

### Environmental Threats to the Health of Children: The Asian Perspective

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In Asia, as in the rest of the world, there are serious and significant effects on the health of children arising from environmental contamination. On 9–11 April 2000, the first biannual meeting on Environmental Threats to the Health of Children in the Asian Pacific was held in Manila, Republic of the Philippines, with over 120 attendees representing 15 countries. The goal of the conference was to bring to light the specific environmental conditions existing in the Western Pacific Basin countries that are affecting the health of children living in these countries and to raise awareness of the special vulnerability of children to degradation of the environment. Through open discussion the meeting fostered both an increased visibility of existing programs directed to environmental threats to the health of children within the different governments in the region and promotion of regional cooperation on the issue.

Environmental quality has important direct and indirect determinants of children's health in Asia and elsewhere in the world. Poor children and especially poor children in the poorest countries are most at risk for environmental quality problems. Poor children are the most vulnerable and disenfranchised segment of any society, and environmental hazards in conjunction with social stress and malnutrition often pose almost insurmountable barriers to a child's normal development. It is the health of children under 5 years of age that is most damaged by poor environmental quality. The lack of safe drinking water and uncontaminated food is of particular importance, causing morbidity and mortality through diarrhea and other infections, both because of exposure to infectious organisms and contaminant-induced suppression of the immune system.

It is a truism in all the world that the major predictor of ill health is poverty, and the reason this is true is because poor people are the least able to obtain uncontaminated water and food, receive immunizations and quality health care, and obtain the knowledge

necessary to avoid factors that cause sickness. One of the most moving aspects of this conference was a video shown by participants from Cambodia of children at the Phnom Penh city dump scavenging for food and anything that could be sold so that the child could buy food. Figure 1 shows a scene from this video. Children, like the girl illustrated, often spend all day scavenging for items among the foul odors and filth. Some of the homeless children even sleep on the garbage under an old cloth or canvas strip supported by four poles (Figure 2). Not only are these children exposed to contaminated food and water, but they are also particularly vulnerable to being bitten by mosquitos carrying diseases such as malaria and dengue, to say nothing of the diseases transmitted from rats and other pests that inhabit a garbage dump. Because of the mass killings that took place in Cambodia in the recent past, homeless street children are all too common in Cambodia. Similar scenes are common in many of the major city dumps throughout Asia.

Our Cambodian colleagues also discussed sexual exploitation of children, ranging from child prostitution to the actual selling of children. Both boys and girls are sold for sexual purposes, usually to foreigners. Other children are given drugs that cause gross physical deformities by adults who believe that deformed children will be more effective beggars.

There are a number of problems related to environmental exposure pathways of children in Asia, particularly in the less-developed countries. For example, there is a particular lack of education, enforcement, and understanding regarding exposure risks. Although countries have environmental protection laws, enforcement often is poor. Public officials are frequently paralyzed because of lack of resources, facilities, and direction. Standards for environmental contaminant exposure are often viewed as a Western agenda, and for the most part are

simply ignored. There is also an attitude among certain workers who believe that it is their fate to be exposed, and therefore they accept these exposures. There are frequent problems of child labor (especially a problem in India, but also in many other countries), often in hazardous occupations such as paint pigment factories. Another custom common in Asia is for families to live on the site of the father's employment, resulting in occupational exposures for the children as well. There is often inadequate or no labeling of pesticides. Frequently government agencies compete rather than cooperate. Often there is a tolerance of risk by the public that would never be acceptable in the West. This is particularly true for occupational exposures where, for example, welding will be done without safety glasses, or industrial waste will be discharged into a stream in which children are playing.

#### How Children Are Exposed in Asia

Contaminated drinking water remains a major environmental health problem all over the world, even on occasion in developed countries. However, this is the major public

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health issue in many developing countries, including many in Asia, where 4 million infants and children die each year from diarrhea (1), usually as a result of drinking water contaminated with infectious organisms. Children who consume contaminated drinking water get infectious diseases, parasites, and especially diarrhea, and because health care is often inadequate, they frequently die. Contaminated drinking water is a problem even in some of the capital cities of the region, but is a particular problem in rural areas where there is no water treatment. In many areas raw sewage runs directly into rivers and streams that are the source of water for drinking and washing.

In Bangladesh the ground water is naturally contaminated with arsenic. A number of years ago international agencies drilled many deep wells in an effort to provide safe drinking water. Up until that time the country's main water source was surface water, which was free of arsenic but contaminated with infectious organisms that caused diarrhea and other infectious diseases. Unfortunately the well waters were not tested for arsenic, a known carcinogen (2–4). Subsequently, many, but not all, of the wells have been found to have very high levels of arsenic. As a result, up to 25,000,000 people are at risk of cancer, with 900,000 skin cancers expected. This exposure continues to this day. Similar but less massive problems exist in several parts of China and in Chile (5). Arsenic is a toxin, and the body concentrates arsenic in keratin-rich tissues (skin, nails, hair), resulting in hyperkeratosis, with many cracks in the skin (4). Although not limited to children, the problem with arsenic in drinking water is serious in many areas of the world, and exposure of children to arsenic results in toxicity which can develop into cancer later in life.

Mining waste leaching into bays, streams, or lakes presents a different route of exposure to contaminants. One mine in the Philippines has dumped 40 billion tons of mine wastes into the ocean, just offshore.



**Figure 1.** A young girl scavenging for food and items to sell at the Phnom Penh city dump.

This has resulted in elevated mercury levels in fish 100 miles away. Such activities often go unregulated, and frequently there is no or an inadequate response from government officials warning people not to eat the fish. On occasion the concentrations of mercury, cadmium, and lead in fish have exceeded standards by 4- to 30-fold, yet these fish are in the marketplaces for human consumption.

Children in many Asian countries have significant exposure to various organic chemicals, including pesticides, solvents, polychlorinated biphenyls (PCBs), and dioxins. It was reported that in Indonesia the use of DDT in agriculture continues, even though DDT was officially banned years ago. Many dangerous and persistent pesticides continue to be used, often illegally. In a study in Cambodia, 23% of children 6–12 years of age in the village of Siem Reap suffered from skin lesions secondary to pesticide exposure, where the exposure came both from the living and play areas and from child labor in the agricultural fields. In general in Asia there has been little study of PCB exposure, primarily because of the cost of analytical measurements. There have been a few PCB measurements around abandoned U.S. military bases and around the Yushu and Yu Chem poisonings in Japan and Taiwan, respectively, where PCBs have contaminated cooking oils. There is little doubt that PCB exposures are extensive, and further investigations are called for. Exposure to dioxins and furans is also not well documented, but is likely to be significant because of the common practice of burning plastics in backyard burn barrels and city dumps.

### Environmentally Induced Diseases in Children in Asia

Vietnam has a problem of enormous magnitude as a result of the spraying of Agent Orange over wide areas of the former South Vietnam during the war in the late 1960s and early 1970s. Almost 19 million gallons of Agent Orange were applied during the



**Figure 2.** "Home" for some children at the Phnom Penh city dump consists of a makeshift shelter located on top of the garbage.

war. In one specific area, Aluoi Valley, 549,274 gallons of Agent Orange were sprayed on a population area of about 33,000 persons, 1% of whom recall having the application directly on their bodies. Hung and colleagues (6) reported on the incidence of birth defects and adverse reproductive outcomes in three communities where Agent Orange was heavily applied (Dong Son, Hong Thuong, and Huong Lam) compared to one community (Hong Van) where there was little application. The most seriously contaminated village, Dong Son, located near the A So airfield, has experienced a clear increase in incidence of birth defects. The rate was 2.3% before the spraying, and rose to 6.5% in the years after spraying. The years with the greatest incidence of birth defects were 1968 and 1969. It is likely that paternal exposure is a factor in these birth defects. In a study of children born to North Vietnamese veterans, 5% of the children born to veterans who were heavily exposed suffered birth defects, whereas only 1% of children born to veterans who remained in the North during the war, and therefore were not highly exposed, were born with birth defects.

Tables 1 and 2 show the numbers of adverse reproductive outcomes and birth defects, respectively, for longer periods before and after spraying in the three more exposed villages. There was a large increase in adverse reproductive outcomes, including stillbirths, spontaneous abortions, hydratidiform moles, and choriocarcinomas, after the period of application of Agent Orange. The peak incidence was reached in 1966–1967. In the 10 years prior to spraying (1955–1964) the incidence of adverse reproductive outcomes was 11.9% of births, whereas in the 10 years after spraying (1965–1974) the incidence was 27% (6). The increase in birth defects peaked slightly later than did the increase in adverse reproductive outcomes (1967–1968).

Although the effects of exposure to neurotoxic substances such as lead, mercury, PCBs, and pesticides are less easily quantitated, such exposures pose an enormous threat to the health of children in many countries in this region. Because these exposures are often at levels that do not cause obvious and immediate illness, yet are associated with a reduction of intelligence quotient (IQ) and attention span, their impact on the society receives less attention (7). Nevertheless, factors that cause reduced IQ in many individuals in the population, even if it is only on the order of 5 IQ points per individual, may have an enormous effect on the overall productivity and competitiveness of the population. With a high incidence of lead and mercury elevation and a likely widespread

**Table 1.** Adverse reproductive outcomes as a function of total pregnancies and birth in three villages in Vietnam 35 years before (1930–1964) and after (1965–1999), and 10 years before (1955–1964) and after (1965–1974) the spraying of Agent Orange.

	1930–1964	1965–1999	1955–1964	1965–1974
Total recorded pregnancies	396	5,747	253	803
Total normal births	348	4,800	226	631
Total reproductive failures	47	917	27	171
Ratio of failures to normal births	13.5%	19.10%	11.9%	27%

**Table 2.** Birth defects in three villages in Vietnam in the 35 years before (1930–1964) and after (1965–1999), and 10 years before (1955–1964) and after (1965–1974) the spraying of Agent Orange.

	1930–1964	1965–1999	1955–1964	1965–1974
Total normal newborns	1,423	4,310	473	610
Total birth defects	33	283	10	31
Ratio of birth defects to normal births	2.3%	6.5%	2.1%	5%

contamination with pesticides, PCBs, and dioxins, the effects of the individual contaminants may be additive or even synergistic.

Air pollution is a major problem for the children of the Philippines, both indoor air pollution from tobacco smoke and outdoor pollution from traffic (60%) and industry (40%). A Clean Air Act has just recently been passed in the Philippines, which will phase out the use of leaded gasoline by the beginning of 2001. However lead levels in children are high, not only from the lead in gasoline, but also from the extensive mining operations and battery recycling plants. Even newborns often have lead levels of greater than 10 g/dL. Mercury, cadmium, and copper poisonings are also a major problem. Urban air pollution is an enormous problem in many of the large cities, as was documented for Singapore (8,9); Hong Kong; Taiwan City, Taiwan (10); and Ulaanbaatar, Mongolia.

Asthma is the major health hazard to children in the more developed countries in Asia, although asthma is increasing in all countries in the region. The distribution of asthma among the Asian countries is somewhat different than that seen in the United States. In the United States we see asthma incidence particularly elevated in poor, inner-city populations (11), whereas in Asia asthma is particularly elevated in the more affluent countries, such as Japan and Australia, and more tied to affluence than to poverty. In wealthy Singapore, 1 in 5 children has asthma (12), and another 1 in 5 reports symptoms of asthma, but has not been formally diagnosed with the disease (13). Worldwide 8.4% of children suffer from asthma.

A major current question in asthma research is whether the triggers for asthma attacks—especially air pollution and allergens—are also the factors that promote the airway hyperreactivity that is the cause of the disease. Research through the International Study of Asthma and Allergies

in Childhood has shown a direct relationship between the gross national product of a country and the incidence of asthma. Specific risk factors include the absence of infections, small families, receiving immunizations, diets rich in trans-fatty acids and birth length/head circumference. However, there is less clear evidence that allergens and air pollution cause asthma, in spite of strong evidence that they contribute to asthma morbidity and mortality (10). The timing of inducers of asthma, such as viruses, irritants, and allergens, may be of prime importance, but after induction these same factors may be triggers for attacks.

Various environmental agents (lead, mercury, nickel, diesel exhaust particles, tobacco smoke, dioxins, PCBs, and pesticides) alter the immune system and as a consequence play an important role in childhood disease. Immunosuppression, as seen with a number of the organic substances, will be expected to promote infectious disease incidence and morbidity, whereas aberrant immune potentiation may lead to hypersensitivity and autoimmunity. Thus, while infectious diseases in children are not usually considered environmental diseases, they often are directly related to environmental factors that reduce immune system function.

### Risk Assessment and Risk Communication Issues

The barriers to appropriate risk communication in many Asian countries are lack of expertise, lack of sufficient funding, fragmented infrastructure in governments, political credibility issues, and particularly lack of ability to translate issues into layman's language. However, the electronic age offers new opportunities for risk communication. It is important that scientists present correct and easy-to-understand information to the public, and that journalists have appropriate knowledge to understand the scientific information. Effective risk communication is not

something that comes naturally, but is a product of knowledge, preparation, training, and practice. When a community is involved, it is very important to interact with the community. There is a need to recognize the existing community organizations. It is important to listen and acknowledge the sentiments and feelings of the affected residents and to recognize that community organizations such as parishes may play an important role in risk communication.

There are problems with traditional risk assessment, not only in Asia but throughout the world. Traditional risk assessment focuses exclusively on healthy young adult males and does not consider children or other special populations. Traditional risk assessment almost always deals with a single chemical exposure, but children are almost never exposed to only a single chemical. Multiple exposures will at the very least result in additive risks, and there is at least some evidence that there may be synergistic interaction between two or more chemicals in which the effects are greater than additive. Less than half of the chemicals used today have ever been tested for toxicity. Furthermore, even fewer have been tested for toxicity in children or developing organisms. Toxicology alone is not adequate for risk assessment for several reasons. It cannot adequately determine *in utero* exposure, it is difficult to accurately extrapolate between species and to understand effects at all developmental stages, and there are not adequate models for certain end points. Epidemiology is also not sufficient, because exposure is unusually uncontrolled. Exposure assessment often does not work well, especially for children, because of the often constant, low levels of exposure to many different chemicals and the variations of exposure that occur with development. Given all of these problems, risk assessment must be done by collaboration across disciplines by sharing resources, analyses, and ownership of data. Clearly, if we can reduce a child's exposures we will reduce risk, but central to this is to increase awareness of the problem in the public, industry, health care providers, and government regulators and policymakers.

### Summary

In summary, there is a need to obtain better and more coordinated local and global data collection on environmental exposures in children throughout Asia and to relate these exposures to disease outcomes. It would be of great benefit to develop a global, strategic, epidemiologic effort to understand the relationship between environmental exposure and ill health in children (e.g., an international children's cohort). In doing this we need to consider the entire environmental

pathway, from driving forces to health impact, and design interventions accordingly that will improve the environmental health of all children. Finally, it is imperative that we develop a better understanding of the mechanisms and interactions between nutrition, infectious disease, environmental exposures, and genetic predisposition in order to develop better prevention methods. Although the environmental health threats to the children of the Western Pacific Basin are not unlike those of children in the rest of the world, their unique circumstances need to be addressed in context of a rigorous scientific agenda.

Professor Le Hung Lam of the Hanoi School of Public Health eloquently provided meeting attendees with a mandate in his closing comments:

We will have to continue to join together as we do today, to continue sharing our knowledge, experience, and support. This conference is a call to governments, civil society, the private sector,

and the whole international scientist community to renew our commitment to children's health by advancing a new vision for the 21st century—a vision in which every child has a healthy life and a clean environment.

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