Environmental Epidemiology: Origins, Current Status and Future Challenges

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Environmental health has been the sheet anchor of the public health movement. Much progress during last century’s First Public Health Revolution in Western countries, in controlling infectious diseases, came from regulatory environmental controls on water supplies, waste disposal, food purity, and housing—allied with social modernisation. These gains were underwritten by early environmental epidemiological research. Subsequently, although environmental health has been somewhat overshadowed by the rise of modern clinical medicine, there have been further increases in public policy emphasis on the control of environmental pollution.

In today’s complex world, many things are viewed as ‘environmental’. Nevertheless, defining the scope and content of environmental health is becoming increasingly important for political reasons. The reemergence of environmentalism in developed countries has led to new state environmental agencies being created. Consequently, the traditional public health system often finds that it has lost control over the social management of environmental health. The ‘health’ criterion of environmentalism has become somewhat overshadowed by other more politically-prized, and immediate, criteria—sustainable (economic) development, amenity, and conservation.

Environmental epidemiologists should assist, therefore, to broaden the scope of the health-effects and risk-management review processes in the environmental sector. This will improve the formulation of environmental exposure guidelines and standards. Environmental health risk assessment (EHIA) should become an integral part of the now well-established environmental impact assessment (EIA) process. This will require collaboration between health, environment and other sectors. Clearly, there is an important role for epidemiologists in this.

TYPES OF ENVIRONMENTAL HEALTH HAZARDS

Today’s prominent categories of potentially toxic environmental pollutants are: organic chemicals (including organochlorine pesticides and volatile organics such as benzpyrene), heavy metals (e.g. lead, cadmium and mercury), oxides of sulphur and nitrogen and tropospheric ozone (major air pollutants), and sources of ionising radiation (from radon gas, uranium mining and nuclear wastes). Increasingly, there are problems in the disposal of solid and water-borne toxic wastes. Indoor air pollution (including environmental tobacco smoke) has become another focus of concern. These and many other exposures continue to pose significant local environmental health risks—and many impinge most on socially disadvantaged segments of society.

Within the larger population context, most human exposures to these ambient environmental pollutants are at low concentrations, be they in air, water or food. Hence, it is intrinsically difficult to identify adverse health effects via one-off local epidemiological studies—beset as they are with the usual background noise of the (non-experimental) real world1). For this reason, there is an increasing reliance on summarising (by meta-analysis) the results of many separate epidemiological studies. Meanwhile, our prudent assumption is that if adverse health effects occur at high levels of exposure, then commensurately smaller effects are likely to occur at low levels of exposure.

Despite the earlier advances made through sanitation, vaccination and antibiotics, an ever-changing array of environmental infectious diseases persist. For example, outbreaks in different locations of Legionnaires’ disease, amoebic meningitis and blue-green algal blooms are further reminders of the complex microbial environment in which human populations have always lived; likewise, the...
widespread emergence of various viral haemorrhagic fevers in the wake of deforestation and extensions to agricultural irrigation. The recent increase in antibiotic-resistant strains of TB, gonorrhoea, streptococcus, and the malarial plasmodium are evidence that, as we reshape our environment, microbes, through their rapid genetic evolution, adapt to those changes and exploit new ecological niches.

Today, there is a wider agenda emerging for environmental epidemiology. Consider, for example, the well-known environmental health problems associated with coal-burning power stations. Our research has long focused on the local toxicity of air pollutants (e.g. the induction of lung diseases). Little account has been taken of the regional health effects of acid rain (which disrupts various ecosystems that bear on human health and food supplies). And all of this ignores the more geographically and temporally distant population health consequences of greenhouse gas (especially CO₂) accumulation.

ENVIRONMENTAL HEALTH — THE GLOBAL PICTURE

The scale of environmental health problems is now broadening. For the first time ever, we must contemplate the population-wide health consequences of global environmental changes — i.e., disturbances of natural systems upon which the sustained health of populations depends. The anticipated health risks are qualitatively different from those due to the direct-acting toxicity of ‘conventional’ pollutants.

There is a rising awareness of the problems of climate change, ozone layer depletion, and land degradation. Although health researchers and policy-makers have been slow to recognise that these may become major public health problems, the equation is chasteningly simple: disruption of natural systems leads to impairment of ‘life-support’, which, in turn, threatens the health of humans. Good health depends absolutely on a sustained supply of clean air, safe water, adequate food, tolerable temperature, stable climate, protection from solar ultraviolet radiation, and the existence of diverse species and their genes (for beneficial genetic manipulation purposes). We cannot live without this ecological support system.

The various potential effects of global climate change upon human population health illustrate the complexity of this topic. There may be direct effects upon health due to an increased frequency of heatwaves (a source of excess mortality), and an increased frequency of natural weather disasters. There will probably be early indirect effects via changes in the distribution of insects and other vectors that spread infectious diseases such as malaria and dengue. There will be regional effects upon crop production which, in aggregate and in the longer term, are likely to be negative. There may be delayed indirect effects upon public health due to rising sea levels, and from the social-demographic impact of ecological refugees (from floods or famine).

It is important to emphasise that this newly-emergent threat to human health arises predominantly within an ecological context. Whereas the ‘environment’ refers to everything around us, irrespective of its functional relationship to us, ‘ecological systems’ entail dynamically-balanced interdependencies between living species and components of their environment. For the first time, at a global level, there is evidence that we are overloading various of Earth’s ‘sources’ (e.g. supplies of soil and freshwater, ozone layer integrity, ocean fisheries, and global genetic biodiversity) and ‘sinks’ (e.g. atmospheric and oceanic absorption of anthropogenic greenhouse gases). This is a more fundamental hazard to human population health than any that have gone before.

There is, however, much uncertainty around these global-change issues. Health-impact predictions are necessarily predicated on an infrastructure of uncertain predictions from other disciplines — climatology, oceanography, atmospheric chemistry, agricultural science, and so on. Further, we have little direct empirical evidence pertaining to the foressed climatic scenarios of next century; nor would it be sensible to await such definitive evidence! So, assessing the anticipated effects on human health requires extrapolation, modelling and scientific theory. This poses major challenges to environmental epidemiology. We will have much research to do in the coming decades.

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7. See also various discussions in the 8-part series, Climate Change and Human Health, Lancet 1993 (October 23-December 11).