Noise pollution and public health curricula: a missing link in environmental health preparedness

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Abstract

Environmental noise is a pervasive yet under-recognized public health hazard. Robust evidence links transport and community noise exposure to a range of adverse health outcomes, including sleep disturbance, cardiovascular disease, cognitive impairment, and reduced quality of life. Yet, despite its clear health burden, noise pollution remains marginal in global health agendas and is inconsistently integrated into education and training. Recent reforms to public health curricula, particularly in the United States, have contributed to a broader erosion of environmental health content, with noise largely absent or reduced to a subtopic within occupational health. This educational gap has significant implications: graduates often lack competencies in community exposure assessment, epidemiological interpretation, policy evaluation, and intersectoral interventions. Addressing the underrepresentation of noise in public health training is therefore a critical step toward mainstreaming noise as a determinant of health. Embedding core competencies on noise pollution in MPH curricula would enhance professional readiness, promote equity, and better align public health capacity with the scale of the problem.

1. Why noise matters for public health

Environmental noise is a pervasive pollutant with well-established impacts on human health. Unlike many other environmental hazards, it is not directly ingested or inhaled but enters the body through auditory and non-auditory pathways, exerting both acute and chronic effects on physiological systems [1]. Decades of research have demonstrated that environmental noise—particularly from transport sources such as road traffic, railways, and aircraft—is associated with a range of adverse outcomes, including sleep disturbance, cognitive impairment, cardiovascular disease, and reduced quality of life [2]. The World Health Organization (WHO) has recognized noise as the second most significant environmental stressor in Western Europe after air pollution [3]. Despite this robust evidence base, noise pollution remains under-addressed in many national and global public health fora [4]. For instance, noise is rarely featured in major public health monitoring frameworks or burden of disease estimates beyond Europe, and few countries have developed comprehensive noise action plans with the same urgency seen in air quality or climate adaptation strategies. In practice, responsibility for noise regulation often lies with environmental or transport authorities, and its health implications are insufficiently mainstreamed into public health planning, education, and advocacy.

This marginalization raises important questions about the epistemic and institutional conditions that shape public health priorities. A number of factors may explain why noise pollution remains comparatively underemphasized within public health teaching and research. First, the attribution of health effects to noise is often complicated by its collinearity with other urban exposures (particularly air pollution) making causal connections sometimes challenging and often relegating noise to a secondary consideration in environmental epidemiology. Second, historical framings of "quiet" have been tied to socio-economic privilege, with noise sometimes treated as an aesthetic or lifestyle concern rather than a population-level environmental health determinant, which can obscure its equity implications. Third, political-economic pressures surrounding transport and industrial activity may implicitly discourage expanding public health scrutiny into domains where regulatory implications are costly or socially contentious. Finally, contemporary public health pedagogy has tended to prioritize mechanistic physiological pathways over broader social, cultural, and infrastructural determinants, thereby disadvantaging environmental stressors—such as noise—whose impacts are mediated by context, place, and lived experience. Together, these epistemic orientations may have contributed to noise pollution's relatively weak integration into environmental health narratives despite its well-established disease burden.

However, a contributing factor that has received little attention in the literature is the limited integration of noise pollution into public health education and training. Although environmental health is commonly taught in Master of Public Health (MPH) programmes and other health-related degrees, syllabi tend to focus on air and water pollution, food safety, and chemical hazards, with only limited references to environmental noise. The result is a cohort of emerging public health professionals and scholars who are often unaware of the scope and seriousness of noise-related health burdens.

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2. Declining environmental health content in public health curricula

The recent literature has shown that the gap in public health training does not necessarily apply to noise pollution *per se*, but rather to environmental factors more broadly. For instance, Levy et al. [5] highlighted a growing concern in public health education: the steady erosion of environmental health (EH) content in Master of Public Health (MPH) programmes. The authors argued that this decline undermines the capacity of the future public health workforce to respond to pressing challenges such as climate change, pandemics, and systemic environmental injustices. In a United States context, they traced much of the problem back to the 2016 revisions of the Council on Education for Public Health (CEPH) accreditation standards, which shifted from requiring five core content areas—including EH—to a competency-based model. In this new framework, EH is treated only as a learning objective rather than a core competency, possibly signalling to institutions that EH content is less critical. The result has been fewer standalone EH courses, fewer MPH programmes offering EH concentrations, and a risk that many graduates enter the workforce without sufficient EH training. The consequences of this shift extend well beyond academia. A substantial proportion of the governmental public health workforce—particularly in preventive medicine and environmental practice—relies on foundational EH knowledge to carry out its mission. The lack of rigorous EH education risks leaving professionals ill-prepared to address issues ranging from food safety and water quality to climate resilience and environmental justice. While these observations are specific to national (U.S.) circumstances, other countries around the world face similar prospects.

The COVID-19 pandemic starkly illustrated how the environment shapes health outcomes, especially for vulnerable and marginalized communities disproportionately exposed to environmental hazards [6]. However, the question of EH training in medical education is not new. Gehle et al. [7] previously argued that despite the significant role environmental factors play in global disease burden, training on environmental health is largely absent from medical education in the U.S. This lack of exposure results in physicians being underprepared to recognize, prevent, or manage environment-related illnesses, ultimately leading to missed opportunities for prevention and early intervention. Surveys of medical students and practicing physicians consistently reveal insufficient instruction in EH, with many graduates reporting inadequate preparation to handle environmental exposures in clinical practice. The 2009 revisions to the Liaison Committee on Medical Education standards, which introduced "public health sciences" into curricula, created an opportunity to integrate EH training, but this has not yet been widely realized, both in the U.S. and globally. The authors highlight how EH competencies are crucial for all physicians, not just those in preventive or occupational medicine. They proposed integrating EH into existing curricula rather than adding new courses, given the crowded nature of medical education. Strategies include embedding EH content into basic science modules (e.g., toxicology in biochemistry), organ system teaching, patient care courses, and clinical clerkships. Leonardi et al. [8] similarly highlighted the urgent need to strengthen EH education and training, given the combined pressures of pollution, biodiversity loss, and climate change. Current curricula for public health practitioners, clinicians, and allied professionals often lack systematic coverage of these themes, leaving the workforce underprepared for the ecological determinants of health. They reviewed international experiences and showed that training can be reoriented without requiring major new resources by integrating ecological and environmental content into existing curricula. They proposed problem-based, practice-oriented learning approaches that connect natural sciences, epidemiology, and social sciences, and that can be tailored to different groups: public health specialists, healthcare workers, and professionals outside health (e.g., planners, architects, engineers).

3. Positive (but limited) impact of EH training in public health practice

Although clinicians generally recognize the importance of environmental factors on public health, studies have consistently found gaps in environmental health assessment in routine clinical practice [9, 10]. Limited training and time constraints are major barriers to incorporating environmental health assessments into practice [9]. Research indicates that health professionals have moderate levels of environmental health knowledge and skills, with variations across different professional profiles [10]. Improving environmental health training can enhance the competencies of current professionals and their institutions, potentially leading to better integration of environmental health considerations in public health and clinical practice [11].

Environmental health master's programmes in public health and healthcare have generally shown positive outcomes, with graduates applying new competencies in their workplaces and experiencing career progression [12, 13]. However, evidence of their impact on professional practice and the healthcare sector is limited, particularly in low- and middle-income countries [12]. Effective pedagogies include social participation, reflection, and learner-centred approaches [13]. Some studies have identified gaps in curricula, such as leadership and context-sensitive competencies [14]. To address these challenges, schools of public health have undertaken curriculum reviews, using student and alumni surveys to guide changes [15]. While master's programmes show promise in developing healthcare professionals, there is a need for more rigorous studies assessing their outcomes and impact, particularly in diverse global contexts [12, 13].

4. Where is noise pollution?

Looking at noise pollution more specifically, it seems to be present as a topic but unevenly embedded in MPH training globally. In many countries it appears as one topic among "physical agents" within the Environmental and Occupational Health (EOH) or Industrial/Occupational Hygiene tracks, rather than as a standalone public health module. Where dedicated offerings do exist, they are typically electives rather than core requirements. As a result, a sizeable share of graduates finishes an MPH with at best survey-level exposure to environmental noise—aware of it conceptually, but without practical competence in community exposure assessment, epidemiology of health outcomes, or policy evaluation. Regional patterns are discernible. In North America, noise is most consistently taught inside EOH/Industrial Hygiene curricula, often with a strong occupational emphasis (e.g., measurement, hearing conservation, controls) and variable attention to

community/transport noise and health equity. In Europe, coverage is shaped by the regulatory ecosystem (e.g., the Environmental Noise Directive and WHO Environmental Noise Guidelines), so noise commonly appears in broader Environment and Health modules that pair it with air pollution and radiation; standalone noise courses are less common, but policy and mapping concepts surface more frequently. Across the Asia–Pacific region, countries like Australia and parts of Southeast Asia include noise in environmental health or physical hazard subjects; legal/policy content sometimes frames noise as part of environmental regulation. In Latin America and Africa, explicit noise teaching is patchier and usually embedded within general environmental health or occupational safety content; standalone community-noise training is uncommon and often project-driven.

From an informal review of publicly available syllabi and materials, in terms of scope, noise-related teaching within MPH training tends to cover sources and pathways, exposure metrics, basic instrumentation and dosimetry, occupational standards and controls, and to a lesser extent, community guidelines and urban policy responses. The health content commonly emphasizes auditory outcomes (e.g., hearing loss, tinnitus) and selected non-auditory effects (e.g., sleep disturbance, cardiovascular risk), but there is less systematic coverage of environmental justice, life-course impacts, children's health, mental well-being, and intersectoral interventions (e.g., transport planning, building acoustics, urban design). Practical competencies—community sound measurement, simple mapping, interpretation of modelled exposures, and integration into Health Impact Assessment—are offered in some programmes but are far from universal. Two structural drivers are likely to have shaped this landscape. First, noise often competes for curriculum time with high-visibility topics (air quality, climate, chemicals), so it is crowded out unless a programme has an occupational hygiene stream or an urban/environmental planning interface. Second, faculty expertise and local policy salience matter: where cities regularly produce noise maps and action plans, programmes are more likely to teach community-noise methods and policy evaluation; where regulation focuses on workplace hazards, teaching tilts toward industrial noise.

This trajectory, while cautiously positive, is still very uncertain. Planetary health, urban health, and environmental justice frames are pulling noise into broader conversations about healthy, low-carbon, and quiet(er) cities, and low-cost sensors and open data make community-level learning more feasible. Still, there is a clear gap between public health needs and typical MPH training. A pragmatic way forward is to define a minimum competency set for MPH graduates; for instance programmes should aim to achieve the following: (1) explain the burden and mechanisms of noise-related disease; (2) design or interpret basic community exposure assessments; (3) appraise regulations and city-level action plans; (4) propose multi-sector interventions with environmental co-benefits; (5) engage communities and stakeholders in prioritizing quiet area protection. Embedding these competencies into core MPH modules would make noise teaching more consistent and practice-ready across regions. Practical integration of noise-related content does not necessarily require standalone courses; several opportunities exist within existing MPH structures. Noise exposure assessment can be embedded into introductory environmental epidemiology modules by pairing air pollution monitoring exercises with basic sound level measurement and interpretation. Policy-oriented courses can incorporate case studies comparing

EU Environmental Noise Directive mapping requirements with WHO guideline implementation. Urban health or environmental justice modules could integrate analyses of noise inequities using GIS-based exposure datasets. These modular integrations might offer feasible, low-cost pathways for schools to strengthen competencies without expanding curricular load.

5. A call to action

The persistent underrepresentation of noise pollution in public health curricula constitutes a structural barrier to its recognition and management as a major determinant of health. If future professionals are not trained to understand noise conceptually, epidemiologically, and methodologically, it is unlikely to gain traction in the research agenda, health impact assessments, or policymaking frameworks. Closing this educational gap is therefore not only a pedagogical necessity but also a matter of equity and accountability in public health. Calls from across the field underscore the urgency of this task. Levy et al. [5] advocate for accreditation standards that explicitly incorporate environmental health competencies, for certification and credentialing bodies to consistently reflect these domains, and for educators to reinvigorate curricula with innovative, evidence-based content. Their position frames environmental health not as an optional technical element, but as central to advancing equity, justice, and resilience in the face of environmental crises. Similarly, Gehle et al. [7] has argued for seamless integration of environmental health training throughout medical and public health education, ensuring that all graduates acquire at least foundational competencies to address environmental determinants of disease. Leonardi and colleagues [8] extend this perspective by highlighting the ecological challenges of pollution, biodiversity loss, and climate change, and by stressing that training efforts must not be confined to future professionals alone. Current practitioners and decision-makers also require upskilling, as their daily choices already shape paths of environmental sustainability and population health.

Despite this evidence, noise continues to receive less policy and research attention than other environmental stressors [16–18]. While the EU Environmental Noise Directive and the WHO Environmental Noise Guidelines provide frameworks for action, implementation remains inconsistent, and data gaps limit comprehensive assessment of the burden of disease. Stronger national and international policies are needed to regulate sources, promote positive and sustainable soundscapes, and ensure effective urban planning [19, 20]. At the individual level, people can also lower their own noise footprint by adopting lifestyle changes, prioritizing low-noise products, and seeking quieter environments, but systemic change must be led by governments and institutions [21, 22]. Ultimately, the absence of more structured teaching on noise pollution is symptomatic of a broader neglect of environmental health in public health training. Integrating noise more explicitly into MPH and related programmes would not only raise its visibility within the professional community but also strengthen the capacity of the workforce to respond to one of the most pervasive, yet often overlooked, environmental health risks of our time.

Keeping an eye on the bigger picture, although the United Nations Sustainable Development Goals (SDGs) aim to address major drivers of health, equity, and sustainability, noise pollution is not explicitly identified in any of the 17 goals or their targets despite its

clear relevance to human well-being and sustainable development outcomes [23]. Environmental noise effects cut across multiple SDG priorities (e.g., SDG 3—Good Health and Well-being; SDG 11—Sustainable Cities and Communities; and more), yet the SDG framework does not currently include noise in its indicators or targets. This omission frames noise as a "forgotten" environmental barrier to sustainable development and highlights the need to integrate acoustic environments into global health and sustainability frameworks if progress toward interrelated SDGs is to be fully realized.

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Conflict of interest

The author declares that they have no competing interests.

Data availability statement

All data supporting the findings of this publication are available within this article.

Additional information

Publisher's note

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