

Longitudinal Associations Between Ambient Air Pollutants And Cognitive Impairment Among Community-Dwelling Older Adults In Taiwan

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Introduction ► Cognitive impairment

The prevalence among adults aged 65+ in Taiwan is 18.78%.
Cognitive function including global cognition and domain-specific cognition.



Studies have shown higher levels of ambient air pollutants have lower cognitive scores at enrollment and more rapid rates of cognitive decline over time.

► Ambient air pollutants

Including six pollutants: PM_{2.5}, PM₁₀, Carbon monoxide (CO), Ozone (O₃), Nitrogen dioxide (NO₂), and Sulfur dioxide (SO₂).



► Research gap

Longitudinal evidence from cohort studies remains limited regarding the associations between exposure to multiple ambient air pollutants and cognitive impairment, especially in older adults in Taiwan.

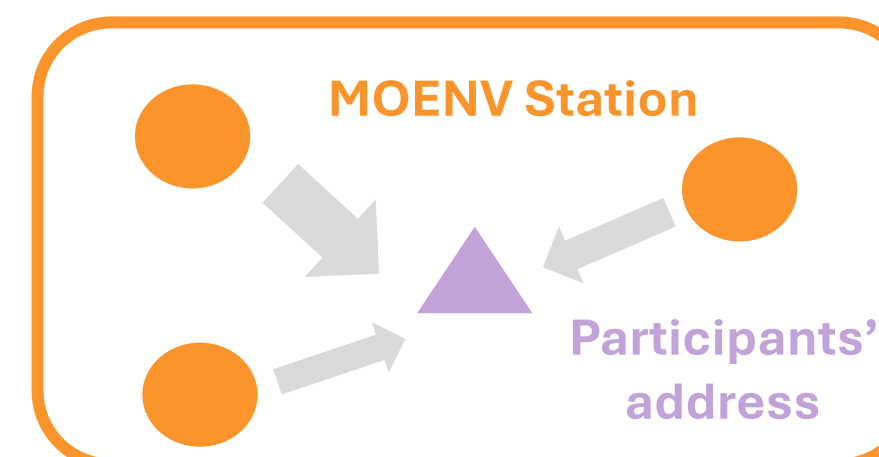
► Study aim

To investigate the longitudinal association between ambient air pollutants and cognitive impairment in community-dwelling older adults.

► Statistical analyses

Descriptive statistics: Kruskal–Wallis test (Continuous variables), Chi-square test (Categorical variables)

Multivariable analyses: Generalized linear mixed models (GLMMs)



Materials and Methods



► Study design

This prospective cohort study (2011–2022) is based on the Taiwan Initiative for Geriatric Epidemiological Research (TIGER).



► Study population

Inclusion criteria: Community-dwelling older adults (Age 65+)

Exclusion criteria: Baseline dementia (MoCA-T score ≤ 21), stroke history, brain tumor ≥ 3 cm, traumatic brain injury with loss of consciousness ≥ 30 min, AD medicine use, and not living in Taipei, Keelung, Yilan and Taoyuan areas

► Assessment of cognitive function

Global cognition: The Taiwanese version of Montreal Cognitive Assessment

Domain-specific cognition: Memory, attention, executive function, and verbal fluency

► Assessment of residential air pollutants exposure

Long-term air data
by MOENV station



Participants' address data
by TIGER cohort

Individual exposure estimation by QGIS & STAR-BME

Abbreviations:
MOENV, Ministry of Environment; QGIS, Quantum Geographic Information System; STAR-BME, Space-Time Analytics and Rendering Tool-Bayesian Maximum Entropy.

Results

Table 1. Association between long-term exposure to ambient air pollutants and cognitive impairment over time (2011-2022; N=524)



Air pollutants	Global cognition by MoCA-T		Domain-specific cognitive tests								
	Impaired (MoCA-T<24)	Continuous	Immediate theme recall	Immediate free recall	Delayed theme recall	Delayed free recall	Digit span		Trail Making	Trail Making	Verbal fluency
	aOR (95% CI)	β (95% CI)					forward	backward	Test A	Test B	
PM _{2.5} (μg/m ³)	0.01 (-0.93, 0.39)	-0.14 (-0.39, 0.11)	-0.01 (-0.12, 0.09)	0.03 (0.29, 4.82)	-0.01 (-0.12, 0.09)	0.01 (-0.09, 0.11)	-0.11 (-0.21, -0.01)	-0.07 (-0.36, 4.02)	-0.07 (-0.16, 0.01)	-0.11 (-0.20, -0.03)	0.02 (-0.07, 0.11)
PM _{coarse} (μg/m ³)	0.02 (-0.03, 0.03)	-0.25 (-0.52, 0.01)	0.01 (-0.12, 0.09)	0.08 (-0.08, 0.13)	-0.03 (-0.14, 0.09)	0.04 (-0.07, 0.16)	-0.07 (-0.17, 0.04)	-0.07 (-0.19, -0.02)	-0.14 (-0.23, -0.05)	-0.09 (-0.19, 0.02)	-0.08 (-0.18, 0.02)
NO ₂ (ppb)	0.01 (-0.05, 0.05)	0.11 (-0.31, 0.49)	0.03 (-0.14, 0.21)	-0.06 (-0.23, 0.11)	0.04 (-0.14, 0.21)	-0.07 (-0.24, 0.10)	0.17 (0.01, 0.33)	0.09 (-0.07, 0.25)	0.12 (-0.02, 0.27)	0.01 (-0.15, 0.16)	-0.15 (-0.31, 0.01)
SO ₂ (ppb)	-0.03 (-0.06, 0.01)	0.33 (0.04, 0.63)	0.01 (-0.12, 0.14)	-0.03 (-0.15, 0.09)	0.09 (-0.03, 0.21)	0.01 (-0.12, 0.12)	0.05 (-0.07, 0.16)	0.03 (-0.09, 0.14)	0.05 (-0.04, 0.15)	-0.04 (-0.14, 0.16)	0.06 (-0.04, 0.16)
O ₃ (ppb)	-0.01 (-0.03, 0.01)	0.04 (-0.12, 0.19)	-0.07 (-0.14, 0.01)	-0.05 (-0.12, 0.01)	-0.06 (-0.12, 0.01)	-0.05 (-0.11, 0.02)	-0.01 (-0.07, 0.06)	-0.01 (-0.06, 0.06)	0.03 (-0.02, 0.08)	-0.03 (-0.08, 0.03)	0.04 (-0.01, 0.09)
CO (ppm)	-0.03 (-0.06, 0.01)	0.31 (0.03, 0.58)	0.02 (-0.09, 0.15)	0.08 (-0.04, 0.20)	0.07 (-0.05, 0.19)	0.11 (-0.02, 0.23)	-0.04 (-0.15, 0.07)	0.03 (-0.08, 0.14)	-0.04 (-0.15, 0.06)	0.05 (-0.07, 0.15)	0.14 (0.03, 0.25)

Numbers in color indicate significant findings ($P < 0.05$). All models were adjusted for age, sex, follow-up time, practice times, years of education, apolipoprotein E $\epsilon 4$ status, depressive symptoms, body mass index, annual income, respiratory disease, alcohol drinking, hyperlipidemia, gait speed.

Abbreviations: PM_{2.5}, particulate matter ≤ 2.5μm in diameter; PM_{coarse}, 2.5μm ≤ particulate matter ≤ 10μm in diameter; NO₂, Nitrogen dioxide; SO₂, Sulfur dioxide; CO, Carbon monoxide; O₃, Ozone; N, number; μg, microgram; m³, cubic meter; ppm, parts per million; ppb, parts per billion; aOR, adjusted odds ratio; CI, confidence interval.

Conclusions & Public health implications

► Long-term exposure to ambient air pollutants was associated with domain-specific cognitive impairment in older adults over time. These findings also suggest that air pollution-related cognitive effects may be subtle, early, and domain-specific.

► Reducing air pollutant exposures should be integrated into comprehensive strategies for healthy aging and dementia prevention.

References

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