

## Environmental Issues

# From noise to heart disease: European Environment Agency sounds the alarm for Europe 2025

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In their recent report, the European Environment Agency's (EEA) *Environmental Noise in Europe 2025* report delivers an urgent message: transport noise is a major cardiovascular risk factor with significant public health, environmental, and economic consequences (Figure 1).<sup>1</sup>

## A widespread and underestimated exposure

At least 112 million Europeans, over 20% of the population, are exposed to transport noise at exceeding the current European Union (EU) Environmental Noise Directive (END) thresholds (55 dB). Using the stricter World Health Organization (WHO) limits, this rises to 150 million people (over 30% of Europeans).<sup>1</sup> The true burden is higher, as current mapping excludes smaller airports, secondary roads, and local railways, leaving millions uncounted.

## Cardiovascular and metabolic burden

In 2021 alone, chronic exposure to transport noise caused 66 000 premature deaths, 50 000 new cardiovascular disease (CVD) cases, and 22 000 cases of type 2 diabetes, equating to 1.3 million healthy life years lost across Europe.<sup>1</sup> These findings confirm extensive epidemiological and mechanistic work, showing that noise from traffic is a potent biological stressor, not a mere nuisance.<sup>2–4</sup>

## Mechanistic insights: from stress to vascular injury

Noise activates the sympathetic nervous system and the hypothalamic–pituitary–adrenal axis, releasing stress hormones that elevate blood pressure and heart rate. This neurohormonal storm induces oxidative stress via the nicotinamide adenine dinucleotide phosphate oxidase (NADPH oxidase; NOX-2), reducing nitric oxide, impairing endothelial function, and promoting inflammation.<sup>5</sup> Over time, these pathways accelerate hypertension, atherosclerosis, and heart failure, a progression comparable in magnitude to air pollution and smoking.<sup>3,6</sup>

## Why nighttime noise matters most

Nighttime noise is especially damaging. The European Noise Directive threshold for  $L_{night}$  (50 dB) is exceeded for at least 72 million people. Using WHO's stricter nighttime limits (45 dB road, 44 dB rail, 40 dB aircraft), the exposed population nearly doubles to 139 million.<sup>1,7</sup>

Sleep disruption is the key mechanism. Intermittent peaks from aircraft or freight trains fragment sleep, reduce slow-wave and rapid eye movement phases, and cause repeated blood pressure surges and sympathetic activation.<sup>8,9</sup> Even a single simulated night of aircraft noise can acutely impair endothelial function and raise stress hormones; chronic exposure magnifies these effects through sustained oxidative and inflammatory stress.

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## Premature deaths per 100,000 people

Environmental and climate risk factors



Environmental noise



Unsafe water,  
sanitation and  
handwashing



Radon



Ambient air pollution – PM<sub>2.5</sub>

82

Secondhand  
smoke

12

Noise  
(END thresholds)

14

Non-optimal temperature

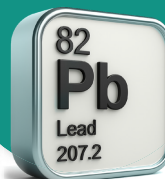
39

Noise  
(WHO recommendations)

18

Lead

17



**Figure 1** Premature deaths per 100 000 people in Europe attributable to major environmental and climate risk factors, based on European Environment Agency 2025 data. Ambient air pollution (PM<sub>2.5</sub>) remains the leading contributor, followed by non-optimal temperatures, noise (at WHO-recommended and END thresholds), lead exposure, secondhand smoke, radon, and unsafe water/sanitation. Environmental noise ranks among the top preventable causes of premature mortality. Adapted from EEA (2025)<sup>1</sup>

## Biological cascade of harm

The following sequence has been established<sup>3</sup>:

- (1) Acoustic stress perception: noise activates the auditory pathway, amygdala, and hypothalamus.
- (2) Neuroendocrine response: cortisol, adrenaline, and noradrenaline rise, increasing heart rate and pressure.
- (3) Vascular oxidative stress: NOX-2-driven reactive oxygen species diminish nitric oxide and damage the endothelium.
- (4) Inflammation: cytokines (IL-6, TNF- $\alpha$ , and CRP) promote leucocyte adhesion and plaque formation.<sup>10</sup>
- (5) Metabolic disruption: stress and sleep loss impair insulin sensitivity and favour diabetes.<sup>11</sup>
- (6) Long-term outcome: cumulative vascular ageing and atherothrombosis raise lifetime CVD risk.

## The silent burden on children

At least 15 million European children are exposed to harmful noise, leading to 560 000 reading impairments, 63 000 behavioural disorders, and 272 000 cases of overweight.<sup>1</sup> Chronic exposure affects cognitive development, emotional balance, and metabolism, factors that may predispose to adult CVD. Schools near major transport corridors are particularly vulnerable, and protecting children from noise should be a public health priority.

## Europe's slow progress towards 'Zero Pollution'

The EU's *Zero Pollution Action Plan* aims to reduce by 30% the number of people chronically disturbed by transport noise by 2030 (vs 2017).

Yet between 2017 and 2022, the reduction was only 3%.<sup>1</sup> Even under optimistic projections, the decline by 2030 would reach only 21%, thus far below the target. This reflects both policy inertia and technical difficulty in reducing road traffic noise, the dominant source across Europe. Binding limits aligned with WHO guidelines are urgently needed, as repeatedly emphasized by the European Court of Auditors.<sup>7</sup>

## Beyond human health: ecosystems, and economy

Noise also harms biodiversity: 29% of Natura 2000 protected sites experience transport noise levels damaging to wildlife.<sup>1</sup> Chronic noise alters animal communication, migration, and reproduction, disrupting ecosystem functions such as pollination and predator–prey balance.

The economic toll is enormous, at least €95.6 billion annually (0.6% of EU gross domestic product), mainly from premature mortality and healthcare costs.<sup>1</sup> Mitigation is highly cost-effective: EU analyses indicate up to a ten-to-one return in social and health benefits per euro invested.<sup>1</sup>

## Policy priorities and co-benefits

To reverse current trends, the EEA, WHO, and European Court of Auditors recommend:

- Lowering END thresholds to match the WHO limits, especially for night noise<sup>7</sup>
- Integrating noise into cardiovascular prevention guidelines, recognizing it as a modifiable risk factor alongside air pollution, hypertension, and smoking<sup>2,3</sup>
- Prioritizing source control: reduced vehicle speeds, low-noise tyres and pavements, rail grinding, and optimized flight routes
- Embedding noise mitigation in urban planning: buffer zones between transport corridors and homes or schools, noise-insulated buildings, and promotion of public and active transport
- Leveraging co-benefits with climate and air quality policies, since decarbonization, green infrastructure, and sustainable mobility also reduce noise exposure
- Legally binding EU legislation that enforces WHO-based limits with clear compliance timelines, ensuring Member States deliver measurable reductions

## The cardiology community's mandate

For cardiologists, this report is not merely environmental; it is a cardiovascular call to action. The mechanistic evidence linking noise to endothelial dysfunction, oxidative stress, and inflammation is now robust and causal.<sup>2,3</sup> Therefore, noise deserves equal attention to smoking cessation or hypertension management in clinical prevention strategies.

### Key clinical and research priorities include:

- Incorporating environmental noise into the European Society of Cardiology prevention guidelines
- Launching public awareness campaigns on the cardiovascular hazards of noise
- Expanding clinical studies on pharmacological and behavioural interventions that mitigate noise-induced vascular damage

- Targeting vulnerable populations, children, the elderly, and patients with pre-existing CVD, for protective measures and education

## A cardiovascular imperative

Reducing environmental noise is not only an environmental or quality-of-life objective but also is central to CVD prevention. The 2025 EEA report exposes a "silent" epidemic affecting more than one-third of Europeans, costing tens of billions annually, and affecting both human and ecological health.

If Europe aims to achieve its *Zero Pollution* vision and reduce CVD mortality, noise must move to the heart of public health and environmental policy. Silence, in this case, truly is golden, protecting arteries, minds, and ecosystems alike.

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## Declarations

### Disclosure of Interest

All authors declare no disclosure of interest for this contribution.

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