State of the Science: Children's Environmental Health in Alaska and the Circumpolar North

Protecting children at the top of the world

by
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"Meaningful change takes so long and help is not coming fast enough for our generation. As Native people, we honor our children and our elders. It's critical that we take measures now to protect our children's environment and their health and well-being.

Our people and our traditional way of life continues through them - that's why this Children's Environmental Health Summit was so significant to me, so that our languages, our songs and dances, our creation stories will continue, not only as a people, but also our culture."

Vi Waghiyi
Tribal Member, Native Village of Savoonga
and
Environmental Health and Justice Director,
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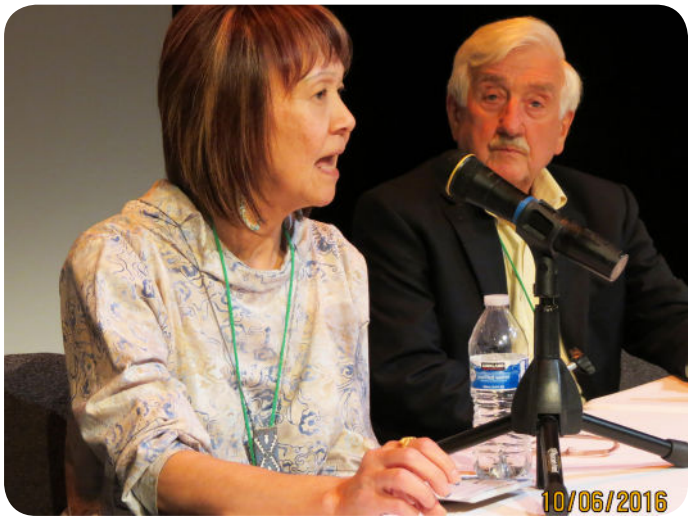
Introduction: Children's Environmental Health Summit

by Jessica Thornton, Conference Coordinator and
Civic Engagement Coordinator, Alaska Community Action on Toxics

Children in Alaska and the Circumpolar North experience disproportionate exposures to toxic chemicals that have long-term negative health consequences such as neurodevelopmental effects, cancer, birth defects, metabolic disorders, and compromised immune systems. In order to address these health disparities, Alaska Community Action on Toxics (ACAT) organized the 2016 Children's Environmental Health Summit – the first of its kind in Alaska.

The Summit (CEHS) took place on October 5 and 6, 2016 at Alaska Pacific University. Participants included students, health care professionals, Alaska Native leaders, scientists, teachers, policymakers, and children's health advocates. Over fifteen Alaskan communities were represented, and the sponsorship program made it possible to provide scholarships to thirteen participants from eight Alaska communities (Gambell, Savoonga, Nome, Kivalina, Elim, Diomede, Atqasuk, and Brevig Mission).

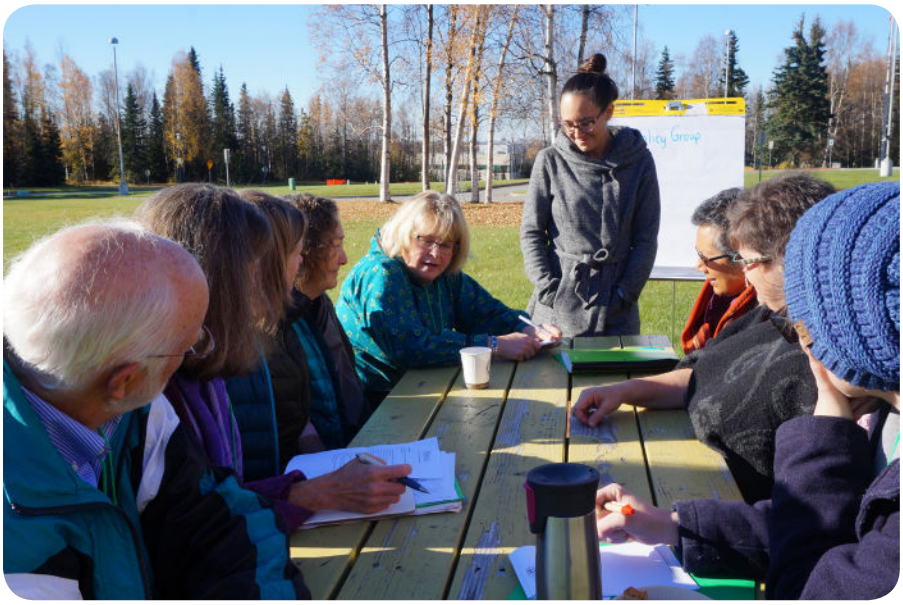


The first day of the summit consisted of plenary sessions addressing case studies from community leaders and health professionals, as well as the state of the science on certain health disparities, including endocrine disruption, neurodevelopmental effects, birth defects, and childhood cancer. Presentations from a combination of community leaders, health care providers, children's advocates, and scientists created a balance among Western-style research, on-the-ground perspectives, and traditional knowledge and wisdom. Summit participant, Elise Miller, Director of the Collaborative on Health and the Environment, commented:

> Not only were there presentations by some of the luminaries in environmental health research and long-dedicated health advocates from around the country, there were also powerful talks given by those from communities in Alaska that have been significantly impacted by exposures to toxic chemicals. You could have heard a pin drop when several women from different tribal groups – Savoonga, Inupiaq, Nay'dini'aa Na', and others – described their experiences about the health impacts of toxic exposures

they had witnessed in their villages. [To read Elise's full blogpost about the CEHS, please visit: http://ourhealthandenvironment.wordpress.com].

We wanted the Summit to be a springboard for action, rather than an end in itself – so much of the second day was devoted to working group discussions in the areas of policy, research, health care, education and outreach, and environment. The working groups provided a series of recommendations and actions to be carried forward after the summit with the help of a volunteer Children's Environmental Health Task Force.



Evaluations of the CEHS were overwhelmingly positive, with a large majority of participants rating the overall experience as "Excellent." One of the participants, a mother and teacher from the Inupiaq Native community of Unalakleet, offered the following reflection:

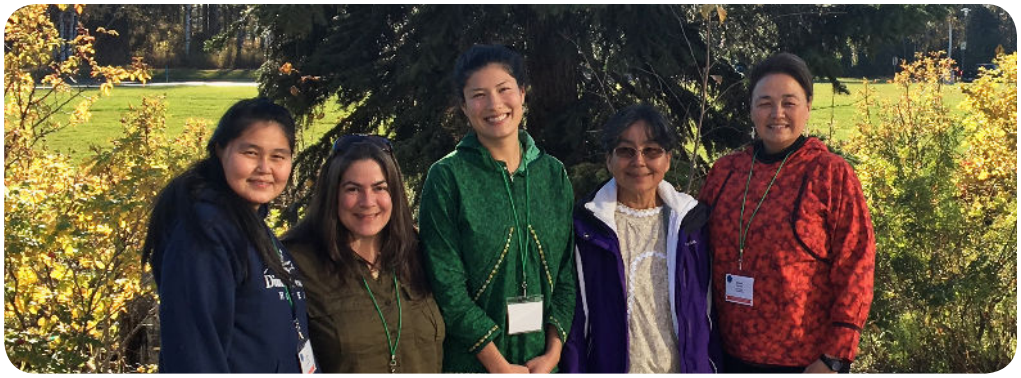
> One thing I noticed among all of these people who were gathered together, was their passion for what each one was called to do . . . There was an air of excitement in the conference; people spoke from their hearts . . . When I spoke to all the people from the podium, who work very hard in their fields, about my day-to-day life with [a child with] autism, the difficulties and the joys, you could have heard a pin drop when I was done. Many of them said it was empowering for them to continue to do their work, knowing there are people out there who live behind closed doors, lives damaged unnecessarily by toxics. Anyway, I was humbled and blessed to attend and be around such greatness! And I learned immeasurably.

Another participant called the conference "transformative," and a local physician

commented:

> A lot of hard work and planning went into making this conference a smashing success. The speakers were excellent and very passionate and inspirational. We were all motivated by their research and stories and then the breakout sessions allowed us to engage in discussion and action. I heard rave reviews from many participants.

As a result of the conference, twelve participants volunteered to create a task force to implement the recommendations developed by the CEHS working groups. The Children's Environmental Task Force is comprised of traditional healers, tribal environmental coordinators, parents, health care professionals, and academics that represent the wide base of advocates needed to address the complex challenges facing children's environmental health in Alaska and the Circumpolar North. ACAT convenes the task force on a monthly basis.



Background: Children's Environmental Health

A Snapshot of Children's Environmental Health Worldwide

A disproportionate burden of disease and death in children globally is attributable to environmental causes and conditions. Nearly one-third of deaths each year in children under age five years are linked to environmental factors. The impact of these environmental risks is worsened by poor social and economic conditions such as conflict, poverty and malnutrition.[1] In low-income countries, the rate of infant deaths related to environmental causes is twelve times higher than in high-income countries.[2]

Some of the environmental conditions linked to childhood diseases worldwide include toxic chemical exposures, unsafe water, inadequate sanitation and hygiene, poor housing conditions, radiation, indoor and outdoor air pollution, extreme temperatures, and natural disasters.[3] This report focuses on toxic chemicals in the environment and associated impacts to children's health.

Chemicals in Our World

In the modern world, people are continuously exposed to a multitude of chemicals in the environments where we live, work, learn, and play. Persistent organic pollutants (POPs) are toxic chemicals that remain in the environment; build up in our bodies (bioaccumulate); increase in concentration (biomagnify) up the food chain; and threaten the health of humans, wildlife, and the global environment.[4]

Nursing infants are at the top of the food chain, and thus have the highest risk of exposure to POPs.[5,6] Even developing fetuses in the womb are exposed to toxic chemicals.[7] Data from the U.S. Centers for Disease Control and Prevention suggest that 90% of pregnant women in the United States have concentrations of sixty-two chemicals of concern in their bodies.[8] Many of these chemicals are able to pass from the mother to her developing fetus through the placenta, and to her child through breast milk.[9,10,11,12]

It is important to note that in spite of these findings, breastfeeding remains by far the best food for infants, as the exceptionally high concentration of nutrients in breast milk actually reduces infants' health risks from exposures to harmful chemicals.[13,14]

Children's Unique Vulnerability and Critical Windows

Children are especially vulnerable to environmental hazards, due to their physiology, behaviors, and growth. Children need more food, water, and air relative to their body weight than adults. The normal behaviors of children (crawling and playing on the floor and putting their hands and other objects in their mouths) make

them more likely to come into contact with contaminants in dirt and dust. Furthermore, because organ systems are developing in children, they are more susceptible to disruptions from chemical exposures.[15]

The timing of exposure is an important factor. Certain periods of development are especially vulnerable to toxics. Known as "critical windows of vulnerability," these include embryonic and fetal development, infancy, early childhood, and adolescence.[16,17,18] During these critical windows, even extremely low exposures to toxic chemicals at levels now commonly found in the environment can cause lasting damage.[19]

Environmental Health Disparities in Children of the Circumpolar North

While children generally are disproportionately exposed to chemicals of concern, those living in Alaska and the Circumpolar North may face even greater exposure. The Arctic is a hemispheric "sink" for toxic chemicals that migrate from distant agricultural and industrial operations throughout the Northern Hemisphere. These chemicals, known as persistent organic pollutants or POPs, travel north on air and ocean currents and settle in the Arctic, posing serious risks to human health. Arctic Indigenous Peoples who rely on traditional subsistence foods harvested from the land and sea are particularly vulnerable to exposure to these chemicals, and have been found to have levels of POPs concentrations in blood and breast milk that are among the highest of any population on Earth.[20]

Mounting evidence shows that children's exposures to toxic chemicals before and after birth are linked to a host of serious diseases and medical problems such as birth defects; damage to the nervous, reproductive, and immune systems; and various cancers. Chemicals of concern interfere with normal development and functioning of systems in the body, leading to health conditions that can occur throughout life.

This report summarizes the state of known scientific evidence about children's exposure to chemicals of concern and how these exposures may harm their health. Although more studies focusing on Arctic populations are needed, the results of existing studies are sufficient to raise concerns.

Environmental Exposures and Children's Health Outcomes

This section summarizes the scientific literature concerning the association of environmental exposures to certain chemicals and adverse health outcomes for children, including: endocrine disruption, neurodevelopmental disorders, birth defects, cancers, and respiratory disorders.

Endocrine Disruption

Chemicals that interfere with the actions of hormones in the body are known as endocrine disrupting chemicals (EDCs). These chemicals are unique in that both the timing and amount of exposure may trigger completely different health effects. EDCs are particularly damaging during critical windows of vulnerability, when even subtle disruptions in the normal functioning of hormones may cause significant damage to a developing embryo, fetus, or child. During these critical windows, low doses of EDCs can result in more severe health effects than high doses. Recent studies replace the outdated approach in toxicology that assumed erroneously that "the dose makes the poison."[21]

Many pesticides, flame retardants, plasticizers, and fuels are EDCs. Polychlorinated biphenyls (PCBs) is a group of organic compounds used to manufacture plastics and as lubricating fluids in products such as transformers. Dichlorodiphenyltrichloroethane (DDT) is an organochlorine insecticide. PCBs and DDT are just two types of EDCs that are POPs that are of particular concern in the Arctic because they travel north, settle out in the cold climate, and enter the food chain.

Two examples of EDCs that are not POPs are Bisphenol A (BPA), used for the production of plastics such as baby bottles, medical devices, water bottles, and food containers and "the everywhere chemical," phthalates, a family of man-made chemicals used to manufacture plastics, solvents, and personal care products."[22]

Although BPA and phthalates are not POPs, they are so widely used in consumer products that people are continuously exposed through EDC-laden dust in homes, offices, and automobiles.[23,24] Children in the Circumpolar North are disproportionately exposed because they are kept

indoors for longer periods of time during the winter, and homes that are kept closed retain more of the contaminated dust than those that have open windows and doors.

Due to their potential to affect all organ systems in the body, EDCs are associated with a wide range of health problems. According to the Endocrine Society,

> [t]he incidence of endocrine-associated pediatric disorders,

> including male reproductive problems (cryptorchidism, hypospadias, testicular cancer), early female puberty, leukemia, brain cancer, and neurobehavioral disorders, have all risen rapidly over the past 20 years. . . . Data from human, animal, and cell-based studies have generated considerable evidence linking EDC exposure to these and other human health disorders.[25]

The frequency and degree to which people are exposed to endocrine disrupting chemicals may be one factor in the changing sex ratio of the human race. Historically, the ratio of males to females at birth has been slightly higher for males than females. However, a 2007 study found this ratio is declining in the United States' white population and in Japan.[26] Another study of parents in the Great Lakes region during 1970-1995 found maternal exposure to PCBs was linked to a decreased chance of having a male child.[27]

In the Arctic, results of a preliminary 2007 survey conducted in Greenland and eastern Russia by the Arctic Monitoring and Assessment Programme (AMAP) showed an estimated female-to-male sex ratio of 2:1 (two girls to one boy) in these communities, and that only girls and not boys were being born in one village in Greenland.[28] The former chairman of the Inuit Circumpolar Conference, Aqqaluk Lynge, responded:

> Here in the north of Greenland, in the villages near the Thule American base, only girl babies are being born to Inuit families.[29]

This sex ratio research was later expanded to include populations in northern Canada, which confirmed a 2:1 sex ratio.[30] In 2009, AMAP reviewed evidence from various studies on the sex ratio in the Arctic and concluded,

> Systematic epidemiological studies, including all possible confounding factors and other relevant contaminants, must be performed before any conclusive statements can be made.[31]

AMAP's most recent research in Arctic Russia, published in 2015, found that pregnant women with high levels of PCBs and other POPs in their blood gave birth to girls almost twice as often as boys.[32] This observed imbalance in the sex ratio of Russia newborns appears to exist in other Arctic communities, as well.

The role that EDCs play in various adverse health outcomes will be discussed throughout this section of report.

Birth Defects

There is a growing body of scientific evidence suggesting environmental chemicals are linked to birth defects and other harmful reproductive health effects in both males and females.[33] These health effects can have permanent, lifelong impacts on health throughout development, childhood, and into adulthood. Some of these effects can be passed on to future generations.[34]

Alaska has the highest rate of birth defects in the United States. As reported by the State of Alaska Department of Health and Social Services, the prevalence of birth defects in Alaska is twice as high as the national average.[35] Moreover, Alaska Native infants were found to have more than twice the incidence of birth defects as

white infants in Alaska. Dr. Bradford Gessner, former Chief of Alaska's Maternal and Child Health Epidemiology Unit, stated this rate cannot be explained simply by cigarette smoking, alcohol consumption, or maternal age.[36]

Research has shown that toxics cross the placenta as readily as residues from cigarettes and alcohol. These and other chemicals are similarly hazardous to the health of developing fetuses and children, as the following studies have found:

- A review of scientific studies revealed contaminants such as solvents, heavy metals, and pesticides are linked to birth defects such as heart abnormalities, oral clefts (lip and/or palate), neural tube defects (incomplete development of the brain, spinal cord, and/or protective coverings of these organs).[37]
- Prenatal exposure to phthalates, used as plasticizers in consumer products, is linked to lower serum testosterone levels in newborn and adult males, and indicators of feminization in baby boys (such as shortened anogenital distance).[38,39]
- PCBs are linked to low birth weight. A meta-analysis of twelve European birth cohort studies found that low-level exposure to PCBs impairs fetal growth.[40]
- Two landmark studies in Alaska found that women from communities with hazardous open dump sites were more likely to deliver preterm or low birth weight babies.[41,42] These studies found that women from communities with open dump sites that were considered "most hazardous" by EPA standards delivered babies who weighed less, were too small for their gestational age, were born too early, or had higher rates of some birth defects than babies born to women living in communities near less dangerous dump sites. This research highlights the role that environmental exposures may play in birth outcomes. Children with low birth weights are at a higher risk for several diseases throughout their lifetimes.[43]

Neurodevelopmental Disorders

The developing brain is especially vulnerable to toxic exposures.[44] The blood-brain barrier is still developing and thus more permeable than the mature brain.[45] The brain also develops over a longer period than other organs[46,47] and is made of various types of neurons with distinct stages of growth and susceptibilities to toxic exposures.[48] This increased vulnerability, paired with the widespread use of chemicals in everyday products, creates the conditions for increased population-wide exposure to chemicals of concern.

There is a growing body of evidence showing that chemicals commonly found in a wide range of consumer products are linked to neurodevelopmental disorders. EDCs can impact the brain by interfering with the development and function of neurons, synaptic circuits, neurotransmitters, and the brain's structural organization – all of which can adversely affect behavior.[49,50]

In 2015, forty-six leading scientists, medical experts, and children's health advocates developed Project TENDR (Targeting Environmental NeuroDevelopmental Risks) with the goal of reducing

widespread exposures to chemicals that interfere with the brains of babies before and after birth. Their July 2016 Consensus Statement identified toxics that increase risk for neurodevelopmental disorders – chemicals that have been detected in the bodies of virtually all Americans by the U.S. Centers for Disease Control and Prevention.

The group concluded that "to lower children's risks for developing neuro-developmental disorders, policies and actions are urgently needed to eliminate or significantly reduce exposures to these chemicals."[51]

Project TENDR's Consensus Statement declared categorically that although neuro-developmental disorders have complex and multiple causes, humankind has the ability and responsibility to prevent chemicals from harming brain development.

The Project TENDR experts identified the following toxics of concern, which are only examples of the many harmful chemicals and metals that increase the risk of neurodevelopmental disorders and contribute to learning, behavioral, or intellectual impairment in children:

Organophosphate Pesticides

Prenatal exposure to organophosphate pesticides has been associated with:

- Mental development and pervasive developmental problems at age two and three.[52,53]
- Attention deficit hyperactivity disorder (ADHD) and attention problems in children at various ages in different studies: age three,[54] age five,[55] and ages six to eleven.[56]
- Deficits in social functioning among African Americans and among boys.[57]
- Autism spectrum disorders (ASD) and developmental delay (DD) in children of mothers residing within 1.5 kilometers (approximately 1 mile) of an agricultural pesticide application.[58]

Polybrominated Diphenyl Ethers (PBDEs)

PBDEs are a class of chemicals used as flame retardants that interferes with the development and aging of the brain. PBDEs are widely used in furniture, carpet padding, and electronic devices. People can accumulate PBDEs in their bodies from household dust that is digested, inhaled, or absorbed through the skin. PBDEs are linked to cognitive deficits, as well as structural and functional changes in the brain that affect behavior adversely.[59] Peer-reviewed research has found associations between prenatal exposure to PBDEs and:

- Lower IQ and higher scores for hyperactive behaviors in U.S. children.[60]
- Increased attention problems among

children at age four;[61] and lower scores on mental and physical development tests from ages one through four years old and age six in children with higher concentrations of PDBEs in umbilical cord blood. These findings come from a study of White, African American, and Asian American women who were pregnant in New York City on September 11, 2001.[62]

- Impaired attention and poorer fine motor coordination at age five and seven, and decreased IQ at age seven, in a study of both prenatal and childhood exposures in California children.[63]

Polycyclic Aromatic Hydrocarbons (PAHs)

Diesel and gasoline vehicles, furnaces, stoves, tobacco smoke, incinerators, and forest fires emit PAHs, nitrogen dioxide, particulate matter, and other air pollutants. Combustion-related air pollutants have been linked to:

- Autism in California children from age three to five from prenatal exposure to traffic-related air pollution.[64]
- Neurodevelopmental delay from prenatal exposure to traffic-related pollution, as well as impaired neurodevelopment in younger children and lower academic achievement and neurocognitive performance in older children from childhood exposures.[65]
- Lower verbal IQ scores in children in Poland at age seven from prenatal and postnatal exposure. In this study, the risks of cognitive dysfunction were reduced for children that were breastfed exclusively for a minimum of six months.[66]
- Reduced global IQ from pre- and postnatal exposure to PAHs in ambient air pollution.[67]
- Autism spectrum disorder from pre- and postnatal exposure to fine particulate matter (PM2.5) in ambient air pollution.[68]
- Autism in children from exposure during pregnancy and up to one year old to traffic-related air pollution, nitrogen dioxide, PM2.5, and PM10.[69]

Lead

Lead is a well-known toxicant to children's health and development.[70] According to current scientific consensus, there is no safe level of blood lead concentration in children.[71,72]

Children are exposed to lead from deteriorating paint in homes, schools, child care centers, and other buildings built before 1978, when lead was banned for use in paints in residential and child-occupied facilities.

Dust contaminated with lead is commonly stirred up in renovation, repair, and maintenance activities. Children are especially at risk of exposure to contaminated dust. Children may also be exposed to lead by eating foods grown in lead-contaminated soil, paint chips, or dust, and from imported children's toys and jewelry that contain lead.[73] Contaminated water from

lead pipes and fixtures is also a source of exposure in many communities.

Data from the U.S. Environmental Protection Agency in April 2016 found that twenty-eight water systems in Alaska, including schools and hospitals, had levels of lead in water that exceeded federal limits.[74,75] This number decreased to thirteen as of November 1, 2016.[76]

Exposure to lead has a well-established association with the following health effects:

- Lowered IQ, impaired attention and memory, and other cognitive deficits.[77,78,79]
- Decreased brain volume in young adults after experiencing elevated blood lead levels during childhood.[80]
- Reduced school performance[81] and delinquent behavior later in life, both due to lead exposure in early childhood.[82,83]

Emerging evidence also suggests that lead exposure is linked to ADHD.[84]

Mercury

Mercury and related compounds are potent neurotoxins that can cause serious, long-term, adverse health effects in humans, especially young children. Mercury pollution in the Circumpolar North, including Alaska, comes primarily from emissions from Asian industry and other global sources that travel to the Arctic on air and ocean currents.[85]

Once mercury enters the water system and converts to the absorbable form of methylmercury, it can build up in fish, wildlife, and people. Pregnant women and nursing mothers may pass on their body burdens of mercury to their developing fetuses and breastfed children. Methylmercury readily crosses the placenta and is excreted in breastmilk. [86,87,88]

Mercury contamination in Alaska fish required the State of Alaska to issue fish consumption advisories for the first time. In 2007, the State restricted consumption of certain fish for women who are or could become pregnant, nursing mothers, and children age twelve and under. Children and developing fetuses are particularly vulnerable to the harmful effects of mercury:

- Neurobehavioral effects, including learning disabilities, altered motor function, and memory.[89,90]
- Mental retardation, cerebral palsy, and seizures from high exposure levels associated with catastrophic environmental releases of mercury.[91,92,93]
- Visual and hearing impairment, tremors, and muscle spasms.[94]
- Impairment of the developing central nervous system in developing fetuses and children.[95,96,97]
- Deficits in language, attention, and memory in children from prenatal methylmercury exposure through mothers' regular consumption of fish and marine mammals.[98,99]

Another study showed that while prenatal mercury exposure is associated with ADHD, the benefits of eating fish during pregnancy help protect the fetus from these effects.[100]

Polychlorinated Biphenyls (PCBs)

PCBs are compounds once used as insulators in the electrical industry and a

wide range of other consumer products, such as caulks, adhesives, plastics, and carbonless copy paper. PCBs are considered persistent organic pollutants (POPs) and are toxic at extremely low levels. PCBs are worldwide in the environment and in human bodies.101 They are banned in the United States, Northern Europe, and globally through the Stockholm Convention on Persistent Organic Pollutants.[101]

In Alaska, PCBs are found at the 700 active and inactive military sites throughout the state. PCBs from global sources can travel on wind and ocean currents and build up in the bodies of wildlife and people of the Circumpolar North, particularly Arctic Indigenous Peoples that rely on subsistence foods.[102]

PCBs, like other POPs, accumulate in fatty tissue in the body. People are exposed to PCBs through foods such as fish, dairy products, marine mammals, and breast milk.[103] PCB exposure is linked to the following health effects:

- Lower developmental test scores, short-term memory defects, and lower IQ levels in children exposed prenatally.[104,105]
- Impaired neurodevelopment from prenatal exposure.[106,107,108]
- Lower muscle tone and depressed reflexes in children with higher exposures to PCBs in breast milk, at levels of exposure similar to background levels in the U.S.[109]
- Impairments in mental and motor development in children at 7, 18, 30 and 42 months of age from prenatal exposure in cord blood, at levels of exposure similar to background levels in Europe.[110]
- Increased risk of emotional and behavioral disorders in children from maternal consumption of PCB-contaminated rice oil during pregnancy.[111]

Respiratory Disorders

Respiratory disorders are common in children throughout the world, and many are associated with indoor and outdoor air pollutants such as tobacco smoke, molds, particulate matter, and smoke from solid fuels used for household cooking and heating.[112] Children are more vulnerable to respiratory health effects than adults for a number of reasons.[113] Infants and young children need more oxygen per unit of body weight and have faster inhalation rates than adults, and thus they are disproportionately exposed to air pollutants.

Also, children's airways are narrower than those of adults and more easily irritated by air pollutants.[114] Asthma is the most common non-communicable disease among children worldwide.[115] Other common respiratory disorders in children include acute respiratory infections, acute otitis media (middle ear infections), pneumonia, and sudden infant death syndrome (SIDS).

Numerous studies have documented high rates of acute and chronic respiratory illnesses in the Arctic and Circumpolar North:

Asthma

In spring 2011, the Alaska Department of Health and Social Services conducted a survey with 1,327 students from forty con-

ventional public high schools.[116] The same survey was conducted with 969 students from sixteen alternative high schools serving high-risk students. They found 22.1% of high school students reported having asthma during their lifetime, and 10.3% reported currently having asthma.

For Alaska Native students, those rates are 26.4% and 12.7%, respectively, in conventional high schools and 27.8% and 14.8%, respectively, in alternative high schools. The rates of asthma prevalence and incidence for Alaska Native high school students are higher than the national average of 23.0% and 11.9%, respectively.[117]

In a 2004 study, researchers measured the prevalence of chronic respiratory symptoms among Alaska Native middle school students in the Yukon-Kuskokwim Delta region of Alaska. Children in two small rural, coastal communities in the region were compared with those living in the larger community of Bethel, the regional hub city. Children in the rural communities were twice as likely to experience chronic productive cough (without asthma diagnosis or symptoms), but they were 63% less likely to have asthma-like symptoms (without a diagnosis) than children in Bethel.

Because the health outcomes studied were not diagnosed conditions, but rather were self-reported, the results would not be affected by differing access to care or diagnostic practices among the communities. The researchers suggested that these differences between the rural and city children may be due to different environmental exposures – allergens in Bethel; viruses and bacteria in the rural villages.[118]

Respiratory Infections

A 2012 review of research in Canada's First Nations and Inuit children found higher rates of respiratory infections, including viral bronchiolitis, pneumonia, and tuberculosis in these communities compared to other Canadian children. Additionally, children with severe respiratory infections in early life were more likely to have long-term lung disease. Researchers linked these health effects to social and environmental conditions such as poverty,

overcrowding, poor housing conditions, mold and secondhand tobacco smoke.[119]

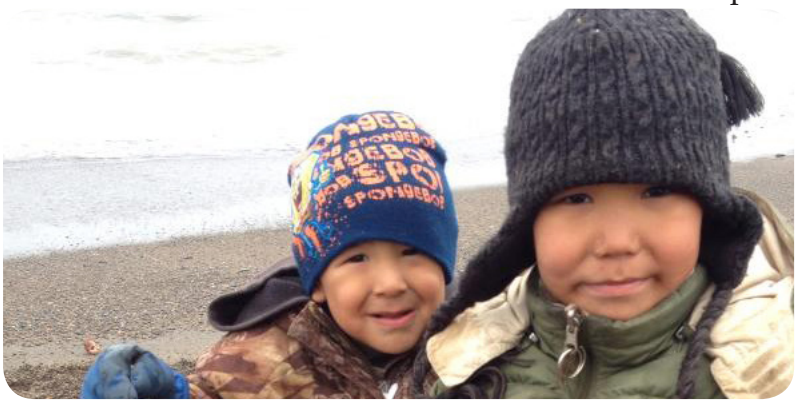
An earlier study of Inuit children in Nunavik, Canada found that prenatal exposure to PCBs was linked to middle ear infections and lower respiratory tract infections in preschool children between age five and seven.[120] Exposure to PCBs and other POPs in this community is noted to be exceptionally high due to a traditional diet based on fish and marine mammals, similar to other Arctic Indigenous Peoples.

In a study of remote villages in southwest Alaska, researchers found a signifi-

cant increase in chronic respiratory conditions among Alaska Native infants and young children who had been hospitalized for respiratory syncytial virus (RSV) infection at less than two years of age. These children experienced a greater risk of wheezing, lower respiratory infections, and asthma before age four, but the risk decreased by age five.[121]

Cancer

Many chemicals that are known or suspected carcinogens (cancer-causing agents) are used in household and other consumer products and found in indoor environments. Adults and children alike are exposed to a mixture of these chemicals on a regular basis, but children are



particularly vulnerable to these exposures and their associated health effects.[122] Only 5-10% percent of childhood cancers are attributable to inherited genetic material.[123] Most childhood cancers are thought to be due to complex interactions between genes and the environment. Some of the research on childhood cancer linked to chemicals of concern is summarized below:

Pesticides and Indoor Air Pollutants

A growing body of evidence shows that pesticides and indoor air pollutants are linked to a range of cancers in children:

- Parental exposure to pesticides during the preconception, prenatal, and postnatal periods has been linked to an increased risk of childhood cancers.[124,125] Children of fathers exposed to pesticides were found to have an increased risk of developing leukemia,[126] central nervous system tumors,[127,128] and rare kidney cancer (known as nephroblastoma or Wilms' tumor).[129] Childhood leukemia has also been associated with both prenatal and direct exposure of children to household pesticides,[130] as well as parental occupational exposure to pesticides prenatally.[131]
- Numerous studies show links between childhood brain cancer and pesticide exposures, including parental use of household pesticides during pregnancy and after birth,[132, 133, 134, 135, 136] and children's contact with pesticides used on pets.[137]
- Other studies have found an increased risk of childhood leukemia and lymphoma due to exposure to indoor volatile organic compounds,[138, 139, 140] indoor insecticides,[141, 142, 143] and childhood lice shampoos.[144]

Parental Occupational Exposures

Parental occupational exposures are associated with increased risks of childhood cancers. Children may be at risk of exposure to workplace chemicals due to contaminated clothing or other items brought home from work, chemicals crossing the placenta during pregnancy, and adverse effects on fathers' sperm.[145]

A review of occupational studies found high risks of cancers for children of aircraft

workers and radiation-exposed military workers. Factory workers, machinists, painters, and workers in the chemical and petroleum industries were more likely to have children with leukemia and lymphoma.

Childhood brain cancer was also associated with parental occupations in the paint, petroleum, and chemical industries. Parental occupational exposure to hydrocarbons was strongly linked to childhood leukemia.[146]

In Ohio-born children, researchers found childhood brain cancer associated with paternal occupation in agriculture, metalworking, and structural work in the construction industry, and in electrical work in the machinery industry.[147]

Environmental Exposures

A wide range of environmental exposures have been linked to an increased risk of common childhood cancers such as leukemia and non-Hodgkin's lymphoma.[148, 149]

Leukemia:

- Ionizing radiation
- Metal dusts
- Secondhand tobacco smoke
- Carbon tetrachloride (used to produce refrigerants and aerosol propellants, for cleaning and degreasing, in fire extinguishers and spot removers) and other chlorinated solvents
- Trichloroethylene (used as a degreaser and in adhesives, paint removers, typewriter correction fluids, and spot removers)

Non-Hodgkin's Lymphoma:

- 1,3-butadiene (made from processing petroleum and used to make synthetic rubber and plastics)
- Aromatic amines (used to produce polymers)
- Chlorophenols (used as pesticides and disinfectants)
- Creosotes (used in preservatives and antiseptics)
- DDT and dichlorodiphenyldichloroethylene (DDE)(used in pesticides for malaria control)
- Dioxins (industrial by-products and widespread environmental pollutants)
- Ionizing radiation
- Polychlorinated biphenyls (PCBs); (used in electrical apparatus, carbonless copy paper, heat transfer fluids)
- Secondhand tobacco smoke
- Solvents including carbon disulfide, carbon tetrachloride, tetrachloroethylene (used in dry cleaning) and trichloroethylene (used for cleaning and degreasing).
- Malathion (an insecticide used to treat childhood head lice and agricultural crops).[150,151]

Research Gaps and Recommendations

First and foremost, traditional knowledge and community observations about community health should be valued and considered alongside scientific information. Despite all of the advances of technology, basic observation is still the foundation of science. Communities have valuable firsthand knowledge of their own health and wellbeing and often observe the earliest warning signs of illness and disease.

On St. Lawrence Island, Alaska (in the northern Bering Sea), Yupik elder and health aide Annie Alowa raised the first alarm of the growing incidence of cancer, low birth weight and miscarriage in her community following military occupation and subsequent contamination of the Island during the Cold War era. Her observations led to the first health studies on the Island and initiated decades of advocacy for accountability and cleanup of contaminated sites. Scientists must acknowledge community concerns and work together with community and Tribal leaders to understand fully the complex challenges that communities face in the Arctic and Circumpolar North.

The body of scientific evidence on links between environmental exposures and children's health is growing, but is likely just the tip of the iceberg. Humans encounter complex mixtures of toxicants on a daily basis, which calls for a different approach to research that examines the effects of multiple, simultaneous exposures on health.[152] Additionally, more research is needed to demonstrate the persistence and bioaccumulation of pollutants in the Arctic and their health effects on Arctic Indigenous Peoples who bear a disproportionate burden of exposure to these global contaminants. Finally, multigenerational studies are needed to examine the long-term impact of exposures on children's health and development.[153]

Existing policies and regulations on chemicals fail to protect public health and the environment. Tens of thousands of chemicals on the market today remain untested; many are in products we use every day that are found in our homes and workplaces. Industrial chemicals, heavy metals, and pesticides continue to contaminate our air, water and food despite attempts to regulate industry to prevent these contaminants from entering the environment.

The U.S. Environmental Protection Agency (EPA), U.S. Food and Drug Administration, and other federal agencies are hampered in their ability to serve the public interest because current laws allow chemical manufacturers too much authority to regulate themselves. Manufacturers can legally keep products on the market despite evidence that the chemicals in them are harmful.

Some consumer products, including household cleaning products, pesticides, cosmetics, and other personal care products are exempt from safety testing. Loopholes in labeling laws also exempt companies from listing all ingredients in these products. Hidden behind the claim that formulas are "trade secrets,"

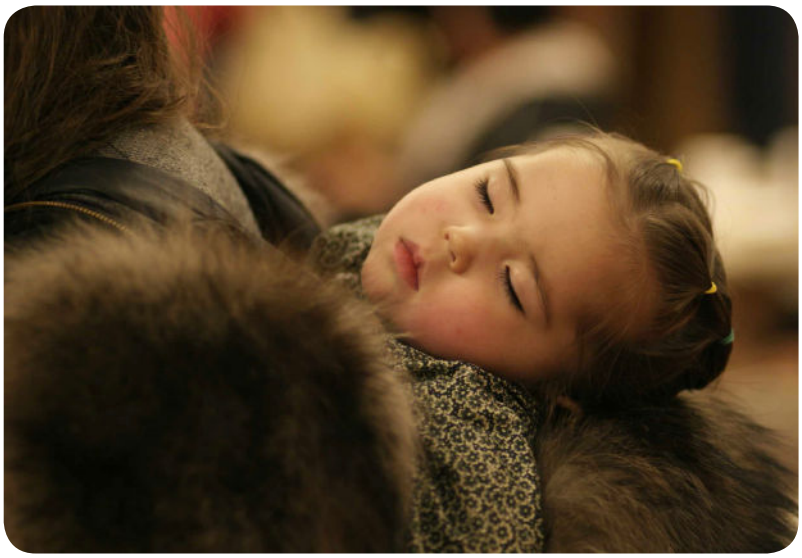
manufacturers have dodged their responsibility to let consumers know about the harmful chemicals in their products.

With the 2016 passage of the Frank R. Lautenberg Chemical Safety for the 21st Century Act, the U.S. EPA now has added authority to regulate chemicals. The Lautenberg Act includes measures to:

- Provide better protection of vulnerable populations
- Reduce the EPA's analytical burden
- Establish deadlines for chemical reviews and a minimum schedule for enforcement actions
- Maintain existing state authority to regulate chemicals
- Streamline the process of requiring manufacturers to conduct toxicity testing
- Clarify guidelines for manufacturers to claim confidential business information; strengthen oversight of new chemicals, and expedite action on priority chemicals considered persistent, bio-accumulative and toxic.[154]

Nevertheless, additional provisions are needed to phase out rapidly the most dangerous chemicals on the market and ensure communities' right-to-know.

Alaska Community Action on Toxics advocates for policies that follow the Precautionary Principle, an upstream approach to protecting health by preventing exposures to harmful chemicals. If chemicals are suspected to cause health problems, then measures to limit and avoid unnecessary exposure to those chemicals should be taken.[155] The Precautionary Principle means that "It is better to be safe than sorry."



Science to Action

Health care professionals, scientists, policymakers, schools, academic institutions, community members, and parents all have a role to play in exploring opportunities for improving the health of current and future generations of children and creating recommendations for change in the areas of education, policy reform, research and prevention.

The October 5-6, 2016 Children's Environmental Health Summit featured presentations on a wide range of topics. The strategies and tools in these presentations may be used as a guide to establish and implement systemic changes needed to improve children's environmental health.

A full list of presentations is included below; videos of the presentations can be found on ACAT's website: www.akaction.org.

Children's Environmental Health Summit 2016

Our Children, Our Future: Health Disparities Among Alaska's Children

- Rosemary Ahtuangaruak – Inupiaq Tribal Leader, Former Village Health Aide
- Allison Kelliher, M.D. – Tribal Doctor, Family and Integrative Medicine, Southcentral Foundation
- Vi Waghiyi – Native Village of Savoonga Tribal Member, and Environmental Health and Justice Director, Alaska Community Action on Toxics
- Lisa Wade – Council Member, Director of Health, Education, and Social Services, Nay'dini'aa Na'

Respiratory Health Crisis: A Case Study from Fairbanks

- Patrice Lee – Citizens for Clean Air

State of the Science: Endocrine Disruption and Birth Defects; Implications for the Health of Future Generations

- Carol Kwiatkowski, Ph.D. – The Endocrine Disruption Exchange
- David Carpenter, M.D. – Director, Institute for Health and the Environment, University at Albany

- Vi Waghiyi – Native Village of Savoonga and Environmental Health and Justice Director, Alaska Community Action on Toxics

State of the Science: Childhood Cancer
- Richard Clapp, D.Sc., M.P.H – Boston University
- Rosemary Ahtuangaruak – Inupiaq Tribal Leader, Former Village Health Aide

State of the Science: Neurodevelopment
- Philippe Grandjean, M.D., D.M.Sc. – Harvard School of Public Health, and University of Southern Denmark
- Donna Erickson – Mother and Tribal Member from Unalakleet

Protecting Future Generations: Historical Trauma and Community Approaches to Healing
- Kathy Sanchez – Environmental Health and Justice Program Manager, TEWA Women United
- Lisa Navraq Ellanna – Director, Kawerak's Katirvik Cultural Center (Nome, Alaska)

Opportunities and Initiatives to Protect the Health and Environment of Children: Collaboration in Research and Policy
- Ruth Etzel, M.D., Ph.D. – Director, Office of Children's Health Protection, U.S. Environmental Protection Agency
- Kimberly Gray, Ph.D. – National Institute of Environmental Health Sciences
- Nica Louie – National Center for Environmental Research, U.S. Environmental Protection Agency
- Maureen Swanson, M.P.A – Learning Disabilities Association of America and Co-Coordinator of Targeting Environmental Neurodevelopmental Risks (Project TENDR)
- Nsedu Obot Witherspoon, M.P.H. – Executive Director, Children's Environmental Health Network

Science to Action: Creating a Broad-Based Movement for the Protection of Future Generations
- Charlotte Brody, R.N. – National Coordinator, Healthy Babies Bright Futures and Vice President of Health Initiatives, BlueGreen Alliance

Tools for Environmental Health Investigations
- Madeleine Scammell, Ph.D. – Boston University

Engaging Healthcare Professionals in Policy Actions to Protect Children's Health
- Katie Huffling, M.S., R.N., C.N.M. – Alliance of Nurses for Healthy Environments

Creating Consensus for the Protection of Children's Environmental Health
- Elise Miller, M.Ed. – Director, Collaborative on Health and the Environment
- Vi Waghiyi – Native Village of Savoonga Tribal Member and Environmental Health and Justice Director, and Alaska Community Action on Toxics

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