Environmental Health:
Women's Unique Burdens and Opportunities

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Our relationship with the environment has become an area of increasing focus as we seek social and personal solutions to environmental problems, rather than relying on those solutions that are purely technological in nature (National Council for Science and the Environment). Whether men and women have the same relationship with the environment has long been a topic of interest. Do men and women establish those relationships through the same mechanisms? Ecofeminists would argue that men and women differ profoundly in their connections to nature and the environment, with women a part of nature itself and men somehow separate still from it (Sachs, 1997). Women have always been considered to be uniquely connected to nature, with Mother Earth as the ultimate metaphor; however, with this unique connection comes profound responsibilities. Those who bear the children bring with them a lifetime's exposure to environmental toxins and can pass on this legacy to their unborn children (Chemicalbodyburden; Mattison, Coussens, & Gilbert, 2003; National Resources Defense Council).

Women bear a special burden because of our biology and the impacts of our behavior on our children, both prenatally and in young developing children. Differences that make us women allow us our unique place in the world and its natural order; however, these differences also predispose us to special risks from environmental exposure. Such a risk can be considered to be the possibility, if not the likelihood, of an undesirable or unwanted biological response, resulting from exposure to some type of environmental toxin. Environmental toxins may be naturally occurring substances or those that are anthropogenic (manmade) in origin and the term is used to refer to a substance that interferes with or destroys normal cellular function and impacts the health of an organism. The general population's perception of risk may be based not only on each individual's own experience but also on cultural, social, and political beliefs and the *zeitgeist* of the time (Hughes, 1996).

It is often difficult to prove that any given organism response is related to exposure; it is more difficult yet to prove that the observed response is actually caused by the exposure. Add to that the difficulties of accurately observing and measuring responses, often on a cellular level, and it is not difficult to understand the inherent problems in interpreting dose-response relationship data (Hughes, 1996). In lay terms, it may be difficult to prove that an exposure actually caused a problem; however, we can surely extrapolate that a high dose exposure to a toxin over a long period of time is something to be avoided.

How does exposure to environmental toxins impact our health? Due to differences in physiology, there are particular concerns for the environmental health risk of women and children (American Physiological Society; Chemicalbodyburden; National Resources Defense Council). An understanding of anatomy and physiology provides a foundation for understanding how exposure to toxins occurs and how our health, through the specific structure and physiological function of our organs, is impacted by such exposure.

There are three primary routes of absorption into the body once an exposure has occurred: through the skin, the respiratory system, and digestive system. Each route has its own structural and functional components that impact the stages of toxin exposure through elimination from the body.

It is known that the skin (and its associated structures) is the largest organ system in the human body. It is comprised of the skin, fingernails and toenails, hair follicles, and mammary glands. It plays an important role as a barrier to toxin entrance and helps eliminate toxins or their metabolites through sweat or other glandular secretions (Hughes, 1996).

The respiratory system is comprised of the nose, throat, windpipe, bronchial tubes, and pulmonary subsystems. Due to its structure, the respiratory system is less effective in serving as a barrier to toxins. With its close structural and physiological connections with the cardiovascular system, is a prime site for absorption and rapid distribution of toxins throughout the body (Hughes, 1996).

The digestive system includes the mouth, oral cavity, esophagus, stomach, small intestine, large intestine, rectum, anus, and associated systems such as the pancreas and liver and is able to transport toxins to the rest of the body (Hughes, 1996).

There are easy routes for distribution of toxins throughout the body, with the exception of the brain because of a physiological barrier known as the blood-brain barrier. Specialized cells impede the progression of toxins into the brain. Another physiological barrier is that of the placenta. As with the blood-brain barrier, the placenta slows down the diffusion of toxins but does not completely stop the progression.

Toxins can continue to circulate through organs and change their structure (biotransformation) and may become stored in bones, the liver, the kidneys, and in fat (bioaccumulation). Blood continues to circulate throughout these organs and toxins may be deposited in other tissues. Elimination occurs through the kidneys, fecal elimination, and exhalation through the lungs. Because of their structure and function, direct damage to these organ systems is a true risk (Hughes, 1996).

Hundreds of environmental toxins impact our health; however, only a few will be addressed: pesticides (insecticides and fungicides); chemical toxins known as hormone disruptors; and metals such as lead and mercury.

Insecticides and Fungicides

Most insecticides are neurotoxins that disrupt a nerve transmission impulse either at the synapse or along the pathway of the impulse and work by inhibiting enzyme function. Insects exposed to neurotoxins exhibit twitching, weakness, paralysis, and death with similar responses having been noted with human exposure. A well-known group of insecticides are the organophosphates. Organochlorines such as DDT and its metabolites act to either stimulate or depress the central nervous system, they accumulate in high amounts in tissues, and their metabolites are very persistent in tissues (Hughes, 1996).

Hormone Disruptors

Polymers that can be molded or deformed by heat and pressure are known as plastics. Plastics have added chemicals to make them more flexible known as plastisizers. One chemical currently under study, Bisphenol A (PBA), has been found to leach into food and liquids from plastic food containers, bottles, wraps, and the lining of food cans. It has been found in a large majority of people in developed countries. It is detectable in urine and blood and has also been noted in amniotic fluid, the placenta, umbilical cord blood, and breast milk. Because it is chemically very similar to estrogen, it is of particular concern. It is theorized that the body misidentifies this chemical as estrogen and responds as it would to estrogen. Researchers have found that BPA can actually increase the production of fat cells, and is now considered to be implicated in the development of obesity. (International Obesity TaskForce: 2008, May 15).

Polychlorinated biphenyls (PCBs) are a group of synthetic organic compounds used in manufacture of electrical capacitors and transformers (Landrigan, 2001). Although production of PCBs was halted in the 1970s, they are widely dispersed in the environment, are fat soluble, and accumulate at high levels in predator fish high on the food chain. Children are exposed prenatally through their mothers' consumption of contaminated fish as PCBs cross the placenta. Postnally, they are exposed through breast milk ingestion or through their own consumption (Agency for Toxic Substances and Disease Registry, 1998). PCBs have significant negative effects on the developing brain and nervous system (Birnbaum, 1994). Animal studies have shown reproductive changes in structure or function, such as the feminizing of males, changes in prostate size, and underdevelopment of the penis and testes. In females, uterine dysfunction has been noted. This leads to the lack of development of secondary sex characteristics (Hughes, 1996).

Metals

Metals usually enter the body through the gastrointestinal and respiratory routes. Since urine is the most common site of elimination, the kidney, its substructures, and the bladder are all at risk. Lead may be the most well known and well studied metal contaminant. Its toxicity has been known since the early 1800s and its most obvious and researched effect is on the developing central systems of children. Children exposed to lead may have significant and permanent damage to the brain. It is linked to lowered IQs, disruptive classroom behaviors, an inability to pay attention (Needleman, Gunnoe, Leviton, Peresie, Maher, & Barret, 1979; Thomson, Raab, Hepburn, Hunter, Fulton, & Laxen, 1989; Silva, Hughes, Williams, & Faed, 1988), and failure to stay in school (Needleman, Schell, Bellinger, Leviton, & Allred, 1990).

Mercury occurs in the environment through natural geological processes. It also accumulates in the environment as a by-product of coal burning. Methyl mercury, given off from this burning, is of the most concern and accumulates in water and fish. It is known to cause damage to the brain and the kidneys. Animal studies have shown that all types of mercury cross the placenta and safe levels of mercury are not known (Hughes, 1996). Prenatal exposure to methyl mercury, from the mother's consumption of fish and shellfish, can adversely impact the fetus's brain and nervous system growth. For all children, the primary health effect of methyl mercury is damage to the neurological system and its subsequent development. Negative impacts on cognition, memory, attention, language, fine motor skills, and visual spatial skills have been seen in children exposed to methyl mercury in the womb (Environmental Protection Agency). Exploration of the gene-environment interaction between rising rates of autism and environmental contamination on one community has been noted (Centers for Disease Control and Prevention).

Body Burden

It is apparent from the information above that we are continuously exposed to chemicals and it is difficult for us to know the extent of our current and past exposure to chemicals. The concept, *body burden*, refers to the total amount of chemicals that are present in the body at any given time. Toxic chemicals, including naturally occurring and anthropogenic (manmade) chemicals get into the body through various means of exposure as described above (chemicalbodyburden). Some chemicals are broken down or metabolized by our bodies and excreted in hours or days. Other chemicals can reside in our bodies for years in the brain, blood, semen, muscle, bone, adipose tissue, or in other organs. Some particular pesticides such as DDT can remain in the body for decades. Of the approximately 80,000 chemicals in use in the US, several hundred have been found at measurable levels in bodies around the world. Some current estimates are that we have approximately 700 contaminants in our bodies at any given time. For most, there are little or no studies that examine either the short-term or long-term impact in humans (chemicalbodyburden), although differences in physiology and age must be considered with respect to environmental toxin exposure and effects.

An abundance of research has demonstrated that there are differences in normal physiology and response to disease when considering sex. Women generally have a lower body weight, smaller organ size, a higher percentage of body fat, and have higher rates of obesity than men, with fluctuations in hormones considered to be one of the possible factors (Centers for Disease Control and Prevention, 2002; Lovejoy, 1998). Actual structural and functional differences in the brains of females and males have been well documented (De Bellis, 2001; Gur, 1999). It is known that these structural and anatomical differences result in women exhibiting different responses than do men to pharmaceutical drugs (Meibohm, Beierle, & Derendorf, 2002; Rademaker, 2001), with women having more adverse reactions and more serious reactions to pharmaceutical drugs than men (Stewart, 2001; Miller, 2001; Rademaker, 2001). Sex differences become even more significant when the effect of environmental toxins is considered. With long-term storage of toxins, the effects can be seen for long periods of time in women. The impact of hormone disruptors cannot be underestimated. During pregnancy, hormonal changes and laying down of extra fat occurs, and this is an especially critical period. Many chemicals cross the placenta. A woman who breastfeeds needs to be especially cognizant of environmental health risks to her child.

Children are at particular risk because pound for pound, children drink more water, ingest more food, and breathe more air then do adults, making them more susceptible to environmental toxin exposure. They are frequently exposed to contaminants that are considered safe for adults; however, their lower body weights are not taken into account (Environmental and Energy Study Institute; Pesticide Action Network North America). Exposure to an environmental toxin can occur prior to conception (an exposure of either parent prenatally), during prenatal development, and postnatally, including the time of sexual development.

Prenatally, an infant is exposed to what the mother is exposed to. The impact on the mother might be insignificant; however, the impact on the fetus could be profound. Fetal exposure that is safe for adults may result in birth defects when a fetus is exposed. Because of the many rapidly developing systems in the embryo and fetus, the timing of the exposure is critical (chemicalbodyburden). Exposure to hormone disruptors and other environmental toxins in the fetus because of primary exposure to the mother can result in changes in development and in prematurity.

Much of what we know about environmental connections to prematurity, we know from animal studies; however, it is clear in humans that certain occupational exposures increase the risk of prematurity including metal working, electrical occupational work, janitorial work, food service work (the connection is not clear), and textiles. Solvent exposure in women is the most clearly connected and pesticides exposure in men is well documented. Many people think it is only the women who need to be worried about exposure; however, men may bring home toxic residue and contaminate clothing, furniture, bedding, etc. for women and children in the home, increasing the body burden for the entire family (Mattison, Wilson, Coussens, & Gilbert, 2003).

Premature birth is also linked to air pollutant exposure. This includes tobacco related pollutants, either from first or second hand exposure, and particulate & sulfur exposure. There is a moderate increased risk of prematurity, and a direct risk for growth retardation in the womb, abnormalities in the development of the placenta, and reduced neonatal lung function. The more one smokes, the worse it is with a 54% - 130% increase in premature births, depending on the level of smoking. Premature infants are then at risk for neurological and developmental difficulties. Additionally, many chemicals are found on the end of a burning cigarette. The risk from second hand smoke is clear as there is no filter for those near a person smoking. It is postulated that there is a direct effect on the smooth muscle of the uterine wall (Mattison et al., 2003).

Other increased risks for prematurity include exposure to sulfur dioxide from coal burning. The level of total suspended particulates in the air is also linked to prematurity.

Exposure to DDE, a metabolite from DDT is also a known risk. Although banned since 1970 in the US, it is used in 25 countries for malaria control. The more DDE there is in blood serum, the higher the risk for premature birth (Mattison et al., 2003).

An additional source of concern for infants and young children is the risk of toxin exposure through breast milk. Although breastfeeding is still the best food for infants because of its nutritional and immunological benefits, breast milk can be contaminated by chemicals excreted from the mother into the milk (Mattison et al., 2003). As children reach the point of potential sexual maturity, toxin exposure may interfere with or change this process. Hormone disruption is thought to be implicated in the precocious secondary sexual development seen in many young girls (Herman-Giddens, 1997). Children also spend more time on the floor, touch surfaces that are dusty, and then put their hands in their mouths. Toys come in contact with environmental toxins from various surfaces and the toxins are spread to the child through ingestion or inhalation.

Summary

What can we do to minimize risks? One important action we can take is to increase biomonitoring or measuring levels of contaminants in our systems. Since the mid 20th Century, we have been able to measure the exposure to, the amount of chemicals or toxins, and the persistence of these toxins in the body. What we have not always been to do is to identify the impact of exposure to toxins in either the short term or long term. The Centers for Disease Control and Prevention (CDC) have begun issuing chemical toxin exposure reports. Advances in technology have allowed scientists to measure levels of toxins directly in the blood and urine rather by indirectly estimating population exposure through the measurement of air, water, or soil samples. Currently, approximately 116 chemicals, including 34 pesticides are biomonitored (Centers for Disease Control and Prevention). Much more monitoring and outcomes-based research is needed.

A more important action is to promote dissemination of knowledge to the general population. Much of the information available is found in scientific journals and more needs to be done to get this information to the public in ways that promote utilization of the information. Primary health care providers must be more involved. There must be more done to support efforts at the community, state, local, and federal levels to reduce/avoid the use of pesticides in schools, day care centers, and homes (Center for Children's Health and the Environment). Partnerships between parents, schools, other community agencies must increase. We have the opportunity to profoundly impact the lives of future generations, in smaller ways than did Rachel Carson but significant still. I can almost hear her say, "We must protect our future".