Unit II:
Harmful Environmental Exposures and Vulnerable Populations

INTRODUCTION

Unit I highlighted various roles of the nursing profession where knowledge of environmental exposures is central to practice. In Unit 2, the focus is upon population groups who are most vulnerable to harmful environmental exposures. While risks to adverse health outcomes can vary according to geography, housing and location of environmental exposures, some humans are at greater risk due to their biophysical and sociopolitical vulnerability. Unit 2 explains risk and vulnerability across the lifespan with a focus upon specific vulnerabilities and harmful effects at various developmental stages. A second chapter highlights anticipatory guidance for parents and caregivers to reduce environmental exposures for children from infancy to adolescence. Third, Unit 2 considers the impact of social determinants of health, which are commonly referred to as factors where people live, learn, work, play and pray. Social determinants at neighborhood and community levels impact individual level exposures. Finally, Unit 2 includes a chapter about the effects of social determinants on the vulnerability of immigrants and refugees. See Unit 5: Sustainable Communities, for the chapter about Environmental Justice, which addresses the adverse outcomes for those who live in more environmentally hazardous areas.

HARMFUL ENVIRONMENTAL EXPOSURES AND VULNERABLE POPULATIONS

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All humans are at risk for harmful effects of environmental hazards. For certain human populations the risks of harm are greater due to biologic, social, economic, or other factors. Such population groups are often referred to as vulnerable populations. A vulnerable person or group has "aggravating factors that place them at greater risk for ongoing poor health status than other at-risk persons" (Maurer, 2013, p. 528). Some vulnerable groups include children, the poor, those without homes, refugees, those with disabilities and those with mental illness. These vulnerable populations have been identified through epidemiological studies as having poorer health outcomes. This paper will discuss various factors that make specific populations across the life span more vulnerable to poor health outcomes from environmental stressors.

RISK AND VULNERABILITY

Risk is the likelihood that a harmful health event will occur in a given population during a specific time period. Our knowledge of risk emerges from the science of epidemiology. Epidemiology is the study of health and illness in human populations. Epidemiological studies show that environmental hazards can cause poorer health.

Environmental hazards can increase human risk of illness, disability and premature death. The Environmental Protection Agency (EPA) defines risk as the "chance of harmful effects to human health or to ecological systems resulting from exposure to an environmental stressor" (EPA, 2015). An environmental hazard is "any physical, chemical, or biological entity" that causes harm. The EPA also provides information on risk assessment for such hazards.

Some common factors that affect the risk of harmful health events cannot be changed. Such factors include age, gender, race or ethnicity. Other factors that affect the risk of harmful health events can be changed. These factors result from biophysical, environmental, psychosocial and sociopolitical circumstances (Leffers et al, 2004). When environmental threats to health are examined, all humans are at risk in relation to global climate change and the increasing use of untested and toxic chemicals.

Vulnerability can be defined as "a varying state of weakness or strength that can be mobilized when one encounters a threatening event" (Leffers et al, 2004, pg 19). This definition includes individual and experiential factors that result in variability of outcomes across populations.

Risk and vulnerability are related to each other. Some describe vulnerability as a series of threshold factors that increase or amplify risk and lead to poorer health outcomes. Others argue that vulnerability can vary according to the capacity of the individual and many not lead to poorer health outcomes. This view says that positive attributes of those identified as vulnerable can enable them to overcome risk and vulnerability, leading to better outcomes (Leffers et al, 2004). The North Carolina Preparedness and Emergency Response Research Center (NCPERRC) makes a similar distinction between risk and vulnerability. They note that risk is directly affected by a hazard while the degree of vulnerability is defined as "the characteristics of person or group and their situation that influences their capacity to anticipate, cope with, and resist and recover from the impact of an emergency" (NCPERRC, 2012).

The notion of "windows of vulnerability" refers to specific times during human development that have been identified for higher risks to health. For example, at times a child can have better recuperative capacity than adults. In other situations, children are at far greater risk (Brent, Tanski, & Weitzman, 2004; Sanchez, Hu, Litman & Tellez-Rojo, 2011).

Various populations have been identified as more vulnerable to environmental hazards. As stated earlier, individual and experiential factors can lead to different vulnerability across populations. These factors include those whose biophysical characteristics make them more vulnerable such as the developing fetus, infants, children and older adults. People with acquired biophysical factors such as chronic illness, those with differences in functioning due to trauma, and those with altered immunity also become more vulnerable to poor health outcomes. Additionally those born with congenital anomalies and with variations in cognitive and physical abilities may be at more risk from specific toxic exposures.

Behavioral factors such as developmental age appropriate behavior, activities, hobbies and occupational exposures all raise vulnerability. Social factors such as where a person lives, works or spends a great deal of time can also make him or her more vulnerable.

The following discussion will address biophysical, behavioral and social factors that increase vulnerability. For each of the areas, the topic will be addressed across the lifespan from fetal development through the older adult population.

EMBRYONIC AND FETAL DEVELOPMENT

Biophysical Factors

Healthy fetal development requires precise timing and feedback for cells to divide and mature properly for necessary cell replication and differentiation. For this to occur there is an interaction between genetic and environmental factors (Schettler, Solomon, Valenti and Huddle, 1999; Brent, Tanski & Weitzman, 2004). For the developing fetus the risks are acquired through exposures across the placenta from the pregnant mother. In fact, any exposure to the fetus from the mother is considered environmental ("Environmental Factors in Birth", 2009). So, while the only exposure pathway for fetal toxic exposures is placental, the fetus is particularly sensitive to the broad range of all environmental toxins that the mother is exposed to before and during her pregnancy. As will be discussed later, the pregnant mother's exposure risk varies throughout pregnancy due to the variations in maternal physiology during pregnancy. Toxins may affect both the structural development and biochemical function of cells in fetal organ systems. Fetal sensitivity to toxins occurs as a result of the flexibility of the cell and the capacity for changes during embryonic development. For each specific exposure, many things interact to create the risk and health outcomes. The magnitude of the exposure, the dose of the toxin, the embryonic stage, and metabolism of the mother and embryo all interact to vary the risk and the outcomes. The embryo is particularly sensitive to structural damage due to these mechanisms. Additionally, the blood brain barrier is not fully developed in the embryo allowing neurotoxins greater access to the fetus (Schettler et al, 1999). Often the woman is unaware that she is pregnant during this critical period when she may be exposed to toxins. Additionally, many chemicals have not been tested for toxicity to human development. Due to the stage of fetal development the impact of these risks can be very serious and harmful, resulting in life long impairments (Dietrich, et al, 2005). The study of what are referred to as windows of vulnerability or critical developmental periods is complex and requires sophisticated data analysis (Sanchez, Hu, Litman & Tellez-Rojo, 2011; Selevan, Kimmel & Mendola, 2000).

The healthy development of children must be a priority. Tickner & Hoppin (2000) argue that children are generally more vulnerable to environmental exposures and have less control of those environments than do adults. In addition, the risks to susceptible children are not well understood scientifically. Therefore, in the absence of clear evidence the Precautionary Principle must be followed (Tickner and Hoppin, 2000).

Many adverse health outcomes for the developing fetus are referred to as birth defects. Genetic factors as well as environmental exposures interact in ways to create problems with organ structure or function. While scientists agree that environmental exposures are not well understood, those exposures that are known require more action and those that are not known require more research ("Environmental Factors in Birth", 2009). Reported adverse health outcomes from environmental health threats such as toxic chemicals include low birth weight infants, congenital anomalies, pregnancy loss from miscarriage, and neurodevelopmental problems (See Table1). (Swanson, Entriner, Buss, & Wadhwa, 2009; Kim & Cizmadia, 2010)

Table 1: Commonly Identified Chemical Exposures and Birth Defects

Exposure	Birth Defect or Low Birth Weight
Arsenic	Cardiac Defects
Bisphenol A	Reproductive system anomalies
Dioxin	Neural Tube Defects Neurobehavioral Problems Hypospadias Oral Clefts
Lead	Cardiac Defects Neural Tube Defects Neurobehavioral Problems Hypospadias Oral Clefts
Methyl Mercury	Neural Tube Defects Neurobehavioral Problems
Particulate Matter in Air	Vascular Defects (Patent Ductus Arteriosis)
PCB's	Impaired hearing*
Sulphur Dioxide	Musculoskeletal defects Cardiac defects
Environmental Tobacco Smoke	Low Birth Weight
Air pollution	Low Birth Weight
Pesticides	Low Birth Weight Congenital Anaomalies

* Noted in animal studies

Also endocrine disrupting chemicals (EDCs) have been linked to altered gender development and sexual organ malformations. Common environmental estrogens that mimic estradiol and attach to estrogen receptors are certain polychlorinated biphenyls (PCBs), Bisphenol A (BPA), phthalates, and pharmaceutical estrogens. High-level exposures have been confirmed for their role in gender related effects and scientists fear that even low level exposure can also result in these birth defects ("Are EDCs blurring", 2005). Additionally, lead accumulates in children's bones and can be released to continue exposing the child to lead poisoning and serious neurological outcomes.

Another feature of exposure is bioaccumulation. Bioaccumulation is a process by which toxins accumulate as they move up the food chain. Humans are at the top of the food chain, absorbing chemicals from meat, fish and produce consumed in the diet and as a result carry more concentrated levels of chemicals in the body. Consequently, the pregnant woman may have large amounts of toxins in her body that are passed on to the very small fetus. Due to its small size, the developing fetus can be exposed to a greater proportion of the toxin, which can result in life-long neurological deficits (Schettler, Soloman, Valenti, & Huddle, 1999).

Scientists examine the relationship between in-utero development and adult health. Mounting evidence supports the argument that prenatal exposures lead to lifelong consequences in adulthood. These consequences include congenital anomalies, risk for hypertension, insulin resistance, kidney disease and other health conditions. Recent studies in the area of epigenetics indicate that prenatal exposure to environmental contaminants can adversely affect the fetal epigenome and put the fetus at risk of diseases and disorders throughout the lifespan and transgenerationally (Perera & Herbstman, 2011).

Finally, studies examine the likelihood of preterm birth resulting from exposures to environmental toxicants. Though no consistent evidence has been found to date, there are indications that future studies might document such evidence (Ferguson, O'Neill, & Meeker, 2013).

INFANTS

Biophysical Factors

Once delivery occurs, the newborn physiology must transition from life sustaining fetal processes to independent functioning that includes respiration, nutrition and elimination. The resting respiratory rate in infants is twice that of adults; this means that infants are exposed to 2 times more toxins per body weight than are adults. Nutritionally, infants take in 2 ½ times more water and 3 to 4 times more food per body weight than adults. This increases infant exposures to pesticides and other toxins in food and water much greater than exposures in adults. Infants have less developed brain, respiratory, gastrointestinal, immune, reproductive and metabolic systems than older children and adults (Bearer, 1995; Wigle, 2003). Their gastrointestinal tract is more permeable making it easier for toxins to be absorbed. Common exposures to toxins include pesticides, heavy metals, persistent organic pollutants and phthalates. Common pesticides are organophosphates, pyrethroids, organochlorides and DDT.

Social Factors

Most infants are delivered in hospitals where they are exposed to chemicals used the nursery and hospital settings, particularly Polyvinyl chloride (PVC), di 2-ethylhexyl phthalate (DEHP) and Bisphenol A (BPA). PVC is used in medical products as a plasticizer for tubing and other devices. Most PVC medical devices are from 20-40% DEHP and are common in hospital nurseries. Neonatal intensive care units often use PVC medical products for IV solutions, enteral feedings and other necessary treatments. These chemicals are known to leach out of the medical device into fluids containing lipids. As reproductive and developmental toxins these chemicals can expose infants at the time when they are adjusting to extrauterine life and have immature organ systems. Due to their small size and variety of exposures, newborns in NICUs can be exposed at far greater levels comparative to adult exposures (Schettler, 2002). While nursing initiatives such as Green Birthdays by the American College of Nurse Midwives seek to improve health care settings, infants continue to be exposed to environmental hazards from the moment of their birth. For many newborns that require NICU care, the length of time spent in the NICU can be weeks or months, thus increasing their exposure to these hazards.

Additionally infants spend most of their time in a single environment for prolonged periods, such as a crib, where the exposures do not vary. However, if hazardous materials are present, they become more concentrated in this single environment (Bearer, 1995). Infants attending day care are confined to the same environment all day where they may be susceptible to indoor air contaminants. Indoor air quality in homes is often 10-50 times more hazardous than outdoor air where infants are exposed to carcinogens, neurotoxins and pesticides. While breastfeeding is recommended as the best nutrition for infants, chemicals such as polybrominated diphenyl ethers (PBDEs), PCBs, organochloride pesticides and dioxins that accumulate in human fat tissue in the breast have been

shown to be transmitted to the infant during breastfeeding. These chemicals can also be found in formulas made from cow's milk. Further, the skin of a newborn is a highly absorptive surface and infants are exposed to a number of toxic chemicals in the personal care products that are applied to their skin (Bearer, 1995).

CHILDREN

Biophysical Factors

Children are more susceptible to environmental toxins because their ongoing physical development and physiology put them at greater risk. Tickner and Hoppin (2000) note that children are more susceptible to environmental toxins for 4 important reasons:

- they undergo periods of rapid growth and development (window of vulnerability);
- they have age-related differences in absorption, metabolism, detoxification and excretion of substances;
- they incur greater exposure to environmental toxins; and
- they incur exposure from the fetal period throughout life so that the cumulative effects of toxic exposures lead to greater risk.

The actual specific period of vulnerability for adverse effects of the toxic chemical exposures depends upon the toxin itself and its mechanism for action, the dose of that toxin, the actual target tissue for the toxicant and the timetable for development in the child (Wigle, 2003). Other factors that affect exposure and risk are location of toxin and child, breathing zones, oxygen consumption, food consumption, water consumption and behavioral development (Bearer, 1995).

Children's developmental changes from infancy to adolescence affect the toxicokinetics of their exposures. For example, their body composition has greater water content and less lipid content that can affect chemicals that bind to lipids. While that may offer protection in the early months, the body lipids rise rapidly after birth for the first nine months. This rise in lipids increases the child's sensitivity to lipid binding chemicals such as dioxin. Children have a larger sized liver per body weight which can allow for hepatic metabolic clearance. But the larger liver can also allow for activation of toxic metabolites. Immature enzyme function in the liver reduces the body's ability to clear/remove environmental chemicals while immature renal function slows the elimination of chemicals and metabolites. There is a long postnatal period of development for the lungs and brain. Limited serum protein binding capacity in the birth to 3 month period of infancy creates the potential for more toxicants and chemicals in the body when pharmaceuticals and environmental chemicals are not bound to the serum and freely circulate in the infant's body (Ginsberg, Hattis, Miller, & Sonawane, 2004). Such physiological processes of normal development create critical periods where toxic exposures can be most harmful.

Children breathe more rapidly than adults and take in more air than adults. Toddlers generally breathe twice as fast as adults while school age children under the age of 12 years breathe about 1 ½ times as fast as adults. Children consume 3-4 times more food per body weight than adults, and drink more than 2 and ½ times more water per body weight than adults. As a result, they experience greater exposures to environmental health hazards of 2 to 5 times that of an adult.

Human development continues through childhood and the digestive, excretory and reproductive systems have not reached full development during childhood. As a result the protective mechanisms of a fully developed adult gastrointestinal tract may reduce exposures while mature kidneys and liver are better able to detoxify and eliminate toxins that affect children in greater concentrations. Additionally, toxins continue to pose risk for healthy reproductive system development and can result in decreased fertility and damage to reproductive structures and function (Silbergeld & Patrick, 2005).

Behavioral Factors

Children are more vulnerable to toxins due to behavioral factors as well due to oral, dermal and inhalation exposures specific to developmental stage behaviors (Moya, Bearer & Etzel, 2004). Children play at ground level both inside on the floor and outside in grass and other play spaces. Consequently they are exposed to materials that are tracked inside onto floors, and settle from the air. Common hazards on floors are pesticides and fertilizers, cleaning supplies, lead dust in older homes, and other household chemicals (Sattler, Afzal, Condon, Belka & McKee, 2010). Outdoor hazards include the chemicals used in lawn and garden care but also chemicals transported by water runoff that include petroleum products, automotive additives, paints, and other industrial products.

Children also use hand to mouth behavior to learn and explore which makes them more vulnerable to toxins on household items as well as toxins within products such as toys. Harmful chemicals such as lead, cadmium and phthalates have been found in products commonly used by children including sleep accessories such as positioners and wedges, teethers and other plastic toys. Research

indicates that on average a child's hands contact contaminated surfaces up to 32 times during eating, with even more contact to food before the food enters the mouth. Approximately 20-80% of dietary exposures come from such hand to mouth behavior (Akland et al, 2000).

While infants may spend more time in cribs and indoors, as children age they are more likely to be at play both indoors and out of doors. Indoors they are likely to sit and lay on floors while outside they are likely to play in grass or soil, which can contain harmful pesticides. These can also be tracked into the home on human and animal feet. Wood playground equipment often has been treated with creosote and arsenic, which are toxic.

Other location factors include the time a school age child spends in the school setting. Indoor air in schools has been identified as a source of carcinogens, neurotoxicants and endocrine disruptors (EDCs). These include chemicals such as lead, radon, pesticides, asbestos, and volatile organic compounds (VOCs) such as solvents and formaldehyde. Further, schools can be a source of environmental hazards such as cleaning products as well.

In addition, children live in families where they can be exposed to "take home toxins". This refers to toxins that their family members are exposed to in the work setting and carry home on their clothing and personal belongings. A commonly recognized take home toxin is asbestos, which is linked to the development of lung conditions, particularly mesothelioma. Decades later, children who have been exposed to chemicals in their home or from take home toxins are at risk of developing conditions such as mesothelioma, Parkinson's Disease, and various forms of cancer.

Nurses can aid families to anticipate childhood risks during various stages of development through the tools provided in the PSR (Physicians for Social Responsibility) Pediatric Environmental Health Tool Kit.

ADOLESCENTS

Biophysical factors

During puberty the adolescent experiences changes in hormones and the metabolic interactions of neurochemicals for development. This poses a "window of vulnerability" for the adolescent whose endocrine, immune, musculoskeletal and reproductive systems are undergoing maturation and can be heavily exposed to chemicals known to affect many systems. According to the Environmental Working Group report, Teen Girls' Body Burden of Hormone-Altering Cosmetics Chemicals, an array of sex hormones present at minute levels in the body are responsible for the transition from childhood to adulthood and current research suggests that adolescents may be at particular risk for exposure to even trace levels of hormone disrupting chemicals.

Behavioral Factors

Adolescent girls are likely to increase their use of personal care products and cosmetics increasing their exposure to toxic chemicals in such products. Studies indicate that, on average, girls have up to 13 hormone altering chemicals from 4 chemical families - phthalates, triclosan, parabens, and musks - in their bodies. In addition to posing serious health effects as hormone disruptors, these chemicals have the potential to cause cancer as well. Results suggest that young women are being exposed to a wide variety of cosmetic preservatives that puts them at serious risk during this important period of development (EWG, 2016).

Adolescents also are at risk due to their occupational exposures. During this phase of life they are most likely to begin employment in a variety of settings and more than 80% do work during some part of the year (Etzl & Balk, 2003). Frequently, adolescent boys go to work in the summer in lawn care services, painting and sealing driveways. At times they begin to work as entrepreneurs creating their own summer employment in such positions that are not monitored by Occupational Safety and Health Administration (OSHA). They may be unaware of the hazardous materials to which they are exposed. Adolescents employed in a variety of settings can be exposed to environmental tobacco smoke, solvents, and other cleaning agents (Etzl & Baklk, 2003). A report by OSHA noted that more than 2 million youth are exposed to farm related hazards. Beyond the dangers of heavy equipment injuries are adolescents' exposures to the fertilizers and pesticides used in agricultural settings. These include chemicals known to be carcinogenic, neurotoxicants and hormone disruptors.

PREGNANT MOTHERS

Biophysical Factors

While most scientists are concerned about prenatal exposures for the fetus, there is evidence that pregnant women are also at more risk themselves for exposure to environmental toxins due to their changing physiology during pregnancy. For example, decreased motility of the gastrointestinal tract increases intestinal transit. This delay can lead to greater absorption of toxins. Due to decreased plasma albumin concentration during pregnancy, compounds that are normally bound to albumin are altered kinetically (Brent, 2004). Increased extracellular fluid volumes affect the transfer of compounds dependent upon fluid concentration. Therefore, many toxins can actually move more readily into the pregnant mother. In

addition, there are changes in renal elimination, changes in maternal liver metabolism, and variations in uterine blood flow that affect her ability to detoxify and clear toxins from her body. Elevated blood lead levels in the pregnant mother may lead to pregnancy induced hypertension, a most serious and potentially life threatening complication of pregnancy (Yazbeck et al, 2009).

ADULTS

The average weight Caucasian man is the norm to which all standards for chemical safety have been applied. As a result, the discussion of vulnerability compares the various populations across the lifespan to the healthy adult. In addition, factors that affect the overall health of an adult such as chronic illness, affect the adult's susceptibility to environmental toxins.

Social Factors

Where a person lives, works, attends school, worships and plays can increase the risk of toxic exposures. These are considered to be the social determinants of health and greatly impact health outcomes. These exposures can have a serious impact upon their health. Beyond the individual level issues or household residence, school and workplace, there are neighborhood effects that impact the health of poor and minority populations at much higher levels of exposure. These increased exposures and negative health outcomes are commonly termed issues of *environmental justice*. However those who live in more hazardous areas suffer injustice from their greater exposure to toxins.

In addition, the various hobbies and recreational activities that a person pursues can impact the amount of toxins they are exposed to in their lifetime. If the hobby includes paint and paint thinners, for example, an individual would be placed at a similar risk to those who are exposed occupationally. Home gardeners can be exposed to pesticides used.

Further, various traditional remedies include toxins such as mercury, lead and other heavy metals. Folk remedies that contain lead, such as "greta" and "azarcon" are used to treat an upset stomach. In many Latino communities a form of mercury *azogue* is ingested to relieve empacho, a form of gastrointestinal malaise (for more information: HIDDEN DANGER Environmental Health Threats in the Latino Community). In a study of traditional Asian herbal remedies, levels of arsenic, lead and mercury were found to be at toxic levels in 49% of the products and 74% of them exceeded public health guidelines for prevention of disease (Garvey, Hahn, Lee & Harbison, 2001).

Behavioral Factors

Workplace exposures to hazards affect almost all categories of workers globally. The Occupational Health and Safety Administration (OSHA) reports that in 2008 more than 5,000 workers in the United States alone lost their lives in work related events. Early concerns for occupational health and safety began with identification of the hazards of coal miners and the development of pneumoconiosis or black lung disease. Common examples of occupations known for serious health effects from environmental toxins are agricultural workers who are exposed to pesticides, workers in dry cleaning establishments who are exposed to solvents such as tetracholoroethylene (PERC), shipyard workers, and those who work with insulation who are exposed to asbestos. (McDermott et al, 2005).

Workers exposed to chemicals such as vinyl chloride, benzene, copper sulfate, plastics and asbestos have higher rates of cancers such as lung cancer, kidney cancer and leukemia and other blood related conditions. Workers exposed to environmental tobacco smoke, carbon monoxide, or solvents are at increased risk for heart disease including arrhythmias. Since the early recognition of the link between occupation and health with coal miners, a variety of other lung conditions have been linked to workplace exposures including byssinosis (Brown lung) and those who work with cotton; silicosis and those who work in sandblasting and with ceramic and cement materials; and asthma from chemicals such as chromium, aluminum, nickel and exposure to dust. Those who work in smelters or foundries and those in the pharmaceutical industry are at greater risk of neurological disorders through workplace exposure to toluene, mercury, lead, arsenic, pesticides, plastics, and carbon monoxide. (See Table 2).

Various federal agencies such as the Occupational Safety and Health Administration (OSHA) and National Institute of Environmental Safety and Health (NIOSH) study, monitor, enforce standards and provide important research and education to improve worker health. The American Association of Occupational Health Nurses supports nursing efforts in occupational and environmental health. They provide links to their text, Essentials of Occupational and Environmental Health Nursing. Nurses are exposed to many hazardous chemicals in their work in the hospital and other health care settings. It is known that various medical products that nurses are exposed to contain toxic substances. However, there has been little confirmation of the health burden this places upon a nurse's body. In a bio-monitoring study conducted by the organization,

Table 2: Chemical Exposure and Health Outcomes

Chemical Exposure	Adverse Health Outcome
Vinyl chloride	Liver cancer Cardiovascular disease
Benzene	Leukemia Aplastic anemia Neutropenia
Benzidine (various chemical formulas)	Bladder cancer
Copper sulphate	Anemia and blood disorders
Plastics	Neurological effects
Asbestos	Asbestosis Lung cancer Mesothelioma
Particulate matter	Asthma Cardiovascular disease Pulmonary disease Lung cancer
Sulphur dioxide	Asthma
Environmental Tobacco Smoke	Cardiovascular effects Pulmonary disease Asthma
Carbon Monoxide	Cardiovascular disease including angina
Solvents	Arrhythmias Liver damage
Cotton fibers	Byssinosis
Dust from cement; sandblasting; ceramics	Pneumoconiosis Bronchitis
Pesticides	Skin cancer

Hazardous chemicals exist in health care. (Wilding, Curtis, & Welker-Hood, 2009).

Physicians for Social Responsibility, nurses and physicians in 10 states were found to have levels of chemicals with known or suspected negative health outcomes. In those tested, bisphenol A (BPA), mercury, phthalates, polybrominated diphenyl ethers (PBDEs), triclosan, and perflorinated compounds (PFCs) were among the chemicals found. All persons in the study had at least five of the six kinds of chemicals tested and all had BPA and some form of phthalates in their bodies (Wilding, B.C., Curtis, K., & Welker-Hood, K. (2009). Hazardous chemicals exist in health care.

Further, evidence suggests that previous ethnic and racial disparities in workplace exposures to toxins persist today. Historically, black workers were shown to be disproportionately exposed to silicosis, chromate, and carcinogens from coke ovens. Latinos are shown to face disproportionate risks from pesticide, lead and mercury exposure (NRDC, 2004). More recent reports of disproportionate exposures show that Latino agricultural workers, Native American mine workers and newly immigrated Asians are among those whose workplace exposures exceed that of whites (Murray, 2003).

OLDER ADULTS

Biophysical factors

The Environmental Protection Agency created an Environmental Public Health Framework to address concerns for older adults. It is important to note than persons older than age 65 demonstrate great variability in physical changes that affect vulnerability. Frailty of the very old, the presence of serious health conditions and residential, behavioral, and lifestyle factors contribute to differences in susceptibility (Geller & Zenick, 2005).

Older adults are at greater risk for harmful health effects from toxic exposure for two reasons. First, they experience physiological changes related to aging. The effectiveness of their respiratory system to clear inhaled toxins is diminished due to decreased lung volume, elasticity and lowered ventilation rate. Weakened skin integrity reduces their capacity to resist dermal exposures. Liver metabolism and renal function is less effective due to reduced blood flow, effects of aging and the effect of specific age related diseases. Reduced capacity to metabolize and excrete toxins absorbed through respiratory, gastrointestinal, and dermal pathways increases the harmful effects of toxic exposures. Polypharmacy is frequent in older adults and the interaction of a large number of pharmaceutical chemicals and environmentally adsorbed chemicals puts added stress on metabolic processes. In addition, changes in immunity and other processes of aging combine with exposures earlier in their lifetime to contribute to the development of illnesses. For example, Parkinson's disease has been shown to be related to exposure to neurotoxins earlier in life.

Second, the older population experiences a greater number of chronic illnesses that can be adversely affected by exposures to environmental hazards. Conditions such as Chronic Obstructive Pulmonary Disease (COPD), asthma and other chronic lung conditions are made worse by exposure to environmental tobacco smoke, particulate matter, tobacco smoke and other criteria air pollutants. Studies indicate that air pollution and climate can have significant adverse effects on those who have cardiac disease (Gold & Samet, 2013).

Behavioral factors

Older adults spend up to 90% of their time indoors exposing them to indoor air pollution, which is comprised of outdoor air contaminants as well as specific contamination in indoor settings (Davis, 2009). Outdoor air pollution includes pollutants such as sulfur dioxide, nitrogen dioxide, ozone, and particulate matter.

Most of the literature that addresses environmental risk among of people with developmental disabilities or cognitive delays examines the relationship of toxic exposures and neurodevelopment effects. More research is needed to explore the effects of toxic exposures to an individual who has some type of cognitive or developmental difference. Researchers question whether physiological factors such as alterations to the nervous system make an individual more vulnerable to added exposures.

Persons with Alterations in Cognitive and Physical Abilities

Environmental exposures are associated with a number of neurodevelopmental effects (EPA, 2013). Organizations such as the American Association on Intellectual and Developmental Disabilities note that the potential for cumulative effects of hazardous chemical exposure for the population with intellectual and developmental disabilities should be addressed through ongoing research (AAIDD, 2012). People with developmental differences who are able to work can be exposed to toxins in their work setting. Those living with physical and cognitive disabilities are more likely to live in community based residential homes where they are likely to be exposed to a variety of household environmental health toxins from poor indoor air quality. These pollutants include carbon monoxide, lead, mercury, radon, pesticides and household cleaning products (Davis, 2009). The American Association on Intellectual and Developmental Disabilities addresses the risks for environmental exposures in their position statement (AAIDD, 2012).

GLOBAL HEALTH

Across the globe, all humans are at greater risk from climate change in terms of changes in temperature and humidity, drought, plant life, wildfires, and changes in air quality. However, some regions of the world are experiencing the harmful effects of climate change at a greater rate. Water is becoming scarcer in many regions and the melting of the ice cap and glaciers is putting some poorer, heavily populated regions into crisis.

Researchers estimated that 25-53% of the burden of illness worldwide can be attributed to environmental health risk factors when they considered nutritional factors in food, pesticides and environmental tobacco smoke but excluded known genetic causes and behavioral factors such as smoking and diet (Smith, Corvalan & Kjellstrom, 1999). While the researchers were unable to confirm these estimates, their findings indicate that environmental hazards contribute to disease and financial burdens worldwide (Smith, Corvalan & Kjellstrom, 1999). The World Health Organization (2015) has methodology to quantify the disease burden attributable to environmental health risks including indoor and outdoor air pollution, lead, mercury, occupational exposures to carcinogens, environmental tobacco smoke and solar radiation. Toxins such as lead in gasoline, arsenic and high levels of fluoride in water, and DDT are exposures found in the developing world that do not occur in the United States.

Additionally, the policies of the richer countries contribute to global health disparities. Currently many pesticides banned for use in the United States and Europe are sold for use in poor tropical regions. Many developed countries have been disposing of pharmaceuticals by dumping these and electronic hazards in poorer countries (Ahsanuddin, 2012; Bradley, 2014). Currently, for example, Kenya has large electronic-waste dumps near large population centers (Schluep, Rochat,Munyea, Laissaoui, Wone, Kane, Hieronymi, 2008).

Finally, protection is more limited in many regions of the world. As developing countries adopt many of the less environmentally friendly products such as plastic bottling and bags, they are more likely to dispose of these non-recyclables by dumping and burning. Such practices increase the human risks, particularly carcinogens from air, water and soil pollution.

This overview of the vulnerability to environmental health risks by a variety of populations highlights the biophysical, behavioral and social factors that increase risk for many people. Advocacy to reduce risk of exposure to toxins and to protect health in ways that the Precautionary Principle advises must be evident for all people globally. The particular needs of the vulnerable populations

discussed here add evidence to the need for policy change.

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VULNERABLE POPULATIONS - ANTICIPATORY GUIDANCE

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INTRODUCTION

Anticipatory guidance is education provided to parents and child caregivers on a variety of health topics related to the child's development. This guidance should focus on the development the child will experience in the next 3 months to 1 year. Anticipatory guidance related to environmental health is an important component of this education to protect the child's health today and in the future. Each developmental age brings about different environmental health concerns that need to be addressed with parents and caregivers. Many of these topics should be revisited often as they build upon one another. It is important to remember that when a child moves out of a particular developmental category, the environmental health topics discussed in previous stages should be reviewed as a majority of the health concerns are still present in the child's life.

INFANTS

Infant developmental stages are broken into four different categories to address the rapid growth and development that occurs in the first year. These categories are 0-3 months, 3-6 months, 6-9 months, and 9-12 months. As the child progresses through each stage they become more curious about their surroundings and the world, potentially putting them in contact with more dangerous things.

0-3 MONTHS

Infants 0-3 months spend 15-18 hours sleeping each day. It is important that sleeping surfaces be free of toxic chemicals that could affect the child's growth and development. Major infant mattress manufacturers have laden their products with dangerous flame retardants, volatile organic compounds, toxic waterproofers, and unknown antibacterial chemicals. The good news is that not all manufacturers are using these toxic chemicals in their mattresses (Clean and Healthy New York, 2011). Healthcare providers can access the 2011 Mattress Matters report and 2013 update from the following websites to provide parents with information on mattress companies that do not use toxic chemicals. Then parents can make an informed decision when purchasing this essential item for their infant.

Mothers who are breastfeeding need to be cautious about their seafood intake because of the mercury levels present in seafood. Mercury exposure is a concern for infants due to its negative effects on brain development and the nervous system. When foods contaminated with mercury are eaten by a breastfeeding mother, the toxins are passed into the breastmilk. Seafood is a nutritious food that breastfeeding mothers should include in their diet as it provides B-vitamins, omega-3 fatty acids, and is a lean protein. However, consumption needs to be monitored.

Table 1: Mercury Levels In Seafood

HIGHEST LEVELS OF MERCURY	• Snapper
• Marlin	• Sea Trout (Weakfish)
• Orange roughy	• Tuna (canned, chunk light)
• Tilefish	• Tuna (Skipjack)
• Swordfish	**LOW LEVELS OF MERCURY**
• Shark	• Anchovies
• King Mackerel	• Butterfish
• Tuna (bigeye, Ahi)	• Catfish
HIGH LEVELS OF MERCURY	• Clam
• Chilean Sea Bass	• Crab (Domestic)
• Bluefish	• Crawfish/crayfish
• Grouper	• Croaker
• Mackeral (Spanish, Gulf)	• Flounder
• Tuna (canned, white albacore)	• Haddock
• Tuna (Yellowfin)	• Hake
MODERATE LEVELS OF MERCURY	• Herring
• Bass (Striped, Black)	• Mackeral (N Atlantic, Chub)
• Carp	• Mullet
• Cod (Alaskan)	• Oysters
• Croaker (White Pacific)	• Perch (ocean)
• Halibut (Pacific and Atlantic)	• Plaice
• Jacksmelt (Silverside)	• Salmon (Canned, Fresh)
• Lobster	• Sardines
• Mahi Mahi	• Scallops
• Monkfish	• Shad (American)
• Perch (freshwater)	• Shrimp
• Sablefish	• Sole
• Skate	• Squid (Calamari)
	• Tilapia

Table 1 lists mercury levels for different types of seafood. Fish that are classified as having the highest levels of mercury in them should be avoided altogether. Breastfeeding mothers should eat no more than three 6-oz servings per month of fish that have high levels of mercury. Fish that have moderate levels of mercury in them should be eaten no more than six times a month in a 6 oz. serving. Fish that have the lowest levels of mercury

in them can be eaten in 6 oz. servings up to two times per week (American Pregnancy Association, 2013). The National Resources Defense Council has a seafood mercury calculator available on their website. Users can put in their weight, type of fish, and serving size and the results will provide information on how much mercury you have consumed and what your safe levels are.

3-6 MONTHS

What baby does not enjoy the jangling of car keys? How many parents have used this object as a diversional activity for their infant or allowed their infant to hold and mouth car keys? The answer is most parents and infants. What many parents don't know is why car keys are a dangerous object for the infant to play with. Car keys contain lead, a toxic chemical. Young children absorb lead at a greater rate than adults and elevated blood lead levels can cause anemia, hearing damage, learning disabilities, speech difficulties, behavioral problems, and other neurologic effects. Parents should be educated to not let their child play with car keys due to the potential for lead exposure. In addition, education needs to be provided on the importance of washing their hands after they handle car keys, and especially before any food preparation or breastfeeding.

Infants can get their first tooth as early as 3 months of age. To help soothe the pain for cutting teeth, caregivers can give infants teethers. It is important that parents pick teethers that are Bisphenol-A (BPA), polyvinyl chloride (PVC), and phthalate free. Parents should read the packaging to see if the product states that they are free of these toxins. While this can be a daunting experience for parents, healthcare providers can provide parents with information on safe products. Some manufacturers that have products that meet these standards are MAM, Vulli, and Zoli. In addition, Safe Mama has compiled a list of BPA, PVC, & phthalate free teethers.

The majority of infant toys are made of plastic material. Infants will inherently put these toys in their mouth, whether they belong there or not, as this is their natural way of exploring an object. A large number of toys contain harmful chemicals such as PVC, BPA, lead (a stabilizer in PVC products), cadmium, phthalates, and flame retardants. These chemicals are associated with a number of negative health impacts such as cancer, endocrine disruption, altered growth and development, and reproductive health impacts. (Uding & Schreder, 2014). Products that do not contain these harmful chemicals are available, but may not be labeled or sold in major toy stores. Healthcare providers have the unique opportunity to provide parents with the appropriate resources to purchase healthy toys for their child during health care visits or post the information to their office website/Facebook page. Box 1 lists a variety of healthy toy resources that healthcare providers can share with parents and child caregivers.

Box 1: Safe toy resources (Moms Rising, 2014)

http://www.healthystuff.org/ search over 1,500 toys by name or manufacture to see toy health rating

http://www.momsrising.org/

text healthytoys (toy name) to 41411
will receive an instant message back on whether the toy is toxic

6-9 MONTHS

Around 6 months of age, infants may start to crawl and expand their exploration of the world. Crawling brings on a new set of safety concerns for parents and childcare providers. Through crawling, infants are exposing themselves to more dirt, dust, germs, and chemicals that they pick up on their hands, clothes, mouths, and face. The infant is closer to the ground and therefore breathes in more toxins that are present in dust and dirt. It is imperative that healthcare providers provide the following health tips to parents of a soon to be crawler to help protect the child from toxic exposures:

11. Remove shoes at the door
    a. Decreases dirt, organisms, chemicals (such as lead, mercury, pesticides) on the floor
12. Wet mop hard floor surfaces weekly
    a. Decreases toxic chemicals found in dust (i.e. flame retardants)
3. Avoid toxic cleaning chemicals during mopping
    a. Make your own cleaner:
        i. 67 Homemade All-Natural Cleaning Recipes
        ii. Do It Yourself Recipes for Eco-Friendly Cleaning
        iii. Green Cleaning Recipes
    b. Examples of companies that produce non-toxic floor cleaners
        i. Bona
        ii. Method
4. Vacuum carpets weekly
    a. Decreases exposure to toxic chemicals

In addition, parents need to be vigilant about how they store any chemicals, cleaners, and medications when they have a child who is mobile (crawler or walker). These products should be stored up high and in a locked cabinet that only an adult can open. Products should also be stored in their original container. If a child accidentally ingests the product, healthcare providers can utilize the

information on the container to provide timely and safe care. Healthcare providers should provide parents with the national poison control number (1-800-222-1222) and instruct them on when to call.

At 6 months of age, children begin eating solid foods. Fruits and vegetables are some of the first foods that are introduced to infants and hold important nutritional value. Children can be exposed to pesticides through fruits and vegetables that they eat. Children's top favorite foods include strawberries and apples which have been found to contain high levels of more than one pesticide. To reduce a child's exposure to toxic pesticides, healthcare providers can provide parents and caregivers a list of foods that they should try to buy organic (dirty dozen plus) and those foods that are less contaminated or non-organic (clean fifteen). See Table 2 for the fruits and vegetables that fall into the dirty dozen and clean fifteen categories.

Table 2: Fruits and Vegetables and Pesticides

Dirty Dozen Fruits & Vegetables	Clean Fifteen Fruits & Vegetables
Apples	Asparagus
Celery	Avocados
Cherry tomatoes	Cabbage
Cherries	Cantaloupe
Cucumbers	Cauliflower
Grapes	Sweet Corn
Nectarines	Eggplant
Peaches	Grapefruit
Spinach	Honeydew
Strawberries	Kiwi
Sweet bell peppers	Mangos
Tomatoes	Onions
	Papayas
	Pineapples
	Sweet peas
	Sweet potatoes

(Environmental Working Group, 2016)

At 6 months when infants start eating more solid foods their meals become messier. At this time parents may opt to replace cloth bibs with plastic bibs that are more resistant to messier meals. Healthcare providers can educate parents to look for bibs that are PVC, phthalate, and vinyl free. It is important to explain to parents that when a child uses a bib that has one of these toxins in them, the toxin is ingested into the child's body via inhalation and contact with food.

Sunscreen can be applied to an infant after 6 months of age. Infants have a greater risk of negative health effects from toxic chemicals found in sunscreens because their skin is immature and they have a greater ratio of surface area to body weight than adults. Given this information, healthcare providers should educate parents on which sunscreens are safe to use. Sunscreen should be free of parabens, phthalates, oxybenzone, polyethylene glycols (PEG's), and propylene glycol and protect against UVA & UVB rays. SafeMama has provided a great list of safe sunscreens to use that healthcare providers can share with their patients, but it is not inclusive.

9-12 MONTHS

As early as 9 months of age an infant can start to walk expanding their ability to come in contact with more toxins. With this new found mobility, infants have access to more objects that they can put in their mouths and consequently ingest toxins. For example, infants may now have access to electronic devices, such as TVs and computers, which contain toxic flame retardants that are harmful to the developing child. Parents need to be educated on the importance of keeping children away from everyday products that contain toxins.

Between 9 and 12 months, infants may start to use a dish for their food during meal time. It is important that parents do not use dishes that contain melamine, BPA, phthalate, formaldehyde, or PVC. These chemicals can adhere to food placed on these chemical containing dishes, which ultimately transfers the chemical to the child's body. These chemicals are hormone disruptors and have been found to cause negative health effects such as attention deficit hyperactivity disorder (ADHD), reproductive problems, and thyroid problems (National Institute of Environmental Health Sciences, 2013). In addition, when storing the child's foods, parents should avoid plastics with the numbers 3, 6, & 7 (Healthy Child Healthy World, 2013). Glass or stainless storage is best. Also, foods heated in the microwave should not be heated in plastic containers. Use glass or ceramic containers instead.

TODDLER

As children progress into toddlerhood they are exposed to new toxins outdoors, as they expand their range of exploration with their new found mobility. Toddlers love to play in dirt, especially as they are helping an adult with gardening or digging to find worms. Some of the toxic chemicals that can be found in dirt are lead, pesticides, arsenic, mercury, dioxins, and other heavy metals (Shayler, McBride, & Harrison, 2009). It is important to remind parents to diligently wash their child's hands after playing in dirt to rid their hands of toxic chemicals such as lead and pesticides.

The majority of U.S. households use pesticides and herbicides on their grass and garden plants to prevent or get rid of weeds, bugs, and disease. After application of these chemicals, children have an increased risk of coming in contact with these chemicals and the negative health effects from exposures. Children who are playing outside in the grass or by plants treated with pesticides have a higher exposure rate than adults. This is because toddlers will touch the treated area and are closer to the ground breathing in more of the toxin. In 2011, three studies found a decrease in IQ scores and behavioral tests in children age 6-7 years who were exposed to high levels of organophosphate pesticides in the womb or as infants (Bouchard et al., 2011; Engel et al., 2011; Rauh et al., 2011). Health care providers should educate parents and caregivers to use non-toxic pesticides and keep children away from areas that have been treated with pesticides. In addition, hand washing is always an important prevention measure to decrease continued chemical toxin exposure after playing outside.

During warm weather, children love to play in water and with garden hoses. Garden hoses have been found to contain lead, chlorine (due to PVC), bromine (a flame retardant chemical), tin, phthalates, arsenic, and bisphenol A (BPA). Education can be provided to parents on how to decrease their child's exposure to garden hose toxins which includes not drinking water from the hose, don't leave the hose in the sun, let the water run for a few minutes before filling a pool, buy a lead free hose, and wash your hands after handling a hose (Ecology Center, 2013). There are also drinking water safe garden hoses available that do not contain PVC or lead. If using a drinking water safe hose, water should be allowed to run for several minutes prior to drinking because contaminants can collect in standing water.

Children's plush furniture that has popular cartoon characters or other stimulating designs is highly desired by young children, yet they may be covered in harmful chemical flame retardants. Flame retardants have been shown to cause negative health effects and do not effectively work in decreasing fire risks to children. Parents and child caregivers need to be advised to not purchase products that contain polyurethane foam that is treated with flame retardants and be provided a list of alternative kid friendly furniture that does not contain toxic chemicals (Center for Environmental Health, 2013).

PRESCHOOLERS

Preschoolers are creative and love to work with a variety of art and craft materials. Preschoolers are also curious by nature and are more likely to sniff, taste, or "paint" their skin with art supplies increasing their exposure to potential toxins. Adults who purchase art and craft materials for children should supervise children to ensure they are using the product appropriately and take the following steps listed in Table 3 to ensure that the products are safe. The National Library of Medicine has an online Household Products Database that provides toxicity information on commonly used household products, including art supplies. Parents can also make homemade finger paint or play clay (see Table 4) that is 100% safe if accidentally ingested.

Table 3: Safer art supplies

Material to Avoid	Safer Alternatives
Aerosols, sprays	Liquid non-aerosol products, manual applicators
Cold water, commercial, & powder dyes	Plant based dyes (such as canned beets, cranberries, frozen blueberries, turmeric)
Instant papier-mâché	Papier-mâché made from newspaper and library paste or white paste (flour/water)
Powdered forms of clays, glazes, paints, pigments	Moist clay, liquid non-aerosol products
Products containing lead or heavy metal (some enamels, paints, glazes)	Similar products without chronic health hazard labels, water based markers and paints
Solvent based products (rubber cement, turpentine, permanent markers)	Water based glues, markers, paints

(California Environmental Protection Agency, 2013)

SCHOOL AGERS

Lunch Boxes

When children start attending primary school they will be eating lunch away from home and often times carrying a lunch box. Children's lunch boxes, especially those that have popular cartoon characters on them, have been found to contain phthalates which we know are harmful to developing children (Schade, 2012). Phthalates have been found to be a causative factor in ADHD and asthma (Bertelsen et al., 2013; Kim et al., 2009). Chemicals are released from these lunch boxes and can cling to food and hands allowing the chemical to be ingested into the child's

Table 4: Homemade art supplies

Homemade Finger Paints	Homemade Play Clay
Ingredients: • 1 cup flour • 4 cups cold water • plant based dyes	Ingredients: • 1 cup flour • 1 cup water • ¼ cup salt • 2 tbsp cream of tartar • 1 tbsp oil • plant based color dye
Directions: In medium pot combine flour and 1 cup of water. Stir until smooth. Add remaining 3 cups of water. Cook and stir over medium heat until thick and bubbly. Remove from heat and let cool. Divide into containers and tint with dyes. Plant Based Dyes • drain juice from canned beets or thawed frozen berries • simmer then drain coffee, tea, or crushed plant material such as purple grapes, red or yellow onion skins, walnut hulls, cranberries, or oak or apple tree bark	Directions: Mix flour, salt and cream of tartar in a medium pot. Add water and oil. Cook over medium heat for 3-5 minutes, stirring frequently. When dough forms remove from heat and knead. Divide and add dye. Store in an airtight container or baggie. See directions for finger paints for plant based color dye instructions

(California Environmental Protection Agency, 2013)

body. Healthcare providers can advise parents to purchase lunch boxes that state they are PVC and BPA free to protect their children from these harmful chemicals.
School supplies

In the fall, as students go back to school, new school supplies are purchased by thousands of families. School supplies, such as backpacks, 3-ring binders, vinyl rain boots, raincoats, lunchboxes, notebooks, and art supplies, have been found to contain a number of harmful chemicals, such as phthalates (Schade, 2012). Healthcare providers can recommend to parents of school agers that they avoid buying products that are made out of PVC or vinyl which has the recycling number 3 on it. The Center for Health, Environment, and Justice has created a Back to School Guide for PVC free school supplies that can be utilized by healthcare providers to educate families.

Gymnastics

Gymnastics is a popular sport for young children and is a sport many children stick with for years. While the physical activity gained from this sport is good for children's health, the toxic chemical flame retardants they are exposed to in the gym are not. Flame retardants have been found in the polyurethane blocks that gymnasts fall into for a soft landing. Flame retardants are known to be hormone disrupting chemicals (Carignan et al., 2013). While a safe alternative to the blocks does not exist, healthcare providers can recommend to their patients to wash their hands and shower immediately after practice to rid their skin of the toxic chemicals.

TEENAGERS

Cosmetics

As school-agers become teenagers the number of personal care products and cosmetics they use increases. They start to use deodorant, more hair care products, make-up, and perfume or cologne. The majority of personal care products being sold in the US contain toxic chemical ingredients that can have negative health effects. See Table 5 for a list of harmful chemicals and associated health effects. This increased usage exposes teenagers to more toxic chemicals while their bodies are still developing. Healthcare providers can encourage teenagers to find out if the products they use are harmful by utilizing a variety of online resources:

1. GoodGuide - has an app for phones to scan products and provides information on healthier alternatives
2. EWG's Skin Deep cosmetic database
3. Make your own non-toxic lip gloss recipe

Work Exposures

During the late teenage years children start to get jobs that can expose them to new toxins depending on the work environment. Some examples of unhealthy work environments include restaurants that allow smoking exposing teenagers to secondhand smoke, farms that use harmful pesticides, janitorial work which exposes teenagers to toxic chemicals, and cashier or retail salesperson which exposes teenagers to BPA from handling receipts (Ehrlich, Calafat, Humblet, Smith, & Hauser, 2014). Healthcare providers need to educate

Table 5: Harmful Chemicals and Associated Health Effects

Harmful Chemicals	Negative Health Effects
Triclosan	Interferes with thyroid hormone metabolism, interferes with estrogen and androgen receptors
Parabens	Cancer, reproductive problems
Fragrance	Unknown as "fragrance" could be anything, can trigger asthma and headaches
Phthalates	Cancer, reproductive problems

(Beyond Pesticides, n.d.; Darbre & Harvey, 2008)

teenagers on safe and healthy work environments and provide them with examples of jobs that they can do but would not have a negative effect on their health. In addition, they can also educate teenagers on some simple steps to decrease their exposure to toxins in the work environment, such as frequent hand washing after handling receipts or opening windows for fresh air when using cleaning products.

ONLINE RESOURCES/TOOL KITS

For Healthcare Providers

- Pediatric Environmental Health Specialty Unit
  - Physician guide to safer plastics
- U.S. PIRG Education Fund
  - 2013 Annual Survey of Toy Safety
- Physicians for Social Responsibility
  - Pediatric Environmental Health Toolkit
  - Environmental Health Reference Card
- Clean and Healthy New York
  - Pocket size card information sheet on common chemicals and how to protect yourself

For Parents/Child Caregiver

- Safer Chemicals Safer Families
  - Safer rain gear
- Toxic Free Future
  - Toxic Chemicals Remain In Children's Products
- Safe Mama
  - A large volume of product information sheets to help the consumer purchase healthier products
- healthystuff.org
  - provides information on the health and safety of products based on research findings
- Healthy Child Healthy World
  - Variety of resources on healthy daycares and schools, safer foods, and healthy nursery
  - Healthy apps, books, e-books, webinars, videos, and reports
- Children's Environmental Health Network
  - Eco-Friendly Child Care

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IMMIGRANTS AND REFUGEES AS A VULNERABLE POPULATION

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INTRODUCTION

In the U.S., the number of immigrants have increased from 5% of population in 1970 to 12% in 2004, with projections of the immigrant population making up 15% of the U.S. census by 2025 (Martin & Midgely, 2006). According to the 2010 U.S. Census, there are 40 million people living in the U.S. who are foreign-born; representing 12.9% of the U.S. population (U.S. Census Bureau, n.d.). Although immigrants to the U.S. represent many nations, the foreign-born U.S. residents that comprise the largest segment of the population were born in Mexico (11.7 %), China (2.2), India (1.8), Philippines (1.8 %), and Vietnam (1.2 %) (U.S. Census Bureau, n.d.). Furthermore, the U.S. also has a history of welcoming refugees; in 2012 alone, the U.S. received 58,238 people as refugees. More than half the refugees to the U.S. in 2012 were from the Near East and South Asia (30,057) (U.S. Department of State, 2013).

Those immigrating to and seeking refuge in the U.S. have primarily resided in California, Florida, Illinois, New York and Texas. There has been a recent trend, however, in which immigrants and refugees are settling throughout the country (U.S. Census Bureau, n.d.). This trend leads to greater diversity within our communities and requires the nurse to have an understanding of the needs of foreign-born populations related to their past environmental exposures and their unique environmental risks with resettlement in the U.S.

ENVIRONMENTAL EXPOSURES FROM COUNTRY OF ORIGIN

Like everyone else, we are influenced by our environments. Body burden studies have found that people living in the U.S. their entire lives have a legacy of chemical exposures. Immigrants and refugees arrive in the U.S. with past environmental exposures from their native land. Depending on the circumstances of the immigrating person those environmental exposures can place an immigrant or refugee at greater health risk.

OCCUPATIONAL EXPOSURES

Workplace environmental exposures in the country of origin influence the health of people immigrating to the U.S. The World Health Organization (n.d.) has identified that people from developing countries are more likely to be exposed to airborne particulates, carcinogens, and risks of workplace injury. Those employed in agricultural jobs are at risk for pesticide exposures and depending on the climate of the country of origin heat related illnesses such as skin cancer and renal disease (Wesseling, Crowe, Hogstedt, Jakobsson, Lucas & Wegman, 2013). Outdoor workers are particularly vulnerable to greater risk of heat related illnesses as a result of climate change. Climate change also is expected to exacerbate existing chronic diseases such as pulmonary and cardiac disease (Intergovernmental Panel on Climate Change, 2014).

It is helpful to remember that not all resettled immigrants and refugees were employed in countries with strict occupational health requirements for worker protections. Assessment of past employment actives and exposures is an important first step to determine environmental risks. In addition to the risk described for agricultural workers in the previous paragraph, workers in manufacturing may be at risk for musculoskeletal injury from repetitive activities or chemical and noise exposures from working with industrial equipment and lubricants. Those who were employed in the health care sector may have risk of biological exposures, while the extraction (mining) industry presents the risk of radiation, poor air quality, and chemical exposures (Frumkin, 2010). For more information regarding global occupational health risk see WHO Occupational Health web site.

The role of many women from developing countries remains traditional and their work is in the home. This makes immigrating women from some developing countries vulnerable to household indoor smoke from indoor cook stoves that use wood or other biomass fuel. Poor indoor air quality is associated with pulmonary conditions such as acute respiratory infections, tuberculosis, and lung cancer, as well as heart disease and poor pregnancy outcomes such as low birth weight (World Health Organization, 2006). Nursing assessments should include identifying chronic diseases and previous exposures in the immigrating person's country of origin.

CULTURAL & FOLK PRACTICES

Cultural practices can put immigrants and refugees at risk for environmental hazards. For example, women from some parts of Africa, South Asia, and the Middle East may use traditional eye cosmetics known as kohl (Arabic: kuhl; Punjabi: sirma; Hindi: kajal; Telegu: katuka from: https://theurbanmuslimwomen.wordpress.com/2008/09/22/kohl-for-the-eyes/). Kohl can also be applied to infants' eyes at birth as it is believed to strengthen the eyes and protect the child from the evil eye. Kolh preparations may contain

lead and this practice can put women and infants at risk of lead toxicity.(See Unit III, pages 61-62 in e-text)

Furthermore, some traditional medicines that are used as part of Hispanic, Chinese, Middle Eastern, Indian and other Asian folk health practices have been noted to contain heavy metals including lead. The U.S. Center for Disease Control and Prevention offers detailed information about folk medications that may place immigrant and refugee families at risk for lead and other heavy metal exposures. The nurse should assess past use of traditional medicines and determine if the immigrating family continues to rely on these traditional medicines.

DISASTERS

Natural and manmade disasters have the capacity to disrupt the infrastructure that provides clean water and air as well as safe food and medicines. Consequently, immigrant and refugee families may present with health problems related to exposure to poor air and water quality as a result of disruptions of utilities. These disasters could be the reason for immigration to the U.S. Natural disasters such as volcanoes, earthquakes, tornadoes and hurricanes can create health problems for the people in the surrounding communities. For example, volcanic activity generates gases such as sulfur dioxide, carbon dioxide and hydrogen chloride as well as particulate matter that can affect human health. The U.S. Geological Survey web site describes air pollution related to volcanic activity.

With increasing development, natural disasters can influence the built environment and lead to a manmade disaster. This was the case with the 2011 earthquake and subsequent tsunami near Fukushima, Japan that ultimately led to the release of radiation from the nearby nuclear power plant. Following the Fukushima nuclear disaster, WHO (2013) conducted a health risk assessment and identified that those people living closest to the nuclear reactors at the time of the accident had an increased risk of solid cancers (4%), breast cancer (6% increase for infant females), leukemia (7% increase for infant males) and thyroid cancer (70% increase for infant females). It is important that the nurse takes the time to learn the history of the country of origin and reason for immigration so that health screening can be targeted to the patient's environmental health risks. For more information regarding environmental health impacts of disasters please go to.

WAR AND AREAS OF CONFLICT

Disputes of our world's limited natural resources such as water rights can be an antecedent to war. War itself, a manmade disaster, presents additional environmental risks to immigrant and refugee families. Psychological trauma and physical disability as consequence of military conflict can be complicated by environmental exposures of warfare including chemical weapons that affect military and civilian populations (Dworkin, Prescott, Jamal, Hardawan, Aras, & Sandro, 2008). Iraqi refugee families attributed congenital anomalies of children that were born following maternal exposure to chemicals used during the Iraqi war (McDermott-Levy & Al Balushi, 2015).

IMMIGRANTS & REFUGEES LIVING IN THE U.S.

Immigrants to the U.S. are less likely to have health insurance and are less likely to seek care from a health care professional. Furthermore, citizenship influences access to U.S. sponsored health insurance programs such as Medicaid and Medicare. Consequently, 44% of non-citizen immigrants do not have health insurance (George Washington University, 2012). Access to health care is further limited by language barriers, cultural differences, perception of health needs, and immigrant status (Ku & Jewers, 2013). These factors influence how an immigrant patient or family would respond to or understand the risks or impacts of environmental exposures.

LANGUAGE

Language and access to interpreters also creates barriers to health information for refugees (Morris et al., 2009) who may come to the U.S. with a variety of physical and mental health problems (Jamil, Farrag, Hakim-Larson, Kafaji, Adbulkhaleqm & Hammad, 2007; Ramos, Orozovich, Moser, Phares, Stauffer, & Mitchell, 2010). One problem for those new to the country is the ability to access environmental health information related to the area of resettlement and to read instructions on chemical labels such as pesticides and cleaning agents. The National Service Center for Environmental Publications of the EPA has environmental health resources in 23 languages and dialects to support the immigrant and refugee family. Safe and proper use of household pesticides and cleaning agents can be a problem for recent immigrants who may not be able to read instructions in English. One thing that may assist those new to the U.S. is that in 2003 the member countries of the United Nations published a harmonized chemical hazard communication system called the "Globally Harmonized System of Classification and Labeling of Chemicals" (OSHA, n.d.). As a result of harmonization, most countries rely on standardized warning symbols and standardized safety data sheets (formally MDS). While this will not completely overcome some language barriers for recent immigrant or refugee families, standardization does provide common warning pictographs from country to country. For more information regarding international chemical labeling

standardization see Occupational Safety & Health Administration web site regarding global harmonization. An another important role for the nurse is to not only teach safe use of household chemicals but to offer safer, nontoxic alternatives.

CULTURAL IMPLICATIONS IN THE U.S.

Adding to barriers of access to a health professional regarding environmental health information is the perceptions of the role of the nurse. In some cultures it is not acceptable to ask questions of the providers and nurses do not have a role other than following the physician's orders. Also the U.S. health care system is very complex and can be confusing to a newly arriving immigrant; therefore, someone with an environmentally related problem may not know how to access a health care provider for assistance. Nurses need to make themselves available to immigrant and refugee communities in order to educate those new to the U.S. in the role of the nurse and environmental risks and safe practices. Social organizations and the faith community are groups in which the nurse can access immigrant and refugee communities. For example, Villanova University nursing students partnered with a senior center that serviced elderly Asian immigrants to teach healthy gardening practices that did not rely on pesticides. See How does your garden grow?

ECONOMICS & HOUSING

Many immigrants and refugees arrive in the U.S. and find themselves living at a lower standard of living than they had in their home country (Morris et al., 2009). In the U.S. they may find themselves living in substandard housing, older homes in disrepair, or be victim of unscrupulous landlords. Home environmental risks that may be a problem for this population are lead based paint, carbon dioxide from poorly maintained furnaces, or pests such as roaches or rodents. The nurse should assess the age of homes, the availability and policies related to carbon monoxide detectors, and if pests are a problem for the immigrating family. If an environmental risk is identified the nurse should make appropriate referrals and educate the family in mitigation methods.

CONCLUSIONS

Immigrants and refugees may come to the U.S. with previous environmental health exposures that require assessment and management if there are health consequences. Additionally, once in the U.S., immigrants and refugees are at risk as a result of language and cultural barriers as well as potential challenges accessing the health care system. Nursing assessments should focus on the unique previous exposures and potential risks in the resettled immigrant. Once risks and health problems are identified the nurse can make appropriate referrals and participate in interventions that promote health of this vulnerable population.

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