

Urban One Health: Advancing health and well-being nexus across humans, animals, and urban ecosystems

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With globalization and urbanization advancing, cities have become intricate socioecological systems, with highly concentrated resources in health-care, education, and economy, yet concurrently exposed to diverse environmental and public risks, such as air pollution, heat waves, infectious disease outbreaks, and ecological degradation. There is growing recognition that health promotion in urban areas requires an integrated consideration of human, animal, and environmental well-being. This perspective aligns closely with the One Health concept, which underscores the imperative of coordinated actions across human, animal, and environmental sectors to foster their integrated and balanced development. Initially focused on the prevention and control of zoonotic diseases and antimicrobial resistance, the One Health concept has progressively expanded to encompass broader concerns, including ecosystem services, climate adaptation, and community equity.¹ Now, embedding the One Health approach into urban health agendas will constitute a significant step toward promoting the interconnected well-being of humans, animals, and ecosystems. The time is ripe to consolidate the theoretical foundations and practical pathways of Urban One Health in confronting the intertwined challenges of health and sustainability in cities.

FROM ONE HEALTH TO URBAN ONE HEALTH

Clarifying the scope of One Health is essential for achieving integrated health governance. The initial concept emphasizes minimizing health risks at the human-animal-environment interfaces through prevention, preparedness, response, and mitigation. It has since evolved toward the holistic governance of socioecological systems, positioning health equity and sustainability as fundamental objectives. The theoretical foundation lies in interdisciplinary and transdisciplinary insights of complex interactions and dynamics across ecological, social, cultural, political, and economic systems. Within systems, elements are mutually connected and operate in an interdependent manner, where dynamic changes at any scale may profoundly reverberate or catalyze

other elements and the whole system. Building on this understanding, the Theory of Change offers a guiding framework to illustrate how collaborative actions trigger transformative processes for integrated health outcomes.¹

Cities are critical socioecological interfaces, where interactions among human, animal, environmental, and institutional systems are densely concentrated, and where governance, infrastructure, and public policy converge to shape health outcomes jointly. Recognizing cities as strategic arenas for interventions highlights their pivotal roles in advancing health equity, fostering sustainability, and strengthening resilience. The following sections outline the core domains of Urban One Health, explore its manifestations across macro- and micro-perspectives, natural and anthropogenic systems, and socioecological contexts, and highlight key actions for practice (Figure 1).

Urban multi-pollutant exposures

Accelerated industrialization casts cities as hotspots of multi-pollutant accumulation. Urban multi-pollutants originate from diverse anthropogenic and natural sources, including emissions from industrial production, vehicular exhaust, road dust resuspension, sewage and waste management systems, residential and commercial activities, and biological components such as pollen, spores, and bioaerosols. Typical pollutants include particulate matter, sulfur dioxide, nitrogen oxides, heavy metals, and organic compounds. These pollutants can interact and migrate across the atmosphere, water bodies, and soils, forming a spatially intertwined network of pollution that affects human and animal health through food chains, bioaccumulation, and alterations in microbial communities. Such exposure may trigger multi-system disorders, along with systemic inflammation and immune dysfunction.²

Urban planning and built environment

Under planetary urbanization, health emerges as a collective property,



Figure 1. Conceptual framework of Urban One Health The top of schematic illustrates the theoretical foundation of One Health and explain how it connects to urban settings and why urban settings serve as important interfaces that driving human-animal-environment interactions. The middle of the schematic illustrates the elements of the urban environment and highlights core domains for advancing urban health under the One Health lens. The bottom of schematic outlines potential actions to achieve integrated health for humans, animals, and the environment in urban areas.

reflecting how the anthropogenic environment shapes the conditions that sustain or undermine life in the Anthropocene city. The built environment is a microcosm of One Health, and urban planning mediates the interactions among human, animal, and environmental health. Land cover patterns, surface impermeability, and urban morphology regulate environmental dynamics, creating exposure gradients that shape multispecies vulnerabilities.³ Urban noise and artificial light at night perturb circadian and behavioral rhythms and induce physiological and psychological stress across

species. Artificial surfaces (e.g., cement, asphalt, glass, steel) modulate thermal fluxes, intensify noise and glare, and disrupt light regimes. Spatial layout of infrastructures (e.g., hospitals, parks, nursing homes) can limit access to health services. In parallel, building morphology (e.g., building height, vertical density, and street canyons), together with utility infrastructures such as drainage and waste systems, can impede ventilation efficiency, facilitate the accumulation of multi-source pollutants, and exacerbate urban heat island effects.

Urban ecology and microclimate

Transformations in urban land use, along with the spatial configuration of buildings, roads, vegetation, and other infrastructures, have altered natural habitats. These changes generate diverse microclimatic and ecological patterns that shape the human, animal, and ecosystem health in urban areas. Urban vegetation and water bodies regulate local microclimates and mitigate heat waves through shading, evapotranspiration, and high thermal capacity of water, while improve air quality by filtering particulate matter and other pollutants.⁴ Beyond regulatory functions, they also foster social interaction and mental well-being among residents. Meanwhile, green and blue spaces serve as critical habitats for birds, insects, and small mammals, sustaining aquatic and semi-aquatic ecosystems that enhance biodiversity and ecological resilience. However, they also increase contact among wildlife, livestock, and humans, thereby heightening the risks of the zoonotic spillover events. These microclimatic and ecological patterns affect the dynamics of microorganisms and vector species, linking broader health processes across species.

Urban microbiomes

Urbanization has restructured the composition, diversity, and function of microbial communities, thereby reshaping human-animal-microbe interactions and introducing new health risks. Urban microbiomes encompass diverse microbial communities across environmental media, humans, animals, and building environments, collectively supporting vital ecosystem functions such as nutrient cycling, organic matter decomposition, pollutant degradation, and the regulation of pathogenic organisms.⁵ Compared with microbiomes in natural environments, urban microbiomes generally exhibit reduced diversity and more complex spatial patterns. They enhance urban ecological stability and resilience, regulate local microclimates, and support human immune regulation. Meanwhile, cross-species interactions within urban settings create pathways for microbial exchange, enabling pathogen persistence, and facilitating the spillover of zoonotic pathogens. In parallel, dense populations, combined with polluted environments, impose selection pressures that accelerate the proliferation and adaptation of pathogenic and antibiotic-resistant microorganisms within cities, amplifying health risks within urban ecosystems.

Urban equity and justice

The distribution of ecological, artificial, and economic resources is often uneven, leading to spatial disparities in urban health outcomes. Urban equity and justice concern the fair distribution of health resources, environmental benefits, and exposure risks, emphasizing balanced development across human, animal, and ecological systems. However, wealthier communities have easier access to high-quality public spaces such as remnant forests, green spaces, medical resources, while socioeconomically vulnerable population (e.g., low-income individuals, immigrants, and the elderly) and occupationally vulnerable population (e.g., veterinary professionals, construction and infrastructure workers, and urban delivery workers) are disproportionately exposed to ecological degradation, environmental pollution, and zoonotic disease risks.³ An equity-oriented understanding of urban ecosystems contributes to enhancing social cohesion and reinforcing health resilience. This also aligns with the Sustainable Development Goals, particularly the objective of building inclusive, safe, and sustainable cities.

ADVANCING THE URBAN ONE HEALTH AGENDA

The five domains interact and intersect through the environmental, spatial, biological, and social dimensions, collectively shaping holistic health and well-being in urban systems. Integrating the One Health framework into urban health governance is therefore vital for building sustainable, equitable, and resilient cities. To translate this framework into practice, the following concrete actions need to be incorporated into future health agendas.

First, adequate knowledge production, integration, and sharing are essential prerequisites for advancing awareness and understanding of the Urban One Health concept. Urban health challenges are inherently cross-media, cross-spatial, and cross-population, requiring the integration of health, ecological, architectural, social, and comprehensive management sectors. Yet, most existing studies remain siloed within single sectors. Enhancing interdis-

ciplinary research and knowledge sharing is therefore crucial to understanding the dynamic linkages between urbanization, ecosystem transition, and health, thereby supporting policy innovation and sustainable urban planning.

Second, establishing a cross-sectoral data-sharing platform that integrates information on pollution, ecology, microclimate, microbiomes, and social equity is essential for comprehensively assessing health risks and supporting evidence-based decision-making in urban health governance. Such data sharing and coordinated decision-making can be prioritized for antimicrobial resistance monitoring in wastewater and hospital environments, joint surveillance of air-water-soil pollution, and vector and respiratory-borne diseases early warning systems integrated for heatwaves, air pollution, and precipitation. Meanwhile, attention should be given to potential challenges of data governance, including the concerns of privacy, ethics, and algorithmic fairness.

Third, advancing Urban One Health governance requires integrating multi-sectoral policies into a unified and coordinated framework and establishing an intersectoral coordination mechanism that clearly defines sectoral responsibilities and standardized workflows. It necessitates a close collaboration across, but not limited to, the public health, sanitation, ecological, housing, environmental monitoring, and social welfare sectors. Policies should be embedded within the One Health concept and ensure consistency across policy goals, resource allocation, and evaluation criteria. In addition, enhancing public participation and transparency of information is essential to fostering co-governance among multiple stakeholders, thereby improving policy accountability and implementation effectiveness.

Fourth, urban planning should integrate the principles of human-animal-environment coexistence with the pursuit of urban equity and justice. Well-planned urban spaces can mitigate environmental stressors, sustain urban biodiversity, and foster community interaction and connectivity. Urban planning should also incorporate measures to curb disease spread, improve health risk management, and build urban resilience. Moreover, equitable access to environmental and health-promoting resources should be ensured across all socioeconomic groups to foster inclusive and sustainable urban well-being.

A concrete example can be found in Singapore. Under a Whole-of-Government framework, it has launched a series of initiatives (i.e., Healthier SG community programs, Park Connector Network, and ONEHealthSG programs) to reduce health risks and enhance urban livability by linking urban infrastructure, health services, environmental sectors, and communities in an integrated manner. However, there are still many cities that have yet to fully acknowledge urban areas as critical sites for integrated human, animal, and environmental health, underscoring the imperative for immediate, coordinated urban actions.

The Urban One Health framework provides an integrated lens for tackling complex urban health challenges. Future actions hinge on interdisciplinary collaboration that advances urban health research, multisectoral governance, and locally grounded One Health practices. Through coordinated and inclusive actions, these efforts will lay the foundation for more resilient and equitable urban environments.

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DECLARATION OF INTERESTS

The authors declare no competing interests.