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Environmental health hazards in childhood

Introduction

Although food safety has long been of interest to the public health community, its actual impact on morbidity and mortality is difficult to quantify, and the value of simple interventions has not always been appreciated fully. A nutritionally adequate food supply is essential for health, but it must not endanger consumer health because of the presence of biological or chemical hazards.

However, it was not until 2000 that the 53rd Word Health Assembly adopted a resolution on food safety.

Global foodborne illness

Acute foodborne infections diseases and intoxications are major global public health concerns and the challenges they present appear o be escalating. In the developing world, foodborne pathogenic microorganisms are estimated to cause up to 70 percent of the roughly 1.5 billion annual episodes of diarrhea, and the related 3 million deaths in children under the age of five.

The reasons for this are complex, but include the emergence of new agents of disease, the increased occurrence of large outbreaks of foodborne illness,

a heightened recognition of the impact of illness on children and other susceptible populations, changing patterns of trade and consumption of food, and the utilization of new technologies in food production and processing.

Meaningful monitoring of foodborne illness requires effective surveillance systems at local, national and international levels, and the resources necessary to operate such systems are inadequate in many countries. Even where surveillance programmes exist, foodborne illness is not reported.

Hence, our knowledge on foodborne illness is based on passive reporting, which grossly underestimates the true level of illness.

Microbiological foodborne hazards

Foodborne illness in infants and children is caused primarily by biological agents and is manifest mainly as gastrointestinal symptoms such as vomiting and diarrhea. Major bacterial illnesses include salmonellosis, campylobacteriosis, listeriosis and cholera. Hepatitis A and norovirus are the most common foodborne viral diseases. Protozoa such as Giardia, Toxoplasma and Cryptosporidium are another group of foodborne pathogens of major public health importance. Trematodes, cestodes and nematodes are transmitted through raw or undercooked foods of animal origin and may cause severe, acute and long lasting illnesses.

Infants and children, pregnant women and the foetus, older persons and the ill and immunocompromised are the most vulnerable to foodborne illness.

Even mild bouts of gastroenteritis pose serious threats to children, as they often lead to dehydration and may result in death unless treated properly. This is especially significant in undernourished children.

Adverse health effects range from mild gastroenteritis (diarrhea and vomiting) to life threatening neurological, renal or hepatic syndromes. For example, a pathogen may produce toxins that result in enteric disease and also severely damage susceptible organs, e.g. haemolytic uraemic syndrome (HUS) that is caused by damage to the kidneys from Shiga-toxin (Six) producing strains of E.coli. chronic sequelae also may arise through immunemediated reactions that result in disorders such as reactive arthritis (including Reiter's syndrome) orGuillain Barre syndrome.

Dose-response relationship

The likelihood that an individual may become ill after ingesting a foodborne pathogen is influenced by interactions between host, pathogen and food matrix. Host factors such as age, sex, genetics, nutritional status and general state of health influence an individual's response to a pathogen. Furthermore, virulence mechanisms will influence the ability of the pathogen to cause infection. A single, viable, infectious pathogen has the potential to initiate the infection process and cause illness.

Increased susceptibility to pathogens by sub-populations

Indeed, the risk to infants (0-12 mo) and children (1-10 yrs) from specific foodbone pathogens s clearly higher than for any other age group. Children are expressly at risk from salmonellosis, campylobacteriosis, shigellosis, and illnesses caused by EHEC (e.g. E. coli 0157: h7), Cryptosporidioum, Listeria and Yersinia. Pregnant women have increased susceptibility to infection by L. moocytogenes and transplacental infection poses great risk to the growing foetus.

e.g. Toxoplasma gondii, hepatitis E virus and Coxiella burnetlii. The incidence at birth of congenital toxoplasmosis ranges among countries from <1/10,000 live births to an estimated 10/10,000 live births

Influence of diet on foodborne risks

Exclusive breastfeeding minimizes infants exposure to foodbrone and waterborne pathogenic microorganisms and actually confers protection through its anti-infective properties. On the contrary, bottlefed infants may be exposed to a range of pathogens. Bacterial contamination of the water used to reconstitute infant formulae and poor cleaning and sanitation of bottles and teats represent a significant risk to infants. With the introduction of complementary (weaning) foods to meet infants evolving nutrient requirements, infants are exposed to a range of foodborne hazards. Diarrhoea is a leading cause of death in children under the age of five in developing countries. Diarrhoeal disease may be responsible for over 40%

of all deaths in children. Careful selection of raw materials and food, followed by its hygienic preparation and storage are essential to avoid foodborne illness in these sub-populations.

Selected biological contaminants

Shiga toxin-producing Excherichia coli 0157:H7

In some perons, particularly children under 5 years of age and the elderly, this pathogen can lead to the development of HUS, a life threatening illness characterized by haemolytic anaemia, thrombocytopenia and acute kidney failure. Foods that have been associated with E coli O157:H7 infections are raw or under-cooked beef (especially ground beef), unpasteurized raw milk, unpasteurized apple cider, sprouts, lettuce and salami.

Enterobacter Infections

Those at greatest risk of infection are preterm (premature) and immunocompromised infants fed milk-based powdered infant formula.

Clostridium botulinum neurotoxin

Botulism is a rare, acute descending flaccid paralysis caused by a neurotoxin produced by cl. Botulinum. Intoxication results from ingestion of food contaminated with the profound neurotoxin. Traditional food vehicles include improperly heat processed low acid canned foods such as asparagus, green beans and corn. Home-preserved vegetables remain a major cause of this illness. More recently, food sources have included chili peppers, chopped garlic, tomatoes stored in oil and vacuumpacked smoked fish.

Honey is a reservoir for Cl. Botulinum and epidemiological studies have implicated honey consumption as a risk factor.

Rotaviruses, hepatitis A and noroviruses

Hepatitis A and gastroenteritis causing viruses such as rotaviruses, noroviruses, astroviruses, and other caliciviruses are transmitted via food. Viruses are considered the most common cause of infectious gastroenteritis.

Rotavirus infection is the most common cause of severe viral diarrhea in infants and young children under 5 years of age. This pathogen results in the hospitalization of approximately 55,000 children each year in the US.

The most common symptoms of viral gastroenteritis are watery diarrhea and vomiting. Patients also may have headache, fever and abdominal cramps. Symptoms occur 1-2 days after infection and last for 1-10 days. However, dehydration due to vomiting or diarrhea is a major problem for infants and young children. Food also may by contaminated by food handlers. Raw and undercooked shellfish grown in polluted waters are also important vehicles for viral gastroenteritis.

HIV and other viral infection

Human milk may be the source of viral infections in nursing infants whose mothers have acquired HIV or cytomegalovirus infections.

Exposure of infants and children To selected chemical contaminants

Such chemicals include environmental pollutants, residues of veterinary drugs and pesticides, industrial pollutants, heavy metals, biotoxins, mycotoxins and certain substances used in food processing. Although illness may be acute, the effects of exposure are generally chronic and irreversible, such as developmental delays and cancer.

On a body weight basis, infants and children consume more food and water and breathe more air than adults. The skin surface area of an infant per unit of body weight is double that of adults and food consumption by infants per unit of body weight is approximately two times higher than for adults.

Persistent organic pollutants (POPs)

Persistent organic pollutants (POPs) are a group of toxic chemical substances that persist in the environment, bioaccumulate along the food chain and are a risk to human health. The twelve substances initially classified as POPs under the Stockholm Convention are aldrin, chlordane, DDT. Dieldrin, endrin, heptachlor, mirex, toxaphene, polychlorinated biphenols (PCBs), hexachlorobenzene, dioxins and dibenzofurans.

POPs resist biodegradation and are isoluble in water, but are readily stored in fatty tissue where concentrations can become magnified up to 70,000 times background levels. Potential health effects of POPs include cancer, allergies and hypersensitivity and diseases of the nervous and immune systems. Of particular concern are dioxins that may function as endocrine disrupters. Breast-fed infants can receive up to 14% of their lifetime exposure to dioxins from breast milk.

Heavy metals

Small amounts of heavy metals, such as mercury and lead, can be harmful to the foetus, infants and young children, resulting in cognitive and growth defects. Food is an important source of exposure to these substances. Care should therefore be exercised with young children because they absorb these substances more easily than adults and are more susceptible to their harmful effects. Fish is the main source of exposure to methylmerecury. However, young children are more vulnerable than adults. Small amounts of lead also can be harmful to the foetus, infants and young children. Even low-level exposures of children to lead may lower IQ, result in learning disabilities and behavioural abnormalities, and cause kidney damage. Lead also can enter food, especially acidic food such as fruit juice, from lead-based glazes and lead-soldered cans.

Nitrate and nitrite

The major acute toxic effect from nitrate and nitrite poisoning is the development of methaemoglobinaemia, a condition where more than 10% of the haemoglobin is transformed into methaemoglobin, thereby reducing the oxygen carrying capacity of the blood. When transformation exceeds 70%, the condition can be fatal. Neonates are at special risk when exposed to high nitrate/nitrite levels due to a transient deficiency in methaemoglobin

reductase and the greater susceptibility of haemoglobin F (foetal haemoglobin) to oxidation.

Mycotoxins

The growth of moulds on agricultureal commodities may result in the production of mycotoxins. Aflatoxins are a class of mycotoxins produced by Aspergillus flavus that grows on peanuts, corn and other nuts. Aflatoxins are human careinogens and considered one of the most dangerous contaminants of food and animal feed.

Food additives

Public health concerns about the use of food additives, such as preservatives, artificial colouring agents, flavour enhances, sweeteners and antimicrobials, generally are unfounded. Most developed countries have registration and approval processes that are designed to ensure the controlled use of substances that have met exacting safety assessments.

Waterborne Hazards in Children

Introduction

Water has a central role in societies. Historically, health, wealth and economic development always greatly have benefited from effective management of water supplies. No other part of socioeconomic development has continued to be as incredibly cost-effective in relation to the wealth created. Over a wide range of income distributions, rich and poor countries alike have to invest less than I percent of the average income to ensure excellent water supplies and resource management. The reasons for concern over the world's water resources and their health impact on children can be summarized within three key areas: water scarcity, water quality and water-related disasters.

Today, more than 2 billion people are affected by water shortages in over forty countries: 1.1 billion do not have sufficient drinking water and 2.4 billion have no provision for their sanitation.

Water scarcity

It is estimated that 54 percent of accessible runoff water is appropriated by humans. Water for human use is becoming increasingly scarce. Only half the children in the developing world have access to clean drinking water and even fewer have access to sanitary waste facilities. The average person in the developing world uses 10 liters of water a day. Water is collected by an average walk of 6 kilometers, mostly by women and children. Current predictions are that by 2050 at least one in four people are likely to live freshwater shortages. The situation is particularly grave in many of the developing world's cities. This is worrisome given predictions of a 60 percent increase in the world's urban population by 2020. Presently, half the population of developing countries live in water poverty. Water scarcity also has direct adverse health effects by restricting personal and domestic hygiene. Inadequate washing procedures and frequency facilitate diseases, such as trachoma, relapsing fever and typhus.

Water Quality

Chemical Risks

The most frequent sources of pollution are human and industrial waste, agricultural pesticides and fertilizers. It is estimated that half of the developing world's population is exposed to polluted sources of water that increase disease incidence. Key forms of chemical pollution include industrial organic substances, acidifying substances from mining aquifers and atmospheric emissions, heavy metals from industry, ammonia, nitrate and phosphate pollution and pesticide residues from agriculture, as well as sediments from human-indeed erosion and salinisation. Methaemoglobinaemia following the intake of nitrate in drinking water is

the most serious acute health problem linked to the chemical pollution of water resources in many developing countries. Chemicals in drinking water can have acute and chronic toxic effects on humans. The guideline values (GV) for potentially hazardous water contaminants.

GVs are based on various parameters: the contaminant's estimated NOEL (no observed adverse effect level), the fraction allocated to drinking water, the daily drinking water consumption, the body weight and an uncertainty factor. Children are among the most vulnerable groups of water consumers and are most affected by adverse health effects of water contaminants.

Arsenic

Arsenic is an extremely toxic metal that gets into drinking water primarily through the dissolution of naturally occurring minerals and ores. The fatal dose may be as low as 100 mg. Sings of a chronic intoxication, which also can be fatal, occurafter years of consumption. Its first symptoms are black spots on the hands and the planta pedis. There is a clear dose-response relationship with disease risk and duration of use of arsenic contaminated water. The skin also may become hard and chapped. Endemic arsenical dermatitis is seen in villages in West Bengal. The provisional WHO GV for arsenic is 0.01 mg/1.

Fluorides

Nearly all waters contain traces of fluorides. The concentration is usually<0.5 mg/1. Children need approx 1.5 mg/1for the development of healthy teeth and skeleton. Chronic poisoning by the ingestion of more than about 6 mg of fluorine per day results in a condition known as fluorosis (weight loss, anaemia, spotted dental enamel. alopecia and skin inflammation). The WHO GV for fluoride is 1.5 mg/1.

Cadmium

Occurrence of cadmium in drinking water is mainly caused by man. Cadmium is found in batteries and in fossil fuels and discharged into the environment through discarding or burning. This heavy metal is both stored

in the kidneys and the liver. WHO has established a GV of 0.003 mg/1 for cadmium.

Aluminium

Aluminium enters the environment through acid rain. Sulphur dioxide from industrial and domestic waste is dissolved in rain water. This reduces its pH by forming acids. Acute exposure is related to accidental AI3 contamination of other processed water or water sources, resulting in a significant increase of acute health problems such as headache, nausea, vomiting, diarrhea. One of the more worrying correlations between long term water quality and ill health is the presumption that dementia may be higher in people who chronically drink water with high aluminium contents. The current European Community (EC) recommended maximal limit is 0.2 mg/l.

Nitrate

High concentrations can be caused by leaching from saltpeter stocks, fertilisers from agriculture and from degradation and oxidation of organic and inorganic substances. In creased methaemoglobinaemia in infants. The current EC recommended maximal limit is 50 mg/l.

Lead

Increased lead values in untreated water are found close to lead mining areas and lead treatment plants. The main sources of lead in drinking water, however, are lead pipes and fittings. Several studies have reported a strong association between increased blood lead and lead in drinking water. Lead is heavily toxic. It damages enzymes essential for blood synthesis and for the nervous system. An increased lead concentration causes neuropsychological damage in children. The WHO GV for lead is 0.01 mg/l.

Pesticides

Pesticides are substances that are used against undesirable microorganisms, small fungi, algae, viruses, insects, plants, nematodes and animal parasites for the protection of agricultural crops and animals. The spectrum of effects ranges from acute toxicities on nerves to cancerogenic effects when pesticides when pesticides accumulate in the body. Several highly toxic

insecticides, for example DDT, are now prohibited in many countries. Some current WHO GVs are chlorpyrifos 30 mg/l, DDT and metabolites 1 mg/l, and pyriproxyfen 300 mg/l.

Bromate and trihalomethanes

Bromate and trihalomethanes are important disinfectant by products. The provisional GV for bromate is 0.01 mg/1. Trihalomethanes are cleassified as carcinogenic compounds. WHO GVs are: chloroform 200 mg/l, bromoform 100 mg/l, dibromochloromethane 100 mg/l and bromodichloromethane 60 mg/l.

Microbial risks

Most water induced disturbances are infections. These infections diseases are classified into four main groups.

Waterborne disease

Cholera and typhoid fever are classical examples of diseases caused by highly infections organisms, i.e. only a few organisms are needed to cause severe diarrhea. Furthermore, shigellosis, hepatitis A, amoebic dysentery and other gastrointestinal diseases also are recognized t be waterborne.

Diseases associated with inadequate water supplies. Pathogens are transmitted from person to person or from contaminated surfaces to person by the faecal-oral route. Eye, skin and diarrhea illnesses occur often under these circumstances (traehoma, scabies, flea and tickborne diseases).

Water-based diseases

Parasites are the cause of helminthic disease. Their infective larval forms inhabit freshwater, find their way back to humans by boring through wet skin (schistosomiasis), are ingested with water plants, crustaceans or fish that are eaten raw, are not sufficiently cooked (liver and lung flukes) or are swallowed as minute crustaccans (Cyclops water fleas) that are themselves infected.

Water related (vector-borne) diseases

Breed in water, adult mosquitoes may transmit malaria, filariasis and virus infections such as dengue, yellow fever and Japanese encephalitis.

Water-related disasters

Throughout the last decade of the 20th century, over 665,000 people died in natural disasters, of which 90 percent were water-related events. The vast majority of victims (97 percent) were from developing countries. Growing concentrations of people and increased infrastructure in vulnerable areas such as coasts and floodplains and on marginal lands means that more people are at risk. Although poor countries are more vulnerable. Worldwide, floods constitute the most frequent reported disaster events, while droughts claim the greatest number of victims.

Water-related disease burden for children

The most recent estimates of the global burden of disease (GBI) suggest that around 6 percent of the GBD is linked to inadequate hygiene (water, sanitation, food, personal hygiene), and about 15-20 percent affect the 0-4 age group. In 1995, about 19 percent of deaths among children less than 5 years old in all developing countries were caused by diarrhea. Including all effects, an estimated 88 percent of all diarrhoeal diseases in the world is attributable to inadequate water, sanitation and hygiene. At any time, it is estimated that half of the world's hospital beds are occupied by patients suffering from waterborne diseases.

Transmission pathways:

- Transmission through ingestion of water.
- Transmission caused by poor personal, domestic or agricultural hygiene
- Transmission through contaminated aerosols

2.2 million people in developing countries, most of them children (1.8 million), die every year from diseases associated with lack of access to safe

drinking water, in adequate sanitation and poor hygiene. Some 6,000 children die every day from this group of diseases. In the past decade, diarrhea killed more children than all who were lost to armed conflicts since World War II.

By lowering immunity levels, diarrhea increases mortality rates from othr opportunistic diseases, especially respiratory infections. Parasites consume nutrients, aggravate undernutrition, retard children's physical development and result in poor school attendance and performance. Around one third of diarrhea may be due to poor drinking water quality even in systems fully complying with prevailing standards. Children are among the individuals who are at increased risk of developing more severe outscomes from infectious water-associated diseases. Other than age, the outcome of exposure to infectious microorganisms depends on a number of additional host factors including immune defects, inadequate nutrition and other non-specific host factors.

Airborne hazards in children

Introduction

Air pollution presently impedes the development of the world's economy and threatens human health. Some airborne hazardous sub-stances are natural, becoming toxicants when inhaled or ingested, but many toxicants are man-made, resulting from human abuse and lack of appropriate control. Available evidence links mercury vapor, lead, tobacco smoke and other air pollutants to adverse health effects, such as neurodevelopmental disorders, respiratory and cardiovascular dysfunctions, endocrine disruptions, reproductive problems and cancer.

Children's vulnerability to airborne toxins

Persons of all ages are affected by air pollution, but developmental periods are particular vulnerable. Worldwide, as much as two third of all preventable health problems due to environmental conditions occur among children. Second, children have more hand-to-mouth behaviour, which increases ingestion of toxic chemicals that might be present in dust. It is essential to understand that airborne hazards are not only inhaled through the

respiratory tract, but also may be ingested when hazards occur in dust. Third, children are shorter than adults, increasing their exposure to toxins in dust, soil carpets, and other toxins (e.g. lead) that form low-lying layers in the air. There are three biological bases for this heightened vulnerability. First, children's metabolic pathways are immature and their abilities to detoxify and excrete certain toxins are lower than those of adults. Secondly, children are undergoing rapid growth and development and developmental processes are disrupted easily. Many organ systems – the nervous system, the reproductive organs and the immune system- undergo very rapid growth and development in the early months and years of life. Additionally, because children have a longer future than most adults, they are more likely to develop chronic diseases that may be triggered by early environmental exposures. Consequently, certain carcinogenic and toxic exposures sustained early in life appear more likely to lead to disease than are the same exposures encountered later in life.

Hazardous pollutants and sources

Are ozone, particulate matter, nitrogen dioxide, sulfur dioxide and heavy metals such as lead and mercury.

Indoor air pollutants

Children spend most of their time indoors, with their primary exposure to air pollution coming from breathing air inside homes and schools rather than from the outdoors. Three indoor air pollutants (carbon monoxide, tobacco smoke and mercury vapor) are among the most important indoor air pollutants to consider because excessive exposures to them may lead to severe illness or death.

Carbon monoxide

Common sources of carbon monoxide (CO) are gas furnaces and heaters, gas ranges and ovens, gas clothes dryers, other fuel-powered equipment and appliances, wood and coal heating, fireplaces and charcoal grills. Exposure to CO may occur in and around automobiles when there is incomplete combustion due to poor vehicle maintenance and inadequate ventilation.

Exposure also may occur when gasoline-powered equipment is used in poorly ventilated places.

Tobacco smoke

Tobacco smoke is composed of more than 3,800 different chemical compounds. Exposure to environmental tobacco smoke may occur in a variety of environments, such as in the home, school, children care settings, relatives homes and motor vehicles.

Mercury vapor

Elemental mercury is liquid or vapor at room temperature. The major source of atmospheric mercury vapor is from burning fossil fuels, especially high-sulfur coal. Other sources include scientific instruments, electrical equipment, dental amalgams (a composite metal containing approximately 50% mercury that has been used to fill decayed teeth since the 1820's), fluorescent light bulbs and button batteries. Mercury mining and smelting, refining processes, waste incinerators (especially medical waste), crematoriums and chloral kali production.

Outdoor air pollutants

Worldwide, the most pervasive air pollution problem is caused by ozone, particulate matter, lead, sulfur dioxide (SO_2, acid aerosols, and nitrogen dioxide (NO_2).

Ozone

Ozone is a relatively insoluble gas that is a highly active oxidant and thus can react with lipid cytoplasmic respiratory tract membrane.

Particulate matter

Particulate matter is referred to as “soot” in the public media. Particulate matter is a mixture of solid particles and liquid droplets in the air, including dust, dirt and smoke. Particulate matter may be emitted directly into the air, or it may be formed in the atmosphere by condensation or transformation of gas emissions. Sources include factories, power plants, diesel trucks and other motor vehicles, construction activities and windblown dust.

Lead

Lead was known and used widely by ancient civilizations. Lead is used in some glass, eating utensils, folk medicines and plumbing. It also is used in paint pigments, solders, wall and window construction, cosmetics, sheeting of ships, roofs, gutters, containers, sealants, protective coatings, printing type, insecticides, batteries, plastics, lubricants, ceramics, machine alloys and gasoline additives. Currently, industrialized countries steadily are replacing leaded gasoline with lead free gasoline but environmental lead omitted by vehicles will remain for decades.

Sulfates and nitrates

The atmospheric deposition of acidic species, i.e. sulfates and nitrates, has been recognized for a long time. Indoor exposure also could be produced by gas cooking coal combustion, tobacco smoke, etc.

Adverse effects

These include respiratory, neurobehavioural, endocrinological and carcinogenic outcomes.

Respiratory effects

The respiratory system is the primary target of air pollutants. Children residing in industrially polluted towns had an increased lifetime prevalence for physician-diagnosed allergies, eczema, bronchitis, wheeze, shortness of breath and cough with cold compared to children from less polluted control

areas. Air pollution increases the severity of asthma. Associations between passive smoking and respiratory illnesses are well documented. Infants whose mothers smoke are 38% more likely to be hospitalized during the first year of life for pneumonia than are those whose mothers do not smoke. The number of cigarettes the mother smoke are more than twice as likely to have had pneumonia as are infants of parents who not smoke. There is strong epidemiologic evidence linking exposure to passive smoking to sudden infant death syndrome. Additionally, children whose parents smoke are approximately 60%more likely than are children whose parents do not smoke to develop middle ear effusions between 8% and 15% of middle ear effusions may be attributable to passive smoking.

Neurobehavioural effects

The developing child who is exposed to neurotoxic chemicals during critical developmental windows of vulnerability may suffer lifelong adverse impacts on brain function. Lead and mercury interfere with normal brain development, with long term consequences for brain function.

Lead

Lead's toxicity has been known for thousands of years. The effects of lead are dependent on the levels and terms of exposure. Generally speaking, at