

Environmental Noise and Air Pollution as Risk Factors for Hearing Loss and Dementia: The Tramontana Cohort Study in Taranto, Italy

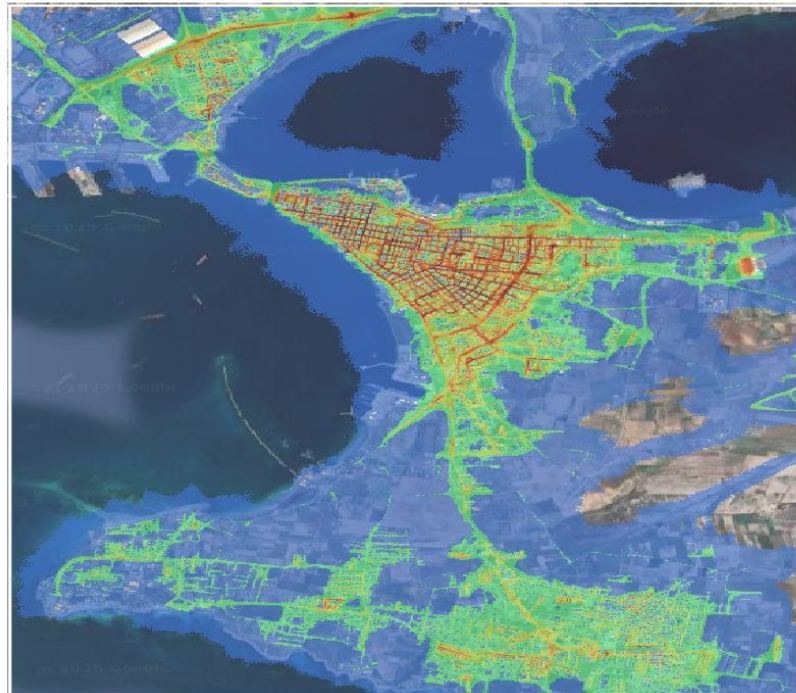
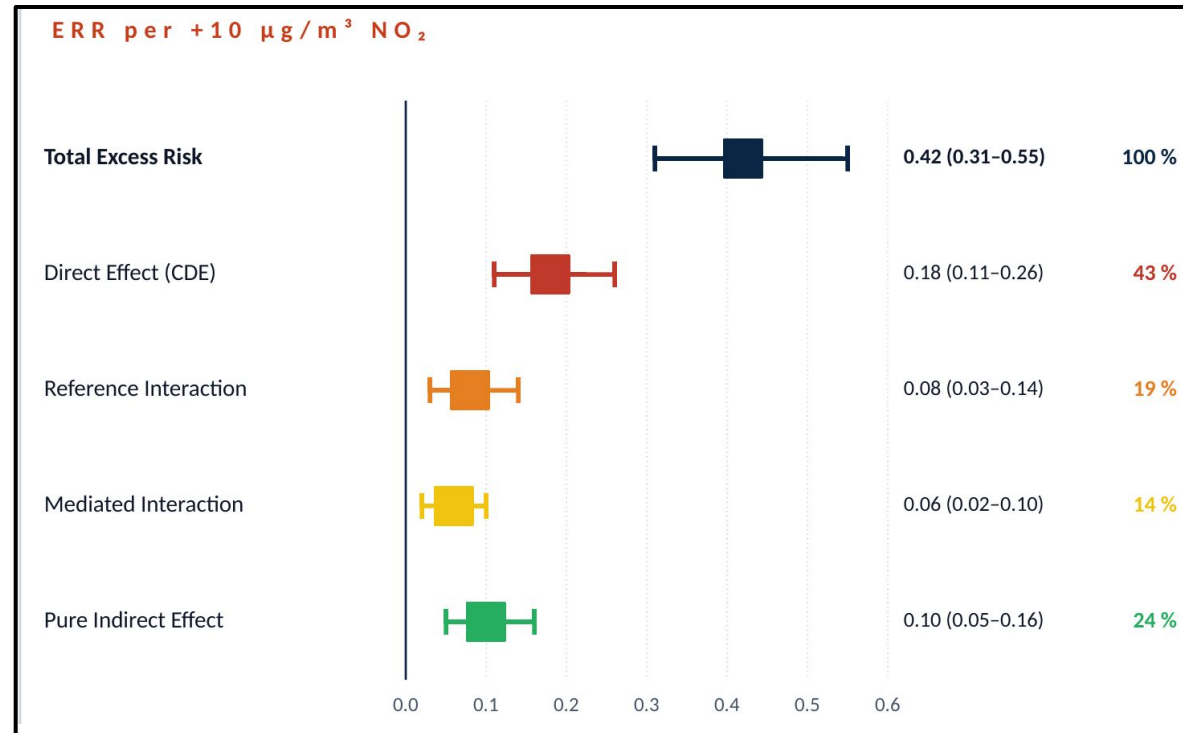
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Rodolfo Sardone, on behalf of the MISTRAL Consortium (Horizon Europe funded).

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Long-term air pollution and community noise independently increased incident hearing loss; in adults ≥60 years air pollution increased dementia risk — and ≈38% of the NO₂→dementia effect ran through hearing loss.

INTRODUCTION	METHODS	RESULTS	CONCLUSIONS	REFERENCES																											
Background Hearing loss is associated with hospitalization, falls, cardiovascular disease and dementia, and is potentially modifiable — so identifying preventable environmental risks matters. Taranto is an industrial Mediterranean city (ILVA steelworks, harbour shipping, SS7 ring road) with a steep material-deprivation gradient and high exposure to air pollution and community noise. Aim To test whether long-term PM_{2.5}, NO₂ and community noise (Lden) increase 10-year incidence of hearing loss and dementia, and whether hearing loss modifies the pollution–dementia association in adults ≥60 years. TARANTO • annual NO₂ (µg/m³)  Residential annual NO₂ (µg/m³), Taranto — 100×100 m exposure surface (CTM + machine-learning downscaling).	Design Tramontana retrospective cohort (2015–2025), part of Horizon EU project MISTRAL (GA 101095119); 201,719 adult residents followed for 10 years (all secondary data). Exposure Daily PM_{2.5} and NO₂ at the residential address from a 100×100 m model coupling chemical-transport (FARM-CTM) dispersion with machine-learning downscaling; long-term noise (Lden) from a retrospective urban campaign across ten neighbourhoods. Outcomes & analysis Incident hearing loss: pure-tone average 0.5–2 kHz, better ear, >45 dB HL (1,125 cases). Incident dementia among adults ≥60 at baseline (n=64,592; 927 cases). Quasi-Poisson models gave incidence rate ratios (IRR, 95% CI) adjusted for age, sex, socioeconomic status and disability; dementia models added baseline hearing loss, pollutant×hearing-loss interactions and a 4-way mediation decomposition.	Over follow-up, 0.56% of participants developed hearing loss. Higher long-term PM_{2.5}, NO₂ and Lden were each independently associated with greater hearing-loss incidence; air pollution also predicted dementia, and prior hearing loss was the strongest non-environmental predictor. <table><tr><th>Predictor</th><th>IRR</th><th>95% CI</th></tr><tr><td colspan="3">Incident hearing loss</td></tr><tr><td>PM_{2.5}, per +5 µg/m³</td><td>1.10</td><td>1.02–1.18</td></tr><tr><td>NO₂, per +10 µg/m³</td><td>1.06</td><td>1.01–1.12</td></tr><tr><td>Community noise Lden, +5 dB</td><td>1.08</td><td>1.00–1.17</td></tr><tr><td colspan="3">Incident dementia, age ≥60 y</td></tr><tr><td>PM_{2.5}, per +5 µg/m³</td><td>1.10</td><td>1.03–1.18</td></tr><tr><td>NO₂, per +10 µg/m³</td><td>1.11</td><td>1.05–1.17</td></tr><tr><td>Baseline hearing loss</td><td>1.55</td><td>1.31–1.83</td></tr></table> Noise–dementia associations became non-significant after adjusting for air pollution. The PM_{2.5}×hearing-loss interaction was significant (p<0.05): pollution effects on dementia were stronger among those with pre-existing hearing loss.	Predictor	IRR	95% CI	Incident hearing loss			PM _{2.5} , per +5 µg/m³	1.10	1.02–1.18	NO ₂ , per +10 µg/m³	1.06	1.01–1.12	Community noise Lden, +5 dB	1.08	1.00–1.17	Incident dementia, age ≥60 y			PM _{2.5} , per +5 µg/m³	1.10	1.03–1.18	NO ₂ , per +10 µg/m³	1.11	1.05–1.17	Baseline hearing loss	1.55	1.31–1.83	 4-way decomposition of the NO₂ (+10 µg/m³)→dementia effect: ≈38% mediated by hearing loss (E-value 1.82). Take-home Long-term air pollution and community noise increased incident hearing loss. In older adults, air pollution increased dementia risk — particularly with pre-existing hearing impairment — and ≈38% of the NO₂ effect was mediated by hearing loss. Integrated strategies targeting pollution, noise and hearing health may reduce the dementia burden (Apulia Regional Prevention Plan 2026–2030).	1. Livingston G, et al. Dementia prevention, intervention, and care: 2024 report of the Lancet standing Commission. <i>Lancet</i> 2024;404:572–628. 2. Lin FR, et al. Hearing intervention to reduce cognitive decline in older adults (ACHIEVE): a randomised controlled trial. <i>Lancet</i> 2023;402:786–797. 3. Rocheeld J, et al. Long-term PM_{2.5} exposure and incident dementia: a systematic review and meta-analysis. <i>Cardiol Rev</i> 2026. 4. MISTRAL Project · Horizon Europe GA 101095119. CONTACT Rodolfo Sardone, PhD, MPH Research & Innovation Unit, Local Health Authority of Taranto rodolfo.sardone@asl.taranto.it University of Liverpool, Liverpool, UK rsardone@liverpool.ac.uk 
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