Reproductive Health Research and Resources

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Environmental reproductive health is the study of exposures to environmental contaminants, particularly during critical periods of development, and their potential effects on all aspects of future health—including conception, fertility, pregnancy, sexual health and development, and adult health.[1]

The term "*environment*" encompasses not only a person's physical work and living environment, but also their social and cultural environment.

When examining reproductive health, it is critical to remember that adverse effects from exposures to environmental toxicants at any point in development can have lifelong and even intergenerational impacts. As such, addressing reproductive health requires a life course approach which addresses both early life disadvantages and cumulative impacts over time.

Sources of Reproductive Toxicity

Research has linked exposure to environmental toxicants with various reproductive diseases and disorders, many of which harm a person's ability to conceive and complete a successful pregnancy.

In the table below are some examples of these toxicants and their associated reproductive health effects. The reproductive effects are grouped according to the strength of evidence (strong, good, limited).

Before interpreting the following table, note:

- The table shows only a handful of environmental contributors, as there are far too many to list on this page. The same is true for their associated reproductive health effects.
- *The research on these toxicants is constantly changing and expanding.* These findings are subject to change as further research is conducted.
- The associated reproductive effects may be results of direct and/or *in utero* exposures.

Examples of Potential Reproductive Toxicants

Toxicant	***Examples of Adverse Reproductive Effects***		
	Strong	***Good***	***Limited***
Air Pollution (PAH, PM10, PM2.5)		Fetotoxicity, low birth weight, preterm delivery,[2,3,4,5,6]	

BPA		Altered prostate gland development, fetotoxicity,[7] PCOS[8]	Uterine fibroids,[9] accelerated or delayed puberty, fetotoxicity, genito-urinary malformations,[10] male sexual dysfunction,[11,12] reduced male fertility[13,14,15,16]
Diethylstilbestrol (DES)	Endometriosis,[17] Female reduced fertility, menstrual disorders[18]	Fetotoxicity, ectopic pregnancy, early menopause, preterm delivery,[19] low birth weight,[20] cryptorchidism[21]	Uterine fibroids[22]
Dioxins		Menstrual disorders[23]	Endometriosis,[24,25,26] abnormal sperm, accelerated or delayed puberty, genito-urinary malformations, fetotoxicity, low birth weight, female reduced fertility[27]
Flame Retardants (PBBs, PBDEs)		Cryptorchidism[28]	Abnormal sperm,[29,30] accelerated or delayed puberty, hormonal changes[31]
Heavy Metals			
Arsenic	Miscarriage, stillbirth[32,33,34]	Birth defects, [35] low birth weight[36]	Genitourinary malformations[37]
Cadmium		Male reduced fertility[38,39]	Fetotoxicity[40]
Lead	Female/Male reduced fertility[41,42] abnormal sperm[43] birth defects, miscarriage, low birth weight[44]	Delayed puberty[45,46,47,48]	
Mercury		Male reduced fertility;[49] fetotoxicity[50] menstrual disorders[51]	
PCBs		Male reduced fertility;[52,53] endometriosis,[54,55] low birth weight, miscarriage,[56,57,58] menstrual irregularities[59]	Accelerated or delayed puberty, female reduced fertility[60]

Pesticides (Esp. DBCP & Kepone)	Reduced male fertility, Abnormal sperm[61,62,63]	Fetotoxicity, genito-urinary malformations, hormonal changes, menstrual disorders, reduced female fertility,[64] low birth weight[65,66,67]	Cryptorchidism,[68] early menopause[69]
Phthalates		Hormonal changes[70]	Abnormal sperm, fetotoxicity, genito-urinary malformations, menstrual disorders, preterm delivery, testicular toxicity[71]
Solvents		Fetotoxicity, low birth weight, menstrual disorders, female reduced fertility[72]	Abnormal sperm, male reduced fertility, genito-urinary malformations[73]

Other Exposures	***Examples of Adverse Reproductive Effects***		
	Strong	***Good***	***Limited***
Alcohol	Birth defects, pregnancy loss, low birth weight,[74] hormonal changes;[75] male and female reduced fertility[76]		
EMF		Male infertility[77]	Miscarriage[78]
Heat	Male reduced fertility, abnormal sperm[79]		
Ionizing Radiation	Miscarriage, low birth weight, reduced fertility,[80] fetotoxicity, menstrual disorders[81]		
Tobacco Smoke (Active and Secondhand)	Ectopic pregnancy, sexual dysfunction,[82] fetotoxicity, preterm delivery, female/male reduced fertility, menstrual disorders, low birth weight, hormonal changes[83]		

Since extensive research goes into demonstrating a connection between a type of exposure and a reproductive disease, there are few chemicals for which there is strong enough evidence to conclusively indicate a connection to a particular reproductive disease.

For more information on the types of chemicals that might negatively affect your reproductive health, see the resources at the bottom of the page.

Pregnancy Health and the Environment

"Women are the first environment. We are an embodiment of our Mother Earth. From the bodies of women flows the relationship of the generations both to society and the natural world."

-Katsi Cook, Mohawk midwife and reproductive justice activist

Like Cook's statement, mothers embody their relationships with the environment in a number of ways:

1. Many environmental toxicants, such as lead and PCBs, can accumulate in a mother's body over time, both prior to and during pregnancy. These toxicants may then be passed down to her children through her blood and breast milk.
2. Stress responses and some chemicals can induce changes in a mother's genetic makeup, which can also be passed on to future generations. See CHE's page on Gene Environment Interactions.
3. Early exposures (in utero, in infancy, in adolescence) that negatively impact a woman's reproductive health can negatively impact her pregnancy outcomes.

As such, a mother's health before, during, and after pregnancy are all crucial in determining the health of her child. Environmental exposures that happen at all stages in a woman's life are relevant when discussing pregnancy.

When exposures do happen during pregnancy, critical windows of development are essential considerations. According to the World Health Organization, a critical window of susceptibility is a period in which exposures can alter the development of a fetus in a particularly harmful way. These windows include periods in which cell growth is occurring, tissues are forming, and the body is still without most protective capabilities (such as an immune system, blood brain barrier, or a DNA repair system).

The Critical Windows of Development[84] timeline from the Endocrine Disruption Exchange[85] shows how exposure to certain chemicals can affect different anatomical systems (e.g., reproductive, endocrine, central nervous, and immune systems) at different stages in prenatal development.

Pregnancy Complications and Environmental Contributors

Complications that arise during pregnancy can have pervasive and long lasting health impacts on the child. Adverse pregnancy outcomes such as miscarriage, stillbirth, and birth defects can be a deeply traumatic experience for expecting parents, and can also pose a physical threat to mothers.

While all pregnancy outcomes are the results of genetic, endocrine, behavioral, and environmental factors, there are a number of potent chemicals and other types of

environmental toxicants known to negatively affect fetal health. These toxicants are often called fetotoxicants.

Two examples of broad pregnancy complications that can arise as a result of environmental exposures are issues related to fetal growth (impaired fetal growth, low birth weight, and preterm birth) as well as pregnancy loss/fetal death. Birth defects are not included on this page, as you can see more information on CHE's page on Birth Defects.

Impaired Fetal Growth, Low Birth Weight, and Preterm Birth

Impaired fetal growth[86] includes issues such as low birth weight and being small for gestational age (SGE). Impaired fetal growth can lead to an increased risk of many childhood and adult illnesses. [87]

Impaired fetal growth often coincides with preterm birth,[88] which is defined by the CDC as the birth of an infant before 37 weeks of pregnancy. In 2014, preterm birth affected about 1 of every 10[89] infants born in the United States. Preterm birth is the greatest contributor to infant death, and a leading cause of long-term neurological disabilities in children. [90] Preterm birth is also associated with a number of other health issues.

Pregnancy Loss (Miscarriage, Stillbirth)

In the United States, both miscarriage[91] and stillbirth[92] are terms describing the unplanned loss of a pregnancy,[93] but they differ according to when the loss occurs (less than 20 weeks after pregnancy, and 20 or more weeks after pregnancy, respectively). Among women who know they are pregnant, 15 to 20 percent will have a miscarriage, while about one percent will have a stillbirth.[94]

The causes of pregnancy loss are numerous, complex, and not always well understood. Miscarriages and stillbirths may occur for many reasons, such as the following:

- The egg or sperm may be damaged, making fertilization difficult or impossible and/or preventing the fertilized egg from surviving afterwards.

Table 2: Examples of Known Fetotoxicants
Anaesthetic gases Cocaine[95] diethylstilbestrol (DES) Ethylene oxide Thalidomide[96]

- A problem may exist in the hormone balances needed to maintain the pregnancy.
- The fetus may not have developed normally.
- Physical problems may exist with the uterus or cervix.[97]

What causes most of these problems is still unknown. However, the harmful effects of many toxicants on the fetus have been known for many years. For examples of fetotoxicants, see Tables 1 and 2, as well as the resources at the bottom of the page.

Issues in Fertility and Sexual Health

People's ability to conceive, give birth, and raise children in a healthy environment is an essential to ensuring a nation's future prosperity. As such, issues of infertility have received substantial research attention. Infertility[98] is defined as the inability to conceive after one year of unprotected sex. Particularly in societies that place a strong emphasis on childbearing, infertility is a condition with many psychological, economic, and medical implications.

While there is concern among many scientists about what has been suggested to be an increase in infertility amongst people in industrialized nations, changing social and behavioral variables make it difficult if not impossible to draw conclusions over time with confidence. Some researchers suspect that lifestyle changes in industrialized nations, accompanied by a gradual increase in the number and amount of environmental toxicants people are exposed to over the years, could contribute to overall decreases in fertility.[99]

While infertility may be caused by a wide variety of influences—including aging, acute and chronic diseases, treatments for certain conditions, and behavior—countless environmental toxicants are known or suspected to affect fertility in both men and women. Since the exposures thought to harm male and/or female fertility are too numerous to describe here (See the bottom of the page for more references), we will focus primarily on the suspected roles of environmental toxicants in diseases of the female and male reproductive tracts.

Diseases of the Female Reproductive System

Endometriosis[100] is a disease affecting between 10% and 15% of reproductive age women. It occurs when the tissue that lines the inside of the uterus (called the endometrium) grows outside the uterus on other parts of the body. It is one of the leading causes of infertility, with about 30% to 40% of those affected being infertile.

Associated Toxicants: DES (diethylstilbestrol),[101] *dioxins,[102,103,104] *some pesticides[105,106]

Polycystic ovarian syndrome (PCOS)[107] is a common endocrine disorder characterized by irregular periods, androgen excess, pelvic pain, and ovarian cysts. By some measurements, the prevalence of PCOS is as high as 15%–20%. Women with PCOS have a higher risk of developing diabetes, endometrial cancer, infertility, miscarriage, and high blood pressure.[108]

Associated Toxicants: BPA[109]

Uterine fibroids (Leiomyoma)[110] occur in 25% to 50% of all women, though some estimates are much higher. Fibroids are made of muscle cells and other tissues that grow in and around the

wall of the uterus and can cause pelvic pain, abnormally heavy periods, abnormal uterine bleeding, infertility and complications in pregnancy.

Associated Toxicants: DES (diethylstilbestrol),[111] phytoestrogens[112,113]

Diseases of the Male Reproductive System

Hypospadias[114] is a birth defect in in boys where the opening of the urethra (the tube that carries urine from the bladder to the outside of the body) is not located at the tip of the penis. The abnormal opening can form anywhere from just below the end of the penis to the scrotum. It is estimated that about 5 out of every 1,000 boys born in the United States have hypospadias, making it one of the most common birth defects.[115]

Associated Toxicants: Endocrine disrupting chemicals (EDCs) such as BPA,[116] Solvents,[117] and pesticides[118]

Cryptorchidism,[119] or undescended testicles, is the most common genital problem encountered in pediatrics. About one third of premature boys have an undescended testicle on at least one side, compared to 2–8% incidence in full-terms boys. An undescended testicle happens when one or both of a child's testicles do not drop down into the scrotum before birth. If left untreated, cryptorchidism has negative effects on the testis over time, and may be associated with reduced fertility as an adult.[120]

Associated Toxicants: DES (diethylstilbestrol), [121] maternal smoking,[122,123] and exposure to brominated flame retardants[124,125] may be associated with higher rates of cryptorchidism.

Other Areas of Concern in Reproductive Health

In addition to the aforementioned diseases, altered sex ratios in certain areas, and changes in the timing of puberty have gained significant research attention over the years.

Early Puberty in Girls

Recent studies have shown what appears to be a decline in the age of puberty onset over the last half century in several industrialized nations. In the United States, girls get their first periods a few months earlier than they did 40-50 years ago, and they develop breasts one to two years earlier.[126] The hormonal cues that initiate the onset of puberty are sensitive to a variety of influences, including obesity, nutrition, stress, as well as exposure to environmental pollutants.[127]

Associated Toxicants: Certain organohalogens[128,129] as well as DES (diethylstilbesterol) and other estrogens are known to cause early puberty in girls. Tobacco and cigarette smoke is associated with early puberty in girls,[130,131] while lead[132,133,134] and certain flame retardants[135,136] are associated with delayed puberty in girls. There is limited evidence that BPA,[137] pesticides,[138,139] phthalates,[140,141] and other endocrine disrupting chemicals[142,143,144] may alter the time to sexual maturation, but the mechanisms are still poorly understood.

Altered Sex Ratio

The ratio of male to female offspring at birth is typically 104–107 boys are born for every 100 girls, excluding societies where selective abortion skews the sex ratio. Any ratio significantly deviating from this standard is typically considered an altered sex ratio. Although research investigating the effects of environmental exposures on sex ratio is still fairly limited, some studies have found associations between certain chemicals and a deviation in the proportion of male births. As many of these chemicals are also known to affect fertility, some researchers have proposed that departures from this fairly stable ratio could reflect damage to reproductive systems.

Environmental contributors In a 2011 review of over 100 studies of eight exposure categories, fathers' exposures to dioxins were associated with a decreased proportion of male births, whereas fathers' exposures to PCBs were associated with an increased proportion of male births.[145] There is good evidence to suggest that DBCP, fungicides, mercury, or boron may contribute to altered sex ratios, although some findings have been inconsistent and the biological mechanisms remain unknown.[146]

While other major areas of concern within reproductive health include cancers of the reproductive tracts/organs (breast, prostate, and ovarian cancers, etc), and birth defects, they are not included on this page. To find out more information on these issues, see CHE's pages on Cancer and Birth Defects.

Reproductive Toxicant Resources

Below are some resources outside of CHE's website that provide information on different reproductive toxicants, including their sources and effects on health:

California's Proposition 65 Database,[147] also known as the Safe Drinking Water and Toxic Enforcement Act of 1986, is the most up-to-date and authoritative list of reproductive toxicants available. It places chemicals on its list through the following criteria:

1. an independent science advisory board has concluded they possess sufficient evidence of such toxicity in animals or humans
2. an authoritative organization, such as the National Toxicology Program, has reached a similar conclusion, and/or
3. a federal regulatory agency requires a reproductive toxicity warning label.[148]

The March of Dimes[149] is a foundation that funds research to prevent birth defects, premature birth and infant mortality. For information on the safety of different chemical exposures during pregnancy, see Is it safe?[150]

Other government resources on toxic substances include the following:

- *Agency on Toxicant Substances and Disease Registry*, Toxic Substances Portal - Reproductive
- *U.S. National Library of Medicine* HazMap[151]

This document is student work. CHE makes no claim that all the information has been verified.

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