Environmental pollution: It's effect on life and the global burden of disease

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Exposures to environmental pollution remain a major source of health risk throughout the world, though risks are generally higher in developing countries, where poverty, lack of investment in modern technology and weak environmental legislation combine to cause high pollution levels. Associations between environmental pollution and health outcome are, however, complex and often poorly characterized. Levels of exposure, for example, are often uncertain or unknown as a result of the lack of detailed monitoring and inevitable variations within any population group. Exposures may occur as range of pathways and exposure processes. Individual pollutants may be implicated in a wide range of health effects, whereas few diseases are directly attributable to single pollutants. Long latency times, the effects of cumulative exposures, and multiple exposures to different pollutants which might act synergistically all create difficulties in unravelling associations between environmental pollution and health. Nevertheless, in recent years, several attempts have been made to assess the global burden of disease as a result of environmental pollution, either in terms of mortality or disability-adjusted life years. About 8–9% of the total disease burden may be attributed to pollution, but considerably more in developing countries. Unsafe water, poor sanitation and poor hygiene are seen to be the major sources of exposure, along with indoor air pollution. Despite the major efforts that have been made over recent years to clean up the environment, pollution remains a major problem and poses continuing risks to health. The problems are undoubtedly greatest in the developing world, where traditional sources of pollution such as industrial emissions, poor sanitation, inadequate waste management, contaminated water supplies and exposures to indoor air pollution from biomass fuels affect large numbers of people. Even in developed countries, however, environmental pollution persists, most especially amongst poorer sectors of society.

In recent decades, too, a wide range of modern pollutants have emerged not least, those associated with road traffic and the use of modern chemicals in the home, in food, for water treatment and for pest control. Most of these pollutants are rarely present in excessively large concentrations, so effects on health are usually far from immediate or obvious. As the problems of environmental exposure that concern us today imply large relative risks. Detecting small effects against a background of variability in exposure and human susceptibility, and measurement error, poses severe scientific challenges. The progressively larger number of people exposed to environmental pollution (if only as a result of growing population numbers and increasing urbanization) nevertheless means that even small increases in relative risk can add up to major public health concerns. The emergence of new sources of exposure and new risk factors, some of them—such as endocrine disruptors—with the capacity to have lifelong implications for health, also means that there is a continuing need for both vigilance and action. As the impact of human activities and issues of environmental health become increasingly global in scale and extent, the need to recognize and to address the health risks associated with environmental pollution becomes even more urgent. Effective action, however, requires an understanding not only of the magnitude of the problem, but also its causes and underlying processes, for only then can intervention be targeted at where it is most needed and likely to have greatest effect. As background to the other chapters in this volume, therefore, this chapter discusses the nature of the link between environmental pollution and health and considers the contribution of environmental pollution to the global burden of disease. Environmental pollution can be simply, if somewhat generally, defined as the presence in the environment of an agent which is potentially damaging to either the environment or human health. As such, pollutants take many forms. They include not only chemicals, but also organisms and biological materials, as well as energy in its various forms (e.g. noise, radiation, heat).

The number of potential pollutants is therefore essentially countless. There are, for example, some 30,000 chemicals in common use today, any one of which may be released into the environment during processing or use. Fewer than 1% of these have been subject to a detailed assessment in terms of their toxicity and health risks4. The number of biological pollutants is truly unquantifiable. They include not only living and viable organisms, such as bacteria, but also the vast array of endotoxins that can be released from the protoplasm of organisms after death. There is, therefore, no shortage of potential environmental risks to health. The link between pollution and health is both a complex and contingent process. For pollutants to have an effect on health, susceptible individuals must receive doses of the pollutant, or its decomposition products, sufficient to trigger detectable symptoms. For this to occur, these individuals must have been exposed to the pollutant, often over relatively long periods of time or on repeated occasions. Such exposures require that the susceptible individuals and pollutants shared the same environments at the same time. For this to happen, the pollutants must not only be released into the environment, but then be dispersed through it in media used by, or accessible to, humans.

Health consequences of environmental pollution are thus far from inevitable, even for pollutants that are inherently toxic; they depend on the coincidence of both the emission and dispersion processes that determine where and when the pollutant occurs in the environment, and the human behaviours that determine where and when they occupy those same locations. The whole process can simply be represented as a causal chain, from source to effect as this indicates, most pollutants are of human origin. They derive from human activities such as industry, energy production and use, transport, domestic activities, waste disposal, agriculture and recreation. In some cases, however, natural sources of pollution may also be significant. Radon, released through the decay of radioactive materials in the Earth's crust, arsenic released into ground waters from natural rock sources, heavy metals accumulating in soils and sediments derived from ore-bearing rocks, and particulates and sulphur dioxides released by wildfires or volcanic activity are all examples. Release from these various sources occurs in a wide range of ways, and to a range of different environmental media, including the atmosphere, surface waters, ground waters and soil. Estimates of emission by source and environmental medium are inevitably only approximate, for they can rarely be measured directly.

Instead, most emissions inventories derive from some form of modelling, either based on emission factors for different processes or source activities5 or on input–output models (i.e. by calculating the difference between quantities of the material input into the process and quantities contained in the final product). Emissions to the atmosphere tend to be more closely modelled and measured, and more generally reported, than those to other media, partly because of their greater importance for environmental pollution and health As this shows, combustion represents one of the most important emission processes for many pollutants, not only from industrial sources, but also from low-level sources such as motorized vehicles and domestic chimneys, as well as indoor sources such as heating and cooking in the home or workplace. Emissions from industrial combustion or waste incineration tend to be released from relatively tall stacks, and often at high temperature, with the result that they are dispersed widely within the atmosphere. Emissions from low-level sources such as road vehicles and low-temperature combustion sources such as domestic heating, in contrast, tend to be much less widely dispersed. As a result, they contribute to local pollution hotspots and create steep pollution gradients in the environment. In urban environments, for example, traffic-related pollutants such as nitrogen dioxide and carbon monoxide typically show order-of-magnitude variations in concentration over length-scales of tens to a few hundred metres6. Evaporation and leakage are also important emission processes contributing to local variations in environmental pollution

Biography

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