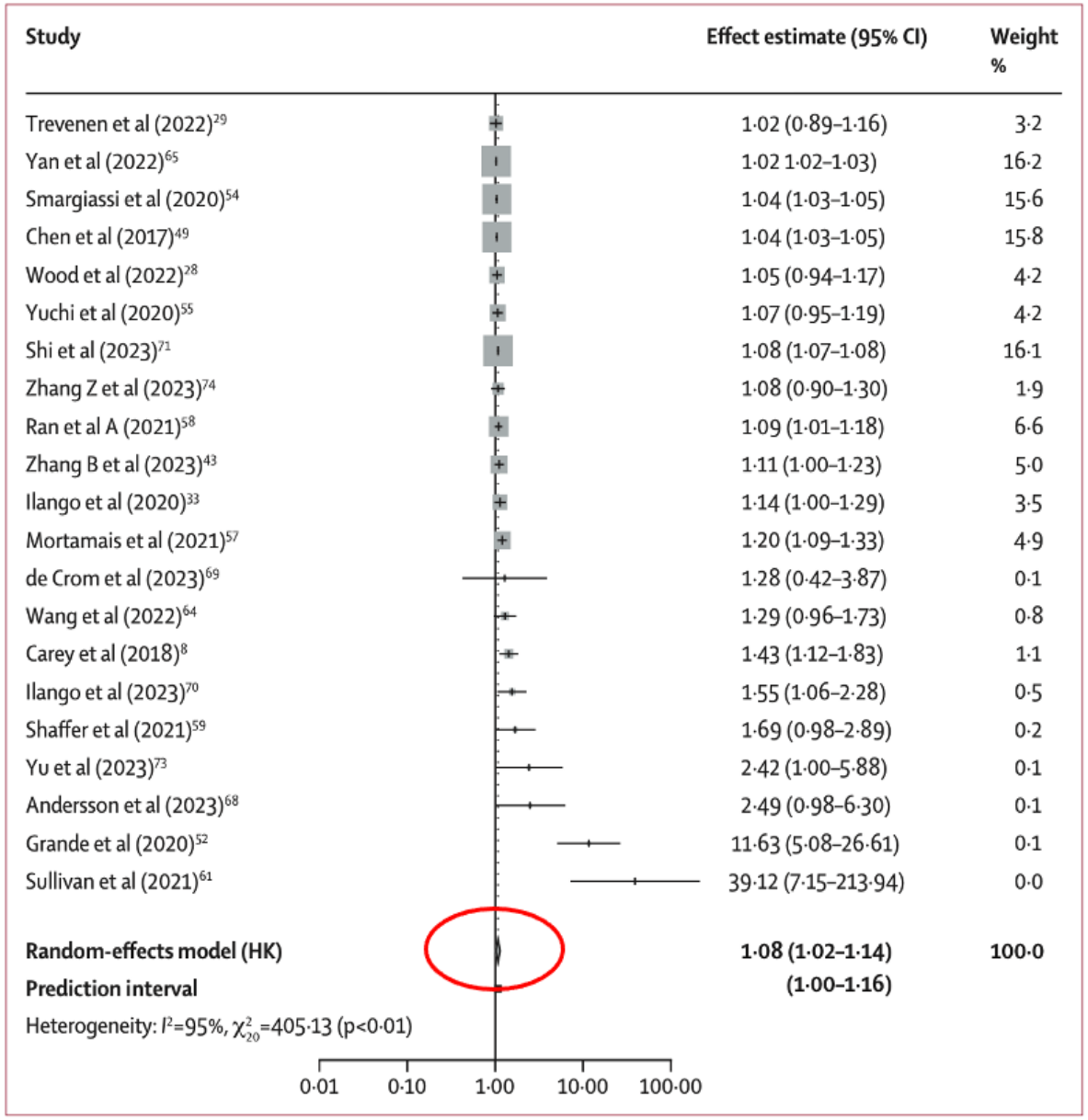


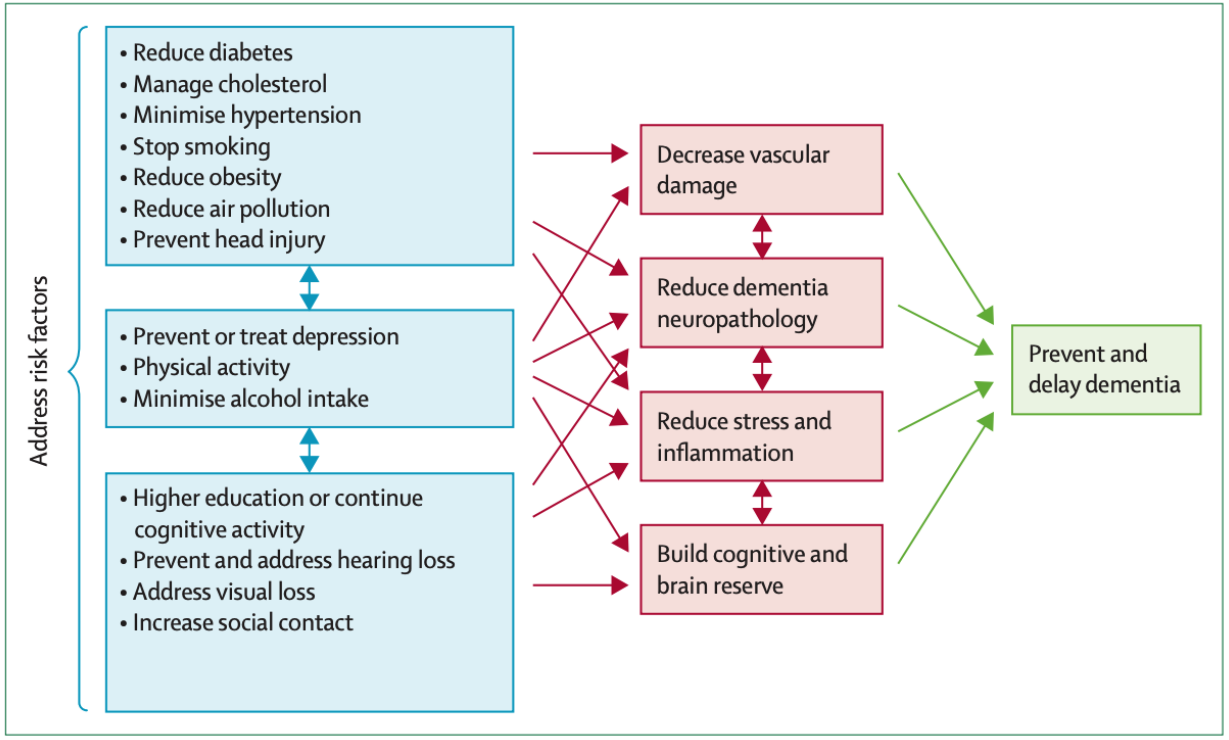
Figure 2: **Random-effects meta-analysis of adjusted effect estimates for $PM_{2·5}$**

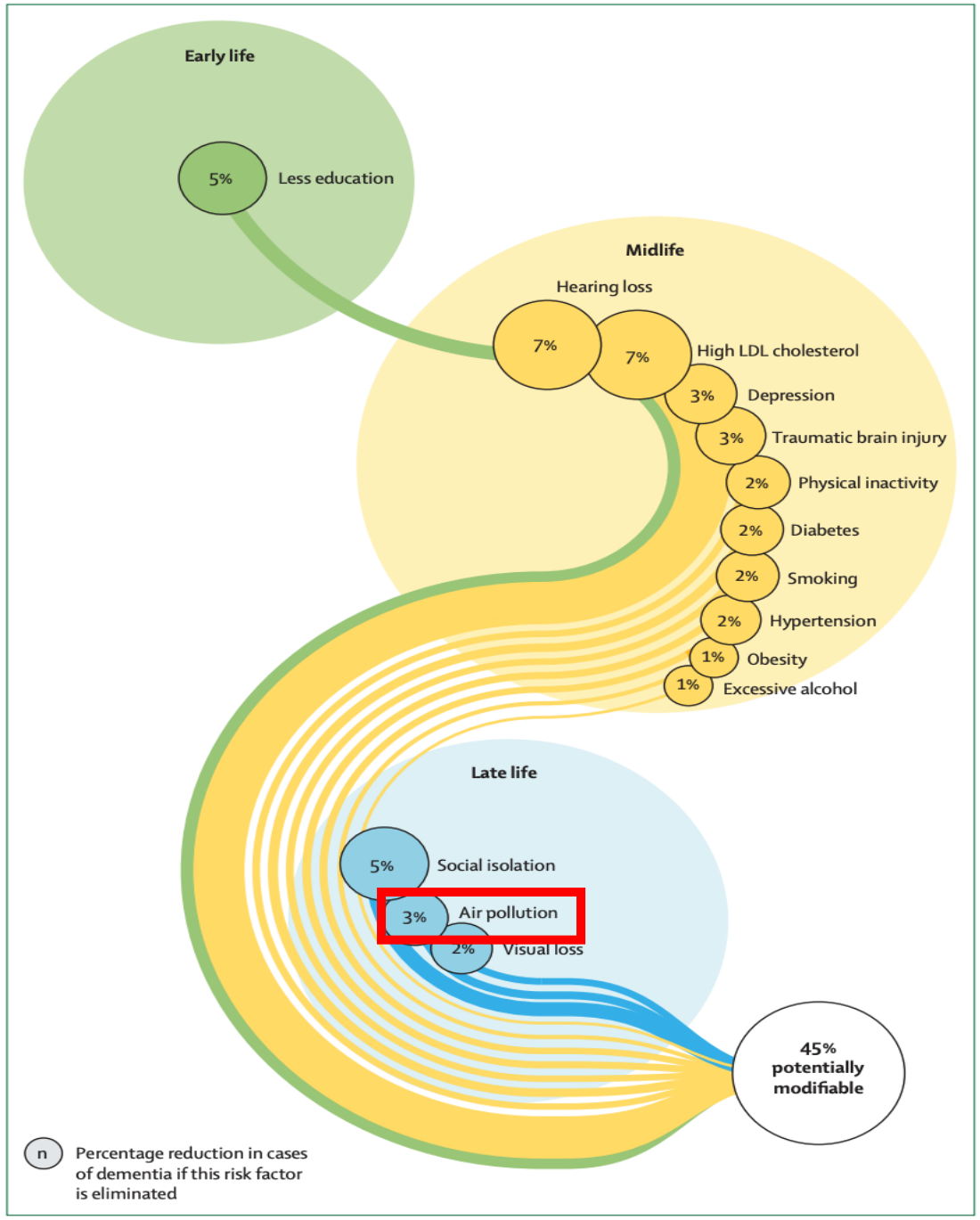


Rogowski et al, 2025

Dementia prevention, intervention, and care: 2024 report of the *Lancet* standing Commission

Gill Livingston, Jonathan Huntley, Kathy Y Liu, Sergi G Costafreda, Geir Selbæk, Suvarna Alladi, David Ames, Sube Banerjee, Alistair Burns, Carol Brayne, Nick C Fox, Cleusa P Ferri, Laura N Gitlin, Robert Howard, Helen C Kales, Mika Kivimäki, Eric B Larson, Noeline Nakasujja, Kenneth Rockwood, Quincy Samus, Kokoro Shirai, Archana Singh-Manoux, Lon S Schneider, Sebastian Walsh, Yao Yao, Andrew Sommerlad, Naaheed Mukadam**





Parkinson Disease

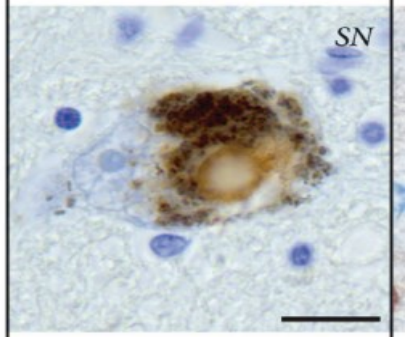
Ashley Rawls, MD, MS , and Michael S. Okun, MD, FAAN



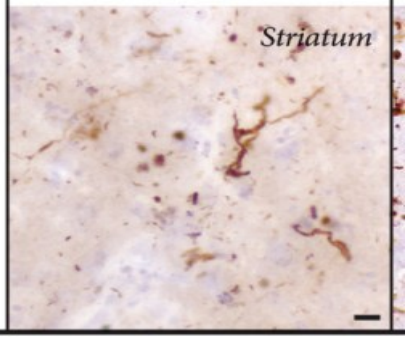
Progressive neurodegenerative disorder characterized by dopaminergic neuronal loss in the substantia nigra and abnormal α-synuclein aggregation.

- **Motor symptoms**
- Bradykinesia
- Resting tremor
- Rigidity
- Postural instability and gait disturbances
- **Non-motor symptoms**
- Hyposmia, constipation, and REM sleep behavior disorder
- Depression, anxiety, and sleep disturbances
- Autonomic dysfunction
- Cognitive impairment and dementia

Clinical	Parkinson's disease (PD)
Age of Onset (years)	~60
Duration (years)	~12
Motor signs	All
L-dopa responsive	Yes
Non-motor signs	
Autonomic	Late
Hallucinations	Late
Olfactory dysfunction	Early
Dementia	Late
Main synucleinopathies	NCIs



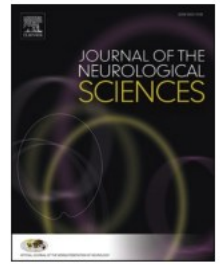
Neurites



McCann et al, 2014

Global, regional and national burden of Parkinson's disease, 1990–2021: Update from the GBD 2021 study

Rong Yang [a,b,c,1], Mou Sun [a,b,c,1], Wen Chen [a,d], Hao Feng [a,b,c], Bing Chen [a,b,c], Yi Liu [a,b,c], Qiuguo He [a,b,c], Lin Wang [a,b,c], Chengong Zou [a,b,c], Xiaoquan Luo [a,b,c], Zhou Li [a,b,c], Anhui Fu [a,b,c], Fei Qiao [a,b,c], Hui Tang [a,b,c], Jing Yang [e,**], Haibo Ren [a,b,c,*]



Parkinson's disease burden worldwide
(GBD 2021)

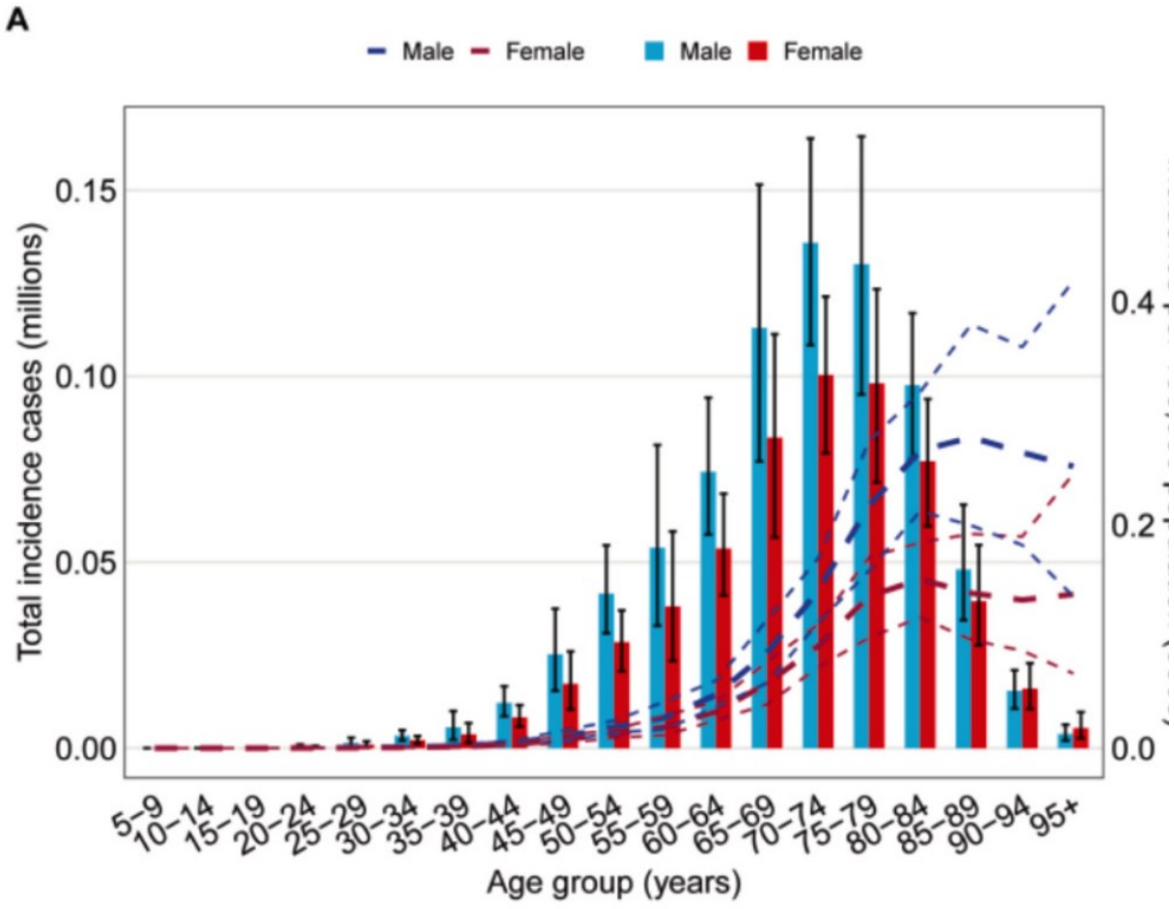
11.77 million
people living with Parkinson's disease

+273.75%
increase in prevalent cases since 1990

7.47 million
disability-adjusted life years (DALYs)

Western Europe — GBD 2021

180.27 per 100,000
age-standardized prevalence rate (2021)



Yang et al, 2026

JAMA Network | Open

Original Investigation | Neurology

Air Pollution and Parkinson Disease in a Population-Based Study

Key Points

Question Is air pollution in the form of particulate matter with a diameter of 2.5 μm or less ($PM_{2.5}$) and nitrogen dioxide (NO_2) associated with the risk and clinical characteristics of Parkinson disease (PD)?

Findings This case-control study including 346 patients with PD matched with 4813 controls found that $PM_{2.5}$ and NO_2 exposure was associated with statistically significant increases in PD risk and risk of developing dyskinesia. Higher exposure to $PM_{2.5}$ was associated with a statistically significant increase in risk of the akinetic rigid PD subtype in subcohort analysis among patients with PD.

Table 2. Association Between Mean Annual $PM_{2.5}$ and NO_2 Exposure and Risk of PD Using Logistic Regression

Air pollutant	Exposure, μg/m³, range	All PD cases and controls		Metropolitan populations only	
		OR (95% CI)[a]	*P* value	OR (95% CI)[b]	*P* value
$PM_{2.5}$, quintile					
First (lowest)	5.05-8.55	1 [Reference]	NA	1 [Reference]	NA
Second	8.56-9.20	1.035 (1.01-1.06)	.002	1.10 (1.00-1.21)	.04
Third	9.21-9.77	1.07 (1.05-1.01)	<.001	1.15 (1.06-1.26)	.001
Fourth	9.78-10.48	1.10 (1.07-1.13)	<.001	1.17 (1.08-1.28)	<.001
Fifth (highest)	10.49-17.43	1.14 (1.11-1.18)	<.001	1.23 (1.11-1.35)	<.001
$PM_{2.5}$, spline, per 1-μg/m³ increase					
1	5.05-10.60	1.05 (1.04-1.06)	<.001	1.05 (1.03-1.08)	<.001
2	10.61-17.43	1.01 (1.00-1.03)	.01	1.01 (0.98-1.05)	.47
NO_2, quintile					
First (lowest)	4.64-13.57	1 [Reference]	NA	1 [Reference]	NA
Second	13.58-16.17	1.02 (0.97-1.06)	.46	1.02 (0.96-1.08)	.56
Third	16.18-18.25	1.02 (0.98-1.06)	.45	1.02 (0.96-1.08)	.54
Fourth	18.25-20.69	1.05 (1.01-1.10)	.03	1.02 (0.97-1.08)	.46
Fifth (highest)	20.70-48.51	1.13 (1.07-1.19)	<.001	1.11 (1.04-1.19)	.002

Krzyzanowski et al, 2024

JAMA Network | Open

Original Investigation | Neurology

Air Pollution and Parkinson Disease in a Population-Based Study

Figure 1. Risk of Parkinson Disease (PD) vs Controls by Mean Annual Exposure to Particulate Matter With a Diameter of 2.5 µm or Less ($PM_{2.5}$)

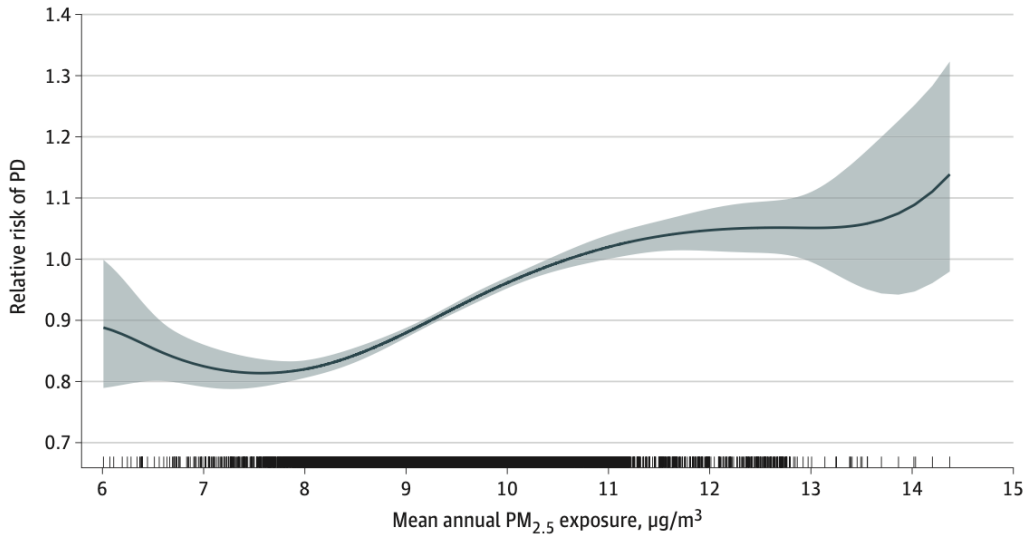
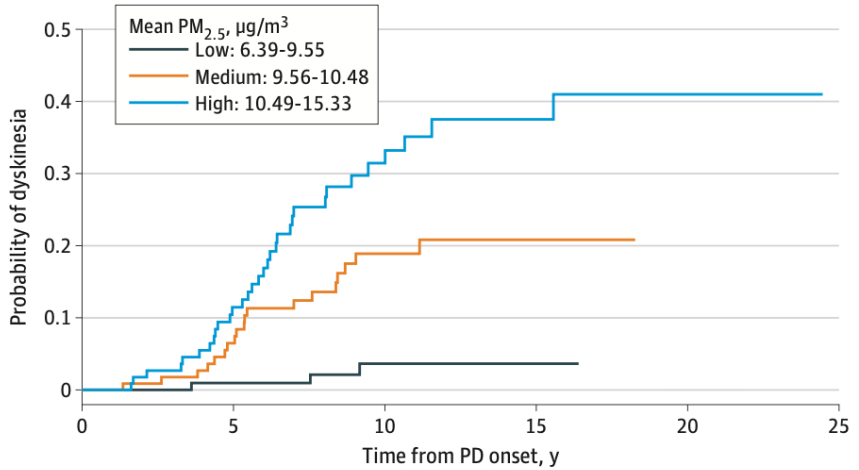


Figure 2. Kaplan-Meier Cumulative Incidence of Dyskinesia Among Patients With Parkinson Disease (PD) by Tertiles of Exposure to Particulate Matter With a Diameter of 2.5 µm or Less ($PM_{2.5}$)



No. at risk						
Low	115	99	52	2	0	0
Medium	115	97	53	10	0	0
High	116	85	40	19	5	0

Krzyzanowski et al, 2024

Contents lists available at ScienceDirect

Journal of Stroke and Cerebrovascular Diseases

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



Discrimination of ischemic versus hemorrhagic stroke type by presenting symptoms or signs: A systematic review and meta-analysis

Clodagh M McDermott, MSc [a,b,*], Allie Seminer [a], Sinéad Comer [a], Alfredi Mulihano [a], Catriona Reddin, MSc [a,b], Conor Judge, PhD [a,b], Maria Costello, PhD [a,b], Michelle Canavan, PhD [a,b], Andrew Smyth, PhD [a,b], Paul Hurley, PhD [c,d], Finn Krewer, PhD [a], Martin J O'Donnell, PhD [a,b]

Acute neurological injury caused by an interruption of cerebral blood flow or rupture of a cerebral blood vessel.

Ischemic stroke

Arterial occlusion → cerebral infarction

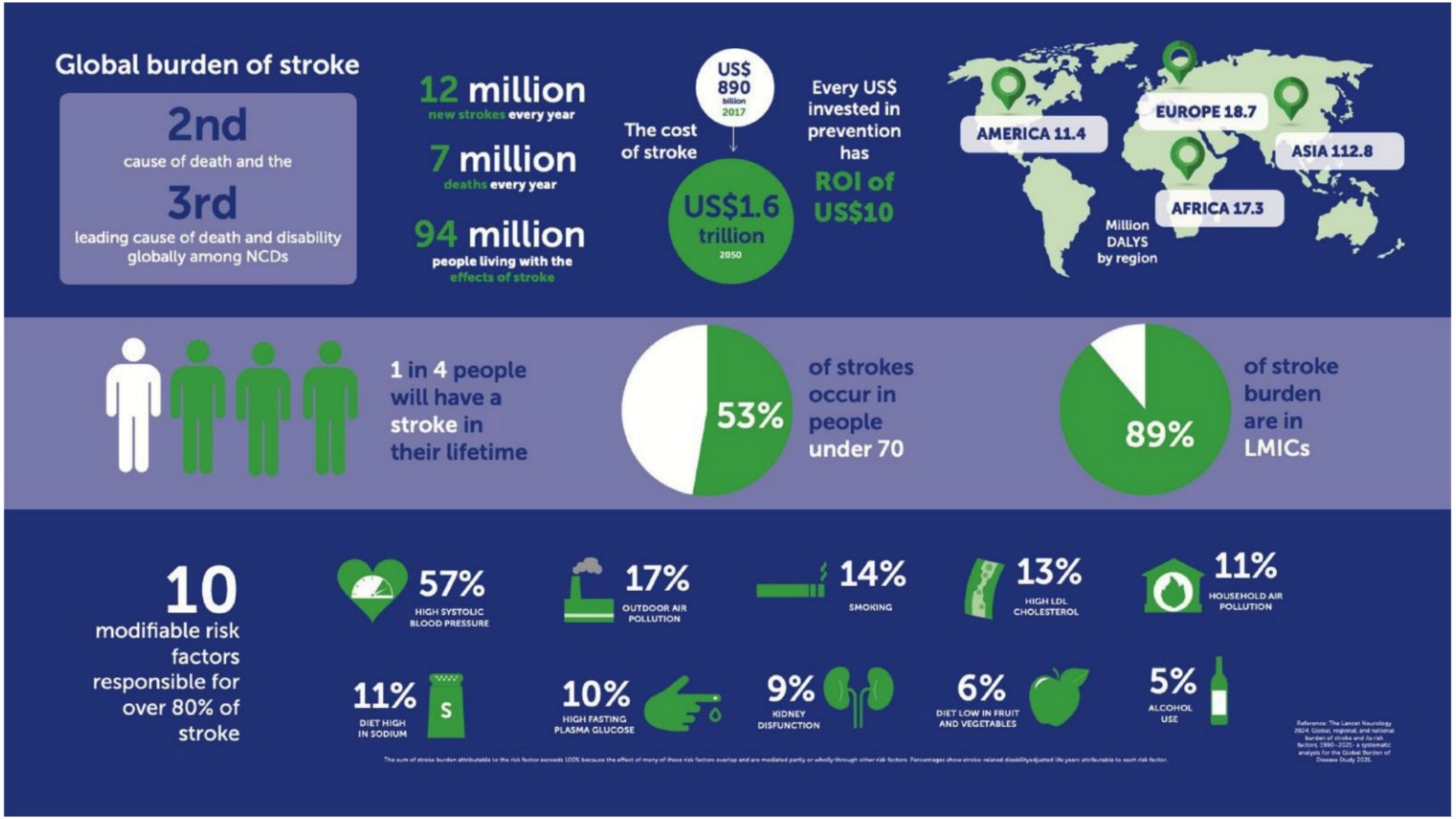
- **Large-artery atherosclerosis**
  Atherothrombosis or artery-to-artery embolism
- **Cardioembolism**
  e.g., atrial fibrillation
- **Small-vessel occlusion**
  Lacunar infarction
- **Other or undetermined causes**
  e.g., dissection or cryptogenic stroke

Hemorrhagic stroke

Vessel rupture → intracranial bleeding

- **Intracerebral hemorrhage**
  Hypertension; cerebral amyloid angiopathy
- **Subarachnoid hemorrhage**
  Most often rupture of an intracranial aneurysm
- **Other causes**
  Vascular malformations or coagulopathy

World Stroke Organization: Global Stroke Fact Sheet 2025



Feigin et al, 2025

Short term exposure to air pollution and stroke: systematic review and meta-analysis

Anoop S V Shah,[1] Kuan Ken Lee,[1] David A McAllister,[2] Amanda Hunter,[1] Harish Nair,[2] William Whiteley,[3] Jeremy P Langrish,[1] David E Newby,[1] Nicholas L Mills[1]

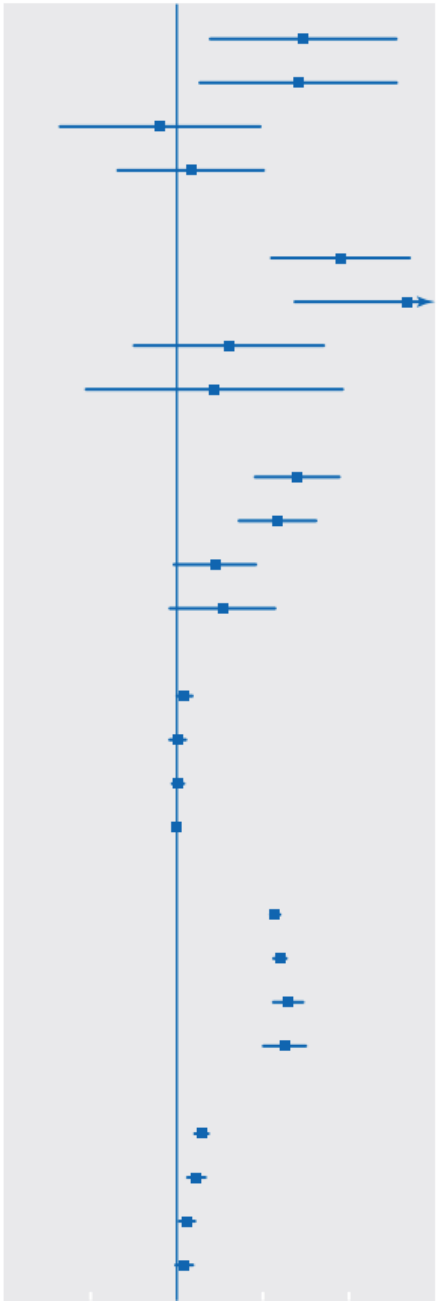
ELIGIBILITY CRITERIA

Studies investigating the short term associations (up to lag of seven days) between daily increases in gaseous pollutants (carbon monoxide, sulphur dioxide, nitrogen dioxide, ozone) and particulate matter (<2.5 μm or <10 μm diameter ($PM_{2.5}$ and PM_{10})), and admission to hospital for stroke or mortality.

RESULTS

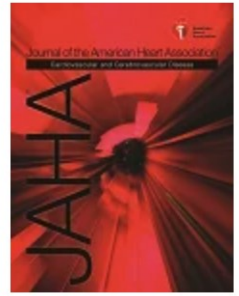
From 2748 articles, 238 were reviewed in depth with 103 satisfying our inclusion criteria and 94 contributing to our meta-estimates. This provided a total of 6.2 million events across 28 countries.

	No of events	No of estimates	Relative risk (95% CI)	I
CO (per 1 ppm increment)				
Overall	2 010 272	37	1.015 (1.004 to 1.026)	6
Lag 0	1 719 291	24	1.014 (1.003 to 1.026)	6
Lag 1	1 488 861	23	0.998 (0.986 to 1.010)	7
Lag 2	1 515 116	18	1.002 (0.993 to 1.010)	4
SO_2 (per 10 ppb increment)				
Overall	1 791 159	52	1.019 (1.011 to 1.027)	3
Lag 0	800 628	27	1.027 (1.014 to 1.040)	3
Lag 1	711 955	26	1.006 (0.995 to 1.017)	3
Lag 2	654 676	22	1.004 (0.989 to 1.019)	3
NO_2 (per 10 ppb increment)				
Overall	2 012 159	70	1.014 (1.009 to 1.019)	5
Lag 0	1 175 010	40	1.012 (1.008 to 1.016)	1
Lag 1	783 556	34	1.004 (0.999 to 1.009)	1
Lag 2	700 551	27	1.005 (0.999 to 1.011)	1
O_3 (per 10 ppb increment)				
Overall	1 234 335	53	1.001 (1.000 to 1.002)	5
Lag 0	433 935	29	1.000 (0.999 to 1.001)	
Lag 1	236 551	23	1.000 (1.000 to 1.001)	2
Lag 2	82 199	16	1.000 (1.000 to 1.000)	
$PM_{2.5}$ (per 10 μg/m^3 increment)				
Overall	2 476 524	41	1.011 (1.011 to 1.012)	8
Lag 0	1 963 515	29	1.012 (1.011 to 1.013)	8
Lag 1	803 394	22	1.013 (1.011 to 1.015)	6
Lag 2	697 365	15	1.013 (1.010 to 1.015)	7
PM_{10} (per 10 μg/m^3 increment)				
Overall	2 607 993	78	1.003 (1.002 to 1.004)	2
Lag 0	1 405 957	43	1.002 (1.001 to 1.003)	1
Lag 1	864 448	33	1.001 (1.000 to 1.002)	1
Lag 2	694 772	24	1.001 (1.000 to 1.002)	1



Long-Term $PM_{2.5}$ Exposure and Risks of Ischemic Heart Disease and Stroke Events: Review and Meta-Analysis

Stacey E. Alexeeff, PhD; Noelle S. Liao, MPH; Xi Liu, MPH; Stephen K. Van Den Eeden, PhD; Stephen Sidney, MD, MPH



METHODS AND RESULTS: We sought to quantitatively summarize studies of long-term $PM_{2.5}$ exposure and risk of IHD and stroke events by conducting a review and meta-analysis of studies published by December 31, 2019. The main outcomes were myocardial infarction, stroke, IHD mortality, and cerebrovascular mortality. Random effects meta-analyses were used to estimate the combined risk of each outcome among studies. We reviewed 69 studies and included 42 studies in the meta-analyses. In meta-analyses, we found that a 10-μg/m^3 increase in long-term $PM_{2.5}$ exposure was associated with an increased risk of 23% for IHD mortality (95% CI, 15%–31%), 24% for cerebrovascular mortality (95% CI, 13%–36%), 13% for incident stroke (95% CI, 11%–15%), and 8% for incident myocardial infarction (95% CI, –1% to 18%). There were an insufficient number of studies of recurrent stroke and recurrent myocardial infarction to conduct meta-analyses.

CONCLUSIONS: Long-term $PM_{2.5}$ exposure is associated with increased risks of IHD mortality, cerebrovascular mortality, and incident stroke. The relationship with incident myocardial infarction is suggestive of increased risk but not conclusive. More research is needed to understand the relationship with recurrent events.

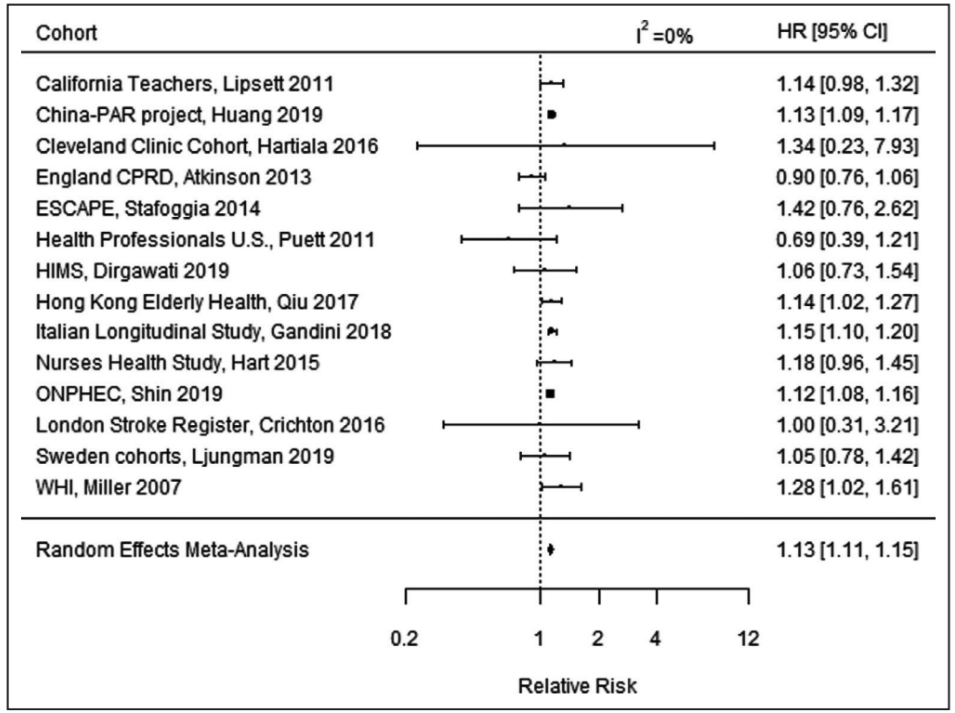


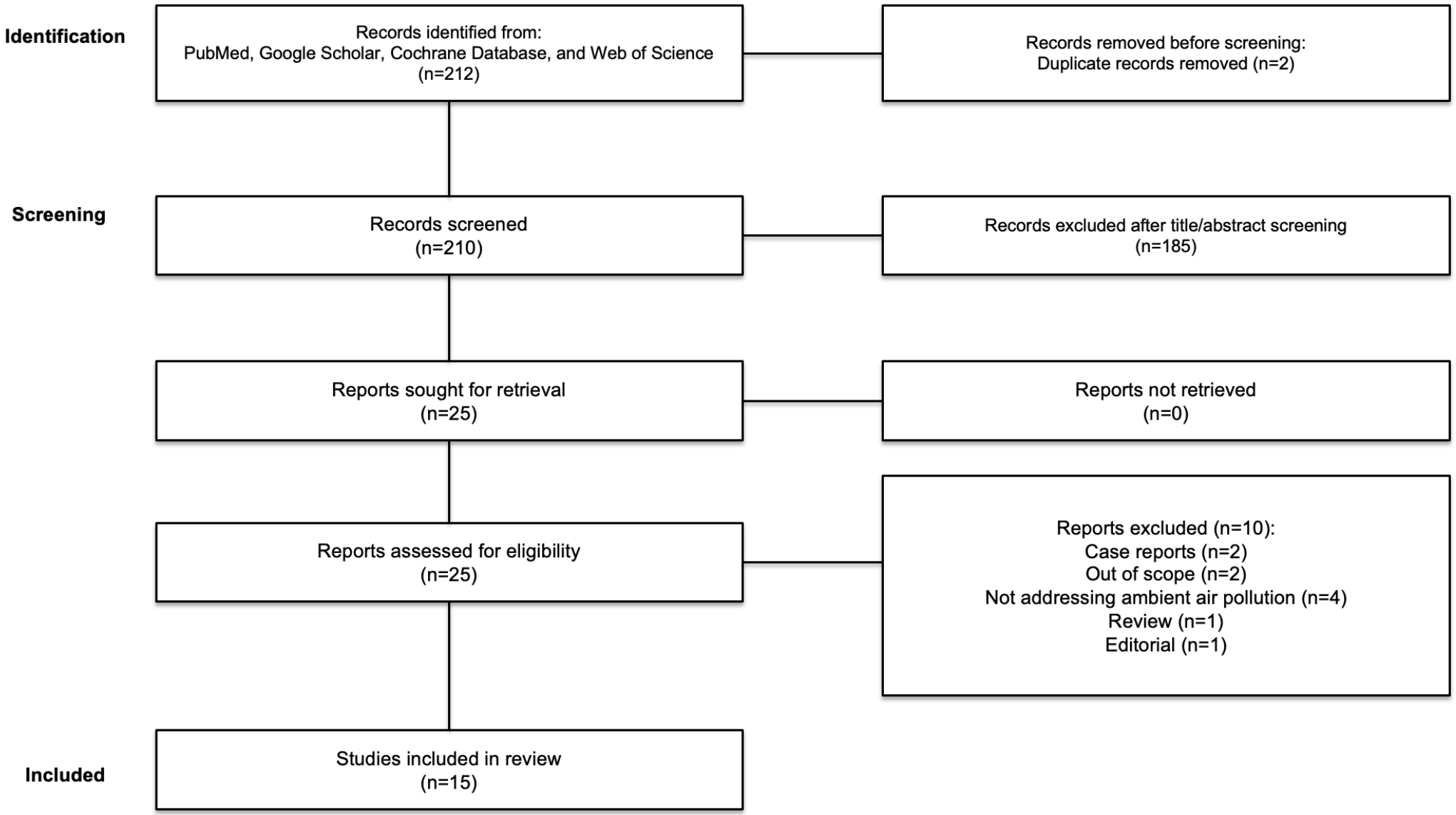
Figure 4. Meta-analysis of the relative risk of incident stroke per 10-μg/m^3 increase in long-term fine particulate matter <2.5 μm in diameter exposure, combining effects of 14 studies.[11]
China-PAR indicates Prediction for Atherosclerotic Cardiovascular Disease Risk in China; CPRD, Clinical Practice Research Datalink; ESCAPE, European Study of Cohorts for Air Pollution Effects; HR, hazard ratio; HIMS, Health in Men Study; ONPHEC, Ontario Population Health and Environment Cohort; and WHI, Women's Health Initiative.

Air pollution and covert cerebrovascular disease: a systematic review

--Manuscript Draft--

Order of Authors:

Antonina Luca
Giovanni Leonardi
Gian Luca Di Tanna
Valentina Gallo
Guglielmo Trovato



- PM2.5 was the most frequently assessed pollutant
- An association between NOx/NO2 with WMH was suggested
- Exposure to CO and SO2 appeared to be associated with silent ischaemic lesions and WMH.
- PM might be associated with silent ischaemic lesions, albeit the evidence is far from being conclusive.

Study reference	Study design	Study, location (years of recruitment. Exposure assessment, and outcome ascertainment)	Sample size	Sex	Exposures	Outcome
Chen et al, 2017 [24]	Longitudinal	WHIMS cohort, USA (recruitment 1997-2007; exposure assessment: 1996-2005; outcome ascertainment: 2005-2006)	1403	1403 F	PM2.5, diesel PM	SVID
Kulick et al, 2017 [27]	Longitudinal	Northern Manhattan Study, USA (recruitment: 1993-2001; exposure assessment: 6-months, 1 year and 2 years before MRI; outcome ascertainment: 2003-2008)	1,075	413 M; 662 F	PM2.5, NO_x, NO_2, O_3	WMH, SBI
Power et al, 2018 [25]	Longitudinal	ARIC study (Forsyth County, Jackson, Minneapolis suburbs, Washington County), USA (recruitment 1987-1989; exposure assessment 1990-2007; outcome ascertainment 2011–2013).	1,753	701M; 1052 F	PM2.5, PM10	WMH, lacunes, and microbleeds
Wu et al, 2021[29]	Longitudinal	Meinian Health Screening, China (recruitment: 2018; exposure assessment: 2015-2017; outcome ascertainment: 2018)	1,400,503	708,277 M; 692,226 F	PM 2.5, PM10, NO_2, CO	Brain infarcts
Sun et al, 2024 [22]	Longitudinal	UK Biobank, United Kingdom (recruitment 2006–2010; exposure assessment 2010-2011; outcome ascertainment 2023)	44,470	20,940 M; 23,530 F	PM2.5, PM2.5 absorbance, PM10, NO_x, NO_2	WMH
Canning et al, 2025 [19]	Longitudinal	1946 British Birth Cohort, England, Scotland, and Wales, United Kingdom (recruitment: 1946; exposure assessment: 2010; outcome ascertainment: 2015-2017)	453	233 M; 220 F	PM2.5, PM10, PMcoarse, PM2.5 absorbance NO_2, NO_x,	WMH
Grande et al, 2025 [20]	Longitudinal	SNAC-K-MRI, Stockholm, Sweden (recruitment: 2001–2004; exposure assessment: 2001-2004, 2004-2007, 2007-2010; outcome ascertainment: 2004-2007 and 2007-2010)	457	187 M; 270 F	PM2.5, PM10	WMH
Ballvé et al, 2024 [18]	Cross-sectional and longitudinal	ISSYS cohort, Barcelona, Spain (recruitment: 2010-2012; exposure assessment: 2008-2011; outcome ascertainment: at baseline 2010-2012 and at follow-up 2014-2016)	976	482 M; 494 F	PM 2.5, PM10, PMcoarse, PM2.5 absorbance, NO_x, NO_2	CBI, WMH, WMH progression
Ma et al, 2025 [32]	Cross-sectional and longitudinal	META-KLS, Kailuan, China (recruitment: from 2020; exposure assessment: 0, 2, 3 and 5 years before recruitment; outcome ascertainment: at recruitment from 2020)	1216	575 F; 641 M	PM2.5, PM10, SO_2, NO_2, CO	WMH, lacunes, CMB, CSVD
Wilker et al, 2015 [33]	Cross-sectional	Framingham Offspring Study, New England, USA (recruitment: 1998-2001; exposure assessment: 2000; outcome ascertainment: 1998-2001)	943	487 F; 456 M	PM2.5, residential proximity to major roadways	WMH, CBI
Jeong et al, 2022 [30]	Cross-sectional	Seoul, South Korea (recruitment: 2006-2013; exposure assessment: the same year as recruitment; outcome ascertainment: 2006–2013)	3,257	1,758 M; 1,499 F	PM10, NO_2, SO_2, CO	WMH, SLI, CBM
Cho et al, 2023 [31]	Cross-sectional	EPINEF Study, South Korea (Seoul, Incheon, Wonju, Pyeongchang) (recruitment: 2014-2017; exposure assessment: 2001-2016; outcome ascertainment: at recruitment 2014-2017)	874	392 M; 482 F	PM2.5, PM10	WMH
Duchesne et al, 2023 [28]	Cross-sectional	Three-city Montpellier Study, Montpellier, France (recruitment: 1999–2001; exposure assessment back extrapolated to 1994-2000 from 2010 data; outcome ascertainment: 1999-2001)	582	282 M; 300 F	PM2.5, NO_2, BC	WMH
Soeterboek et al, 2024 [23]	Cross-sectional	Maastricht Study, Maastricht, The Netherlands (recruitment: 2010–2017; exposure assessment: 2013-2016; outcome ascertainment: 2013-2017)	4,002	1,968 M; 2,034 F	PM2.5, PM10,, soot, NO_2	WMH
Azab et al, 2026 [28]	Cross-sectional	CAHHAM Cohort, Canada (recruitment: 2014-2018; exposure assessment: 2008-2012; 2014-2018)	6,878	3,050M; 3,824 F	PM2.5, NO2	cCVD burden (composite index including WHM and silent infarcts)

Conclusions

- Evidence links air pollution to stroke, dementia and other neurological outcomes.
- Both acute exposure peaks and long-term exposure matter for cerebrovascular health.
- Associations vary by pollutant and outcome; causality and effect size remain uncertain for some disorders.



Take-home message: Reducing air pollution is a population-level opportunity for neurological disease prevention.