
Viewpoint

Population health as the 'bottom line' of sustainability: a contemporary challenge for public health researchers

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Sustainability is now firmly on society's agenda. For five centuries, the West has proceeded on the assumption of continued progress, leaving a positive legacy to the next generation. This idea was enhanced by enlightenment thinking, the rise of market economics, and the cumulative wealth dividend that flowed from industrial capitalism. The dominant manifestation over the past two centuries has been growth—of population, wealth, knowledge, and our domination of the natural world.

Inevitably, this burgeoning production, consumption, and waste generation eventually overloads many of the natural systems upon which we depend. Today there is evidence of overload: climate change, stratospheric ozone depletion, nitrification of the biosphere, acidification of oceans, accelerating loss of species, freshwater shortages, and so on. Clearly, our prevailing cultural values, technologies, and behaviours are not ecologically sustainable: on current trends the natural world cannot continue to furnish the 'services' upon which our societies, health, and lives depend.

Therein lies a major challenge for public health researchers—undertaking research that will assist society understand and avert these systemic dangers to health.

We have spent a productive half century elucidating individual-level causes of diseases, especially non-communicable diseases. This has been the proving ground of modern epidemiology. Meanwhile, in the background, ongoing population-level changes—demographic, social, trading system, and environmental—have gathered momentum. While these changes have yet registered little on the radar of mainstream public health research, they

bear mightily on present and future health risks to populations. Over the past decade, WHO has paid increasing attention to these social and economic fundamentals, including convening international commissions on macroeconomics and health and social determinants of health and coordinating reviews of the health risks from climate change and ecosystem disruption.

A new generation of public health books and reports is beginning to address 'global' issues such as poverty, urbanisation, globalisation, and social and economic inequities. Their adverse impacts on the level and equity of population health are often viewed as obstacles to sustainability. Meanwhile, we have been slower to grasp the even more serious import of global environmental changes. Yet the extraordinary fact is that, for the first time at a global level, humans are collectively overloading Earth's capacity to supply, absorb, replenish, and stabilise,¹ and this poses a profound, potentially irreversible, form of non-sustainability. Species lost cannot be regained; damaged ecosystems (wetlands, forests, reefs, etc.) cannot easily, or ever, be rebuilt; global climatic conditions can flip from one state to another; land degraded and oceans acidified will take decades to restore.

In nature every by-product from one organism becomes substrate for another organism. In contrast, much of all that modern consumer society produces enters the waste stream within 6 months and accumulates in the environment. This squandering of natural capital, by depletion and degradation, is clearly unsustainable. Yet the trend is escalating as the rest of the world industrialises and urban populations everywhere aspire to heightened material consumption. Future generations will, somehow, have to foot the bill for this now-global degradation of atmosphere, soils, water, biodiversity, and natural habitats.

Yet this threat to ecological sustainability remains poorly recognised. Our understanding of how the natural world and its biogeochemical systems (the 'Earth system') work is rudimentary and limited in scope. Many neoclassical

economists fail to understand that the natural environment is the true source of our wealth: the human-made economy is a complex of technologies and transactions which 'add value' to nature, while being wholly dependent upon the natural world.

Much recent concern over 'sustainability' focuses on impediments to human well-being (sometimes encompassing health) due to unalleviated poverty, ageing, uncontrolled urbanisation, etc. While important, those changes do not entail a threat of irreversibility, of losing something essential that has no substitute. Conviction, meanwhile, is strong on both sides: among those concerned to preserve the biosphere intact for future generations and those concerned to alleviate social inequities and tensions. Aware of the complex interdependence between these two domains, the World Bank's 2003 World Development Report called, Solomon-like, for development that is both 'environmentally and socially sustainable'.

There the wisdom often stops, however, since there is as yet little appreciation of the ultimate rationale for achieving sustainability.

Health as the 'bottom line'

Much discussion about sustainability treats the economy, livelihoods, environmental conditions, our cities and infrastructure, and social relations as if they were ends in themselves; as if they are the reason we seek sustainability. Yet their prime value is as the foundations upon which our longer-term health and survival depend.

Until the public health community highlights the centrality to the overall sustainability project of long-term population health, and particularly its dependence on maintaining Earth's life-support systems, society will continue to miss the real point—namely, that 'ecological sustainability' is not just about maintaining the flows from the natural world that sustain the economic engine nor maintaining iconic species and iconic

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ecosystems. It is about maintaining the complex systems that support health and life. Population well-being and health, understood thus, become the real bottom line of sustainability.

This view of population health as central criterion of society's management of the living environment mirrors Amartya Sen's discussion of the role of 'freedom'. He imputes both a constitutive and an instrumental role to freedom. The constitutive dimension refers to freedom as a goal, a right, an end in itself. Freedom though, like health, also has instrumental value; it facilitates poverty alleviation, economic productivity, social cohesion, and so on.

Maurice King made a related argument that population health should be a long-term 'sustainable' social goal.² He argued that a lopsided programme of medical and public health interventions to save young lives in Africa in the near term, unaccompanied by longer-sighted interventions to lower fertility and lessen population pressures, would cause 'demographic entrapment'. Narrow short-sighted interventions, he argued, lead to non-sustainable outcomes: population growth, degraded environments, falling food yields, and rising rates of conflict, disease, and death. Coherent interventions only make sense if they ensure the long-term sustainability of the population's health.

How can we in the public health domain improve our society's understanding of the significance of population health in relation to the pursuit of 'sustainability'?

Research needs

Against this changing background, the public health research portfolio is at risk of being (as the English say) 'penny wise but pound foolish'. Studies of the health risks of high voltage power lines, leg-length in childhood, and so on remain a legitimate part of the epidemiologist's research task of identifying new or overlooked risks to health as societies undergo changes. However, since the health risks posed by global environmental changes are of a different type and scale, they are more likely to turn out as 'pounds' than 'pennies'—first, they impinge on whole communities and populations and, second, they portend future escalating health risks from frank ecological non-sustainability.

Three types of research are required. Empirical studies can elucidate how variations in environmental and ecological systems affect health risks. Second, are global environmental changes already affecting health? Gleaning such evidence is challenging in the earlier stages of change, because the signal-to-noise ratio

is often low. Third, and furthest removed from our current research repertoire, is the need to make credible estimates of future changes in the health risks due to plausible scenarios of ongoing changes in large-scale environmental systems.

Consider these three categories in relation to the health risks of climate change: a topic area that has provided a strong lead in developing new research methods.^{3,4}

First, empirical studies can assess, say, how different age–sex categories are affected by heatwaves, and whether, in a single season, a succession of heatwaves have progressively diminishing health impact. Second, as temperatures continue to rise, there are suggestive reports of various infectious diseases undergoing changes in range and seasonality. Viewed collectively, these are beginning to look persuasive. However, there is need to develop 'pattern recognition' methods applicable to such ensembles of findings.

The third category, estimating future health risks, is least familiar. While epidemiologists often project documented past exposures and current disease trends, to estimate future disease risks, we have little experience in doing this in relation to modelled scenarios of future environmental conditions. Such scenarios usually entail plausible ranges of the underlying 'drivers' (e.g. fossil fuel combustion as determinant of greenhouse gas emissions) rather than formal probability distributions. There are substantial uncertainties about future societal trajectories and climate system responses to continuing atmospheric changes. Risk functions, extending into future decades, may not be linear, and may exhibit discontinuities.

During 2001–2005, ~1500 researchers from around the world, from many disciplines, conducted the Millennium Ecosystem Assessment (MA). This entailed a systematic review of the scientific literature on how humans are changing Earth's ecosystems, of how current trends may affect the future state of ecosystems, and of the current and likely future impacts on human societies (including the risks to human health). In fact, the scientific literature on that latter topic is sparse. Health researchers have been unaware of, or reluctant to engage in, such questions—while environmental scientists, ecologists, geographers, and others have failed to recognise how ecosystem changes affect humans.⁵

That health researchers have been slow to engage with 'ecological sustainability' and its risks to health tells two things. First, it reflects the inherent conservatism of science in general; a reluctance to look beyond defined professional boundaries and paradigms. Second, more

generously, the slowness also reflects the enormous quantum-like leap that is required, from studying specific, local, mostly direct-acting 'exposures' to studying how changes in whole natural systems can, via varied pathways and over protracted time, affect health.

Emerging and re-emerging infectious diseases: an unexpected stimulus?

An unexpected stimulus for thinking in larger scale, ecologically oriented, terms has come from the infectious diseases domain. These diseases have rebounded in recent decades, reflecting various recent and radical shifts in the ecology of human living, mobility, technologies, and economic activity.⁶ This has required us to reactivate some of the population-level, ecological, concepts and research skills that underpinned the widespread study and surveillance of infectious disease transmission patterns during the first two-thirds of the past century.

Consider the contributions of intensified food production. The 'mad cow disease' episode in 1980s Britain, and the subsequent risks to beef consumers, provided one unusual example. The research required an appreciation of population dynamics, interspecies relationships, genetic evolution, commercial practices and feeding systems, and epidemic modelling. In Malaysia in the late 1990s, the encroachment on rain forest by pig farmers exposed the pigs and then the farmers to the 'Nipah' virus carried by rainforest fruit bats, who, when faced with both deforestation and the dessicating El Niño event of 1997–1998, sought food from orchards around the pig farms. Pigs were infected, leading to several hundred human infections and over one hundred deaths. These health risks could only be elucidated within an ecological frame.

Poultry farming extends the narrative. The avian influenza viruses that circulate naturally in wild birds also readily infect domesticated poultry. There is prolific asexual exchange of genetic material between viruses. The influenza A virus (which includes the H5N1 strain) is particularly genetically labile and undergoes ready genetic mutation and reassortment.⁶ In this it is assisted, first, by traditional family farming, in southern China and elsewhere in Southeast Asia where poultry cohabit with pigs (readily infected by influenza viruses from both bird and human sources), and, second, by crowded 'factory farming' which may facilitate the evolution of viral virulence when there is no selective advantage in keeping the host bird alive.

These recent surprises from the infectious diseases realm underscore the need for public health researchers and practitioners, first, to assist society understand the risks inherent in current modes of social and economic ‘development’ and the resultant large-scale environmental changes, and, second, to find ecologically attuned ways of managing social change so as to minimise health risks.

Conclusion

Much concern about ‘non-sustainability’ reflects awareness that we are now overloading natural environmental capacities at regional and global scales. This jeopardises the biosphere’s life-support systems. Public health researchers have a responsibility to ensure that their societies understand that, in the final

analysis, sustainability is about ensuring positive (and equitable) human experience—of which health is fundamental. If our way of living and of managing the natural environment do not underwrite current and future population health, then that trajectory represents non-sustainability.

The faint-hearted may say that it is too hard; or that it entails too much projection to the future; or that the textbooks do not prescribe appropriate methods. Yet the history of epidemiological research, as an applied science, is one of responding to the public health issues of the time—whether miasmas, infectious diseases, the rise of ‘chronic diseases’, or the perspectives of social epidemiology. All have required new study designs, new learning, and new collaborations. Today, we must again rise to the challenge, to meet society’s needs.

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