EVALUATING THE IMPACT OF LONG-TERM EXPOSURE TO AMBIENT PM_{2.5} on lung cancer incidence and mortality: A comprehensive meta-analysis

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INTRODUCTION

LUNG CANCER is recognised as one of the most common causes of

RESULTS AND CONCLUSIONS

The random-effects meta-analysis revealed that a 10 µg/m³

cancer morbidity and mortality worldwide¹, and it is the second

leading cause of death, with the highest number of years of life lost

in highly developed regions². It is widely recognized that ambient

exposure to particulate matter with a diameter below 2.5 μ m (PM_{2.5})

represents the foremost global environmental risk factor^{1,2}, being

associated with several health outcomes, including lung cancer,

ischemic heart disease, and chronic obstructive pulmonary disease³.

AIM

To derive exposure-response relationships reflecting the relationship between lung cancer incidence and mortality cases as function of exposure to ambient $PM_{2.5}$.



Is exposure to PM_{2.5} associated with an increased risk of

increase in long-term PM_{2.5} exposure was associated with an

increase of 25% in the combined risk of lung cancer incidence and

mortality (pooled risk estimate: RR = 1.25 (95% CI: [1.11; 1.41])).

Author	Year	Country	Outcome	Risk Ratio	RR	95%-CI	Weight
Gowda et al.	2019	USA	Incidence		0.85	[0.53; 1.36]	1.2%
Bauwelinck et al.	2022	Belgium	Mortality		0.97	[0.95; 0.98]	5.6%
Wang et al.	2020	China	Mortality		1.00	[1.00; 1.00]	5.6%
Wang et al.	2020	China	Mortality		1.04	[1.03; 1.04]	5.6%
Chen et al.	2020	Canada	Incidence		1.04	[1.03; 1.05]	5.6%
Guo et al.	2016	China	Incidence		1.07	[1.06; 1.09]	5.6%
Pope et al.	2019	USA	Mortality	-	1.08	[0.99; 1.18]	5.0%
Erhunmwunsee et al.	2022	USA	Incidence		1.10	[1.10; 1.11]	5.6%
Yin et al.	2017	China	Mortality	+	1.12	[1.09; 1.16]	5.5%
Wong et al.	2016	China	Mortality	+=	1.14	[0.96; 1.36]	3.7%
Pun et al.	2017	USA	Mortality	+	1.15	[1.12; 1.18]	5.5%
Hart et al.	2015	Netherlands	Incidence	+	1.17	[0.93; 1.47]	3.0%
Lo et al.	2022	China	Incidence		1.17	[1.01; 1.37]	4.0%
Cheng et al.	2022	USA	Incidence		1.20	[1.01; 1.43]	3.7%
Cierpiał-Wolan et al.	2023	Poland	Incidence		1.22	[1.20; 1.23]	5.6%
Gharibvand et al.	2017	USA	Incidence		1.32	[0.88; 1.98]	1.5%
Tomczak et al.	2016	Canada	Incidence		1.34	[1.09; 1.64]	3.3%
Klompmaker et al.	2021	Netherlands	Mortality	+	1.37	[1.34; 1.40]	5.6%
Lepeule et al.	2012	USA	Mortality		1.37	[1.07; 1.75]	2.8%
Katanoda et al.	2011	Japan	Mortality		1.41	[1.21; 1.64]	4.0%
Shin et al.	2022	South Korea	Mortality		1.55	[0.86; 2.79]	0.8%
Chen et al.	2023	United Kingdom	Incidence		- 2.14	[1.14; 4.01]	0.7%
Cierpiał-Wolan et al.	2023	Poland	Incidence		2.62	[2.59; 2.64]	5.6%
Huang et al.	2021	United Kingdom	Incidence		2.66	[2.40; 2.95]	4.8%
Random effects model (HK)				•	1.25	[1.11; 1.41]	100.0%
Prediction interval	_					[0.96; 1.63]	
Heterogeneity: $I^2 = 99.9\%$,	$\tau^2 = 0.0155$,	p = 0					

When analysed separately, PM_{2.5} exposure was associated with



<u>11% increase in lung cancer incidence risk</u>

(RR = 1.11; 95% CI: [1.04; 1.18])



developing lung cancer?

METHODS



A comprehensive search was performed across multiple

literature databases for studies published between

January 2010 and July 2023.



Based on predefined eligibility criteria, a total of 27

studies were included in the final analysis.



- A random-effects meta-analysis, standardizing <u>effect sizes</u> to a 10 μ g/m³ increase in PM_{2.5}, beta-coefficients were used.
- Heterogeneity was estimated using restricted maximum



14% increase in lung cancer mortality risk

(RR = 1.14; 95% CI: [1.04; 1.25]).

Substantial heterogeneity was observed across all meta-analyses

(I² > 80%), suggesting considerable variability between studies.

Egger's test indicated no statistically significant evidence of

publication bias for incidence.



Long-term exposure to PM_{2.5} is significantly

associated with an increased risk of lung cancer.

Nevertheless, given the considerable heterogeneity observed, in

addition to the potential impact of small-study effects, a cautious

interpretation of these results is imperative. It is recommended that

future research endeavours focus on the identification of sources of

likelihood. Between-study heterogeneity was assessed with the I²

statistic and tau², with I² > 80% indicating substantial

heterogeneity.

 Subgroup and sensitivity analyses were conducted to <u>explore</u> sources of variability and assess the robustness of findings.

Publication bias was evaluated using funnel plots and Egger's

regression test, provided enough studies was available.

Analyses were conducted using the 'meta' package in R (v 4.3.2).

variability and the conduct of comprehensive analyses. This will

facilitate more precise estimation of the long-term health and

economic impacts. The dissemination of findings from such

research will inform the development of targeted prevention

strategies and policy support.

REFERENCES

¹IARC (2025) Global lung cancer incidence according to subtype: new study highlights rising adenocarcinoma rates linked to air pollution ²Global Burden of Disease Collaborative Network. (2023) Global Burden of Disease Study 2023 (GBD 2023); ³WHO. (2024) Fact sheet: Ambient (outdoor) air pollution.



